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UTILITY/INDUSTRY ENVIRONMENTAL MANAGEMENT COURSE

ENERGY TRAINING PROGRAM

Presented By

BLACK & VEATCH

Sponsored By

OFFICE OF ENERGY ENVIRONMENT & TECHNOLOGY
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U S AGENCY FOR INTERNATIONAL DEVELOPMENT

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Black & Veatch
IIE/USAID Training Program
Utility/Industry Environmental Management
March 17 - March 21, 1997

<u>Monday</u>

Welcome and Introduction

I Overview of Environmental Management

- A Environmental Impacts of Energy Production
- B Evolution of Environmental Management
- C Traditional Environmental Management Systems
- D Reengineering Environmental Management
  - 1 Command and Control Regulations
  - 2 Social Policy
  - 3 Economic Incentives
  - 4 Liability Exposure
  - 5 Competitive Advantage
  - 6 Accidents

II Overview of ISO 14000

- A What is ISO 14000?
- B Development and Policy
- C ISO Standards
- D EMS Standards and Other Environmental Management Tools
- E Reasons to Seek EMS Registration
- F Modules of an Environmental Management System
- G Implementation and Operation
- H Checking and Corrective Action
- I Management Review
- J Issues and Concerns
- K Drivers and Benefits
- L What Will the Standard Mean for Business?

Appendix A - Standards and Guidelines in the ISO 14000 Series
Appendix B - Comparison of Environmental Management System Standards
Appendix C - Initial Environmental Review Questionnaire
Appendix D - Terms

III International Institutions and Project Approval

- A Elements of Approval
- B International Funding Organizations
  - 1 World Bank
  - 2 International Finance Corporation of World Bank Group
  - 3 African Development Bank

Tuesday

IV Environmental Assessment

- A Introduction
  - 1 Facility Siting
  - 2 Environmental Assessment Process
  - 3 Baseline Studies
  - 4 Comparison of Alternatives
  - 5 Impacts and Mitigation
  - 6 Environmental Management Plan
  - 7 Preparation of EIA Document
- B Facility Siting Process (Pre-EIA Work)
- C Terms of Reference (TOR)
  - 1 TOR for Tano Field Development and Power Project
  - 2 World Bank Sample TOR for Environmental Assessment of Energy Facilities
- D Ghana Environmental Regulations
  - 1 The Environmental Protection Agency Act, 1994
  - 2 Environmental Impact Assessment Procedures in Ghana
- E Examples of Development Bank Guidelines
  - 1 African Development Bank Environmental Assessment Guidelines
  - 2 World Bank Guidelines
- F Case Studies
  - 1 Hydropower Stations
  - 2 Thermoelectric Power Station

Wednesday

V Environmental Auditing---Compliance

- A Introduction
- B Types of Environmental Audits
- C Management Support
- D Management Environmental Policy
- E Audit Objectives
- F Development and Management of an Environmental Audit Program
  - 1 Steps to Developing a Program
    - Establish Company objectives and Policy
    - Identify Audit Coordinator and Other Audit Team Members
    - Develop Audit Tools
    - Train the Audit Team
    - Testing the Audit Program
    - Establish the Review Schedule
    - Conduct the Audits (See Section G - Audit Coverage, and Section H - Audit Procedures, below)
    - Evaluate Effectiveness
    - Implement a Continuing Audit Program
  - 2 Managing the Environmental Audit Program
    - Performance reporting
    - Staff Management
    - Quality Assurance
- G Audit Coverage
  - 1 Compliance Areas
    - a Air emissions
    - b Wastewater discharges
    - c Stormwater discharges
    - d Solid wastes
    - e Hazardous wastes
    - f PCBs
    - g Hazardous materials
    - h Petroleum storage and handling
    - i Pesticide management
    - j Drinking Water
    - k Worker health and safety
- H Audit Procedures
  - 1 Pre-Audit Activities
    - a Audit planning
    - b Notifying the facility
    - c Compiling and reviewing background information
    - d Reviewing relevant regulations
    - e Defining audit scope and team responsibilities
    - f Reviewing audit protocols and checklists

H Audit Procedures (cont)
- 2 On-Site Activities
  - a Arrival and opening conference
  - b Records/document review (paper audit)
  - c Staff interviews
  - d Physical inspection of facilities
  - e On-site post-audit debriefing
- 3 Post-Audit Activities
  - a Data information management
  - b Follow up data collection
- 4 The Audit Report
  - a Basic requirements
  - b Level of background information
  - c Level of compliance reporting
  - d Legal review
  - e Requirements for follow up
- Appendix Example audit protocols and checklists

I Protecting Audit Results
- 1 Protecting the Environmental Audit Report
- 2 Attorney-Client Privilege
- 3 Company Maintained Confidentiality

J Training Auditors
- 1 Selecting the Trainers
- 2 Selecting the Trainees
- 3 Selecting the Training Techniques
- 4 Keys to Successful Training
- Appendix Sample Training Tools

VI Environmental Auditing for Industrial Property Purchases

A The American Society for Testing and Materials (ASTM) Standard and Due Diligence Practices
- 1 Evolution of the ASTM Standards
- 2 Components of a Property Assessment Process
  - a Records review
  - b Site reconnaissance
  - c Interview with current owners
  - d Report and evaluation

<u>Thursday</u>

VII Preparing for the Audit (Field Trip Preparation)

A Team Formation

B Pre-Audit Planning

Thursday (cont)

VIII Audit of a Facility
- A On-Site Activities
- B Post-Audit Discussion

Friday

IX Designing Environmental Management Systems--Creating Environmental Vision
- A Defining Your Goals and Vision
  - 1 Strategic Considerations
  - 2 Key Elements of Environmentally Sound Companies
  - 3 Characteristics of Successful Companies
- B The Environmental Policy-Setting Process
  - 1 Phase I Leadership Challenge
  - 2 Phase 2 Corporate Environmentalism Defined
  - 3 Economic and Environmental Integration
- C Developing Your Own Environmental Policy Statement
  - • Group Exercise
- D Environmental Management in the Future
  - 1 What to Expect in the Next Five Years

X Implementing a Comprehensive Environmental Management Plan
- A Objectives and Benefits of Comprehensive Environmental Management
- B Policies vs Programs
- C Keys to Successful Implementation
  - 1 Environmental Organization
  - 2 Environmental Staffing
  - 3 Environmental Compliance Tracking
  - 4 Pollution Prevention Program
  - 5 Site Management
  - 6 Employee Training
  - 7 Records Retention
  - 8 Communications
  - 9 Emergency Response
  - 10 Public Relations
  - 11 Environmental Auditing
  - 12 Financial Assessment
  - 13 Energy Conservation
  - 14 Due Diligence Program
  - 15 Risk Financing / Insurance
  - 16 Human Resource Requirements
  - 17 Employee Accountability
  - 18 Standardization

ENERGY TRAINING PROGRAM

The Energy Training Program (ETP) of the United States Agency for International Development (USAID) trains energy and environmental professionals from A I D -assisted countries (AACs) in how best to assess, utilize, and manage their energy resources ETP supports the program plans and activities of USAID's Center for Environment, the regional Bureaus and the overseas Missions

ETP works with AACs' energy and environmental sectors to assess their capabilities and identify training needs In response to their needs, the program develops courses in conjunction with the U S energy and environmental industry ETP ensures that participants receive practical, skills-oriented training in every program and access to modern technologies, methodologies, and management techniques Its staff closely monitor each training program to guarantee excellence

ETP covers the full range of conventional and alternative energy options available to AACs, with an emphasis on energy efficiency, environment, renewable energy, and privatization ETP has developed a two-pronged approach to training the Management-Level Training Program (MTP) and U S -based courses The MTP provides short-term, in-country workshops for senior management and policy makers These workshops are designed to increase understanding and build support for energy and environmental issues among key decision-makers The U S -based courses provide more in-depth, practical training This integrated approach is designed to strengthen the institutional capacity to plan and implement sustainable energy projects

To further enhance the effectiveness of training, ETP has established an Alumni Network, uniting its over 4,000 graduates The Network is served by the *ETP Digest*, a newsletter which provides information on individual alumni accomplishments and upcoming training opportunities

The Institute of International Education (IIE) has managed the Energy Training Program since it began in 1981

INSTITUTE OF INTERNATIONAL EDUCATION

For most of the twentieth century, the Institute of International Education (IIE) has worked to share knowledge and skills across national boundaries Virtually all the human resource development projects IIE serves today were created to meet priority needs identified by host-country leadership in consultation with national or international funding agencies All are structured to provide, through education and training, a progression of realistic steps toward specific goals In recent years these have ranged from working with the countries of Eastern Europe to address crushing environmental and economic problems, to providing the training Sri Lanka needs to diversify its agriculture from dependence on export crops, to prepare black South Africans for leadership in their changing country's complex economy

IIE currently administers 275 programs serving over 10,000 foreign trainees from 165 countries each year The more than 200 sponsors of these programs include the U S Agency for International Development (USAID), the U S Information Agency (USIA), foreign governments, foundations, private companies, international organizations and development banks, universities, research institutes, non-governmental organizations, and individuals IIE is registered with the United Nations as a Non-Governmental Organization (NGO)

More than one-third of today's programs are designed to strengthen developing countries' institutions through education and training IIE's contribution to this process is a staff experienced in all aspects of designing and managing training projects

Ghana Utility/Industry Environmental Management

Course Providers

Stanley L Rasmussen

Mr Rasmussen is an attorney with Black & Veatch International, in the Energy Group's Power division He is currently the Environmental Licensing Unit Leader, delegating environmental compliance and licensing projects, and managing Black & Veatch environmental permitting and licensing personnel Mr Rasmussen is also currently assisting Consolidated Edison Company of New York, Inc with the development of an environmental audit program and is also providing personnel with training concerning environmental auditing and regulatory compliance for utilities Since coming to Black & Veatch, Mr Rasmussen has also provided instruction for numerous environmental training classes

Prior to joining Black & Veatch, Mr Rasmussen was the General Counsel for an environmental testing laboratory, providing legal consultation in hazardous waste disposal and compliance monitoring, occupational safety and health, asbestos identification and abatement, contract review, and bid document preparation He has also served as the Assistant Legislative Counsel for the Kansas State Legislature and as a law clerk for the Denver Water Department

Michele Stern

With more than thirty years in the field, Dr Michele Stern has extensive experience in the managing and preparing environmental risk and impact assessments for a wide range of domestic and international projects Her areas of expertise include issues related to ecology, limnology, aquatic biology and toxicology, and protected species She is presently an environmental scientist with Black & Veatch International, in the Energy Group's Power Division, assigned to Environmental and Licensing Services Section of the Plant Services Department Her primary responsibilities include environmental impact assessments and monitoring activities associated with the design or licensing of power facilities

Before joining Black & Veatch Dr Stern was an Associate Professor of Biology at the University of Missouri, Kansas City She had also served in the United States Army for three years as an Environmental Science Officer and Nuclear Medicine Science Officer Dr Stern has provided testimony as an expert witness on several occasions, and served as an environmental consultant to the U S Army Corps of Engineers, U S Fish and Wildlife Service, and the U S Environmental Protection Agency

Francine Steininger

Ms Steininger has experience working on a wide variety of environmental issues including environmental project management in developing countries, development of environmental action plans, and coordination of regional environmental programs At IIE she serves as environmental program officer and is responsible for the environmental aspects of U S -based courses and in-country workshops under the Energy Training Program With IIE Ms Steininger has worked with Indonesia, India and the Dominican Republic developing courses and workshops in Environmental Management, Waste-to-Energy, Air Pollution Control and Energy Efficiency

Ms Steininger came to IIE from the World Bank's Environment Division Among her responsibilities were developing projects to assist industry in phasing out the use of ozone depleting substances in Tunisia & Bulgaria She also participated in the development of a national environmental action plan for Syria and played an important role in the Middle East, North Africa and Eastern Europe Region's environmental review process for investment projects

U S AGENCY FOR INTERNATIONAL DEVELOPMENT
CENTER FOR ENVIRONMENT

The U S Agency for International Development (USAID) allocates a significant portion of its assistance efforts to the wise management of environment and natural resources USAID has further underscored the importance of environmental issues by creating the Center for Environment The Center's mandate is to provide technical and programmatic leadership and support to the Agency and its domestic and international development partners in addressing global environment and sustainable development problems

Specifically, the Center provides technical support to USAID field missions and regional bureaus, identifies and analyzes cntical environmental problems nd the constraints to their resolution, guides Agency strategy in specific environmental areas such s global climate change and biodiversity, helps to ensure consistent excellence in technical capabilities and Agency programs, and synthesizes and disseminates data from technical and scientific research

The Center for Environment also collaborates with a wide range of partners -- host countries, non-governmental organizations, other U S government agencies, international organizations, and other donor countries -- to solve environmental problems on local, regional and global levels

The Center for Environment focuses on three strategic objectives that include the Agency's two global environmental priorities reduction of climate change and biodiversity conservation The Center's objectives are

- *Sustainable Living Resources* -- Increased and improved protection and sustainable use of natural resources, emphasizing forests, biodiversity, and freshwater and coastal systems

- *Sustainable Cities* -- Development of urbanization processes to make cities more livable, emphasizing reduction of urban and industrial pollution and improved environmental infrastructure

- *Sustainable Energy Systems* -- Environmentally sound energy production and use through greater energy efficiency, renewable energy, appropriate environmental technology, and improved regulatory frameworks

An integrated approach is central to USAID's development strategy and is reflected in all of the Center's activities The Center seeks to address the social, economic, and political causes underlying environmental and natural resource degradation and takes these issues fully into account when considering solutions and developing programs

IIE/USAID Training Program

Utility and Industry
Environmental Management
Workshop
March 17-21, 1997

Introduction

- Monday
  - Overview of Environmental Management
    - Impact of Energy Production
    - Evolution of Environmental Management
    - Traditional Environmental Management Systems
    - Reengineering Environmental Management
  - Overview of ISO 14000
  - International Institutions and Project Approval

Introduction

- Tuesday
  - Environmental Assessment
    - Facility Siting
    - Terms of Reference
    - Ghana Environmental regulations
    - Examples of Development Bank Guidelines
    - Case Studies

Introduction

- Wednesday
  - Environmental Auditing
    - Types of Audits
    - Development and Management of an Audit Program
    - Typical Audit Coverage
    - Audit Procedures
    - Protecting Audit Results
  - Auditing for Industrial Property Purchases

Introduction

- Thursday
  - Prepare for Audit Field Trip
    - Team Formation
    - Pre-Audit Planning
  - Audit of a Brewery
    - On-Site Activities
    - Post-Audit Discussion

Introduction

- Friday
  - Designing Environmental Management Systems
    - Defining Goals and Vision
    - Environmental Policy-Setting
    - Developing Your Own Environmental Policy Statement

Introduction

- Friday (continued)
  - Implementing a Comprehensive Environmental Management Plan
    - Objectives and Benefits
    - Policies vs Programs
    - Keys to Successful Implementation

Environmental Impacts of Energy Production

The costs and benefits of environmental impacts must be taken into account during the planning, construction, and operation of all types of energy producing facilities This section discusses the various permanent and transitory impacts likely to be incurred during the construction and operation of hydroelectric, geothermal, and thermoelectric facilities, and electric and gas/oil transmission lines A table summarizing typical environmental impacts affecting the above facilities is included for your reference In addition, excerpts from various development bank documents discussing the potential environmental impacts of energy producing facilities are included as reference material

Environmental Impacts of Energy Production in Africa

Environmental Impacts	Hydropower	Thermal	Power Transmission Lines	Oil/Gas Distribution Lines
Changes in Hydrology				
Resettlement				
Loss of Agricultural Land				
Loss of Infrastructure and Housing				
Loss of Natural Vegetation				
Loss of Wildlife Habitat				
Aquatic Weed Growth				
Diseases				
Loss of Scenery				
Soil Erosion				
Air Pollution				
Water Pollution				
Soil Pollution				
Social Impacts				
Conflicts in Land Use				

World Bank

Summaries of Potential Environmental Impacts for:

- Electric Power Transmission Systems
- Oil and Gas Pipelines
- Hydroelectric Projects
- Thermoelectric Projects

The following section contains excerpts from *Guidelines for Environmental Assessment of Energy and Industry Projects*, Volume III of the World Bank Environmental Assessment Sourcebook, 1991

ELECTRIC POWER TRANSMISSION SYSTEMS

1 Electric power transmission systems include the transmission line, its right-of-way (ROW), switchyards, substations, and access or maintenance roads The principal structures of the transmission line include the line itself, conductors, towers, and supports (e g , guy wires)

2 The voltage and capacity of the transmission line affects the sizes required for these principal structures For example, the tower structure will vary directly with the required voltage and capacity of the line Towers can be single wood pole structures for small voltage transmission lines up to 46 kilovolts (kV) H-frame wood pole structures are used for line ranging from 69 to 231 kV Self-supporting single-circuit steel structures are used for 161 kV or larger lines Up to 1,000 kV transmission lines are possible

3 Transmission lines can range from several kilometers to hundreds of kilometers in length The ROW in which the transmission line is constructed can range in width from 20 meters to 500 meters or greater depending upon the size of the line and the number of transmission lines located within the ROW Transmission lines are primarily overland systems and can be constructed to span or cross wetlands, streams, rivers, and nearshore areas of lakes, bays etc Underground transmission lines are technically feasible but are very costly

Potential Environmental Impacts

4 Electric power transmission lines are linear facilities that will affect natural and sociocultural resources The effects of short transmission lines can be localized, however, long transmission lines can have regional effects In general, the environmental impacts to natural, social, and cultural resources increase with increasing line length As linear facilities, the impacts of transmission lines occur primarily within or in the immediate vicinity of the ROW The magnitude and significance of the impacts increase as the voltage of the line increases, requiring larger supporting structures and ROWs Operational impacts also increase For example, electromagnetic field (EMF) effects are significantly greater for 1,000-kV lines than for 69-kV lines

5 Negative environmental impacts of transmission lines are caused by construction, operation and maintenance of transmission lines Clearing of vegetation from sites and ROWs and construction of access roads, tower pads, and substations are the primary sources of construction-related impacts (see Table 10 2 at the end of this section for a summary of all potential impacts) Operation and maintenance of the transmission line involves chemical or mechanical control of vegetation in the ROW and occasional line repair and maintenance These, plus the physical presence of the line itself, can be a source of environmental impact

6 On the positive side, power line ROWs, when properly managed, can be beneficial to wildlife Cleared areas can provide feeding and nesting sites for birds and mammals The "edge" effect is well-documented in biological literature, it describes the increased habitat diversity resulting at the contact between the ROW and the existing vegetation Power lines and structures can serve as nesting sites and perches for many birds, especially raptors

18

Special Issues

Effects on Land Use

7 Electric power transmission lines have the greatest impact on land resources A dedicated electric power transmission line ROW is required Grazing and other agricultural uses are usually not precluded in ROWs, but other uses are generally not compatible Although ROWs are generally not very wide, they can interfere with or fragment existing land uses along the ROW Long transmission lines will affect more areas and result in more significant impacts

8 Transmission lines can open up more remote lands to human activities such as settlement, agriculture, hunting, recreation, etc Construction of the ROW can result in the loss and fragmentation of habitat and vegetation along the ROW These effects can be significant if natural areas, such as wetlands or wildlands are affected, or if the newly-accessible lands are the home of indigenous peoples

Clearing and Control of Vegetation in Rights-of-Way

9 A variety of techniques exist for clearing vegetation from the ROW and controlling the amount and type of new plant growth From an environmental point of view, selective clearing using mechanical means or herbicides is preferable and should be evaluated in project EAs Broadcast aerial spraying of herbicides should be avoided because it affords no selectivity, releases unnecessarily large amounts of chemicals into the environment, and because it is an imprecise application technique, may result in contamination of surface waters and terrestrial food chains, as well as elimination of desirable species and direct poisoning of wildlife

Health and Safety Hazards

10 Placement of low-slung lines or lines near human activity (e g , highways, buildings) increases the risk for electrocutions Technical guidelines for design ordinarily minimize this hazard Towers and transmission lines can disrupt airplane flight paths in and near airports and endanger low-flying airplanes, especially those used in agricultural management activities

11. Electric power transmission lines create electromagnetic fields (EMFs) The strengths of both electric and magnetic fields decrease with distance (e g , meters) from transmission lines The scientific community has not reached consensus on specific biological responses to EMF, but the evidence suggests that health hazards may exist Several states in the United States have promulgated rules regulating EMFs associated with high-voltage transmission lines

Induced Development

12 Depending on their location, transmission lines may induce development in or bordering on ROWs or in lands made more accessible In locales where the supply or housing is limited, cleared ROWs are often attractive sites for unpermitted housing, which in turn gives rise to other environmental impacts and overburdens local infrastructure and public services

Project Alternatives

13 The environmental assessment should include an analysis of reasonable alternatives to meet the ultimate project objective of the distribution of electricity to load centers The analysis may lead to alternatives which are more sound from an environmental, sociocultural, and economic point of view than the originally proposed project A number of alternatives need to be considered, including

- taking no action to meet the needed capacity
- alternative voltages
- DC transmission lines (permitting narrower ROWs)
- alternative sources of electricity
- construction of smaller power facilities closer to the loads as an alternative to bulk power transmission
- energy and load management plans to reduce need for additional power
- upgrading of existing facilities
- alternative routes and substation sites
- underground transmission lines
- alternative methods of construction including costs and reliability
- alternative transmission tower design and materials (e g , wooden poles, steel or aluminum structures, etc)
- alternative maintenance techniques and road designs

14 One of the most important considerations is an evaluation of alternative routes and substations sites Many of the environmental impacts resulting from electric power transmission lines can be avoided or minimized by careful ROW and substation site selection

Management and Training

15 The most critical environmental decision associated with electrical power transmission line construction and operation is the route selection Environmental scientists need to work with the transmission line engineers in route selection and development of mitigative measures Depending on the education and experience of the staff, training in the environmental management of electrical power transmission lines may be warranted The major environmental specialties related to the environmental management of electrical power transmission lines are ecological impact and social impact assessments Environmental training and management may be warranted for ROW maintenance techniques, including the proper use of chemical and mechanical clearing methods

16 The training should be done as part of the environmental assessment phase of the project and with assistance from the environmental consultant If at all possible, the project sponsor's environmental staff should be involved in the environmental assessment study This will ensure an understanding of the environmental aspects of the project In particular, staff workers must have an understanding of the rationale for the recommended mitigation and monitoring that they may be implementing

17 Local, regional, and national environmental agencies involved in the review and approval of the project may also need training to monitor and enforce compliance during the construction and operation of the project

Monitoring

18 The monitoring requirements for transmission lines will be dependent on the type of environmental resources involved and the degree to which they are affected Monitoring construction activities may be required to assure that negative land use and/or ecological impacts are avoided and proper mitigation measures are employed Monitoring of these impacts will be short-term (e g , weeks) and occur along the line as it is constructed Monitoring may be especially critical at crossings of major water bodies or wetlands, near wildlands and cultural properties The actual monitoring will be based on visual inspections of the materials being used, the construction practices, and mitigation measures Monitoring of ROW maintenance activities is also to be required to assure proper vegetation control methods, to prevent invasion of exotic species, and to support decisions which take advantage of possible benefits to wildlife

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) • Maintain native ground cover beneath lines • Replant disturbed sites • 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 • Maintain habitat (i e , native vegetation) beneath lines • Make provisions to avoid interfering with natural fire regimes
3 Increased access to wildlands	3 • Select ROW to avoid sensitive wildlands • Develop protection and management plans for these areas • 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 • Install sediment traps or screens to control runoff and sedimentation • Minimize use of fill dirt • Use ample culverts • 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 • Utilize alternative tower designs to reduce ROW width requirements and minimize land use impacts • Adjust the length of the span to avoid site specific tower pad impacts • 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 • Select herbicides with minimal undesired effects • Do not apply herbicides with broadcast aerial spraying • 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 • Install towers and lines to minimize risk for avian hazards • 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 • 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 • Construct visual buffers • Select appropriate support structure design, materials, and finishes • 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 • Construct facilities to reduce demand • Provide technical assistance in land use planning and control to local governments
2 Increased access to wildlands	2 • Route ROW away from wildlands • Provide access control

24

OIL AND GAS PIPELINES

1 Oil and gas pipeline projects include the construction and operation of offshore, nearshore and/or overland pipelines Pipelines can range in size up to 2 meters in diameter They can range in length from several kilometers to hundreds of kilometers Overland and nearshore pipelines are generally buried Offshore pipelines are generally located on the seafloor in waters as deep as 350 to 450 meters, but subsea pipelines have been laid below 1,500 meters in special cases

2 The major facilities associated with oil or gas pipelines include the pipeline itself, access or maintenance roads, the receiving, dispatch and control station, and the compressor station or pump stations Because of internal friction and changes in elevation encountered along the line, booster stations are required for long-distance crude oil and product pipelines at regular intervals (e g , approximately 70 kilometers [km]) Compression stations are installed at appropriate intervals along gas transmission lines to maintain pipeline pressures The pipeline may transport unrefined oil or gas from a wellhead to transfer or processing facilities Refined oil and gas may be transported by pipeline to an end user, such as a petrochemical plant or power plant

Potential Environmental Impacts

3 Pipeline installation in upland areas involves surveying, right-of-way (ROW) clearing, ditching, pipe stringing, bending, welding, wrapping, coating and installing cathodic protection for corrosion control, placement in ditch (for buried pipelines), backfilling and cleanup The same general activities occur in wetland areas, but dredging and spoil disposal are necessary for placement of the pipeline In completely water-logged soils and open-water areas, pipeline-laying barges are used for dredging, pipeline fabrication and placement

4 Installation of pipelines in offshore areas involves laying the pipeline on the bottom The pipeline may be anchored with concrete blocks or concrete casing If the pipeline is to be buried, then digging the trench is required Pipeline is laid by a laying barge Trenching is accomplished by underwater trenching machines Most often the natural processes of current and wave action are relied on for the burial of pipelines in offshore areas, but artificial burial can be accomplished In nearshore/landfall areas, buried pipelines are required

5 Proper pipeline operation emphasizes maintenance and checking of equipment Periodic ground or aerial inspection along the pipeline route is required to detect leaks Devices used to scour or clean paraffin and scale from the inside of oil pipelines (referred to as scrapers, balls, and "pigs") or to separate materials pumped through the pipeline or to remove liquids and condensate (in gas pipelines) can result in wastes that must be disposed of Pipeline life depends on the rate of corrosion and inside wear of the pipe Corrosion protection is a necessity in most soils, especially in wet or saline areas Leaks or ruptures of oil and gas pipelines can have significant impacts beyond the immediate vicinity of the pipeline

Positive Impacts

6 In some cases, oil and gas pipelines may be viewed as contributing to environmental quality by making cleaner fuels more available (e g , low sulfur gas versus high sulfur coal) for energy production and/or industrial purposes In offshore areas, unburied pipelines may create habitat for marine organisms attracted to the new "artificial reef"

Negative Impacts

7 Offshore, nearshore, and upland oil and gas pipelines have different environmental impacts according to type, as amplified in the paragraphs below (See also Table 10 3 at the end of this section for other examples) The magnitude of their impacts depends on the type and size of the pipeline installed, the significance depends on the degree to which natural and social resources are affected

8 **Direct Impacts: Offshore Pipelines**

(a) Installation of pipelines in offshore and nearshore areas may result in the loss of benthic and bottom-feeding organisms from trenching and/or turbidity associated with pipeline laying The significance of these impacts will depend on the type of aquatic resources affected and the extent these resources are affected

(b) The construction of the pipeline can result in the temporary resuspension of bottom sediments The redisposition of sediment may alter aquatic habitat characteristics and lead to changes in species composition The significance of these effects will depend on the type and importance of aquatic organisms affected For example, the significance of habitat alteration of seagrass beds or coral reefs, considered important feeding and breeding habitats for fish and other animals, may be greater than the alteration of the deep offshore benthic habitat

(c) If pipeline trenching occurs in nearshore and offshore areas where toxic chemicals have accumulated in the sediments (e g , harbors near industrial outfalls of toxic chemicals such as mercury and polychlorinated biphenyl [PCBs]), the laying of the pipeline can result in a resuspension of these toxic sediments and temporarily lower water quality immediately above the pipeline Bioaccumulation of these toxic chemicals may occur in aquatic organisms (e g , fish and shellfish)

(d) In nearshore and offshore areas used for bottom fishing, pipelines can interfere with bottom trawling, resulting in loss or damage to fishing equipment as well as accidental ruptures to pipelines Anchor dragging can also result in pipeline damage and oil spills

9 **Direct: Upland Pipelines**

(a) Installations of pipelines can lead to erosion in the vicinity of the pipeline In hilly areas, this can lead to instability in the soils and landslides Runoff and sedimentation can lower water quality in rivers and streams during construction

(b) Installation of pipelines and maintenance roads can lead to alteration of drainage patterns, including blocking water flow and raising the water table on the upslope side of the pipeline, and can lead to the killing and reduction of vegetation, such as trees If a pipeline cuts through a large forested area, this impact could be significant Water supply to wetlands can be altered

(c) Creation of ROWs can lead to the invasion of exotic plants which may out-compete native vegetation If uncontrolled, this can have a significant impact over time In addition, pipeline installation can result in habitat fragmentation of natural areas (e g , wildlands), resulting in the loss of species and lowering of biodiversity

(d) In developed areas, oil and gas pipelines can result in the loss of land use and displacement of inhabitants due to the placement of pipeline and substations Some types of agricultural activities may only be affected in the short-term during construction

(e) Above-ground pipelines can create barriers for humans and migratory wildlife This could be significant depending upon the length and location of the pipeline

(f) Archeological sites are vulnerable to damage or loss during pipeline construction

(g) Pipeline construction can cause temporary interruption of traffic This could be significant in developed areas, if the pipeline crosses major transportation routes

(h) Ruptures and leaks, as well as wastes generated at the pump and transfer stations, can result in potential contamination of soils, surface water and groundwater The significance of this contamination is dependent on the type and size of the leak, on the type and volume of wastes generated, and on the degree to which the natural resource is affected Ruptures of oil pipelines crossing rivers and other water bodies or wetlands can result in significant environmental damage

(i) Gas pipeline leakage or rupture can cause explosions or fires In developed areas, such accidents pose significant human health risk

10 Indirect Impacts

(a) Upland pipelines can result in inducing secondary development (e g , squatters) within the pipeline ROW This unplanned development can place strain on the existing infrastructure for an affected area

(b) Upland pipelines can allow access to otherwise inaccessible natural areas (e g , wildlands) This can result in degradation and exploitation of these areas

Special Issues

Natural Resources

11 Marine and estuarine water resources are affected by offshore and nearshore oil and gas pipelines Freshwater resources can be affected by upland pipelines Depending upon the ROW location, the construction of the pipeline in and near streams, rivers, lakes, and estuaries could result in significant water quality impacts from sedimentation and runoff In addition, the flood storage functions of these systems can be altered by changing surface water drainage and by construction of facilities within these water bodies

12 Construction of undersea pipelines may impact significant coastal and marine resource (e g , coral reefs, sea grass beds, etc), and affect fishing activities Ruptures of the oil pipeline or accidental spills of oil at terminals would significantly affect water quality in streams, rivers, lakes, estuaries, and other water bodies along the pipeline ROW Possible groundwater contamination could occur from these spills, depending on the type and extent of the spill and the hydrogeological features of the area

13 Long pipelines can open up less accessible natural areas, such as wildlands, to human activity (agriculture, hunting, recreation, etc) Depending on the tolerance of the ecological resources in these areas and the sociocultural characteristics of the population, these activities may have adverse impact

Pipeline Safety

14 The transportation of natural gas by pipeline involves some degree of risk to the public in the event of an accident and subsequent release of gas The greatest hazard is a fire or explosion following a major pipeline rupture

15 The primary cause of pipeline accidents is outside forces, implicated in more than half of all service incidents Other causes include corrosion and material and construction defects Accidents result from careless operation of mechanical equipment (bulldozers and backhoes), earth movements due to soil settlement, washouts, landslides or earthquakes, weather effects (winds, storms, thermal strains) and deliberate damage Some countries have national safety standards for the construction and operation of gas pipelines The World Bank has environmental guidelines for the construction and operation of oil pipelines

Other Special Issues

16 Depending on the location, oil and gas pipelines may impact cultural properties, land settlement, tribal peoples, biological diversity, tropical forests, watersheds, and wildlands World Bank policies and guidelines have been developed for these impacts (see relevant discussions in Chapters 2 and 3)

Project Alternatives

17 The environmental assessment for oil or gas pipeline should include an analysis of reasonable alternatives to meet the ultimate project objective The alternative analysis may lead to designs that are more sound from an environmental, social, and economic point of view than the originally proposed project The following alternatives should be considered

- the "no action" alternative (i e , examine the feasibility of taking no action to meet the needed fuel capacity)
- alternative means of delivering the oil or gas (e g , tankers)
- upgrading existing facilities
- alternative routes and substation sites
- alternative methods of pipeline construction including costs and reliability
- alternative pipeline design and materials (e g , buried versus elevated pipelines)

18 The appropriateness and inappropriateness of these alternatives should be addressed in relation to environmental and economic factors Because oil and gas pipelines are linear facilities, one of the most important alternatives available is in choice of routes Many of the environmental impacts associated with oil and gas pipelines can be avoided or minimized by careful route selection

Management and Training

19 As discussed in the preceding paragraph, one of the most critical environmental decisions associated with oil and gas pipeline construction and operation is the route selection Environmental scientists should work with the pipeline engineers to select routes and develop mitigative measures

20 Depending on the education and experience of the staff, training in the environmental management of oil and gas pipelines may be warranted In particular, staff workers must have an understanding of the rationale for the recommended mitigation measures and monitoring program that they may be implementing Local, regional, and national environmental agencies involved in the review and approval of the project may also need training to monitor and enforce compliance with environmental management requirements of the project

21 Safety training and education may be necessary, including evacuation procedures and containment plans for oil spills and gas ruptures An emergency response plan may be required in areas where there is risk to the public from accidents

Monitoring

22 The monitoring requirements of oil or gas pipelines will be dependent on the type of environmental resources and the degree to which they are affected Monitoring of construction activities

will be required to ensure compliance with good practices and any special requirements to avoid or mitigate adverse impacts and to detect any impacts which occur so that corrective action can be initiated Material storage and equipment repair yards and construction worker camps should be included The actual monitoring may range from visual inspection of the mitigation system (e g , sediment traps) to more extensive water quality monitoring during the pipeline construction across or near a water body If pipeline construction involves the potential for resuspension of toxic substances, an extensive chemical and biological monitoring program may be required

23 Monitoring should occur before, during, and for some period after the pipeline is laid or buried The objective of this monitoring program will be determined by the extent and duration of the recontamination of the water body Monitoring of the operation of the oil and gas pipelines will be required to assure proper mechanical functions or to identify structural conditions resulting in leaks or ruptures

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 • Use alternative pipeline construction techniques to minimize resuspension of sediments (e g , laying pipeline versus burying pipeline) • 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 • Mark and map location of offshore pipelines • 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 • Utilize appropriate clearing techniques (e g , hand clearing versus mechanized clearing) along upland ROWs to maintain native vegetation near pipeline • Replant disturbed sites • 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 • Install sediment traps or screens to control runoff and sedimentation • Use alternative pipeline laying techniques that minimizes impacts • Stabilize soils mechanically or chemically to reduce erosion potential
5 Alteration of hydrological patterns	5 • Select ROW to avoid wetlands and flood plains • Minimize use of fill • 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 • Maintain native ground cover (vegetation) above pipeline • 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 • Design construction to reduce ROW requirements • Minimize offsite land use impacts during construction • 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 • Elevate or bury pipeline to allow for movement
9	Increased traffic due to construction	9	• Phase construction activities to control traffic • Construct alternative traffic routes
10	Chemical contamination from wastes and accidental oil spills	10	• Develop waste and spill prevention and cleanup plans • Utilize spill containment techniques • 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 • Develop emergency evacuation plans and procedures • Monitor for leaks • 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 • Construct facilities and provide financial support to existing infrastructure
2 Increased access to wildlands	2 • Develop protection and management plans for these areas • Construction barriers (e g , fences) to prohibit access to sensitive wildlands

HYDROELECTRIC PROJECTS

1 Hydroelectric projects include dams, reservoirs, canals, penstocks, powerhouses, and switchyards for the generation of electricity The dam and reservoir may be multi-purpose, if watershed rainfall and stream flow characteristics and water and power usage patterns permit, hydroelectric reservoirs can also provide one or more of the following services irrigation, flood control, water supply, recreation, fisheries, navigation, sediment control, ice jam control, and glacial lake outburst control However, these are competing uses for the waters stored behind dams and each may imply a different diurnal or annual operating rule curve for the reservoir

2 In a hydroelectric project, for example, the operator will maximize power benefits by varying reservoir level in accordance with a rule curve that is close to the reservoir trajectory in a very dry year For flood control, an operator will draw down the reservoir to have maximum volume for flood retention available at the beginning of the rainy season Irrigation reservoirs will be filled and releases made according to the growing seasons of the crops being irrigated In project planning and development of the rule curve, any conflicts between competing uses should be resolved

3 Hydroelectric projects necessarily entail construction of transmission lines to convey the power to its users Electric power transmission lines are covered separately in the section on "Electric Power Transmission Systems "

Potential Environmental Impacts

4 The principal source of impacts in a hydroelectric project is the construction and operation of a dam and reservoir (see the section on "Dams and Reservoirs") Large dam projects cause irreversible environmental changes over a wide geographic area and thus have the potential for significant impacts Criticism of such projects has grown in the last decade Severe critics claim that the social, environmental, and economic costs of dams outweigh their benefits and that the construction of large dams, therefore, is unjustifiable Others contend that in some cases environmental and social costs can be avoided or reduced to an acceptable level by carefully assessing potential problems and implementing cost-effective corrective measures

5 The area of influence of a dam and its reservoir extends from the upper limits of the reservoir to as far downstream as the estuarine, coastal and offshore zones, and includes the reservoir, dam and river valley below the dam While there are direct environmental impacts associated with the construction of the dam (e g , dust, erosion, borrow and disposal problems), the greatest impacts result from the impoundment of water, flooding of land to form the reservoir, and alteration of water flow downstream These effects have direct impacts on soils, vegetation, wildlife and wildlands, fisheries, climate and human populations in the area (See Table 10 8 at the end of this section for other examples and recommended mitigation measures)

6 The dam's indirect effects include those associated with the building, maintenance and functioning of the dam (e g , access roads, construction camps, power transmission lines) and the development of agricultural, industrial or municipal activities made possible by the dam

7 In addition to the direct and indirect effects of dam construction on the environment, the effects of the environment on the dam must be considered The major environmental factors affecting the functioning and lifespan of the dam are those caused by land, water, and other resource use in the catchment areas above the reservoir (e g , agriculture, settlement, forest clearing) which may result in increased siltation and changes in water quantity and quality in the reservoir and river downstream These are usually thoroughly addressed in the engineering studies

8 The obvious benefit of a hydroelectric project is electric power, which can support economic development and improve the quality of life in the service area Hydroelectric projects are labor-intensive, as well as providing employment opportunities Roads and other infrastructure may provide local inhabitants with better access to markets for their crops, educational facilities for their children, health care, and other social services Moreover, the generation of hydropower provides an alternative to the burning of fossil fuels or to nuclear power, which allows the power demand to be met without producing heated water, air emissions, ash, and radioactive waste If the reservoir is a truly multi-purpose facility, that is, if the various purposes stated for it in the economic analysis are not mutually inconsistent, other benefits may include flood control and the provision of a more reliable and higher quality water supply for irrigation, domestic and industrial use Intensification of agriculture locally through irrigation can in turn reduce pressure on uncleared forest lands, intact wildlife habitat, and areas unsuitable for agriculture elsewhere In addition, dams create a reservoir fishery and the possibilities for agricultural production on the reservoir drawdown area, which in some cases can more than compensate for losses in these sectors due to dam construction

Special Issues

Hydrologic and Limnological Effects

9 Damming the river and creating a lake-like environment has profound effects on the hydrology and limnology of the river system Dramatic changes occur in the timing of flow quality, quantity and use of water, aquatic biota, and sedimentation dynamics in the river basin Hydroelectric projects, in particular, are liable to create major changes in the river flow patterns downstream because storage and releases are managed in response to power demand cycles rather than the hydrologic cycles to which the downstream riparian environment is adapted

10 The decomposition of organic matter on the flooded lands creates a nutrient-rich environment Fertilizers used upstream may add to the nutrients which accumulate and recycle in the reservoir This not only supports an active reservoir fishery but stimulates the growth of aquatic weeds, such as water lettuce and water hyacinth Weeds and algal mats can be expensive nuisances which clog dam outflows and irrigation canals, negatively affect fisheries and recreation, increase water treatment costs, impair navigation, and substantially increase water loss through transpiration

11 If the inundated land is heavily wooded and not sufficiently cleared prior to flooding, decomposition will deplete oxygen levels in the water This affects aquatic life and may result in large fish kills Products of anaerobic decomposition include hydrogen sulfide, which corrodes generator turbines and is noxious to aquatic organisms and methane, which is explosive and a greenhouse gas

35

12 Oxygen depletion typically occurs first in the deeper water where oxygen used by bacteria in decomposition is not offset by oxygen released by plant photosynthesis When the intake for power generation is located at the lower level of the reservoirs, as is usually the case, water released from the turbines into downstream waters may be deficient in oxygen and may contain hydrogen sulfide It may also be lower in pH and colder than the surface water Releases of water with these characteristics can adversely affect plant and animal communities in the river below the dam

13 Suspended particles carried by the river settle in the reservoir, limiting its storage capacity and lifetime, and robbing downstream waters of sediment Many agricultural areas on floodplains have always depended on nutrient-rich silt to sustain productivity As sediment is no longer deposited on the floodplain downstream, the loss of nutrients must be compensated by fertilizer to maintain agricultural productivity The release of relatively sediment-free waters can result in the scouring of the downstream riverbeds (which may be beneficial in some cases, detrimental in others)

14 Additional effects of changes in the hydrology of the river basin include altered levels of the water table both above and below the reservoir, and upstream encroachment of saline waters into estuaries that have direct ecological impacts and affect downstream water users

Social Issues

15 The benefits of hydroelectric dams often accrue to communities and industries some distance away from the dam Those who typically bear the heaviest environmental and social costs of the dam construction -- namely, the inhabitants of area inundated by the reservoir -- may not receive a proportionate share of the benefits Reservoir filling results in the forced relocation of those living on the land (in some projects from hundreds of thousands to over a million people), which profoundly affects them as well as those present in the resettlement areas (For information on "Involuntary Resettlement," see Chapter 3) For those remaining in the river basin, access to water, land and biotic resources often is restricted Artisanal riverine fisheries and traditional floodplain (recession) agriculture are disrupted by changes in stream flow and reduced silt deposition Floodplains of many tropical rivers are vast areas of great importance for human and animal populations When the floodplains shrink, land use must change or populations are forced to move Water-related diseases (e g , malaria, schistosomiasis, onchocerciasis, encephalitis) may increase with the creation of a reservoir and associated water management structures, if they are endemic to the area

16 Social and environmental problems arise from controlled and uncontrolled influx of population groups into the area, such as construction workers and power plant employees, seasonal laborers for other dam-induced activities, and rural people who take advantage of increased access to the area provided by roads, transmission lines or improved river navigation (see "New Land Settlement" and "Induced Development" sections in Chapter 3) The consequences are health problems, overburdened public services, competition for resources, social conflicts, and negative environmental impacts on the watershed, reservoir and downstream river basin

Fisheries and Wildlife

17 As mentioned, riverine fisheries can be expected to decline because of changes in river flow, deterioration of water quality, loss of spawning grounds and barriers to fish migration However, a reservoir fishery, sometimes more productive than the previous riverine fishery, is created

18 In rivers with biologically productive estuaries, both marine and estuarine fish and shellfish suffer from changes in water flow and quality Changes in freshwater flows and thus the salinity balance in an estuary will alter species distribution and breeding patterns of fish Changes in nutrient levels and a decrease in the quality of the river water can also have profound impacts on the productivity of an estuary These changes can also have major effects on marine species which feed or spend part of their life cycle in the estuary or are influenced by water quality changes in the coastal areas

19. The greatest impact on wildlife will come from loss of habitat resulting from reservoir filling and land-use changes in the watershed Migratory patterns of wildlife may be disrupted by the reservoir and associated developments Poaching and eradication of species considered to be agricultural pests have a more selective effect Aquatic fauna, including waterfowl, reptiles, and amphibian populations are expected to increase on the reservoir

Seismic Threat

20 Considerable evidence has linked the creation of reservoirs with seismic events, but the probability that the reservoir will induce seismicity in aseismic areas is difficult to predict In seismic areas, a reservoir may advance the occurrence of an earthquake, possibly resulting in more frequent but less destructive events The EA should consider both of these phenomena

Watershed Management

21 Increased pressure on upland areas above the dam is a common phenomenon caused by the planned resettlement of people from the inundated areas and by the uncontrolled influx of new people into the watershed On-site environmental deterioration, as well as a decrease in water quality and increase in sedimentation rates in the reservoir, results from clearing of forest land for agriculture, grazing pressures, use of agricultural chemicals, and tree cutting for timber or fuelwood Similarly, land use in the watershed of the lower river basin affects the quality and quantity of water entering the river It is essential that dam projects be planned and managed in the context of overall river basin and regional development plans, including both the upland catchment areas above the dam and floodplain, and the watershed areas downstream

Project Alternatives

22. A variety of alternatives to proposed hydroelectric projects may exist Individually or in combination, they may influence size, location, and timing of a proposed hydroelectric project

- Alter demand for energy by conservation measures, efficiency improvements, or restrictions on regional growth
- Utilize thermal power plants or alternative energy sources, including low-head hydropower cogeneration by industry, biogas, etc
- Investigate possibilities for siting the project on an already dammed river by diversifying the functions of that dam

- Site the proposed project on the river where it will minimize the negative and social impacts
- Adjust dam height, inundation area and dam design to minimize negative environmental impacts

Management and Training

23 Responsibility for management of a single-purpose hydroelectric project is typically the responsibility of a public or private electric utility Multi-purpose reservoirs may be managed or overseen by government agencies with broader authority to allocate water to competing uses, although it is not uncommon in some countries for a power utility to provide and manage recreational access areas for the public and to sell excess water to other users Whatever the arrangement, it is important that there be provision for coordinated planning of land and water use in the watershed and region Often this is accomplished by a river basin authority or other regional entity The section on "Dams and Reservoirs" provides more information on this topic

24 The organization operating the dam and reservoir should be in charge of collecting baseline data, building and managing the dam, producing a water-use master plan with management strategies for regulation of the reservoir, and controlling disease vectors It has become a common practice, and is advisable in most cases, for the operating entity to establish an environmental management unit at the project level The operating organization should also be consulted in planning for municipal water supplies and water treatment facilities, as well as notified and asked to comment on permit requests for major water withdrawals and wastewater discharges upstream

25 The line agency with responsibility for energy should ensure intersectoral cooperation at both the policy and field levels with government ministries responsible for agriculture, fisheries, forestry, range and livestock, health, wildlife, tourism, municipal and industrial planning, and transportation

26 An environmental and economic monitoring program should be established The monitoring work could be carried out by the implementing agency and/or the operating organization, or by the river basin authority, if one exists Disciplines which may need to be involved in designing the program and interpreting results include hydrology, limnology, fisheries, forestry/botany, wildlife ecology, livestock/ range management, rural sociology and health

27 To take maximum advantage of training opportunities, project environmental staff should be in place early and should be involved in the EA, the development of mitigation measures and monitoring program, and supervision of construction They are then in the best position to understand the environmental aspects of the project and to carry out monitoring and environmental management

Monitoring

28 There is no standard monitoring program for a hydroelectric project, but the EA should include one that is designed for the specific project Which ones of the following variables to monitor depends on the management information needs

- rainfall
- stored water volume in the reservoir
- annual volume of sediment transported into reservoir
- water quality at dam discharge and at various points along the river, including
  - salinity
    - pH
    - temperature
    - electrical conductivity
    - turbidity
    - dissolved oxygen
    - suspended solids
    - phosphates
    - nitrates
  - river flow at various points downstream
  - volume of water used, by use type, at the reservoir and downstream
  - hydrogen sulfide and methane generation behind dam
  - limnological sampling of microflora, microfauna, aquatic weeds and benthic organisms
  - fisheries assessment surveys (species, population size) in the river and reservoir
  - wildlife (species, distribution, numbers)
  - livestock (species, numbers, distribution, condition)
  - vegetation changes (cover, species composition, growth rates, biomass) in the upper watershed, reservoir drawdown zone, and downstream areas
  - impacts on wildlands, species or plant communities of special ecological significance
  - public health and disease vectors
  - in- and out-migration of people to area
  - changes in economic and social status of resettlement populations and people remaining in the river basin

Table 10 8 Hydroelectric Projects

Potential Negative Impacts	Mitigating Measures
Direct	
1 • Negative environmental effects of construction • air and water pollution from construction and waste disposal • soil erosion • destruction of vegetation • sanitary and health problems from construction camps	1 • Measures to minimize impacts • air and water pollution control • careful location of camps, buildings, borrow pits, quarries, spoil and disposal sites • precautions to minimize erosion • 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 of dam and reservoir size • Protection of equal areas in region to offset losses • 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 • 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 • 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) • Weed control measures • Harvest of weeds for compost, fodder or biogas • 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 • Control of land uses, wastewater discharges, and agricultural chemical use in watershed • Limit retention time of water in reservoir • 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) • Reforestation and/or soil conservation activities in watersheds (limited affect) • Hydraulic removal of sediments (flushing, sluicing, release of density currents) • 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

42

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 • Provision of fish ladders and other means of passage • 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 • Vector control • 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 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 • 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

44

THERMOELECTRIC PROJECTS

1 Bank-supported thermoelectric power projects may include gas-fired steam, oil-fired steam, coal-fired steam, combined cycles, gas turbine, and diesel power plants (The Bank has also participated in geothermal energy projects and may finance solar energy and alternative fuel projects, but these are currently uncommon and are not discussed in this section) The major components of thermoelectric projects include the power system (i e , power source turbine and generator) and associated facilities, which may include the cooling system, stack gas cleaning equipment, fuel storage and handling areas, fuel delivery systems, solid waste storage areas, worker colonies, electrical substations and transmission lines The type of facility and size of thermoelectric projects, as well as location, will determine the type and size of these associated facilities

Potential Environmental Impacts

2 Negative impacts can occur both during construction and operation of thermoelectric plants Construction impacts are caused primarily by the following site preparation activities clearing, excavation, earth moving, dewatering, dredging and/or impounding streams and other water bodies, establishing lay-down areas, and developing borrow and fill areas The large number of workers employed in constructing power plants can have significant sociocultural impacts on local communities

3 Thermoelectric plants are considered major air emission sources which can affect local and regional air quality Sulfur dioxide (SO_2), oxides of nitrogen (NO_x), carbon monoxide (CO), carbon dioxide (CO_2) and particulates (which may contain trace metals) are emitted from the combustion of fuels by thermoelectric projects The amounts of each depend on the type and size of facility, the type and quality of fuel, and the manner in which it is burned The dispersion and ground level concentrations of these emissions are determined by a complex interaction of the physical characteristics of the plant stack, physical chemical characteristics of the emissions, meteorological conditions at or near the site during the time the emissions travel from the stack to the ground level receptor, topographical conditions of the plant site and surrounding areas, and the nature of receptors (e g , people, crops, and native vegetation)

4 The largest wastewater streams from thermoelectric plants are typically rather clean cooling water and can be either recycled or discharged to a surface water body with minimal effects on chemical quality The impacts of waste heat on ambient water temperature need to be considered, however, when evaluating plants for which once-through cooling is being considered A small ambient temperature increase can radically alter aquatic plant and animal communities Other effluents from thermoelectric projects are less plentiful but can significantly affect water quality For example, liquid effluents from coal-fired power plants include discharges from cooling system blowdown, boiler blowdown, demineralizer backwash and resin regenerator wastewater, ash transport wastewater, runoff from coal piles, ash piles and the site, as well as other miscellaneous low-volume wastewater and discharges from accidents or spills Trace metals, acids, and other chemicals in various combinations are found in these effluents Oil spills have a negative impact on water quality at oil-fired facilities

5 Because a number of the impacts can be avoided altogether or mitigated more successfully and at less cost by prudent site selection, "Plant Siting and Industrial Estate Development" should be read in conjunction with this section (For a summary of the potential environmental impacts that can occur during the construction and operation of thermoelectric plants, see Table 10 9 at the end of this section)

Special Issues

Global and Transboundary Impacts

6 Emissions from thermoelectric projects can act as precursors of acid precipitation, particularly when coal with its high sulfur content is the fuel Acid precipitation accelerates the deterioration of buildings and monuments, radically alters aquatic ecosystems of certain lakes, and damages vegetation in forest ecosystems The combustion of fossil fuel in thermoelectric plants also generates CO_2 and NO_x, and global warming has been attributed to increases in CO_2 and NO_x in the atmosphere However, it is currently impossible to predict the exact contribution of specific emissions from a particular thermoelectric project to these regional and global problems

Cooling Water and Waste Heat

7 Many generating plants which use steam also have once-through cooling systems If the high volume of water that large plants of this type require is taken from natural water bodies such as rivers and bays, there is a risk of mortality to aquatic organisms from entrainment and impingement in the cooling system This can significantly reduce populations of fish and shellfish, some of which may be commercially important

8 Heated water discharges can elevate ambient water temperatures This can radically alter existing aquatic plant and animal communities, favoring organisms which are suited to higher temperatures The new communities are then vulnerable to the opposite effect, namely, sharp reductions in ambient temperature following plant shut-downs because of failure or scheduled maintenance

9 Use of evaporative cooling towers reduces the volume of water which must be withdrawn for cooling to that needed as make-up water to offset evaporation Towers eliminate thermal discharge but produce cooling tower blowdown which must be discharged In colder climates, there is another alternative the temperature of cooling water discharge can be reduced by beneficial use of waste heat in the form of hot water or steam, e g , for heating buildings or aquaculture ponds

10 Either form of cooling entails some consumptive loss of water, thereby reducing the volume available for drinking, irrigation, navigation, and other uses in water short areas

Impacts on the Community

11 One of the major impacts from power plants involves the influx of workers for building the plant Up to several thousand workers may be required during the several years of construction of a large plant and up to several hundred workers for its operation There is the potential for great stress where the host

46

community is small A "boom town" condition or induced development can result This can have a significant negative effect on the existing community infrastructure school, police, fire protection, medical facilities, and so forth Similarly, the influx of workers from other localities or regions will change local demographic patterns and disrupt local social and cultural values, as well as living patterns of the residents Another potential impact is the displacement of the local population because of land requirements for the plant site and associated facilities Significant disruption of local traffic can occur from the construction and operation of a thermoelectric plant Finally, large power plants can be visually obtrusive and noisy

Project Alternatives

12 The environmental assessment should include an analysis of reasonable alternatives to meet the ultimate objectives of the hydroelectric project The analysis may lead to alternatives that are more sound from an environmental, sociocultural, and economic point of view than the originally proposed project A number of alternatives need to be considered

- no action (i e examine the consequences of taking no action to meet the expected demand needs)
- alternative fuels
- energy and load management alternatives
- site location alternatives
- alternative heat rejection systems
- alternative water supply/intake alternatives
- plant and sanitary waste discharge alternatives
- solid waste disposal alternatives
- engineering and pollution control equipment alternatives
- management control alternatives
- social structure alternatives including infrastructure and employment

13 Alternatives should be evaluated as part of the conceptual design process, however, those alternatives that provide cost-effective environmental control are preferred The appropriateness of these alternatives should be addressed in relation to environmental and economic factors

Management and Training

14 Because of the major environmental considerations involved in the construction and operation of a thermoelectric project, a team of environmental engineers and scientists need to be a part of the design and management staff for the facility This group should work with the power plant engineers in all phases of the project that have environmental implications Depending on the education and experience of the environmental staff, a training program in the environmental management of thermoelectric projects may be warranted

A number of environmental discipline specialties that relate to management of thermoelectric projects need to be understood, including the following

- ambient air quality monitoring, modeling, and pollution control
- water resources monitoring, modeling, and pollution abatement
- solid waste management and control and industrial hygiene
- toxic substances control and hazardous waste management
- noise abatement
- natural resource protection and land use planning
- socioeconomic impact assessment

15 Environmental training may be required for general impact assessment concepts, methodologies, monitoring theory and methods, data collection and analysis, and pollution control strategies The training should be done as part of the environmental assessment phase of the project and with assistance from the environmental consultant If at all possible, the environmental staff should be involved in the environmental assessment study This will ensure an understanding of the environmental assessment of the project In particular, staff workers must have an understanding of the rationale for the recommended mitigation and monitoring that they may be implementing Training should be given to the technical staff and supervisory staff who will interface with the power plant engineers and managers

16 Staff training in and management enforcement of standard operating and maintenance procedures, as well as health and safety procedures will be required to minimize environmental and health and safety impacts of the plant once it is in operation

17 Often, there are no emission limitations or air quality standards in the borrower country that would affect potential thermoelectric projects The World Bank has criteria that can serve as guidelines in lieu of country air quality standards These environmental guidelines and other recognized criteria (e g , studies of known effects) should be used as limits to protect human health and the environment

18 Local, regional, and national environmental agencies involved in the review, approval, and oversight of the project may also need training to monitor and enforce compliance during the construction and operation of the project

Monitoring

19 The purpose of a monitoring program is to provide information that the predicted impacts from a project are within the engineering and environmental acceptable limits, and to provide early warning information of unacceptable environmental conditions Monitoring for thermoelectric projects should begin before construction to determine baseline conditions Construction and operational monitoring will determine the degree and significance of impact that will occur during these phases of the project Normally a year of preconstruction monitoring will be sufficient to characterize the environmental resources potentially affected by the project The length of construction and operational monitoring will

depend on the environmental resource that is being affected and the expected duration of the impact For example, if a continuous cooling water discharge is planned, then weekly or daily water quality monitoring may be needed for the life of the facility Specific monitoring programs will be required depending on the type of thermoelectric project and the type of resources predicted to be affected

20 Continuous air monitoring of the primary pollutants emitted from the facility will be required Monitors should be established to measure emission concentrations and ground level concentrations at previously defined air quality receptor locations (e g , residential areas, agricultural areas, etc) Meteorological conditions for the site need to be characterized for air modeling purposes If appropriate meteorological data are unavailable, then meteorological monitoring will be necessary

21 Air monitoring of the workspace for dust, noise, and levels of toxic gases is necessary to protect operating personnel

22 The type and nature of the wastewater discharge will determine if surface water quality monitoring will be required Expected pollutants should be measured as well as water quality parameters that are important for human health and public welfare If not more frequent, seasonal water quality monitoring may be necessary Groundwater monitoring may be required if contamination of groundwater is predicted Monitoring should be conducted upstream at the point of discharge, and downstream from the point of discharge in any receiving water body used by the public or considered environmentally significant (e g , rivers, drinking and irrigation wells) Geophysical testing of the site may be required to characterize geological conditions under the proposed facility If groundwater is proposed for cooling, then a pump test may be required to determine groundwater quantity and quality

23 Biological monitoring may be appropriate if important biological resources occur near the project and are predicted to be affected, e g , the discharge of cooling effluents into a estuary In this case, sampling of representative kinds of aquatic organisms would be necessary Important air quality receptors (e g , sensitive crop species) and downwind of the stacks may require monitoring if adverse impacts are predicted Sampling would be seasonal Monitoring of the social environment may be warranted to ensure that infrastructure impacts are within acceptable limits

24 The monitoring program should be designed to provide scientifically defensible information useful for determining the status of environmental resources affected by the thermoelectric project, to provide information to predict future effects, and to provide information for management decisions on possible mitigation if observed or predicted impacts are considered unacceptable

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 • Design higher stacks to reduce ground level concentrations • Use cleaner fuels (e g , low sulfur coal) • Install air pollution control equipment
2 Increased noise and vibration	2 • Use lower rated equipment • Control the timing of noise and vibration to least disruptive periods • Install noise barriers
3 Change in surface water and groundwater quality	3 • Treat discharges chemically or mechanically on-site • Prevent groundwater contamination through use of liners • Use deep well injection below potable zones • Construct liners for ponds and solid waste disposal areas • Dilute effluent at point of discharge
4 Toxic effects of chemical discharges and spills	4 • Develop spill prevention plans • 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) • Dilute thermal condition by discharging water into larger receiving water body • Install mechanical diffusers • Cool water on-site in holding pond prior to discharge • 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 • 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 • 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 • Restore or create similar wetlands
11 Avian hazards from stacks, towers, and transmission lines	11 • Site stacks and tower away from flyways • Install deflectors, lights, and other visible features
12 Human population displacement	12 • Select alternative site or site layout to avoid displacement • Involve affected parties in the resettlement planning and program • 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 • 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 • Develop and implement "chance find" procedures to recover, relocate or restore structures (see "Cultural Property" section for detailed discussion) • 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 • Construct visual buffers (e g , plant trees)
16 Worker exposure to dust from ash and coal	16 • Provide dust collector equipment • Maintain dust levels ≤ 10 mg/m^3 • Monitor for free silica content • Provide dust masks when levels are exceeded
17 Worker exposure to toxic gases leaking from broilers	17 • Maintain boilers properly • Monitor concentrations with levels not to exceed SO_2 5 ppm CO 50 ppm 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 • 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 • Provide behavioral and/or psychological readjustment programs and services

Inter-American Development Bank

Summaries of Potential Environmental Impacts for

- Hydropower Stations

The following section is an excerpt from the Inter-American Development Bank's *Guide for Assessing the Environmental Impact of Hydropower Stations* This section discusses the identification, forecasting, and assessment of environmental impacts of hydropower stations

2 5 Identification, Forecasting and Assessment of Environmental Impacts

Section 2 1 provided a short list of the main environmental impacts to be expected from a hydropower station

In this part of the EIA, a detailed presentation should be made for each anticipated environmental effect of importance, with information on the following its nature (depending on the environment affected), occurrence conditions (direct or indirect, positive or negative, temporary or permanent, cumulative, etc), estimated magnitude of the impact, the measures to be used to minimize adverse impacts so that the overall situation will be protected or even enhanced to the extent possible

As a follow-up to what was indicated in Section 1 2 (Scope and Phases of an EIA), the general assessment methodology consists of a four-step iterative process, namely identification of impacts, forecasting or quantification, assessment of their importance, and determination of mitigation measures With each mitigation alternative that is proposed, the process should be repeated until the impact is deemed "acceptable" (importance of the impact)

In this process, it will be observed that some impacts are inevitable and that others create irreversible and irrecoverable damages on environmental resources and/or values In this chapter of the EIA, these impacts should be identified and discussed, otherwise "there will be no project "

Single impacts are analyzed below and some suggestions are given for the forecasting process

2 5 1 Impacts on water resources

2.5 1 1 Identification and forecasting

2 5.1 1.1 Change in the hydrological regime

The main effects of a hydropower project on the regional and local hydrology are the change from a lotic regime to a lentic regime along a section amounting sometimes to several hundreds of miles and the variations of the flows and of the downstream drainage regimes of the dam These impacts should be characterized using the following indicators

- Reservoir area and volume, fluctuation of volumes and levels, time of permanence of the water and height of the dam over the original river bottom

- Regulated flow rates and those used for electric generation

55

- Remaining flow rates downstream from the dam and corresponding levels

- General flows discharged into the receptor river and corresponding levels

As a consequence of the construction of the dam, other secondary impacts take place with regard to the water, which are described below

Evidently, in the case of water edge dams, there is no place for a reservoir and, consequently, characterization should be done only through the two last aspects mentioned (flow rates downstream from the dam and discharged generation flow rates)

2.5.1.1.2 On water quality

In general, in the reservoirs as well as in the natural lakes, the pollutants that most significantly affect the quality of the water are phosphorus and nitrogen, which are nutrients that allow increasing the biological production (micro- and macrophytes) In addition, sewage and industrial waste water contributes to deteriorating the quality of the water due to the high content of organic matter, pathogenic bodies, metallic ions and toxic substances In rural zones, agrotoxics also worsen the problem The time of permanence of the water in the reservoir (time of detention), the average depth, the flooding surface, and the nutrient intake constitute the most significant indicators in comparing hydropower alternatives

Eutrophication is the most common natural process in lentic environments, characterized by an increase in biological productivity, as a result of the progressive increase of the nutrient content and better reproduction opportunities offered by the lacustrine regime The primary biological productivity (measured in milligrams of chlorophyll per cubic meter of water) characterizes the lake's trophic condition Oligotrophic reservoirs are those with low nutrient and chlorophyll concentrations, mesotrophic ones are those with intermediate concentrations and eutrophic ones are those with a high concentration (see Table 2)

Table 2
Trophic States (concentrations in mg/m^3)

State	Total phosphorus	Chlorophyll	Types of algae
Oligotrophic	> 10	< 2 5	Gkyptomonas Staurastrum Elakatotnx Dinobryon others
Mesotrophic	10 - 35	2 5 - 8	Vanous
Eutrophic	> 35	< 8	Microcystis Anabaena Aphanizemenon Coelosphaenum Aphanocapsa

Eutrophication a natural slow process has been accelerated to critical levels due to the discharge of waste from urban and industrial growth and to the higher use of fertilizers and has become the main problem in reservoir management Eutrophication is considered to be a negative effect, set off by the high production of algae (basis of the food chain) and macrophites that enrich the biological environment with energy capture through photosynthesis The periodic death of these organisms feeds the growing process of decomposition and synthesis

The high content of organic matter harms the quality of the water for domestic, industrial recreational and fishing uses Some important effects are the disagreeable odor and flavor and the high corrosiveness

The increase of biological productivity requires the presence of macronutrients such as carbon, nitrogen and phosphorus Carbon is obtained from the carbon dioxide dissolved in the water, which is replaced by that existing in the air Nitrogen and phosphorus usually come from outside sources Of these nutrients only phosphorus is not freely available in the area and usually becomes a limiting factor

In the case of reservoirs, the Eutrophication potential is also related to the organic matter and fertilizers present in the area to be flooded Consequently, cleaning of the area to be flooded should be guided by limnological studies that establish the optimal amount of organic matter that can be admitted in the mass of water Management of water quality in the reservoir should be basically aimed at halting the Eutrophication process, which is generally achieved by controlling the phosphorus levels

For conditions where there is a significant presence of residues with a high demand for oxygen or with pathogenic bacteria, the reservoir can function as a receiving body and through self-purification process is able to improve the water's physical, chemical and bacteriological characteristics

A longer time of permanence promotes the sedimentation of suspended solids and even of pathogenic bacteria Likewise, it favors aerobic decomposition, where a broad range of organic matter can be oxidated In some cases, when due to the high organic concentration a biochemical oxygen demand (BOD) takes place, higher than the reservoir's natural re-aeration capacity, anoxic decomposition takes place, where anaerobic microorganisms use nitrate (NO_3) as the terminal electron in the absence of oxygen Anaerobic decomposition gives way to final products without oxygen, such as methane, hydrogen sulphide and ammonium, characterized by unpleasant odors and other offensive environmental effects In general, in these hydropower reservoirs the eventual occurrence of anaerobic conditions takes place mainly in the tail of the lake and in the deep layers In other areas of the reservoir, thanks to the self-purification that originates from the natural capacity for re-aeration and photosynthesis, the reservoir renews its aerobiosis and maintains good quality water and aquatic life

To forecast the effect of a reservoir on the behavior of physical, organic and bacteriological water conditions, different numerical models are available today Table 3 shows a comparative summary of one-dimensional and two-dimensional water quality models that can be applied to hydropower reservoir studies However, the modelling of rivers and reservoirs is currently a technique at the disposal of many specialists, for which reason it is possible (and desirable) to prepare specific models for each river or reservoir

Table 3 - First Part
Water Quality Models Used throughout the World

Name of model	Description	Major features	Data Requirements	Output
CE THERM 1	One-dimensional model (vertical) of the reservoir's temperature	Temperature, total dissolved solids (TDS), suspended solids (SS), according to density Specification of output points for source streams, based on target temperature Re regulation options, pumping of stored volumes and/or peak hydroelectricity	Pace of inflow and values of the parameters Flow rate/operations speeds Structural configuration and hydraulic restrictions of the outlets Initial parameter profiles Morphometric data Meteorological data Process and speed coefficients Temperature and liberated flow objectives (if the routine is used to decide flow rate output points)	Vertical profiles and values for flows, over time (printed and/or plotted) Statistics for foreseable and observed values Information on flow rates Operational schedules for output configurations at multiple levels
CE-QUAL R1	One-dimensional model (vertical) of the reservoir's water quality	All characteristics of the CE THERM R1 Allows simulating the most important physical, chemical and biological processes and those elements associated with water quality Simulates anaerobic processes Monte Carlo simulations	Like the case of the CE THERM R1, plus optimization of the parameters (if optimization parameters are used)	Same forms as in the case of the CE THERM R1

58

Table 3 - Second Part
Water Quality Models Used throughout the World

Name of model	Description	Major features	Data Requirements	Output
WESTEX	One-dimensional (vertical) model for the reservoir's temperature and conservation elements	Simulates the temperature and water quality conservation elements Optimal design/operation of multiple-level discharges for the target temperature Reservoir reregulation option under generation and repumping conditions	Same as CE THERM R1, in addition to the optimization of parameters if optimization routines are used	Vertical profiles, over time, of the parameters Discharge quality over time Optimization results as the selection of sites for multiple level discharges Operating schedules for multiple outlet configurations
CE QUAL W2	Two-dimensional model (longitudinal and vertical) of the hydrodynamics and water quality of the reservoir, estuary, and other two-dimensional bodies of water	Resolves the two-dimensional hydrodynamics Limits of flow head Permits multiple ramifications Simulates temperature, salinity, and up to 19 additional water quality variables	Basically equivalent to CE-QUAL (THERM) R1 Tide conditions in confined bodies and applications in the estuaries Morphometric data including the width of each cell	Speed and other water quality parameters at all two-dimensional sites of the square (printed) Graphs of two-dimensional vectors, outlines of parameter concentration (in two dimensions) Time series data and charts Statistical results Reinitiation of subsequent files for immediate reinitiation simulations

Table 3 - Third Part
Water Quality Models Used throughout the World

Name of model	Description	Major features	Data Requirements	Output
SELECT	One-dimensional model (vertical) of the continuous state for selective water discharges from the reservoir	Calculation of discharge zone distribution for a reservoir stratified by density Calculation of temperature, density and conservation elements at the moment of discharge Multiple types of outlet (spillway, water quality control floodgate, flood control output, etc) managed internally The operator specifies the output points in operation or selects them internally based on the quality desired (for example, temperature) Re aeration of hydropower and flood control	Reservoir profiles for temperature (density) and conservation parameters Speed of flow rate/operation Structural configuration and hydraulic limiations of outlets Quality objectives (if it is decided to operate by site)	Vertical profile of the output zone Flow rate qualities Appropriate operation of the site to achieve quality goals
WESSEL	Two-dimensional laterally averaged stratified flow model	Hydrodynamics of the two dimensions, according to the density Non hydrostatic Irregular geometry	Geometric and grid data Flow rates and boundary conditions Initial density profile	Specific printed speeds, densities and pressures

Table 3 - Fourth Part
Water Quality Models Used throughout the World

Name of model	Description	Major features	Data Requirements	Output
STEADY	One-dimensional (longitudinal) steady-state flow temperature and dissolved oxygen model	One dimensional seasonal regime Seasonal flow rates Allows branches, closed loops, lateral inflows, and withdrawals Flow can be fragmented and non uniform	Flows, depths and velocities Average equilibrium temperature and heat exchange coefficient Inflow temperature and dissolved oxygen (DO) Speed coefficients	Printed results for foreseable temperature and dissolved oxygen (DO) in each node
QUAL IIE	One-dimensional (longitudinal) flow water quality model	Simulates up to 11 (plus 4 arbitrary) water quality constituents Steady state or time varying water quality Steady or slow varying flow Flow augmentation Allows branches, closed loops, lateral inflows, and withdrawal Able to specify or roughly simulate hydraulics	Scoping and riverbank data Flow augmentation data (optional) Gauging data Hydraulic or channel data Reaction speed coefficients Initial conditions Inflow data Meteorological data	Input data echo Tabular output of hydraulic data, meteorological data, flows, productivity data and concentrations Longitudinal profile chart for parameters

Table 3 - Fifth Part
Water Quality Models Used throughout the World

Name of model	Description	Major features	Data Requirements	Output
CE QUAL RIV1	One-dimensional dynamic flow, flow hydraulics over time (RIV1H), and water quality (RIV1Q) models	Simulates dynamic (highly unstable) flows Simulates up to ten parameters of water quality over time Allows branching systems Allows multiple control structures Current, structural and wind reaeration options Direct energy balance or equilibrium temperature approach for temperatures	Physical data, cross section geometry, elevations and locations of node, lateral inflows and tributaries control structures Initial conditions Boundary conditions for flow and water quality Speed coefficients and other parameters Meteorological data or equilibrium temperatures and exchange coeficients	Hydraulic information and water quality values printed for all nodes at specified intervals Time series plots of selected variables in selected nodes
HEC 5Q	Reservoir system simulation/optimization model for multiple use water resources including water quality, water supply, hydropower and flood control	Regulated determination of balanced reservoir system Optimum gate regulation for multiple water quality parameters	Inflow quantity and quality Initial water quality conditions System configuration and physical description Reservoir Regulation Manual Operation Criteria System diversifications Water quantity and quality targets at system control points Coeficients	Reservoir and river water quality profiles Reservoir and river discharge rate elevations and travel time

2.5 1 1 3 Thermal stratification

The joint action of the height of the dam, the nutrient content and the time of permanence of the water of the reservoir could generate anaerobiosis problems in the lake's deep layers (hypolimnion), due to thermal stratification This problem is more serious in tropical countries, where temperature variations do not favor the destabilization and periodic reversion of the layers

When the water going into the reservoir through its branches has a higher temperature and therefore a higher density than the deeper water, it tends to glide aerobically over the upper layer (epilimnion) of the liquid mass The amount of oxygen in the epilimnion tends to be high due to superficial re-aeration and to the activity of photosynthesis In the underlying layer, known as the thermocline or metalimnion, there is an abrupt drop in the temperature This maximum temperature gradient brings with it an increase in the density, giving the thermocline a great resistance to the mixture and a certain amount of hydraulic stability, with the corresponding accumulation of particulate, bacteria and an increase of the demand for dissolved oxygen

The liquid mass underneath the thermocline known as the hypolimnion, has very small temperature variations, generally of about 2 to 3°C, with few possibilities of re-aeration The insufficiency of oxygen, along with the biochemical demand of oxygen and a high time of permanence, aggravate and sustain this stratification process of the stored water s quality

Normally, this situation does not have any practical repercussions on small captation of water on the surface or for discharges through the spillway On the other hand, a serious problem could occur if the water outlet is located deeper, in the hypolimnion to be able to use to the maximum the stored volume The organic matter content and the probable anaerobiosis present there make the water inadequate for many uses

For this reason, public water supply technology for a long time has adopted the installation of outlets at different levels managed through floodgates located in capturing towers or curtains in those cases where there is a possibility of thermal stratification, with the consequent water quality stratification

Since water quality practically does not affect its energy productivity the problem of thermal stratification has not been incorporated yet to the water outlet design technology for turbines in hydropower stations This is a problem that deserves further investigation, to revise technical standards and correct designs that have already been prepared but not implemented, mainly in tropical regions

In fact, the quality of the water discharged by the turbines directly affects the environmental conditions along the river section located downstream, causing damage to the ecosystems and fish life and increasing treatment costs for public and industrial supply

As in the cases of self-purification and eutrophication the use of mathematical water quality models allows correctly forecasting thermal stratification and, based on this the adequate selection of mitigation measures to be applied

2.5 1 1 4 Discharge of generation flows

A hydropower station can produce a wide spectrum of effects on the river valley located downstream from the dam, due to the new characteristics of its water going from highly positive to very harmful effects and passing through neutral results

As a general rule, these effects are associated with the discharge regime and with the changes in quality caused by the reservoir These new conditions modify the hydraulic and ecological balance of the water course under the dam and have possible negative effects on the geomorphology, flora, fauna and economic activities The main effects reported are the following

- High hourly oscillations in the discharge of the turbines, to optimize energy production according to the demand for electricity, can cause strong oscillations in the flow rate and in the level of the water course that are harmful for navigation, water captation, safety of population surrounding the river, the geomorphological stability of the riverside, etc These oscillations can come close to nearly 50%, depending on the load factor of the electric power consumer market, which could result in dramatic effects in the case of a large plant (such as Itaipú, for example)

  The situation described above could worsen in the cases of hydropower stations in charge of covering peak demands Since they are normally located close to urban-industrial centers, these hydropower stations affect rivers that are very sensitive to multisectoral interests The need for complementing can also result from the expansion of thermal and nuclear plants, in as much as they tend to operate on a base regime

- In interconnected electrical systems it is possible to use to the maximum hydropower resources available in the respective hydrographic basins, with lower capital investments and taking advantage of their different rain and flow rate regimes For example, the loss of flow along the spillway of a reservoir fed temporarily by excess rain can be avoided by activating the turbines to the maximum and exporting electricity to regions going through a dry spell where, to the contrary, the turbines might be closed so that the volume of the reservoirs might be recovered This transfer of water from on basin to another, through the transmission network cables can aggravate environmental problems, since in the basins experiencing a dry spell shutting off the turbines would increase the scarcity of water resources for other users downstream and, at the same time, this same maximum activation of the turbines in the basins with excess rain would tend to aggravating flooding problems in sections downstream from the plant

In mountain regions, privileged hydrological topographic and geological situations can frequently take place, offered by adjacent sections of hydrographic basins, which offer economic solutions for hydropower use by transferring flows between basins Among the effects of this type of use, the following can be mentioned

- Reduction of the average annual flow rate downstream from the transfer dam, the negative effect of which should be assessed to determine possible limitations to these transfers

- The transfer causes a water increase in the basin receiving the discharges from the plant This sudden increase of the flow rate is reflected in an increase of the levels of the surface and ground waters and can have an effect on the stability of the river canal, on its infrastructures

(bridges and roads), on the quality of the water, on fishing and on flooding, among others, where management will require adequate environmental planning

Forecasting of each one of these effects can be done using hydrological, topographic, geomorphological, mapping and other techniques, including the use of mathematical forecasting models, whenever deemed necessary

2 5 1.2 Assessment methodology

With regard to the impact on flow rates and levels, the assessment should establish the importance of these changes, in terms of percentages of increases or reduction of natural flow rates and levels, that is before the project

With regard to impacts on the quality of the water, the simplest way to "assess" their importance is to perform a comparison between expected concentrations of the main water quality indicators (BOD, OD, phosphates, total and suspended solids) with the recommended quality criteria established in the current laws, regulations, and accepted standards

A review of the different laws governing this matter is beyond the scope of the present work American legislation, which most countries usually follow, establishes two quality patterns those allowed and those desired The latter serve as objectives for river decontamination plans Table 4 presents the criteria allowed for the quality of surface waters, in terms of pollutants from hydropower stations The figures presented in this table may provide some orientation for the evaluation procedure

Table 4
Allowable and Desirable Quality Criteria for Some Pollutants in Surface Waters, in the USA (in mg/l)

Pollutants	Allowable level	Desirable level
pH	6 0 to 8 5	6 0 to 8 5
Oils and fats	Absent	Absent
Color	74	10
Dissolved oxygen	4	Saturated
DBO_5 (1)	5	< 5
Ammonia	0 5	0 01
Chlorides	250	25
Phenols	0 001	Absent
Soluble iron	0 3	Absent
Dissolved solids	500	200
Sulphates	250	50
Phosphates (1)	0 025	0 025
Nitrates (1)	10	10
Total coliforms (1)	1000	

(1) Colombia (Decree 1594/85)

65

The assessment of the importance of irreversible impacts, such as the flooding of land, the variations in the reservoir's level, the transfer of flow rates between basins, the discharge of generation flow rates, the fluctuation between ground water levels and others without which there would "be no project", can be focused on better through their importance for the economic and social activities and/or for the ecology of the region (see the corresponding sections)

2.5.1.3 Mitigation measures

Many of the impacts on water resources and related activities can be avoided or mitigated if they are adequately considered in the hydropower station's planning and design processes In particular, three basic factors condition the magnitude of these impacts

- The existence of an additional volume in the reservoir so that it may fulfill multiple objectives (additional height of the press), instead of the volume strictly needed to for regulation related to energy purposes However, it should be considered that a higher volume involves a larger flooded area, which in turn could involve considerable impacts on land use and on the regional and local economy, which should be taken into account

- Adopting the discharge regime that best responds to the economic and environmental interests of downstream users, instead of an operation scheme that barely optimizes the economic efficiency of the turbines, or the attention given to the peak demand, or to the interconnected energy system or even to the operation schemes based on water transfers to other basins

- Adopting design criteria and environmental management criteria for the hydropower station and its reservoir that facilitate the self-purification of the water and control the eutrophication, the thermal stratification and other harmful effects for water quality

The additional volume added to the reservoir to attend multiple objectives downstream usually causes the regulation of the flow rate and of the level of the stream from the dam on, reducing the volumes of the overflows and increasing the dry season flows, with the following positive effects

- Improvement of the navigable bed, along with the economy and safety of river port facilities

- Recovery of land that could become flooded or lack irrigation, as well as an increase of the water supply for different uses

- Increase of the energy productivity of the electric plants located downstream, due to the increase of the firm flow

- Longer useful life of the reservoirs located downstream, thanks to the decrease of solid flows

The adoption of a discharge regime that produces better economic and environmental results for users or the water course located downstream from the dam is a factor that should result from the balance of these results with the energy optimization criteria This balance is particularly useful in large plants located far from the consumption centers, which can be designed to work under a base regime

Among the technological measures that can be applied to mitigate the environmental impacts, the following can be mentioned

- Construction of another reservoir right downstream, to regulate the discharges and ensure multiple uses, even including electric generation These advantages should be weighed against the negative impacts caused by the construction of the reservoir (flooding of land, expropriation, etc)

- Retention of the daily peak flow of a relatively small reservoir and return of that same water through pumping during hours of minimum demand This is known as the reversible plant, capable of deregulating the energy production and discharge flow downstream, while supplying at the time the peak demand under economic conditions

- Establishment of satisfactory limiting conditions in the optimization models, which means that they have to be components of a large whole that represents the multiple uses of the water resources, within an integrated regional and inter-regional development system

- Multi-use reservoirs located upstream from the transfer dams can be planned as compensatory reservoirs that reduce discharges during swelling of the river and increase the firm dry season flow

All the above involves a change in the political, legal, technological and managerial perspectives of these projects, in such a way that there is a holistic vision, with transparent information to stimulate the participation of society and of the other water users in the optimization decision-making process The energy sector, with its well known tradition in strategic planning, can play a leading role within this process

During the construction stage of a plant, due to the large number of employees, sewage waste should be led to compact sewage water treatment stations These plants should be sized according to the number of workers During the operational phase, treatment needs decrease as a result of the reduced number of workers

2.5.2 Impact on air quality

2.5.2 1 Identification and forecasting

It is a well known fact that large reservoirs cause changes in the micro-climate There is a controversy regarding the effects on the regional climate

On hot days, with little air movement, the large mass of evaporated water hangs over the reservoir With night cooling, it condenses in the form of fog, continuing until dawn and affecting the degree of humidity and air temperature over the reservoir and surrounding areas

An increase in rainfall around the reservoir has also been registered in some studies In Aswan (Egypt), it rained for the first time when Lake Nasser filled up (Icold, 1980)

Climatological observation programs with hydrometeorological networks extended along the reservoir basin, are already a common monitoring practice to supply the data needed for planning and operation Based on local temperature data, relative humidity and air movement in the area of the future reservoir, one can have an indication of probable, not very probably and improbable changes in the micro-climate, for different project alternatives

A possible problem in reservoirs fed with polluted sewage water is the exhalation of methane, hydrogen sulphide and ammonium gases, which are particularly characterized by their bad odor

2.5.2 2 Assessment

The importance of possible changes in the local climate should be assessed according to the land uses around the reservoir If crops are planted in the area that are very sensitive to humidity, it is possible that problems could develop further on Plagues and especially some types of insects that transmit plant and animal diseases can also develop more, particularly if the local climate is dry In humid and very humid climates, this impact could be negligible

Likewise, methane, hydrogen sulphide and ammonium emissions from reservoirs with highly contaminated water become important only if there are populations in the area that would suffer from the bad odors and other annoyances However, one must not forget that methane, along with CO_2 is one of the gases responsible for the so called "greenhouse effect" or heating of the atmosphere's lower layer, due to the thermal effect of the accumulation of these gays in the upper atmosphere (gases do not allow infrared radiation coming from the earth to escape to the atmosphere)

2.5.2 3 Mitigation

The only measure that can be applied, in the event that the existence of a change is proven, as well as its impact on agricultural and cattle-raising activities, is to establish compensation measures for possible losses, such as technical assistance to change crops or control diseases, economical credits to change crops and other similar measures

The elimination of bad odors caused by the gases that emanate from reservoirs highly contaminated by organic matter can be achieved using prevention measures to avoid that extremely contaminated waters reach the reservoir Among these measures we have the treatment of municipal or industrial waste water If this is not possible, and as long as the seriousness of the problem justifies doing so, it is possible to apply measures such as mechanical aeration in cells within the reservoir itself and the elimination of floating vegetation that allows an oxygen exchange and the penetration of light in the water

2.5 3 Impact on noise levels

2.5.3 1 Identification and forecasting

It is important to consider the noise linked to the construction and operation of a hydropower station to ensure both the health as well as the safety of the workers and acceptance on the part of the community This is an indirect and temporary effect (linked to machinery operation) and can have residual effects on the health of the people exposed to it

To forecast the noise level caused by the machinery, the following steps should be taken

- Identification of existing activities and uses of land that could be affected by noise from the plant.

- Determination, with the help of equipment manufacturers, of the noise levels generated by each piece of equipment and its levels at different distances, especially in sensitive nearby areas

- Addition of the expected level due to the hydropower station to the actual noise level in sensitive areas

Sound level at the receptor level (sensitive areas) may be forecast by using the following relationship

$$L = LO - DS - DA - DG - DE - DF$$

where

L is the noise level expressed as Leq at the receptor in dB(A)

LO is the basic noise level of the source

DS is the attenuation due to geometric expansion, that is,

$$DS = 20LOG\ (d_2/d_1)$$

where

d_2 is the distance of the receiver from the source

d_1 is the distance at which L was measured, that is, wave divergence reduces sound pressure level by 6 dB every time the distance from the source doubles

DA is the attenuation due to air absorption

DG is the attenuation due to ground absorption

DE is the excess attenuation due to features such as natural or artificial barriers

DF is the correction to take account of sound reflection

There are many models using the above-mentioned equation to assess sound pressure at receptors, although a first estimate may be given very rapidly Of the above-mentioned factors that affect the noise volume, the primary are distance and barriers The effect of distance may be evaluated as shown above, and the barriers generally abate noise level by 5 to 10 dB

The other above-mentioned factors become significant when distances between source and receiver become large (more than 300-400 meters) In these cases, the utilization of more sophisticated models is necessary and the knowledge of emission spectra are required

2.5.3.2 Assessment

The legal aspects of community noise control range from the general laws against public nuisances to detailed laws and regulations which limit the noise that a given source may make to land-use restriction designed to protect noise-sensitive land use

If no local laws and regulations exist or if they are or difficult to apply, different types criteria may be applied to assess the importance of noise These can be found in the corresponding manuals (dangerous levels for human hearing, close to sensitive receptors, others) Table 5 shows allowable levels of noise, according to Italian legislation

Table 5
Criteria for Risks of Loss of Hearing

Maximum duration allowed per day h	Noise level dB (A)
8	90
6	92
4	95
3	97
2	100
1 5	102
1	105
0 5	110
0 25 or less	115 (maximum)

2.5.3.3 Mitigation measures

In general, hydropower stations do not have a high noise impact When it does exist, especially during the construction phase, sound isolation measures can be adopted (temporary barriers) around the sources (compressors, diesel generators, hoists, trucks to transport materials and equipment, etc) In addition, on-site construction workers and operators must apply protective measures, as necessary (industrial safety)

2.5.4 Impacts on land resources

2.5 4 1 Identification and forecasting

The main impacts of a hydrothermal plant on land resources are related to the use of the soil for the reservoir and plant facilities, with the erosion and land destabilization of the reservoir's banks, with the destabilization of the river-bed and its banks downstream from the dam, and with induced seismicity

70

2 5 4 1 1 Land use

The construction of a hydropower station and especially of the reservoir uses up a very large area, of around several hundreds of and sometimes thousands of hectares dedicated to agricultural, cattle-raising, forestry, protection or other uses Consequently, forecasting the impact involves the following

- Determine the surface to be used by the reservoir, plant and attached facilities, this is engine room, load tunnels, canals, camps, roads, etc

- Define the quality of the land to be used by the reservoir and plant facilities, from the standpoint of their quality for agricultural purposes If the land has a high agricultural value, the proportion to be used with respect to the total surface of these soils in the region or municipality should be indicated

- Identify and characterize existing mining resources in the area to be flooded, as well as their extraction possibilities and strategic value for the economy of the country and region

In general, all of these are direct impacts, with a residual nature (total change of land conditions in the affected area)

2.5 4 1 2 Erosion and destabilization of land along the reservoir banks

With a full reservoir, the waves caused by the wind can cause erosion along the banks Further operations of filling and emptying the reservoir subject the soil along the oscillation strip to hydrostatic compression and decompression, with consequent fluctuations in ground water level This in turn causes land-sliding and crumbling of the riverbank formations

Erosion and landslides leave the banks progressively unprotected and looking bad, with silting up of the reservoir

Geomorphological maps, along with field and laboratory work, allows assessing the risks of erosion and landslides along the banks The magnitude of the problem is determined for the width and length of the strip, for its height and slope, for the nature and thickness of existing formations, and for the characteristics of the waves associated to the dominant winds and shape of the banks

2.5 4 1.3 Erosion and destabilization of banks downstream from the dam

The construction of the dam, with the reservoir's decanting, blocks the passage of solid matter that is normally transported in suspension by the river This can cause a physical imbalance in some parts of the river located downstream from the press, since it interrupts the replacement of matter removed hydraulically by the water's normal draining, unstabilizing the river's equilibrium section

This situation can extend to the river's outlet, as occurred in delta of the Nile, as a consequence of the Aswan dam

Forecasting and controlling this effect depends on specialized solid transportation hydrodynamic studies that use numerical or analog models

71

Table 6
Maximum Advisable External Sound Level

Use of land	Maximum level Leq in dB (A)		Maximum difference betweeen levels before and after Leq in dB (A)	
	day	night	day	night
Very sensitive*	50	40	5	3
Residential areas	55	45	5	3
Mainly residential areas	60	50	5	3
Urban areas	65	55	5	3
Mainly industrial areas	70	60	5	3
Industrial areas	70	70	7	7

*Educational facilities, hospitals, clinics, theaters, churches, protected wildlife areas.

2.5 4.1 4 Induced seismicity

The interest of seismologists and dam builders in this problem as awakened after the earthquakes that took place Kremasta, Greece reservoir, in 1966, and in the Konya, India one, in 1967 These dams are 147 and 103 m high and have a capacity of 4 8 and 2 7 billion cubic meters, respectively (Icold, 1980)

Much of the systematic observation carried out since then demonstrates that the risk exists, though it is small and associated to local tectonic peculiarities, caused by filling of the reservoir This risk depends on the presence of faults and other local geological anomalies, and on their action on the volume and filling time of the reservoir

2.5.4.1.5 Other impacts

The construction and operation of the reservoir and other facilities of a hydropower station can cause other impacts on the land, among which the following can be noted

- Erosion and destabilization of the geomorphologically unstable slopes, as a consequence of the construction of roads and of the land movements needed for certain kinds of infrastructure These impacts, in addition to involving sometimes high costs to compensate for damages, cause more than one conflict among local communities

- Destruction of the relief and soil in the material extraction areas and, in general, in the quarry sites Areas affected by the extraction of building materials, if they are not restored, cause other problems, like the formation of breeding places for mosquitoes, damage to the landscape, erosion and sedimentation of rivers, etc

12

- Recovery of flooded land and increase of agricultural land in the valley downstream from the dam, as a consequence of the regulation of the river flow and consequent flood control This positive effect could counteract the negative effect caused by the loss of productive land under the reservoir

- Occupation of land for the disposal of solid household waste from the plant's workers In general, these could be small areas if disposal is carried out in a technical way, in technically designed and built sanitary landfills

2.5.4.2 Assessment

The assessment on the importance of the impact on land use is measured according to the proportion of fertile land used by the reservoir and plant, or of land that is apt for more desirable social or environmental uses The impact can be important if, for example, the agroindustry is going to use the only land with high agricultural value in the zone

With regard to geomorphological problems, their importance can be measured by the magnitude of potential erosion or land destabilization problems caused by the creation and oscillation of the reservoir and by implantation activities of the plant and its complementarv works

With regard to the disposal of solid wastes, their amount and chemical characteristics constitute the basis on which to assess their potential danger and/or need for special disposal

2.5 4 3 Mitigation measures

For land use

The use of land must include economic, social and environmental compensation measures for the local administration and communities, due to the eventual loss of a resource linked to their traditional activities

To counteract potential land degradation processes a series of well-known erosion control, slope stabilization, reforestation and other related practices can be applied

With regard to domestic solid waste, food scraps (restaurants) could be sold to local pig raisers Recyclable materials (paper cardboard, cans, plastic, etc) could be given to the trade union, to be sold for recycling The rest could be taken to a manual sanitary landfill

2.5 5 Impact on ecological resources

2.5 5 1 Identification and forecasting

Probable environmental impacts on biota include

a Disappearance of forest areas and loss of habitat
b Reduction of wildlife (land and air) and/or alterations in their composition or location
c Reduction of water fauna and/or alterations in their composition or location

13

2 5.5 1 1 Disappearance of forest areas and loss of habitat

Land clearing in the site to be used by the reservoir and plant facilities, can lead to cutting down of native plants (trees or bushes) and to the corresponding loss of the habitat for many animal species

If the plants that exist in the reservoir area are not cleaned out, their decomposing under the water would give way to serious water pollution problems which, in turn, would have a severe impact on the other biotic components

To quantify the potential impact, two indicators can be used

a Area covered by different types of plants (trees, bushes, grass), to be flooded

b Plant biomass in the area to be flooded The establishment of this biomass is usually done by counting individual plants and collecting height and diameter data for the different types of plants that exist there, in plots that represent the different types of plant cover to be able to calculate the volume of plants to be taken out

In addition based on the lists of species prepared during the inventory phase the number of protected species in the flooding area should be determined

2 5 5 1 2 Reduction of land fauna

Based on the lists and abundance indexes prepared during the ecological inventory phase, the number of species should be calculated and, if possible, the number of individuals that will be affected by the loss of their habitat For this, two indicators are suggested masto and bird fauna

The impact on some species could simply be their displacement to a nearby site, if it exists For others, however, the impact can involve a reduction in their number This latter case should be analyzed, particularly with relation to species in danger of extinction

The implantation of the lake can generate conditions for an increase in the number and variety of bird fauna mainly with regard to ducks and other water birds The loss of the land habitat is often compensated advantageously by the increase of lacustrine sites and borders with intense biological activity

2 5 5 1 3 Reduction of water fauna

A reservoir is not a favorable habitat for many of the large fish species that lived and reproduced on the original river with running waters (lotic environment)

After its formation the lake or reservoir gives way to a competitive process, according to the evolution of the biomass where certain species predominate temporarily until a new balanced ecosystem is established where predatory species of limited economic value are able to live and prevail This evolutionary process must be adequately monitored to take advantage in as much as possible of the ecological wealth of the new body of water

Along the section of the river located downstream from the press, very significant negative impacts can take place due to possible changes in the quality of the water and in the discharge regime The decanting of muds and the regulation of flows that takes place in the reservoir can have a net negative effect for fish life downstream, as the river biota is impoverished and the flooding and sedimentation are eliminated, the same which form par of the biological process of periodic creation of environments for the spawning and development of fingerlings of desirable fish species and of other water animals

On the other hand, the obstacle created by the dam hinders the migration of fish species, thus interrupting the reproductive process of these species, which disappear in the river section downstream from the dam

The quantification of the impact on fish life therefore involves the following, based on the inventories prepared during the previous EIA phases

- Determine the original fish species of the river that would not be able to develop under the new conditions of the lentic regime, along with their economic and/or recreational importance

- Determine the species that could suffer the effects of changes in the quality of the water and in the flow regime downstream from the press,along with their economic and/or recreational importance

- Determine the migratory species that could be affected by the dam and their actual economic importance upstream from the reservoir

2.5.5.2 Assessment

The assessment of the importance of the disturbances on the fauna and flora can be done in different complementary ways

a The first is based on grading the importance of the ecosystem or of the specie that will be affected This importance is usually a subjective value judgement based on the consideration of several criteria, such as those indicated in table 7

Table 7
Attributes for the Assessment of the Relative Importance of Species and Ecosystems

1	Role of the local ecosystem according to the regional ecosystem or importance of the species in the ecosystem function
2	Unique or isolated species or ecosystems
3	Actual or potential aesthetic value
4	Actual or potential scientific value
5	Actual or potential economic value
6	Relative size or ranty
7	Prospect of continuous persistence

75

b Resilience is a measure of the capacity of a system to absorb environmental tensions or wear and tear without becoming an obviously different state It depends on the system's ability to reorganize under pressure and establish alternative paths for its energy flows, with the intention of ensuring their viability after the disturbances, though eventually there will be modifications in the structure of certain species The type of response from a species or ecosystem to an environmental tension is given by a series of partial and independent reactions, which are listed in Table 8

The most important element in the resilience of the species is probably their birth rate or recovery rate The ecological significance of a given mortality rate, regardless of its cause, must be interpreted along with the capacity of the species to repopulate depredated areas Some species do not have the potential to recover form a temporary numerical reduction Others that are more resistant show relatively small population effects over the long term when they are subjected initially to an equivalent impact

Table 8
Ecological Responses to Environmental Stress Considered in Assessing Resilience of Ecosystems or Populations

1	Mortality
2	Changes in the birth rate
3	Displacements (emigration or immigration)
4	Changes in appearance, growth or vitality of individuals
5	Changes in behavior
6	Disruption of inter relationships between ecosystems (for example in the predator prey relationship)

c A third factor is ecological sensitivity, expressed in the degree of acceptance to possible changes In general, there are four levels of ecological sensitivity

- Areas of minimal sensitivity, or those already altered extensively by human activity, in such a way that new human interference probably will not induce measurable ecological changes
- Areas of maximum sensitivity, where significant flora and fauna are highly susceptible to minor effects from human interference and the consequences of this impact probably cannot be reduced by means of any practical measure to a level considered generally to be acceptable
- Areas of moderate and high sensitivity, respectively, classified between the two extremes mentioned above

In general terms, ecosystems covering large areas offer more flexibility in defining different project alternatives That is, the sensitivity of the ecosystems varies inversely with the size of the area, since those reduced in size face more probabilities of being eliminated

76

2.5.5.3 Mitigation measures

As with the other impacts, mitigation measures can refer to planning actions and technological interventions

- In the regional planning of hydropower stations and multiple use of water resources, it is recommended to concentrate the development in certain hydrographic basins and define the preservation of others aimed at becoming representative samples of the primitive native flora and fauna that exist in the region The effective implantation of zoning of this type can be included among the compensation commitments that form part of the mitigation measures

- Among compensatory measures of a biological nature we can cite the creation and maintenance of environmental protection areas characterized by wildlife equivalent to the areas affected by flooding The creativity of scientists has thus led to the implantation of germoplasma banks, ecomuseums and other similar measures

- An applicable mitigation measure consists in rescuing wild animals in the area to be used by the reservoir, during the filling phase There is an amount of controversy among specialists on if these animals should be taken to zoological parks and other institutions where they grow up in captivity, or if they should be let loose in another wildlife area of the region This second alternative, which would apparently seem more natural, can cause negative biological results if one takes into account that the new habitat of these species is already balanced

- With regards to water fauna, the main mitigation measure are

  Based on the results of the biological monitoring of the reservoir, introduce exotic species of high commercial value that are used in the lacustrine environment and that are capable of developing under the system's limitations However these programs should be carefully planned, so that the species that are introduced do not become "plagues" that attempt against the existing resources

  Plan dam discharges in such a way to cause controlled flooding of the sites of biological interest downstream from the reservoir, or install fish farming stations for the artificial reproduction of the fish destined to repopulate the rivers

  In certain currents, migratory fish could be of commercial or recreational importance In these cases, fish ladders, elevating chambers and other mechanisms to transfer them out of the dam can constitute effective mitigation measures, although the greatest difficulty is the return downstream after spawning A measure that does not involve the transfer out of the dam is the deviation of the shoals through spawning channels and fingerling breeding facilities that simulate natural conditions

2.5 6 Socioeconomic impacts

The main effects of a hydropower station are very possibly those of a socioeconomic nature, both with regard to positive as well as negative effects Their balance determines the viability of the plant

77

Positive benefits can be classified into three categories

- Effects caused by the electric power supply

- Direct benefits from the hydropower development and that result from the multiple use of the reservoir and the regional insertion of the works and infrastructure services needed to implant and operate the plant

- Indirect and cumulative development benefits, within the framework of integrated regional development

These benefits are generally aimed at different regions where energy is produced, or at privileged classes in society

Among the direct and indirect negative impacts, the most important one are related to changes in land use, economic activities, water supply, population dynamics and socio-cultural conditions As opposed to the benefits, they usually affect poor populations in the area of direct influence, for which reason they should be given maximum attention

2 5 6 1 Impacts on land use

2.5.6.1 1 Identification and forecasting

The main impact of the construction of the reservoir is the elimination of the different land uses in the flooded area Since this generally coincides with valleys that are used for agricultural activities, their elimination poses a compensatory demand for land in other places In addition often small settlements or villages are flooded and need to be relocated In unoccupied areas, reservoirs can particularly affect forestry, protectionist, recreational uses, indigenous reservations and others

An induced effect is the occurrence of a land valuation process close to the plant, due to its potential to provide services for the workers (housing, food services etc) In more than one case, workers and their families illegally take over land especially along the edges of nearby towns, giving way to the appearance of shantytowns

When the time between the acquisition of the land and the filling of the reservoir is long (several years), it could happen that previous owners or settlers from other parts take over the land, causing social problems for the company owning the development

An adequate quantification of this impact involves calculating the surfaces covered by different uses in the area to be used for the reservoir and its surrounding protection zone, as well as by the other plant facilities Likewise, ownership of the land to be affected should be indicated, as well as the value of the land

This data can be obtained from the feasibility studies and from the division into lots of the areas to be acquired

78

2.5 6 1.2 Assessment

The assessment process should be conducted taking into account actual and potential land use in the area of the reservoir and other plant facilities The impact could be high if the actual usage is intensive and demands a large number of workers Otherwise, the impact will be low

Depending on the actual use given to the land and the size of the project (on which the number of workers depends), the value of the land could increase (positive and permanent impact) In that case, an arbitrary value can be assigned to the land and an economic comparison may be attempted between the arbitrary value and the value the land may assume

The importance of problems caused by possible illegal settlements and other problems can be judged according to the living conditions of the residents of the region and of the productivity of the land

2 5 6 1 3 Mitigation

The ideal situation would be to acquire the land to be used by the reservoir and plant facilities at its commercial value In many countries, it is the custom to pay for land based on an appraisal that does not take into account the fiscal value (cadastral appraisal) which is not fair for the owners and causes the project to be rejected

If the residents of the area are poor peasants or indigenous communities that could quickly spend the money they receive and be left without money and without land, it is recommended that relocation projects be carried out, duly based on sociological, anthropological, agricultural, housing and other necessary studies, supported by technical assistance and inexpensive credit campaigns for their resettlement

Illegal settlements could be controlled through the acquisition of land destined exclusively at the temporary or permanent settlement of low-income workers' families However, the best would be to handle the workers' problem as is indicated further below (employment)

2.5 6 2 Impacts on water supply

2.5 6 2 1 Identification and forecasting

a Construction phase

The clean water consumption of the workers can vary, depending on the climate, between 100 and 200 liters per inhabitant per day

In addition, a higher volume might be needed to meet the construction needs The demand for household use might be concentrated in one site (camps near the plant) or dispersed among nearby towns, depending on the policy adopted with regards to recruitment and location of workers Meeting these needs exerts a direct impact on the availability of water and an indirect impact on the preexisting uses of this resource, although its duration is temporary

b Operations

Once the reservoir goes into the filling and operations phase, there could be higher impacts on the availability of water for other uses than hydropower, especially of project planning has not taken into account a reserve or reservoir water for multiple uses The most affected uses downstream from the dam could be navigation (if it exists), fishing, irrigation and public supply The impacts could be particularly serious in dry climates, where flow rate recovery is low

In addition, during the operational phase water is needed to meet the human consumption needs of workers This demand in general does not pose a conflict with other uses

Additional water consumption could be foreseen because of the presence of additional household consumption generated by the employees of the power plant and induced activity

Quantifying the corresponding impact involves calculating total needs and establishing the collecting, treatment and conduction systems to consumption sites The construction of the collecting and conduction system can also generate impacts of less importance but that also need to be controlled

2.5.6 2 2 Assessment and mitigation

The assessment should be based on the comparison between water demands and the availability of water for the different uses and the availability of water resources downstream from the dam

Mitigation measures applied in these cases are the same mentioned with regard to impacts on water (section 2 5 1 3)

2.5 6.3 Impacts on social conditions

2.5 6.3 1 Identification and forecasting

The main socioeconomic and cultural impacts of a hydropower station occur during the construction phase, when there is a greater need for labor During operation, these impacts are much lower, since the personnel employed is reduced over ten times over and the plant becomes another medium-small sized industry

a Impact on population dynamics

According to Latin American averages, the construction of a 500 MW hydropower station requires up to 4,000 direct jobs for the peak and its activities and can take between four to six years At the same time, nearly 2,000 indirect jobs arise in equipment manufacturing, installation, maintenance and construction material commercialization companies, in addition to other commercial activities Since hydropower stations are usually built in low population areas, population migrations could take place which, in the case of a plant this size could amount to 15,000 persons, between workers and their families which crate an important demand for services and food These migrations take place during the recruitment phase of workers for civil works, which demands a high amount of unskilled labor These flows generate different problems related to housing, sanitation health and education

80

Forecasting the impact thus involves estimating the new population that will move into the region as a result of the construction of the plant During operation, the impact is negligible since a plant of this size operates with 200 to 300 employees

b Impact on the work market and employment level

The creation of direct employment constitutes a positive impact on the local economy in moments of recession or when there is a high unemployment rate in the area, due to the lack of professional preparation If the work market is saturated, the demand for workers could cause problems of salary inflation or migration Indirect employment also constitutes a positive impact of the hydropower station, since these jobs cover the entire area of influence and often go beyond it

The distribution of direct workers is the following

- 33% unskilled labor
- 44% semi-skilled labor
- 13% skilled labor, with incomplete instruction
- 6% skilled labor, with complete basic instruction
- 2% mid-level technicians (electricians, mechanics, etc)
- 2% high-level professional and management

Forecasting this impact requires establishing the profile for each particular case, indicating in as much as possible the number of single and married employees, since this is of great importance to estimate the housing demand

Predicting the impact involves comparing the demand for workers for the project with the region's unemployment levels, to determine to what extent the project will satisfy the existing employment demand (positive impact) or to what extent workers will have to be imported from outside the region

c Impact on housing and public services

The impact of a hydropower station on the infrastructure basically depends on the population growth in the region due to the project If most workers come from the region itself, this infrastructure will not change If most of them come from other regions, a strong impact can be expected on the availability of infrastructure, especially in the following areas

- **Housing**· migrant labor involves a demand for the few available houses and rooms in boarding houses, creating a serious problem for the local inhabitants who do not own their own houses This leads to problems related to slum areas and overcrowding
- **Schools** some of the workers arriving from other regions arrive with their families, causing an increase in the demand for schools, which cannot always be covered by the local administration

81

- **Medical-hospital services** a large number of people in a community involves an increase in the demand for medical doctors and hospital beds It should be taken into account that with the construction of a new plant there will not be the conditions to built a new hospital, services provided by existing ones will decrease in quality Even in the case where no new workers arrive, plant construction workers will have better medical assistance than before, which involves a higher amount of medical-hospital care

- **Power, clean water and sewage systems** in general, local administrations do not have the capacity to provide these services to new inhabitants, which leads to the occurrence of unsanitary conditions, such as open sewage systems, with the consequent risk of transmitting diseases brought from other regions

- **Urban management plan** the arrival of low-income workers could affect existing urban zoning plans

- **Transportation** the construction of a hydropower station can increase the traffic problems on some roads Worker transportation could require 6 trips a day on the part of 30 to 40 buses The transportation of equipment and materials could make roads used by inter-municipal or local trucks and buses dangerous

Predicting these impacts involves estimating the additional demand for housing (based on the migrant population estimate) and, depending on this, additional education, health, clean water, sewage, energy, transportation and other services

d Impact on public health

The main impacts on public health attributed to a hydropower station are those due to the arrival of migrant workers and their families, which could be affected by endemic diseases in the area that they are not prepared for (malaria, bacterial and viral diseases, etc) In addition, the consumption of untreated water could lead to an incidence of water-related diseases, such as amebiasis, diarrhea and other gastrointestinal diseases

During construction, it is common to see a high incidence of sex-related diseases among workers, as a result of the influx of prostitutes on weekends

Forecasting these impacts can be done through a comparison between the description of the zone's actual morbidity and that estimated for the plant's construction phase The difference between both descriptions allows estimating the incidence of diseases that can be attributed to the project and, based on the migrant population, the number of cases of diseases (sick population)

2.5.6.3.2 Assessment

As a rule, in these fields there are no legal standards that can be used as comparative elements to evaluate the importance of these impacts As a result, this assessment should be conducted on the basis of a comparison between the situation without the project (actual or future) and the situation caused by the project, to establish aspects such as

82

- Population increase attributed to project (workers plus their families) and percentage with respect to the population in the region or city

- Volume of employment to be generated that could be covered by local workers without causing inflated salaries and the part that will be supplied by workers from other regions

- Lack of houses and/or boarding rooms for migrant workers and their families

- Lack of clean water supply, sewage and power services

- Lack of spaces in schools, hospital beds and medical doctors to cover the needs of the agroindustry's workers during the different phases

- Lack of roads and/or traffic needs during plant construction

With regard to the impacts on health, the assessment should be based on a comparison between the concentrations foreseen for air and water pollutants in the plant's area of influence and the values permitted by legislation This is because the air and water quality standards or patterns are established based on correlations between contamination levels and related diseases If expected concentrations are low, the impacts will be small Then, based on the data on the population's actual health, the climate-asthma relationship and the concentration of pollutants that the project will cause in the air, an assessment should be made of the impact of the plant on the future health of the population

2.5 6.3 3 Mitigation measures

a Population growth

In as much as possible, population growth in the region should be avoided One way of reducing this impact is by giving preference to workers that already live in the area of influence Through a worker formation program it is possible to recruit unskilled workers and make them into welders, assemblers and electricians, for the levels required by the project Agreements with professional training institutions can be very useful to train local workers and thus avoid migrations Public bodies responsible for employment should be contacted for the installation of hiring centers in different points of the region These centers can also serve as migrant worker selection and orientation centers

b Employment

If, on the one hand, the project seeks to reduce the problem of lack of employment, on the other hand, beginning with the project's design phase, the future demobilization of those workers should be avoided in order not to punish the region with a new wave of unemployment Therefore, a program should be prepared which seeks to a) avoid that the reduced demand of labor and consequent lay-off of workers causes a significant impact on the local work market and society, b) reduce social problems and tensions caused to all company workers due to the future completion of works and lay-off of workers

The corresponding mitigation program could contain the following measures, among others

- Linearization of demand the project must be conceived as a linear schedule, attempting to obtain the most homogenous labor demand as possible to reduce the peaks of demand to the minimum, which also involve peaks of demobilization

- Spacing in the termination of tasks in as much as possible, the project should be conceived as a schedule of activities that takes into account demobilization with regard to different tasks The aim is to reduce the number of workers laid off simultaneously, thus facilitating the absorption and relocation of these workers on the market

- Spread-out hiring integrated to other mitigation programs, hiring of workers should be done throughout the region around the industry, to reduce the housing problem, dilute the transportation problem over a larger area, not overload the basic existing infrastructure, spatially dilute the problem of demobilization and facilitate the reinsertion of professionals in the market to their original areas

- Training during the period in which workers are working for the company, they should be placed in specific training programs both to prepare them for their functions in the company as well as to improve their professional knowledge The more prepared these workers are, the more easily they will be hired in the work market

- Re-use in plant operation during plant construction a selection and training process should be put under way to be able to later use some of these workers in its future operation

- Use in other projects trained and experienced plant construction personnel should be given priority in hiring the workers needed for other projects within the country's electric expansion plan

c Housing and public services

To reduce the impact of the housing demand, the following alternatives exist

- To build temporary housing close to the plant, for single migrant workers and, in general, for workers that reside in other regions

- For workers that migrate with their families, one alternative is to build brick housing complexes, with 50 m² residences This construction could be carried out in agreement with local governments, which could receive them as a donation once the project has finished

In the event that the schools in the region do not have the openings needed to receive migrant workers' children, one way of mitigating this impact is to support local authorities in the improvement of existing schools by building and equipping new classrooms for which the local governments would commit themselves to place teachers

In terms of medical assistance for company workers, an outpatient medical unit should be planned, with complete infrastructure to carry out the following activities personnel admission tests, work

44

accidents, public health, clinic consultations and emergency treatment More serious cases should be referred to the hospitals, in ambulances owned by the plant In addition, it is recommended that agreements be established with regional hospitals Quite frequently, electric companies donate new wings or re-equip old ones with equipment (X-rays, resonance) that they are not able to purchase, thus benefitting the entire population in the region

Mitigation measures for sanitary services are closely related to solving the housing problem However, contracts with civil works construction and electro-mechanical assembling companies should stipulate their obligation of collecting all waste matter and of disposing it adequately in a sanitary landfill Likewise, the adequate removal and disposal of all solid waste generated during the construction phase should be ensured, including rock matter from excavation In addition, the project should include the construction of portable rest-rooms in different plant construction sites, with public water and sewage services, to meet workers' needs

Mitigating the impacts on the transportation system requires the application of measures such as the following

- Planning of bus and truck schedule If the roads cannot handle the increase in traffic, the broadening of existing roads, building of new ones or paving of secondary access roads should be requested from the local authorities

- Planning of schedules, in such a way that the traffic from company buses does not coincide with the normal traffic of the region Likewise, the transportation of equipment should not congest roads not able to handle the increased traffic The transportation of large pieces of equipment should be coordinated with local traffic authorities

- Road signals and education for the communities located close to the construction site, to avoid accidents especially involving pedestrians

- Adoption of drastic internal rules for company drivers and firing of any of them who disobey them

d Public health

With regard to impacts on health, the only viable means for mitigation consists in expanding the coverage of medical care services and infrastructure, to respond to potential demands of the sick population

To avoid problems of noise, the main measure is the acoustic isolation of the engine room, which is broadly practiced now in day for industrial safety reasons In addition, it would be convenient to plant tree screens around the plant, with three or four rows of trees of different heights and with large and perennial leaves Besides cutting down on noise, this screen will avoid the visual impact caused by the plant

85

2.5.6 4 Impacts on the economy

2 5.6 4 1 Identification and forecasting

The main impacts of a hydropower station on the economy are usually positive and indirect They are felt in two main fields living conditions and economic development

a Living conditions

Mainly during the construction phase and to a lesser extent during operation, the living conditions of the population linked directly and indirectly to the project usually improves, due to the following factors

- Income from the workers' salaries, which increases the purchasing power in the region
- Activation of commerce and other services, to meet the demands of plant workers and particularly those of the project itself (banks, construction materials, small workshops, etc)
- Activation of agricultural production, to meet the food needs of plant workers
- Possible income for the local administration or regional bodies from property, industrial and commercial taxes and particularly from rights or shares from energy sales Some countries have established this share as a percentage of block energy sales 4% in Colombia and 8% in Brazil Part of this income is destined for environmental improvement and part to improve the service infrastructure (aqueducts, sewage systems, schools, health posts etc)

Forecasting the impact requires an estimate of the total amount of income for the region from these items, for each year of construction and then for each year of operation This brute impact, divided by the population, will allow a calculation of the regional GDP index due to the project

b Regional development

As was noted in dealing with the impacts on land use, the flooding of an extensive area for the reservoir could annul a rather important agricultural production, depending on the area cultivated, the technological level of the activity and the results obtained (or loads per hectare, in the case of cattle-raising) Likewise, it is possible that the project will eliminate or reduce mining production

In addition, the reduction or elimination of flooding in the valley located downstream from the dam, in response to the regularization of the flows, could recover extensive areas that can be used for agricultural activities This production could counteract the losses in the zone of the reservoir and plant

The construction of the plant and reservoir could lead to the establishment of other industries and services in the region, creating more sources of employment and increasing income, thus improving the regional economy In addition, it might draw the attention of the environmental authorities toward the region who could become more interested in resolving other problems affecting the population

2.5 6 4 2 Assessment and potential

The assessment of the importance of these factors should be based on the existing economic situation (without the project) salary and income levels of the population municipal budgets (for services) agricultural production and dynamism of the economy The comparison between the current GDP and the GDP generated by the project could be an index in evaluating the impact on the economy

Since these are positive impacts, they should be enhanced in as much as possible to achieve a good insertion of the project in the economy and life of the region

2.5.7 Aesthetics and impact on tourism

2 5 7 1 Identification and forecasting

A visual impact analysis is generally required to show the effects of the proposed development on the surrounding landscape For this, the physical characteristics of the proposed development area should be identified and evaluated, from the landscape standpoint, and afterwards related to the characteristics of the proposed reservoir and plant facilities In general the creation of the reservoir can significantly improve the local landscape and contribute to develop new economic activities, such as tourism

It should be kept in mind that some of the impacts on the landscape are temporary, whereas others are permanent

In another sense, if there are archaeological or historical sites within the construction area, the impact on cultural values could be very high

2 5 7 2 Assessment and mitigation

A situation where the power plant facilities (different from the reservoir) are completely visible from access roadways and from scenic roads is viewed as the worst case for visual impact Mitigation measures such as tree screens or other barriers should be considered

Materials used during construction are often abandoned on the site, producing a strong aesthetic impact Cleaning of abandoned excavation sites or waste dumps should be included among the proposed mitigation measures This is the particularly the case of dam material extraction sites and quarries in general

If, due to the opinion of experienced archaeologists, the construction site is of great value, it should be changed to another location If the value is low, an archaeological rescue program can be implemented before reservoir filling begins

2.5 8 Hazards in working environment Industrial safety

An important aspect of environmental control for industries is to provide adequate facilities within the industrial complex itself to protect the health and safety of the workers This includes adequate safety and accident controls in the reservoir and generation facilities

The industrial safety plan should extend to peasants or indigenous people who cross the reservoir to carry out their daily business, particularly to avoid accidents and/or provide help in the event that they occur

The noise from the engine room can be easily taken care of by providing workers with protective devices, if necessary

2 6 Environmental Monitoring of the Development

Environmental monitoring is necessary to control the reservoir's physical-chemical and generation flow parameters, to assess the reservoir's biological performance, to identify possible micro-climate changes and to control destabilization phenomena along the reservoir banks and in the flow downstream from the dam For this, the monitoring equipment needs to be purchased, the parameters, sites and frequency of sampling need to be established and periodic reports need to be published on the impact observed

The acquisition of monitoring equipment should be based on the project design (executive project), once the EIA has been approved by the environmental authorities Once the work begins, the environmental laboratory should be one of the first to be finished, to begin monitoring immediately

According to all this, in a hydropower station, the monitoring program should mainly cover water quality, the local climate and the geomorphological processes

2.6 1 Water quality monitoring

Water-monitoring plans should envisage the collecting of chemical and biological from the reservoir, its main branches, the generation flows and the river downstream from the plant's discharge

Parameters to be monitored in principle are the following pH, temperature, turbidity, dissolved solids, suspended solids, total solids, oils and fats, conductivity, COD, BOD5, OD, sulphates, chlorides, total and fecal coliforms and others that might be felt necessary Likewise, it is recommended to periodically measure the primary productivity of different points of the reservoir, at different depths

The sample collecting and analysis methodology should be selected carefully and agreed upon previously with the environmental authorities

2 6 2 Meteorological monitoring

Meteorological monitoring has the objective of following up on the main meteorological parameters of the area of the reservoir, to identify and characterize possible climatic changes that could be attributed to the presence of the reservoir

88

Inter-American Development Bank

Summaries of Potential Environmental Impacts for

- Thermoelectric Stations

The following section is an excerpt from the Inter-American Development Bank's *Guide for Assessing the Environmental Impact of Thermoelectric Stations* This section discusses the identification, forecasting, and assessment of environmental impacts of thermoelectric stations

2.5 Identification, Forecasting, and Assessment of Environmental Impacts. Paragraph 2 1 provided a short list of the main environmental impacts to be expected in a thermoelectric station

In this part of the EIA, a detailed presentation should be made for each anticipated environmental effect of importance, with information on the following its nature (depending on the environmental affected), occurrence conditions (direct or indirect, positive or negative, temporary or permanent, cumulative, etc), estimated magnitude of the impact, the measures to be used to minimize adverse impacts so that the overall situation will be protected or even enhanced to the extent possible

As a follow-up to what was indicated in Section 1 2 (Scope and Phases of an EIA), the general evaluation methodology consists of a four-step iterative process, namely identification of impacts, forecasting or quantification, assessment of their importance, and determination of mitigation measures With each mitigation alternative that is proposed, the process should be repeated until the "impact" is deemed acceptable (importance of the impact)

90

In this process, it will be observed that some impacts are inevitable and that others create irreversible and irrecoverable damages on environmental resources and/or values In this chapter of the EIA, these impacts should be identified and discussed, otherwise "there will be no project "

Single impacts are analyzed below and some suggestions are given to speed up the forecasting process

2.5 1 Impacts on water resources

2.5.1.1 Identification and forecasting Water pollution may be physical, chemical, or thermal, and thermoelectric stations may produce some of each during each phase and process of the project If dealing with a traditional steam-driven station of the eighties, the major sources of pollution are as follows

2.5 1.1.1 Crude water treatment The water taken in the river should be treated before its use in the plant The treatment is traditional, with the addition of aluminum sulfate, calcium hydroxide, and polyelectrolyte for floccule formation, and chlorine for eliminating microorganisms, in amounts as indicated below

a	Aluminum sulfate	$Al_2(SO_4)3\ 12H_20$	30 to 60 mg/l
b	Calcium hydroxide	$Ca(OH)_2$	15 to 30 mg/l
c	Chlorine	Cl_2	1 to 5 mg/l
d	Helper for flocculation-polyelectrolyte (if necessary)		0 1 to 0 3 mg/l

Sedimentation and flocculation processes will settle the mud from the suspended matter in the river at the bottom of the treatment station It is important to know the concentration of total solids in the water taken to calculate the amount of mud retained at the bottom of the station If, for example, the average content of solids in the river is 150 mg/l and the catchment flow is 100 m^3/h, the amount of solids at the bottom of the station will be (150 g/m^3 x 100 m^3/h=) 15,000 g/h If this solid keeps a dilution of 5%, it would account for an effluent of (15 l/0 05=) 300 l/h with mud from the river

In addition to the mud, the chemical products used in treatment can generate impacts, especially aluminum sulfate In order to estimate its magnitude, the amount of aluminum sulfate that will be used is calculated, the corresponding part of aluminum is determined, and it is assumed that everything goes to the river Afterwards, the additional concentration of Al in surface waters is calculated This same procedure is applied to the sulfates

2 5 1.1.2 Water demineralization system The ionic exchange process is broadly used in thermal plants for demineralizing the water for the boilers The main component of

91

the process is an ionic exchange resin that has the property of permitting the exchange of one insoluble ion for another that is soluble, thus reducing the danger of scaling In practice, the water to be treated passes through a filter full of a resin capable of exchanging ions Depending on the ion to be exchanged, the resin can be cationic or anionic If the water to be demineralized contains calcium sulfate, the demineralization reaction will be

$$CaSO_4 + R\,H_2 \longrightarrow R\,Ca + H_2SO_4$$

where R represents the resin of the cationic exchange The water to be treated now contains sulfuric acid and its passage through an anionic exchange resin will produce a virtually pure effluent

$$H_2SO_4 + R\,OH \longrightarrow R\,SO_4 + H2O$$

The resins have a finite capacity to exchange ions After depleting they capacity, they have to be regenerated, this is achieved by washing them with a regenerative solution

$$R\,Ca + H_2SO_4 \text{ solution} \longrightarrow R\,H_2 + CaSO_4 \text{ solution}$$

$$R\,SO_4 + NaOH \text{ solution} \longrightarrow R\,OH + Na_2SO_4 \text{ solution}$$

To regenerate cationic resins, hydrochloric acid is used and for anionic resins, caustic sodium is used Hydrochloric acid and caustic sodium are barely partially retained by the resins in the regeneration process and, because of this, the discharge of these effluents into the rivers may contaminate their waters

For a 350-MW plant, the need for demineralization water is on the order of 35 m^3/h For regenerating resins, in each cycle (24 hours in the cationic and anionic resins) close to 100 kg of HCl and 100 kg of NaOh are used When they are mixed, the effluents of the two exchangers are virtually neutralized, with barely a few adjustments needed to correct the pH in the neutralization tank Nevertheless, the mixture of these effluents produces close to 150 kg/day of NaCl, in addition to the impurities withdrawn from the water by the resins This effluent cannot be discharged abruptly into the river because, due to its high concentration (150 kg of sodium chloride in a tank of 100 m^3), it can considerably enhance the salinity of the receiving water, depending on its volume

2 5.1.1.3 Cleaning of equipment

a. Internal cleaning of the boilers

Before entering into operation, the boiler goes through a two-phase cleaning process acid and alkaline In the alkaline phase, the boiler is filled with an alkaline solution, which is heated in the boiler at 20% of normal working pressure and after several hours is drained For a 350-MW thermoelectric station, a heated solution of 85 m^3 is generated, with close to 850 kg of chemical products, in addition to removed impurities

92

(mainly lubricants and oils, although already saponified and which will not cause any problem)

For the acid cleaning of new oilers, a hydrochloric acid solution with 5 to 7% of HCl, in addition to sodium fluoride (0 5%), or ammonium bifluoride and an inhibitor (0 2%) In this case, an effluent of 85 m^3, heated at about 70°C and with close to 6,000 kg of chemical products, in addition to the removed impurities (mainly ferrous oxide and a bit of silica) After the acid cleaning, the boiler is normally inspected and then it undergoes a complementary cleaning with citric acid (0 6%) Draining this acid solution (at room temperature) involves a volume of 85 m^3, with about 500 kg of citric acid After further washing with water, the boiler is passivated with hydracine (200 ppm N_2H_4 and 10 ppm NH_3) This passivation solution normally is not drained, rather it is left in the boiler and at the beginning of the load the hydracine and ammonia surpluses are expelled with the discharges

The drainage products stemming from alkaline cleaning (caustic soda or sodium hydroxide, sodium carbonate, and trisodium phosphate), for a total of 680 kg, need 340 kg of HCl to be neutralized The sodium sulfite becomes sodium sulfate (neutral) If the 85 m3 of this solution, duly cooled, were sent to a neutralization tank, they could serve to partially neutralize the solution of 85 m_3 of hydrochloric acid stemming from the acid cleaning Nevertheless, as close to 4,250-6,000 kg of HCl are used, there would still be a large surplus of acid, that would have to be neutralized with caustic soda, before discharge into the river

Only a small amount of acid is really consumed in the boiler cleaning process For example, if 400 kg of iron were dissolved (most as iron oxides and the rest as metal iron), considered a moderate amount, close to 500 kg of hydrochloric acid would be consumed Therefore, there would still remain, after neutralization of the 680 kg of alkaline products, between 3,400 and 6,000 kg of HCl to be neutralized with caustic soda The problem is that, if all of this chemical product were neutralized in one 200 m^3 tank, the outcome would be a solution with close to 5% NaCl, in addition to the fluoride waste, the inhibitor, and all the iron removed in the process (partly in solution and partly in solid form, the latter for filtration) Thus, considerable dilution should be envisaged so that the quality of the receiving body will not be significantly affected

After several years of operation, other chemical cleaning of the boiler might be necessary, although this might be obviated by an adequate treatment of the condensate and feedwater of the boiler Nevertheless, if this other cleaning does take place, it should be kept in mind that, in addition to the Process normally applied for new boilers, a process for removing copper and copper oxides would have to be included The amounts of these impurities are quite small (under 50 kg in a 350-MW station) but even then they would still have to be diluted several hundred-fold, inasmuch as heavy metal concentrations are limited to very small values in the waterways (less than 1 mg per liter in clean water)

9

b Washing the external parts of the boiler, the air pre-heaters, the outer surfaces of the steam generator and the heater

The metals in contact with fire and furnace gases should be cleaned periodically (several times a day) in order to remove the soot that has accumulated This cleaning should be done by means of high-pressure steam or with jets of water The volume effluent, small but heavily loaded with solids that sediment easily, should be estimated on the basis of the frequency of the washing and the type and quality of the fuel to be used

Occasionally it will be necessary to wash the outer surfaces of the steam generator The effluent will contain a large amount of solid matter such as ash, burnt coal, refractory matter, and oil additives, and its volume should be estimated on the basis of the frequency of the washing and the type and quality of the fuel

The washing of the air heaters should be done fairly often, during any relatively long stop and when there is obstruction of the heaters The effluent will contain high amounts of soot, oil ash, and additives and will be acid

On the basis of the estimations of mud amounts (or muddy effluents) to be produced in the various wash sections, the concentration of total solids to be expected in the receiving body is calculated

2 5.1 1 4 Cooling system As indicated in the introduction (What is a Thermoelectric Station?), there are three basic systems for cooling the waters used in the boiler's steam condensation once-through, wet-tower cooling, and dry-tower cooling

Before entering the system, especially if towers are used, the cooling water undergoes a chemical treatment that seeks to eliminate scaling and corrosive properties and avoids the development of algae, bacteria, and fungi To inhibit corrosion and scaling, chromates (pure or combined with phosphates and zinc) or phosphates (pure or combined with zinc) are used Chromates were forbidden in the United States due to the high rate of river pollution generated for the most part by effluents from thermoelectric stations In order to combat the development of living organisms, products such as chlorine, chlorine dioxide, quaternary ammonia salts, stannous organic and sulfur organic compounds, chlorated phenols, copper salts, thyocyanides, etc , are used Of these, chlorine is the most widely used, followed by chlorophenols and quaternary ammonia salts Copper salts (normally copper sulfate) are highly toxic, since concentrations of hardly 0 2 mg/l of this sulfate in water are lethal for some fish species

The **once-through** system uses water from a river, lake or the sea just once and then returns it to its source with a temperature that is 10 to 15°C higher This is the simplest and most economical means, but it is constrained by the lack of water and by the danger of thermal pollution of the receiving body In this case, the chemical composition of the effluent is virtually equal to that of the taken water, except for minimum amounts of metal oxides due to the inner corrosion of the equipment and biocides The frequent application of chlorine, the most widely used biocide, fluctuates one to ten times a day, this produces a residual chlorine concentration of 0 1 to 0 2 mg/l

If this is the system to be used, the flow to be discharged (or taken) should be indicated, as well as the temperature of the receiving source and the effluent and amount of biocides to be used The study should estimate the temperature increase in the receiving source and the extent of the damage that this temperature increase will produce for the water ecology The presentation should show the magnitude and path of the plume or trail of the heated water before returning the temperature to normal, as well as the estimated alteration of the natural ecological values of the affected zone

In the **wet cooling tower** system (with natural or exhaust draft), part of the water is evaporated and the temperature of the circulating water returns to normal Because of this, the discharge from the cooling tower will also have a normal temperature for the area and there will be no thermal pollution The chemical characteristics of the water from the cooling tower depends on the characteristics of the water taken, the chemical treatment for this water, the pollutants in the air and taken in the tower, and the presence of biocides and natural phenol compounds which, when combined with chlorine, form toxic compounds and give a bad taste to the water

Owing to the losses due to evaporation that takes place in the wet towers, the Ca, Mg, Na, CO_3, HCO_3, SO_4 and Cl salts that are naturally present in the water increase their concentrations in the recycling water, until their solubility ceiling is reached Thereafter scaling that diminishes the efficiency of the heat exchanger and, as a result, the station's efficiency begins to take place In order to avoid this scaling, part of the recycling liquid is constantly discharged, so that the concentration of salts in this liquid never reaches a saturation point Thus, an amount of water with high salts content is removed and replaced by an amount of water with low salts content equal to the discharge plus the evaporated amount, which is on the order of 15-30 gpm/MW The discharge rate is from 0 5 to 3% of the volume of the recycling liquid in the system

As a result of the above, it can be concluded that the effluent of a wet tower will have a content of dissolved solids on the order of three times the water taken, in addition to impurities stemming from the chemical products that are used, whose measurement is necessary for determining the treatment to be used

As a result, forecasting the impact implies the following

a To estimate the amount of water to be taken permanently from the source in order to replace the losses due to evaporation and discharge

b To calculate the concentrations that will reached by the salts, biocides, and other chemical compounds referred to in the discharge water and the receiving waterway

In the **dry tower cooling** system, the water runs inside metal pipes and is cooled by a natural or forced current of air The hot water does not come into contact with the cooling air, so that there is no loss due to evaporation nor are there constant discharges There is therefore much less make-up water than in other systems, there is no thermal (or atmospheric) pollution, and the tower can be located anywhere It is the best

95

alternative for dry areas Its major drawbacks are the high costs of installation, operation, and maintenance (higher than for other systems) and the aesthetic impact (especially in natural draft towers, which may be very tall) Nevertheless, there is a small auxiliary wet tower for cooling the hydrogen systems, the turbine's lubricant oils, bearings, etc The tower has a small bottom discharge, and the system's make-up water is hardly 3% of what would be needed for a wet tower As a result, forecasting the impact in this case should especially focus on the expenses of the auxiliary water tower and the eventual discharges of the main cooling system

2 5 1 1.5 Draining the coal piles In coal-fired plants, another source of pollution is runoff from the open air storage of coal When the sulfur compounds in coal (pyrite, for example) come into contact with the air's oxygen and humidity, sulfuric acid is formed, the sulfuric acid, in turn, is leached by the water seeping through the coal pile, producing a low pH effluent (high acidity) and dissolving the inorganic salts and metals in coal Thus, in addition to large amounts of coal particulates and other nonsoluble solid matter entrained by rain, the rain effluent may contain high concentrations of dissolved salts, metals, and even sulfuric acid, which are toxic for the environment

The quality of the effluent running from the coal piles depends on its sulfur content, the sulfur/alkaline balance, and the time that has elapsed since the last rain This is due to the fact that rainwater may take several days or even weeks to leave the area of deposit, during which time there may be considerable formation of sulfuric acid owing to the humidity

Runoff characteristics also depend on climate conditions In periods of little rain but high humidity there can be substantial formation of H_2SO_4 which, when diluted in a small volume of liquid, can lead to a pH that is under 1 5 Therefore, during periods of little rain, the concentration of pollutants dissolved in the effluent can be very high, leading to severe pollution problems in rivers, which at just this time are at their lowest levels

The coal piles have heights ranging from 4 to 30 meters, and in some American plants they cover a surface area of up to 30 hectares In the United States and Canada, stored coal involves volumes that fluctuate between 80 and 18,000 cubic meters per installed MW The piles have an average height of 11 5 meters, cover a surface area of 7 hectares, and entail a volume of 2,200 cubic meters per installed MW

The coal oxidation rate also depends on humidity, oxygen, and sulfur contents, which increase with air and water flows There is spontaneous combustion of coal when its oxidation generates more heat than the heat that is dissipated As long as oxygen enters the pile, oxidation will continue and when the temperature inside the pile reaches 70°C, there is a rapid and irreversible rise in temperature, leading to the beginning of combustion

The leaching of toxic metals depends on the pH of seepage waters With a pH of about 9 0, most metals have a solubility that is under 0 1 mg/l, whereas with about 5 0 this solubility turns out to be 10,000 times greater Thus, if the runoff is acid, in addition to suspended solids and sulfuric acid, it can contain solubilized metals, especially iron, manganese, zinc, copper, arsenic, and other coal-formation elements

96

When the calcareous content of coal is high, the runoff has a pH that is over 7, with low leaching of metals When the coal has a high sulfur content, the runoff is characterized by a low pH content, high concentrations of suspended solids, sulfates, iron, copper, and other elements, as observed in Table 2 It can be noted that the sulfate contents are almost 100 times higher than those observed in the case of alkaline coals and that iron contents increase 30,000 times

It is interesting to compare the quality of the runoff from the piles during the rainy and dry seasons (Table 3) During the former, there is mostly surface water that does not penetrate the pile, whereas during the latter the rain seeps through the pile and appears on the surface days or weeks after the rainfall It can be observed that during rain, the quality of the runoff is about constant, whereas the seepage effluent displays variable characteristics, reaching extreme values of 1 5 for pH, 57 g/l in terms of sulfates, and 23 g/l in terms of iron As this runoff reaches the surface and ground waters precisely during the dry season, it endangers clean water supply sources

An important fact to be observed is that, even when the pH of the drainage is close to 7, the effluent can be highly contaminated by toxic elements, including radioactive elements This is due to the high content of suspended solids entrained by the water They consist of ultrafine coal solids, which carry the toxic elements they contain to the river It is important to observe that some effluents have high chemical demand for oxygen (CDO) values When an effluent enters into a waterway, it can absorb all the free oxygen, thus annihilating the water's fauna by asphyxiation

Table 2
Drainage Characteristics of Two American Coals with Different Sulfur Contents
(in mg/l)

Parameters	Coal with 0 5% sulphur	Coal with 4 8% sulphur
Sulphates	440	49 000
Arsenic	0 12	40
Chromium	0 018	2
Copper	0 015	8
Iron	0 47	17 600
Lead	0 12	0 2
Nickel	0 12	7 8
Zinc	0 015	14 5
Boron	15	

Source Epstein, 1992

97

Table 3 Characteristics of the Drainage from Coal Piles in the United States during the Rainy and Dry Seasons (coals with 1 8% of S and 0 35% of Fe)		
Parameter (mg/l)	**Dry Season**	**Rainy Season**
Suspended Solids	12 19 000	1 700 13 000
Dissolved Solids	2 300 21 000	2 300 115 000
Iron	160 23,000	700 1 400
Aluminum	20 1 800	70 100
Manganese	2 100	9 15
Sulphates	90 57 000	1 600 2 700
pH	1 4 3 3	2 3 3 3

Source Epstein, 1992

From the above it can be deduced that, in order to correctly predict the impact of coal pile runoff, the characteristics of the mineral that will actually be used in the plant will have to be studied For this purpose, an experiment can be performed, exposing a five-ton pile to the air on a wooden or concrete platform The rainwater seeping through the pile should be collected in a catchment recipient under the platform and periodically analyzed to evaluate its quality

2.5.1.1 6 Effluent from the ash transport system In some coal-fired thermoelectric stations, ash is removed by mixing the ash with water and hauling it to a sedimentation area Coal ash is a potential pollutant, both because of the pH of its run-off and because of the solubilization of the toxic elements in its chemical composition The ash composition reflects the coal's composition, which in general contains all the elements of the periodic table

The solubilization of toxic elements in fly-ash is different from that in bottom-ash Fly-ash absorbs, on its surface, the elements that are partially volatilized in the furnace, so that the concentration of these elements is higher in this type of ash than in bottom-ash, with the aggravating factor that the elements are available on the surface Therefore, when hydraulically transporting ash to its disposal site, fly-ash has a greater potential for releasing toxic elements Because of this, the U S Environmental Protection Agency (EPA) has forbidden the hydraulic disposal of ash in new plants

The pH of the ash-carrying effluent is determined by the ratio between the iron/sulfur content and the calcium/sodium content Ash with a S or Fe content that is three times higher than the Ca + Na content is acid, if the inverse is true it is basic In the world, more than 70% of the ash is basic

In the case of fly-ash, the character of the effluent may be mixed This ash absorbs sulfur on its surface and the initial pH is lower than 7 0 (acid) After a few hours or days, the solubilization of calcium neutralizes the acidity and takes the pH up to values close to 10 (highly basic) Fly-ash is potentially the most dangerous since it provokes the solubilization of a wide range of toxic elements If there is enough time and if the sedimentation pond or basin has a good hydraulic operation, the suspended ash in the effluent can settle Likewise, it can also precipitate many of the leached metals during the acidity period

A poorly lined settling pond will allow the effluent to seep to the ground, leading to the pollution of ground waters, as indicated by the analyses conducted in wells located at 100 meters from this type of pond, where it has been observed in addition that the pollutants (metals) fluctuate depending on the period of the year and the plant's operating schedule

The pH of the effluent also depends on the chemical composition of the coal and the type of furnace If the coal's combustion temperature is high, the existing sulfur escapes through the stack in the form of gas (SOx) and the pH of the effluent could reach 10 if the ash is alkaline, although in most cases, the pH is almost neutral for bottom-ash and slightly acid for fly-ash By contrast, if the combustion temperature is low, the sulfur compounds emerge on the surface of the light particulates When they come into contact with water, these particulates produce sulfuric acid, thus accelerating the leaching of the toxic elements in the ash

The speed of solubilization for each element depends on the pH of the effluent For most elements, solubility reaches a peak at pH values close to 1 0 and falls logarithmically until the pH of minimum solubility, generally between 8 and 10 Nevertheless, this is not the case for Se, As, Mo, Hg, B, and Cd, whose respective solubilities in a basic medium are high

In order to calculate the impact of the ash-carrying effluent, an experimental procedure should be envisaged The coal to be used in the plant should be burned in conditions that are as similar as possible to those that will prevail in the actual burning The ash should undergo solubilization testing in accordance with current standards, and the solubilized effluent should be analyzed to determine the content of metals and toxic substances By extrapolation, depending on the real amounts of ash to be produced in the future plant and soil and ground water conditions, the potential concentrations of the pollutants in the ground waters and/or in the receiving surface waters should be calculated

2 5 1 1 7 Other waste waters Other waste waters that are capable of polluting surface waters are household waste waters (sewage waters), effluent from the laboratories, and waters for cleaning the grounds and other installations

The volume and flow of sewage water to be produced during construction and operation with their respective organic loads should be estimated Depending on whether there is a water treatment plant, the impact of these waters on the receiving body should then be estimated, especially in terms of biochemical demand for oxygen (BDO) and the concentration of dissolved oxygen The lower the volume of the receiving body and the greater the waste waters, the larger the impact

The effluent from the laboratories generally contains remnants of fuel used in the plant, as well as chemicals used in laboratory tests Although its volume is very small, chemical compound concentrations may be very high To forecast the impact, the volume of waste waters and the amounts of chemicals to be used have to be known On the basis of these data, concentrations in the effluent and receiving body are calculated

The major components of the water for cleaning the yards and other installations are suspended solids An estimate of the water to be used for these tasks and the amount of solids to be entrained have to be estimated, in order to calculate the respective concentrations in the effluent and receiving source

2.5 1 2 Assessment methodology The simplest way to assess the impact is to perform a comparison with current laws, regulations, and accepted standards

Table 4
Permissible and Desirable Quality Criteria for Surface Waters in the United States, for Selected Pollutants in Thermoelectric Power Plants
(in mg/l)

Pollutants	Permissible Level	Desirable Level
pH	6 0 to 8 5	6 0 to 8 5
Oils and lubricants	Absent	Absent
Color (units)	74	10
DO	4	Saturated
Ammonia	0 5	0 01
Arsenic	0 05	Absent
Barium	1 0	--
Boron	1 0	-
Cadmium	0 01	--
Cyanides	0 2	Absent
Lead	0 05	Absent
Chlorides	250	25
Copper	1 0	Absent
Chromium VI	0 05	Absent
Phenols	0 001	Absent
Soluble iron	0 3	Absent
Manganese	0 05	--
Mercury	--	0 002
Selenium	0 01	Absent
Dissolved solids	500	200
Sulphates	250	50
Uranium	5	Absent
Zinc	5	Absent

A comparison may be made between accepted standards for discharge into surface waters and/or by comparison between the expected concentration in the surface or ground water and the recommended criteria for water

A review of the different laws governing this matter is beyond the scope of the present work U S legislation, on which most countries base their own legislation, establishes two quality patterns permissible and desirable levels The latter serve as goals for river decontamination plans Table 4 shows these two quality criteria in surface waters for pollutants that are inherent to thermoelectric plants Table 5 indicates the discharge standards for specific liquid effluents of thermoelectric plants established for the United States and refers to maximum permissible concentrations for a pollutant in a plant's effluent, before its discharge into a receiving body

Table 5
Standards for Discharging Liquid Effluents
from Thermoelectric Power Plants in the United States
(in mg/l)

Parameter	Daily Maximum	Monthly Average
pH	6 to 9 (a,b,c)	6 to 9 (a b,c)
Oils and lubricants	20 (a,b,c)	15 (a,b,c)
Suspended solids (except ash ponds)	100 (a,b,c)	30 (a b,c)
Effluents in ash ponds		
Suspended solids (SS)	100 (a)	30 (a)
SS effluent carrying bottom ash	100 (b c)	30 (b,c)
SS effluent carrying fly-ash	100 (b) 0(c)	30(b) 0(c)
Metals in effluents from cleaning and purging boilers		
Iron	1 (a,b c)	1 (a,b,c)
Copper	1 (a,b,c)	1 (a,b,c)
Drainage from cooling tower		
- Chlorine	0 5 (a,b,c)	0 2 (a,b,c)
Zinc	1 0 (a,b,c)	1 0 (a,b,c)
Chromium	0 2 (a,b,c)	0 2 (a,b,c)

a United States, to be reached in 1977
b United States, to be reached in 1983
c United States, for new power plants

The figures presented in the tables may provide some orientation for the evaluation procedure

2.5 1 3 Mitigation The impacts of a thermoelectric station on water resources can be virtually eliminated by using widely known, relatively low-cost technologies In order to prepare this part of the guide, the volume and concentrations of the pollutants stemming from the plant's various operations should be known For the effluents that do not comply with environmental legislation requirements, one of the technologies described in the present section should be chosen

a Reutilization of water

The efficient use of water resources can be improved by the cascade method, where the water flows from a process that requires high-quality water to another that accepts lower-quality water The advantage is that it reduces the amount of water to be treated and the number of treatment units Thus, for example, the effluents from the treatment plant and the runoff from the coal piles can be used to transport waste ash, as long as it is alkaline, thus promoting the mutual neutralization of the effluents

One rule adopted in some plants is to separately treat the small flows that contain high concentrations of dissolved solids and metals, since the more diluted these pollutants are in the effluent the harder it is to remove them The other effluents can be treated together, by means of self-neutralization, co-precipitation, and sedimentation of suspended particulates In this case, the equalization deposit should have sufficient volume to retain effluents of variable quality and volume, since some flows are continuous, others are discontinuous but daily, others occur a few times a year and others depend on meteorological conditions

Various plants have striven to operate at zero discharge because the ash drawn from the bottom of the settling ponds carry a great deal of water, which turns out to be an effective way to blowdown the system The presence of a nearby coal mine allows the plant's surplus water to be used for upgrading the coal, which leads to a zero discharge into the environment

Certain U S plants have operated in a closed circuit for various years, with in some cases a small discharge that has to undergo chemical treatment Thus, the make-up water can be reduced to 5% of the circulating flow, with a discharge into the lower river at 2% of circulating flow (in the case of non-recirculating systems, both the make-up and the discharge into the river are 100% of the circulating flow)

b Effluent from water treatment

All the effluent of the treatment plant should be carried to plant's general treatment station This should include a settling tank, an oil and lubricant remover, and a neutralization tank The mud, once densified, should be disposed of in a conveniently located landfill

The plant's sewage effluent should only reach this plant once it has been biologically treated since the high level of salts would not permit bacterial activity

The final effluent should be discharged into the receiving body by dilution perpendicular to the direction of the flow, in order to minimize even further the environmental impact, which in itself is already quite small

c Effluent from boiler demineralization and blowdown

The effluent from the boiler feedwater demineralization system should be carried to the plant's general treatment station, where it will be diluted in the latter, until the concentrations established for sodium chloride by current discharge standards are reached

The boiler blowdown waters generally present excellent chemical quality and do not require treatment, they can be therefore be sent directly to the river water treatment station (for recycling) Their flow is small, their pH is between 9 6 and 10, and their concentrations of salts are low (less than 0 1 mg/l) Therefore, the only treatment that is recommended is pH correction

d Effluent from cleaning the equipment

In order to mitigate the impact of the effluent stemming from the cleaning of the boilers, its pH should be increased to 8 0, which is the least-solubility level for most metals Thereafter, a polyelectrolyte is added to provoke metal flocculation After sedimentation, the effluent will virtually contain only sodium chloride This liquid could be discharged into the receiving body, with a dilution so that discharge norms are complied with or so that the quality standards set for the intake source are not exceeded The slush that has settled at the bottom of the basin should be densified, filtered, and conveniently disposed of in a landfill, an operation that is performed only a few times during the station's useful life

The effluent from the plant's internal washing, characterized by large amounts of suspended material, should be transferred to the plant's general effluent treatment station, after passing through a small duct with an oil filter Its flow is small compared to other water discharges

e Effluent from the cooling system

If the cooling system is open, thermal pollution can be avoided by transferring the effluent to conveniently sized cooling ponds, where the water is stored until, due to evaporation, its temperature reaches values that permit its return to the source

If the cooling system is closed (especially the wet tower), the mitigation measures can include the following

- Avoid the use of chromates and copper sulfate and restrict the use of zinc salts, although their doses are small and do not contribute to increase their concentrations beyond permissible levels

- Check the use of other chemical products, in order to maintain the application doses low, so that the water is not inappropriate for discharge into natural sources This is especially applicable to pH and hardness correctors, polyphosphates, phosphates, chlorine, and others Polyphosphates and phosphonates reach average concentrations of 10 ppm in tower blowdowns, and in the river they will be virtually imperceptible The same is applicable for zinc

- The salts that will be present in the runoff, in concentrations that are three times higher than the initial concentration, are salts coming from the river itself, therefore their return to the river will permit maintaining the source's initial conditions

It is important to recall that the runoff water that is returned to its source is treated water, that is, part of the pollution in the river will remain in the plant's crude water treatment station, including toxic metals, pesticides, and others As a rule, in well-operated thermoelectric stations, the quality of rivers does not suffer an appreciable impact

f Runoff from coal piles

The main problems of runoff from coal piles are their acidity and content of suspended and dissolved solids (metals and other toxic substances)

The acid runoff from coal piles can be avoided if coal pyrite oxidation is prevented There are basically two techniques to achieve this One consists of stimulating air circulation between the piles in order to foster the rapid removal of the heat generated This technique, nevertheless, enhances the seepage of rain water, leading to the entrainment of pollutants generated in the coal and pyrite oxidation process The second technique consists of preventing contact between oxygen and coal by compacting the piles In this method, oxidation is diminished because the exposed area compared to volume is reduced As a result, rain water seepage and entrainment of pollutants, which turn up in smaller amounts, are decreased The U S National Coal Association suggests that piles of over 450 tons of coal should be compacted

Some preventive measures to reduce oxidation and acid runoff are

- Construction of drainage ditches upstream from the piles to prevent runoff water from passing through the coal

- Location of piles in sites that are outside the natural course of surface runoff

- Checking for the flushing up of water, before using an area for coal storage

The main treatments for drainage effluent are lining, simple sedimentation, chemical neutralization, the addition of flocculants, the addition of polymers, aeration or mixture with other plant effluents More sophisticated techniques such as inverse osmosis, ion exchange or electrodialysis are only mentioned in the literature but are not used in practice

Lining the storage area is aimed at avoiding seepage of acid effluent and the resulting pollution in the ground strata It should be preceded by soil compacting and can involve plastic or a plastic sheeting, with a 15-centimeter sand or earth cover to prevent its tearing by the coal Care should be taken when using concrete, since sulfuric acid corrodes cement It is also suggested that metal channels and station entry pumps should be avoided and preference granted to gravitational flows

Equalization pond or pool performs various duties primary settling, partial neutralization of acid effluent peaks, and above all water storage with capacity for heavy rain This permits sizing the chemical treatment unit for a flow that is much lower than the one observed in the channels, since the effluent that is stored in the pool can be treated over several days

Retention of the effluent in the pool favors sedimentation of the suspended solids Nevertheless, this practice has demonstrated that simple sedimentation is not always sufficient to remove most of the ultrafine coal residues, which leads to turbid effluent In the case of acid effluents, the retention aggravates the problem of toxic metals, since their concentrations increase over time

If the pH of the equalization pond effluent is over 6 0 and if the SS and dissolved metal content is low, the effluent may be discharged into the river Otherwise, it should be transferred to the **chemical treatment unit** Lime or another alkali is added to the reaction tank to neutralize the action of sulfuric acid, while air is injected to oxidize the bivalent Fe to the trivalent Fe (iron hydroxide 3)

$$3CaCO_3 + 2FeSO_4 + H_2SO_4 + 1/2O_2 + 2H_2O \longrightarrow CaSO_4 + 2Fe(OH)3 + 3CO_2$$

After neutralizing and oxidizing the iron, the effluent passes to the settling tank, where the sulfates and metal hydroxides are deposited at the bottom, resulting in an optimal-quality effluent that can be discharged into the river

In order to speed up the settling process, two techniques are used adding a flocculant (alum, for example) or polyelectrolyte to the reaction tank or returning part of the output water (neutralized but not settled) to the unit's entrance In the first case, the alum or polyelectrolyte helps to form floccules under the action of the turbulence produced by the inblown air These floccules settle rapidly, producing a slush with up to 10% of solids In the second case, the floccules that have already been formed serve as aggregation nuclei for the formation of even larger floccules, leading to the formation of slush with up to 35% solids, with a high settling speed and an optimal-quality effluent The content of solids in the settled slush is important for its final disposal If it is low,

the slush has to be watered down before being disposed of in a landfill or over the stored coal In this case, the slush will be burnt along with the coal and will be collected by the air particulates intake system for its later dry disposal with the fly-ash

In practice, the removal of metals in the runoff is obtained by increasing the pH to appropriate values, which fluctuate between 7 5 and 10, according to the elements that are present Each metal has its minimum solubility pH and the ideal pH should be studied in terms of the metals to be removed For this purpose, the most sophisticated treatment is not always the most efficient It has been demonstrated that the simple addition of lime can help achieve removal efficiencies of over 99%, which is better than procedures based on soda, aluminum sulfate, and polymers (Table 6)

To reduce operating costs, in some stations the effluent from the coal piles is mixed with the effluent from the ash-carrier Indeed, a long period in the ash pond effectively neutralizes the effluent, and permits the insolubilization and precipitation of toxic metals

g Ash carrier effluent

After burning the coal in the station, its ash should be removed and disposed of in an appropriate site Of the two main types of ash, between 60 and 90% correspond to fly-ash and between 10 to 40% bottom-ash, depending on the combustion system used (see section on Air Quality Impacts)

Table 6
Treatment for the Drainage from the Coal
with the Addition of Lime
(Mine of Dalhousie, Canada Values in mg/l)

Parameter	Drainage of pile without treatment	Drainage of pile with treatment
pH (units)	1 2	7 7
Sulphate	49,600	1,575
Total phosphorus	300	0 02
Total arsenic	40	0 003
Total chromium	2 0	0 04
Total copper	8 0	0 04
Total iron	17 600	0 74
Total lead	0 2	0 05
Total nickel	7 8	0 08
Total zinc	14 5	0 02

106

Fly-ash is taken by anti-pollution equipment (baghouse filters, electrostatic precipitators, cyclones) and placed in dry storage in silos on the plant's site for its later disposal by dry or wet methods Bottom-ash, by contrast, falls into a pool located at the base of the furnace, where it is cooled and then carried by a wet or dry method to a silo where it is carried to the final disposal site

There are various ash-management combinations for removing ash from the plant Transport systems are classified as either wet or dry even though water consumption is also involved in the dry process

In the **dry process,** fly-ash is carried pneumatically to a silo These silos are very large and enable the storage of ash stemming from various days of operation Upon removal from the silo for disposal in a landfill, they are humidified until they reach a humidity level of 10-20% (in terms of weight), in order to facilitate their handling and avoid dust problems The fly-ash that is for sale is managed by a dry method to maintain its cementing properties In the case of bottom-ash, once it falls into the pool it is cooled and humidified without producing any liquid disposal (bottom-ash absorbs up to 35% of the water) The make-up water can come from anywhere in the plant The ash is removed from the pool by means of a conveyor belt to a silo, where it is taken by trucks or train In this case, there is no liquid effluent to be treated in the system, and it is therefore referred to as dry transport

In the **wet process,** bottom-ash is carried by water after grinding to a smaller size of 10 millimeters After being ground, the ash is carried by means of water jets in a solution with 1% content of solids to settling ponds or water bins (these are built in pairs, so that when one is used for settling or discharging the other is being filled)

After liquid-solid separation, the floating part, which is the clarified liquid of the upper part of the settlement basin, can be recycled In practice, however, constant blowdown is necessary in a flow that fluctuates with the coal and depends on ash leaching If this blowdown does not take place, there is a constant accumulation of salts in the system and scaling in the equipment Before its discharge into the river, this effluent should undergo treatment, as indicated below For the water transport of fly-ash, it is mixed in a jet of water until it reaches a 5% concentration of solids, and then it is carried to a settling pond The ash deposited in this pond are then removed and carried to a landfill or the pond itself can serve as the final disposal site The floating clarified liquid can be partially recycled and the rest discharged into the river after treatment From the environmental standpoint, the water management of ash involves the considerable advantage of eliminating noise, dust, and traffic problems stemming from the transport of ash by truck Among the drawbacks the following should be mentioned

- Danger of polluting ground waters with toxic elements if the settling ponds are not impermeable Waterproofing or lining the ponds is often quite expensive, as its cost can account for between 20 and 40% of the investment for the ash disposal system

- Production of a surface effluent (floating liquid), highly loaded with suspended and dissolved matter

- Recycling the pond's effluent requires channels, pumps, and maintenance, which also affects costs

- The embankments of the pond may burst, annihilating life in the affected rivers

The problem of scaling in ash-carrying systems is more severe in the case of fly-ash, since leaching is much greater than for bottom-ash Owing to the severity of the leaching problem as a source of pollution, the EPA has been discouraging the use of water methods for handling ash, especially fly-ash

The problems to be resolved for the effluent from the fly-ash transport system are similar to those for the effluent from the coal piles Suspended solids can be retained by passage of the effluent through settling ponds An ideal pond for this purpose would be one that retains 100% of suspended solids and whose effluent would be free from alien chemical substances

In practice this does not occur Some particulates require more time to settle than the time that the effluent remains in the pond But if the settling time is lengthened, conditions for the leaching of toxic metals are created

In pond sedimentation, the effluent remains more or less 24 hours in natural or artificial ponds lined by rubber, plastic, clay or bentonite in order to prevent the leached effluent from seeping A good-sized pond, from the hydraulic standpoint, permits obtaining an effluent with less than 30 mg/l of solids in suspension The dissolution of salts in the ash may require, nevertheless, an additional chemical treatment aimed at eliminating salts and leached metals during the time of retention in the pond

In stations that do not wish to install large ponds or have no free space available, laminar settling can be used This involves the passage of effluent through plastic pipes mounted in a module Within these pipes the flow regime is absolutely laminar, generating rapid sedimentation of the particulates The inclination of the pipes permits self-cleaning, and more than 95% of the suspended solids can be removed in one hour The hydraulic load applied to the laminar settlers in thermoelectric stations is on the order of 4 cubic meters per hour per square meter, which means an area 50 times smaller than what would be needed for a settling basin In case a chemical after-treatment is required, a unit equal to the one used to treat the effluent from the coal piles is installed In this case, the settling ponds considered here operate as primary settling basins The secondary settler requires a short retention time (less than 2 hours)

The sedimentation process is highly efficient in the case of ash-carrying effluent, especially bottom-ash, as indicated in the example of Table 7, where it can be noted that the final effluent has excellent conditions, with a lower amount of solids than the water taken at the source Nevertheless, in order to neutralize the acid pH (less than 6 0) of the effluent, an additional chemical treatment should be applied, or it should be mixed with another plant effluent whose pH would be capable of neutralizing it

108

Table 7
Characteristics of the Effluents Carrying Fly ash
and Bottom Ash before Sedimentation and
of the Combined Effluent after Settlement in Ponds
(Values in mg/l) Coal Fired Power Plants in the United States

Parameter	Water Taken in River	Affluent with Fly-ash	Affluent with Bottom ash	Pond Effluent
pH	6 3	4 4	5 6	4 3
Suspended solids	22	76 000	4 100	14
Aluminum	0 7	1,100	56	6
Chromium	0 04	1 3	0 1	0 04
Copper	0 04	5 1	0 3	0 1
Iron	0 5	2 500	112	0 6
Zinc	0 05	2 8	0 1	0 1

When the settling ponds operate at low efficiency, they have to be overhauled after this problem has been confirmed Sometimes, attempts are made to remodel the effluent entry and outlet system (distributing it along the respective face and avoiding punctual entry or exit) or to establish mechanisms that permit better flow distribution Sometimes, however, it is enough to increase the retention time, as indicated in Table 8

Table 8
Characteristics of the Affluents and Effluents of the
Settling Pond of the Dallman Power Plant in the U S A
Before and After Enlarging the Lake
(Except for pH and turbidity, values in mg/l)

Parameter	Affluent with bottom ash	Affluent with fly-ash	Combined Lake Affluent	Effluent before Lake Expansion (Ret = 1 d)	Effluent after Lake Expansion (Ret = 5 d)
Suspended solids	660-650	1500-41000	600-41000	900 1600	8 14
Iron	9 42	19 40	9 42	20 26	0 3-0 4
Aluminum	5-6	9 200	5-200	7 33	0 7-0 8
Zinc			0 1-4 8		0
Phosphorus			0 2-5 5	1-5	0
Turbidity (JTU)				8-1700	3 5
Color			15 30		10 15
pH			7 4-9 2		8 2 8-4

One alternative to ponds, which is being studied by energy concession-holders, is the use of water bins, or concrete tanks where the water/ash mixture settles for several hours The ash goes to the bottom, where it is extracted in the shape of a transportable lamina, while the clarified water spills and returns to the system to bring more ash to the station Because it operates as a closed circuit, this system has no discharge, which is favorable from the environmental standpoint

When the effluent from the ash pond has high levels of toxic metals, they have to be removed before discharge The treatment is based on the solubility of metals in terms of pH, and it is similar to the process for coal pile runoff referred to above A low pH causes the solubilization of metals such as Al, Cr, Cu, Fe, Hg and Zn, in the form of sulfates A pH of 8 5 to 9 0 is ideal for removal (precipitation in the form of metal hydroxide) of Cu, Cr, and Zn, but a pH of 10 is optimal to insolubilize Ni and Fe In order to minimize the level of all these materials, an ideal intermediate pH should be sought

h Household waste water

During the station's construction phase, owing to the large number of employees, the sewage effluent should be taken to compact sewage treatment stations As the estimated water consumption for sanitary purposes is 100 liters per day for a 350-MW plant, the total capacity of the stations should be 500 cubic meters per day In the operating phase, personnel needs involve about 250 employees, and the station's capacity should be 30 cubic meters per day The use of stabilization ponds is not advisable since they are not reliable for the total removal of pathogenic bacteria These needs may turn out to be smaller, if the sewage disposal and/or water treatment systems of the neighboring municipalities or city where the plant will be located are used

2 5 2 Air quality impacts

2.5 2.1 Identification and forecasting The effects of possible air pollution from a thermoelectric station has certainly provoked the most interest in terms of environmental impact The pollutants emitted mainly include sulfur dioxide (SO_2), particulate matter, nitrogen oxides (NOx), aldehydes, carbon monoxide (CO), and hydrocarbons (HC) In addition, the emissions can include trace elements contained in the fuels used In the atmosphere, photochemical reactions lead to new pollutants, such as ozone and peroxyacetyl nitrates (PANs), which cause smog The cooling system can generate substantial amounts of water steam, which is at the origin of fogs SO_2 and humid air can form sulfuric acid, which creates acid rain In addition, the burning of fossil fuels releases substantial amounts of carbon dioxide (CO_2) and gas, which although not toxic can play an important role in the formation of the greenhouse effect

Fuel burning is the main air pollution source of a thermoelectric station Knowledge about the fuel's composition permits estimating the amount of air needed for perfect combustion and, therefore, the volume of flue gases

110

The chemical composition of fuels varies over time, owing to their origin, in the case of oil and gas, or because of natural variations in the mine itself, in the case of coal Chemical analyses should especially show the contents of carbon, sulfur, chlorine, and nitrogen, calorie power, ash content, humidity, and content of trace elements such as Ca, Mg, Sb, As, B, Cd, Cr, Co, Cu, Fe, Pb, Mn, Mo, Ni, V, Zn, Se, Sr, Al, Zr, Be, Hg, and radioactive elements (in parts per million—ppm)

For oil, the ash content is small, under 1%, so that, in general, air particulate control equipment is not required The sulfur content, however, can be quite high, up to 7%, which requires a gas desulfurization system Vanadium in crude oil is also a problem because of the corrosion it provokes and its role as an acid rain catalyzer in the atmosphere High mercury contents have also been found in some crude oils

For coal, the ash content can reach up to 50%, which makes the use of electrostatic precipitators obligatory to retain particulate matter Sulfur contents vary between 0 2 and 7% in terms of weight, which could require a system to retain this pollutant Regarding trace elements, coal contains virtually the entire periodic table It should be recalled that the polluting potential of an element depends not only on its concentration but also its toxicity In 1975, coal-fired thermoelectric stations emitted 60% of the beryllium discharged into the atmosphere in the United States Today, this level declined to 30%, thanks to the rigorous control of particulates in the stations For the same reason, cadmium emissions fell from 400 tons in 1975 to 8 tons in 1990

Gas is the best fuel from the environmental standpoint, because of its low content of sulfur and trace elements and because it is does not produce soot when it is burned

Since the major atmospheric pollutants of thermoelectric stations come from only one single source (the burning of fuel), it is suggested that the impact analysis be done by pollutant rather than by source, in contrast to the recommendation for water impacts

a Sulfur dioxide

The major environmental problems caused by thermoelectric plants are sulfur emissions, in the case of oil-fired and coal-fired plants, and emissions of particulates in the case of coal The sulfur that exists naturally in the fuel is transformed during combustion in sulfur dioxides (SO_x) The most common of these oxides is sulfur dioxide (SO_2), a colorless gas that can be detected in concentrations on the order of 1,000 to 3,000 grams per cubic meter Beyond 10,000 grams per cubic meter, the gas is an irritant Virtually 95% of sulfur is released in the form of SO_2

The SO_2 emission is a direct impact of the thermoelectric stations on the air quality, especially considering its toxicity Moreover, it is a continuous impact with a duration that is equal to the plant's useful life, although its deposit on the ground and plants or its absorption by animals and man may generate long-term, and even irreversible effects on human health Nevertheless, as indicated below, the presence of SO_2 in the air can produce secondary effects, the most important of which is the formation of acid rain With modern control equipment, these problems may disappear

Until the late seventies, this gas caused severe environmental problems in the world's industrialized areas, including acid rain Nevertheless, in the eighties great strides were taken in developing gas scrubbers and their prices dropped considerably Today, avoiding the environmental impact of sulfur dioxide is hardly a political issue

In order to estimate the impact of SO_2 on air quality, the first step is to calculate the amount of SO_2 emitted, in accordance with the following formula

$$Q\ (SO_2) = 1\ 9 \times Mfuel \times Ts$$

where Q (SO_2) is the SO_2 mass emitted into the atmosphere by unit of time (kg/s), Mfuel is the fuel mass burnt by unit of time (kg/s) and Ts is the sulfur content in the fuel in terms of mass percentage

Another way of calculating is by using the specific emission factor for the fuel to be used, which can be determined experimentally as follows

$$Q\ (SO_2) = FE \times Mfuel$$

where FE is the emission factor in kg of SO_2 per kg of fuel

Once the SO_2 emission is known, the following step is a calculation of the concentration that the SO_2 would reach in the area's atmosphere in order to then assess its importance and determine the need for anti-pollution equipment For this purpose, computerized dispersion model techniques should be applied to simulate the pollutant discharged from the stack, which requires, in addition to emission rates, data on the region's atmospheric conditions, the characteristics of the gas, and the height and size of the stack

There are many models that can be used to forecast air quality The Gaussian plume model for continuous sources is probably the most well known The model to be used should be selected bearing in mind the characteristics of the surrounding surfaces of the future energy plant In fact there are models that take into account the presence of buildings, wet and dry deposit, and the presence of hills around the site Table 9 presents the most widely used and recommended models

All these models can forecast the concentration for various types of meteorological situations (wind direction, wind speed, atmospheric stability) and calculate the average annual, monthly, daily, and hourly concentration of a pollutant

It is important to emphasize that the results of this type of model depend largely on the meteorological input data, such as height of inversion layer, classes of stability, wind direction and speed The resulting concentrations of a pollutant may fluctuate by more than one order of magnitude, depending on the height of the inversion layer and wind direction and speed at the same distance of the emission source

112

Oftentimes there are no meteorological data, or they are available only for distinct sites and for a short period of time In this case, use of the short-term version of the above-mentioned models may be useful the worst meteorological case of maximum concentration at ground level per hour can be established

Generally, the worst scenario selected entails a meteorological situation in which the wind blows at a speed of 1 meter per second from the source to the receiving bodies, with the inversion layer located at the region's most frequent height, assuming the worst possible sulfur content forecast and with the plant operating at full capacity As a rule, a smoke-cloud situation is not taken into account, unless it is expected that this special meteorological situation will occur It is advisable to indicate the frequency of these unfavorable conditions, since they are sometimes so rare that they should be considered a "second-worst case"

The dispersion models cannot provide a concentration forecast when wind speed is under 1 meter per second If it is expected that this type of situation will be the most frequent, another type of model should be considered

b Suspended particulates

The emission of particulate matter (PM), also known as ash, dust, and soot, comes from the burning of any fossil fuel Impurities, silica, metal and carbon particles that are not burnt are entrained with the combustion gases, thus generating PM emissions In the case of gas-fired thermoelectric stations, this problem is virtually inexistent As for oil, if the oil is high-quality and the burning is well-controlled, the emissions are invisible and provoke little environmental damage In the case of coal, the situation may be critical, since the ash content can reach 50%, of which 70% is transformed into fly-ash In other words, for each 100 kg of burnt coal, there is a potential emission of 35 kg of ash

For the burning of oil, the emission is estimated at 0 1% of the burnt mass and is composed of unburnt fuel and carbonaceous matter, in addition to the impurities in the fuel Close to 80% of the particulates have a diameter of under 1 micra

The greatest direct impact of ash emitted by the thermoelectric stations is the presence of dust in its areas of influence, even within homes The most important indirect effect is the catalyzation of SO_2, transforming it into sulfuric acid Visibility is also affected by the particulate matter discharged into the air Relays and other electric contacts are damaged by dust, and factories are forced to filter the air that enters into their facilities With modern PM control equipment, these problems can disappear The problem of dust generated by the action of wind on coal piles is difficult to quantify but there are easy solutions that can be applied (see Mitigation)

As for SO_2, the first step to forecast air pollution by PM is to estimate the emission rate, which can be done using the following formula

Table 9

Some Gaussian Plume Dispersion Models

The first four models have been recommended by the Environmental Protection Agency of the United States and can be obtained from the National Technical Information Service, Department of Commerce of the United States The fifth model was recommended by the National Alternative Energy Agency of Italy

Name of the model	Description
VALLEY	Stable state Gaussian plume dispersion algorithm designed for calculating the concentration either for 24 hours or annually resulting from the emissions of up to 50 site and area sources Empirical dispersion coefficients are used and adjustments for elevation of the plume and for limited mixtures are included The height of the plume is adjusted according to assessment of the ground and classes of stability
COMPLEX I	The assumption of the dispersion in this model is based mainly on the Valley Model The height of the plume is adjusted by the method of close by collision under stable conditions and by the method of medium height under neutral or stable conditions Like the Valley model, the horizontal dispersion during the stable periods empirically includes the effects of the terrain
MPTER	Dispersion model to calculate the hourly or annual concentration in flat or slightly sloped terrain It bears in mind the height of the plume, aerial descent phenomena and possible chemical reactions It should not be used for complex topography
ISCST	It was designed to shape complex configurations of sources (site volume, and area) in areas with relative flat surfaces Algorithms of construction stellae are included to simulate the presence of buildings near the sources In this way it is possible to evaluate the disposal of emissions in the cooling towers
DIMULA	Gaussian plume dispersion model Calculates the annual and hourly concentration The last version takes into account the morphology of the terrain It also includes routines for evaluation without wind conditions or disposal rates

$$Q\ (PM) = FR \times Mfuel \times Tc$$

where Q (PM) is the mass of particulates emitted into the atmosphere by unit of time (kg/s), FR is the fraction of ash generated in the burning and that is discharged into the atmosphere, Mfuel is the mass of fuel burned by unit of time (kg/s), and Tc is the ash content of the fuel (% in mass) For the burning of oil FR = 1 For coal, FR fluctuates according to the characteristics of the combustion system Part of the ash goes into the atmosphere (fly-ash) and part remains at the bottom of the boilers (bottom-ash) On average, fly-ash is around 70%, that is its FR = 0 7

For the burning of coal, the emissions depend on the ash content of the fuel and the waste carbon, otherwise known as Conradson carbon Total emissions are given by the preceding formula with FR = 1 and Tashtot is the ash plus Conradson's carbon If more reliable data are lacking, the emission factors suggested by the EPA are used 7 kilos per one million cubic meters for gas and 1 2 kilos per 1,000 liters for oil

Once the emission rates are known, the following step is to calculate the concentrations that the PM will achieve in the area of influence, in order to then assess their importance and determine the need for control equipment For this purpose, the same dispersion model can be used for SO_2, under the same meteorological and flue conditions and for the same scenarios Nevertheless, the existence of a filter required by emission standards (if any) and the possible presence of desulfurizers should be taken into account, since these also retain particulates, as long as the concentration is not too high Thus, for an oil with 1 to 2% ash, the desulfurizer retains a large part of the ash but in the case of coal with 30-50% ash, the desulfurizer will be blocked by the particulates, which therefore would require a PM filter instead of a gas scrubber

c NOx, HC, aldehydes, CO and photochemical oxidants

In contrast to SO_2 and PM, which are formed independently, hydrocarbons (HC), carbon monoxide (CO), nitrogen oxides (NOx), and photochemical oxides are closely linked, whether in their formation or as precursors of each other Because of this they need to be studied together The control of CO, NOx, and HC emissions can be obtained optimizing the burning of fuel in the boilers Routine CO measurements in gases enable the quality of the fuel to be determined Low CO contents are reflected in low HC contents

The concentrations of these pollutants in the plumes of efficient thermoelectric stations are low and only produce adverse environmental effects when the plume overlaps the plume produced by cities with a high density of motor vehicle traffic

Nitrogen oxides (NOx)

Contrary to SO_2 emissions, which depend solely on the fuel's sulfur content, NOx emissions depend on the fuel's nitrogen content, the temperature of the flame, the surplus oxygen, the air/fuel proportion, the configuration of the air/fuel mix, the interaction between burners, the layout of the heat exchange surfaces, and the nitrogen in the combustion air Of the total NOx formed, part comes from the oxidation of nitrogen present in the combustion air, which is called "thermal NOx" The experience shows that, in the case of coal, hardly 20-50% of the emissions are thermal, in the case of oil, 50% of the emissions are thermal, and in burning gas, 100% of the emissions are thermal, in other words the fuel's nitrogen is of virtually no importance

There are various nitrogen oxides, but the most important in terms of ecological effects are nitric oxide (NO) and dioxide (NO_2) The major NOx sources are gasoline-driven automobiles and thermal boilers, which account for 90% of total emissions Of the nitrogen oxides that are emitted, close to 95% is nitric oxide (NO), followed by NO_2 and

115

other oxides In polluted atmospheres, the NO is transformed into NO_2, leading to a chain of reactions that are as yet not well understood and that produce photochemical oxidants Only the NOx emitted by the stack can be considered a direct impact capable of being controlled in plant processes The generation of photochemical oxidants and its corresponding effects is considered an indirect or secondary impact

Of the nitrogen oxides, only NO_2 is a danger for the environment Nevertheless, its effects are difficult to determine, because they almost always appear in combination with photochemical oxidants

The manufacturer of the boiler should be consulted for supplying the NOx flue emission rate If better data are lacking, the following emission factors can be used 12 5 kilos per 1,000 liters for crude oil, 0 177 kilos per 1,000 cubic meters for gas and 10 kilos per ton for coal Once the emission rates are known, the concentrations that the NO_2 can attain in the air within the plant's area of influence are calculated For this purpose, the same model used for SO_2 and PM can be used

Hydrocarbons (HC) and aldehydes

HC emissions depend on the same factors stated for NOx Most of the hydrocarbons emitted by the flues of the thermoelectric stations are not environmentally harmful The danger takes place when they react with NOx as a result of sunlight, forming photochemical oxidants such as ozone The only dangerous HC are the polynuclear aromatic hydrocarbons (PAHs), which are emitted during the burning of fuels at a low temperature The most well-known is benzo(alpha)pyrene, a carcinogen that has a great affinity for animal and human fat

Forecasting the impact can be done according to the procedure suggested for SO_2 In order to calculate the emission rates, the following factors can be used 0 09 kilo per ton for coal and 0 384 kilo per 1,000 liters for oil For gas, the emission is negligible

Aldehydes are organic compounds that are volatilized during combustion Its emissions can be estimated by means of the following factors 0 0022 kilo per ton for coal, 0 45 kilo per million cubic meters for gas, and 0 072 kilo per 1,000 liters for oil

Carbon monoxide (CO)

Just as for HC, CO is the outcome of the incomplete combustion of fuels, although motor vehicles account for 80% of its emissions CO also contributes to the formation of photochemical oxidants and in open environments its effects are small CO concentrations produced by thermoelectric stations are very low and do not exert a significant environmental impact

If required, their potential concentrations in the air can be estimated by the same procedure suggested for SO_2 The emissions factors to be used are 0 22 kilo per ton for coal and 0 0048 kilo per 1,000 liters for oil For gas, they are deemed to be negligible

116

Photochemical oxidants

Atmospheric oxidants, mainly ozone (O/3), peroxyacetyl nitrate (PAN), and nitrogen dioxide, are produced photochemically from hydrocarbons and NO, in the presence of sunlight These photochemical oxidants are capable of oxidizing reagents that are not easily oxidized by the O/2 Their concentrations depend on the concentration of reagents and meteorological factors such as light intensity, temperature, humidity and wind speed The initial reaction is the oxidation of the NO emitted by the motor vehicles and the plants, as indicated below

$$2NO + O_2 \longrightarrow 2NO_2$$

The NO_2 formed is photochemically very active, since it absorbs light in almost the entire spectrum When it absorbs ultra-violet light, the NO_2 dissociates and forms, among others, ozone and PAN, through complex reactions

Because they are secondary pollutants, the photochemical oxidants cannot be quantified on the basis of flue emissions They should be monitored and, if necessary, their precursors should be controlled, which is difficult in the case of NO One important fact recently observed and as yet not well explained is the decline of ozone concentration in the plume of high-efficiency thermoelectric stations This can be due to the fact that the ozone of the air reacts to the NO of the plume, leading to NO_2 and O_2

d Trace elements

Trace elements are minor elements found in the fuel in very small amounts, generally on the order of parts per million (ppm) Among these, the following should be mentioned antimony, barium, beryllium, boron, copper, fluor, lead, manganese, mercury, molybdenum, nickel, selenium, tellurium, thallium, tin, uranium, vanadium, zinc, thorium, and plutonium

The most volatile elements are gasified during combustion and are condensed on the fine particulates (under 1 micra) in the stack Thus, in addition to the direct danger that fine particulates represent for man, they also imply much danger as a result of the toxic elements that are absorbed, among which mercury and radioactive elements Until a few years ago, when electrostatic precipitators were inefficient, coal-fired thermoelectric stations were the major source of mercury in the air, especially around the plants The presence of trace elements in the gas is virtually nil In coal and oil, characteristic concentrations are as follows (in terms of ppm)

Metal	Coal	Crude oil
As	0 4 - 130	0 002 - 1 7
Cd	0 01 - 300	0 03 - 2
Pb	O 7 - 220	0 001 - 0 3
Hg	0 1 - 1 6	0 01 - 30

117

The emission of trace elements can be estimated on the basis of the fuel's chemical composition Depending on their behavior, these elements can be classified into four groups

Group I Elements carried in the ash and uniformly distributed on fly-ash and bottom-ash, thus its concentration is identical in both types of ash As a result, one single measure of concentration in ash or in coal provides the data needed for analyzing environmental impact Included in this group are Al, Ba, Be, Co, Cu, Fe, K, Mg, Mn, Mo, Ni, and Th For the elements of this group, atmospheric emissions are restricted to the amounts of trace elements in fly-ash that is discharged through the stack There is virtually no emission in the form of gases

Group II These are elements whose compounds in coal have a boiling point that is lower or similar to the temperature in the combustion area, where, because of this, part of the element is volatilized Once in the stack, where the temperature of the gases is lower, the volatilized compounds are condensed on the surface of the fly-ash As a result, the concentration of this type of trace element declines in the bottom-ash and is enhanced in the fly-ash The elements in this group are Cr, Sn, Ti, U and V

Group III. These are elements whose compounds in coal have boiling temperatures that are much lower than the temperatures in the combustion area As a result, there is a considerable drop in their concentration in bottom-ash and a substantial rise in fly-ash In addition, part of the element manages to cross the low-temperature area prevailing in the stack (about 150°C) and is discharged into the atmosphere in the form of gas Quantification of losses in the form of gas is of the utmost importance for the study, since they account for at least about 15% of the mass of the element contained in the coal, whereas atmospheric emissions due to the inefficiency of the filter system account for about 3 5% The degree of volatilization of the elements of group III depend on the burning system, the time the ash remains in the combustion area, type of coal, and the path of the gases before they reach the atmosphere A longer course enhances the possibility that the elements will be absorbed by the particulates of fly-ash, thus reducing the volatilized fraction (light-end) Group III contains those elements that are most toxic to man, such as As, B, Cd, Pb, Sb, Se and Zn

Group IV These elements have such low boiling points that most of the element is discharged in the form of gas and only a small part is condensed on the particulates of fly-ash They involve Br, Cl, F and I, in addition to Hg They are virtually inexistent in bottom-ash, whereas a small part is retained and deposited on the minor particulates of fly-ash Close to 90% of Br, Cl, and F, 80% of I, and 95% of Hg are emitted in the form of gas

Once the emission of trace elements is known, its concentration in the air of the plant's area of influence can be estimated through the use of the same dispersion model used for SO_2 and PM

e Other secondary pollutants

This section will refer to two important secondary impacts mentioned in the preceding sections acid rain and the greenhouse effect

Acid rain

In the atmosphere, in the presence of water and catalyzing particulates of iron, nickel, vanadium or manganese and sunlight, SO_2 can be transformed into sulfuric acid in the form of aerosols and fall with rain If the atmosphere contains ammonia, the acid is neutralized, thus reducing its capacity to harm the atmosphere The most toxic sulfates after sulfuric acid are transition metal sulfates It is important to differentiate acid rain from acid emissions, which are discharged directly into the atmosphere by certain industries, such as the fertilizer industry, which emits fluosilicic and phosphoric acids In these cases, the acid rain occurs in the site of the industry, whereas in the case of the thermoelectric stations, it can occur as a rule more than 500 kilometers from the sulfur emission site

There are many effects attributed to acid rain destruction of forests, acidification of lakes, disappearance of fish and declining agricultural production, among others These effects began to be observed on a large scale as of 1970 and explain the fear that this phenomenon inspires among people

Apart from SO_2, other gases in the atmosphere can also produce, either naturally or artificially, acidity in rainfall This is the case for CO_2, which is dissolved in water thus producing carbonic acid (H_2CO_3) or nitrate sulfates generated naturally (volcanoes and swamps) or artificially, which when combined with water produce sulfuric or nitric acid Under conditions of equilibrium and clean atmosphere, the normal pH of rain is on the order of 5 6 If the atmosphere is rich in alkaline compounds (dust, for example), the rain can become alkaline, with a pH on the order of 9 0, as has occurred in certain areas of India The same occurs in regions subject to widespread biological decay processes, where ammonia production increase the pH of rain

Nevertheless, there is still much debate over the direct relationship between the artificial emission of sulfur and nitrogen and the acidity of rain The arguments cited to refute this linkage include the acidity of the rains of the Amazon forest (average of 4 6 over 100 measurements, with values of up to 3 6), as well as low pH values in regions far distant from industrial centers (Hawaii and northern Canada) and the evidence of rain with an under-five pH 350 years ago in the Himalayas and the Antarctic It should also be kept in mind that more than 60% of the sulfur in the atmosphere comes from natural sources and that large amounts of NOx are generated by lightning, bacteria, and forest fires (some sources claim that these sources in themselves would be enough to lower the pH of rain to 4 4-4 6) The arguments in favor indicate an appreciable decline of pH in the rain of industrialized regions such as northeastern United States, southern Norway (with possible origins in England and Germany), and Holland In this last country, a strong correlation between the pH of rain and annual SO_2 emission has been observed

119

Until now there is no mathematical model to predict acid rain generated by a thermoelectric station The most that can be done is to compare the area's global emissions, including the thermoelectric plant, with the emissions of a region where acid rain has been detected

Greenhouse effect

The so-called greenhouse effect refers to a possible increase in global temperature of the terrestrial atmosphere, produced by the growing concentration of CO_2 in the air, in turn stemming from industrial emissions, mainly from thermoelectric plants Carbon dioxide is the outcome of the complete burning of a fuel, and in an ideal thermoelectric plant it would be the only carbon oxide that would be present in the emission gases Nevertheless, a NASA report of March 1990 questions the existence of this phenomenon, inasmuch as the measurements of air temperature in 10,000 sites on the Earth's surface do not indicate any average increase in global temperature

f Visibility

Atmospheric visibility may be affected by SO_2 emissions and by the water steam from the cooling tower

The gradual oxidation of SO_2 increases the air concentration of sulfates, which are for the most part found in aerosols, from 0 1 to 1 0 microns Since visible light is between these wavelengths, light is heavily scattered by the sulfates, thus diminishing visibility (nitrates produce the same effect)

The speed of SO_2 transformation in sulfates is quite variable, although the estimates can be based on a rate of 0 2 to 1 5% per hour Because of this, a region's fog is caused by SO_2 discharged at hundreds or thousands of kilometers away, which makes identification of polluting sources quite difficult It should be recalled that the dispersal power of aerosols is related to air humidity and its chemical composition In Los Angeles in the United States, a direct relationship between the presence of aerosols in the air, especially sulfates and nitrates, and the deterioration of visibility has been observed A relationship between peak ozone concentration during the day and the content of sulfates responsible for the loss of visibility has also been observed This correlation is more marked on days with a relative air humidity of over 70%, which shows the photochemical character of the formation of sulfates In a research study conducted by the World Health Organization (WHO), a loss of visibility was observed for SO_2 and PM observations over 100 grams per cubic meter, air humidity over 50%, and high temperature The decline of visibility in the atmosphere of polluted cities causes an increase of up to 20% in the consumption of electric power for lighting and heating

Predicting the impact of SO_2 and sulfates on visible is difficult to quantify Nonetheless, it is suggested that, before installing any new thermoelectric station, the visibility of the area to be affected should be analyzed, for which purpose photographic, contrast, telephotometry, and transmitometry techniques can be used These measures can serve

to protect a thermoelectric station under construction, because the negative atmospheric effects can already be occurring due to other pollution sources located hundreds of kilometers away from the plant

In addition, operation of the wet cooling towers provokes water steam emissions, which can form fogs with plumes of up to five kilometers long from the plant In certain regions of Canada and the United States, fog occurs in 80% of winter mornings, severely obstructing the circulation of ships, motor vehicles, and airplanes This fog is closely related to the air's relative humidity in the region

The fogs are also deemed responsible for increasing the acidity of rain downwind from the cooling towers, owing to the interaction between the humidity coming from the towers and the SO_2 coming from the stack Water steam emission is also responsible for increases in the surrounding area's cloudiness and rainfall In some plants, damage to the vegetation has been reported around the cooling towers, because of the chromates used as anti-corrosive agents in the cooling system and carried by the drift from the tower

As a result, in order to estimate the impact due to the fog, it is necessary to consider the characteristics of the cooling towers (height), the volume of the steam to be released, air humidity, wind direction and speed, and the uses of soil or activities of the region (agriculture, transport, others) that can be affected

2.5 2.2 Assessment methodology The simplest way to assess the impact consists of conducting a comparison with accepted laws, regulations, and norms Regarding the major air pollutants, the most advanced countries adopt at least three types of legislation

a The air quality criteria or standards, which limit pollutant concentrations for specific sample times These criteria were established on the basis of observations of the pollutant-disease ratio and strive to protect the population's health These are the so-called first criteria, which should be complied with obligatorily In some countries there are secondary standards, that seek to preserve the population's general welfare These standards are desirable but not mandatory Table 10 shows air quality criteria for SO2, PM, and other pollutants that are proper to thermoelectric stations

b In the eighties, emission patterns and standards were adopted in most industrialized countries, in order to diminish the load of pollutants discharged into the atmosphere There are various inter-related ways of expressing this set of standards In the United States and other countries, this standard is stated in terms of the pollutant load emitted by the burning of one fuel unit, divided by the energy contained in this same unit Table 11 shows the emission standards for SO2 and PM in several selected countries It should be noted that in Sweden the emission standard is stated in terms of the pollutant load contained the combustion gases These types of legislation, which restrict emissions, exert a considerable impact on

Table 10 Criteria for Air Quality in Selected Countries for Pollutants Typical of Thermoelectric Power Plants ($\mu g/m^3$)			
Parameter	Primary (for health)		Secondary (for welfare)
	Sampling time	Concentration	Concentration
SO_2	Annual arithmetic mean 24 hours (a) 3 hours (a)	 80 365	 60 269
Total PM	Annual geometric mean 24 hours	 75 260	 1,300 60
PM < 10 µm	Annual geometric mean 24 hours	 50 150	
CO	8 hours (a) 1 hour (a)	10 mg/m^3 40 mg/m^3	
NO_2	Annual arithmetic mean	100	100
O_3	Max day 1 hour average	235	235

SOURCE National Air Quality and Emissions Trend Report 1988 USEPA
(a) Not to be exceeded more than once a year

some types of fuels It may be more economical to transport a coal that has a lower sulfur content and higher calorie power over long distances than to use a nearby coal that involves lower extraction costs but has a higher sulfur content and lower calorie power, thus requiring a gas scrubber with an over-90% efficiency

c One kind of more advanced legislation is the so-called Prevention of Significant Deterioration of the Air Quality Law of the United States This law provides for a maximum increase in the concentration of a given air pollutant that a thermoelectric plant can produce, according to the site For example, in the United States, although the air quality criterion in a nonpreservation zone is 365 grams per cubic meter for SO2, a thermoelectric plant can only increase already existing pollution measured over 24 hours by 91 grams per cubic meter, for the annual average, the maximum permissible increment is 20 grams per cubic meter for areas not considered protection areas In the case of PM, the permissible increases are 37 grams per cubic meter for daily measurements and 19 grams per cubic meter for the annual average, in areas that are not environmental

There are quality criteria established for trace elements Table 12 provides a summary of several countries The inclusion of American total limit values (TLV) is aimed at estimating a maximum concentration for the minor air pollutants, when there is no

122

specific legislation By dividing the TLVs by 100, the quality criteria for 24 hours in countries that had already adopted the specific legislation are obtained In the case of chrome, for example, the TLV/100 is 1 gram per cubic meter' whereas in Russia and Yugoslavia 1 5 grams per cubic meter is permitted For the beryllium, the TLV is 0 02 gram per cubic meter, whereas Israel and Yugoslavia, 0 01 gram per cubic meter It is suggested that, in the absence of legislation, the TLV values divided by 100 should be adopted TLVs are air pollutant concentrations which supposedly almost all workers are repeatedly exposed to, day after day, in a 40-hour work week without adverse health effects The TLV are valid within industry limits Outside these limits, there are environmental air quality standards

If the area under study has no air quality legislation, it is necessary to consult legal authorities in order to determine who is legally competent to establish norms There are cases where agencies that are not empowered to establish norms do so after the plant has begun operating, thus leading to conflicts that can last for years Likewise, it should be verified if there are plans to modify current legislation The EIA should indicate that meeting emission standards (how much can be discharged into the atmosphere) does not mean that air quality standards are not complied with or vice-versa A high smokestack may lead to an imperceptible SO_2 concentration on the ground, although its emission through the stack is over 1,000 ng/J, which violates the emission norm (1 21 lb/MBTU = 520 ng/J) Another assessment criterion is to adopt norms established by international agencies (WHO or others)

Table 11
Emission Standards for SO_2 and Particulate Matter in Selected Countries

Country	SO_2	Particulate Material
United States - Coal - Petroleum/gas	1 21 lb/MBTU (1) < 0 6 lb/MBTU (2) 0 80 lb/MBTU (1) < 2 20 lb/MBTU (3)	0 031 lb/MBTU
France	2 21 lb/MBTU	
Germany	1 71 lb/MBTU	
Sweden	2,400 mg/Nm^3	
Europe	100/150 mg/Nm^3	

(1) Plus gas scrubber with 90% efficiency
(2) If under this value, a scrubber with 70% efficiency
(3) If under this value, filter not required
MBTU = Million BTUs (British Thermal Unit), J = July

Table 12
Environmental Air Quality Criteria for Trace Elements
and TLV values, all in $\mu g/mg^3$ in Various Countries

Element	Quality criteria (24 hours)	TLV (e)
Arsenic	3 0 (f,h,l,m), 6 0 (g)	500
Barium		500
Beryllium	0 01 (g,h)	2
Bromium		700
Cadmium	3 0 (h)	100
Copper		100
Chromium	1 5 (f,g,h)	100
Fluoride		200
Iodine		1,000
Mercury	0 3 (f,h), 1 0 (g,i)	10
Nickel		1,000
Lead	0 7 (f) 1 0 (j,k), 5 0 (g), 10 (i)	200
Selenium		200
Titanium		15,000
Uranium		50
Vanadium	2 0 (f), 3 0 (h)	100
Zinc		5,000

e=United States, f=Russia, g=Israel, h=Yugoslavia, j=Romania, k=Hungary, l=Poland

NOTE For elements which do not have a quality criteria, it is suggested to use TLV/100 The criteria for air quality are for 24-hour measurements

2.5.2 3 Mitigation Measures

2.5 2.3 1 For SO_2

To mitigate the impacts caused by sulfur emissions, gas desulfurizers or scrubbers are used, their function is to retain compounds such as SO_2 Once the SO_2 concentrations in the air are calculated, assuming that the plant does not use filters, and comparing these values with the maximum legally permissible values (to see if they are over the limit), the calculation has to be repeated assuming the existence of filters with a given efficiency, until quality standards are reached

If the region has SO_2 emission standards, it is possible that the plant will be obliged to install filters, even if air quality is good For this purpose, it is necessary to calculate the fuel's emission factor to be used and compare it with current emission standards Afterwards the minimum efficiency of the sulfur retention system should be determined so that the fuel can be used without violating the emission standard These calculations should be repeated for other possible alternatives

124

Nevertheless, the simple existence of emission standards can oblige the plant to install a desulfurizer (in the United States, plants are obliged to install filters with 90% efficiency)

The EIA should contain a brief description of the equipment to be used, indicating how it works, its efficiency, where it has already been used, its reliability and its investment cost There are at least 50 patented flue gas desulfurization systems (FGD), although most are based on wet scrubbing processing, with alkaline water (Ca, Mg or Na) Dry scrubbing processes are less expensive but their efficiency is lower The price of a traditional wet scrubber for a 350-MW thermoelectric plant is on the order of US$60 million, although costs are declining annually

For those elements that have no quality standard, it is suggested that the TLV/100 be taken Air quality patterns are measured over 24 hours

The dimensions of a desulfurizer are larger than the plant itself In addition, it consumes between 2 and 15% of the energy generated in the plant (operating cost) and, depending on the technology, may require space for settling ponds It is therefore important not to underestimate the size of the equipment, since there may not be enough physical space

In the United States, the use of desulfurizers has become compulsory owing to the high SO_2 concentrations in the air and the frequency of acid rains, compared to the also high SO_2 emissions from the thermoelectric plants 10 million tons per year only in northeastern United States, for a total of 27 million tons per year along with the other sources This situation is evidently not the same in most countries and regions of Latin America and the Caribbean In addition, the year-round foliage and vegetation of a large intertropical zone can produce ammonia in quantities that are sufficient to neutralize SO_2 emissions and acid rain formation The dust from the alkaline soils characteristic of some tropical areas also exert a neutralizing effect

With these considerations and in view of the political will to develop certain nonindustrialized areas, emission standards could be relaxed, at least temporarily, as long as air quality is maintained This is particularly valid for places with a good atmospheric dispersion, low air pollution levels, that burn fuels with low sulfur contents, and that generation SO_2 concentrations in the air that are below quality criteria The high investments needed to obtain a very small benefit could therefore be channeled, for the time being, toward needier sectors, without implying that in the future the plant will not have its gas scrubber For these cases, a possible strategy could be set up using the following mitigation measures

a To install a high smokestack, so that plant emissions are not felt at ground level The cost of this solution is low and easy to implement, even for operating plants (less than US$1 million to build a 150-meter-high smokestack)

b To maintain strategic deposits of fuel with low sulfur content to be burned when atmospheric conditions are unfavorable for the dispersion of pollutants (high stability, thermal inversions or others)

125

c To reduce electric power generation when the meteorological conditions are unfavorable, for which purpose an adequate coordination should be established with the national interconnected system's management

d To reserve in the area of the thermoelectric plant a sufficiently large space for the future installation of a gas scrubber

e To install an acid rain monitoring network within a radius of 200 to 400 kilometers of the plant, to supervise the evolution of the rain quality before and after the station is commissioned If the emissions acidify the environment, the thermoelectric station should immediately install gas scrubbers

f To monitor the region's fauna and flora to detect indices of acid rain

g To monitor wet and dry deposits within a radius of 50 kilometers around the smokestack

2 5.2 3.2 Particulate matter (PM)

The major PM control systems are as follows

a Cyclones used in the coal-fired thermoelectric stations to remove particulates that are larger than 50-100 micrometers Its efficiency attains 70%, which is not sufficient

b Gas scrubbers, also used to remove particulates For coal ash, its efficiency reaches 99% For oil ash, the efficiency is hardly 80-85%, because its emissions contain a high proportion of minor particulates of 3 micras, for which the efficiency of scrubbers is low

c Electrostatic precipitators, exclusively aimed at retaining combustion gas particulates, which are ionized by a jet of electrons and then taken by electrified plates placed before the smokestack Its efficiency can reach up to 99 8%, although for coals with low sulfur content, it is lower, making it obligatory to use additives in the combustion gas

d Baghouse filters, in which the combustion gas passes through a bag where even the finest particulates are taken Its efficiency can attain up to 99 99% and its cost is similar to that of the electrostatic precipitator, although its maintenance is more expensive because of the continuous need to change bags

The price of bag filters with an efficiency of 99 9% is on the order of US$60 per kilowatt The electrostatic precipitators with a similar efficiency cost US$150 per kilowatt, but with an efficiency of 99 5% they cost US$85 per kilowatt and with 98% efficiency about US$30 per kilowatt

126

2.5 2.3 3 Nitrogen oxides (NOx)

There are no gas scrubbers that have a high efficiency in NOx removal The only feasible alternatives are high smokestacks and new boilers (burning systems)

The cyclone-type burners, introduced in 1940, are very efficient for coals with a high ash content, but their NOx emissions are high In order to reduce these emissions a tangential burning system was introduced a few years ago, which reduced the NOx emissions by one third of their value This technique involves technological problems at first, such as the high corrosion of inner walls, increase in ash volume, and loss of the boiler's efficiency, among others These problems were already resolved by some boiler manufacturers, and tangential burning is recommended at present to reduce NOx emissions

The reduction of NOx emissions by means of thermal excitation can be achieved through the following a) the recirculation of combustion gases, b) phase combustion, c) water or steam injection, d) preheating reduction, e) reduction of the heat emission rate Water or steam injection techniques or air preheating reduction are not used in practice, since they imply a loss of the system's efficiency The recirculation of combustion gases turned out to be inefficient in the case of coal burning

The reduction of NOx stemming from the N in coal or oil can be achieved by various methods a) use of a fuel with low N content, b) reduction of surplus air, c) phase combustion The use of a fuel with low N content entails few advantages in the case of coal, since this parameter varies very little from one coal to another The reactions between the fuel's nitrogen and oxygen are delayed, burning as much fuel as possible in an oxygen-deficient atmosphere This is done by limiting the combustion air that is being supplied next to the burners and directing the air outside the flame zone, by means of which the mixture of N volatilized with the air (at high temperatures) is limited When the fuel's nitrogen is volatilized in the absence of air and at a high temperature, most of the N of the hydrocarbons is reduced to molecular N On the basis of this, the generation of NOx is limited by the Zeldovich reaction (thermal excitement)

The oxygen deficiency that constrains NOx formation is also unfavorable for complete fuel oxidation Therefore, contact between the fuel and the oxygen should be enhanced before the gases leave the furnace This is achieved by recirculating the fuel-rich flame in an air-rich zone As the fuel-rich gases are cooled, irradiating thermal energy, the gases flow toward the air-rich area and combustion is completed at a temperature that is less favorable for NOx formation This is the principle of phase combustion Table 13 shows a summary of the efficiency of the various NOx control techniques in the burning of gas, oil, and coal

In a combustion technique with low oxygen surplus, a minimum amount possible of surplus air is supplied to the combustion Some experiments show that the important factor to be controlled is the oxygen content in the combustion gases If the oxygen in these gases is reduced from 4 to 2%, a 30 to 40% reduction in NOx emissions is

Table 13
Efficiency of Different Control Methods for NO_x Emissions

Category	Method	Reduction in NO_x (%)		
		Gas	Petrol	Coal
Prevention of thermal NO_x	Recirculation of gases	60	20	--
	Reduction in preheating	50	40	-
	Water/steam injection	60	40	-
Prevention of thermal NO_x and fuel NO_x	Combustion by stages	55	40	--
	- Lowering excess air	20	20	20
	- Reduction rate of heat liberation	20	20	20
Prevention of fuel NO_x	Change to fuel with lower N content	--	40	20

obtained, depending on the type of furnace Other experiments have shown that the reduction of surplus air in the primary combustion zone can diminish NOx emissions by 60% and that the addition of 20% of air away from the front of the flame increases carbon combustion efficiency from 98 to 99 2%, with the same NOx reduction The burning of low surplus air requires reasonable uniformity in the air-fuel ratio in all the burners, in order to avoid incomplete combustion With pulverized coal, this balance is difficult to obtain, since, in general, a furnace has various burners, this requires special control equipment and careful supervision to avoid explosions, CO, smoke, hydrocarbons, and incomplete combustion The excess of air can be reduced until the CO level reaches 200 ppm, at which point smoke problems begin to occur

In phase combustion, 85 to 95% of the stoichiometric air is admitted into the flame through the burner's neck, the remaining air is injected through the openings placed above the burners Reductions of up to 50% in NOx emissions have been observed Various mechanisms contribute to this reduction first, the lack of oxygen for NOx formation when the main flame operates under sub-stoichiometric conditions, second, a lower flame temperature than that of normal combustion, third, a time of residence in the region of maximum temperature lower than normal combustion In furnaces that already exist, the upper burner can be withdrawn and transformed into an air entry With this, operating burners work under sub-stoichiometric conditions This technique was tested by the TVA in the United States in 16 wall-fired coal furnaces, in which transformation of the upper burner into a secondary air entrance produced a reduction of up to 50% in NOx emissions

128

Layout and spacing of burners are also important Very close burners increase flame temperature and lead to high NOx emissions Burners located at the sides of the furnace produce flames tangential to a circle in the middle of the boiler Thus, the flame of each burner has little chance to interact with the flame of other burners, producing a lower temperature and a lower energy emission rate Thus, tangential burning enables reductions of up to 40% in NOx emissions

Phase combustion is obtained by adding a single air entrance above the burners One important change in modern burners compared to the original tangential burners is the distribution of secondary air into two jets one that goes around the flame (secondary wall) and the other which is directed parallel to the wall Variations in the proportion of secondary air that is directed next to the wall, at the angle of this air with the flame's angle and in the form of a primary air emission peak, considerably influence NOx emissions Experience shows that minor emissions occur when 80% of the secondary air is directed next to the wall and at the same angle of the flame as the horizontal flame

2.5 2.3 4 Trace elements There is no specific technology for retaining trace elements If trace elements are associated to particulate matter, the particulate retention filters also remove microelements

As for trace elements that are volatilized, only gas scrubbers are capable of retaining them, even though they are never used specifically for this purpose The efficiency of gas scrubbers in removing trace elements can achieve 99% in the case of coal and 85% for oil In mercury, the efficiency drops to 60% in some cases

If an element is present in a relatively high proportion in coal or oil and is a potential pollutant, one alternative consists of seeking other types of coal or oil where the element is present in a lower concentration

Upgrading coal is also a way of reducing the content of some trace elements On occasion, it is worthwhile to upgrade a coal, so that a small part of the energy is lost in exchange for greater retention of trace elements in the waste discharged

One efficient and relatively inexpensive technique to control the concentration of trace elements in the air at ground level consists of installing high smokestacks Although the amount of trace elements discharged into the atmosphere does not change, the air quality standards in the plant's surroundings are complied with

2.5.3 Impacts on noise levels

2.5.3 1 Identification and forecasting Controlling noise from geothermal resource development is important to ensure both worker health and safety and community acceptance Noise exerts a direct impact that is temporary (linked to the operation of machinery), capable of being mitigated, cumulative (if there are other noise sources), and capable of exerting a irreversible effect on the health of exposed persons

Noise sources generally associated with the construction and operation of a thermoelectric station are related to the machinery used in the various operations As a result, the expected sound levels depend on the characteristics of each equipment and its operating conditions

In order to forecast the noise level, the following steps are suggested

a Identification of existing activities and land uses that could be affected by noise from the plant

b Determination, with the help of an equipment manufacturer, of the noise levels generated by each equipment and its levels at different distances, especially in nearby sensitive areas

c Addition of the expected noise level as a result of the installation of the thermoelectric station to the current noise level in sensitive areas

Sound at the receptor level (sensitive areas) may be forecast by using the following relationship

$$L = LO - DS - DA - DG - DE - DF$$

where

L is the noise level expressed as Leq at the receptor in dB(A)

LO is the basic noise level of the source

DS is the attenuation due to geometric spreading, that is,

$$DS = 20LOG\ (d_2/d_1)$$

where

d_2 is the distance of the receiver from the source and

d_1 is the distance at which L was measured, that is, wave divergence reduces sound pressure level by 6 dB every time the distance from the source doubles

DA is the attenuation due to air absorption

DG is the attenuation due to ground absorption

DE is the excess attenuation due to features such as natural or artificial barriers

DF is the correction to take account of sound reflection

130

There are many models using the above-mentioned equation to assess sound pressure at receptors, although a first estimate may be given very rapidly Of the above-mentioned factors that affect noise volume, the primary factors are distance and barriers The distance effect may be evaluated as shown above, and barriers generally abate noise level by 5 to 10 dB (see Harris)

The other above-mentioned factors become significant when distances between source and receiver become large (more than 300-400 meters) In these cases, the utilization of more sophisticated models is necessary and knowledge of emission spectra is required

2.5.3.2 Assessment. Noise is one of the major environmental problems of modern life, one over which legislators, for a long time, have had the least power Unfortunately, it is inseparable from normal human activities and urban growth Only recently has it been regulated by specific legislation

The legal aspects of community noise control range from general laws against public nuisances to detailed laws and regulations that limit the noise that a given source may make and land-use restriction designed to protect noise-sensitive land use

Since local laws and regulations are generally absent or difficult to apply, the following criteria may be applied for the assessing noise

The environmental impact of noise can have several effects, ranging from hearing loss to annoyance A noise problem is said to exist when noise interferes with human activities Specifically, sufficiently loud noise may

1 Damage hearing or health

2 Interfere with work chores

3 Interfere with speech communication

4 Interfere with sleep

5 Cause annoyance

Table 14 provides the generally accepted damage risk criteria for hearing The generally accepted noise level to date has been that, if the ear is exposed to 90 dB(A) Leq for 8 hours per day over 20 years, permanent deafness will occur Further studies have concluded that there is a risk of partial hearing loss leading to possible permanent hearing damage after 40 years of exposure to steady daily noise level of 75 dB(A) Leq for 8 hours per day

In communities, noise control annoyance and physiological damage may occur at a much lower noise level

Table 14 Criteria on Risks for Hearing Loss	
Maximum permissible duration per day, h	**Level of Noise dB(A)**
8	90
6	92
4	95
3	97
2	100
1 5	102
1	105
0 5	110
0 25 or less	115 (maximum)

Studies on sleeping people have shown that noise affects sleep in a number of ways, including shortening the sleeping period and increasing the number of awakenings The question of adaptation to noise has also been studied Although some adaptation seems to occur for low intensity levels, there seems to be little or no adaptation to noise levels above 60 dB(A) indoors

In addition to the direct effects of noise on health, sleep, and communication, there are indirect effects of annoyance which are related to the way a person feels about noise It has become common practice to base noise policy decisions or remedial actions on the cumulative percentage of people who describe their noise exposure as annoying or highly annoying Several noise scales have been established based on these responses Table 15 provides an example of this type of scale (drawn from Italian legislation)

2.5.3.3 Mitigation measures Most thermal plants do not exert a high sound impact If they do, especially during the construction phase, sound insulation measures can be adopted (temporary barriers) around the sources (compressors, diesel generators, hoists, trucks for transporting coal and ash, others) This is worth while especially if the plant is constructed close to populated or urban sites In addition, on-site construction workers and operators should take the necessary industrial safety precautions

2.5.4 Impacts on land resources

2 5.4 1 Identification and forecasting The major impacts of thermoelectric station on land resources come from land taking for the station's facilities and for the disposal of solid waste

132

Table 15 Maximum Advisable Level of External Noise				
Use of the land	**Maximum Level Leq in dB (A)**		**Maximum Difference between level of background before and afterwards Leq in dB(A)**	
	Day	**Night**	**Day**	**Night**
Very sensitive areas 1/	50	40	5	3
Residential areas	55	45	5	3
Mainly residential areas	60	50	5	3
Urban areas	65	55	5	3
Mainly industrial areas	70	60	5	3
Industrial areas	70	70	7	7

1/ Educational facilities, hospitals, clinics, theaters, churches, and protected wildlife areas

2.5.4 1.1 Land taking. The physical installations of a thermal plant covers a relatively small area compared to a hydropower or geothermal power plant Nevertheless, depending on the capacity to be installed and the technology to be used, this area can fluctuate between a few hectares and a bit more than ten As a result, forecasting the impact implies the following

a Determining the surface to be taken by the plant and its installations, namely, storage yards, treatment systems, settling ponds, etc

b Defining the quality of the soil to be occupied and its installations, in terms of quality for agricultural and livestock purposes If it is high-value agricultural and livestock land, the share to be taken of the total surface of such land in the region or municipality should be indicated

c Identifying and characterizing the land problems that might emerge or be triggered as a result of the station's installation, such as erosion, compacting, subsidence (if the plant is going to be built on organic or very compressible soils), slope destabilization, others

As a rule, all these impacts are direct and irreversible (total change in land conditions in the area to be affected)

133

2 5.4.1.2 Disposal of solid waste from the thermoelectric station There are various types of solid waste generated by a thermoelectric plant waste from restaurants (food remains), from maintenance workshops (pieces of iron, tin, wood, and others), from inside the plant (slush from the water treatment plant and demineralization system, soot from cleaning the equipment), from office trash and general cleaning (paper, earth, etc), and especially the waste from the desulfurizer and the ash (in the case of coal) The former are easy to eliminate but the latter require specialized procedures

a Ash disposal

Depending on the ash transport system used (see section 2 5 1 3 8), the ash to be disposed of may be either wet or dry The disposal system to be used largely depends on the humidity of the ash, in other words, its transport system inside the plant The disposal of wet ash can be done in settling ponds or landfills, whereas for dry ash landfills or piles on the ground can be used As described in the section Mitigation Measures, each system has its own technical specifications, violation of which will generate environmental problems In addition, ash, especially fly-ash, can be used as construction material or raw material for certain industries

The disposal of ash exerts a direct and irreversible impact on the ground, since it implies covering the ground or destroying it for the landfill or the settling ponds Nevertheless, over the medium and long term, rehabilitation of the landfill's surface plant covering can create conditions that are similar or better than the initial ones (in case of poor-quality lands, for example)

In addition to its impact on the ground, the inadequate disposal of this waste may generate important environmental impacts on the following environmental elements

- On the quality of ground water, which can be achieved by the leached elements coming from the ash piles, heavily loaded with salts and toxic metals

- On surface waters, whose turbidity and chemical characteristics can be affected by the entrainment coming from the ash piles

- On the landscape

Moreover, the use of ash as an additive in agriculture, both intentionally and involuntarily, by means of fly-ash deposit on the ground, may incur severe environmental damage In addition to the advantage of neutralizing the soil's acidity and supplying it with several micronutrients, ashes can exert a negative environmental impact on plants and animals Some elements are directly toxic for plants, others are toxic for men and animals that feed on them The selective absorption of trace elements contained in ash can damage the productivity of crops, as experiments conducted in advanced countries using coal have demonstrated

134

b Other waste

Waste from the boiler cleaning system and other electromechanical equipment has characteristics similar to those of ash, although its volume is comparatively very small Its impact is therefore similar, although lesser

The slush from the water treatment plant and the waste from the demineralization system hold no important toxic components and can be disposed of jointly with the ash or used as dust suppressors (dry disposal)

Household wastes, due to their organic components, generate foul smells during decomposition, and their leached elements are characterized by a high organic load, leading to the biological pollution of receiving surface waters and/or ground water

As a result of gas scrubbers (especially SO_2), the neutralization of sulfur compounds with calcareous materials has become a new source of substantial amounts of solid and/or liquid waste, whose inadequate disposal or treatment likewise generate impacts on land quality and the quality of ground and/or surface waters that receive their effluents

In order to adequately forecast the impact of the thermal plant's solid waste disposal, it is necessary

- To calculate the volume or quantity of solid waste to be produced by the plant and whose collection or disposal might have to be done on a daily, weekly, monthly, or yearly basis

- To analyze the disposal system to be used by the station for each class of waste and forecast the impact in terms of

  Surface to be taken for the landfills

  Modification of the characteristics of land relief and soil

  Danger of ground and surface water pollution by the leached elements and effluents from the landfills, in keeping with what was stated for the water impact and depending on the land's characteristics in the temporary or final disposal areas

  In order to know the polluting potential of ash and its leached elements and thus predict their impacts on soil and water, it would be advisable to simulate the process of ash decomposition as a result of weather, for which purpose there are laboratories where the ash alternately undergoes dry and wet climate As a result, the action of weather is speeded up and the natural action of several years is simulated over a two-week period

The impacts of disposing solid wastes on the ground are direct and irreversible

135

2 5.4 2 Assessment The assessment or appreciation of the importance of the impact on land taking is measured in terms of the proportion of fertile soils occupied by the plant or land fit for social uses or environmentally desirable The impact can be important if, for example, the station is going to take the only land in the region that has a high agricultural value Likewise, this importance can be measured by the magnitude of erosion problems, land compacting, or soil destabilization generated by the actions of the station's installation

Regarding the disposal of solid waste, the amount and chemical characteristics of these wastes are the basis for assessing their danger and/or the need for special disposal In addition, comparison with local regulations should permit an assessment of the impact's importance

2.5 4 3 Mitigation measures

2 5.4 3 1 Land taking Land taking can only involve fiscal, economic, or environmental compensatory measures to indemnify the municipality and local communities for the loss of a resource for its traditional activities

In order to stem potential land deterioration processes, it is possible to apply a series of well-known erosion control processes, slope stabilization, reforestation, and others

2 5.4.3 2 Solid waste disposal

a. Ash disposal

The mitigating measures are as follows

- Use of ash in the construction industry, as the base for highways, cement additive, raw material for shingles or tiles, the source of heavy metals (especially volatile), and others This use absorbs only a small part of the total ash generated and depends on actual marketing possibilities

- Disposal in settling basins (ponding) This is a popular and cheap method linked to a wet transport system, by means of which the ash is carried by water to a pond, where it settles and the surplus is returned to the plant The pond may serve as an intermediate or final disposal station In the latter case, after filling it has to be covered with impermeable material and earth and then replanted In addition, at the beginning of the process plans should be made to waterproof the pond with plastic or clay

  If ponding is used, the settling basins should be designed and built with appropriate hydraulic and land specifications, in order to ensure adequate settling speed and time, avoid seepage, prevent the bursting of dikes or their erosion and other aspects of interest In order to define the waste disposal project, information on the following aspects is required

136

Capacity of the site to withstand load without bursting the lower impermeable layers

Location of ground water level and its variation with meteorological conditions

Land permeability

Location of clay deposits that can be used for waterproofing

Risks of damage due to high water and floods

Quality of the ash-carrying effluent to determine the need for discharge and/or treatment

Speed of settling of the particulates for sizing the settling pond

Effects of an eventual break in the pond's embankments

If the settling ponds are not the final disposal site, it is necessary to periodically dredge the pond and carry the ash to the final disposal site (landfill)

Although the wet disposal system (in settling ponds or landfills) is relatively easy to apply and has the advantage of not generating dust, it does entail some drawbacks, among which the following

The volume required to dispose of the water-carried ash (or wet ash) is 1 5 to 2 times greater than the volume required for dry ash

It is very difficult to change the ash disposal site, if an ecological factor were to require this

The final disposal site should be previously waterproofed In sites where the landfills were not adequately waterproofed, the presence of As, Ba, Cr, Hg, Mo and Se has been reported in the ground water, in concentrations of up to 10 times the permissible level

Water consumption for hydraulically carrying and disposing ash is 15 times greater than what is required for the dry system Energy consumption is also twice as much

The process generates an enormous amount of effluent that contains trace elements, mainly heavy metals Because of this, the wet disposal of fly-ash is being gradually forbidden, at the same time, thorough recycling of the waste-ash-carrying effluent is being required

- Landfilling This technique can only be used if the ashes appear sufficiently solid for handling by machinery The operation covers the withdrawal of ash from the temporary settling pond (water transport) or from the silo (dry transport), transport, compacting in cells, immediate coverage with impermeable material and earth, and later restoration of plant covering In order to avoid ground water pollution problems, the landfill should be located in an area of low permeability and with deep ground water level, line the cells with material of low permeability, cover the ash with impermeable material and install drains around the landfill

  For building the ash fills, the same types of landfills used for solid household waste are available, namely

  Trench landfilling, where the ash is buried in diggings made for this purpose

  Slope landfilling (clump fills), used in hilly terrain and conveniently built to blend with the environment

  Area landfilling, by means of which gullies, dips, or natural depressions in the terrain are used Its major problem is controlling surface and ground waters, since water naturally flows through these depressions

  In the case of dry ash, pile disposal or adequately covered heaped hills can also be used on the terrain's natural surface This system is used where the land is flat and has the additional drawback of exerting a notable visual impact on the landscape

The disposal of dry-carried ash does not require waterproofing the fill's area and thus savings can be made, as long as a drainage system that prevents the penetration of runoff or ground water or the seepage of rainwater through the deposit or the heap is built With this system, the following additional advantages can be reckoned with

Pollution of ground and surface waters is minimal

Land recovery continues as the ash heap grows As the designed height of the heaps is reached, they are covered over with clayish soil and plants and their rehabilitation with plant cover is completed Thus, the area of exposed waste material is small

Water and energy consumption, as well as the generation of liquid effluents, is small Water consumption in the wet disposal system is several times higher

Compacted ash can be used as building material, therefore, a well-planned ash deposit can become a holding dam or levee

138

The volume required for the disposal of dry ash is smaller The density of highly compacted fly-ash is on the order of 1,400 kg/m3 or more, whereas the same ash at the bottom of a settling pond has a density on the order of 900 kg/m3 or less

Dry disposal permits an easier future recovery of ashes for both its use in construction and for the recovery of metals

Dry ash deposits can have a wider range of uses after being recovered than wet ash deposits In addition, the dry system is more flexible, since it permits the transport of ash for any site

Small, highly polluted flows, such as the effluents from the demineralizer and the cleaning of the boilers, can be safely disposed of, using them as dust suppressors

Among the drawbacks of dry transport and disposal, the following can be mentioned

Noise and dust generated by truck transport This problem can be resolved using covered conveyor belts

A manually controlled system is vulnerable and unreliable in the case of strikes or stoppages

The dry disposal process is generally more expensive than the wet system when the latter does not entail recycling the effluent But when recycling is included, the wet system may cost 70% more than the dry system

The permeability of fly-ash and bottom-ash differs widely For bottom-ash, typical permeability is 0 001 centimeter per second, whereas for fly-ash this rate drops down to between 0 000001 and 0 0000001 centimeter per second This can be taken advantage of in order to prevent the water that has seeped into the deposit from reaching great depths Fly-ash can be used to form horizontal layers within the deposit, with a slight sloping toward the drainage Thus, the water that has seeped can rapidly drain off away from the disposal area through the bottom-ash One thick layer of fly-ash can also be spread over the impermeable material and fly-ash can be used as the last layer of the deposit's covering, in order to reduce rainwater infiltration

- Mine disposal This is a special type of area landfill, used when in the immediate surroundings of an open-sky pit the ash is used to fill the mine, thus restoring the area to its original topographic conditions As in the other cases, this solution also requires the prior waterproofing of the pit to be filled, in order to avoid the seepage of leached elements

The slush produced in the water treatment plant and the boiler water demineralization system can be disposed of along with the ash

The application of different ash disposal techniques depends on local conditions such as the acceptability of settling ponds, the availability of water and land, legislation, the proximity of sites for landfills, and the possibility of marketing the ash

b Disposal of gas scrubber waste

The same principles used for disposing ash are also valid for disposing the solid waste from the gas scrubber Experience has shown that this waste has high contents of heavy metals and toxic substances (salts), which renders its disposal difficult In some countries, the plants sell this waste to gypsum manufacturers

c. Solid household waste

Food remnants (restaurant) can be sold to local pork farmers Recyclable material (paper, carton, tin cans, plastic, etc) can be sold to a recycling concession The rest can be carried to a manual sanitary landfill, if the station is located in a rural sector If it is in an urban area, its collection, transport, and disposal can be handled by the municipality's sanitation department

2.5.5 Impact on ecological resources

2.5.5.1 Identification and forecasting The probable environmental impacts on the biota include the following

2.5 5.1 1 Loss of habitat. The taking and clearing of land on the site to be used by the station's facilities, including those for effluent treatment (in the construction phase) and for solid waste disposal (in the operating phase), can lead to the loss of the local habitat and the destruction of native plants, when the plant will be located in a rural environment that has undergone little intervention by man (which is quite rare) This involves a direct and irreversible impact on the affected area

In order to quantify the potential impact, the surface covered by natural vegetation that will be affected should be determined. If necessary, the amount of affected trees and other plants, as well as animal species, should be estimated by means of direct or indirect methods

2.5.5.1.2 Effects of atmospheric pollution on the biota Few experimental studies have been conducted in Latin America and the Caribbean to determine the effects of pollutants on vegetation and fauna As a rule, it is known that the linkage between pollutants and plant damage is complex and involves factors that are as yet not well known The atmosphere generally contains more than one pollutant, and great caution should be applied when extrapolating the effects of scarcely one pollutant on the vegetation in environmental conditions

140

Indeed, the reactions of plants to different mixtures of pollutants can be cumulative (sum total of the effects), less than cumulative (antagonistic effects), or more than cumulative (synergic) In addition to the mixture of pollutants, the interaction of variable environmental factors (land, temperature, humidity, sunlight, etc) and the fluctuating doses of pollution condition the type and intensity of the impacts The effects of pollutants on plants can be visible or latent The visible effects appear as anomalous pigmentation (chlorosis or yellowing), morphological changes and necrosis The latent effects, more difficult to detect, involve growth and production changes or modifications in cellular processes (such as the production of TPN, the metabolism of nucleic acid or DNA activity), among others In addition, they can be positive or negative Acute lesions generally appear after a toxic dose of a pollutant, which could lead to necrosis Chronic lesions (visible but not involving necrosis) appear more frequently as a result of prolonged exposure to a pollutant in relatively low concentrations or a short exposure to high concentrations

a SO_2

Sulfur is one of the elements required for plant development Plants take sulfur from the soil or directly from the air, through stomas The demand for sulfur from the soil to achieve good crops varies from 10 to 40 kilos per hectare per year Because of this, at certain SO_2 concentrations or doses, even very high for crops such as tobacco, agricultural yields are considerably enhanced Nevertheless, as indicated in Table 16, beneficial or harmful concentrations fluctuate widely from one plant to another and change depending on meteorological conditions and the presence of other pollutants in the air (synergic, antagonistic, or other effects) Inside the plant, the SO_2 reacts with tissular water and is transformed into sulfites and biosulfites, which in turn are transformed into sulfates, which are 30 times more toxic than the former The accumulation of sulfates may reach phytotoxic levels, thus leading to the appearance of chronic visible lesions

Regarding the impact on animals, as a rule, concentrations that are 100 times higher than environmental concentrations are needed to kill small animals or 50 times higher to produce some effect on large animals Of all the pollutants generated by thermoelectric plants, only acid rain has provoked damage to animals, especially water animals and amphibians Toxological studies on SO_2 in laboratory animals indicated that sulfuric acid aerosol is more toxic than gaseous aerosol

b Acid rain

The effects of acid rain on plant life can be direct (by contact or absorption) or indirect, through the soil and the water As for SO_2, they can be visible (spots or patches on the foliage, necrosis) or elusive (declining growth rates in the woods and crops, germination of conifers affected) These may appear after many years Their effects on the soil is apparent especially in a decline of the soil's nitrogen content and edaphic breathing and an increase in the leaching of its nutrients or toxic elements, such as aluminum Sulfur concentrations in acid rain needed to stunt plant growth are quite lower than the concentrations needed to produce visible effects It is therefore possible that damage on foliage cannot be observed, but that growth is being stunted

141

Table 16
Some Effects of SO_2 on Vegetation

Plant	Concentrations	Effects
Tobacco	1,500 µg/m³	80% increase in weight of leaves
Sunflower	1,000 µg/m³	Increase in yield
Corn	500 µg/m³	Increase in yield
Pear	0 3 ppm	Pollination inhibited
Soybean	269 µg/m³ (6 h/d, 150 days)	Chronic lesions in leaves without decrease in productivity
Eucalyptus (Australian)	500 µg/m³ (24 h) 100 µg/m³ (40 d)	Visible damage Visible damage
Pines (USA)	1,600 µg/m³ (3 h)	Visible damage
Vegetables (USA)	800 µg/m³ (3 h)	Visible damage
Sensitive plants	0 5-2 0 ppm	Visible damage
Majority of plants	0 2 ppm (long exposure) (572 µg/m³)	For exposure under this, there are no lesions
Some mosses	0 02 ppm	Maximum bearable
Synergetic Effects		
Tobacco	600 µg/m³ SO_2 + 200 µg/m³ O_3	Severe damages Isolated action of each pollutant does not cause harm
Radishes, alfalfa	260 µg/m³ SO_2 + 200 µg/m³ O_3 (4 h) 130 µg/m³ SO_2+ 100 µg/m³ O_3 (8 h/d, 5 weeks)	Foliage damage Antagonistic effects in production drop

Plants most sensitive to SO_2 pines, soybean, wheat
Plants with a high demand of SO_2 corn, sunflower, cotton, tobacco
SOURCE various (see bibliography)

The crops that are most sensitive to acid rain include cereals such as rye, oats, soybean and wheat, vegetables such as beans, broccoli, carrots, lettuce, spinach, and cucumbers, flowers such as violets and zinnias, trees such as appletrees, elms, pear trees, and above all pine trees, the main victims of acid raid Certain crops can be stimulated in terms of yield at a pH level between 3 0 and 4 0, as is apparent in tomatoes, green peppers, strawberries, alfalfa, and pasture grass It has also been demonstrated that acidity levels found in the environmental air do not impair the germination process of several species of trees, on the contrary they stimulate this process possibly owing to the fertilizing effect of the sulfur and nitrogen from the rain

142

It seems that the moisture absorption capacity of foliage (or ease of moisture saturation) is one of the most important factors in plant response to acid rain Bean leaves are easily wet (rapidly absorbing humidity) and show lesions under rains with a pH of 3 0 to 3 5 By contrast, for the waxy leaves of critic plants, the damage only appears with a pH close to 2 0

Although laboratory experiences with rains that are far more acid than natural ones have indicated plant damage, in practice it has not yet been possible to accurately determine if acid rain is responsible for the damage to U S and European forests Scientists believe that acid rain may be one of the factors, in addition to ozone, hostile climate, disease, drought, and fungi

The most notable effects of acid rain are on water life Unpolluted waters contain dissolved calcium and magnesium bicarbonates, which can obstruct abrupt pH fluctuations Acid rain can destroy the lakes' capacity to maintain a constant pH, since it replaces bicarbonates for sulfates, which leads to growing acidity Disappearance and death of fish have been reported in the lakes of northern Europe and North America, where pH has dropped to values under 4 5

According to scientists, the acidity itself does not provoke the death of fish, but severely affects their spawn and fry (recently hatched fish or fingerlings), since they require a neutral medium to develop Thus the artificial acidification of the lake prevents the fish from reproducing and as the fish population ages, they disappear In addition, fish require a minimum content of salts to develop (mainly calcium potassium, and sodium), which are eliminated from the water by the acid, when the salts are no longer available (because they are missing or because acidity inhibits their absorption), the fish die Acid rain also provokes the dissolution of toxic elements, and high concentrations of Al, Mn, Zn, Cd, Pb, Cu, and Ni have been found in acidified lakes These metals damage the fish, oftentimes leading to death

In addition to the fish, other water species have also been affected by acid rain, especially, bacteria, algae, and invertebrates, whose decline affects the decomposition cycles of organic matter at the bottom of the lakes and, therefore, the supply of nutrients for water life

A drop in the amount of fish in turn affects the birds that feed on them, especially those that consume small fish (the first to disappear) and those that catch their fish by flying over the surface of the Jake Birds that fish by submerging their heads are less affected because their better visibility compensates for the lesser abundance of fish, since acidification enhances water transparency conditions Likewise, non-fish-eating ducks prefer acidified lakes because of the greater abundance of insects

The multiplication of insects in acid lakes depend on the species Some insects manage to reproduce at a pH of 4 0, although the variety of species is low, their biomass is high, due to the lack of their major predators, the fish But SO_2 exerts a negative impact on useful insects, such as bees Laboratory studies indicate that bees that have experienced

400 micrograms per cubic meter of SO_2 over 30 days grow slowly and are unable to fly long distances, in contrast to unaffected bees Because of this, the bee's reproductive capacity is impaired, since mating takes place in the air, in mid-flight, and the bee loses its capacity to catch minor insects that attack plants and which, due to the lack of predators, multiply far more than without pollution The pollination power of the bees is also affected, which could indirectly affect plant growth

c Particulate matter

The effects of fly-ash on plant life is restricted to areas that are adjacent to the sources, where deposits are large The effect basically consists of obstructing or preventing the breathing of plants and sunlight absorption If high-efficiency anti-pollution equipment is used, this problem will not arise

In stations that use low-efficiency filters, damage to grazing animals has been detected The literature cites cases of cattle grazing around coal-fired thermoelectric stations with worn teeth that prevent them from feeding properly As for the meat from these animals, studies conducted in the United States show that grazing animals are effectively polluted by the ash deposited on their grasses, therefore, periodical analyses to detect possible contamination by trace elements are recommended

d Other pollutants

NOx, CO, and HC concentrations produced by thermoelectric stations are low and do not exert adverse effects on the biota High concentrations of photochemical may cause severe effects on the biological environment, although it should be emphasized that these oxidants (including ozone) are not emitted by the plants Ozone in particular and PANs to a lesser extent are the most damaging pollutants for plants Ozone is at the origin of losses amounting to hundreds of millions of dollars per year in the agricultural sector of California, it has virtually eliminated 18 different crops

2.5 5 1.3 Thermal impact on the biota The efficiency of a thermal plant can amount to about 40% and the rest of the energy from the fuel is dissipated into the environment (atmosphere or river, depending on the cooling system) Dissipation in the atmosphere causes few problems, but dissipation in rivers leads to thermal pollution

Thermal pollution rarely causes the death of water organisms Pollution increases the oxygen consumption and heart rate of fish, affecting their appetite, digestion, and growth rate High temperatures make water organisms move more quickly, which leads to physical stress

Likewise, temperature is a critical factor for spawning and hatching during the spring, when the water's temperature rises naturally, inducing gonad development This is especially dramatic in estuaries, where oysters and shellfish spawn a few hours after the water reaches a critical temperature High temperatures also accelerate the hatching of fish eggs For trout, for example, the eggs hatch after 130 days at 3°C and after 30 days

144

at 12°C Thermal pollution does not substantially affect phytoplankton and zooplankton For algae, the impact is small if the temperature does not rise above 34°C Crustaceans die when the temperature reaches 35°C

Forecasting the impact of thermal pollution on the biota, when the plant uses the once-through cooling system, should be based on available literature and the region's past experience

2 5 5.2 Assessment For loss of habitat, the assessment should be based on the relative importance of the species found within the affected area presence of rare or endangered species, forests, or crops

Assessment of the impact of pollution on the biota can be based on two types of criteria

a Air quality criteria for wildlife established by legislation, if any The future estimated concentrations, as explained in the section on air quality impacts, should be compared with these standards, in order to determine if they will be exceeded or not If no legislation is applicable, the following maximum permissible levels should be used

For SO2 0 2 ppm (572 micrograms per cubic meter)

For acidity of lakes or rivers

Critically acid pH < 4 5

In danger of acidification pH 4 5-5 5

b Assessment of the impacts' importance based on existing bibliography and the analysis of plant and animal resources of the area of influence that can be affected As for acid rain, based on data from developed countries that experience this problem, it should be indicated that thermoelectric plant emissions are not enough to produce atmospheric acidity Regarding thermal pollution, the assessment should be conducted on the basis of available knowledge on acceptable temperature ranges for the area's fish species and bearing in mind the estimate of the temperature to be achieved by the waters of the receiving source

2.5 5 3 Mitigation measures As a rule, it is expected that, by applying the mitigation measures established to control air and water quality (see corresponding sections), the impacts on plant and animals will also be controlled, in accordance with standards currently in force

Nevertheless, some complementary measures could be necessary

a If a crop or livestock activity in the region is slightly affected and if meteorological mitigation measures have already been implemented, one alternative could be to provide technical assistance and economic support to the

campesinos so that they will change their crop or activity This alternative may be advantageous for the farmer or cattle-raiser and may incur a very low cost for the station The support could consist of supply of seed or calves (cattle or smaller livestock species), machinery, soil and climate studies in order to select the best alternative, fertilizer, and other

b Regarding acid rain, if there is any doubt about its possible occurrence, the company should commit itself to installing a gas scrubber, if this phenomenon were to appear In this case, there should be enough space for installing a desulfurizer In some industrialized countries that have lakes acidified by acid rain, alternative solutions have been applied, such as increasing the height of smokestacks (up to 400 meters in a copper foundry in Canada) and adding lime to the lakes

2 5 6 Socioeconomic impacts

2 5.6 1 Land use impacts

2.5 6.1 1 Identification and forecasting A thermoelectric station may generate an indirect impact, for example, it may induce urban expansion toward the plant (if the area is located on the outskirts) or may stimulate urbanization around it (if it is located in a rural sector) A land reappraisal process may take place around the station because of the services delivery potential for the plant's workers (housing, education, etc)

On the other hand, new uses can be affected by the potential pollution generated in the plant, especially if the areas to be urbanized are located downwind from the smokestack

2.5 6.1.2 Assessment The assessment process should be conducted taking into account the present use of the land around the area to be exploited

Depending on land use and expected pollution, it is possible to effectively present an appraisal of the land (positive and permanent impact) In this case, an arbitrary value can be assigned to the land, and thereafter an economic comparison can be made between arbitrary value and the value that the land could acquire

2.5.6.1 3 Mitigation The ideal situation is to keep residential areas away from the plant and from the axis linking the stack with the direction of prevailing winds or the areas that display the highest air pollution These areas should be purchased and reforested or, at most, occupied by industries that are not sensitive to atmospheric pollution In order to define these measures, the conclusions of the environmental impact assessment of sulfur and PM emissions should be kept in mind

146

2 5.6 2 Impacts on water supply

2 5.6 2 1 Identification and forecasting

a Construction phase

If a 350-MW station is considered, about 500 cubic meters of clean water are needed for consumption by the workers In addition, a similar or greater volume is needed to meet construction needs, which would imply a direct impact on water availability and an indirect impact on pre-existing uses of this resource, even if its duration is temporary

b Operations

During the operation phase, water is required for the following purposes

- Human consumption (about 30 cubic meters per day for a 350-MW plant)
- Boiler needs (35 cubic meters per hour, even if real needs involve only discharging the demineralizer)
- Cleaning of the boilers and the electromechanical equipment
- Cooling water needs may be very high in case of once-through systems If wet towers are used, make-up water requirements for discharge and evaporation are on the order of 15-30 gpm/MW
- Water transport of ash (if this system is used) or wetting the ash (if the dry system is used)

Additional water consumption can be expected due to the additional presence of homes of the energy plant's workers and the corresponding induced activity This additional consumption can amount to 200 liters per inhabitant per day

Meeting these needs implies a direct and permanent impact on available resources

The quantification of the corresponding impact involves estimating total needs and defining a water catchment, treatment, and carrying system to the plant The building of a water catchment and distribution system may also generate impacts that need to be controlled, even though they might be of little importance

2 5 6.2 2 Assessment and mitigation The assessment should be conducted by comparing water demands with available water resources in the area and pre-existing uses, which may entail a constraint for future use Since as a rule one of the criteria used to determine the location of a plant is the existence of water resources to meet the facility's needs, this impact is generally low or negligible

Nevertheless, re-using or recycling water in various activities where this is possible can be highly useful, not only to reduce operating and treatment costs but also to meet needs, especially in those areas where there is a shortage of water

2.5 6.3 Impacts on social conditions

2 5.6.3 1 Identification and forecasting The major socioeconomic and cultural impacts of a thermoelectric plant take place during the construction phase, when there is a higher demand for manpower During the operation, these impacts are much lower, since there is ten times less personnel and the station becomes just another small or medium-sized industrial facility

a Demographic impact

According to Latin American averages, the construction of a 350-MW thermoelectric station generates up to 3,500 direct jobs during peak periods and can require between three and five years Parallel to this, there are close to 2,000 indirect jobs in equipment manufacturing, firms for the installation, maintenance, and marketing of the construction materials, in addition to other business activities If the thermoelectric plant is built in a sparsely settled area or if the regional labor market is saturated, demographic migrations may occur which, in the case of a station of this size, can amount to 15,000 persons, including workers and families, which will generate an important demand for services and food These migrations occur during the worker recruiting phase for civil works, which require a great deal of unskilled labor Problems arising from the settlement of this population have been observed in the construction of hydropower stations, generally located far from large cities, where the construction firms have to cope with various housing, sanitation, health, and education issues If, as usually occurs, the plant is built next to a large city, it is possible for the area's own population to provide the large amounts of required unskilled labor

Forecasting the impact therefore implies an estimation of the new population that will truly come to the region as a result of the plant's construction During the operation, the impact is slight, since a plant of this size can operate with about 250 employees

b Impact on the labor market and employment rate

The creation of direct jobs exerts a positive impact on the local economy in recessionary periods or when unemployment in the area is high because of lack of professional training If the job market is saturated, the demand for workers may lead to salary inflation or migration problems Indirect jobs also exert a positive impact from the thermoelectric station, mainly because these jobs are distributed over the entire area of influence and sometimes even beyond it

The composition of demand for direct workers can be broken down as follows

148

- 33% unskilled labor
- 44% semi-skilled labor
- 13% skilled labor, with incomplete schooling
- 6% skilled labor, with complete basic schooling
- 2% mid-level technicians (electricians, mechanics, etc)
- 2% university-trained professionals and executives

Forecasting the impact involves determining this kind of profile for the specific plant, indicating, to the extent possible, the number of single and married employees, which is important to estimate housing demand

Forecasting the impact implies comparing the demand for project workers with regional unemployment levels, in order to determine to what extent the project will be able to meet existing demand for work (positive impact) or how much labor it should import from outside the region

c Impact on housing and public services

The plant's impact on the infrastructure essentially depends on the population growth to be generated in the area by the project If most employees come from the area itself, supply of this infrastructure will not be altered If most come from other regions, a heavy impact on the availability of infrastructure is to be expected, especially in the following fields

- Housing migrant labor implies a demand on the few houses and quarters available in boarding homes, thus creating a severe problem for local inhabitants who do not own their own homes This leads to overcrowded housing and slum-dwelling
- Schools part of the workers coming from other regions arrive with their families, thus increasing demand for school enrolment, which cannot always be met by the municipal school system
- Medical and hospital services a larger number of persons in a community implies an increase in the demand for physicians and hospital beds Since building a hospital may require more time than building a power station, the conditions for installing a new hospital will not be available and the services delivered by existing health facilities may decline in terms of quality But even if there is no immigration of labor, the employees for building the station will have greater medical assistance than before, which will imply a higher number of medical and hospital consultations

149

- Energy, clean water, and sewage system in general, the municipalities do not have the conditions to supply these services to the new inhabitants, thus leading to unsanitary conditions, such as open sewage systems, with the subsequent risk of transmitting diseases from other regions

- Urban plan the arrival of low-income workers may impair the municipality's urban zoning plan, if there is one Areas designated for industry may be overrun by slums, which may lead to future conflicts owing to industrial pollution or noise

- Transport the construction of a thermoelectric station may increase traffic problems on several highways Transport of workers may require six daily trips of 30 to 40 buses The transport of equipment and materials may endanger the roads heavily used by pedestrians

Forecasting these impacts requires estimating the additional demand for housing (based on estimations of migrant population) and, on this basis, education, health, clean water, sewage, energy, transportation, and other services

d Impact on public health

SO_2

The apparent effects of SO_2 on man and animals are higher frequency of breathing, increased resistance to air flow, decline in the volume of breathed air, acute irritation of the upper respiratory tract and the conjunctiva, and worsening of asthma and cardiopulmonary problems Nevertheless, as indicated in the section on biota impacts, studies show that the relationship between pollution and health involves a large number of factors such as the simultaneous existence of more than one pollutant, meteorological conditions, socioeconomic conditions, and the smoking habit, making it difficult to accurately determine the influence of one pollutant in particular over another Moreover, studies point out that the effects are produced mainly by sulfates and sulfuric acid, which are formed from SO_2

Various observations show that adverse effects appear when the average annual concentration of SO_2 is higher than 130 grams per cubic meter Temperature changes can produce more asthma attacks than high concentrations of SO_2 (200 grams per cubic meter) Nevertheless, only 15 grams per cubic meter of sulfates for 24 hours are sufficient to trigger an asthma epidemic Studies in sites polluted by SO_2 have led to the following conclusions

- Sulfates are much more toxic than SO2 Oxidation of SO2 in sulfates in the laboratory increases their toxicity twenty-fold

- Not all sulfates are irritants to the same degree when the size of the particulates are identical, the toxicity from higher to lower is as follows sulfuric acid, ammonia sulfate and zinc, zinc sulfate and ammonia sulfate

150

- The size of the sulfate particulates is the critical factor in determining the degree of irritation For example, for 0 8 micrometer particulates, sulfuric acid is two times more toxic than ammonia and zinc sulfate Nevertheless, the latter, in the form of 0 3 micrometer is three times more toxic than sulfuric acid in a 0 8 micrometer spray

In high air-pollution episodes (with SO_2 and other pollutants), children and the ill are the most affected, mainly those who have cardiac or respiratory problems (bronchitis)

Particulate matter

The effects of particulate matter emitted by the burning of fossil fuels on man mainly depend on the size of the particulates The larger particulates of 10 micrometers are retained in the upper respiratory tract (nasopharynx) and rapidly expelled or ingested By contrast, about 70% of the particulates with a diameter under 0 5 micrometer are deposited in the lung These small particulates have high concentrations of toxic elements, and the lung easily extracts from these particulates the elements that make them toxic

Another important effect stemming from PM is the obstruction of the respiratory tract Particulates deposited in the tracheobronchial area are expectorated after one or two days of mucociliar action or they are ingested The action of the cilia can be impeded, however, in the case of smokers, who are the most affected by the pollution In this case, the particulates that are deposited in the lungs may remain for hundredsoof days before they are expectorated or carried to the pulmonary lymphatic system During this lapse of time, these particulates may be partially dissolved, and the toxic elements that have been dissolved may be absorbed by the circulatory system

The SO_2 when isolated has little effect on man Nevertheless, along with particulate matter, the SO_2 becomes toxic, leading to the so-called synergic effect, where the action of both elements together is greater than the action of each one separately The formation of sulfuric acid is enhanced by the presence of ash, which acts as a catalyzer, and acid, once formed, helps to leach the toxic elements on the surface of the particulates As a result, in general, the combined action of PM and acid is responsible for the cardio-respiratory problems that are apparent in highly polluted areas Disasters attributed to SO_2 pollution are due to its synergic action with PM Table 17 shows the synergic action of these two pollutants on human health

Trace elements

There still are many doubts regarding the effects of trace elements on human health, especially the effects that small concentrations may have over the long run It is known that many trace elements can accumulate in the body, implying that, after 15 or 20 years close to an industrial installation, a person can acquire diseases that are typical of the workers of that industry Among the worst effects of air pollution by trace elements are the following a) death or acute diseases, b) severe diseases, declining life expectancy, or affected growth and development, c) alteration of important physiological functions, such as lung ventilation and carrying of oxygen by hemogoblin, d) influence on complex

151

Table 17 Synergic Action of SO_2 and Particulate Matter in the Air (concentrations expressed in $\mu g/m^3$)		
SO2 concentration	**PM concentration**	**Effects on man**
500 (daily average)	500 (daily average)	Excess mortality and hospital admission
250-500 (daily average)	250 (daily average)	Worsening of patients with pulmonary diseases
100 (annual average)	100 (annual average)	Respiratory systems
80 (annual average)	80 (annual average)	General discomfort

SOURCE Epstein, 1992

activities such as learning and driving vehicles, e) influence on diverse functions of the nervous system, such as estimation of time, f) deposit of toxic substances in the body, g) discomfort, bad smell or other effects which lead people to consult doctors, without apparent cause, or to move away from the area

Trace elements emitted by thermoelectric power plants can penetrate the human body through breathing, skin absorption, or ingestion of contaminated foodstuff In the latter, the elements are deposited on the leaves of the plants and on the soil, from where they are ingested by animals For the population residing in the surroundings of the power plant, breathing is the most important accessway, while for populations that are further away, food constitutes the main source for the absorption of these trace elements Over time, dangerous concentrations of pollutants can accumulate on the vegetation, even when air levels are below the danger point Plants can absorb toxic elements, although this is not as important as the elements falling on top of leaves Consumption of these plants by animals leads to the contamination of meat, milk, and other animal products

From the toxicological standpoint, the enrichment of volatile ashes with trace elements is very important, as the tissues of the body can extract these elements more efficiently when deposited in the lungs—as was already indicated—than when deposited in the upper respiratory tract Furthermore, particles that go to the stomach remain for only a short period of time, and only 5 to 15% of toxic metals are retained In the lung, length of stay of the particles can be various years with, 60 to 80% of the trace elements being absorbed by the 30 square meters of fine membranes of the alveoli or air sacs which separate the circulatory system from the air that is inhaled

2.5.6.3.2 Evaluation. In general, in these fields there are no legal standards that can be used for comparison to evaluate the importance of the impacts Consequently, this assessment must be done by comparing the situation without the project (current and future) and the situation generated by the project, so as to establish the following aspects

152

a Population increase attributable to the power plant (workers plus their families) and their share of the region's or city's population

b Volume of jobs to be generated that can be handled by the local labor market without producing wage inflation and those jobs that will have to be filled by outside workers

c Shortage of housing and/or rooms for migrant workers and their families

d Shortage of clean water, sewage, and energy services

e Shortage of places in schools, hospital beds, and doctors to meet the needs of the power plant's workers during its different stages

f Lack of roads and/or traffic needs during construction of the power plant

Regarding the impact on health, it must be assessed by comparing the forecast concentration of atmospheric and water pollutants in the plant's area of influence with legally permissible values, inasmuch as air and water quality standards or patterns are established by correlating pollution levels and related diseases If the forecast concentrations are low, the impacts will be low Then, depending on the population's current health status, the relationship between climate and asthma, and the concentration of pollutants that the power plant will produce in the environment, the power plant's impact on the population's future health will be assessed

2 5 6.4 Mitigation measures

2 5.6.4 1 Increase in the population An increase in the region's population must be avoided, to the extent possible Granting preference to workers that already live in the region of influence may help to minimize this impact By implementing a job-training program, unskilled workers can be recruited and converted into welders, assemblers, and electricians at the level required by the project Agreements with agencies that train skilled workers can be highly useful for training local workers and avoiding migrations Public employment agencies must be contacted to establish recruitment centers at various points in the region Such centers can also serve as screening and guidance centers for migrants

2.5.6 4.2 Employment Although construction may contribute to coping with unemployment, advanced planning should be envisaged during the project's design phase, so that the eventual demobilization of these workers will not penalize the region with a new wave of available laborers Therefore, a program should be aimed at a) preventing the reduction in demand for the workers and their consequent dismissal from causing a significant impact on the local labor market and society, and b) minimizing the social problems and tensions of the company's workers, because of the construction's termination and dismissal of the employees

The corresponding mitigation program can contain, among others, the following measures

a Demand linearization the project must be conceived as a linear timetable, geared to achieving homogeneous demand for the laborers, to the extent possible, thus reducing both demand and dismissal peaks

b Spacing the termination of different work areas to the extent possible, the project should involve a schedule of activities that takes into account the dismissal of each work area, so as to minimize the problem of large contingencies discharged simultaneously, thus facilitating the absorption and relocation of dismissed workers on the market

c Diffused recruitment workers must be recruited in an integrated fashion with other mitigation programs from the entire area surrounding the power plant, thus minimizing housing and transportation problems, avoiding overloading the existing basic infrastructure, minimizing the problem of dismissal in terms of space, and facilitating the reinsertion of professionals in the markets of their areas of origin

d Training specific training programs should be provided for the workers during their contract, in order to prepare them for project jobs, as well as to improve their professional knowledge and skills With higher skills, these workers can be reabsorbed more easily in the labor market

e Recycling construction workers for operating the power plant during the power plant's construction, workers must be screened and trained so they can be hired to operate the plant once it has been commissioned

f Use in other projects trained personnel with experience in the construction of a power plant must be granted priority when workers are needed in other power expansion projects in the country

2.5.6.4 3 Housing and public services To lessen the impact of demand for housing, the following alternatives are available

- Construction of temporary housing near the power plant for single migrant workers and in general for workers from other regions

- For workers who migrate with their families, an alternative is the construction of several blocks of brick houses, each measuring 50 square meters The construction could be carried out in agreement with municipal governments, to which they would be transferred as a donation at the end of construction

Where regional schools do not have room for the children of migrant workers, to mitigate this impact, support to local authorities can be provided to improve the existing school infrastructure by expanding and building new classrooms, including commitments by the municipalities to hire more teachers

154

To provide medical care for the workers, the company must envisage an outpatient medical unit, completely equipped to perform the following activities staff admission exams, on-site work-related accidents, public health, clinical visits, and emergency treatments Severe cases should be transported by power plant ambulances to local hospitals It would also be advisable to establish agreements with regional hospitals Power utilities often donate rooms to hospitals or upgrade old rooms with new equipment (x-rays, resonance) that hospitals are unable to acquire and which benefit the region's population as a whole

Mitigating measures for sanitation services are closely related to dealing with the housing problem Nevertheless, contracts with construction and electromechanical assemblies firms must stipulate the adequate collection and disposal of household waste by these firms, using manual sanitary landfills Likewise, the adequate removal and disposal of solid waste, including dirt and rocks from construction activities, clearing, and digging, should be ensured The project should include the installation of lavatories throughout the power plant's construction area, as well as clean water and sewage services, to meet the needs of the workers

To mitigate impacts on the transportation system, the following measures have to be applied

- Planning of bus and truck routes If the highways cannot cope with increased traffic, steps must be taken with the competent authorities to enlarge existing roads, build new ones, and pave secondary roads

- Working hours should be scheduled so that the traffic of the company's buses does not coincide with normal city traffic (especially during rush hours) Likewise, equipment transport should avoid congesting roads that cannot handle increased traffic Large equipment should be transported with the cooperation of the local highway police force

- Adequate road signs should be posted, and communities living near the construction site should be informed of their usefulness, to avoid accidents, especially those involving pedestrians

- Strict internal regulations for the company's drivers should be established, and those who do not comply with these rules should be dismissed

2 5.6 4 4 Public health The only viable way to mitigate health impacts is to reduce air and water pollutant concentrations For this, the project must comply with environmental laws by treating liquid, solid, and gaseous effluents

To avoid noise problems, the main measure is acoustic insulation of the power house This practice is currently widely used, for industrial safety reasons Furthermore, it is advisable to surround the power plant's grounds with a plant barrier, by planting three or four rows of trees of different heights and with wide perennial leaves In addition to obstructing noise from the plant, this natural fence enhances the power station's visual impact

155

2.5 6 5 Impacts on the economy

2 5 6.5 1 Identification and forecasting Most impacts of a thermoelectric power plant on the economy are positive and, in general, indirect They are apparent in two main areas living conditions and economic development

a Standard of living

Mainly during the power plant's construction and, to a lesser extent, during its operation, the population's living conditions, directly and indirectly linked to the project, generally improves as a result of the following factors

- Income from the workers' wages, which increases the region's purchasing power

- Impetus to trade, business, and other services as a result of demand from workers and, particularly, demand generated by the project itself (banking, construction materials, small workshops, others)

- Greater agricultural and livestock production, to meet the demand for food by the power plant's workers

- Possible income for the municipalities or regional agencies as a result of land taxes and industrial and commercial taxes, especially from royalties or dividends from the sales of the energy produced Some countries have established this share in terms of percentage of bulk energy sales 4% in Colombia and 8% in Brazil Part of this income is aimed at improving the environment and part at improving infrastructure for services (aqueducts, sewage systems, schools, health center, etc)

To forecast this impact, total volume of income for the region from these sources during each construction year and later, during a typical operating year, has to be estimated This gross income, divided by the population, will enable calculation of the regional GNP index resulting from the project

b Regional development

Installation of the power plant can foster the installation of industries and services in the region, thus creating more jobs, improving income, and enhancing the regional economy In addition, it may draw the attention of environmental authorities who, in turn, might become interested in solving other problems that beset the population

This is an indirect impact which is difficult to quantify, except by comparison with similar regions where power plants have already been installed

2.5 6.5.2 Assessment and enhancement The importance of these impacts must be assessed in terms of the current economic situation (without the project) wage-earning and income levels of the population, municipal budget (types of services), and

156

dynamism of the economy Comparison of current GDP with the GDP generated by the project can be an index for evaluating the impact on the economy

Since these are positive impacts, they should be enhanced to achieve a better insertion of the project in the economy and regional life

2 5 7 Impact on Aesthetics and Tourism

2.5 7 1 Identification and forecasting A visual impact analysis is generally required to show the effects of the proposed development on the surrounding landscape For this purpose, the physical characteristics of the area to be affected, from the standpoint of landscape, should be identified and evaluated and afterwards related to the characteristics of the proposed power plant and associated facilities

It should be kept in mind that some of the impacts on the landscape are temporary, whereas others are permanent Nevertheless, all are mitigable

In addition, if there are archaeological or historical sites within the grounds, the impact on cultural values may turn out to be far-ranging

2 5 7.2 Evaluation and mitigation A situation where the power plant and associated facilities are completely visible from access roadways and from scenic roads is viewed as the worst case for visual impact Mitigation measures such as tree screens or other barriers should be considered

Materials used during drilling are often abandoned on the drilling site, producing a strong aesthetic impact Cleaning of abandoned digging or waste accumulation sites should be included among the proposed mitigation measures

2.5 8 Hazards in working environment. Industrial safety An important aspect of environmental control for industries is to provide adequate facilities within the industrial complex itself to protect the health and safety of the workers This includes adequate safety and accident controls and protection against toxic materials and emanations

Common hazardous agents in a thermoelectric environment are dust (fly-ash) and SO_2

Noise is easily managed by supplying workers with protecting devices and acoustically insulting the power house, which generates high levels of sound

Particulate and SO_2 levels should be controlled by a suitable monitoring system to detect levels that are hazardous for health In these cases, the cause of high concentration has to found, individual protective measures have to be adopted, and an interior emergency plan must be implemented

157

Inter-American Development Bank

Summaries of Potential Environmental Impacts for

- Geothermal Energy Facilities

The following section is an excerpt from the Inter-American Development Bank's *Guide for Assessing the Environmental Impact of Geothermal Developments for Energy Purposes* This section discusses the identification, forecasting, and assessment of environmental impacts of geothermal developments

2 5 Identification, Forecasting, and Assessment of Environmental Impacts Paragraph 2 1 provided a short list of the main environmental impacts to be expected during a geothermal development

In this part of the EIA, a detailed presentation should be made for each anticipated environmental effect of importance, with information on the following its nature (depending on the environmental affected), occurrence conditions (direct or indirect, positive or negative, temporary or permanent, cumulative, etc), estimated magnitude of the impact, the measures to be used to minimize adverse impacts so that the overall situation will be protected or even enhanced to the extent possible

As a follow-up to what was indicated in Section 1 2 (Scope and Phases of an EIA), the general evaluation methodology consists of a four-step iterative process, namely identification of impacts, forecasting or quantification, assessment of their importance, and determination of

159

mitigation measures With each mitigation alternative that is proposed, the process should be repeated until the "impact' is deemed acceptable (importance of the impact)

In this process, it will be observed that some impacts are inevitable and that others created irreversible and irrecoverable damages on environmental resources and/or values In this chapter of the EIA, these impacts should be identified and discussed, otherwise "there will be no project "

Single impacts are analyzed below and some suggestions are given to speed up the forecasting process

2 5 1 Impacts on water resources

2 5 1 1 ***Identification and forecasting*** Water pollution may be chemical, thermal, or physical, and geothermal stations may produce some of each during each phase of the geothermal project exploration, development, well testing, and operation of the power plant

Some of the important considerations to be covered include the following

a Disposal of liquid geothermal fluids

Natural fluids contain a variety of substances in suspension and in solution which are biologically harmful, even in low concentrations (arsenic, mercury, lead, zinc boron), which may interfere with growth rates and reproduction, and which can lead to the death of aquatic species and the poisoning of ground water

Potential impacts from water pollutants at individual sites depend on the reservoir's composition and concentration and, of course, on the quantity of liquid discharged

Impacts may stem from discharge in surface or ground waters as a result of cooling tower blowouts, separated geothermal water, drilling mud, and any accidental spills during any phase

Although disposal of these fluids is currently handled in four ways (reinjection, discharge to surface water, lagooning or ponding, and secondary use of effluents), the most promising method, because of its positive implications for the reservoir's life, is reinjection, as long as this reinjection is done directly into the geothermal reservoir Reinjection in more superficial aquifers should be avoided, in which case impacts on ground water quality are very likely to occur

If reinjection is selected as a disposal system, the only impact on surface and ground water will stem from accidental spills and during production tests The resulting pollution would therefore be a direct, temporary, mitigable, and cumulative impact, compared to other eventual natural or artificial sources of pollution

The study should therefore indicate the quantity and the quality of geothermal waters that possibly will be discarded during production tests or that will be discharged due to accidental spills

Roughly speaking, short production tests last an average of four days, with 15,000 cubic meters of total water discharged per well

Based on these rough figures and a rough estimate of the spill occurrence, an assessment of the temperature concentration and variation in the receiving waters may be given together with an estimate of the possible damage to the aquatic flora and fauna

The assessment may take into account the amount of rainfall as a diluting agent

If discharge in surface waters is selected, the flow rate and chemical composition of geothermal fluids during operation and production tests have to be given Impacts in this case will be due to water temperature rises and concentration variations in the receiving waters These impacts are direct, permanent (during the project's lifetime), mitigable, and cumulative negative impacts

The study requires in this case an evaluation of existing aquatic ecology and estimates of the extent of damage which will be imposed on the ecosystem The presentation should show the extent and path of the heated water plume before temperature and concentration return to normal and the estimated alteration in the natural ecology values in the affected zone

If ***evaporating pond or lagooning is selected***, the extent of the surface necessary to evaporate the liquid discharge has to be given Possible liquid infiltration in the ground waters has to be assessed, and the concentration variation in the ground waters has to be estimated Depending on the technique used for building and operating the ponds, the direct impacts on the occupied area could be permanent and irreversible The same applies for ground waters, although in this case the hydraulic features of the aquifer and the region's climate will also play an important role

b Blowouts and other surface leaks

All blowouts are undesirable, and all geothermal well drillings incorporate the use of blowout preventers as standard equipment Under most circumstances, these devices, complemented by properly trained personnel, can handle situations which would otherwise result in a loss of control Nevertheless, blowouts may occur and they can produce water pollution and damage to plants and animals

The particular environmental damage that can occur is, of course, site-specific a blowout of relatively clean steam in an isolated vapor-dominated field entails a smaller potential hazard than a blowout of a very saline liquid in a recreational or very populated area

An EIA should contain a description of the equipment utilized to minimize the likelihood of a blowout or surface leak

164

If geothermal wells are going to be located in a recreational or very populated area, the EIA should present a short risk assessment, aimed mainly at evaluating the consequence of a possible accident (blowout) bearing in mind that, with modern technology, the probability of a complete blowout is very low During the period 1960-1970, only 100 accidents were reported for oil, gas, and geothermal drilling activities as a whole

Surface leakage of geothermal fluid or drilling mud are certainly more common A damaged valve, for example, can send a large quantity of geothermal water through vegetated areas and into stream channels

Although these leaks occur temporarily or sporadically, the resulting land and water pollution can have a residual effect, especially if appropriate mitigation measures are not applied

2 5 1 2 ***Assessment methodology*** The simplest way to assess the impact is to perform a comparison with current laws, regulations, and accepted standards

The comparison may be made between accepted standards for discharge into surface waters and/or by comparison with the expected concentration in the surface or ground water with the recommended criteria for water

A review of the different laws governing this matter is beyond the scope of the present work

AQUATIC LIFE CRITERIA FOR CONSTITUENTS IN GEOTHERMAL FLUIDS

Constituent	Criteria for fresh water Max Conc (mg/1)	Criteria for Sea Water Max Conc (mg/1)	Remarks
Ammonia	0 02		Toxicity pH dependent
Arsenic			Daphne impaired by 4 3 mg/l
Boron			Toxic to minnows at 19000 mg/l
Cadmiun	0 004	0 005	Toxic at <0 5 mg/l all tests
Chromium	0 1		Toxicity varies with pH and oxidation state
Copper	0 1	0 1	Toxicity alkalinity dependent
Iron	1 0		Toxicity variable
Lead	0 01	-	Salmonids most sensitive fish
Manganese		0 1	Not a problem in fresh water
Mercury	0 0005	0 0001	High bio accumulation affects human food
Phosphorus		0 0001	Eutrophication factor
Zinc	0 01		Toxicity dependent on temperature
Total dissolved solid (TDS)			Osmotic effect variable

Source Pasqualetti M J 1980

Table 2

162

AGRICULTURAL USE CRITERIA FOR CONSTITUENTS IN GEOTHERMAL FLUIDS VS CONCENTRATION LIMITS FOR DISCHARGE IN SURFACE WATERS			
Constituent	**Crop irrigation or livestock watering** Max Conc (mg/l)	**Italian Standard for discharge Max Conc** (mg/l)	**Remarks**
Temperature			Max allowed variation 3 °C
Ammonia	-	15	No criteria suggested
Arsenic	0 1	0 5	Toxicity to some crops at 0 5 mg/l No livestock criteria suggested
Boron	0 75	2	Toxic to sensitive plants, e g citrus at <1 mg/l, no livestock criteria suggested
Cadmium	-	0 02	Reduced crop yields at 1 mg/l, crop accumulation related to zinc concentration, no livestock criteria suggested
Chromium	-	2	No criteria suggested
Copper	-	0 1	Toxicity for plants begins at 0 1 mg/l, No livestock criteria suggested
Iron	-	2	No criteria suggested
Lead	-	0 2	Toxic to plants at < 30 mg/l , no livestock criteria suggested
Manganese	0 2	2	Toxicity to plants increases with decreasing ph, no livestock criteria suggested
Mercury	-	0 0005	Bioaccumulation but no criteria suggested
Phosphorus	-	0 1	No criteria suggested, nutrient for crops
Zinc	0 01	0 5	Toxic to some crops at 0 4 to 25 mg/l, May cause iron deficiency in plants, no livestock criteria suggested
Total dissolved solid (TDS)	5000-15000		Osmotic effects in plants, variable harm to both plants and animals
Sodium	0	-	Toxic to certain plants, ratio to other cations important, no criteria given
SOURCE PASQUALETTI M J 1980			

Table 3

geothermal fluids suggested by the U S Environmental Protection Agency (EPA 440/9-76-023, 1976) compared to the permitted limit for discharge in surface waters established by Italian legislation

The figures presented in the tables may provide some orientation for the evaluation procedure

2 5 1.3 ***Mitigation*** Impacts during drilling and exploration phases can be mitigated by reducing time for production tests and utilizing impervious pits to collect geothermal fluids during short production tests and reinjection wells for long production tests

Furthermore, equipment and devices utilized to diminish the likelihood of a blowout or spill from drilling operations should be described and included in the EIA report

Reinjection of spent brines back into the reservoir via injection wells is the only method that is sure and effective not only to mitigate environmental impacts but also to increase reservoir life

The EIS should define reinjection wells and devices used to minimize spills and leakages

2 5 2 Impacts on air resources Air quality

2 5 2 1 ***Identification and forecasting*** The effects of possible air pollution stemming from geothermal activities have surely aroused the greatest interest in terms of environmental impact The constituents released may include arsenic, mercury, and even boric acid but the focus of attention has been the emission of noncondensable gases, such as carbon dioxide, hydrogen sulphide, and radon

As a rule, fossil fuel fired thermoelectric plants emit a larger volume of carbon dioxide, this fact, combined with its nontoxic nature, accounts for the relatively limited attention it has received as a pollutant Nevertheless, public concerns over the greenhouse effect have once again drawn attention to this ever-present component of geothermal activity A comparison between CO_2 emissions from a fossil-fired power plant at a given capacity with CO_2 emission from a geothermal power plant of the same capacity should be made to indicate the differences

For example, considering a geothermal steam containing 5% by weight of noncondensable gas (high value) an emission of less than 0 4 kg of CO_2 per produced kWh may be estimated against an average emission of 0 8 kg of CO_2 per produced kWh from an oil-fired power plant

Concerns about radon are essentially due to its radioactive nature, leading to fears among the people The studies so far carried out (Wilson and others, 1982, George and others, 1980, Dall Aglio and others, 1986) indicate that the levels of radon emitted from the majority of sites are similar to natural radon emissions

164

Furthermore, the above-mentioned study by Wilson and others states that most of non-H_2S emissions are either not of environmental significance or are controllable with currently available technology

Arsenic and boric acid may in fact be emitted mainly through the drift from the cooling tower If the cooling water contains small quantities of these substances (concentrations as high as 0 1 mg per liter of As and 0 003 mg per liter of Hg have been measured in cooling-tower waters), an environmental impact may result The maximum allowable drift from a cooling tower is generally lower than 0 01% of the total mass flow, with a very low deposit rate for these compounds It should be noted however that part of the mercury and the other toxic compounds contained in the cooling waters could come from the biocides used to control the algae in these waters

Nevertheless, the EIA should determine the forecast deposition rate of mercury using one of the dispersion models outlined below

The primary pollutant that would be emitted from the geothermal power plants is hence hydrogen sulphide H_2S is generally present in geothermal streams and is released into the atmosphere during venting and/or condensing of geothermal steam Condensing the geothermal steam results in a condensate stream and a stream of gases that do not condense The H_2S can be present in both the condensate and noncondensable streams

H_2S can also be emitted from steam-venting from geothermal well drilling, well testing, and during equipment malfunctions

The first step of the prediction process is therefore an estimate of the emissions coming from geothermal activities An analysis of emissions during a system failure should be included to evaluate the worst-case impact

The inventory of emissions should therefore include

- emissions from twin silencers (if any),
- outages of power plants,
- emissions from cooling towers,
- emissions from condenser discharge,
- emissions from drains of steam pipelines, and
- emissions from short and long production tests

The purpose of the air quality impact analysis is to estimate pollutant concentrations from potential geothermal activities and, later, to assess their significance Computer-based dispersion modeling techniques should be applied to simulate the release of pollutants from the hypothetical sources

165

The pollutants to be included in the analysis should include H_2S and any other component present in such concentrations as to cause concern There are many models to be used to predict air quality The Gaussian plume model for continuous sources is surely the most widely applied and seems to be the best also in geothermal cases

The model to be used should be selected taking into account the characteristics of the terrains surrounding the future power plant There are in fact models taking into account the presence of buildings, wet and dry deposition, and hills around the site Table 4 shows some of the most utilized and advisable models

All these models are able to predict receptor concentration for each type of meteorological situation that may occur (wind direction, wind speed, atmospheric stability) and calculates annual, monthly or 24-hour average concentrations of pollutants

It is important to stress that results of this type of model depend heavily on the meteorological input data such as height of inversion layer, stability classes, wind direction and speed The resulting pollutant concentrations may vary more than one order of magnitude, depending on the height of the inversion layer, wind direction and speed, at the same distance from the emitting source

SOME GAUSSIAN PLUME DISPERSION MODEL

First 4 are recommended by U S Environmental Protection Agency and are available from the National Technical Information Service, US Department of Commerce The fifth is recommended by National Alternative Energy Agency of Italy

Model Name	DESCRIPTION
VALLEY	Steady state gaussian plume dispersion algorithm designed for estimating either 24 hr or annual concentration resulting from emissions up to 50 point and area sources. Empirical dispersion coefficients are used and includes adjustments for plume rise and limited mixing. Plume height is adjusted according to terrain elevation and stability classes
COMPLEX I	The dispersion assumption in this model is based primarily on the Valley model Plume height is adjusted by the near impingement method during stable conditions and the half height method during neutral or stable conditions As in the Valley model horizontal dispersion during stable periods empirically includes the effects of terrain
MPTER	Dispersion model for estimating hourly or annual concentration in flat or slightly sloping terrains It takes into account plume rise, downwash phenomena and possible chemical reaction. Not to be utilized in complex terrains
ISCST	It was designed for modeling complex source configuration (point volume and area) in areas with relatively flat terrains Building wake algorithm area included to simulate the presence of building near the sources Gravitational settling and deposition routines are also included It is thus possible to evaluate cooling towers drift deposition
DIMULA	Gaussian plume dispersion model It calculates annual and hourly concentration. The new version takes into account terrain morphology. Routines to evaluate no wind conditions and deposition rate are also included.

Table 4

166

Very often meteorological data are not available or are available only for different sites or for short periods of time In this case, the utilization of the short-term version of the above-mentioned models can be useful maximum hourly ground concentration in the worst meteorological case may be determined

The meteorological situation in which the wind blows at a speed of 1 meter per second from the source to the receptors in all atmospheric stability conditions with the inversion layer placed at the most frequent height in the region is generally viewed as the worst-case scenario Fog conditions are generally not taken into consideration unless this particular meteorological situation is expected to occur

Dispersion models are not able to predict concentration when wind speed is lower than 1 meter per second If this situation is forecast as the most frequent, other types of models have to be considered

2 5.2 2 ***Assessment methodology*** The simplest way to assess the impact is to perform a comparison with laws, regulations, and accepted standards

The comparison may be carried out between accepted standards for emissions and/or by comparison of the expected air concentration levels with the recommended or imposed criteria for air quality

When such standards do not exist, an assessment of the effects of the presence of the pollutant in the air on human, flora, and fauna health should be given

H2S emissions often produce concerns and sometimes citizen complaints This is mainly due to its offensive smell so that present H2S concentration ceilings are generally designed to eliminate such odors These limits are based on odors, not on demonstrable physiological effects, and are rather aimed, of course, at satisfying nearby inhabitants than protecting power plant workers This is one of the reasons why different countries react differently to H_2S release problems depending on public pressure or tourist attractions in the vicinity of geothermal power plants

A review of the different laws governing this matter is beyond the scope of the present work Table 5 provides some norms on emission limits and air quality Table 6 summarizes the effects of hydrogen sulphide on human beings

Nevertheless, it has to be stressed that the effect of H_2S on humans, animals, and plant life at concentrations as low as smell threshold (more or less 30 ppb) is not known Apparently no evident damage is reported to the Larderello population, which has been exposed to this level of concentration for more than 40 years It is also important to stress that H_2S does not accumulate in the human body and that there are towns (Rotorua in New Zealand, for example) where natural concentrations of H_2S as high as 30 micrograms per cubic meter may be measured The figures presented in the tables may help to orient assessment procedures

AIR QUALITY STANDARD AND EMISSION LIMITS FOR H_2S		
Country or Organization	**Emission Limit**	**Air Quality Standards**
USA (California)	2 kg/h per well (during test or drilling) 100 gr per gross MWh (during production)	42 µg/m3 as max hourly concentr to be exceeded less than once in the year
USA (Hawaii)	8 5 lb/h per well (during test or drilling) 8 5 lb/h per well or 150 gr per gross MWh whichever is greater (during production)	Max allowable increase in ambient concentr 35 µg/m3
EPA		7 µg/g as continuous exposure
Italy	Max allowable concentr 100 mg/m3 when H_2S flow No limit if flow is lower than 170 kg/h*	42 µg/m3 average on 24 hours for some urban areas
New Zealand		70 µg/m3 as max hourly concentr within geoth field

* The same law indicates limits for As and Hg
As concentration in entrained liquid lower than 1 5 mg/m3 if arsenic flow is higher than 5 g/h
Hg concentration in entrained liquid lower than 0 4 mg/m3 if mercury flow is higher than 1 g/h

Table 5

EFFECTS OF H_2S ON HUMANS AND PLANTS		
Concentration µg/m3	**Effects on humans**	**Effects on plants**
1-45	Odour threshold No reported injury to health	Stimulation in growth of lettuce sugar beet and alfalfa
10	Threshold of reflex effect on eye	As above
500	Smell perceptible	It begins to cause leaf lesions, defoliation, reduced growth in sensitive species
4500		It causes leaf lesions, defoliation reduced growth in sensitive species No effects on grapes, walnut, pears
20000	Maximum allowable occupational exposure for 8 hours (American Conference of Governmental Industrial Hygienists tolerance limit)	
20000 60000	Strongly perceptible but not intolerable smell Maximum concentration causing lung irritation	
150000	Olfactory fatigue in 2-15 minutes, irritation of eyes and respiratory tract after 1 hour, death in 8 to 48 hours	
900000	Fatal in 30 minutes	
1500000	Immediate unconsciousness and rapid death	

Table 6

168

A further consideration on H_2S has to be added when dispersed in the atmosphere, H_2S oxidizes (in some hours) to SO_2 SO_2 is a widely studied pollutant, and the air quality standard for SO_2 may be applicable also for H_2S

The effects of mercury and other metals (as arsenic) may be assessed by comparing calculated deposition rates from the cooling tower drift with the maximum amount of mercury or other metal which can be spread on farming lands These quantities are (for example, in Italy)

- Arsenic 100 grams per hectare per year
- Mercury 15 grams per hectare per year

2 5.2.3 ***Mitigation measures*** Several processes to control or reduce hydrogen sulphide released into the atmosphere have been studied and developed The best method should be selected taking into account the emission limits, air quality standards, and overall economics of the process

A short list of the most known processes is provided below

a Dispersion of noncondensable gases at high elevations by means of tall chimneys or in the cooling towers

This is one of the most economical ways of coping with the H_2S problem and has been adopted in Italy and New Zealand This method may be applied only if emission limits are respected The height of chimneys must be determined considering air quality standards, H_2S concentration, and costs

b Elimination of H_2S from the stream of noncondensable gases by chemical absorption and reaction

In this case, the process can eliminate H_2S both from cooling water and hence reduce emissions from cooling towers and directly from the stream of noncondensable gases

Removal from cooling water

The elimination of hydrogen sulphide from cooling tower waters is especially required when a direct contact condenser is used In this case, in fact, a large portion of H_2S passes in liquid form On the contrary, when surface condensers are used, the elimination of H_2S from the liquid is not generally required

Treatment of the condensate/cooling waters may be obtained by using H_2O_2 as an oxidizing agent but the iron catalyst system is now preferred, in the latter system, ferrous sulphate is added to the circulating waters upstream of the cooling tower, which is able to help sulphur to be oxidized to form elemental sulphur

169

Removal from the noncondensable gas stream

There are many H_2S abatement systems that can be utilized to reduce concentration in the noncondensable gas stream, among which

- **Burner/scrubber system.** Noncondensable gases from the condenser are removed and sent to the combustor and are incinerated at 1,100°C with excess air to convert the H_2S into SO_2

  This system is expensive The hot gas is quenched by direct contact with water and cooled to approximately 70°C The gas is then contacted with an aqueous solution of sodium hydroxide in a scrubber The removal efficiency may be as high as 99 98%

- **Stredford Process** A Stredford unit converts H_2S to elemental sulphur H_2S is essentially oxidized by air to sulphur and water with vanadium as a catalyst The Stredford process can achieve a noncondensable steam-phase H_2S emission control efficiency of 99 9% This process produces elemental sulphur that has to be disposed of

- **LOCAT Process** Noncondensable gases are removed from the condenser and sent to the LOCAT unit where the gas is bubbled into the bottom of the absorber chambers in the LOCAT absorber/oxidizer As the gas bubbles up through the slight alkaline solution, the H_2S is absorbed, ionized, and finally oxidized to sulphur by the ferric ions Overall efficiency is as high as 99 95%, It has never been used in a geothermal power plant

- **Dow Chemical RT-2 Process** The RT-2 system is a proprietary abatement process based on incineration and scrubbing It is in use in a geothermal plant in Hawaii and at the Geysers

- **Reinjection** The noncondensable gases are removed from the condenser, compressed, and sent to a reinjection well This system can be used only if H_2S concentration in the noncondensable gas stream is very high and other methods are therefore not economical At present, reinjection is not used in any geothermal power plant When considering this way to eliminate H_2S emissions, particular attention must be focused on the selection of the material to be used for reinjection pipelines Very high corrosion rates and hence risk of air pollution have been recorded These limits were established on the basis of experiences in Larderello, where geothermal energy has been produced for over 70 years, without any apparent rise in mortality or risk of cancer attributable to the geothermal development

- Recently, the use of new catalyzers that oxidize the H_2S into soluble sulphate, which is sent with the reinjection liquids, has been developed This catalyzer is located in the cooling tower pond and does not require special equipment

A choice between the different methods is difficult, depending on the different characteristics of the geothermal fluids

Also, costs may differ widely A rough estimate may be given according to the following values derived for an noncondensable gas stream of 5 tons per hour and an H_2S percentage of about 1%

Process	Total Operating Cost (US$ per hour)
Stredford	13
LOCAT	18
RT-2	35
Reinjection	depending on characteristics of reinjection well

NOISE SOURCES ASSOCIATED WITH GEOTHERMAL DEVELOPMENT	
Activity	**Typical sound level at 30 m from geometric centre of the source dB(A)**
Site preparation/road construction	Variable depending on the used machinery
Geothermal well drilling	Between 80 and 85 at 30 m from diesel engines
Geothermal well unsilenced	120
Geothermal well with cyclone muffler	85
Construction of facilities	variable
Generating unit operation	
Turbine / generator building	60 - 70
Steam vent gas ejector	90 - 110
Cooling tower	70 - 75

Table 7

2.5.3 Impacts on noise levels

2.5.3 1 ***Identification and forecasting*** Controlling noise from geothermal resource development is important to ensure both worker health and safety and community acceptance Noise exerts a direct impact that is temporary (linked to the geothermal reservoir's operation), capable of being mitigated, cumulative (if there are other noise sources), and capable of exerting a residual effect on the health of exposed persons

Noise sources generally associated with geothermal developments are specified in Table 7 with some typical sound pressure values The reported values are based on measurements of typical equipment but are only indicative and may be very different from site to site depending on the equipment used

Sound level at the receptor level may be forecast by using the following relationship

$$L = LO - DS - DA - DG - DE - DF$$

where

L is the noise level expressed as Leq at the receptor in dB(A)

LO is the basic noise level of the source as shown in Table 9

DS is the attenuation due to geometric spreading, that is,

$DS = 20LOG\ (d_2/d_1)$

where

d_2 is the distance of the receiver from the source and d_1 is the distance at which L was measured, that is, wave divergence reduces sound pressure level by 6 dB every time the distance from the source doubles

DA is the attenuation due to air absorption

DG is the attenuation due to ground absorption

DE is the excess attenuation due to features such as natural or artificial barriers

DF is the correction to take account of sound reflection

There are many models using the above-mentioned equation to assess sound pressure at receptors, although a first estimate may be given very rapidly Of the above-mentioned factors that affect the noise volume, the primary are distance and barriers The effect of distance may be evaluated as shown above, and the barriers generally abate noise level by 5 to 10 dB (see Harris)

The other above-mentioned factors become significant when distances between source and receiver become large (more than 300-400 meters) In these cases, the utilization of more sophisticated models is necessary and the knowledge of emission spectra is required

2 5.3 2 *Assessment* Noise is one of the major environmental problems of modern life, one over which legislators, for a long time, have had the least power Unfortunately, it is inseparable from normal human activities and urban growth Only recently has it been regulated by a specific legislation

The legal aspects of community noise control range from the general laws against public nuisances to detailed laws and regulations which limit the noise that a given source may make to land-use restriction designed to protect noise-sensitive land use

Since local laws and regulations are generally absent or difficult to apply, the following criteria may be applied for the evaluation of noise

The environmental impact of noise can have several effects, varying from hearing loss to annoyance A noise problem is said to exist when noise interferes with human activities Specifically, sufficiently loud noise may

1 Damage hearing or health

2 Interfere with work chores

3 Interfere with speech communication

4 Interfere with sleep

5 Cause annoyance

Table 8 provides the generally accepted damage risk criteria for hearing The generally accepted noise level to date has been that, if the ear is exposed to 90 dB(A) Leq for 8 hours per day over 20 years, permanent deafness will occur Further studies have concluded that there is a risk of partial hearing loss leading to possible permanent hearing damage after 40 years of exposure to steady daily noise level of 75 dB(A) Leq for 8 hours per day

In communities, noise control annoyance and physiological damage may occur at a much lower noise level

Studies on sleeping people have shown that noise affects sleep in a number of ways, including shortening the sleeping period and increasing the number of awakenings The question of adaptation to noise has also been studied Although some adaptation seems to occur for low intensity levels, there seems to be little or no adaptation to noise levels above 60 dB(A) indoors

173

DAMAGE RISK CRITERIA FOR HEARING LOSS	
Maximum allowable duration per day, h	Noise level dB(A)
8	90
6	92
4	95
3	97
2	100
1 5	102
1	105
0 5	110
0 25 or less	115 (maximum)

Table 8

In addition to the direct effects of noise on health, sleep, and communication, there are indirect effects of annoyance which are related to the way a person feels about noise It has become common practice to base noise policy decisions or remedial actions on the cumulative percentage of people who describe their noise exposure as annoying or highly annoying Several noise scales have been established based on these responses Table 9 provides an example of this type of scale (drawn from Italian legislation)

2 5.3.3 ***Mitigation measures*** Most geothermal sites are distant from populated areas, and on-site construction workers and operators must apply protective measures, as necessary

If some receptor is close to the area of activity, the following mitigation measures can be adopted

a **Drilling** Use sound barriers around air compressors, diesel generators (if the drilling rig is electric), and hoists

b **Production tests** Conventional mufflers are not used because debris is vented with the steam Use perforated steel pipes at least 1 meter under the surface of a pond or a vertical twin cyclone or a horizontal straight-through silencer or a rock muffler

c **Operation** Avoid venting to well, since this creates a great deal of noise and severely damages the surrounding vegetation During emergency, deviate steam flow to well-sized silencer

Install a well-sized silencer on the gas ejector system Separate the noise sources from people who are likely to be annoyed and avoid building cooling towers at a distance closer than 500 meters from the receptor

MAXIMUM ADVISED SOUND LEVEL OUTDOOR				
Land use	Maximum level Leq in dB(A)		Maximum difference between background level before and after Leg in dB(A)	
	day-time	night-time	day-time	night-time
Very sensitive areas(1)	50	40	5	3
Residential areas	55	45	5	3
Mainly residential areas	60	50	5	3
Urban areas	65	55	5	3
Mainly industrial areas	70	60	5	3
Industrial areas	70	70	7	7
(1) Educational facilities hospitals convalescence homes churches wildlife sanctuanes				

Table 9

2 5 4 Impacts on land resources

2.5.4 1 *Induced seismicity*

2.5 4 1 1 *Identification and forecasting* Geothermal resources are generally located in areas of high heat flow along thinning crust zones Thus, areas that are geothermally active also have a high likelihood of being seismically active

The major concern with induced seismicity is the potential for injury and loss of life, as well as property damage, resulting from an earthquake These impacts, although indirect and sporadic, are irreversible

Episodes of induced seismicity are in principle possible in geothermal fields when reinjection is taking place Reinjection may in fact open and lubricate existing fractures, causing increased seismic activity

Nevertheless, documented reports of induced seismic activity only refer to when fluids are pumped into subsurface clay aquifers in the continental area (during oil research) This type of occurrence is highly unlikely in geothermal reservoirs where generally the subsurface rocks are self-supporting and saturated with water Thus, injection of water into the subsurface would simply displace water already there and would not act as an added lubricant

Although the relationship between geothermal activity and seismicity is debatable, some of the countries involved in geothermal reinjection have set up microseismic monitoring

equipment capable of detecting seismic events, even those of a very small magnitude Permanent microseismic control networks are reportedly used in New Zealand, Italy, and Japan to stop reinjection if necessary when seismic activity exceeds some pre-established values

2 5 4 1 2 *Assessment* The potential of induced seismicity at a geothermal site cannot be assessed because causes and mechanisms of induced seismicity are not well understood Nevertheless, there is a long experience of reinjection around the world showing that seismic events cannot be directly correlated to geothermal activity

2 5 4 1.3 *Control methods* The recommended sequence of actions to thoroughly understand the possible triggering of an earthquake induced by reinjection are

a Geological mapping Develop detailed geological maps of site area to assess specific hazards such as landslides and surface fault ruptures

b Conduct detailed subsurface exploration (sample collection) to determine potential hazards

c Geophysical surveys to determine performance during an earthquake of site material

d If necessary, set up a seismometric station close to the reinjection well during tests in order to identify the hypocentral coordinates of microseismic events and hence to evidence the possible migration of seismic focuses and verify the possible correlation between reinjection and local seismic activity

e As a precautionary measure, it is advisable to avoid reinjection in areas close to active faults, especially those with compressive fracturing

2 5 4 2 ***Subsidence***

2 5 4 2 1 *Identification and forecasting* Subsidence is the sinking of part of the earth's crust Subsidence is caused by compaction of the sediment and rock underlying an area following removal of a geofluid (oil, gas, groundwater or geothermal fluids) Although subsidence is in itself a direct and residual impact stemming from the fluid extraction, it also has indirect secondary effects, such as the flooding of subsided areas and the destruction of, or damage to, facilities In geothermal energy development, the two major factors that influence subsidence potential are

a geothermal field design and operation as they affect the distribution and quantity of withdrawn and injected fluids, and

b the site's geological structure and geohydraulic characteristics

Subsidence can take place under varied circumstances of geology, hydrology, and tectonics, but it occurs most often when fluids are withdrawn from an aquifer consisting of a porous medium in a compressible and/or fractured bed

One of the best-known examples of such subsidence occurred at Wilmington oil field (California) where vertical and horizontal displacement reached 8 2 and 3 7 meters, respectively In geothermal energy fields, the most widely known example is Wairakei (New Zealand), where subsidence rates of 40 centimeters per year were reported

High-temperature steam-dominated sites are not as subject to subsidence, since the rock units in the reservoir must be competent in the first place Even though this is generally true, a small subsidence rate is reported at the Geyser (2-4 centimeters per year)

Although there is a potential for subsidence, hydrothermal reservoirs are not as subject to subsidence as geopressured reservoirs, where subsidence is almost a certainty Geopressured zones have such a high subsidence potential because the thick sedimentary sequences in which they are found are undercompacted and the water trapped in these sequences actually bear part of the lithostatic load Withdrawing the water from a geopressured reservoir allows compaction of these rock units and result in subsidence Steam-dominated reservoir (the Geysers and Larderello) represent the two ends of the spectrum The resources with characteristics between these extremes will have variable potential for subsidence, depending on the geological structure and reservoir rock potential for compaction The plant design and withdrawal and reinjection strategies will determine the rate and the amount of subsidence

2 5 4 2 2 *Assessment* The major concerns with subsidence are the effects on the surface The amount of economic damage done on the surface, however, depends on surface land use

Indirect effects of subsidence include flooding, dam failures, and surface faulting

Assessment is strictly related to the control methodology

2 5 4 2.3 *Control methods* A site-specific monitoring might be useful to distinguish subsidence caused by geothermal development from other human activities and natural subsidence

Monitoring should start before geothermal development and continuing through development of resources

Furthermore, a very good control technique may be employed to limit the amount of subsidence

All the operators agree that reinjection of the withdrawn fluids is a viable control method and that it will limit the amount of subsidence experienced at and around the resources

In any case, the developer of geothermal energy should account for subsidence in the design of the geothermal plant and field for both environmental and economic reasons

177

2 5 4.3 *Impact of solid wastes*

2 5 4.3.1 *Identification and forecasting*

a **Drilling phase:** The accumulated drilling detritus and mud in the pit close to the drilling are the main wastes generated by the drilling These muds are generally toxic and may require treatment before being eliminated

According to experience, the total volume of detritus and mud to be produced by each well and the total amount of wells in the project should be calculated

b **Operating phase·** The main solid waste produced in the generation facility is the mud that accumulates in the ponds of the cooling towers Additional solid wastes can be created as a result of the formation of scales and scaling in the reinjection pipeline, twin silencers, and others The mud may be composed of elemental sulphur, iron and other minor compounds The scales could consist of silica or sulphur from heavy metals, which are not necessarily hazardous

An annual figures for these muds should be estimated, even though they may fluctuate between 100 and 200 cubic meters per year in a medium-sized plant

c Other potential solid wastes could be those stemming from the possible mitigation of H_2S in the plant, such as sulphur and other materials, whose amounts would depend on the total concentration of H_2S

d The garbage from the workers is another solid waste to be considered, whose quantity can vary according to the number of persons that permanently live in the area (plant workers and the families of the workers who live in the area) The per capita production of solid household wastes can fluctuate between 0 2 and 0 4 kilos per inhabitant per day

The inadequate disposal of these wastes exert a direct impact on the soil, plant life, water resources, and eventually the landscape Soil impacts can be residual, whereas the other impacts can be over the medium and long term

2 5 4.3 2 *Assessment and control* The amount and chemical characteristics of solid wastes are the basis for assessing the hazard and/or need for special disposal In addition, comparison with local regulations should enable an assessment of the impact's importance Depending on their chemical characteristics and the area s geological conditions the drilling muds can remain in the collecting pit or may require disposal in other areas under specific conditions

The muds of the cooling towers can be removed periodically from the cooling tower deposit and collected in an evaporation pond The remaining solid waste can be covered over with earth If the mud is toxic, it should be carried and eliminated according to regulations applicable to hazardous wastes The same applies to wastes stemming from plant H_2S

mitigation (sulphur and other materials) Solid household wastes should be disposed of in manual sanitary landfills, suitably located, designed, and operated

2 5.5 Impacts on ecological resources

2 5 5 1 *Identification and forecasting* Probable environmental impacts on biota include

a **Direct loss of habitat** and destruction of native plant communities as a result of land clearing for geothermal facilities This is a direct and residual (irreversible) impact in the affected area

Siting of roads and well sites during the exploration phase, as well as transmission lines, power plants, and other facilities during the later construction and operational phases, should be examined to determine the quality of plant and animal species that will be disturbed An approximate assessment of the quantity of trees and vegetables disturbed should also be given, as well as animal species, by means of direct or indirect methods

b **Invasion of cleared areas** by introduced weed species This is an indirect impact and can either temporary or permanent, depending on the mitigation or control measures that are applied

Disturbed sites such as unpaved edges of roads (shoulders) and open roadsides are prime sites for weeds From such areas, the weed species may move into small openings in surrounding forests, occupying space once used by native species Invasion by introduced plants may also reduce the habitat quality for native birds and invertebrates, thus affecting the distribution of these organisms

c **Long-term effects** on biota during operation phase Air emission, water spills, and noise from day-to-day operations are the primary concerns when discussing long-term effects

A short list of possible effects on flora and fauna stemming from emitted substances were provide in the preceding paragraphs

2 5 5 2 *Assessment* Assessment will be based on the relative importance of the species living in the impacted area presence of endangered or rare species, forest, and plantations

2 5 5.3 *Mitigation measures* Mitigation measures are crucial in areas where geothermal facilities can exert an impact on forests or endangered species Among the possible mitigation measures, there are

- Limits on vegetation removal to only that which is essential Directional drilling so as to drill up to five wells in less than one hectare Building all the transmission lines along existing road corridors to minimize vegetation removal

179

- Revegetation with native materials as soon as possible Quick revegetation of the disturbed areas provides shade, thus reducing the weed population

- Continual monitoring of developed areas for weeds and appropriate methods of weed control

2 5 6 Socioeconomic impacts

2 5.6 1 *Land use impacts*

2 5 6.1 1 *Identification and forecasting* Land needs during a geothermal development can be temporary (construction and drilling phase) and permanent (operational phase)

a Temporary land take

- Drilling site

Generally involves an area of half an hectare per well, which must be cleared and graded Adjacent to the drill rig are mud pumps, mud tanks, generators, drill pipe racks, tool house, storage tanks, and collecting pit for production tests

In addition to all of these land requirements drilling entails accessway and road construction

The land requirement for drilling wells has to be calculated, bearing in mind that land take for drilling work is temporary

At the same time, the natural plant area, along with a list of the plant species, that will be destroyed has to be given as described above

It has to be borne in mind that production tests may affect large areas around the collecting pit by provoking vegetation damages because of the heat delivery and entrained droplets deposition As a rough figure, an area with a radius of more or less 100 meters may be affected during production tests Also, this zone has to be accounted for when land needs are calculated

- Construction of power plant and gathering system

It is during this phase that land disruption is more noticeable and probably most significant Pipes themselves are built at present on the surface although some consideration has been given to installing underground pipes in some countries (United States, Italy)

A figure for land requirement and cleared plant species has to be given As a rough figure, total land needs for a power plant located in a steam-dominated reservoir can vary from 11 to 35 hectares per drilled well

180

It is important also, in this case, to stress that, once the wells are drilled and the construction phase is completed, the effects on land take begin to diminish In any case, these are direct impacts on current land uses, deemed to be mitigable and temporary, as indicated above

b Permanent land take

Permanent land needs must be considered access roads, power plant, cooling towers, production and reinjection well equipment site The existence of transmission pipes to geothermal sites does not appreciably influence land use farming, for example, can continue among pipelines

It was evaluated that permanent land take is less than 0 35 hectares per MW at the Geysers (steam-dominated field) but may be more than 3 hectares per MW in water-dominated reservoir

In short, forecasting of land take may turn out to be easy when the feasibility study is completed, and when plant type and size and reservoir temperature are known The impacts of land take are direct, permanent, and mitigable (compensatory or other measures)

At the prefeasibility study level, Table 10 provides data for achieving a rough forecast

APPROXIMATE LAND TAKE FOR A 100-MW GEOTHERMAL DEVELOPMENT IN A WATER-DOMINATED SYSTEM

Reservoir Temperature °C	Drilled Wells*	Temporary Land Take hectare	Permanent Land Take hectare
200	67	1500	100
250	39	850	70
300	26	550	50

*One dry well and one reinjection well were assumed for three productive wells and an average flow rate per well of 150 t/h

Table 10

2.5 6 1.2 Assessment The assessment process should be conducted taking into account present land use around the area of future development

Depending on the land use, an arbitrary value can be assigned to the land and an economic comparison may be attempted between the arbitrary value and the value the land may assume

For example, a 100-MW power plant can produce 800 x 10^6 kWh per year and hence a value per hectare of US$500,000 to US$1 million, depending on the different characteristics of the plant, to be compared with the present land value

2 5.6 1 3 *Mitigation*

a **Directional drilling** is the most widely used way to reduce land take Up to five wells may be accommodated in an area only slightly larger than that previously needed for one wellhead The additional cost which results from this type of drilling is partially offset by the lower cost in pipelines and, of course, in land

b **Underground pipelines** could in principle be used to reduce land take At present, they are not utilized due both to the high cost and the difficulty in maintenance operations

2 5 6 2 ***Impacts on water supply***

2 5 6 2 1 *Identification and forecasting*

- **Construction phase**

When mud drilling of geothermal wells is required, about 300 cubic meters of water per day are required for drilling in the softest formations and about 20 cubic meters per day are required when drilling in hard formations If necessary, dedicated wells or rain catchment systems could be used to meet on-site water requirements

Long pipelines could be necessary if underground water is not available around geothermal wells In this case, a description of pipeline location and of the necessary tree clearings should be given Meeting these needs exerts a direct impact on the water availability and an indirect impact on the pre-existing uses of this resource, although its duration is temporary

Water is not required when air drilling is carried out in steam-dominated geothermal reservoirs

- **Operations**

Clean water supply service is required for drinking water, sanitation, occupational safety, and sometimes for chemical mixing Normal use can be estimated at 50 cubic meters per day for a 50-MW power plant Depending on the location of the plant, water would be provided by the country water main, developer-constructed wells, or rain catchment systems

Make-up water is not necessary since generally condensed geothermal steam is enough to meet water requirements

Additional water consumption could be foreseen because of the presence of additional household consumption generated by the employees of the power plant and induced activity Such further consumption could be as high as 200-300 liters per day per inhabitant

10^6 kWh per year and heg these water needs entails a direct and permanent impact on available water supply on the different characteri

2 *Assessment and mitigation* An assessment can be conducted concerning the abundance of natural water in the development area but the overall impact is generally h

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Impacts on the economy and social conditions

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183

Meeting these water needs entails a direct and permanent impact on available water supply

2 5 6 2 2 *Assessment and mitigation* An assessment can be conducted concerning the relative abundance of natural water in the development area but the overall impact is generally not high

Rain catchment systems can help to improve the situation

Water recycling for industrial activities could be highly useful where water is scarce

2 5 6.3 ***Impacts on the economy and social conditions***

2 5 6.3 1 *Identification and forecasting* Socioeconomic impacts heavily depend on the regional characteristics of the area to be developed and on the people's attitude toward geothermal activity

As a rule, research on the economy of the area and an opinion survey on people's attitude about geothermal development can provide a good tool for assessing the impact

A timetable for both construction and operational employment could be given to show possible changes in economic activity

Main impacts could be

- Possible decrease in agricultural activity and the subsequent increase in services and commercial activities Tourist activities could also increase depending on local characteristics Nevertheless, in New Zealand and Bolivia, the development of wells for energy purpose have led to lower earnings from recreational activities, and this has generated conflicts in the local population

- Higher employment rates in the region as a result of both plant operations and related activities Manpower demand can turn out to be very high in the construction phase (450 persons for a 50-MW plant)

- Increase in public services requirements due to probable increase in the population, especially energy, transportation, communications, health, and education

- Increase in schooling due to the needs of employees involved in building and operating the power plant

- Temporary increase in population depending on the different phases of the project's development

- Deterioration in the public health conditions, owing to emissions and noise

Some of the above-mentioned impacts are directly triggered by the project itself, such as the decline in agricultural and livestock-raising activities in the area occupied by the facilities, the

Meeting these water needs entails a direct and permanent impact on available water supply

2 5 6.2 2 *Assessment and mitigation* An assessment can be conducted concerning the relative abundance of natural water in the development area but the overall impact is generally not high

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2 5 6.3 ***Impacts on the economy and social conditions***

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- Increase in schooling due to the needs of employees involved in building and operating the power plant

- Temporary increase in population depending on the different phases of the project's development

- Deterioration in the public health conditions, owing to emissions and noise

Some of the above-mentioned impacts are directly triggered by the project itself, such as the decline in agricultural and livestock-raising activities in the area occupied by the facilities, the

185

drop in tourism, the rise in employment during the field and plant construction and operation phases, and a deterioration of the public health conditions Other impacts such as the rise in service-sector activities, indirect job creation, rise in the demand for public services, and the higher schooling level, are indirect or induced Likewise, some impacts, such as the strong demand for labor during the construction phase, are temporary Other impacts, such as the elimination of agricultural activities in the occupied areas, are permanent

Prior knowledge of the area's socioeconomic characteristics, schooling and health levels, the area's endemic and common diseases, current public services, economic production, tourism, etc (see section 2 4 5) is essential to quantify and forecast the changes to be generated by the project

One of the most sensitive problems is the public health impact In the case of geothermal energy exploitation, there are no reports that a specific disease has been accelerated by air pollutants (generally H_2S), thanks to the low typical concentration of the area surrounding geothermal energy

High noise levels, owing to flaws in the control systems, can led to temporary or permanent hearing impairments

No hazards to public safety during power plant operations are generally reported Blowouts are in principle possible and could have consequences for the population living in the immediate area surrounding a well during drilling if the discharged fluid contains a high quantity of hydrogen sulphide This rarely occurs

2 5 6.3 2 *Evaluation and control* As a rule, in these fields there are no legal standards that can be used as comparative elements to evaluate the importance of the impacts As a result, this assessment should be conducted on the basis of the magnitude of the expected changes population increase, resettlement of communities, additional demand for clean water supply and public services in general, improvement of schooling rates, increase in the death and disease rate, decline in agricultural production, etc It is necessary to bear in mind that some of these impacts can be positive, that is, beneficial for local population conditions

In order to mitigate the impacts on public safety, especially with reference to blowouts, wells should not be drilled in population areas and additional safety precautions should be taken to avoid any risk of blowout

In addition, a contingency plan should be prepared in case as blowout does occur or if especially negative atmospheric conditions occur An emergency situation can arise when a pre-determined H_2S concentration level is attained, under similar meteorological conditions during 12 hours or more For H_2S, this level is generally deemed to be 10 ppm the contingency plan should include a population evacuation program, coordinated with public officials

186

The mitigation measures for the other health impacts are the same as those indicated for air quality control Likewise, impacts on economic activities linked to water use (irrigation, tourism, other) are controlled by means of the measures referred to above for water impacts

The positive impacts should be enhanced to the extent possible in order to increase the project's benefits at both the local and regional level For example, tourism could be promoted through support to local communities for developing complementary activities, such as arts and crafts and others

Finally, what should be sought is in the insertion in the best way possible of the geothermal project into regional and local development processes

2 5 7 Aesthetics

2 5 7 1 ***Identification and forecasting*** A visual impact analysis is generally required to show the effects of the proposed development on the surrounding landscape

In general, the physical characteristics of each subzone of the proposed development should be identified and evaluated and afterwards related to the characteristics of the proposed power plant and associated facilities

It should be kept in mind that some of the impacts on the landscape are temporary, whereas others are permanent Nevertheless, all are mitigable

2 5 7 2 ***Evaluation and mitigation*** A situation where the power plant and associated facilities are completely visible from access roadways and from scenic roads is viewed as the worst case for visual impact Mitigation measures such as tree screens or other barriers should be considered

Materials used during drilling are often abandoned on the drilling site, producing a strong aesthetic impact Cleaning of abandoned drilling sites should be included among the proposed mitigation measures

2 5 8 Hazards in working environment Industrial security An important aspect of environmental control for industries is to provide adequate facilities within the industrial complex itself to protect the health and safety of the workers This includes adequate safety and accident controls and protection against toxic material and emanations

Common hazardous agents in geothermal environment are noise and H_2S

Noise is easily controlled by supplying workers with protecting devices and trying to limit emissions during the design stage

H_2S concentration, especially during drilling, should be controlled with a suitable automatic monitoring system This monitoring system should be able to produce an alert signal when H_2S concentration in the working environment exceeds a pre-established value, for example, from 1 ppm to 5 ppm, and an alarm signal when concentration exceeds 10 ppm

In the first case, the cause of the high concentration has to be looked for and individual protective measures have to be adopted In the second case, individual protective measures have to be taken and the interior emergency plan must be implemented

2 6 Environmental Monitoring of the Facility Depending on the location of the power plant, a monitoring plan could be necessary Water and air quality should in principle be controlled

Water-monitoring plans should envisage the collection of chemical samples of possible liquid discharge to control the stability of the emission

This sampling should be periodical (for example, once every three months) and should cover both surface and ground waters Its objective is to evaluate the concentrations of the elements that could indicate a possible contamination by geothermal fluids, such as boric acid, arsenic, and others

The sample collecting and analysis methodology should be selected carefully, bearing in mind that some elements are found at very low concentrations

The cost of a water-monitoring plan is very low and can be implemented directly by the power plant staff under the supervision of a local official

Air-monitoring plans could be implemented by both stationary and mobile stations

Air-monitoring plans may be more expensive due to the high number of points to be controlled in order to establish the influence of power plant emissions on air quality

Mobile stations could be more useful in a preliminary stage to define where fixed control points should be located

The air-quality monitoring system should include instruments for detecting the following

H_2S	minimum measure range	0-100 ppb
	detection limit	3 ppb
CO_2	minimum measure range	0-500 ppm
	detection limit	1 ppm

- wind speed (range 0-50 m/s, sensitivity <0 5 m/s)
- wind direction (range 0-360°, sensitivity <0 3 m/s)

188

United States Fish and Wildlife Service

Summaries of Potential Environmental Impacts for.

- Small-Scale Hydroelectric Facilities

The following section is an excerpt from the United States Fish and Wildlife Service (USFWS) technical manual on Physical Impacts of Small-Scale Hydroelectric Facilities and their Effects on Fish and Wildlife, 1984

4 2 3 Environmental Effects, Trade-offs, and Mitigation

a Physical effects. Changes in stream flow regime, increased turbidity, and increased siltation are often the most significant construction-related impacts of SSH projects Large changes in stream flow and water quality may occur during construction When water is diverted or blocked, a dewatered zone may be created The severity of the impact of dewatering depends on the nature and extent of the diversion and the existence of ground water flow into the area, but it may result in stranded fish and the destruction of wetland habitats. Roads, causeways, and filled areas, if not properly culverted, can obstruct the flow of water from small feeder streams and wetlands, effectively blocking their contributions to the larger stream and creating pools of stagnant water

Sediments are contributed to the waterway through dredging and the disposal of dredge spoils, by demolition waste, and as a result of excavation Vehicles may compact soils and destroy vegetation cover The repeated passage of heavy vehicles results in a smooth surface with reduced porosity and resistance to water, which increases stormwater runoff rates and can cause gully erosion. Thus, turbidity and downstream siltation tend to increase as large areas are denuded of vegetation and as diverted waters or increased runoff erode otherwise stable surfaces. The sediments ultimately settle out, reducing channel capacity in streams.

b Chemical effects There is little direct chemical impact due to construction per se Air pollutants may be released from equipment, from burning waste and from dirt on roads. Clearing rights-of-way for transmission lines and roads may involve both herbicide spraying and waste burning The immediate effect is air contamination, often followed later by the washing of these materials into streams.

Changes in water quality caused by substances absorbed on sediments and washed into streams may have significant effects. Phosphorus, heavy

metals, and pesticides plus other toxic materials may enter surface water in this manner, these substances can affect all levels of the aquatic food chain

Wash water from concrete mixers contains very fine particulates that are highly alkaline Other potential sources of chemical contamination include sewage, ash from burned refuse, and spills of motor fuel, oil, and paint With the exception of stormwater runoff from the construction site, none of these sources is likely to contribute significant amounts of harmful chemicals to the environment during a typical SSH construction project However, accidental spills of large amounts of diesel fuel, herbicides, or other wastes are always possible and may have a major adverse impact on the environment.

After the dam is completed, impounded water dissolves many of the nutrients present in previously exposed soils Any organic debris on the reservoir bottom will ultimately break down and go into solution as well An additional nutrient source may be leachate from soils along the reservoir shoreline The overall effect is heavy nutrient enrichment in the new reservoirs, which often stimulates primary production in the first few years It usually takes several years before a new impoundment becomes physically, chemically, and biologically stable The initial high levels of productivity may be followed by a decline for a period of up to 10 years (Ploskey 1981)

c. Biological effects Biological impacts of SSH project construction may be direct and extended Figure 15 illustrates the extensive secondary impacts of one construction activity, vegetation removal

Some habitats and many of their associated organisms may be totally destroyed during such construction activities as deforestation, dewatering, temporary flooding of terrestrial habitats and wetlands, excavation of borrow pits, soil scraping, burying debris, crushing vegetation by vehicles, herbicide and insecticide application, burning, or the channelization of streams Some habitats recover naturally after construction, while some habitats may be permanently lost

Floodplain habitats are obviously the most directly affected by SSH construction Habitat loss may be small in terms of total land area, but the ecological effects are often much greater, because lowland habitats and their associated plants and animals are selectively affected. This effect is particularly pronounced in arid regions, where the riverine habitant has a disproportionally high value.

Aquatic organisms may be affected in various ways during construction. Migrating fish may be prevented from moving upstream if passage is blocked during construction Even a short period of blockage, if it occurs during spawning, migration or juvenile out migration, can eliminate one or more whole year classes Fish may become stranded in the dewatered area when a diversion is made or when the reservoir is drained

191

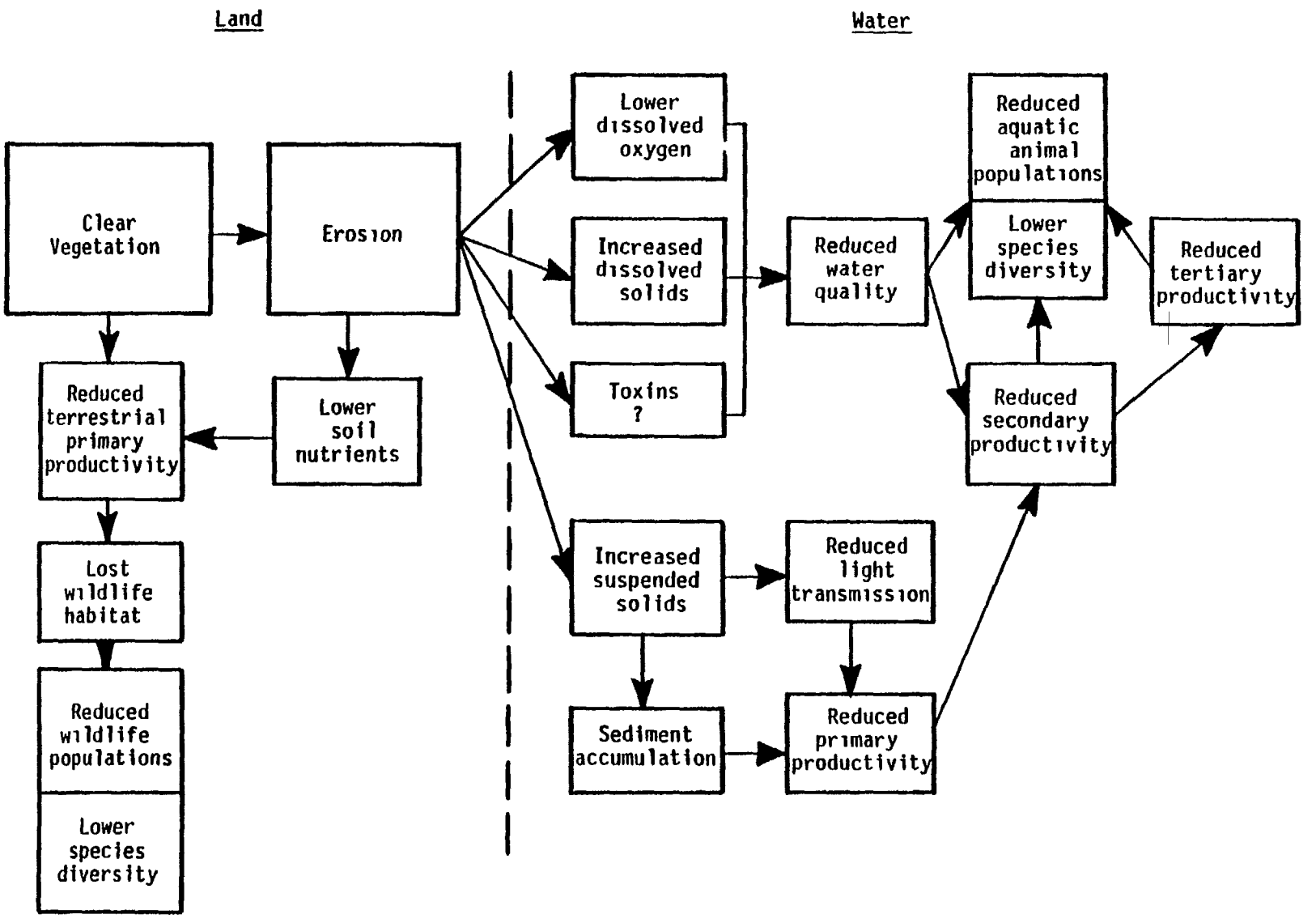

Figure 15 Some potential effects on fish and wildlife of removing vegetation (T. Lloyd Associates 1982)

Lowering reservoir water levels in a rehabilitation project will reduce the area suitable for spawning and subjects fish eggs to dehydration (Fig 16) Drawdown may cause crowding It may also result in the loss of rooted aquatic plants important as food or cover Predators have a greater impact on fish populations when fish are concentrated in pools without cover Competition for food among fish can become intense under these conditions Blasting, if it occurs underwater or where a shock wave can be transmitted into water, may adversely affect fish (Coker and Hollis 1950, Hubbs and Rechnitzer 1952)

Substances toxic to fish originate in many ways. As equipment is cleaned, very fine particulate matter may be washed into streams, along with waste oil Leftover pesticides, herbicides, and paints, or their containers, may be dumped into the water or on adjacent land, however, there are regulations against such disposal The problem of stream pollution may be much worse if stream flow is reduced during dam construction

The sediment mobilized during construction reaches streams with each rainfall or due to wind, landslides, and slope collapse Suspended sediment results in turbid water, which may reduce visibility, clog gills, and distrupt fish spawning If enough sediment settles out, it covers the bottom with a smooth, dense layer, smothering bottom invertebrates and leaving the surface generally unsuitable for spawning by salmonids and many other fish species It will also reduce the suitability of overwintering habitat for juvenile salmonids.

Terrestrial animals are also affected by construction. Heavy equipment operation is noisy and may cause animals to avoid their usual habitats and watering areas As the frequency of vehicular trips to the site increases, the danger of killing animals on the road increases The transition from "jeep roads" to graded, wider access roads means that many more recreational users can reach the site Both workers and visitors may engage in hunting and fishing, off-road vehicle use, and camping, which increases the risk of fires and other disturbances to wildlife and vegetation.

The removal of vegetation reduces available food supplies and reproductive sites, which may result in greater competition, migration to other sites, or loss of species from an area.

In the final stages of construction, the site may be replanted or landscaped When the species used in landscape plantings and ground covers are introduced, they may be of limited value to local wildlife or even involve new weed species, plant diseases, and insect pests.

d Seasonal and regional factors The construction of a small scale hydroelectric facility usually takes from 1 to 3 years. The impacts of different phases of construction vary greatly from season to season at a given site and from site to site and region to region If a reservoir is drained during a period of waterfowl use, the crowding of birds in other available habitats can be a problem Extensive lowering of water levels in

the spring can seriously affect fish spawning, while lowering in the fall will have little effect on spring spawning species Soils are very mobile when wet, exposing large areas of soil to weathering during the wettest season likely will create a greater sediment problem than similar activities during the dry season Selection of construction seasons to avoid environmental impact is not unlimited, however, because factors such as freezing of the ground, flood seasons periods of high fire danger, and the contractors' scheduling conflicts may limit the degree of rescheduling that is feasible

In anadromous fish regions a significant biological concern during construction is the relationship of the construction schedule to fish migrations A reproductive season could be lost if fish migration occurs when passage facilities are incomplete or when the reservoir level is so low that the fish cannot pass through In areas with winter ice, lake fish may be trapped under the ice in a reservoir much reduced in size

In the Eastern United States, where many dams are being considered for rehabilitation, environmentally damaging impacts from construction may be less than in other parts of the country Sites in the East often have existing access roads, many are in the downtown sections of cities and towns

In the Southwest, there is an increased risk of fire during certain seasons Then, projects should be prepared for fire suppression or scheduled to avoid the dry season

e. Trade-offs. The main trade-offs in construction often involve the timing of the construction phases in relation to fish and wildlife needs. Moving rapidly in order to reduce costs and stay on schedule may conflict with the seasonal habitat needs of wildlife On the other hand, delays in construction prolong the adverse impacts of construction on the physical environment, particularly soils Timing of temporary flow diversions and cutoffs to avoid spring or fall migration times is desirable for anadromous fish, but may result in reduced flows later in the season when resident fish and wildlife are most vulnerable due to naturally low summer or winter water supplies

Dredging is one way to increase reservoir capacity or remove accumulated sediment in intakes and canals, but the spoil must be transported and disposed of in a landfill Flushing is an alternative to dredging in some situations, although there is no transportation of spoil or off-site disposal in this case, flushing means that downstream habitats may become inundated with sediment-laden water

Measures to reduce the effects of visitors may involve trade-offs For example, when a site is fenced to keep visitors out, animal access to water also may be restricted If security lighting is installed, nocturnal animals may become disoriented

f Mitigation Mitigation measures for construction impacts fall into two general categories (1) measures designed to avoid or at least minimize a problem, and (2) remedial measures aimed at improving a degraded condition Soil conservation measures, such as seeding ground stripped of vegetation, are an example of the first category of mitigation measures. Remedial measures include cleansing gravel beds clogged with sediment to restore salmonid spawning habitat or removing silt washed into a stream by dredging These techniques are discussed further in the Mitigation Handbook

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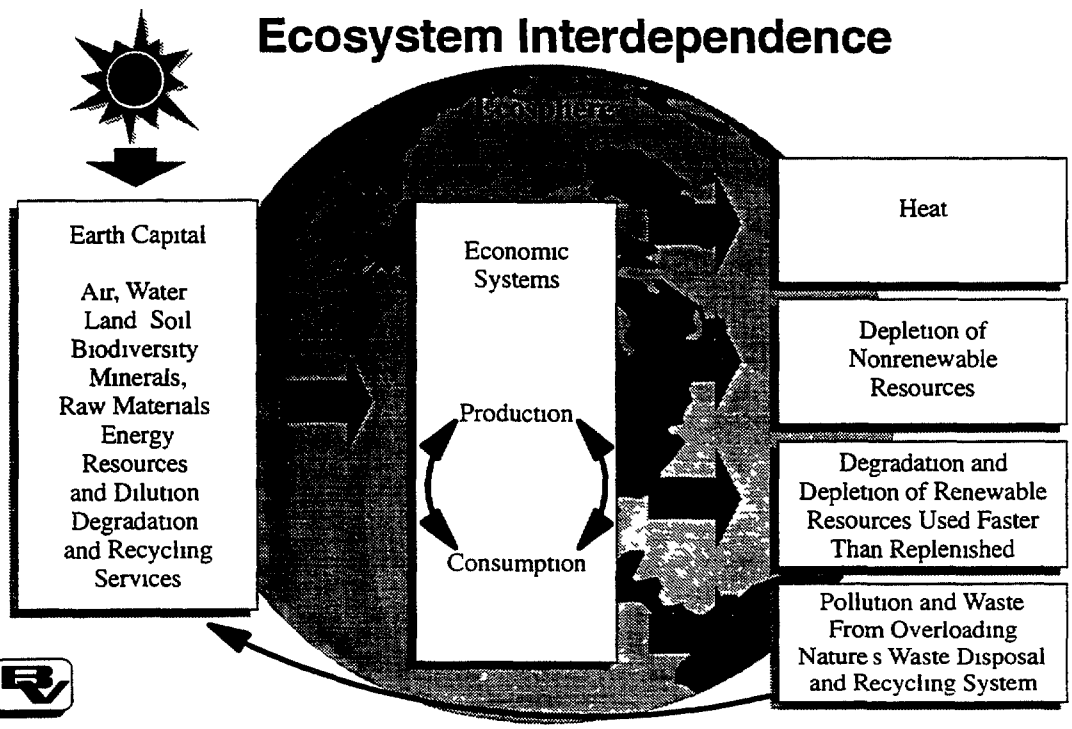
195

Evolution of Environmental Management

Ecosystem Interdependence



196

World Has Become a "Commons"

Shared Space and Resources

- Use of Common Space by Early Societies
- Garrett Hardin's "Tragedy of the Commons" (1968)

World Has Become a "Commons"

Shared Space and Resources

Examples of Commons Principles

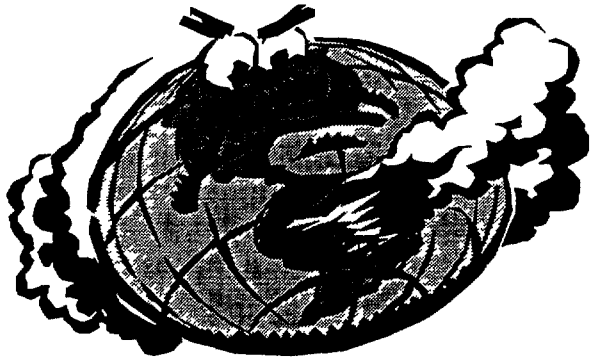
- Acid Rain
- Plant Infectious Diseases

World Has Become a "Commons"

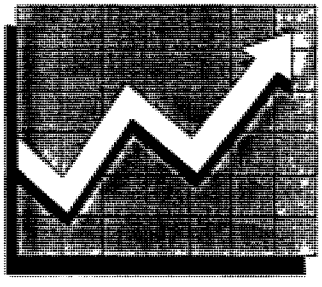
Shared Space and Resources

Examples of Commons Principles

- Global Warming
- Ozone Depletion

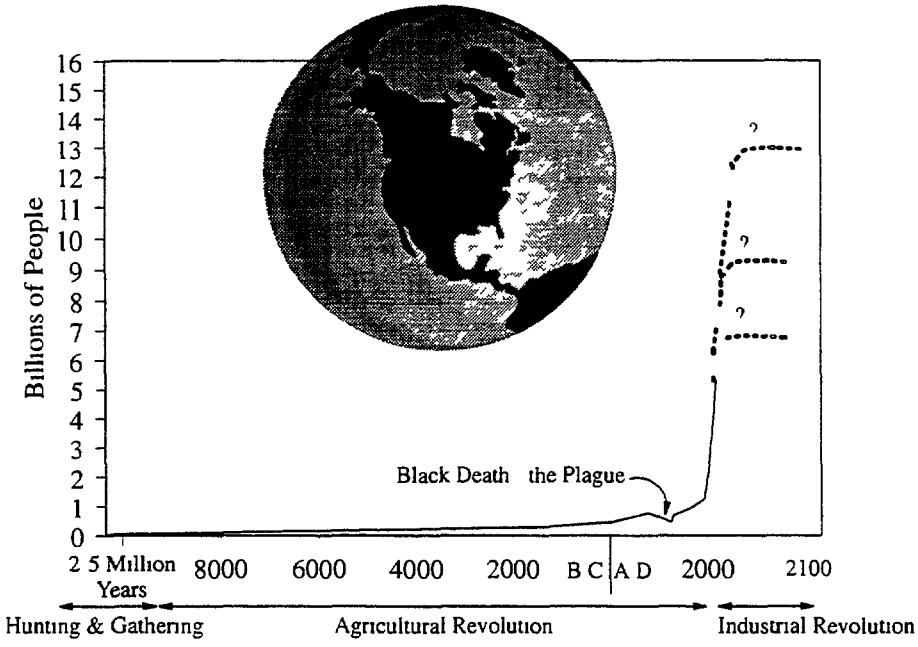


Changes in Society Caused Pollution Problems

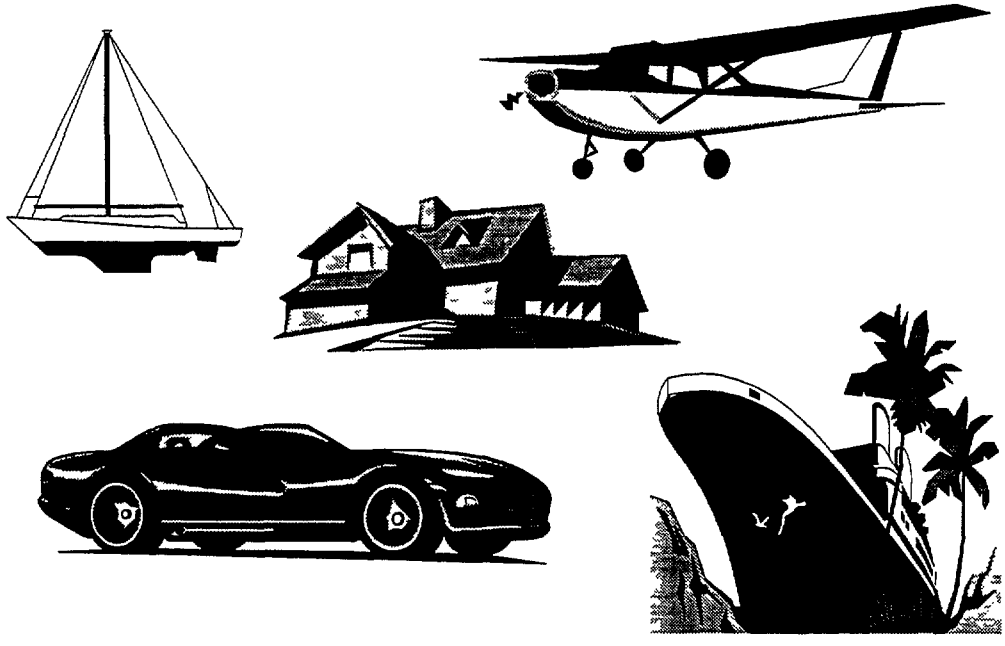


- Population Growth
- Rising Affluence
- Technological Change
- Increased Expectations and Awareness

Rate of World Population Growth



Increased Expectations

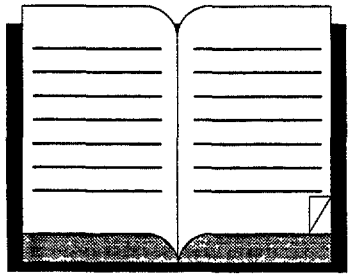


Changing Consciousness

Changing Consciousness

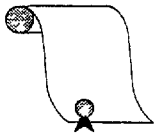
Concern About the Environment

- Environmental Laws and Regulations
  - Clean Air Act
  - Clean Water Act
  - Oil Pollution Act



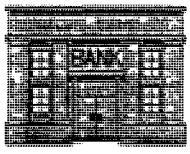
200

Necessity for Environmental Management



- Regulations / Laws / Agreements

- International Relations



- Project Approvals / Banks

- Global Issues (Acid Rain, Global Warming, Marine Environment, Biodiversity)

Environmental Assessment

- ✓ Siting
- ✓ Environmental Impact Assessment (EIA)
- ✓ EIA Process (Studies of Air, Water, Land)
- ✓ Problems of EIAs
- ✓ Cost / Benefit Analysis

Prioritization of Environmental Problems

- Environmental Risk Assessment
- Air Pollution Control Measures

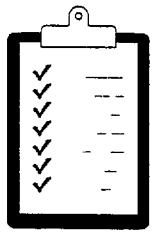
Creating Environmental Vision

- Setting Corporate Policy
- Problem Solving

202

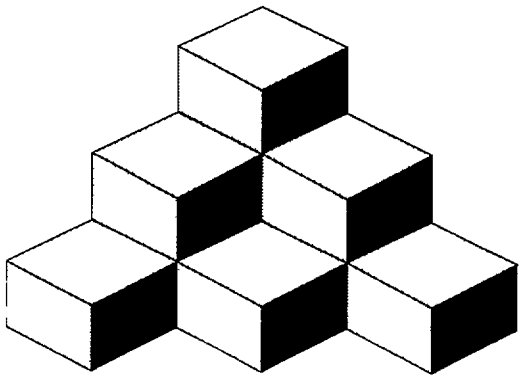
Designing Environmental Management Systems

- Pollution Prevention
- Environmental Monitoring
- Environmental Auditing



Implementing Comprehensive Environmental Management Plan

Building Environmental Capabilities



Implementing Comprehensive Environmental Management Plan

- Use of Total Quality Environmental Management (TQEM)
- Community Outreach and Involvement

EVOLUTION OF CORPORATE ENVIRONMENTAL MANAGEMENT

Prepared for

Environmental Management Course

During the last decade, industries, utilities, and corporations have implemented major changes in the way in which environmental matters are addressed As companies expand their businesses throughout the global community, environmental concerns have an increasing influence on project planning and process design At the February 1990 World Economic Forum, a global business advisory group, 650 industry and governmental leaders identified the environment as the number one challenge facing business

Many corporations are making substantial investments to ensure that environmental protection is considered in all facets of business development According to a 1993 United Nations report, in 1992 United States companies allotted an average of 1 1 to 2 percent of sales revenues to environmental expenditures In 1993, a major United States oil company invested approximately $44 million in capital expenditures for air, water, and solid waste pollution abatement Numerous examples of corporate environmental stewardship could be cited

The emergence of environmental consciousness has resulted in an increased emphasis on sustainable development in developing countries Identifying mechanisms of social, economic, and political cooperation to support development without destroying the natural resource base is an important challenge facing transnational corporations

The emphasis on sustainable development has been influenced by an increased recognition of the interdependence of world ecosystems The global environment is a commons of shared space and resources Actions in one state or country may have far-reaching impacts on the resources and the quality of life in areas remote from the original activity Problems such as acid rain, global warming, ozone depletion, and ocean pollution are just a few examples of global environmental problems crossing jurisdictional boundaries

Acid rain is a term used to refer to forms of acid deposition which can occur in the form of rain, snow, fog, dust, or gas The principle causes are man-made emissions of sulfur dioxide and nitrogen oxides which can be transported hundreds of miles in the atmosphere before falling as acid rain Effects of acid rain include sterilization of lakes and streams, detrimental reproductive effects on fish and amphibians, possible forest dieback, and deterioration of buildings and structures

205

Many scientists also believe that global warming is occurring due to changes in the atmosphere resulting from increases in the level of trace gases such as carbon dioxide, nitrous oxides, methane, and several compounds of chlorofluorocarbons (CFCs) from intensified industrial activity The trace gases form a shield around the earth preventing infrared radiation from escaping into the atmosphere Increased temperatures on the earth's surface may result in melting of polar ice caps, rising sea levels, and other impacts on the earth's climate Other global environmental problems, such as ozone depletion resulting from use of CFCs, ocean pollution, and the spread of plant infectious diseases, can impact ecosystems world wide

I Evolution of Environmental Management

Global environmental problems have resulted from exponential increases in world population The human population is currently over five billion and could double within the next century Population growth fuels the demand for goods and services and fosters the proliferation of new products and their associated wastes and increased energy consumption Technological developments also raise the rate of obsolescence through rapid innovation

The philosophy of environmental stewardship has emerged from an awareness of the harmful effects of these technological developments and their impacts on the physical environment As expectations for a higher quality of life have increased, the physical environment is seen as an important component of human existence Further, the health of the physical environment has been recognized as essential to the maintenance of the human population This change in environmental consciousness has been manifested by the establishment of national parks and wilderness areas, efforts to protect endangered species and their habitats, enacting environmental legislation, and making businesses and governments financially accountable for pollution

II Philosophies of Environmental Management

Environmental management can be achieved either by end-of-pipe abatement or by preventive management End-of-pipe abatement is achieved by the control of pollutants once they have entered the environment It includes monitoring and measuring emissions or discharges to quantify pollutants Pollution control can be effected by implementing options for abatement by modifying processes or mitigating the effect of pollutants subsequent to their release It places a high emphasis on operator training, compliance reporting, and emergency response. Although it can be effective, especially in highly dangerous or risky processes, it is a reactive process with a high potential for environmental and financial liability

Preventive Management emphasizes process and product redesign to minimize the use of and impact on environmental resources Many companies have documented the financial advantages of implementing this approach One firm developed a method of converting tires to achieve a

L06

97% recovery of reusable resources An innovative technique using solvent extraction for battery conversion resulted in recovery of zinc, copper, cadmium, and nickel Other industries have developed manufacturing techniques which minimize the discharge of harmful pollutants Examples include paper pulp manufacturing process which eliminate the use of chlorine and the development of low volatile organic compound liquid coatings in automobile paints This approach provides incentives and freedom to choose the means of achieving an environmental goal while minimizing liability exposure resulting from environmental damage

Preventive management requires a major commitment from management due to the potential impacts on profitability and the requirement for up front expenditures to implement the processes required to minimize pollution Managers must believe that environmental protection is an integral part of its success and must support a "cradle-to-grave" philosophy which integrates environmental concerns into all phases of a product or service life cycle By implementing preventive management, a company can realize significant benefits in the form of positive public relations, enhanced ability to influence environmental regulations, and significant savings in costs of clean up and expenses associated with liability claims

As transnational companies increase in number, the role in sustainable development management becomes more critical Sustainable development management can be defined as

> "Conducting business to meet the needs of the enterprise and stakeholders while protecting sustaining and enhancing human and natural resources needed tomorrow " (United Nations, 1993)

This approach requires an accounting of the company's role in dealing with global environmental problems and is evidenced by clear, specific goals relating to environmental protection A stated policy of no net loss of biodiversity, the implementation of programs for phasing out CFCs, and replanting forests are examples of specific goals identified as part of sustainable development management programs

Consistency of environmental standards across country and continental boundaries is a key element in achieving the international cooperation required to implement this approach Vast differences in standards will encourage companies to "shop" for the least restrictive regulatory atmosphere in which to conduct business International exchange of information on industrial activities will also facilitate sustainable development management The sharing of information on technological advancements such as techniques for using non-toxic materials in standard processes or enhanced methods for pollution control can accelerate pollution reduction Quantifying and pricing the impacts of natural resource exploitation, such as taxing air emissions or natural resources such as timber, will also serve as an incentive to companies to institute creative ways to minimize environmental damage

20

III Driving Forces for Environmental Performance

Key factors driving environmental performance include laws and regulations, competitive advantage, social policy, and liability exposure In their responses to the United Nations study, the companies responding overwhelmingly reported that the existence of laws and regulations was the key factor in stimulating the development of environmental policies and programs The United States has enacted extensive laws and regulations governing air, water, hazardous waste, and worker safety Since 1965, there has been a five-fold increase in the number of laws on environmental protection Currently, there are over 15,000 pages of regulations addressing the environment, health, and safety

The enforcement provisions of these regulatory programs have been strengthened as well In 1994, the United States Environmental Protection Agency carried out 2,247 enforcement actions and administered $165 2 million dollars in fines Other penalties included the requirement that companies conduct environmental audits, donate funds for pollution research, and install computerized waste tracking systems

Europe, Asia, and developing countries are also experienced increased regulation of environmental pollution The current emphasis is on cooperation between industry and government Typically, industry is heavily involved in the development of environmental regulation Corporate involvement in the regulatory framework enhances commitment to compliance and self regulation

Social policies also play a significant role in the development of corporate environmental policies Many companies place a major emphasis on setting an example for the community, the country, and the family Concern for the environmental consequences of their actions and long range implications for future generations is often a clearly stated goal in corporate environmental policies Further, compliance with applicable laws and regulations is seen as both socially and financially advantageous Corporate targets such as reducing water consumption, eliminating the use of CFCs, and reducing ozone depleting emissions reflect corporate societal concerns

Reduction or elimination of pollution can also be cost effective The research and development divisions of many companies increasingly seek ways to minimize waste or to identify benign uses for waste products resulting from industrial activities Ash resulting from the operation of coal-fired generating facilities can be used to produce aggregate for building roads and other surfaces and for producing gypsum for wall board Elemental sulfur can be recovered from integrated coal gasification processes and sold for other commercial uses

In countries with established regulatory programs, the fines associated with noncompliance of environmental regulation can have a significant adverse impact on a company's profits or price of stock Historical records of three companies indicate a 50% drop in stock

prices following environmental incidents such as the closure of a landfill and associated fine, a toxic release, and the closure of an incinerator due to uncontrolled toxic emissions A drastic reduction in property values due to contamination and associated clean up costs can result in further significant financial losses

Major environmental catastrophes also have a major impact on company environmental policies and on the development of environmental regulations The Exxon Valdez, Bhopal, Cuyohoga River, Three Mile Island, and Times Beach incidents are examples of environmental disasters resulting from faulty design, lack of adequate safety controls, failure of compliance with existing regulations, and human error All of these incidents resulted in significant environmental pollution, injury to human life and property, and major financial liabilities

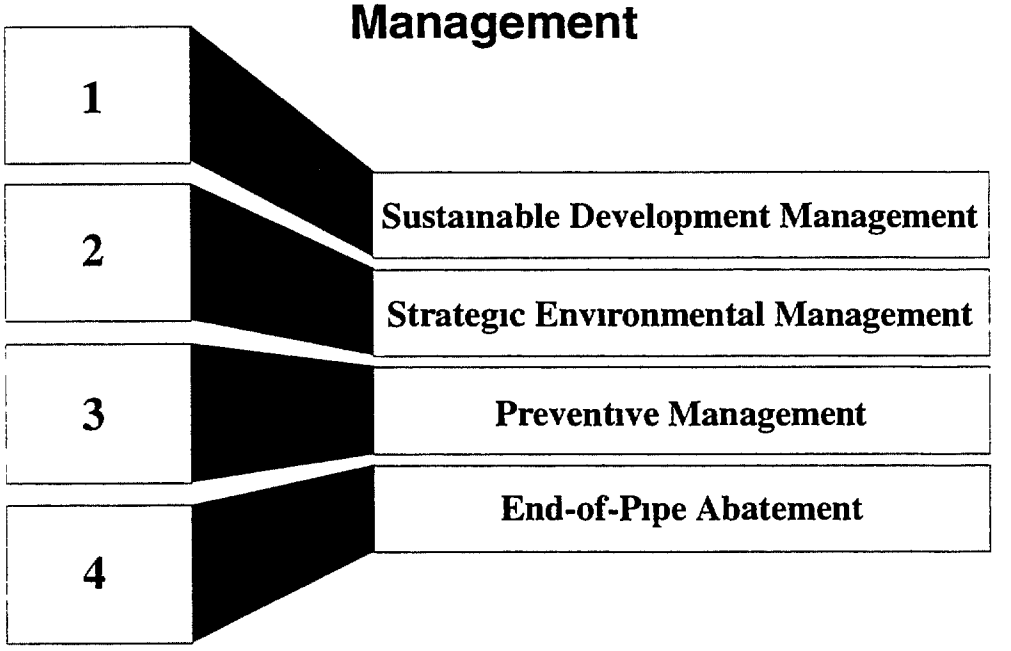
In its report on the Benchmark Corporate Environmental Survey, the United Nations summarized the key factors identified by corporations as critical to furthering global environmental objectives The ten most important factors, in order of priority, are

- Reduction in differences in environmental regulations
- Establishment of international policy guidelines
- Establishment of international technical standards
- Compilation of international laws and regulations
- Creation or strengthening of national regulatory systems in developing countries.
- Reporting on corporate leadership and achievements
- Assistance in review of voluntary corporate performance standards
- Mediating between corporations and governments on environmental conflicts
- Creating or strengthening national inspection systems in developing countries
- Establishing norms and procedures for public disclosure

Efforts to enhance coordination among developed and developing nations will focus on these objectives to foster commitment to global sustainable environmental management As the current and future leaders of these initiatives, you can play a key role in ensuring that these objectives are met

Traditional Environmental Management Systems

Levels of Corporate Environmental Management



Levels of Corporate Environmental Management

Strategic Environmental Management

- Major Commitment From Management
- Management Must Believe Environmental Protection Is an Integral Part of Its Success
- Requires "Cradle-to-Grave" Philosophy
- Benefits
  - Good Public Relations
  - Influences Environmental Regulations

Levels of Corporate Environmental Management

Sustainable Development Management

- Definition Conducting Business to Meet Needs of the Enterprise and Stakeholders While Protecting, Sustaining, and Enhancing Human and Natural Resources Needed Tomorrow

- Accounting of Company's Role in Dealing With Global Environmental Problems
  - States Policy of No Net Loss of Biodiversity
  - Programs for Phase Out of CFCs
  - Replanting Forests

Levels of Corporate Environmental Management

Sustainable Development Management

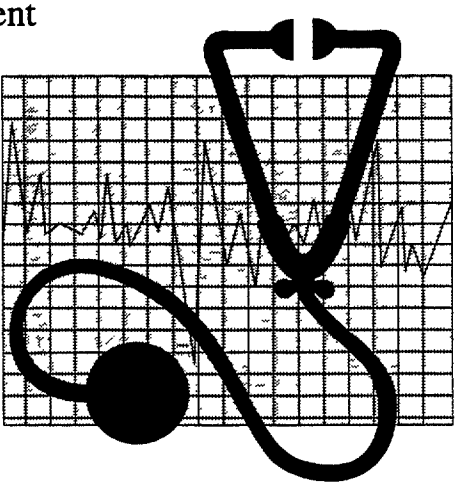
- Encouraging Companies in Sustainable Development Management
  - Consistency of Environmental Standards
  - International Coordination of Environmental Regulation
  - Use of Guidelines
  - International Exchange of Information on Industrial Activities
  - Quantify and Price Natural Resource Exploitation
    - Taxation of Carbon Dioxide or Timber
    - Taxes on CFCs

Preventive Management

- Process and Product Redesign
  - Converting Tires to Reusable Resources (97% Recovery)
  - Battery Conversion -- Solvent Extraction, Yields Metal Recovery -- Zinc, Copper, Cadmium, Nickel
  - Elimination of Chlorine Use in Paper Pulp Manufacture
  - Use of Low Volatile Organic Compound Liquid Coatings in Automobile Plants
- Gives Incentives and Freedom to Choose Means of Achieving Environmental Goal

End-of-Pipe Abatement

- Definition Control Pollutants After Enter Environment
- Compliance-Oriented
  - Monitoring
  - Abatement Procedures
  - Compliance Reports
  - Training
  - Emergency Response



End-of-Pipe Abatement

- Works Best With Highly Dangerous or Risky Productions
- Effective Where There Are Few Enforcement Provisions

CORPORATE AND FACILITY-LEVEL MANAGEMENT SYSTEMS

Environmental management systems, as the term is used in this manual, embrace both corporate and facility-level efforts to plan organize, implement, and control the environmental management activity The specific management system characteristics and elements described above have important application at both the corporate and facility levels Accordingly, a general methodology for assessing environmental management systems should adopt a comprehensive perspective It must address these system characteristics and elements as they exist (or don't exist) at both levels of the company organization

As a practical matter, some management system characteristics and elements have relatively greater importance at one organizational level rather than the other, although most of them have at least some relevance for environmental performance at both Table II-1 presents a useful summary for each management system element and characteristic as to whether it is of primary or secondary importance at each of the two levels and why It will be noted in Table II-1 that some system characteristics and elements are regarded as of primary importance at both levels, for different reasons

Several implications of Table II-1 for the conduct of environmental management system assessments are fairly straightforward First, these assessments will require visits to both corporate offices and individual operating facilities Second, the person doing the assessment should be clear when visiting corporate and facility levels as to what, in the case of each system characteristic and element, is important to find out or confirm Third, in every case, it will be necessary for this person to weigh the assessment evidence gathered at both organizational levels before arriving at any judgments or conclusions as to how well the particular management characteristic or element is being handled Interesting observations and suggestive evidence at one level may need to be followed up by more focused questions and investigation at the other in order to develop accurate findings leading to helpful recommendations

TABLE II-1

RELATIVE IMPORTANCE OF ENVIRONMENTAL MANAGEMENT SYSTEM CHARACTERISTICS/ELEMENTS AT CORPORATE AND FACILITY LEVELS

MANAGEMENT SYSTEM CHARACTERISTIC/ELEMENT	CORPORATE LEVEL		FACILITY LEVEL		COMMENTS
	Primary	Secondary	Primary	Secondary	
Characteristic					
1 Top Management Commitment	√			√	Deals primarily with corporate management attitude behavior
2 Reporting Arrangements	√		√		Reporting level equally critical at corporate individual facility
3 Management Resources		√	√		Important at both levels but critical at facility
4 Line Responsibility		√	√		Deals primarily with operating personnel
5 Ongoing Awareness and Training		√	√		Deals primarily with operating personnel awareness but reflects corporate concern and investment
Element					
1 Policies and Procedures	√			√	Set at corporate to be available and followed at facility
2 Management Organization	√			√	Largely established by corporate
3 Compliance Management		√	√		Facility responsible day to day
4 Planning Process	√			√	Largely done at corporate with important imputs from facility
5 Risk Assessment/Management	√		√		Activity must be pushed by corporate but facility plays key implementing role
6 Regulatory Tracking/Influence	√			√	Largely done at corporate but facility can track its state's regulations
7 Information Systems		√	√		Use most important at facility corporate can provide design support
8 Project/Program Reviews	√		√		Can be done at either level or in combination
9 Issue Specific Programs	√		√		Initiative/implementation can come from either level depending upon the specific program
10 Environmental Assurance	√			√	Driven by corporate but also valuable as additional input to facility

DIVERSITY OF CURRENT ENVIRONMENTAL MANAGEMENT PRACTICES IN THE ELECTRIC UTILITY INDUSTRY

Many factors affect environmental management practices at an electric utility, and the degree of formality and level of sophistication of environmental management systems can vary significantly from company to company, even among individual plants within a company

A critically important factor accounting for observed differences in environmental management systems within the electric utility industry is the type of fuel used The regulatory framework and specific type and number of environmental regulations applicable to each of these energy sources vary greatly Environmental management systems at nuclear plants tend to be very detailed and elaborate, reflecting the numerous compliance requirements (safety as well as environmental) facing this particular sector Hydroelectric stations, by comparison, are confronted with relatively few environmental compliance requirements, and elaborate environmental management systems at these plants may be unnecessary or even counterproductive Relatively speaking, fossil fuel-fired generating stations tend to fall roughly between these two extremes, both in terms of the burden or regulation and the level of sophistication of environmental management systems

The types of facilities in service necessary for the generation, transmission and distribution of electric power also help determine the regulatory requirements applicable to a given utility and, hence, its environmental management system needs Transmission lines, distribution substations, and various service centers and storage areas may present differing environmental challenges depending upon their type, age, and location Likewise, the sophistication of the systems needed to address environmental management concerns at these facilities will vary, depending upon the nature of the specific concern and the relevant regulations

Location of facilities in general is another significant determinant of the management systems necessary to achieve a given required level of environmental performance Regulatory requirements may differ, e g , emission limits and ambient concentrations of criteria air pollutants in attainment vs nonattainment areas, as may the overall potential for adverse environmental impact, e g , an isolated substation away from any water course vs a large substation immediately adjacent to a major river It is appropriate and often necessary for the environmental management systems in place to vary in their formality and sophistication depending upon the physical location of the facility in questions The important consideration is whether or not location issues have been addressed appropriately in the design of its specific environmental management systems

The size of the utility company itself will almost certainly affect the kind of environmental management systems that company is likely to implement The number of facilities a company has bears a direct relationship to the type of environmental management systems necessary to ensure a given level of environmental performance Where there are relatively few facilities, any given level of performance may be achieved by a relatively informal management system As the number of facilities increases, so does the need for formality and sophistication Thus, it may be perfectly appropriate for a small utility to have less formal and articulated environmental management systems in place than a larger utility having many facilities

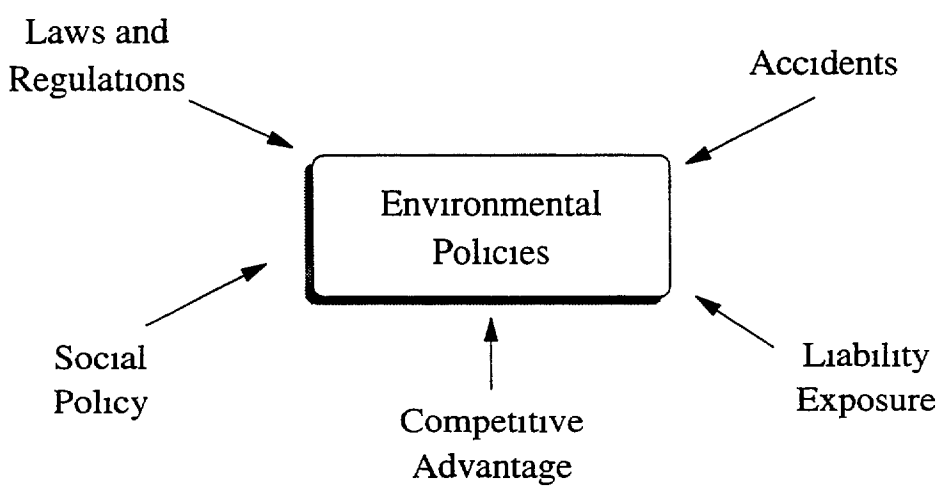
Finally, the culture of the company itself can be a very important determinant of the nature and extent of the environmental management systems likely to be present in a given electric utility Companies vary widely in the degree to which systems are formal and documents, operating under explicit procedures and decision rules This variation often reflects real differences in corporate values regarding the uses and limitations of formality in managing day-to-day operations

The relevance of these industry-specific considerations for the design and use of the environmental management systems assessment methodology contained in this manual is both immediate and direct Variability in environmental management systems across electric utilities is appropriate, indeed to be expected The "model" management system incorporated in the manual is intended to be suggestive only It captures activities judged to be important generally for sound environmental management Some of these activities may not be as important in certain organizational settings as in others Some of them may in fact be performed in a given company without being identified or labeled as such The key to intelligent use of the proposed assessment methodology in each case is flexibility It should be applied every time with a full appreciation of the limits to generality, and the need for judgment in interpreting and using its outputs

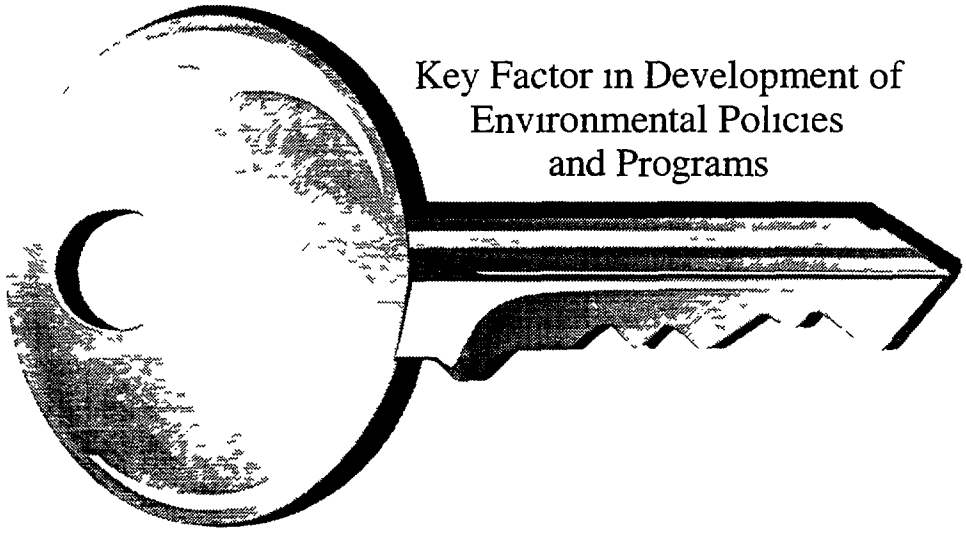
Reengineering Environmental Management

Re-Engineering Environmental Managment

Factors Influencing Development of Environmental Policies



Laws and Regulations



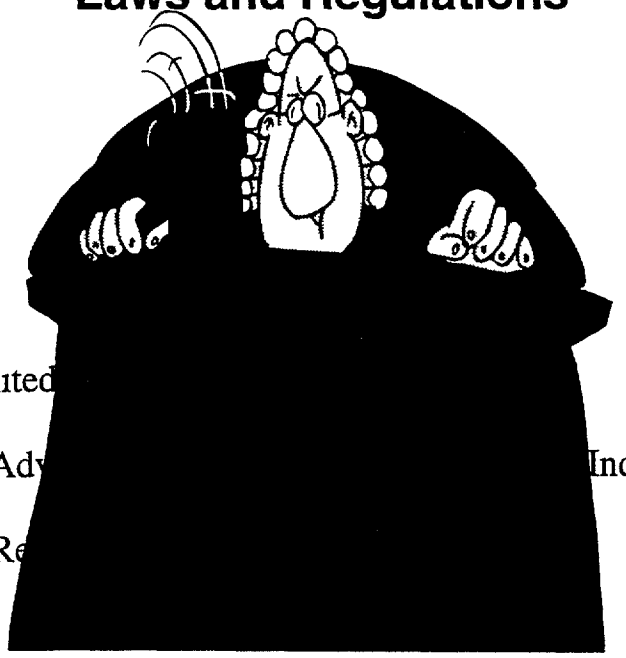
Key Factor in Development of
Environmental Policies
and Programs

Laws and Regulations

United States

- Extensive Laws and Regulations Governing Air, Water, Hazardous Waste, Worker Safety
- Goal Is to Establish Uniform Standards

Laws and Regulations

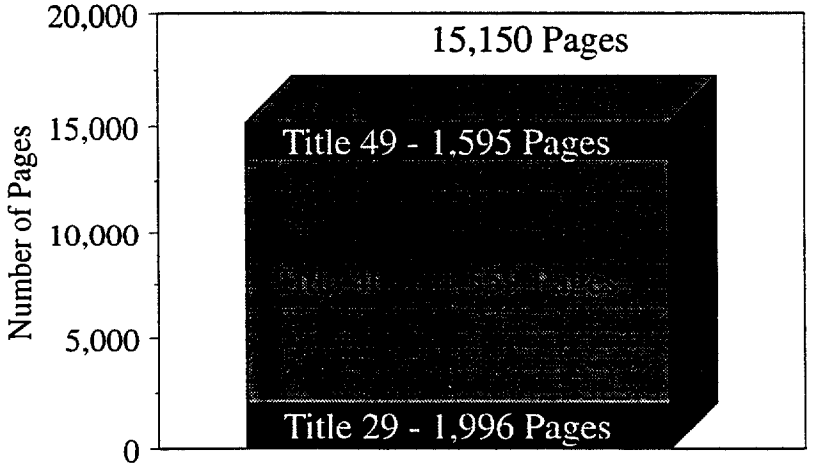


United

- Adv Industry
- Re

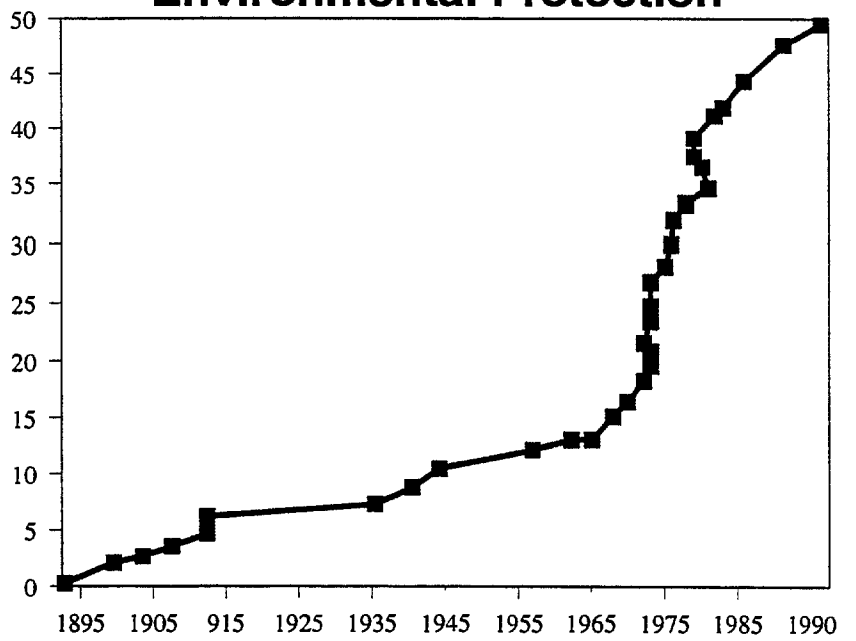
Regulatory Burden

Pages of Federal Regulations



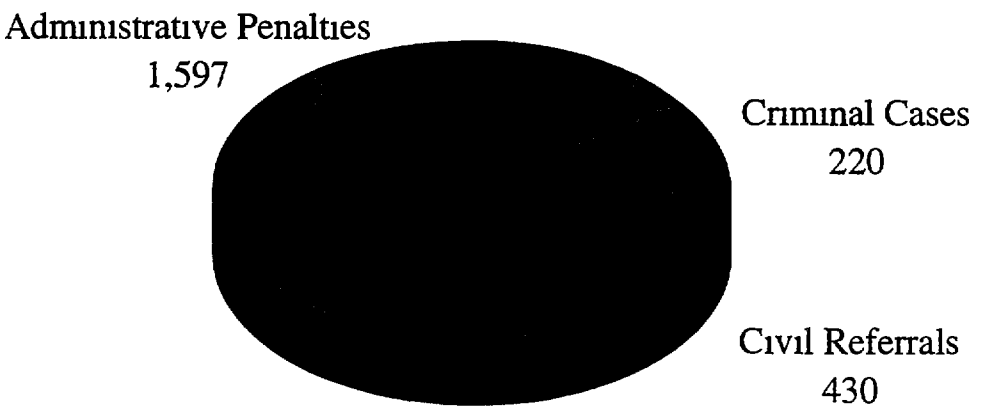
Environment, Health, and Safety

United States Laws on Environmental Protection



1994 EPA Enforcement

2,247 Enforcement Actions



$165 2 Million in Fines

223

Other Penalties in Consent Decrees

- Conduct Environmental Audits

- Donate Funds for Hazardous Waste Research

- Install Computerized Waste Tracking System

Laws and Regulations

Europe / Asia

- Increasing Regulation
- Emphasis on Cooperation Between Industry and Government
- Voluntary Agreement and Corporate Self Regulation

Social Policy

Stewards of the Environment

Corporate Commitment to Environmental Good Citizenship

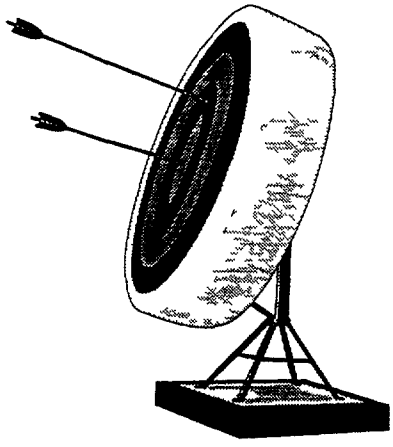
- Set Example for Business, Community, Family, Country
- Protect Environment for Future Generations
- Compliance With Laws and Regulations

Social Policy

Stewards of the Environment

Included in Corporate Targets

- Completely Eliminate Use of CFCs
- Reduce Water Consumption by 20%
- Reduce Ozone Depleting Emissions by 90%



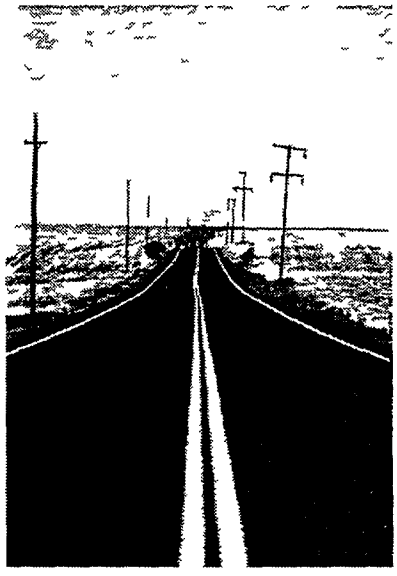
Competitive Advantage and Economic Incentive

Reduction of
Environmental Wastes
Is Cost Effective

Competitive Advantage and Economic Incentive

Markets for Waste Materials
Increase the Bottom Line

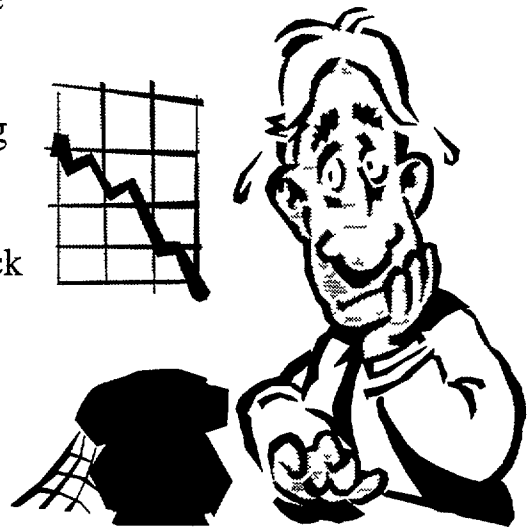
- Ash Can Be Used for Road Building, Gypsum
- Elemental Sulfur Extracted From IGCC Slag



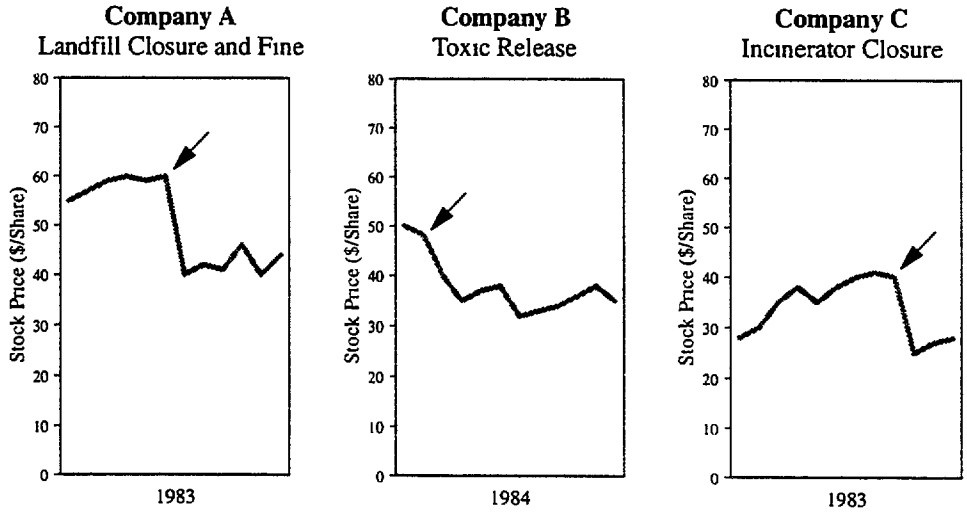
Competitive Advantage and Economic Incentive

Environmental Fines Have Negative Impact

- Affect the Cost of Doing Business
- Can Affect Price of Stock



Actual Historic Stock Price Drops Due to Environmental Incidents



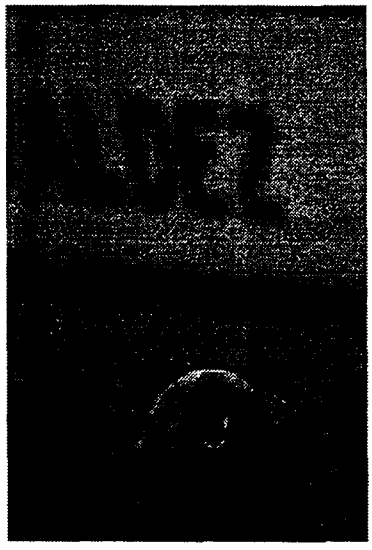
Liability Exposure

Examples of Environmental Catastrophes

- Exxon Valdez
- Bhopal Incident
- Cuyahoga River
- Three Mile Island
- Times Beach

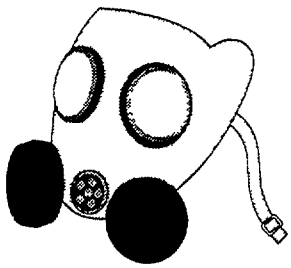
Exxon Valdez

- Nation's Worst Oil Spill
- Hundreds of Thousands of Wildlife Destroyed
- Sloppy Operations, Petty Cheapness
- Oil Pollution Act of 1990, Promulgation of Federal Regulations



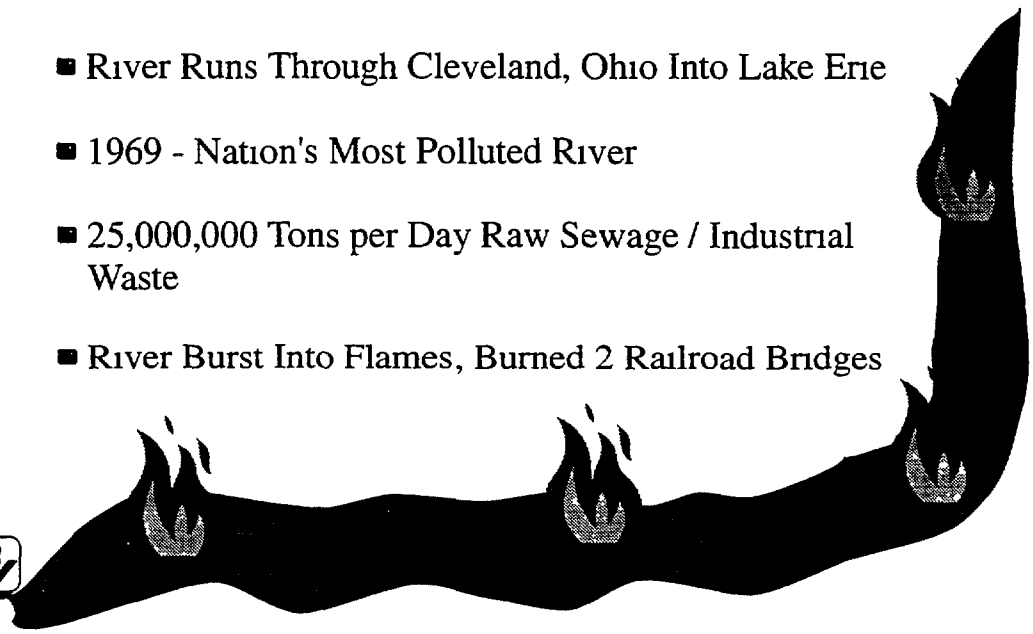
Union Carbide - Bhopal, India

- Worst Industrial Accident in History
- Estimated Over 200,000 People Dead, 300,000 Injured
- False Image of Safety and Benefit
- Need to Develop **Working** Solutions, Technologies Do Not Automatically Fit Cultural Traditions



Cuyahoga River

- River Runs Through Cleveland, Ohio Into Lake Erie
- 1969 - Nation's Most Polluted River
- 25,000,000 Tons per Day Raw Sewage / Industrial Waste
- River Burst Into Flames, Burned 2 Railroad Bridges



Three Mile Island

- Nuclear Power Plant Accident
- Mechanical Failures / Operator Mistakes
- Radiation Released Into Atmosphere
- Resulted in Revised Emergency Plans / Evacuation Procedures

Times Beach

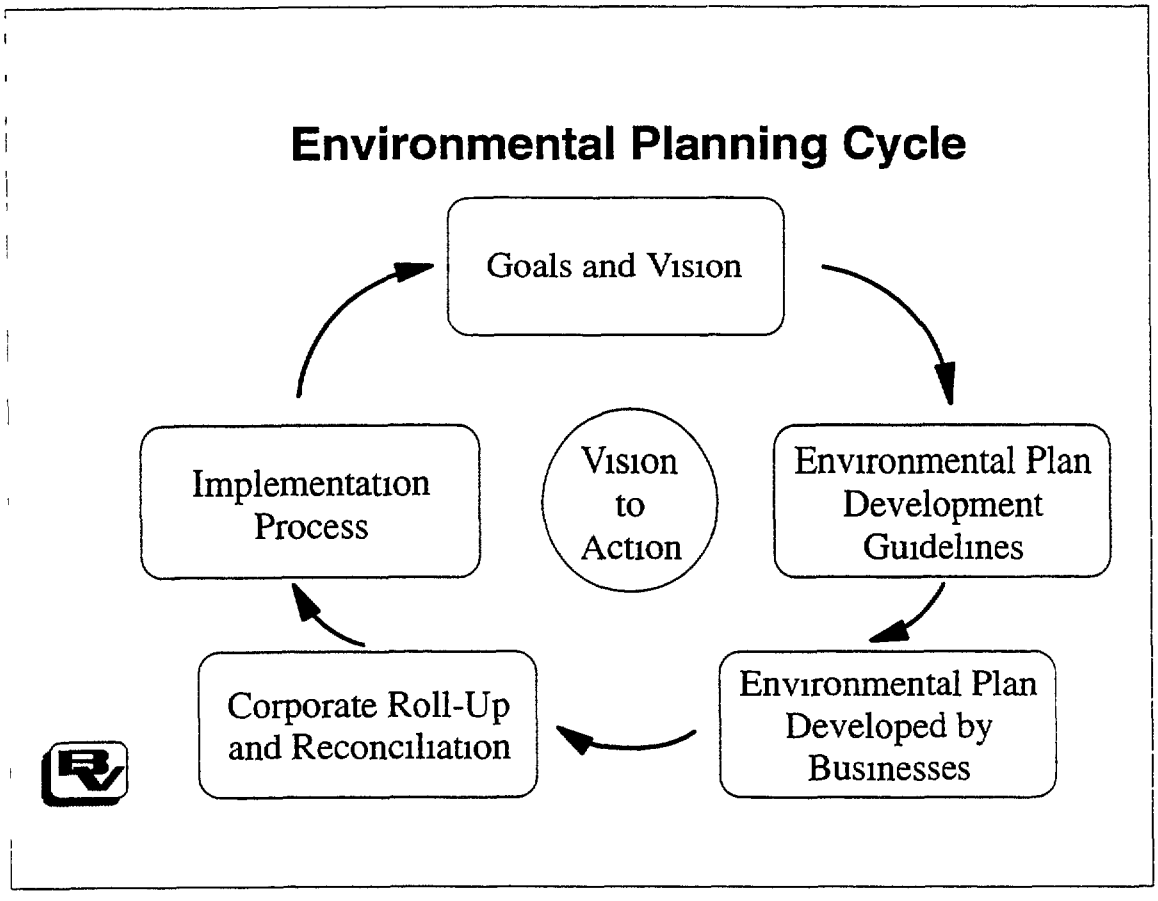
- Chemical Company in Missouri
- Spread 50 Pounds of Dioxin Throughout the State
- 23 Miles of Roads Sprayed With Waste Oil Contaminated by Dioxin
- Government Bought Town, Relocated Residents

231

Keys to Furthering Global Environmental Objectives

- Reduce Differences in Environmental Regulations
- Establish International Policy Guidelines
- Establish International Technical Standards
- Compile International Laws and Regulations
- Strengthen Regulatory Systems in Developing Countries
- Report on Corporate Leadership/Achievements
- Review Voluntary Corporate Performance Standards
- Mediating Environmental Conflicts Between Corporations and Governments
- Strengthen Inspection Systems in Developing Countries
- Establishing Norms and Procedures for Public Disclosure

Environmental Leadership


Environmental Planning Cycle
Goals and Vision
Environmental Plan Development Guidelines
Environmental Plan Developed by Businesses
Corporate Roll-Up and Reconciliation
Implementation Process
Vision to Action

Overview of ISO 14000

What is ISO 14000?

Development and Policy

ISO Standards

- Environmental Management Systems
- Environmental Auditing
- Environmental Performance Evaluation
- Life Cycle Assessment
- Environmental Labeling
- Environmental Aspects in Product Standards
- Terms and Definitions

Environmental Management System Guidance Document

Provides assistance to:

- Initiate,
- Implement, or
- Improve an EMS.

EMS Certification Standard

Provides "core" requirements for developing and implementing an EMS that can be certified.

Environmental Performance Evaluation

Process to:

- Measure,
- Analyze,
- Assess, and
- Describe

an organization's environmental criteria for management's purposes.

Environmental Auditing

Contains:

- Requirements for general principles.
- Guidelines for auditing EMSs
- Qualification criteria for auditors

Life Cycle Assessment

Tool for evaluating environmental attributes associated with a product, process, or service.

Environmental Labeling

Harmonization of criteria for use of ecolabels throughout the world.

Environmental Aspects in Product Standards

Raise awareness in product design provisions.

Terms and Definitions

Delineates and defines technical terms used in 14000 series.

ISO 14000 series covers:

- Organization Evaluation
  - Environmental Management Systems
  - Environmental Performance Evaluation
  - Environmental Auditing
- Products, Services, and Processes
  - Life Cycle Assessment
  - Environmental Labeling
  - Environmental Aspects in Product Standards

Reasons to Seek EMS Registration

Modules of an EMS

Module 1:	Commitment and Environmental Policy
Module 2:	Initial Environmental Review
Module 3:	Planning the Environmental Policy

Modules of an EMS

Module 4: Implementing Environmental Policy

- Roles, responsibilities, authority, and resources defined.
- Awareness
- EMS documentation
- Identify processes and activities that impact environment
- Identify potential for accidents and emergency situations

Modules of an EMS

Module 5: Measurement and Evaluation
Module 6: Audits and Review
Module 7: External Environmental Communication

Implementation and Operation

- Structure and Responsibility
- Training Awareness and Competence
- Internal Communication
- EMS Documentation
- Operational Control
- Emergency Preparedness and Response

Planning Action List

1. Decide, commit, and make senior person responsible.
2. Form a task force.
3. Conduct an EMS assessment using ISO 14001
4. Publish environmental policy, objectives, targets, and action plan.
5. Develop leaders to create and sustain employee awareness.
6. Define organizational structure and responsibilities.

Planning Action List

7. Involve employees in developing and improving the system.
8. Decide on document coding procedure.
9. Flowchart key processes.
10. Code all forms in line with agreed coding procedures.
11. Correlate all forms to flow chart.
12. Review flow charts for accuracy.
13. Develop and use flowcharts as documented procedures.

Planning Action List

14. Review, reconcile, approve, and issue procedures.
15. Prepare new procedures and train staff to implement them.
16. Issue new procedures and the EM program.
17. Describe whole system in EMS manual.
18. Launch system and respond to revision requests.
19. Start auditing.
20. Conduct preassessment.

Checking and Corrective Action

Basic requirements of ISO 14001 are:

- Define responsibility and authority for handling non-conformance
- Act to mitigate impacts.
- Initiate and complete corrective action.
- Implement and record changes to documented procedures

Management Review

Basic requirements of ISO 14004:

- Review of environmental objectives and targets
- Finding of EMS audits
- Evaluation of effectiveness
- Evaluation of suitability of policy

Benefits

- Assist in compliance with regulations.
- Manage future environmental, health, safety, and resource liabilities
- Increase competitive advantage through:
  - Reducing operating and disposal costs
  - Enhancing public image

What Does Standard Mean For Business?

Energy Conservation Measures at a Pulp and Paper Mill

- Repairing and replacing worn or damaged insulation
- Repairing steam leaks, and evaluating steam system for inefficient steam traps and replacing them with more efficient systems
- Consider increasing power output of steam-turbo generator from 0.8 to 1.1 MW, and running medium speed diesel units as baseload units with heat recovery.

Energy Conservation Measures at a Pulp and Paper Mill (cont.)

- Conduct annual plant-wide energy audits, and use data to develop additional energy conservation options.
- Install flue gas analyzers on boilers to facilitate optimal adjusting of fuel to air ratio.
- Conduct a motor load survey to identify opportunities for optimizing motor loadings and for replacing inefficient motors with efficient units.

Energy Conservation Measures at a Pulp and Paper Mill (cont.)

- Replace existing 40-watt fluorescent lamps with energy efficient 36-watt fluorescent tubes. Replace mercury vapor lamps with high pressure sodium lamps, where color is not critical.
- Set up an energy management group to manage energy use and to develop/implement energy-related projects.

II. Overview of ISO 14000

A What is ISO 14000?

The "14000" is merely a number series labeled by International Organization for Standardization (ISO) to cover environmental management standards The emerging set of ISO 14000 standards is the most comprehensive environmental quality management initiative ever undertaken This standard is expected to be the international environmental quality benchmark for conducting business in the global marketplace of the 21st century The first edition of the standard was issued in 1996 and prescribes the requirements for environmental quality management as defined by ISO

The ISO 14000 standard supports the corporate goals of achieving compliance with legal requirements, establishing environmental quality policies, and managing marketplace expectations These goals will be accomplished by implementing environmental quality management systems, environmental audits, environmental performance evaluations, product life-cycle assessments, and product labeling All of these activities comprise a strategic environmental quality program that can be a distinct competitive advantage as well as the gateway to an organization's successful future

ISO standards provide industry with benchmarks against which to measure performance Most of the ISO standards relate to product specification, ISO 14000, like its cousin ISO 9000, is a management system benchmark While ISO product standards are checked in a laboratory, the management standards are verified by audit In either case, the result is an official certificate on which others can rely Both provide a ready reference for buyers and sellers of goods and services This is especially useful in international trade, where customary local standards may vary widely

ISO 1400 requires companies to install a system setting environmental policy, defining goals establishing a program to meet the goals implementing that program in day-to-day operations and emergency situations measuring performance in achieving those goals and taking action when the targets are not met, improvement by repeating the cycle

Environmental management begins with controlling costs, such as waste management, disposal, and cleanup costs Soon, it evolves into a business strategy for companies to gain a "competitive edge"--a reason for consumers to choose products or service of one company over another In the long term, environmental management has a significant role in strategic business planning, taking into account the local and global constraints on human enterprise The overriding goal of the ISO

14000 environmental standard is to establish an objectively verifiable system of environmental management whose focus is to help businesses achieve all of the promise

The standard describes a process, it does not claim to set norms However, it does require that a company's environmental policy include a commitment to comply with relevant environmental laws and regulations Since there are many places in the world where local laws (and even international treaty obligations) are ahead of local industrial practice, compliance with the law is the minimum performance standard, but for ISO 14000 certification it is just a starting point The international drafting committee has tried to create a standard which can be objectively verified ISO 14000 describes what records are to be kept and what actions are required, leaving to management the determination whether the system is succeeding

B Development and Policy

The International Organization for Standardization (ISO) in Geneva, Switzerland, has long provided international product standards ISO is a worldwide federation of national standards bodies from some 100 countries, one from each country ISO is a non-governmental organization established in 1947 The mission of ISO is to promote the development of standardization and related activities in the world with a view to facilitating the international exchange of goods and services, and to developing cooperation in the spheres of intellectual, scientific, technological, and economic activity ISO's work results in international agreements which are published as International Standards

About seven years ago, it ventured into a new direction, promulgating ISO 9000 as benchmark for corporate management of quality management/quality assurance practices ISO 9000 has been widely adopted by the U S business community, particularly those companies doing business with, or trading in the European Union Following the precedent set by ISO 9000, the members adapted the next step in international management certification, ISO 14000, for environmental management systems

The ISO 14000 series of standards emerged primarily as a result of two events the Uruguay round of the General Agreements on Tariff and Trade (GATT) negotiations begun in 1986 and the Rio Conference on the Environment held in 1992 The GATT talks addressed the need to avoid or remove non-tariff barriers to trade, while the Rio Conference established the world's commitment to protection of the environment The ISO 14000 series standards represent a new consensus position for business and the environmental community they are a blueprint for promoting world trade while encouraging and assisting organization to be environmentally responsible It is no longer a question of jobs or the environment, but the standard will now allow jobs and

trade growth while promoting a clean environment

The world's first standard for environmental management systems (EMS)- BS 7750 - was developed and published by the British Standards Institution in 1992 This standard was the model for the ISO 14000 Series developed by the International Organization for Standardization (ISO) ISO 14001, which establishes the requirements for an EMS, is due to be finalized in mid-1996 BS 7750 was also the basis for the European Union's Eco-Management and Audit scheme, known as EMAS

ISO is an international standard and therefore must incorporate the different interests of many countries This standard clearly has the weakest requirements By contrast, EMAS is the most stringent and detailed standard reflecting the high environmental standards of German interests and companies which played a key role developing it

Because ISO 14000 and EMAS are both based on BS 7750, all three standards are quite similar in their approach If your organization complies with BS 7750 today, little effort will be needed to fulfill the requirements of ISO 14001 or EMAS Be aware however, that EMAS emphasizes public environmental reporting A more detailed analysis of similarities and differences as well as a table that lists the corresponding parts of each standard can be found in Appendix B

C ISO Standards

The initial version of the 14000 series environmental management standards consists of six standards

- Environmental Management Systems requirements
- Environmental Auditing requirements
- Environmental Performance Evaluation (EPE) requirements
- Life Cycle Assessment (LCA) requirements
- Environmental Labeling requirements
- Environmental Aspects in Product Standards
- Terms and Definitions

The EMS Guidance Document

The Guidance document provides assistance to organizations initiating, implementing or improving an Environmental Management System The document outlines the elements of an EMS and provides practical advice on implementing or enhancing such a system The EMS principles include identification of applicable regulatory requirements, commitment to continual improvement, and evaluating environmental performance on a regular basis

264

The EMS Certification Standard
This standard provides the "core" requirements for developing and implementing an EMS that can be certified or registered by an external third party, much the same as ISO 9001, 9002, and 9003 This standard is applicable to organizations of all sizes, types, and locations This standard can be used by an organization to improve its environmental performance by integrating the designated environmental management systems with existing management policies and procedures

Environmental Performance Evaluation
Environmental Performance Evaluation (EPE) is a process to measure, analyze, assess, and describe an organization's environmental performance against agreed criteria for appropriate management purposes This process includes gathering data, sorting and grouping the data, assessing how well targets and objectives were met, and reporting the data to interested parties and stakeholders EPE is one of many tools in an environmental management system and provides for measuring environmental impacts that can be controlled by the organization

Environmental Auditing
The Environmental Auditing standards provide requirements for general principles of environmental auditing, guidelines for auditing environmental management systems, and qualification criteria for environmental auditors It is expected that individuals will be able to become Certified Lead Environmental Auditors in much the same manner as ISO 9000 Lead Auditors but with specific knowledge and experience in environmental operations, regulations, and technologies Environmental audits are an essential element of an effective environmental management system, and need to be performed on a regular basis by qualified individuals to assess conformance with organizational requirements

Life Cycle Assessment
Life Cycle Assessment (LCA) is a tool for evaluating the environmental attributes associated with a product, process, or service LCA includes impacts along the entire continuum of a product's life from raw material extraction, through manufacturing, distribution and transportation, use, recycle, to final disposal LCA is used in both the public and private sectors, including the use of LCA as a tool in the development of EcoLabeling criteria in Europe, in developing Environmentally Preferable Products in the U S , and in crafting specific environmental standards in the U S The end results of LCA identify life cycle stages where the greatest impacts occur, and feed into the standards for Environmental Aspects in Product Standards and Environmental Labeling

Environmental Labeling
The increasing use of ecolabels throughout the world requires harmonization of the criteria used to determine which products will be able to use the labels Otherwise, the costs and non-tariff trade barriers to American products will make them less

265

competitive The ISO standard will provide requirements for three types of labels The first type is a "seal of approval" for products that meet specified requirements within a product class The second type will be single-claim labels for such things as recycled content, energy efficiency, etc The third type will be an "environmental report card" that uses a life-cycle approach and allows comparison of the environmental effects of the manufacturing and use of products

Environmental Aspects in Product Standards
This standard is intended to raise awareness that product design provisions can affect the environment in both negative and positive ways, and recommends the use of life cycle thinking and recognized scientific methodologies in developing product standards that incorporate environmental aspects This standard will incorporate many of the "design for the environment" methodologies that are currently being implemented by the Fortune 100 companies Accurate identification and assessment of how provisions in product standards influence the product's environmental effects are complex and need careful consideration and consultation with experts

Terms and Definitions
This standard delineates and defines the technical terms used throughout the entire 14000 series of environmental standards These terms can be easily misapplied or misunderstood, and in an international context can vary significantly in meaning when they are translated into many different languages Therefore, clear and unambiguous definitions for each technical term are a necessity to ensure uniformity of understanding throughout the world

D EMS Standards and Other Environmental Management Tools

Today there are two major areas in the evaluation of environmental management practice One area focuses on organizational issues, and the other on products, services and processes The ISO 14000 series covers the following topics (an overview of the ISO 14000 series is given here)

- Organization Evaluation
  - Environmental Management Systems (14001,14004)
  - Environmental Performance Evaluation (ISO 14014, ISO 14015, ISO 14031)
  - Environmental Auditing (ISO 14010, ISO 14011, ISO 14012, ISO 14013, ISO 14014)
- Products, Services and Processes
  - Life Cycle Assessment (ISO 14040, ISO 14041, ISO 14042, ISO 14043)
  - Environmental Labeling (ISO 14020, ISO 14021, ISO 14022, ISO 14023, ISO 1402X)
  - Environmental Aspects in Product Standards (ISO 14060)

E Reasons to Seek EMS Registration

You can implement an EMS that is in line with one of the EMS standards without external certification Once there is a clear reason to demonstrate conformance to third parties, external certification and registration becomes a factor Some situations where certification could become important are

- A customer requires an EMS certificate as a condition to sign a contract
- Your organization supplies to a customer who strongly suggests you get registration
- A government provides benefits to registered organizations
- You have a site in the European Union, where market pressure or the regulatory environment forces you to get registration or certification
- You export to markets where EMS registration is a de facto requirement for entering the market
- You expect to gain a competitive advantage through EMS registration
- Your major stakeholders (local community, shareholders, unions, etc)expect environmental excellence and an EMS registration is the way to demonstrate it

If one of the reasons above applies in your case, then you should decide whether to get registration for the organization as a whole or just for parts of it If you are already ISO 9000-certified, it makes sense to define its scope in a similar manner If you go for a site by site registration, you have the advantage of not losing the registration for your whole organization if one of the sites does not comply with the requirements of the standard Also, this way the process of implementing, certifying and registering the EMS is broken down into smaller projects that are easier to handle

F Modules of an Environmental Management System

An Environmental Management System that is in line with current EMS Standards like ISO 14001, BS 7750 or EMAS consists of the following seven modules

- Module 1 Commitment and Environmental Policy
- Module 2 Initial Environmental Review
- Module 3 Planning the Environmental Policy
- Module 4 Implementing the Environmental Policy
- Module 5 Measurement and Evaluation
- Module 6 Audits and Review
- Module 7 External Environmental Communication

Below is a short description of each module For organizations that have already implemented one of the EMS standards and want to switch from one standard to

267

another, more information about the corresponding modules for different EMS standards is also provided

Module 1 Commitment and Environmental Policy

The starting point of an EMS is top management commitment and an environmental policy The policy is a written document, with two components a) the rationale for the company to become "green" and b) the overall intentions of the organization regarding environmental issues The policy contains a commitment to comply with all environmental regulations, to prevent pollution and to initiate a process of continuous improvement environmental policy is unique to an organization It must be communicated to all members of the organization and made available to the public The environmental policy is the basis for developing a consistent structure of environmental objectives and targets for an organization

Module 2 Initial Environmental Review

Before an organization can plan and implement an environmental policy, an initial environmental review should be made This review will provide an overview of the environmental issues a company is facing In this initial environmental review every aspect of the future EMS is checked The organization then knows the strengths and weaknesses of its present operations and its management systems This review and the policy statement are the basis for planning the implementation of the environmental policy

Module 3 Planning the Environmental Policy

In the planning stage, all of an organization's interactions with the environment are identified Legal and other requirements that an organization must meet are determined Environmental objectives and targets are defined and environmental management programs are developed to achieve these targets The environmental management programs then assign responsibilities and name the means and time frame by which the targets will be achieved

Module 4 Implementing the Environmental Policy

The implementation and operational components of an EMS take the most time and effort within an EMS project The following aspects are covered in this stage

- The roles, responsibilities and authority of personnel whose activities have an impact on the environment are defined, documented and communicated to all members of the organization In addition, resources for the implementation and maintenance of the EMS are provided A special management representative with the responsibility and authority to enforce the EMS requirements is appointed This management representative reports the environmental

268

performance of the organization directly to top management

- Management must ensure that personnel throughout the organization are aware of the environmental policy, the environmental management programs and the actual or potential impact of their activities on the environment All personnel with a significant contribution to environmental performance need to be adequately trained to handle the environmental aspects of their activities The organization must ensure that these people have the competence to deal with their responsibilities either through education, training and/or experience

- To integrate relevant environmental aspects into daily business information

- To ensure that external auditors can certify the management system according to one of the current EMS standards, the EMS must be well-documented This documentation includes a description of the basic elements of the system and their interaction It also points to related documents There is no need to develop an EMS handbook, but it is common practice to do so The documents related to the EMS must be reviewed, revised and approved on a regular basis so that up-to-date information is available on the task or work activity being performed

- To make sure that the environmental policy is implemented and the objectives and targets met, an organization must identify processes and activities that have a significant impact on the environment The organization must ensure that these activities or processes are conducted as intended (operational control) The organization must also identify environmental aspects of the goods and services it uses, and communicate its environmental requirements to its suppliers and contractors

- The organization must identify the potential for accidents and emergency situations (emergency preparedness) and develop appropriate procedures to respond to these This includes the prevention and mitigation of the environmental impact added These procedures need to be communicated internally and tested to make sure that the response is effective and efficient

Module 5 Measurement and Evaluation

After implementing the environmental policy, management needs to measure environmental interventions and their impact on the environment This is done by building up an environmental effects register (environmental inventory) All equipment used for monitoring and measuring must be accurate and calibrated on a regular basis To check the compliance status of an organization, additional information about regulations and other requirements is needed A so-called "environmental regulations register" is often installed and maintained for this purpose Evaluation assesses

269

environmental performance against the environmental targets and objectives

Responsibilities and authority need to be defined to deal with non-compliance within the EMS This includes specifying the actions to be taken to correct an undesirable situation and to prevent future non-compliance

Module 6 Audits and Review

Audits determine the capability of the EMS to achieve the organization's environmental objectives and targets The EMS must be audited on a regular basis to ensure that the system is working as intended The audit provides the information which top management needs to review the EMS This review is a check to ensure that the system is operating effectively This top management review also addresses changes needed in the environmental policy, objectives and targets or in the EMS itself The review helps to ensure that the following functions are accomplished

- meet third party expectations (stakeholders)
- take into account new businesses or operations
- consider changes in technology
- implement audit findings or
- improve environmental performance

To make sure that the EMS can be audited by external authorities, the system must be documented and the organization must keep records related to the EMS These records must be identified, collected, stored and maintained to provide objective evidence of compliance with the EMS standard, including legal and other requirements Basic records include

- training records,
- measurement and evaluation results,
- management review records and
- audit results

Module 7 External Environmental Communication

One of the key success factors of an EMS is effective communication of an organization's activities regarding environmental issues There are two main communication directions

- communicating environmental aspects of activities, products and services to stakeholders on a continuous basis
- providing periodic information with an environmental report

Continuous communication should target customers, employees, suppliers, authorities, neighbors, the media and the general public This is not one-way communication A

frank relationship with these stakeholders can only be achieved with dialogue Here, the organization should focus on the values and interests of each specific group To open up this dialogue, an organization should consider the following measures

- Identify a contact person to handle inquiries on environmental issues
- Determine the procedure for dealing with external inquiries
- Involve the PR department in compiling information about the organization's environmental protection scheme
- Involve the marketing department in compiling information for the customer about environmental aspects of using and disposing of the product

Periodic information about environmental issues is normally provided with an environmental report This comprehensive report is compulsory only if an organization chooses to comply with EMAS Neither ISO 14001 nor BS 7750 requires an environmental report (look here for a comparison) Nevertheless, compiling an environmental report is good management practice and is often required by external stakeholders (e g shareholders, financial analysts) An environmental report covers the following topics (EMAS)

- Environmental policy
- Environmental strategy
- Description of the EMS components
- Policy regarding environmental aspects related to products and services
- Listing of all inputs (material and energy) and outputs (air pollution, sewage, waste) over the respective period of time (environmental effects register)
- Assessment of compliance with environmental regulations (environmental regulation register)
- Evaluation of environmental performance
- Description of the environmental management programs,including objectives, targets, measures and schedule
- Relationships with external stakeholders
- Audit report findings

Not mentioned in any of the EMS standards, but nevertheless important, is a communication strategy that takes into account the interests of financial stakeholders like shareholders, banks, insurers and financial analysts Management must show that the chosen environmental strategy is efficient and effective and is creating shareholder value An environmental strategy that does not create future free cash flow is economically unsustainable

271

G Implementation and Operation

Structure and Responsibility

The roles, responsibilities and authority of personnel whose activities have an impact on the environment are defined, documented and communicated to all members of the organization In addition resources for the implementation and maintenance of the EMS are provided A special management representative with the responsibility and authority to enforce the EMS requirements is appointed This management representative reports the environmental performance of the organization directly to top management

Training, Awareness and Competence

Management must ensure that personnel throughout the organization are aware of the environmental policy, the environmental management programs and the actual or potential impact of their activities on the environment All personnel with a significant contribution to environmental performance need to be adequately trained to handle the environmental aspects of their activities The organization must ensure that these people have the competence to deal with their responsibilities either through education, training and/or experience Training should be in-depth enough to enable employees to integrate relevant environmental aspect into daily business information

Internal Communication

Procedures should be established and maintained for internal communication between various levels and functions of the organization An organization can communicate in a variety of ways including bulletin board postings, internal newspapers, meetings and electronic mail messages, to name a few Communication should be a two-way process and the information communicated should be understandable and adequately explained

Communication is also needed to demonstrate management commitment, raise awareness, deal with concerns and questions about the organization's activities, products or services, and to inform interested parties about the organization's EMS and performance Results from EMS monitoring, audit and management review should be communicated to those within the organization who are responsible for performance

Environmental Management System Documentation

To ensure that external auditors can certify the management system according to one of the current EMS standards, the EMS must be well-documented This documentation includes a description of the basic elements of the system and their interaction It also points to related documents, which may include a) process information, b) organization charts, c) internal standards and operational procedures and d) site emergency plans Documentation may be integrated and shared with documentation of other systems implemented by the organization Although there is

no need to develop an EMS handbook, it is common practice to do so

Document Control
The documents related to the EMS must be reviewed, revised and approved on a regular basis so that up-to-date information is available on the task or work activity being performed To ensure against unintended use, obsolete documents should be promptly removed from all points of issue and points of use, while any obsolete documents retained for legal and/or knowledge preservation purposes should be identified as such

Operational Control
To make sure that the environmental policy is implemented and objectives and targets are achieved, an organization must identify processes and activities that have a significant impact on the environment The organization must ensure that these activities or processes are conducted as intended This includes procedures to control operations such as documented work instructions to ensure conformance to the EMS, monitoring and control of relevant process characteristics (e g effluent waste streams and waste disposal) and so on Also, the organization should establish procedures for verification of compliance to specified requirements and establish and maintain records of the results In addition, the responsibility and authority for measures to deal with non-compliance and subsequent corrective actions should be specified The organization must also identify environmental aspects of the goods and services it uses and communicate its environmental requirements to its suppliers and contractors

Emergency Preparedness and Response
The organization must identify the potential for accidents and emergency situations and develop appropriate procedures to respond to these This includes the prevention and mitigation of the impact on the environment These procedures need to be communicated internally and tested to make sure that the response is effective and efficient

An emergency plan can include the following elements

- Details of possible accidents (e g chemical spills, fire)
- Actions to be taken if accidents occur
- A list of key personnel and their responsibilities in handling emergency situations
- Drills to test effectiveness

Planning Action List Companies should consider these actions to develop and implement their environmental management system (EMS) to be ready for ISO 14001 registration and to reduce the costs of meeting environmental obligations

1 Decide, commit and make a senior person responsible for the system

775

This person, trained in environmental affairs, will report direct to the CEO

2 Form a Task Force and review need for an EMS advisor Select up to eight personnel from a cross section of grades and functions

3 Conduct EMS assessment using ISO 14001 and report Report will identify adequacy of as-is procedures and need for new procedures

4 Publish Environmental Policy, Objectives, Targets and Action Plan Deploy Policy from the top to develop agreed Objectives, Targets and Plan

5 Develop leaders to create and sustain employee awareness All leaders & Task Force must learn so they understand and can explain

6 Define organizational structure and responsibilities Keep this up to date with names and job titles as a formal document

7 Involve employees in developing and improving their system By awareness sessions, flowcharting, team reviews and experience feedback

8 Decide on the document coding procedure Use this from day one of developing system documentation

9 Flowchart key processes showing all interfaces Start with core processes and then tie in the support processes

10 Code all forms in line with agreed coding procedure Every form should belong to a process, remove redundant forms

11 Correlate all forms to flowcharts Every form should have a place, if not check completeness of flowchart

12 Review flowcharts for accuracy By "accuracy" we mean what actually happens!

13 Develop and use flowcharts as documented procedures Ensure process objective(s) also address environmental aspects

14 Review, reconcile, approve and issue as-is procedures Involve everyone and do not ignore comments Process owners may approve

15 Prepare new procedures and train staff to implement them These may include EMS auditing and dealing with emergencies

16 Issue new procedures and the environmental management program This will be the first program implemented by the EMS

17 Describe the whole system in an EMS manual Keep it slim and simple for customers, every employee and suppliers

18 Launch the system and respond quickly to revision requests Throw a well deserved party! Invite continuous improvement

19 Start auditing to continually improve your integrated system Your trained audit team will come from action Cover suppliers too

20 Conduct preassessment at least two months before the Registrar Use a registered systems auditor and ensure all corrective actions are up to date

These actions take from 6 to 18 months depending on the extent of formalized system, the skills base, workload and the degree of management commitment

H Checking and Corrective Action

When problems occur, the organization must be prepared to correct them and prevent recurrence It is important to focus on the root cause and not on the symptoms The whole point is not just to identify the problem, but to understand why it happened and to change the system, so the same mistake is not made twice In order to do this, the findings, conclusions and recommendations reached from monitoring, audits and other reviews of the EMS should be documented and the necessary corrective and preventive actions identified It is the task of management to make sure that these corrective and preventive actions have been implemented and that there is a systematic follow-up to ensure their effectiveness

The basic requirements in ISO 14001 include procedures for

- Defining responsibility and authority for handling and investigating non-conformance
- Acting to mitigate the resulting impacts on the environment
- Initiating and completing corrective and preventive action
- Implementing and recording changes to documented procedures that result from corrective and preventive action

The ISO 14001 standard also states that corrective or preventive actions "taken to eliminate the cause of actual and potential non-conformance shall be appropriate to the magnitude of problems and commensurate with the environmental impact encountered " Thus, the scope of action depends on the scope of the problem

I Management Review

Based on the audit findings, management should conduct a review to assess the continuing suitability, adequacy and effectiveness of the EMS The review should be broad enough in scope to address the environmental dimensions of all activities, products or services of the organization, including their impact on financial performance and possibly competitive position Not all components of the EMS need to be reviewed at once, but can be reviewed collectively over a period of time Also, reviews of policies, objectives and procedures should be carried out by the level of management who defined them

The review process should include (ISO 14004)

- review of environmental objectives and targets,
- findings of the EMS audits,
- an evaluation of its effectiveness and
- an evaluation of the suitability of the environmental policy and the need for changes in light of
  - changing legislation,
  - changing expectations and requirements of interested parties,
  - changes in the products or activities of the organization,
  - advances in science and technology,
  - lessons learned from environmental accidents,
  - market preferences,
  - reporting and communication

Keeping in mind the commitment to continuous improvement, management should plan corrective and preventive action to improve the EMS They should also make sure to follow up actions, to ensure that the actions were taken and were effective In some cases, the management review may dictate changes in the environmental policy and thereby trigger changes in the EMS itself

J Issues and Concerns

There are many unresolved issues associated with the development and implementation of the ISO 14000 series of standards Still to be developed are accreditation authority qualifications, register accreditation criteria, auditor certification criteria, and auditor training course accreditation criteria Difficulties may be encountered integrating these standards with different regulatory schemes throughout the world, especially when considering the EMAR in Europe and its requirements The question of ISO 9000/14000 dual registration is still open, although it is currently believed that 9000 registration will not be able to be achieved without 14000 conformance

K Drivers and Benefits

The ISO 14000 series of standards will provide a worldwide focus on environmental management and sustainable development The standards also promote a voluntary consensus approach to controlling environmental aspects, in which industry becomes more self-regulating and less dependent on the command and control approach of the current U S regulatory framework The ISO 14000 series will also minimize trade barriers by harmonizing national rules, labels, and methods for evaluating environmental impacts Within a corporation, the ISO 14000 series of standards provide a consistent methodology for maintaining regulatory compliance as well as a structure for moving beyond compliance and proactively managing environmental

276

impacts The ISO 14000 series of standards will also allow an organization to enhance its public posture by demonstrating commitment to environmental excellence and lend greater credibility to environmental performance reporting

L What Will the Standard Mean for Business?

U S companies will be profoundly affected by the international environmental management standard The development and ultimate adoption of ISO 14000 will be a significant factor in driving companies to take a more integrated approach to managing environmental issues Although ISO 14000 will be a voluntary standard, those companies that want to trade, for example, in the EU, or to do business with other companies that do trade in the EU, will be required to demonstrate adherence to the standard because the EU will likely adopt the ISO 14000 standard as conforming to its environmental management directive For some companies, registration under ISO 14000 may be a legal prerequisite to enter the regulated EU market, while others may be asked by the purchasers of their products or services to be registered

There are real benefits to the adoption of such a standard as ISO 14000 For one thing, it provides a way for regulatory authorities, investors, and the public to verify that a company is doing all it can to decrease adverse environmental effects for its operations This fact alone can help decrease the pressure for ever stricter regulations This is the opposite from the situation where the public perceives industry doing as little as it can get away with to prevent environmental penalties--a perception that calls forth demands for the strictest of regulation By analogy, there are no regulations requiring industry to have a financial management system, even though enhanced profits benefit the government through enhanced tax revenues, because the public believes that industry is sufficiently motivated to that direction already In the same way, once the public is convinced that decreased environmental impact is a primarily corporate goal, it should not demand the imposition of excessively tight regulations

Further, a worldwide standard for environmental management tends to decrease competition from companies that do not adhere to it, first by making them less acceptable to consumers and second by eventually requiring by law that they, too, practice environmental management In this way, global management standards are really an outgrowth of global product standards (the original and main occupation of the ISO) and thus a benefit for free trade

With the expectation that 1996 will bring ISO 14000 into practice, companies that trade or do business on an international scale will need to evaluate their current systems (or set up such a system) covering environmental management, auditing, and performance Taking a lesson from the ISO 9000 certification process, companies will be well served to begin improving their environmental management systems before

277

ISO 14000 is a reality Companies that do not pay attention to the ISO 14000 developments may find themselves running to catch up to their competition

Ultimately, ISO 14000 will be a driving force for companies to take a more integrated approach to managing environmental issues on a global scale It has often been said that,"Time is money", the time has come when it is equally common to say,"Waste is cost " This basic truth will soon be followed by,"Green is gold " ISO 14000 begins to provide a basis to evaluate a company's claims in this area in the same way that the financial disclosures of the SEC allow analysts to evaluate a company's financial performance As it becomes clearer that good business management includes the concept of sound environmental management, industry will be pointed in the direction of sustainable development to the benefit of both the stakeholders and the environment

APPENDIX A

STANDARDS AND GUIDELINES IN THE ISO 14000 SERIES

Note The ISO 14000 Series is still under development The technical committee (TC), TC 207, is supervising and developing the ISO 14000 Series The secretariat of TC 207 is held by the Standards Council of Canada (SCC) Each standard undergoes different stages

- Preliminary Work Item (PWI)
- New Work Item (NWI)
- Working Draft (WD)
- Committee Draft (CD)
- Draft International Standard (DIS)

These standards can be classified into four groups according to their focus

- Organization and systems standards
- Evaluation and auditing standards
- Product-oriented standards
- Definition standards

Organization and Systems Standards

- ISO 14001 Environmental Management Systems - Specification and Guidance for Use
- ISO 14004 Environmental Management Systems - General Guidelines on Principles, Systems and Supporting Techniques

Evaluation and Auditing Standards

- ISO 14010 Guidelines for Environmental Auditing - General Principles
- ISO 14011 Guidelines for Environmental Auditing - Audit Procedures - Auditing of Environmental Management Systems
- ISO 14012 Guidelines for Environmental Auditing - Qualification Criteria for Environmental Auditors
- ISO 14013 Management of Environmental Audit Programs
- ISO 14014 Initial Reviews
- ISO 14015 Environmental Site Assessments
- ISO 14031 Evaluation of Environmental Performance

Product-Oriented Standards

- ISO 14020 Goals and Principles of all Environmental Labeling
- ISO 14021 Environmental Labeling - Self Declaration Environmental Claims - Terms and Definitions
- ISO 14022 Environmental Labeling - Symbols
- ISO 14023 Environmental Labeling - Testing and Verification

Methodologies

- ISO 14024 Environmental Labeling - Guiding Principles, Practices and Criteria for Multiple Criteria-based Practitioner Programs (type I)- Guide to Certification Procedures
- ISO 1402X Type III Labeling
- ISO 14040 Life Cycle Assessment - Principles and Guidelines
- ISO 14041 Life Cycle Assessment - Life Cycle Inventory Analysis
- ISO 14042 Life Cycle Assessment - Impact Assessment
- ISO 14043 Life Cycle Assessment - Interpretation
- ISO 14060 Guide for the Inclusion of Environmental Aspects in Product Standards

Definition Standards

- ISO 14050 Terms and Definitions - Guide to the Principles for ISO/TC 207/SC Terminology Work

APPENDIX B

COMPARISON OF ENVIRONMENTAL MANAGEMENT SYSTEMS STANDARDS

Differences and Similarities between ISO 14001, BS 7750, and EMAS

Both ISO 14001 and EMAS are based on BS 7750 However, there are some fundamental differences among these standards, especially between ISO 14001 and the other two standards ISO 14001 is an international standard, while EMAS and BS 7750 are regional standards Generally speaking, ISO is the weakest standard while EMAS has the most stringent requirements BS 7750 and EMAS are quite similar except for the EMAS requirement for a public environmental statement A closer look at the details of the standards shows the following differences

- **Scope** BS 7750 and EMAS apply to a single site, while EMAS generally relates to industrial activities ISO 14001 may apply to only part of a site, for example, a single operating unit, and it includes non-industrial activities, such as government activities

- **Environmental Aspects** ISO 14001 requires only the identification of significant environmental aspects associated with on-site activities By contrast, EMAS and BS 7750 basically require a full inventory of environmental aspects linked to on-site activities With BS 7550, an additional examination and assessment of environmental effects caused by products and services is also required

- **Continuous Improvement** BS 7550 and EMAS require an improvement of environmental impacts, whereas ISO 14001 emphasizes the improvement of the EMS</A> as a means of reducing environmental impacts

- **Objectives** BS 7750 and EMAS require time-scaled environmental objectives ISO 14001 asks only that the environmental management programs have a time frame

- **Contractors and Suppliers** ISO 14001 does not refer to the environmental performance/assessment of contractors or suppliers It asks only that a company communicate its environmental policy to suppliers and contractors In contrast, EMAS and BS 7750 direct an organization to ensure that suppliers and contractors comply with the organization's environmental policy>

- **Documentation** ISO 14001 requires documentation of the environmental policy, objectives, staff responsibilities, communication with external interested parties and several other procedures ISO

14001 requires identification of environmental aspects, but does not specifically require a register of environmental effects and regulations, like EMAS and BS 7550 Both EMAS and BS 7550 require records of the extent to which environmental objectives have been met

- **Audits** EMAS stipulates that a company must carry out an audit at least every three years ISO 14001 and BS 7750 do not specify a minimum audit interval EMAS also requires more extensive auditing than ISO 14001, which requires only EMS auditing

- **Initial Review** EMAS requires an extensive initial review as part of the EMS ISO 14001 does not specifically require this, but it is suggested

- **Communication** EMAS requires a comprehensive public environmental statement that is externally verified by an independent auditor and a simplified annual statement ISO 14001 and BS 7750 ask only that the environmental policy is publicized BS 7750 and EMAS require that environmental objectives and targets are made public

The following table lists the corresponding parts of each standard (which is based mainly on the ISO 14001 standard)

Correspondence between ISO 14001 EMAS and BS 7750

Step	System Element	ISO 14001	EMAS	BS 7750
	Environmental Management System	4 0 General	Article 2 e 3 a Annex I B	4 1
Step 1 Commitment and Environmental Policy	Environmental Policy	4 1	Article 3 a Annex I A I D	4 2
Step 2 Initial Environmental Review	Initial Environmental Review	Annex A 4 2 1 (not mandatory but good practice)	Article 2 b 3 b Annex I C	Annex A 1 2 (not mandatory but good practice)
Step 3 Planning the Environmental Policy	Environmental Aspects	4 2 1	Article 3 b Annex I B 3 I C I D 2 I D 3	4 4 2
	Legal and other Requirements	4 2 2	Article 3 a Annex I B 3	4 4 3
	Objectives and Targets	4 2 3	Article 2 d 3 e Annex I A 4	4 5
	Environmental Management Programs	4 2 4	Article 3 c Annex I A 5	4 6
Step 4 Implementing the Environmental Policy	Structure and Responsibility	4 3 1	Annex I A 5 a I B 2	4 3
	Training Awareness and Competence	4 3 2	Annex I B 2	4 3 4
	Internal Communication	4 3 3	Annex I B 2	4 4 1 4 9
	EMS Documentation	4 3 4	Annex I B 5 I B 4 a	4 7 1 4 7
	Document Control	4 3 5	Annex I B	4 7 2
	Operational Controls	4 3 6	Annex I B 4 I D 6 7	4 8
	Emergency Preparedness and Response	4 3 7	Annex I C 9	4 4 2
Step 5 Measurement and Evaluation	Environmental Data Management	4 4 1	Annex I B 3	4 4 3
	Performance Evaluation	4 4 1	Annex I B 3	4 4 3 4 5
	Non Conformance Corrective and Preventive Actions	4 4 2	Annex I B 4	4 8 4
	Records	4 4 3	Annex I B 5	4 9
Step 6 Audits and Review	EMS Audit	4 4 4	Article 3 d 2 f Annex I B 6 II	4 10 4 10 1 4 10 2, 4 10 3
	Management Review	4 5	Article 3 d Annex I B 1	4 11
Step 7 Environmental Report	Environmental Statement/Report	not required	Article 3 f 3 g 3 h 5 Annex V	not required

IX3

ANNEX C

INITIAL ENVIRONMENTAL REVIEW QUESTIONNAIRE

Methodology

The questionnaire follows the ISO 14001 requirements with slight modifications (e g it includes external environmental reporting, which is not required by ISO 14001 There are six sections Within each section a number of questions have to be answered with scores ranging from 0 (worst) to 3 (best) The score indicates the effort needed in terms of human and financial resources to meet the specific statement

- 0 points huge effort needed (= 0% compliance with the EMS requirements)
- 1 points high effort needed
- 2 points moderate effort needed
- 3 points no effort needed (= 100% compliance with the EMS requirements)

Adding up the scores in each section and comparing them to the maximum possible score (= benchmark) gives a company-specific profile of strengths and weaknesses

Questionnaire

Module of the EMS	Aspect		Assessment
Commitment and Environmental Policy	Commitment	Top management has made a commitment to address environmental issues related to the organization s activities products and services	
	Environmental Policy	Top management has defined an environmental policy	
		The environmental policy is appropriate to the nature scale and environmental impacts of its activities products and services	
		The environmental policy includes a commitment to	
		(a) prevent pollution	
		(b) continuous improvement	
		(c) comply with environmental regulations and other requirements to which the organization subscribes	
		The environmental policy provides a framework for setting and reviewing environmental objectives and targets	
		The environmental policy is documented and communicated to all employees	
		The environmental policy is available to the public	

Module of the EMS	Aspect		Assessment
Planning the Environmental Policy	Environmental Aspects	The organization has established and maintained a procedure to identify the environmental aspects of its activities products and services in order to determine those which can have significant impacts on the environment	
		The organization has ensured that the aspects related to these significant impacts are considered in setting environmental objectives	
		The information about significant impacts and related aspects is up to date	
	Legal and Other Information	The organization has established and maintained a procedure to identify and have access to legal requirements directly applicable to the environmental aspects of its activities products and services	
		The organization has established and maintained a procedure to identify and have access to other requirements to which the organization subscribes directly applicable to the environmental aspects of its activities products and services	
	Environmental Objectives and Targets	The organization has established and maintained documented environmental objectives	
		The organization has established and maintained documented and whenever possible quantified environmental targets	
		The environmental objectives and targets are set for each relevant function and level within the organization	
		When establishing its objectives the organization has considered legal and other requirements its significant environmental aspects its technological options and its financial operational and business requirements and the views of interested parties	
		The environmental objectives and targets are consistent with the environmental policy and the required commitments	
	Environmental Management Program(s)	The organization has established and maintained environmental management program(s) for achieving its environmental objectives and targets	
		The environmental management program(s) include responsibilities at each relevant unction and organizational level	
		The environmental management program(s) include the means and timeframe by which they are to be achieved	
		The organization has established a procedure to ensure that environmental aspects are included in projects relating to new developments of activities products and services	

Module of the EMS	Aspect		Assessment
Implementing the Environmental Policy	Structure and Responsibility	The organization has defined documented and communicated roles responsibilities and authority	
		The organization has provided human and financial resources to implement and control the EMS	
		The organization has appointed a specific management representative who ensures that the EMS is in line with the EMS requirements and reports the performance to top management	
	Training Awareness and Competence	The organization has defined training needs for those personnel whose work may create a significant environmental impact	
		Personnel at each relevant function and level are aware of	
		(a) the importance of meeting the requirements of the EMS	
		(b) the environmental impact of their work activities and the benefits to improve performance	
		(c) their roles and responsibilities within the EMS	
		(d) the potential consequences of departure from specific operating procedures	
	Internal Communication	The organization has established and maintained a procedure for communicating between various levels and functions within the organization	
	EMS Documentation	The organization has established and maintained information to describe the core elements of the EMS and their interaction	
		The organization has established and maintained information to provide direction to related documentation	
	Document Control	The organization has established and maintained a procedure for controlling all EMS documents (properly filed reviewed up to date)	
		Procedures and responsibility are established and maintained to create and modify documents	
	Operational Control	The organization has identified those operations and activities that are associated with the identified significant environmental aspects	
		The organization has planned these activities (including maintenance) to ensure that they are carried out under specified conditions	
	Emergency Preparedness and Response	The organization has established and maintained procedures to identify the potential for and response to accidents and emergency situations	
		The organization has tested these procedures and revised them after accidents	

Module of the EMS	Aspect		Assessment
Measurement and Evaluation	Environmental Data Management	The organization has established and maintained documented procedures to monitor and measure on a regular basis the key factors that can have a significant environmental impact Monitoring equipment is calibrated and maintained	
		The organization has established and maintained information about relevant environmental regulations	
	Performance Evaluation	The organization evaluates and documents performance related to its environmental objectives and targets	
		The organization evaluates and documents compliance with environmental regulations	
	Corrective and Preventive Actions	The organization has established and maintained procedures for defining responsibility and authority for handling and investigating non conformance and for initiating and completing corrective and preventive actions	
		The organization has established a procedure to implement and record any changes in the documented procedures resulting from corrective and preventive actions	
	Records	The organization has established and maintained procedures for the identification maintenance and disposition of environmental records including training records and the results of audits and reviews	
		The environmental records are legible identifiable and traceable to the activities products and services involved	
		The environmental records are stored and maintained in such a way that they are readily retrievable and protected against damage deterioration or loss	

Module of the EMS	Aspect		Assessment
Audits and Reviews	EMS Audit	The organization has established and maintained procedures for periodic EMS audits to be carried out in order to determine whether or not the EMS	
		(a) conforms to planned arrangements for environmental management including the requirements of the EMS standard	
		(b) is properly implemented and maintained	
		The organization has established and maintained procedures for periodic EMS audits to be carried out, in order to provide information on the results of audits to management (including top management)	
		The audit procedures cover the audit scope, frequency and methodologies as well as responsibilities and requirements for conducting the audit and reporting the results	
	Management Review	The organization s top management reviews the EMS periodically to evaluate the suitability adequacy and effectiveness of the EMS	
		The organization s top management reviews the EMS periodically to determine the necessity to implement changes to the EMS	
		The review is documented	

Module of the EMS	Aspect		Assessment
External Environmental Communication	Environmental Report	The organization publishes an external environmental report which covers the company s environmental policy the objectives and targets the environmental performance the environmental management programs and the structure of the EMS	
		The environmental report is validated by external experts	
	Continuous External Communication	The organization considers processes for external communication about its significant environmental aspects and records its decision	
		The organization has established and maintained procedures to identify significant environmental aspects of goods and services used by the organization and has communicated relevant procedures and requirements to suppliers and contractors	
		The organization has established and maintained procedures to the identifiable significant environmental aspects of goods and services produced by the organization and communicated relevant procedures and requirements to customers	
		The organization has established and maintained procedures for receiving documenting and responding to relevant communication from external interested parties	

APPENDIX D

TERMS

Below is an alphabetical list of terms and definitions used in this document The use of these terms and definitions varies largely from one person to another The list below relies on definitions used by internationally recognized organizations (e g ISO, SCC), environmental agencies (e g Environmental Protection Agency of the USA) or research reports of large groups of scientists and projects As long as "ISO 14050 - Terms and Definitions", is NOT finalized environmental managers will have to deal with this terminology problem

Abiotic Resources
Resources which are considered abiotic and therefore not renewable Zinc ore and crude oil are examples of abiotic resources

Ancillary Material
Material that is not used directly in the formation of a product or service

Auditing
See environmental management system audit

Biotic Resources
Resources which are considered biotic and therefore renewable The rainforests and tigers are examples of biotic resources

By-Product
A useful and marketable product or service that is not the primary product or services being produced See also co-product

Certification
The procedure by which third party gives written assurance that a product, process, or service conforms to specific requirements See also registration

Characterization
Characterization aggregates classified environmental interventions/ aspects within an environmental impact category This step results in environmental performance indicators

Characterization Factor
A factor that describes the relative harmfulness of an environmental intervention within one environmental impact category A factor is a result of modeling environmental effects/problems

Classification
Classification attributes are environmental interventions/aspects listed in an <A environmental inventory/environmental effects register according to environmental impact categories

Close-loop Recycling
A recycling system in which a product made from one type of material is recycled into a

different type of product (e g used newspapers into toilet paper) The product receiving recycled material itself may or may not be recycled See also open-loop recycling

Co-Product

A marketable by-product from a process that can technically not be avoided This includes materials that may be traditionally defined as waste such as industrial scrap that is subsequently used as a raw material in a different manufacturing process

Continuous Improvement

The process of enhancing an environmental management system to achieve improvements in overall environmental performance in line with an organization's environmental policy ISO 14004

Damage

A deterioration in the quality of the environment not directly attributable to depletion or pollution

Depletion

The result of the extraction of abiotic resources (non-renewable) from the environment or the extraction of biotic resources (renewable) faster than they can be renewed

Downcycling

See recycling

Eco-Efficiency

The relationship between economic output (product, service, activity) and environmental impact added caused by production, consumption and disposal

Emission

One or more substances released to the water, air or soil in the natural environment See also environmental release, pollution and environmental intervention

Environment

Surroundings in which an organization operates, including air, water, land, natural resources, flora, fauna, humans, and their interrelations This definition extends the view from a company focus to the global system (ISO 14004, BS 7750)

Environmental Aspects

Elements of an organization activities, products or services which can interact with the environment (ISO 14004) A significant environmental aspect is an environmental aspect which has or can have a significant environmental impact (ISO 14004) See also environmental interventions, environmental problem

Environmental Effect

Any direct or indirect impingement of activities, products and services of an organization upon the environment, whether adverse or beneficial (BS 7750) An environmental effect is the consequence of an environmental intervention in an environmental system See also environmental impact, environmental problem

291

Environmental Effects Evaluation

A documented evaluation of the environmental significance of the effect of an organization's activities, products and services (existing and planned) upon the environment (BS 7750)

Environmental Effects Register

A list of significant environmental effects, known or suspected, of an organization's activities, products and services upon the environment (BS 7750) Also see environmental inventory

Environmental Impact

Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organization's activities products or services (ISO 14004) An environmental impact addresses an environmental problem Also see environmental effect

Environmental Impact Added

The total of all environmental interventions of a product or production system evaluated (weighted) according to the harmfulness of each intervention to the environment

Environmental Intervention

Exchange between the economy and the environment including resource extraction emissions to the air, water, or soil, and aspects of land use If resource extraction is excluded, the term used in this case is environmental release See also emission and pollution

Environmental Inventory

An environmental inventory identifies and quantifies - where appropriate - all environmental aspects of an organization's activities, products and services Also see environmental effects register

Environmental Issue

A point or matter of discussion, debate, or dispute of an organization's environmental aspects

Environmental Management

Those aspects of an overall management function (including planning) that determine and lead to implementation of an environmental policy (BS 7750) See also environmental management system

Environmental Management Audit

A systematic evaluation to determine whether an environmental management system and environmental performance comply with planned arrangements, and whether a system is implemented effectively, and is suitable to fulfill an organization's environmental policy (BS 7750)

Environmental Management Manual

The documentation describing the procedures for implementing an organization's environmental management program (BS 7750)

Environmental Management Program

A description of the means of achieving environmental objectives and targets (BS 7750)

272-

Environmental Management Review

A formal evaluation by management of the status and adequacy of systems and procedures in relation to environmental issues policy and regulations as well as new objectives resulting from changing circumstances (BS 7750)

Environmental Management System

The part of an overall management system which includes structure, planning activities, responsibilities, practices, procurements, processes and resources for developing implementing, achieving, reviewing and maintaining an environmental policy (ISO 14004, BS 7750)

Environmental Management System Audit

A systematic and documented verification process to objectively obtain and evaluate evidence to determine whether an organization's environmental management system conforms to the environmental management system audit criteria set by the organization, and communication of the results of this process to management (ISO 14004)

Environmental Objectives

The overall environmental goal, arising from an environmental policy, that an organization sets itself to achieve, and which is quantified where practical (ISO 14004, BS 7750)

Environmental Performance

Measurable results (see environmental performance indicators) of an environmental management system, related to the control of its environmental aspects Assessment of environmental performance is based on environmental policy, environmental objectives and environmental targets (ISO 14004)

Environmental Performance Index

A parameter describing environmental impact with a single figure An index is usually calculated by weighing the actual impact level against a target level Also see valuation

Environmental Performance Indicators

Different parameters describing the potential impact of activities, products or services on the environment These parameters are the result of characterizing classified environmental interventions environmental aspects

Environmental Policy

A statement by an organization of its intentions and principles in relation to its overall environmental performance Environmental policy provides a framework for action and for the setting of its environmental objectives and target (ISO 14004) BS 7750 defines the policy additionally as a public statement

Environmental Problem

An environmental problem is a description of a known process within the environment or a state of the environment which has adverse effects on the sustainability of the environment including society (ISO 14004) They include resource consumption and environmental impacts See also environmental effects, environmental aspects

Environmental Regulation Register

A list of regulations regarding environmental aspects of an organization Also see environmental effects register and environmental inventory

Environmental Release
See environmental interventions

Environmental Target
A detailed performance requirement quantified where practical, applicable to the organization or parts or combination thereof that arises from environmental objectives and that must be set and met in order to achieve those environmental objectives (ISO 14004, BS 7750)

Environmental Strategy
A plan of action intended to accomplish a specific environmental objective

Interested Party
Individuals or groups concerned with or affected by the environmental performance of an > organization (ISO 14004, BS 7750) Interested groups include those exercising statutory environmental control over an organization, local residents, an organization's investors, insurers, employees, customers and consumers, environmental interest groups and the general public (BS 7750)

Open-loop Recycling
A recycling system in which a particular mass of material (possible after upgrading) is remanufactured into the same product (e g glass bottles into glass bottles) See also close-loop recycling

Organization
A company, corporation, firm, enterprise or institution, or part or combination thereof, whether incorporated or not, public or private, that has its own functions and administration For organizations with more than one operating unit, a single operating unit may be defined as an organization (ISO 14004, BS 7750)

Pollution
Residual discharges of emissions to the air or water following application of emission control devices See also environmental release and environmental intervention

Primary Product
The product or service which is the strategic focus of an organization See also by-product and co-product

Prevention of Pollution
The use of processes practices, methods or products that avoid, reduce or control pollution These may include recycling, treatment process changes, control mechanisms, efficient use of resources and material substitution (ISO 14004)

Recycling
The process of re-using material for the production of new goods or services on the same quality level If the quality of the goods and services produced with recycled material is lower then the process is known as downcycling See also close-loop recycling and open-loop recycling

Registration
The procedure by which an organization indicates relevant characteristics of a product, process or service, or particulars of an organization or person, and then includes or registers the product, process, or service in an appropriate publicly available list See also certification

Resources

Materials found in the environment that can be extracted from the environment in an economic process There are abiotic resources (non-renewable) and biotic resources (renewable)

Reuse

The additional use of a component part or product after it has been removed from a clearly defined service cycle Reuse does not include reformation However cleaning, repair, or refurbishing may be done between uses

Solid Waste

Solid products or materials disposed of in landfills, incinerated or composted See also waste

System

A collection of operations that perform a desired function

Valuation

The process of weighing characterized environmental interventions against each other in a quantitative and/or qualitative way This process results in an environmental performance index

Verification Activities

All inspection, test and monitoring work related to environmental management (BS 7750)

Waste

An output with no marketable value that is discharged to the environment Normally the term "waste" refers to solid or liquid materials

Waterborne Waste

Discharge to water of pollutants

APPENDIX A
POLLUTION PREVENTION WORKSHEETS

The worksheets in this appendix were designed to be useful at various points in the development of a pollution prevention program Table A-1 lists the worksheets and describes the purpose of each

Since these worksheets are intentionally generic, you may decide to redesign some or all of them to be more specific to your facility once you have your program underway The checklists in Appendix B contain information that you may find helpful in deciding how to customize these worksheets to fit your situation Appendix C contains examples of worksheets as they might be customized for a pharmaceutical company

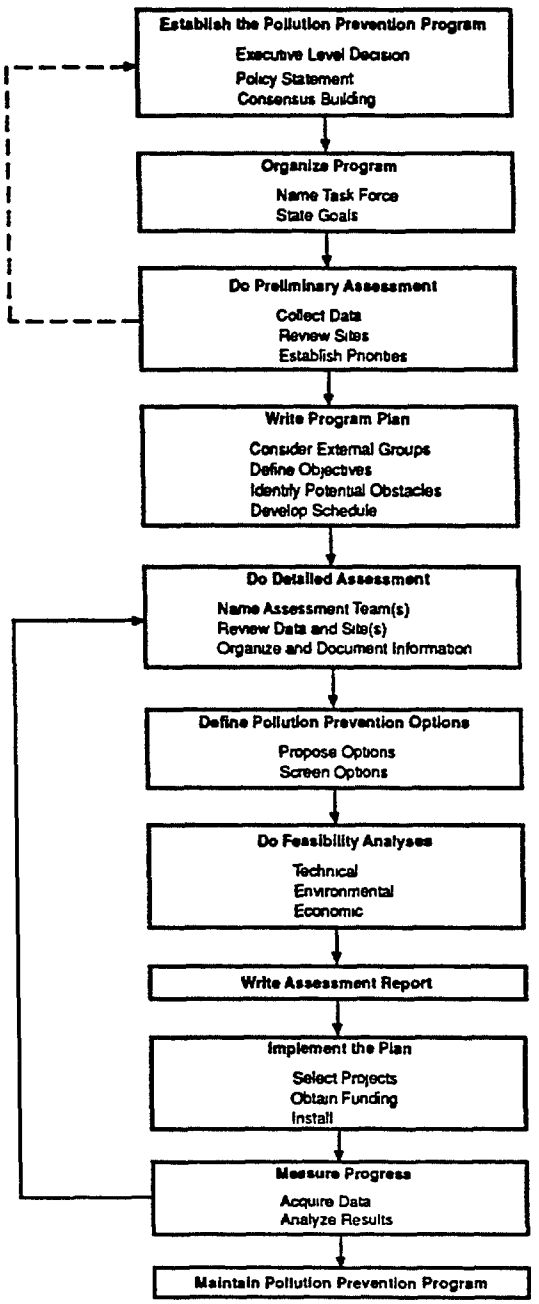
Table A-1 List of Pollution Prevention Assessment Worksheets

Phase	Number and Title	Purpose/Remarks
	1 Assessment Overview	Summarizes the overall program
Assessment Phase		
	2 Site Description	Lists background information about the facility including location products, and operations
	3 Process Information	This is a checklist of process information that can be collected before the assessment effort begins
	4 Input Materials Summary	Records input material information for a specific production or process area. This includes name supplier hazardous component or properties, cost, delivery and shelf-life information and possible substitutes
	5 Products Summary	Identifies hazardous components production rate revenues and other information about products
	6 Waste Stream Summary	Summarizes the information collected for several waste streams This sheet can be used to prioritize waste streams to assess
	7 Option Generation	Records options proposed during brainstorming or nominal group technique sessions Includes the rationale for proposing each option
	8 Option Description	Describes and summarizes information about a proposed option Also notes approval of promising options
Feasibility Analysis Phase		
	9 Profitability	This worksheet is used to identify capital and operating costs and to calculate the payback period

Firm _____	Pollution Prevention Assessment Worksheets	Prepared By _____
Site _____		Checked By _____
Date _____	Proj No _____	Sheet ___ of ___ Page ___ of ___

WORKSHEET
1

ASSESSMENT OVERVIEW



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Date _____	Proj No _____	Sheet ___ of ___ Page ___ of ___

WORKSHEET
2

SITE DESCRIPTION

Firm _____

Plant _____

Department _____

Area _____

Street Address _____

City _____

State/Zip Code _____

Telephone ( ) _____

Major Products _____

_____

SIC Codes _____

EPA Generator Number _____

Major Unit _____

Product or Service _____

Operations _____

_____

_____

_____

_____

_____

Facilities/Equipment Age _____

_____

_____

_____

Firm _____	Pollution Prevention Assessment Worksheets	Prepared By _____
Site _____		Checked By _____
Date _____	Proj No _____	Sheet ___ of ___ Page ___ of ___

WORKSHEET
3

PROCESS INFORMATION

Process Unit/Operation _____

Operation Type ☐ Continuous ☐ Discrete
☐ Batch or Semi Batch ☐ Other _____

Document	Status					
	Complete? (Y/N)	Current? (Y/N)	Last Revision	Used in this Report (Y/N)	Document Number	Location
Process Flow Diagram						
Material/Energy Balance						
Design						
Operating						
Flow/Amount Measurements						
Stream						
Analyses/Assays						
Stream						
Process Description						
Operating Manuals						
Equipment List						
Equipment Specifications						
Piping and Instrument Diagrams						
Plot and Elevation Plan(s)						
Work Flow Diagrams						
Hazardous Waste Manifests						
Emission Inventories						
Annual/Biennial Reports						
Environmental Audit Reports						
Permit/Permit Applications						
Batch Sheet(s)						
Materials Application Diagrams						
Product Composition Sheets						
Material Safety Data Sheets						
Inventory Records						
Operator Logs						
Production Schedules						

Firm _____	Pollution Prevention Assessment Worksheets	Prepared By _____
Site _____		Checked By _____
Date _____	Proj No _____	Sheet ___ of ___ Page ___ of ___

WORKSHEET
4

INPUT MATERIALS SUMMARY

Attribute	Description		
	Stream No ____	Stream No ____	Stream No ____
Name/ID			
Source/Supplier			
Component/Attribute of Concern			
Annual Consumption Rate			
Overall			
Component(s) of Concern			
Purchase Price, $ per _____			
Overall Annual Cost			
Delivery Mode[1]			
Shipping Container Size & Type[2]			
Storage Mode[3]			
Transfer Mode[4]			
Empty Container Disposal Management[5]			
Shelf Life			
Supplier Would			
— accept expired material? (Y/N)			
— accept shipping containers? (Y/N)			
— revise expiration date? (Y/N)			
Acceptable Substitute(s), if any			
Alternate Supplier(s)			

Notes
1 e g , pipeline, tank car, 100 bbl tank truck, truck, etc
2 e g , 55 gal drum 100 lb paper bag, tank, etc
3 e g , outdoor, warehouse, underground, aboveground, etc
4 e g , pump, forklift, pneumatic transport, conveyor, etc
5 e g , crush and landfill, clean and recycle, return to supplier, etc

300

Firm _____	Pollution Prevention Assessment Worksheets	Prepared By _____
Site _____		Checked By _____
Date _____	Proj No _____	Sheet ___ of ___ Page ___ of ___

WORKSHEET
5

PRODUCTS SUMMARY

Attribute	Description		
	Stream No ____	Stream No ____	Stream No ____
Name/ID			
Component/Attribute of Concern			
Annual Production Rate			
Overall			
Component(s) of Concern			
Annual Revenues, $ _____			
Shipping Mode			
Shipping Container Size & Type			
Onsite Storage Mode			
Containers Returnable (Y/N)			
Shelf Life			
Rework Possible (Y/N)			
Customer Would			
— relax specification (Y/N)			
— accept larger containers (Y/N)			

Firm _____	Pollution Prevention Assessment Worksheets	Prepared By _____
Site _____		Checked By _____
Date _____	Proj No _____	Sheet ___ of ___ Page ___ of ___

WORKSHEET
6

WASTE STREAM SUMMARY

Attribute	Description		
	Stream No ____	Stream No ____	Stream No ____
Waste ID/Name			
Source/Origin			
Component or Property of Concern			
Annual Generation Rate (units _____)			
Overall			
Component(s) of Concern			
Cost of Disposal			
Unit Cost ($ per _____)			
Overall (per year)			
Method of Management[1]			

Priority Rating Criteria[2]	Relative Wt (W)	Rating (R)	R x W	Rating (R)	R x W	Rating (R)	R x W
Regulatory Compliance							
Treatment/Disposal Cost							
Potential Liability							
Waste Quantity Generated							
Waste Hazard							
Safety Hazard							
Minimization Potential							
Potential to Remove Bottleneck							
Potential By-product Recovery							
Sum of Priority Rating Scores		Σ(RxW)		Σ(RxW)		Σ(RxW)	
Priority Rank							

Notes 1 For example, sanitary landfill, hazardous waste landfill, on site recycle, incineration, combustion with heat recovery, distillation, dewatering, etc

2 Rate each stream in each category on a scale from 0 (none) to 10 (high)

Firm _____	Pollution Prevention Assessment Worksheets	Prepared By _____
Site _____		Checked By _____
Date _____	Proj No _____	Sheet ___ of ___ Page ___ of ___

WORKSHEET
7

OPTION GENERATION

Meeting format (e g , brainstorming, nominal group technique) _____

Meeting Coordinator _____

Meeting Participants _____

List Suggestion Options	Rationale/Remarks on Option

Firm _____	**Pollution Prevention Assessment Worksheets**	Prepared By _____
Site _____		Checked By _____
Date _____	Proj No _____	Sheet ___ of ___ Page ___ of ___

WORKSHEET
8

OPTION DESCRIPTION

Option Name _____

Briefly describe the option _____

_____

_____

_____

_____

_____

_____

_____

Waste Stream(s) Affected _____

_____

Input Material(s) Affected _____

_____

Product(s) Affected _____

_____

Indicate Type

☐ Source Reduction
- _____ Equipment-Related Change
- _____ Personnel/Procedure-Related Change
- _____ Materials-Related Change

☐ Recycling/Reuse
- _____ Onsite
- _____ Offsite
- _____ Material reused for original purpose
- _____ Material used for a lower-quality purpose
- _____ Material sold

Originally proposed by _____ Date _____

Reviewed by _____ Date _____

Approved for study? _____ yes _____ no By _____

Reason for Acceptance or Rejection _____

304

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Site _____		Checked By _____
Date _____	Proj No _____	Sheet ___ of ___ Page ___ of ___

WORKSHEET
9

PROFITABILITY

Capital Costs

Purchased Equipment _____

Materials _____

Installation _____

Utility Connections _____

Engineering _____

Start-up and Training _____

Other Capital Costs _____

Total Capital Costs _____

Incremental Annual Operating Costs

Change in Disposal Costs _____

Change in Raw Material Costs _____

Change in Other Costs _____

Annual Net Operating Cost Savings _____

$$\text{Payback Period (in years)} = \frac{\text{Total Capital Costs}}{\text{Annual Net Operating Cost Savings}} = _____$$

Table 1. Pollution Prevention Through Good Operating Practices

Good Operating Practice	Program Ingredients
Waste Segregation	Prevent mixing of hazardous wastes with nonhazardous wastes
	Store materials in compatible groups
	Segregate different solvents
	Isolate liquid wastes from solid wastes
Preventive Maintenance Programs	Maintain equipment history cards on equipment location, characteristics, and maintenance
	Maintain a master preventive maintenance (PM) schedule
	Keep vendor maintenance manuals handy
	Maintain a manual or computerized repair history file
Training/Awareness-Building Programs	Provide training for - Operation of the equipment to minimize energy use and material waste - Proper materials handling to reduce waste and spills - Emphasize importance of pollution prevention by explaining the economic and environmental ramifications of hazardous waste generation and disposal - Detecting and minimizing material loss to air, land, or water - Emergency procedures to minimize lost materials during accidents
Effective Supervision	Closer supervision may improve production efficiency and reduce inadvertent waste generation
	Centralize waste management Appoint a safety/waste management officer for each department Educate staff on the benefits of pollution prevention Establish pollution prevention goals Perform pollution prevention assessments
Employee Participation	"Quality circles" (free forums between employees and supervisors) can identify ways to reduce waste
	Solicit and reward employee suggestions for waste reduction ideas

Table 1 (Continued)

Good Operating Practice	Program Ingredients
Production Scheduling/Planning	Maximize batch size to reduce clean out waste
	Dedicate equipment to a single product
	Alter batch sequencing to minimize cleaning frequency (light-to-dark batch sequence, for example)
Cost accounting/ Allocation	Charge direct and indirect costs of all air, land, and water discharges to specific processes or products
	Allocate waste treatment and disposal costs to the operations that generate the waste
	Allocate utility costs to specific processes or products

Table 2. Checklist for All Industries

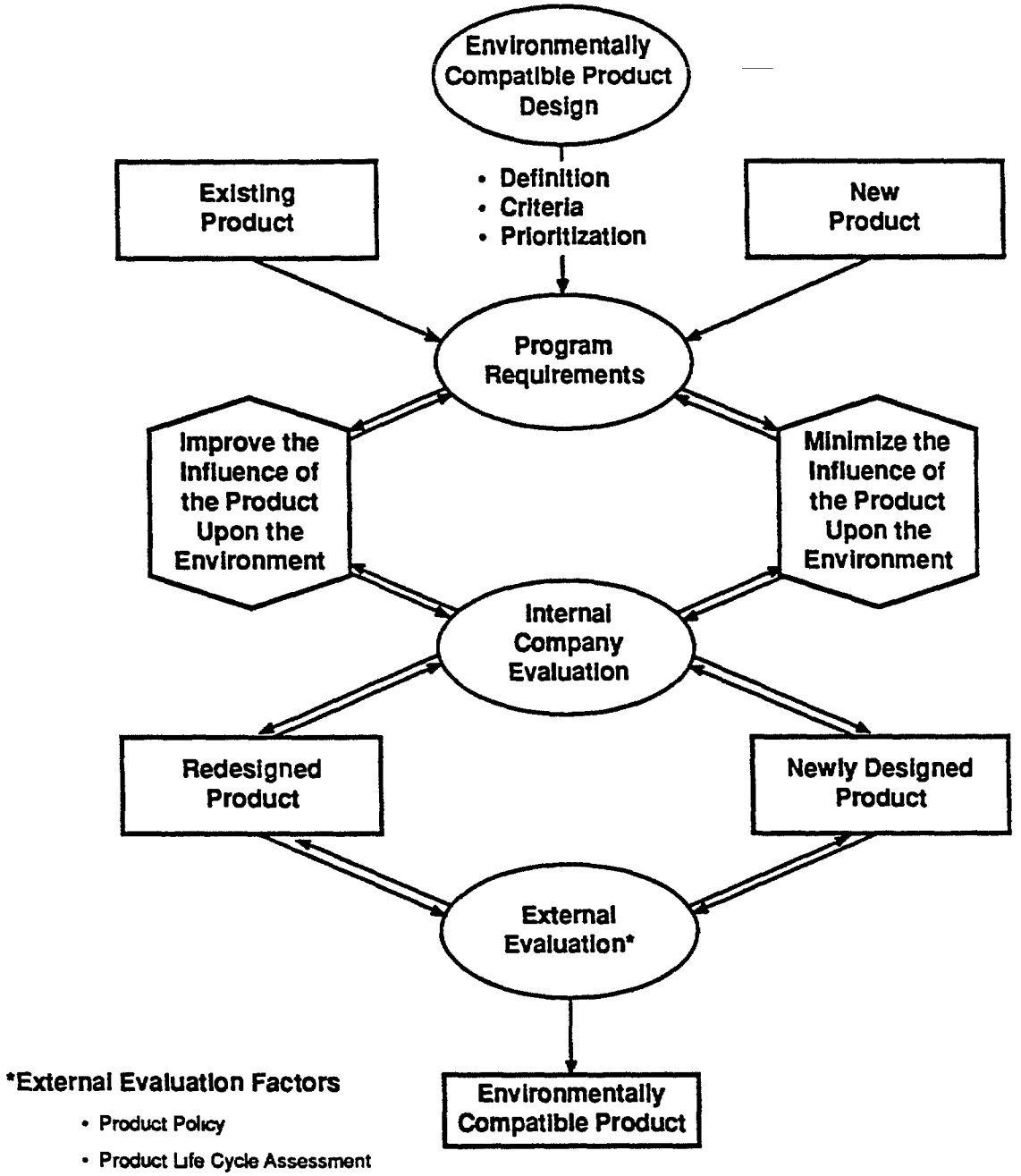
Waste Origin/Type	Pollution Prevention and Recycling Methods
Material Receiving/ Packaging materials, off-spec materials, damaged container, inadvertent spills, transfer hose emptying	Use "Just-in-Time" ordering system Establish a centralized purchasing program Select quantity and package type to minimize packing waste Order reagent chemicals in exact amounts Encourage chemical suppliers to become responsible partners (e g , accept outdated supplies) Establish an inventory control program to trace chemical from cradle to grave Rotate chemical stock. Develop a running inventory of unused chemicals for other departments' use Inspect material before accepting a shipment Review material procurement specifications Validate shelf-life expiration dates Test effectiveness of outdated material Eliminate shelf-life requirements for stable compounds Conduct frequent inventory checks Use computer-assisted plant inventory system Conduct periodic materials tracking Properly label all containers Set up staffed control points to dispense chemicals and collect wastes Buy pure feeds Find less critical uses for off-spec material (that would otherwise be disposed) Change to reusable shipping containers Switch to less hazardous raw material Use rinsable/recyclable drums
Raw Material and Product Storage/ Tank bottoms, off-spec and excess materials, spill residues, leaking pumps, valves, tanks, and pipes, damaged containers, empty containers	Establish Spill Prevention, Control and Countermeasures (SPCC) plans Use properly designed tanks and vessels only for their intended purposes Install overflow alarms for all tanks and vessels Maintain physical integrity of all tanks and vessels Set up written procedures for all loading/unloading and transfer operations Install secondary containment areas Instruct operators to not bypass interlocks, alarms, or significantly alter setpoints without authorization Isolate equipment or process lines that leak or are not in service Use sealless pumps

Table 2 (Continued)

Waste Origin/Type	Pollution Prevention and Recycling Methods
Raw Material and Product Storage/ (Continued)	Use bellows-seal valves Document all spillage Perform overall materials balances and estimate the quantity and dollar value of all losses Use floating-roof tanks for VOC control Use conservation vents on fixed roof tanks Use vapor recovery systems Store containers in such a way as to allow for visual inspection for corrosion and leaks Stack containers in a way to minimize the chance of tipping, puncturing, or breaking Prevent concrete "sweating" by raising the drum off storage pads Maintain Material Safety Data Sheets to ensure correct handling of spills Provide adequate lighting in the storage area Maintain a clean, even surface in transportation areas Keep aisles clear of obstruction Maintain distance between incompatible chemicals Maintain distance between different types of chemicals to prevent cross-contamination Avoid stacking containers against process equipment Follow manufacturers' suggestions on the storage and handling of all raw materials Use proper insulation of electric circuitry and inspect regularly for corrosion and potential sparking Use large containers for bulk storage whenever possible Use containers with height-to-diameter ratio equal to one to minimize wetted area Empty drums and containers thoroughly before cleaning or disposal Reuse scrap paper for note pads, recycle paper
Laboratories/ Reagents, off-spec chemicals, samples, empty sample and chemical containers	Use micro or semi-micro analytical techniques Increase use of instrumentation Reduce or eliminate the use of highly toxic chemicals in laboratory experiments Reuse/recycle spent solvents Recover metal from catalyst

Table 2 (Continued)

Waste Origin/Type	Pollution Prevention and Recycling Methods
Laboratories (Continued)	Treat or destroy hazardous waste products as the last step in experiments Keep individual hazardous waste streams segregated, segregate hazardous waste from nonhazardous waste, segregate recyclable waste from non-recyclable waste Assure that the identity of all chemicals and wastes is clearly marked on all containers Investigate mercury recovery and recycling
Operation and Process Changes Solvents, cleaning agents, degreasing sludges, sandblasting waste, caustic, scrap metal, oils, greases from equipment cleaning	Maximize dedication of process equipment Use squeegees to recover residual fluid on product prior to rinsing Use closed storage and transfer systems Provide sufficient drain time for liquids Line equipment to reduce fluid holdup Use cleaning system that avoid or minimize solvents and clean only when needed Use countercurrent rinsing Use clean-in-place systems Clean equipment immediately after use Reuse cleanup solvent. Reprocess cleanup solvent into useful products Segregate wastes by solvent type Standardize solvent usage Reclaim solvent by distillation Schedule production to lower cleaning frequency Use mechanical wipers on mixing tanks
Operation and Process Changes Sludge and spent acid from heat exchanger cleaning	Use bypass control or pumped recycle to maintain turbulence during turndown Use smooth heat exchange surfaces Use on-stream cleaning techniques Use high pressure water cleaning to replace chemical cleaning where possible Use lower pressure steam



*External Evaluation Factors

- Product Policy
- Product Life Cycle Assessment
- Eco-Label Program
- General Perception
- Market Conditions
- Consumer Organizations
- Design Organizations

Adapted From Dr J C van Weenan, IDES, University of Amsterdam, February 18, 1991

Figure 5 Schematic Representation of the "Eco-Product" Design Process

International Institutions and Project Approval (Banks / Countries)

What Does Independent Engineer Do?

- Potential International Investors hire an Independent Engineer to Provide Assessment of Project.
- Often called "Bank's Independent Engineer".
- Provide Our Engineering Opinion to Investors of Project Risks and Potential Fatal Flaw.
- If High Risks Exist or Fatal Flaw Exists, International Investors Will Not Lend Money to Developers.

Project Assessment: Independent Engineer's Opinion

- Environmental Risks
- Technical Risks
- Economic Risks

Project Development Status

- Conceptual Design
- Environmental Impact Analysis
- Status of Environmental Permit Applications

Environmental Risks

- Regulatory Issues
- Environmental Permitting

Environmental Risks of Regulatory Issues

- Does Supportive Regulatory Framework Exist?
  - Current Regulatory Framework
  - What are Prospects for Future Regulatory Changes?

Environmental Permitting Risks

- Is Process for Obtaining Permits Clear?
- Are Prospects for Successfully Obtaining Permits Good?
- What is Permitting Plan?
  - Time Estimates
  - Uncertainties
  - Fallback Position
  - Alternative Approaches

Does Project Meet World Bank Environmental, Health, and Safety Guidelines?

- Ambient Air
- Stack Emissions
- Liquid Discharges
- Other General Environmental Requirements
  - Transformer Oils
  - Impoundments for Storage Areas
  - Leachate from Coal and Ash Disposal Areas

World Bank Environmental, Health, and Safety Guidelines (Continued)

- Hazardous Material Handling and Storage
- Workplace Air Quality and Noise
- Health and Safety Guidelines
  - Safety Procedures and Training
  - Working in Confined Spaces
  - Sanitary Facilities
  - Adequate Air Ventilation
  - Medical Examination of Personnel

World Bank Environmental, Health, and Safety Guidelines (Continued)

- Hazardous Material Handling and Storage
- Workplace Air Quality and Noise
- Health and Safety Guidelines
  - Safety Procedures and Training
  - Working in Confined Spaces
  - Sanitary Facilities
  - Adequate Air Ventilation
  - Medical Examination of Personnel

Country Issues

- Is Political and Social Direction of Country Moving Towards Political Stability, Democracy, Free Market Economics, and Predictability?

- Is Country Viewed Favorably in the Investment Community

Site for Electric Generating Power Plant

Is Site Appropriate for Power Plant?

- Near Large Electric Demand Area
- Near Electric Transmission Lines
- Near People Desiring Jobs
- Not Close to Faults or Earthquake Area
- Not in Flooding Area
- Transportation Access to Site
    - Roads
    - Railroad
    - Barge or Ship

Basic Electric Generating Power Plant Needs

- Fuel Source and Transportation
- Fresh Water Source
- Waste Water Discharge to Nearby River
- Close to Electric Transmission Line
- Waste Disposal Location and Transportation

Electric Generating Plant Equipment

- Is Conventional Technology Contemplated?

- Is Conventional Equipment to be Installed?
  - Cost
  - Efficiency
  - Reliability
  - Equipment Guarantees

Is Equipment Adequate to Comply With Environmental Requirements When Plant is Operating ?

Fuel Supply

- Is Enough Fuel Available at Low Enough Prices to Meet Financing Needs.
- Is Reliability of Fuel Supply Adequate to Meet Electric Sales Contract.

EPC Contractor

Is Engineer, Procurement, and Construction (EPC) Contractor Qualified to Oversee Engineering Design, Procurement, and Construction of Project?

- Experience of Contractor
- Reputation of Contractor
- Construction Staff at Project Site
- Construction Manager at Project Site
  - Previous Experience
  - Authority

Schedule Overview
Key Milestones/Deadlines

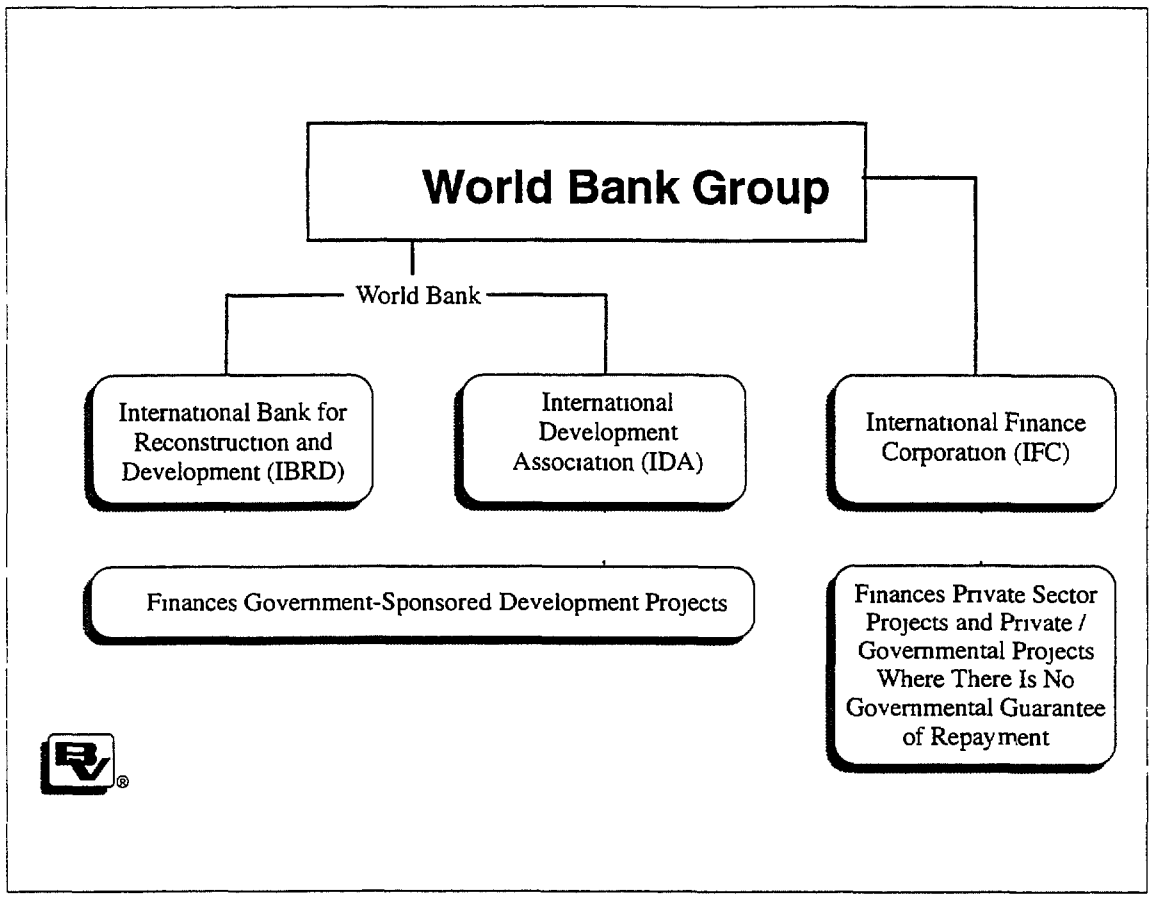
- Monthly Cash Flow of Development Expenses
- How and When Development Expenses Will Be Financed
- Construction Financing
  - Equity
  - Load From Investors
- Monthly Cash Flow of Construction Costs
- Critical Milestones of Development and Construction
  - Critical Path Milestones
  - Delays

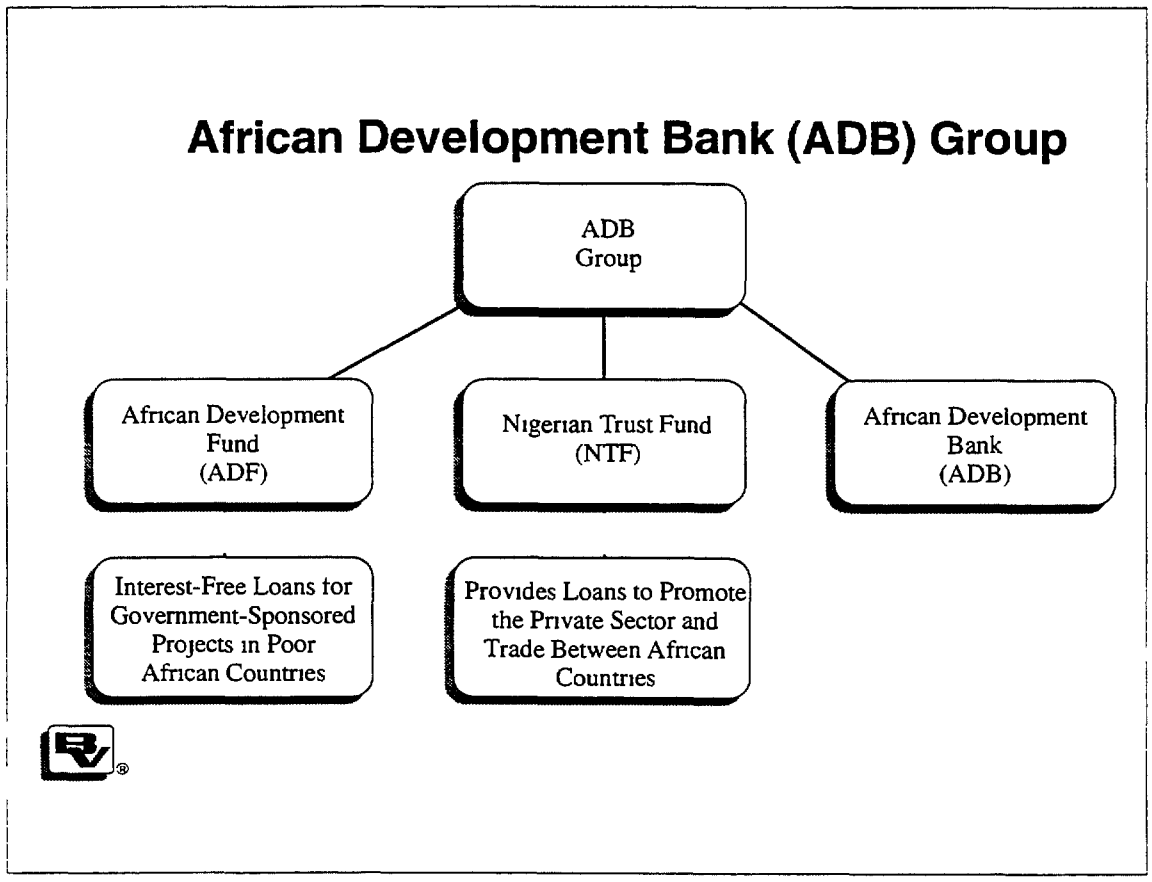
Economic Risks
Will Project Be Profitable?

- Capital Cost
- Electric Sales Price
- Fuel Cost
- Non-fuel Expenses
- Debt Principal and Interest Payments

Electric Sales
Do Electric Sales Reliably Support Project Profitably?

- Average Capacity Factor of MWh Sales
- Fuel Component
- O&M Expenses
- General and Administrative Cost
- Dept Principal and Interest Payment
- Equity Return
- Developer Profit


World Bank Group
World Bank
International Bank for Reconstruction and Development (IBRD)
International Development Association (IDA)
International Finance Corporation (IFC)
Finances Government-Sponsored Development Projects
Finances Private Sector Projects and Private / Governmental Projects Where There Is No Governmental Guarantee of Repayment


African Development Bank (ADB) Group
ADB Group
African Development Fund (ADF)
Nigerian Trust Fund (NTF)
African Development Bank (ADB)
Interest-Free Loans for Government-Sponsored Projects in Poor African Countries
Provides Loans to Promote the Private Sector and Trade Between African Countries

ADB

Finances Economic and Social Development in African Countries Through

- Direct Transfer of Resources to Fund Such Projects and Programs
- The Provision of Technical Assistance and Institutional Support
- Mobilization of External Resources for Investment in Africa

Environmental Review and Approval Process Implemented By Financing Banks

- Perform Environmental Assessment (EA)
- Summarize EA, List Findings and Present to Bank's Environmental Board
- Board Reviews Findings and Requests Additional Information, if Necessary
- Board Makes Decision -- Does Project Meet Bank Standards and Country Standards?
- Conditional Approval Given if Project Has Guaranteed Performance and Compliance
- Phased Dispersion of Funds to Ensure Project Meeting Conditions Throughout Construction and Operation

International Institutions and Project Approval
(Banks / Countries)

Before International Investors loan money to a Project, they obtain an Independent Engineer make an assessment of the project International Investor's Independent Engineer are often called "Bank's Independent Engineer" or "Bank's Engineer"

Independent Engineer's Assessment

In this Project assessment, the Independent Engineer provides his engineer's opinion of the following risks and potential fatal flaws

- Environmental Risks
- Technical Risks
- Economic risks

Environmental Risks

During environmental risks review, one of the first areas reviewed by an Independent Engineer is project development status Project development status usually includes its conceptual project design, status of Environmental Impact Analysis (EIA) and status of environmental permit applications

Environmental risks included regulatory issues and environmental permitting

Regulatory Issues Regulatory Issues questions include

- Does the supportive regulatory framework exist? Are there regulations for the entire country and also regulations for the specific region or state where the project will be located?

- What is the current regulatory framework? This means, how does the regulatory system work? Environmental regulations may be passed by the government, but if there is no regulatory framework for permit application and regulatory enforcement, it is difficult to develop Project design criteria needed to comply with the regulations

- What are prospects for future regulatory changes? Are there potential future regulations that, when passed, will require additional reductions of pollutant emissions? Future changes in the environmental regulations can require addition plant equipment or modifications of existing plant equipment, which means future additional costs

333

Environmental Permitting Risks Environmental permitting risks of a project include

- Is the process for obtaining permits clear? That is, is the permitting process for a project a "one stop" process for one overall project permit, and an easy way to obtain all required environmental permits Or is there a maze of permits required

- Are prospect for successfully obtaining permits good? We have seen several projects canceled because they could not obtain all the permits

- What is permitting plan? The permitting plan for both permits issued by the country and also those issued by the local region or state should include time estimates for obtaining environmental permits, what uncertainties may exist for obtaining certain permits, what a fall back position will be is a permit application is rejected, and alternative approaches to obtain a permit

World Bank Guidelines

International Investors usually ask whether the Project meets World Bank Environmental, Health, and Safety Guidelines International investors are using these guidelines to help control the environment on a world-wide basis The International Investor's position is that they do not want to invest in projects that will pollute the air and water, or that have poor health and safety guidelines for personnel working at the Project These World Bank guidelines include requirements for the following

- Ambient air

- Stack emissions

- Liquid discharges

- Other general Environmental requirements such as, handling and disposal of transformer oils, installing impoundments for storage areas, and controlling leachate from coal and ash disposal areas

- Hazardous material handling and storage

- Workplace air quality and noise

- Health and safety guidelines for safety procedures and safety training, for working in confined spaces, for sanitary facilities, for adequate air ventilation, and for medical examinations of plant personnel

A summary of World Bank and International Finance Corporation (IFC) Environmental Guidelines for fossil fuel based thermal power plants is provided at the end of this Section

Country Issues

Questions asked by International Investors about the country in which the Project will be located are the following

- Is the political and social direction of the country moving towards political stability, democracy, free market economics, and predictability? Questions like this means the Independent Investors are concerned about risks of repayment of their loan and interest As an Independent Engineer, we can only provide our opinion os these issues

- Is country viewed favorably in the investment community? For large project, several investors will be provided the loan Independent Investors do talk to each other all the time It is hard to keep a secret in the investment community

Site for Electric Generating Power Plant

For an electric generating power plant, the plant site location is very important Is the site appropriate for the power plant?

- Is the plant near a large electric demand area? When the electric generating power plant is near a large demand area, building miles and miles of transmission lines is not required Energy losses from the transmission lines will also be reduced

- Is the power plant near an existing transmission line? With a transmission line nearby, the energy losses will be reduced

- Is the power plant near people desiring jobs? If the power plant personnel are not living close to the plant, the developer may have to build housing, schools, etc for the plant personnel families

- Is the power plant near a fault or earthquake area? It is not good engineering practice to build a power plant near a fault in an area with high earthquake potential

- Is the power plant in a flooding area? In a flooding area, the plant will have frequent shutdowns during high water periods The high water can damage much of the plant equipment, resulting additional shutdowns for repairs

- Does good transportation access to the site exist? During construction, large equipment components will be delivered to the construction site It is important to have adequate access to the site by roads, railroad, barge and/or ship for these deliveries During plant operation, good transportation access is necessary of deliveries to the plant and for plant personnel going to and from work

Basic Electric Generating Power Plant Needs

Basic electric generating power plant needs that are reviewed in an Independent Engineer's assessment are the following

- Fuel source and fuel transportation

- Fresh water source, quantity, and quality of the makeup water for the power plant needs Is the fresh water source adequate to meet the needs of the power plant?

- Waste water discharge to nearby river A power plant has large quantities of waste water to discharge Is the nearby river large enough to accept these discharges without exceeding thermal pollution requirements?

- Is the power plant close to a transmission line? As stated before, if a transmission line is required for the plant, the cost of this transmission line will increase the initial cost and ongoing maintenance costs of the Project

- Is the location and transportation for disposal of waste solids adequate? Establishing an adequate waste disposal area is very important for a power plant

Electric Generating Plant Equipment

For high efficiency, reliability and availability, electric generating power plants require proper equipment in the plant

- Is conventional power plant technology contemplated to be used? Investors do not like to invest in "new" technology, because they know that new technology will have a "learning curve" before continuous maximum electric generation occurs This learning curve reduces revenues to the Project, which investors do not like

- Is conventional power plant equipment to be installed? The Independent Engineer's assessment review includes the cost, efficiency, reliability and equipment guarantees of major equipment Installing proper power plant equipment, as far as quality and redundancy, may increase the initial Project cost, but additional maintenance costs of improper equipment will easily be more than the initial cost when using proper power plant equipment Not only maintenance costs will be more, but revenues will be less because of the added outages for repairs of improper equipment

Fuel Supply

Continuous supply of fuel during operation of the power plant is very important Obviously, if no fuel is available, the power plant will be shut down During assessment review by independent engineers, answers to the following questions need to be answered

- Is enough fuel available at low enough prices to meet financing needs?

- Is the reliability of fuel supply adequate so the power plant can generate enough electricity to meet the electric sales contract? This means, can the power plant provide electric MW at the times requested and adequate electric MWh energy to meet the requirements of the Electric Sales Contract? Not only must enough fuel be available to operate the power plant, the fuel has to be available at the times when the scheduled electric MWh energy is requested

- Is fuel available from an alternate source? Although fuel from an alternate source may be more expensive, having fuel to generate adequate electricity for meet electric sales requirements is important

EPC Contractor

The EPC Contractor is responsible for engineering, procurement, and construction of the Project Having an experienced, qualified EPC Contractor is very important for successful, on-time construction completion of the Project Independent Engineer's Assessment includes determining answers to the following

- Is EPC Contractor qualified to oversee engineering, procurement, and construction of the Project? Qualifications include contractor's experience, contractor's reputation, experience of construction staff at the Project site, especially experience of the construction manager Previous experience and authority of the construction manager are keys to successful, on-time Projects

Schedule Overview

Assessment review of the Project schedule includes reviewing key milestones and deadlines during development and construction periods of the Project The assessment includes review of the following

- Monthly cash flow of development expenses Are the amount and timing of development expenses occurring as expected?

- How and when are development expenses to be financed? Is another loan required by the developers to pay for development expenses? If so, how is this additional loan to be repaid?

- How is construction financing to occur? Usually, power plant capital costs are paid by equity from the developers and by a construction loan from

investors After construction is completed, the construction loan is refinanced into a long term loan What percent of the Project capital cost is paid by equity from the developers and how much of the capital cost will be paid from the long term loan by the investment lenders? Repayment of long term loans for power plants may require 15 to 20 years Of course, the interest rate of this long term loan is very important Annual total debt payments include principal and interest payments

- Monthly cash flow of construction costs are usually a good indicator of construction percent completion Monitoring the monthly cash flow is important to avoid excessive capital costs

- Critical milestones of development and construction are reviewed This review includes review of critical path milestones and the effect of potential delays on the construction completion date

Economic Risks

The basic question International Investors ask is Will the Project be profitable? Economic review of a Project for the economic risks includes reviewing the following

- Capital cost Is the capital cost in the expected range of capital costs for a power plant of this type and MW capacity?

- Electric sales price Will revenues from electric sales be enough for the power plant to be profitable?

- Fuel cost Does the Project have a long term fuel contract or is spot market purchases of fuel expected? Long term fuel contracts establishes current and future fuel costs, thus avoiding the fluctuation of fuel costs by buying fuel on the spot market

- Non-fuel expenses Are non-fuel expenses reasonable? Non-fuel expenses include labor expenses, chemical expenses, water, telephone, insurance, taxes and the general and administrative expenses

- Debt principal and interest payments After subtracting fuel and non-fuel expenses from the power plant's revenues, how much cash is available for paying debt principal and interest? Dividing the annual cash available after subtracting fuel and non-fuel expenses by the annual debt payment gives a number, which is often called annual debt service coverage ratio Investors like this annual debt service coverage ratio to be as high as possible to assure enough revenues are made to pay the annual expenses and debt payments Requiring annual debt service coverage ratio values of at least 1 4 to 2 0 is a common investor requirement If expected annual debt service coverage ratios are too low, international investors will not loan money to a Project

Electric Sales

The review of electric sales by the power plant including the question whether electric sales will reliably support project profitability

- Average expected annual capacity factor of MWh sales Revenues and profitability of a power plant

- Fuel component of electric sales price Does the electric sales price vary with fuel cost? That is, is fuel cost passed through as a component of the electric sales price?

- O&M expenses or non-fuel component of electric sales price Are non-fuel expenses passed through as a component of the electric sales price?

- General and Administrative cost Are general and administrative costs reasonable? Are general and administrative costs passed through as a component of the electric sales price?

- Debt principal and interest payment Are annual debt service coverage ratios high enough for the investor? Is the annual debt payment passed through as a component of the electric sales price?

- Equity return Is the expected equity return adequate to repay any equity loan by the developers?

- Developer profit What is the expected developer profit? Although developer profit is not a criteria for obtaining a loan from an intentional investor, if the investor knows that an adequate profit is possible, the chances for obtaining a loan is better

Summary

In summary, before International Investors loan money to a Project, the investor require an Assessment of the Project be made by an Independent Engineer Project risks listed in the Assessment may determine whether the Project will obtain a loan

COMPARISON OF WORLD BANK ENVIRONMENTAL GUIDELINES

Prepared by Kyle E Foote
Environmental & Licensing Services Section (ELSS)

World Bank is one of the leading non-governmental organizations to establish environmental guidelines for new projects in developing nations In the absence of more restrictive national environmental regulations, the World Bank Environmental Guidelines provide a basis for negotiating site-specific environmental conditions and agreements between regulators and industry in those countries World Bank has had the same Environmental Guidelines for "fossil fuel based thermal power plants" in effect since 1988 Officially, they still remain in effect today However, over the past two years World Bank and one of its subsidiaries, the International Finance Corporation (IFC), have worked in conjunction to develop a new, consolidated set of Environmental Guidelines

The World Bank Environmental Guidelines for fossil fuel based thermal power plants were revised on June 30, 1995, again on July 9, 1996, and most recently on October 30, 1996 The revised Environmental Guidelines were established to further protect the environment and to provide more detailed guidance to World Bank and IFC staff, consultants, and project sponsors These guidelines, once officially adopted, will replace the 1988 World Bank Environmental Guidelines, the 1994 IFC/World Bank Guidelines, and any other interim guidelines that have been proposed and implemented between 1988 and 1996 As a practical matter, the October 30, 1996 (proposed) guidelines are already being used by project sponsors to define pollution control requirements for projects in their conceptual stages

The attached table provides a direct comparison of World Bank Environmental Guidelines as established in 1988 (official guidelines) and in October 1996 (proposed guidelines) It is important to understand that the World Bank Environmental Guidelines are not rigid, immovable standards They are intended as guidance and should be implemented to the extent possible However, if circumstances warrant, the World Bank or IFC may allow justifiable deviations In a situation involving financing from a multilateral development bank or a private lending institution other than World Bank or IFC, this flexibility may not be available This is determined on a case-by-case basis and depends on the policies of the particular financing institutions

The Environmental & Licensing Services Section (ELSS) staff will continue to track the status of the Environmental Guidelines and will provide updates and interpretations as necessary In addition, ELSS follows other multilateral development banks' environmental policies and guidelines and can provide assistance upon request Please address any questions or concerns to either Kyle Foote (Staff Environmental Attorney/Licensing Manager) at (913) 458-7541, or to Anne Harris (ELSS Section Leader/Partner) at (913) 458-7060

STACK EMISSIONS		
POLLUTANT	*WORLD BANK (1988)*	*WORLD BANK (1996)*
Particulate Matter		
All areas	100 mg/m^3	50 mg/Nm^3 Alternatively, removal efficiency should be 99 9 %
Sulfur Dioxide		
Unpolluted areas [< 50 µg/m^3]	*500 tpd*	*0 20 metric tonnes per day/MWe for first 1000 MWe + 0 10 mtpd/MWe over 1000 MWe* *2000 mg/Nm^3*
All other areas [≥ 50 µg/m^3]	*100 tpd*	*0 20 metric tonnes per day/MWe for first 1000 MWe + 0 10 mtpd/MWe over 1000 MWe* *2000 mg/Nm^3*
Nitrogen Oxides [NO_x]		
Gaseous Fuels	*86 ng/J ≈ 0 20 lb/MBtu*	*320 mg/Nm^3* *(86 ng/J or 155 ppm)* *conditions dry, 3% excess O_2* *assumes 270 Nm^3/GJ*
Combined Cycle	*N/A*	*86 ng/J (or 50 ppm @ 15 % O_2)*
Liquid Fuels	*130 ng/J ≈ 0 30 lb/MBtu*	*460 mg/Nm^3* *(130 ng/J or 225 ppm)* *conditions dry, 3% excess O_2* *assumes 280 Nm^3/GJ*
Combined Cycle	*N/A*	*130 ng/J (or 76 ppm @ 15 % O_2)*
Solid Fuels	*300 ng/J ≈ 0 70 lb/MBtu* *(Lignite 0 60 lbs/MBtu)*	*750 mg/Nm^3* *(260 ng/J or 365 ppm)* *conditions dry, 6% excess O_2* *assumes 350 Nm^3/GJ*

NOTES

- *Nm^3 (normal cubic meter) is measured at 0°C and 1 atm (101 3 kilo Pascals or 760 mm Hg)*
- *Total mass emissions are measured in "metric tonnes per day" (mtpd) in the 1996 Guidelines*
- *All of the maximum emission levels should be achieved at least 95 percent of the time that the plant or unit is operating, averaged annually*

AMBIENT AIR		
POLLUTANT	***WORLD BANK (1988)***	***WORLD BANK (1996)***
Particulate Matter [PM_{10} or TSP]		
Annual Average	N/A	*50 $\mu g/m^3$ (PM^{10} or for TSP measured according to British Smoke methodology)
Annual Average	N/A	*80 $\mu g/m^3$ (TSP measured using high volume gravimetric samplers with size selective inlet)
Annual Mean	100 $\mu g/m^3$ (PM_{10})	N/A
24-Hour Average	500 $\mu g/m^3$ (PM_{10})	N/A
Sulfur Dioxide		
Annual Mean	100 $\mu g/m^3$	N/A
24-Hour Average	1000 $\mu g/m^3$ (inside fence) 500 $\mu g/m^3$ (outside fence)	N/A
Median of Daily Values for 1 Year	N/A	*80 $\mu g/m^3$
24-hour *(if exceeded > 7 day per year)*	N/A	*250 $\mu g/m^3$
Nitrogen Oxides [NO_2]		
Annual Average	100 $\mu g/m^3$	N/A
24-Hour Average	N/A	N/A
1-Hour Period	N/A	*400 $\mu g/m^3$
1 Hour Period *(if exceeded >7 days per year)*	N/A	*200 $\mu g/m^3$

* The World Bank has established *"trigger values"* instead of actual maximum ambient air quality guidelines (note individual nations may have more restrictive trigger values) A predicted exceedence of a trigger value (or threshold level) would require a more detailed environmental assessment In the event that a trigger value will be exceeded (as predicted by specific air quality modeling methodologies), the project sponsor should engage in further consultation with World Bank, IFC, and/or the national, state, or local regulatory agency to agree upon acceptable impacts to ambient air quality in the affected area

LIQUID EFFLUENT		
POLLUTANT	***WORLD BANK (1988)***	***WORLD BANK (1996)***
pH	6 to 9	6 to 9
BOD_5	50 mg/l	N/A
Heavy Metals [total] *Chromium (total)* *Chromium (hexavalent)* *Copper* *Iron* *Nickel* *Zinc*	5 mg/l N/A N/A N/A N/A N/A N/A	N/A 0 5 mg/l 0 1 mg/l 0 5 mg/l 1 0 mg/l 0 5 mg/l 1 0 mg/l
Oil & Grease	10 mg/l	10 mg/l
Total Suspended Solids [TSS]	60 mg/l	50 mg/l
Residual chlorine	N/A	0 2 mg/l "Chlorine shocking" maximum value 2 mg/l for up to 2 hours, not to be repeated more frequently than once in 24 hours, with a 24-hour average of 0 2 mg/l.
Coal pile runoff and leachate	N/A	Where leaching of toxics to groundwater or their carryover in surface runoff is concern, suitable preventive and control measures such as protective liner and runoff collection and treatment should be implemented
Temperature increase [edge of mixing zone]	5° C above ambient temperature of receiving water / 3° C if receiving waters > 28° C Mixing Zone undefined	3° C above ambient temperature of receiving waters Mixing Zone zone where initial mixing or dilution occurs, determined on a case-by-case basis contingent on quantity, quality, temperature, and flow rate of wastewater effluent, absent these data (where the zone is not defined), mixing zone is 100 meter radius from point of discharge when there no sensitive ecosystems with this distance

3/2

NOISE		
POLLUTANT	***WORLD BANK (1988)***	***WORLD BANK (1996)***
Ambient dBA (day/night)	Residential. 55 / 45 Commercial 70 / 70 Industrial 70 / 70	Residential 55 / 45 Commercial 65 / 55 Industrial 70 / 65 Measurements should be taken at receptors located outside the project property boundary, with and increase in existing ambient level of less than 5 dBA
Workplace	Personnel must use hearing protection when exposed to noise levels above 85 dBA Feasible administrative and engineering controls, including sound-insulated equipment and control rooms should be employed to reduce the average noise level in normal work areas	Workplace noise guidelines have not been revised, refer to 1988 guidelines

Introduction to Environmental Assessment

This session will present and describe procedures used for performing an environmental assessment The Environmental Impact Assessment (EIA) is an effective environmental management tool for integrating environmental factors into development projects

The general objectives of the EIA are as follows

a To identify and describe the environmental resource/values which will be affected by the project
b To describe the effects the proposed project with have on the environmental resource/values - positive and negative, direct and indirect, cumulative and irreversible
c To describe of how the project plan or design will minimize the adverse effects and maximize positive effects
d To describe alternative to the proposed project that could accomplish the same sought after results

In this session we will examine the structure of various EIAs, including the format of the Ghana EIA

EIA

Environmental Impact Assessment

Definition: *Assessment of the changes in environmental resources or values of these resources, resulting from a proposed project.*

Environmental resources means current status or conditions and may include:

- Biological (plants, animals, etc.)
- Physical (water, soils, etc.)
- Socioeconomic (people issues;e.g. finances, relocation)

What is meant by changing values?

Examples:

- Increasing/decreasing job availability.
- Habitat value to wildlife.

Black & Veatch

Relationship of EIA to Feasibility Study (FS)

EIA should be a part any feasibility study for two reasons:

- ***If project proceeds, EIA is normally required for final design approval and securing permits***
- ***Environmental issues can be project stoppers An EIA will identify such issues so that adjustment can be made to the project***

Black & Veatch

Environmental Assessment

Introduction

Objectives of EIA

- To identify and describe the existing environmental resources/values (ER/V) that will be impacted
- To describe the effect the proposed project will have on the ER/V
- To describe ways that the project will minimize adverse effects and maximize positive effects
- To describe alternatives to proposed project

Scoping

Ensure that all issues of importance are addressed - Talk with project's sponsors, decision makers, regulatory agencies, scientific institutions, etc.

EIA answers four questions:

1. What will happen an a result of the project?
2. What will be the extent of the changes?
3. Do the changes matter?
4. What can be done about them?

(5. What will happen as a result of the now-revised project?)

Identification Phase

- Temporary vs permanent, direct and indirect, positive and negative, and cumulative and irreversible impacts.
- Compile list of key impacts
- Name all project's "impact sources'
- Identify impacts themselves through the use of check-lists or other tools.

Forecasting

What will be the extent of the changes?

Assessment

- Comparison with laws, regulations, or accepted standards.
- Consultation with relevant decision makers.
- Consistency with government policy objetives.

Mitigation Analysis

If changes matter:

- Change project sites, technological processes, operating methods, waste disposal routes or locations, timetable, or engineering design.
- Introduce pollution controls
- Provide restoratation of disrupted areas or compensation for damaged resources

Documentation

- Executive Summary
- Project Description
- Description of Existing Environment
- Assessment of Impacts
- Mitigation Measures
- Conclusions
- Summary of EIA for General Public

Role of EIA in Project Planning and Implementation

Environmental Activities	Planning, Design & Construction Activities
1.	
Environmental Reconnaissance	*Reconnaissance Survey*
2.	
Pre-EIA (Initial Environmental Examination)	*Pre-feasibility Study* (Fatal Flaw Analysis)
3.	
Environmental Impact Assessment	*Feasibility Study*
4.	
Checking Design for Environmental Fit	*Final Design* (Plans and Specifications)
5.	
Environmental Inspection of Construction & Mitigation Construction/Implementation	*Construction*
6.	
Monitoring Operations for Environmental Effects and Mitigation Monitoring	*Operations*

Essential Steps in EIA Process

1

Preparation of Work Plan.	- *Schedule* - *Required Activities/Studies* - *Select Qualified Team*

2.

Agency Consultation	- *Local (e.g, city, district)* - *State/Province* - *National/Federal*

Note This activity is repeated as needed throughout the life of the project

3.

Data Collection:	- *Biological* - *Physical* - *Socioeconomic*

4

Data Evaluation & Report Preparation

5.

Applications of Evaluations to Modifying/Improving Project Design

6.

Conclusions/Recommendation & Issue of Final Report

Figure 3

DIAGRAM OF AN ENVIRONMENTAL IMPACT ASSESSMENT AND ITS CONTROL

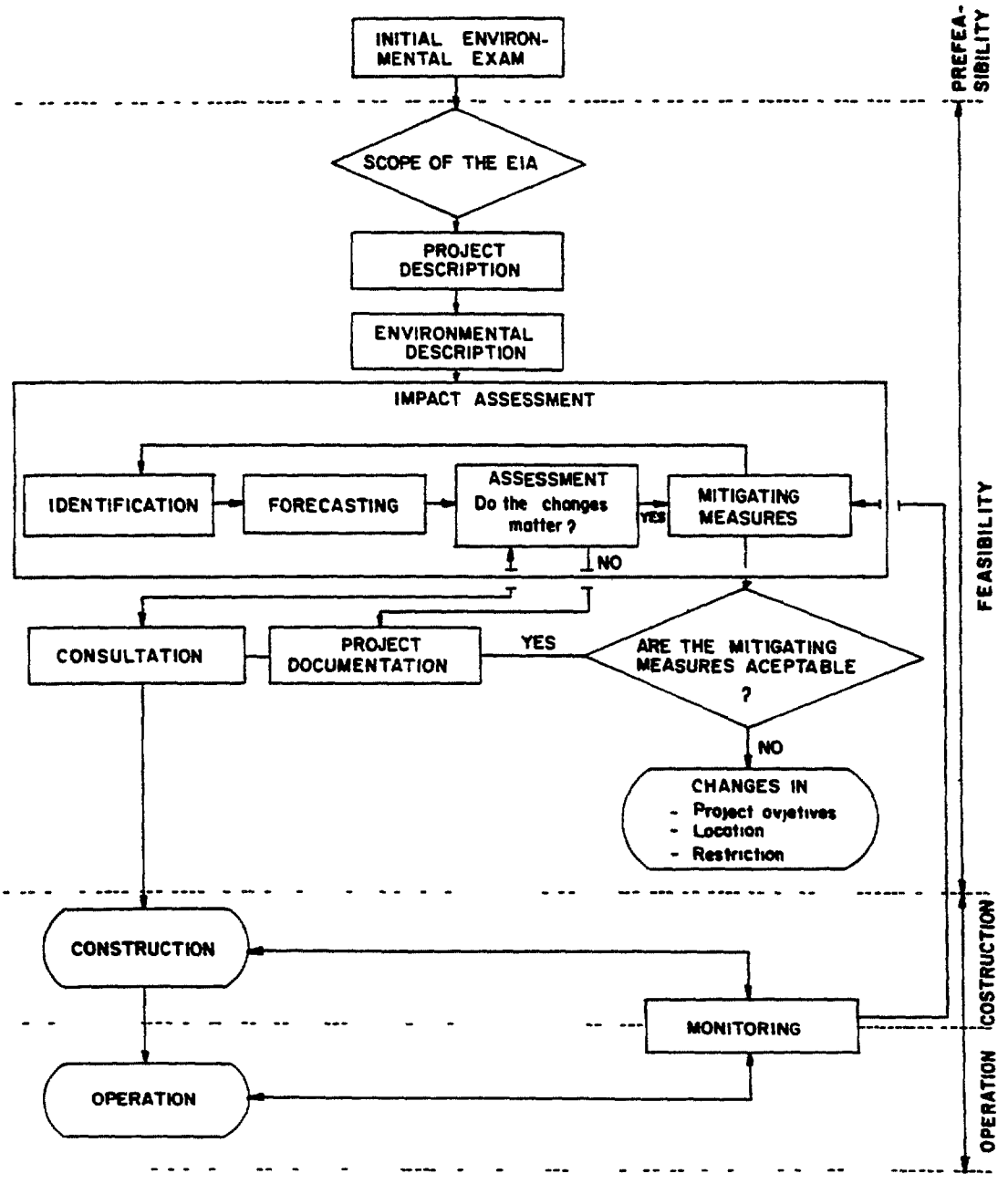


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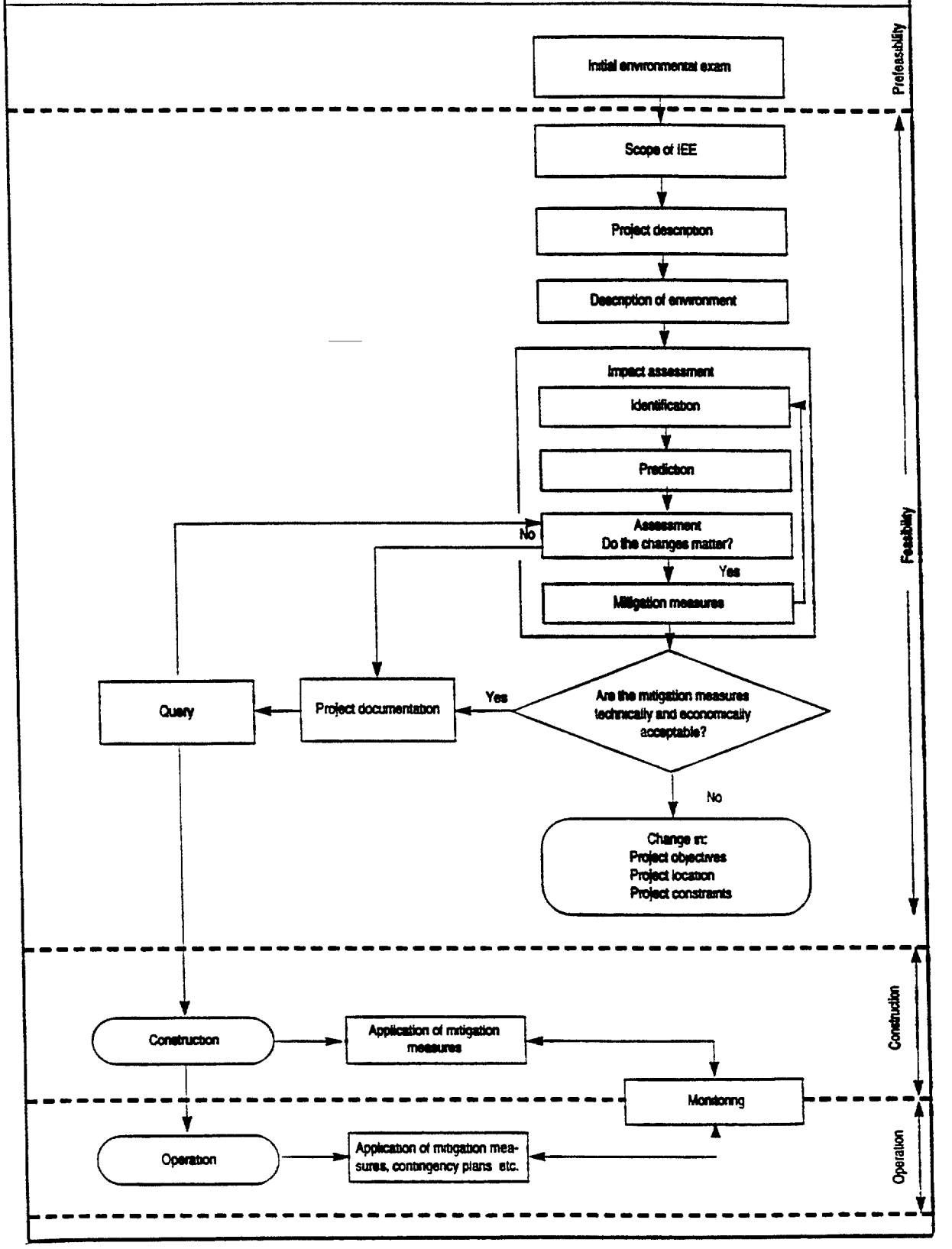
DIAGRAM OF THE ENVIRONMENTAL IMPACT ASSESSMENT PROCESS



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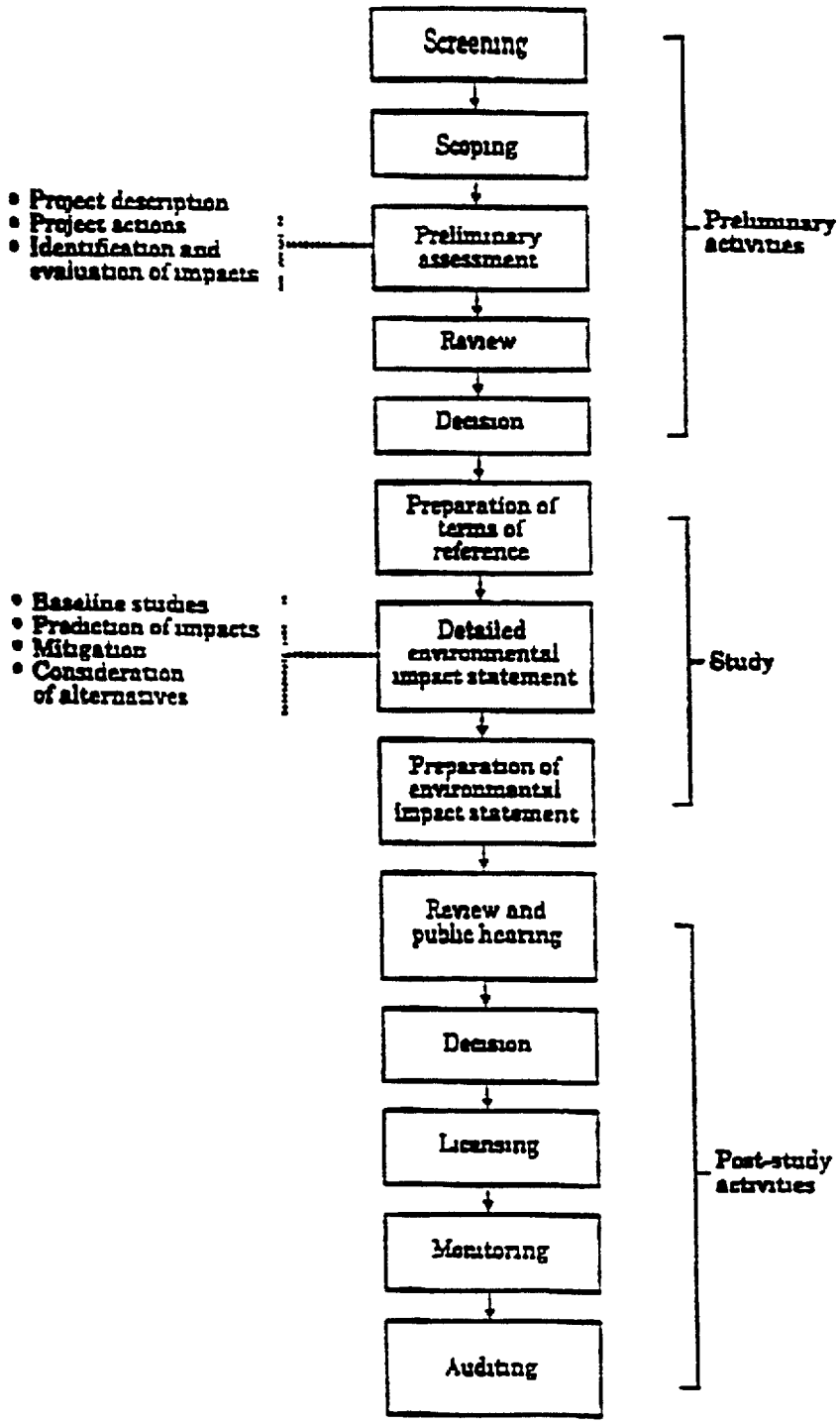

EIA activities.

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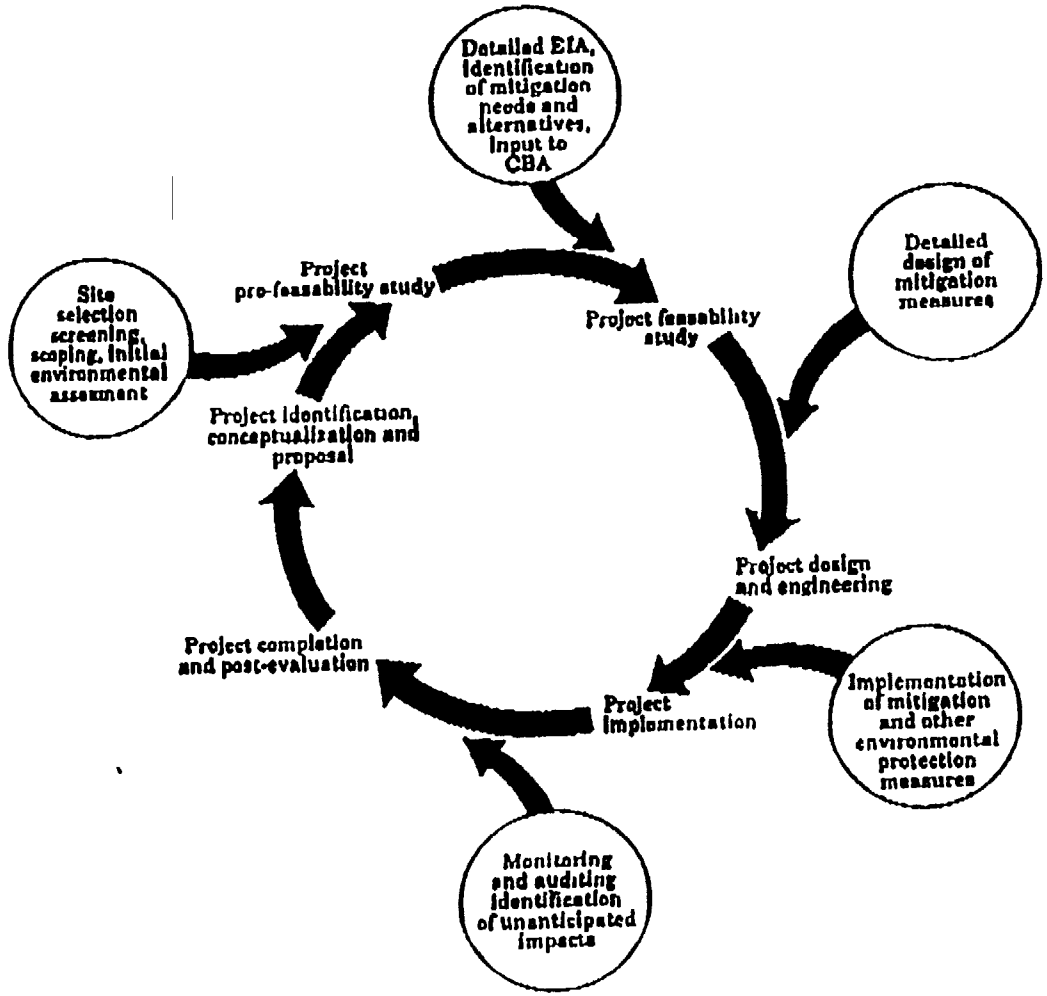

Figure 8 Integrating EIA into the project cycle (Modified from ADB, 1982)

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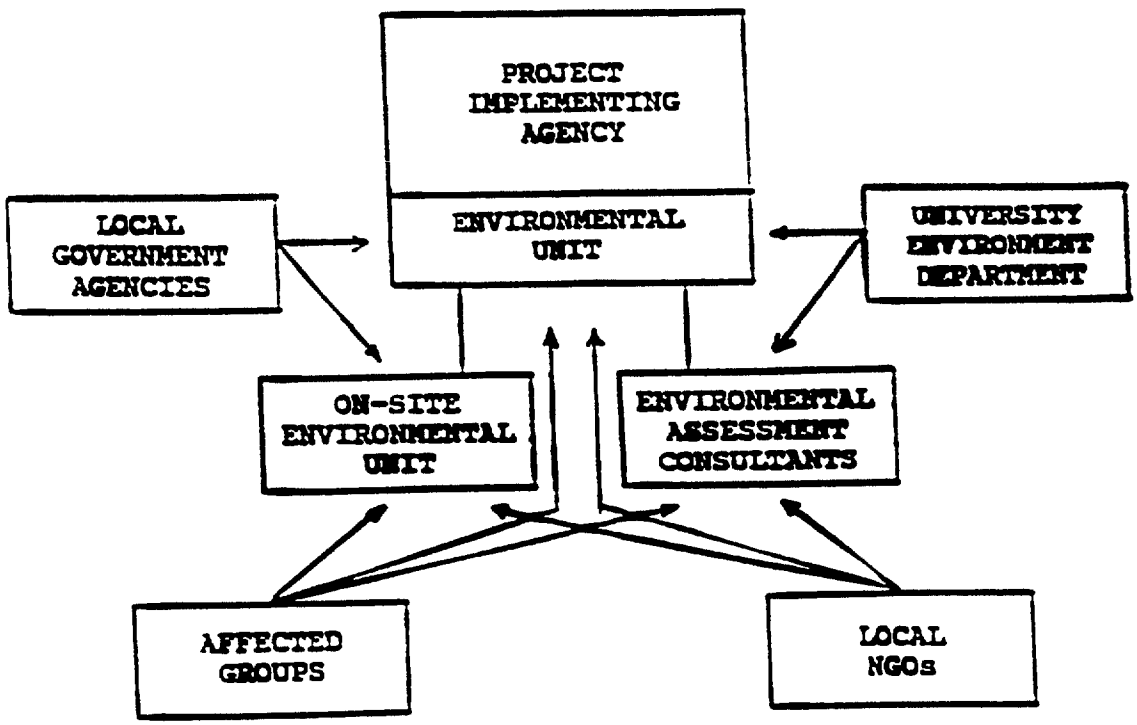
Figure 5.2. Environmental Institutions in Typical Project Organizational Structures



Environmental Resources/Values to be Considered in the EIA	
Classification	Environmental Resource or Value
LEVEL 1 PHYSICAL ENVIRONMENT	
Water Resources	Surface water hydrology and quality Ground water hydrology and quality
Air Resources	Meteorology quality (smog, odors, etc) and noise
Land Resources	Geology mineral resources and seismology Soils and geomorphology sedimentation, erosion and fertility
LEVEL 2 BIOTIC ENVIRONMENT	
Aquatic Resources	Fish-breeding Aquatic biology
Land Resources	Plant covering Wild fauna
Endangered Species	Endangered species
LEVEL 3 HUMAN ENVIRONMENT/ VALUES FOR QUALITY OF LIFE	
Socio demographic	Population/human settlements Levels of health and education Levels of employment and income
Services and Infrastructure	Roadways Energy Water supply Land use (agriculture, industry, recreation, mining, urban areas)
Economic	Local economy
Socio-cultural	History and archeology Indigenous populations Attitudes and values
Esthetics	Scenery Recreation
Legal and institutional	Legal norms Environmental institutions

Table 1.6. Specialists Related to Environmental Assessment

Natural Resource	Subcomponent	Specialist
Air	Air quality Wind direction/speed Precipitation/humidity Temperature Noise	Air quality/pollution analyst Air pollution control engineer Meteorologist Noise expert
Land	Land capability Soil resources/structure Mineral resources Tectonic activity Unique features	Agronomist Soils engineer Soils scientist Civil engineer Geologist Geotechnical engineer Mineralogist Mining engineer Engineering geologist Seismologist
Water	Surface waters Groundwater regime Hydrologic balance Drainage/channel pattern Flooding Sedimentation	Hydrologist Water pollution control engineer Water quality/pollution analyst Marine biologist/engineer Chemist Civil/sanitary engineer Hydrogeologist
Flora and fauna	Environmentally sensitive areas: wetlands, marshes, wildlands, grasslands, etc. Species inventory Productivity Biogeochemical/nutrient cycling	Ecologist Forester Wildlife biologist Botanist Zoologist Conservationist
Human	Social infrastructure/ institutions Cultural characteristics Physiological and psychological well-being Economic resources	Social anthropologist Sociologist Archaeologist Architect Social planner Geographer Demographer Urban planner Transportation planner Economist

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Environmental Impact Assessment. Making it Work in Developing Countries

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Progress in adopting EIA as an environmental management tool has been extremely slow in developing countries, with only nine of the 121 countries having established frameworks for its implementation Even in these few countries, after more than a decade of EIA implementation, the performance of EIA has been dismally poor in spite of considerable efforts, especially in the Asian and Pacific region, devoted to the development of cost-effective EIA methods and techniques This poor performance is attributed to serious flaws in their legislative, administrative, institutional and procedural frameworks. These are discussed and illustrated with specific examples. Suggestions for improvement include the use of a legislative rather than an administrative option to establish authority for EIA, establishment of an independent environmental agency with considerable political influence over sectoral agencies through placement in the office of the President or Prime Minister or a high-profile ministry with responsibility for national economic planning and budgetary control, the decentralization of EIA activities among tiers of government or sectoral agencies; mandatory involvement of the local people, the public and concerned agencies in scoping, reviewing, monitoring and auditing; a procedural arrangement characterized by two-stage assessment, mandatory scoping and preparation of terms of reference, use of registered consultants for EIA studies, provision for public hearings and time limits for review, and the conduct of EIA as a fully-internalized element of the planning process rather than a separate exercise divorced from the technical and economic aspects of project planning and design. EIA guidelines should contain these conditions and there should be adequate provision for judicial involvement in reviewing the actions of environmental agencies and project proponents

Keywords: environmental impact assessment, developing countries, project planning and design, performance outcome of EIA frameworks

1. Introduction

Environmental impact assessment (EIA) emerged as a response to the concerns expressed by the environmental movements of the 1960s about the serious effects of human activities, especially pollution by industries with which existing planning regulations and pollution control measures could not adequately cope Since its

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367

TABLE 1 EIA status in developing countries

Region	Total number of countries	Countries with EIA systems*
Africa	52	—
Asia and Pacific	24	12
Caribbean	11	—
Latin America	20	7
Middle East	14	—
Total	121	19

* See Table 2 for their names.

introduction in the United States of America in 1969, with the passage of the National Environmental Protection Act which requires the preparation of environmental impact statements (EIS) for "major federal actions significantly affecting the quality of the human environment", EIA has been of great interest in virtually all the industrialized nations of the world, where it has now become a major tool for environmentally-sound management practices and for the attainment of sustainable development goals

However, progress in adopting EIA as an environmental management tool has been extremely slow in the developing countries Although these countries have always had general environment-related laws and regulations which can be exploited for EIA purposes, these have had very limited impacts as environmental protection measures because of serious technical, administrative and political constraints (Gilhomee, 1980, Abel and Stocking, 1981, Leonard and Morell, 1981, Geoghegan, 1985, Leonard, 1985, Tolentino, 1986, Gamman and McCreary, 1988, Ebisemiju, in press), in fact, only a few developing countries have used them to demand EIA. Many developing countries also have EIA legislations, but only 19 out of the 121 Sovereign Third World Countries are known to have put in place the necessary administrative, institutional and procedural frameworks for EIA implementation (Table 1)

Various writers have commented on the slow pace at which EIA is being adopted in the developing countries Most of the comments have focused primarily on the technical barriers to EIA implementation These have been identified as including unfamiliarity with the EIA concept itself and its role in the planning process, unfamiliarity with EIA methodologies and techniques, shortage of indigenous staff with experience in the science of environmental assessment and lack of baseline data and the appropriate technology for EIA (Adams, 1982, Sammy and Canter, 1984, Ahmad and Sammy, 1985, Wandesforde-Smith *et al*, 1985, Biswas and Qu Geping, 1987) However, even in the few developing countries with more than a decade of EIA experimentation and implementation, the gap between the intent and the performance of EIA still remains large (Abel and Stocking, 1981, Evans, 1982, Lim, 1985, Roque, 1985, Levy, 1987, Zi, 1987, Htun, 1988, Moreira, 1988, Ning and Whitney, 1988, Lin Lewis, 1989) This failure is in spite of the considerable attention paid by these countries, as well as a number of bilateral and multilateral development aid agencies, to the development of simple cost-effective EIA methodologies and techniques (Suriyakumaran, 1980, AIT, 1982, ERL, 1987)

It is argued that the slow pace at which EIA is being adopted in developing countries is attributable to the absence of an enabling environment for EIA in Third World countries, this absence is analysed and discussed elsewhere (Ebisemiju, 1991, see also Renard, 1987, Towle, 1987) As regarding the observed and documented gap between

the intent and performance of EIA in the few developing countries where the system has been institutionalized, it is here argued that this gap is due more to legislative, administrative, institutional and procedural deficiencies in their EIA systems than to the technical issues widely discussed in the literature and on which workshops and conferences have focused for much of the last decade The primary objective of this paper is to discuss these non-technical constraints with reference to specific examples, and to proffer some solutions that are feasible within the socio–cultural, political and economic realities of Third World countries A clear understanding of these issues will no doubt prove invaluable to the many developing countries, especially in Africa and the Caribbean, which are presently in the process of introducing EIA into their planning systems

2. The goals of EIA

Most definitions of EIA clearly portray it primarily as a tool for predicting, assessing, estimating and communicating the environmental effects of proposed policies, plans and projects (Munn, 1979) Consequently, efforts to stimulate EIA in developing countries have focused mainly on EIA as a tool for environmental analysis (Ahmad and Sammy, 1985, Biswas and Qu Geping, 1987, UNEP, 1988) However, analysis of environmental effects is not enough; the results of the analysis must be incorporated early enough in the project cycle to influence planning and design, the decision to go ahead with the project or not and the implementation and management of the project, and, unless the results of the analysis play a part in decision making, the effort is undoubtedly in vain In order to ensure that developments enhance the productivity of environmental systems, and that this is achieved on a sustainable basis with minimal environmental damage, EIA must not be a technical exercise divorced from the very process of project design and implementation, rather it must be seen and used not only as a tool for the analysis of environmental effects, but, more importantly, as a procedure for bringing the findings of the analysis to bear on policies, plans and investment decisions It cannot be over-emphasized that EIA is not a decision-making process *per se*, decision making in the multi-disciplinary arena of environmental resource planning, development and management is by governments EIA is merely a tool and procedure designed to ensure that adequate environmental considerations enter into the decision-making process EIA therefore, is a tool for shaping policies, programmes and project decisions Its effectiveness in this regard depends not on the robustness of the methodologies and techniques of environmental assessment, but primarily on the effectiveness of the option used for introducing EIA, as well as the institutional and procedural frameworks which are established for its implementation

3 Options for introducing EIA

Two options are available for introducing EIA into the planning process—legislative and administrative The administrative option is usually in the form of a cabinet decision, as in Canada and Japan, or a policy statement contained in development plans national conservation strategies or environmental action plans, as in a number of developing countries For example, the Guidelines on Nigeria's Fourth National Development Plan (1981–1985) contained a directive that "feasibility studies for all

projects, both private and government, shall be accompanied by an environmental impact statement The onus for the preparation of the EIS will be on the owners of the project" (Federal Republic of Nigeria, 1981) Also, one of the three main mechanisms for the implementation of the country's national policy on the environment launched in 1989 is "prior environmental assessment of proposed activities which may affect the environment or the use of a natural resource" (FEPA, 1989)

Such policy statements are more or less expressions of government concern for environmental degradation and the need for resource conservation and environmental protection More often than not, they are made not out of conviction about the utility of the EIA system or an understanding of its mechanisms, but more in response to pressures from donor agencies They also serve as mere lip service to national commitments to certain international conventions and laws dealing with the conservation of resources and preservation of environmental quality for sustainable development. Consequently, they are not backed up by appropriate and effective administrative or legislative actions capable of translating the policy statements into concrete executable actions Thus, for example, a decade after the policy statement on EIA was made in Nigeria's Fourth National Development Plan, the government admitted in the preamble to the National Policy on the Environment that environmental issues "had been neglected or not given sufficient attention . . in actions designed to increase the productivity of the society and to meet essential needs" (FEPA, 1989)

Although such policy statements are not directives as such, they have the advantage of placing environmental issues on government's agenda, creating awareness in the public and private sectors of the economy of the need for and usefulness of the EIA system, and providing some form of "legitimacy" for the consciousness-raising activities of environment-related non-governmental organizations, as well as the voluntary actions of project proponents in conducting environmental assessments

Although cabinet decisions are also administrative directives, they have more compelling force than policy statements A major weakness of the administrative option is that EIA is not legally enforceable. Administrative guidance also generally lacks laid-down guidelines and procedures. State, provincial and local authorities and government lead agencies, therefore, have considerable freedom to determine what form their EIA guidelines and procedures should take. Consequently, the EIA system in a country is likely to be characterized by a heterogenous jumble of decisions, directives, laws and guidelines, as in Japan and Canada. Because environmental degradation is not a respecter of political or administrative boundaries, such non-uniformity in EIA implementation is capable of compounding environmental problems

An overwhelming majority of developing countries with EIA systems have followed the footsteps of the U S.A by employing the legislative option whereby specific laws or decrees are enacted to make EIA mandatory (Table 2) The legislative option is a clear and unambiguous reflection of government's commitment to strong reformist measures and determination to ensure and enforce consideration of environmental matters in the decision-making process It is a particularly desirable option in Third World countries with a low level of awareness of the environmental hazards of modern large-scale development projects, political instability, intense promotion of ethnic rather than national interests, pervasive corruption and abuse of power The implementation of environment-related laws and regulations in developing countries has been significantly inhibited also by lack of political will on the part of government By imbuing environmental policies with force and legitimacy, and establishing a legally-binding set of guidelines, institutional and procedural frameworks, the legislative option not only

570

TABLE 2 Legislations and environmental agencies for EIA in developing countries

Country	Legislation	Environmental agency
Argentina	In preparation	National Directorate of Environmental Planning (DNOA), 1975
Bangladesh	—	Environmental Pollution Control Board
Brazil	National Environmental Policy Law, 1982 CONAMA Resolution 001, 1986	The Special Environmental Agency (SEMA) 1982
China	Environmental Protection Law, 1979	Environment Protection Bureau (1979–1987) Environmental Protection Authority, 1987
Columbia	National Code of Renewable Natural Resources and Protection of the Environment, 1974	National Institute of Renewable Resources and the Environment (INDERENA), 1968
India	Environment (Protection) Act No 29, 1986	Department of the Environment (DOE)
Indonesia	Environmental Management Law, 1982, Regulation PP No 29, 1986	Ministry of Population and the Environment
Republic of Korea	Environmental Conservation Law, 1977, 1979, 1981, 1982, 1983, 1986	Office of the Environment (OOE)
Malaysia	Environmental Quality Act, 1974, 1985	Department of the Environment (DOE), 1974
Mexico	Law of Public Works, 1980; Federal Law of Environment Protection, 1982	Ministry of Urban Development and Ecology (SEDUE)
Nepal	—	Environmental Impact Study Project (EISP)
Pakistan	Environmental Protection Ordnance No XXXVII, 1983	Environmental Protection and Improvement Agency
Papua New Guinea	Environmental Planning Act, 1978	Department of Environment and Conservation, 1978
Peru	—	National Office for Natural Resources Evaluation (ONERN), 1962
Philippines	Presidential Decrees, 1211 and 1151 (1977), 1586 (1978), Proclamation No 1179 (1981)	National Environmental Protection Council (NEPC), 1977
Sri Lanka	National Environmental Acts, 1980, 1984, 1986	National Environmental Authority
Thailand	Improvement and Conservation of National Environmental Quality Acts, 1975, 1978	National Environmental Board (NEB)
Uruguay	—	National Institute for Environmental Preservation (INPMA), 1971
Venezuela	Organic Law of the Environment, 1976	Ministry of Environment and Renewable Natural Resources (MARN) 1976

forces the hands of reluctant governments, but, more importantly, makes it politically easier for environmentally-conscious governments and bureaucratic "heroes" to give environmental considerations adequate weight in the decision-making process. It also permits both the government and the general public, including NGOs, to insist on EIA for proposed actions and to challenge decisions which are patently wrong, biased or environmentally unsound. The mere threat of having to do an EIA by law also stimulates government agencies, project proponents and consultants into a more rational mode of operation.

It is true that nothing prevents military dictatorships which routinely suspend constitutions from putting an existing environmental law "in the cooler". EIA, as practised in developed countries, exposes government policies and actions to public scrutiny and debate through public participation in reviews and litigation. For reasons of political expediency, very few governments in Third World countries would welcome public debate of the environmental implications of their policies, plans and projects, no matter how interested they may be in certain aspects of environmental protection. It is significant to note, therefore, that, although most developing countries with EIA systems opted for the legislative option, there is general lack of judicial involvement in reviewing the actions of environmental agencies and project proponents. This is a cautious strategy to prevent delays in project implementation arising from prolonged litigation, as occurred in the early stages of the implementation of NEPA in the U.S. It can, however, be faulted on the ground that, as Horberry (1984) has rightly observed, "EIA is open to capture by powerful government interests if there are no opportunities to review or challenge the analysis and assessment. Scientists can be biased, the analysis can be skewed to favour a desired result, and the results can be presented in order to favour a prior decision." These unscientific and unprofessional practices thrive best in socio-political systems in which corruption, ethnicism and dictatorship are hallmarks.

If EIA is to be effective in developing countries as an environmental protection strategy, therefore, legislative rather than administrative measures should be taken to introduce the system and implement its guidelines and procedures. Laws must not only establish the authority for the EIA system, they must specify the areas and types of projects and actions that require EIA, the powers of the environmental agency and the general public, and make judicial involvement in the review of decisions and actions mandatory. These requirements bring up the need for the intensification of training in environmental law as an important component of a country's capacity building for environmental assessment.

4 Institutional arrangements

Institutional arrangements deal with the type and effectiveness of the agency responsible for the management of the EIA system, its relationships to focal points in government, especially the sectoral or lead agencies, the mechanisms for co-ordination and co-operation among all agencies and the nature and extent of involvements of actors in the EIA process.

Since the 1972 Stockholm Conference on the Human Environment, developing countries have created a number of administrative bodies and institutional arrangements to promote environmental management objectives (Lohani, 1985, Lowry and Carpenter 1985). The administrative and institutional measures vary from country to country, as well as over time in a given country, and can be categorized into four main groups:

1 adding environmental responsibilities to existing sectoral agencies especially the productive or environment-related agencies such as the Ministry of Agriculture, Ministry of Works, Ministry of Mines, etc,
2 creation of environmental units or departments within sectoral agencies,
3 establishment of a central environmental agency in the form of either an interagency committee, a subsidiary part of a ministry or an independent body placed in the office of the President or Prime Minister as an integral part of the national economic-planning body, and
4 creation of a Ministry of the Environment

Analysis of the relative efficiency of these institutional arrangements by Ibarra (1987) and Szekely (1987) suggest that the most effective framework is the placement of the agency within the office of the President or Prime Minister or in a very-high-profile ministry with responsibility for national economic planning and budgetary control (Tables 3 and 4) This high-profile arrangement places the agency in a strong position to exercise its controlling, supervisory and co-ordinating roles in environmental matters and guarantees adequate funding for its operations It is also most desirable because of the multi-sectoral character of the EIA process

Most environmental agencies in developing countries are subsidiary parts of one ministry or another (Table 2) They are invariably circumscribed because of their low status in the bureaucracy, underfunding and inadequacy of skilled staff and facilities They lack political "clout", authority and legal power to enforce compliance with environmental laws and regulations For example, when the National Environmental Board was created in Thailand in 1975, it was placed in the office of the Prime Minister, where it wielded considerable power and influence by working alongside the extremely powerful National Economic and Social Development Board Ever since it was moved out of the Prime Minister's Office to the Ministry of Science, Technology and Energy in 1979 (Figure 1), NEB has been encountering difficulties in co-ordinating and communicating with lead agencies and state enterprises Also, in Korea, the Office of the Environment, which occupies a sub-ministerial position in governmental hierarchy by its placement under the Ministry of Health and Social Welfare, is overshadowed by the lead agencies which more often than not set aside its recommendations with impunity

Placement of an environmental agency in a high-profile ministry or office of the President or Prime Minister, however, does not automatically guarantee its effectiveness and efficiency Also important is the degree of inter-organizational co-ordination and co-operation it is able to muster among the many sectoral agencies and tiers of government with responsibility for one aspect of the environment or another This co-operation depends on the extent to which the institutional arrangement provides for and encourages such co-ordination and interagency co-operation in the EIA process In this regard institutional frameworks fall into two broad categories viz centralized and decentralized (Lim, 1985) A centralized institutional arrangement is one in which all EIA activities (Figure 2) are concentrated in either the central environmental agency as in Mexico, or in a lead agency, as in Korea (Table 5) The decentralized model is one in which roles in the EIA process are shared among either various tiers of government (hierarchical decentralization), as in Brazil and China, or among lead agencies (functional decentralization), as in The Philippines Thailand and Malaysia (Table 5)

No single model is universally ideal because of differences in the system of government and the placement of environment related responsibilities in the concurrent or exclusive list However, if EIA is to achieve its primary objective of the incorporation

TABLE 3 Effectiveness of environment policy implementation

	Operations		Implementation mechanisms			
			Regulations		Co-ordinated action	
	Allocation of own resources for investment in environmental projects	Capacity to influence allocation of investment	Application of legislation	Environmental impact assessment	Private sector	NGOs/ public sector
Independent units in Environment Ministry	1	4	1	1	3	2
Units in productive ministries agriculture tourism, etc	3	4	3	4	4	4
Units in urban development or Housing Ministry	2	3	3	2	3	3
Units in social sector health	4	4	1	4	4	2
Units in politically high-profile ministries Interior, Planning	4	1	2	1	1	1
Intersectoral executive commissions	4	1	2	2	1	1

Note rating scale 1, effective, 2, limited, 3, nominal, 4 ineffective.
Source Ibarra (1987)

TABLE 4 Comparison of seven options of institutional environmental arrangements according to their efficiency to incorporate environmental planning within the development process

Type of institutional management	Regular authority	Normative role	Influence over resource allocation	Capacity to co-ordinate other sectors	Influence over national planning study	Ability to resolve inter-organizational disputes	Ability to influence local environment	Budget
Sectoral agencies which add environmental responsibilities	Limited	Limited	Limited	None	None	None	None	Limited
Central environmental units at ministerial level	High	High	High	High	Limited	High	Limited	Limited
Central environmental units as subordinate of an existing ministry	Limited	High	Limited	Limited	Limited	Limited	Limited	Limited
Environmental units within sectoral agencies	Limited	Limited	None	None	None/ limited	None	None	Limited
Assigning roles to existing sectoral units	High	Limited	High	None	None	Limited	High	Limited
Environmental offices within national economic planning units	High	High	High	High	High	None	Limited	High
Regional superagencies and inter sectoral commissions	Limited	Limited	None	Limited/ none	None	Limited	High	High

Source Szekely (1987)

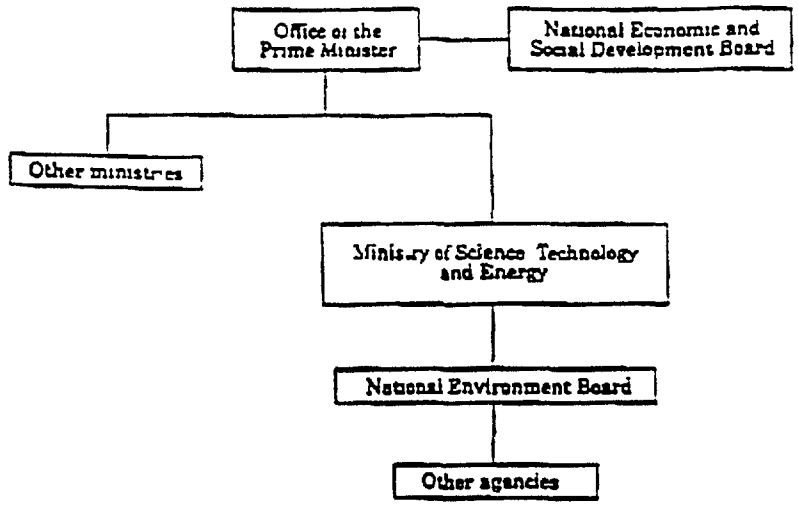

Figure 1 Organizational chart for natural systems management in Thailand (Source: Lowry and Carpenter, 1985)

of environmental considerations into project planning, design and implementation through the disclosure of environmental effects and public scrutiny, then all concerned agencies, tiers of government and the public must be involved in the EIA process Complete centralization of EIA activities in the environmental agency is not desirable This is because there are many sectoral agencies with responsibilities for one aspect of the environment or another Also, the scope of environmental management is so broad that its implementation cannot be concentrated in a single agency Moreover, each lead agency is better structured and have more appropriate personnel to implement EIA State and local authorities also possess greater ability to influence the local environment than central governments

It is suggested, therefore, that EIA responsibilities and roles should be functionally decentralized in countries with unitary systems of government, and hierarchically decentralized in federations where regional offices of the central environmental agency should also be established to assist state and local environmental bodies supervise, co-ordinate and monitor within specific geographical areas such as drainage basins, and act as link between the central and state/local environmental agencies Environmental units should also be established in each sectoral agency, as in The Philippines, to help their respective agencies meet the national environmental policy guidelines, and assist project proponents in the processing and evaluation of environmental impact statements Concerned agencies should be involved in scoping, review, monitoring and post-project evaluation of those aspects of the project that touch on the segments of the environment that are of concern to them This watchdog role ensures interagency co-operation and effective EIS implementation

Thus, although the Department of the Environment occupies a sub-ministerial status in governmental hierarchy in Malaysia (Figure 3), and functions under a federal system of government where states and local governments do not have their own environmental bodies, it has nevertheless received tremendous support from all the three tiers of government and their sectoral agencies This support has been achieved primarily through the decentralization of EIA activities among participants and tiers of government, and the effective mechanisms for intergovernmental and interagency co-ordination and co-operation Environment-related agencies are consulted during the preparation of the terms of reference for detailed assessment, and copies of the EIS are routinely circulated to them by the project initiator for consideration and comments They also participate in the review exercise, and their approval of relevant sections of the EIS must

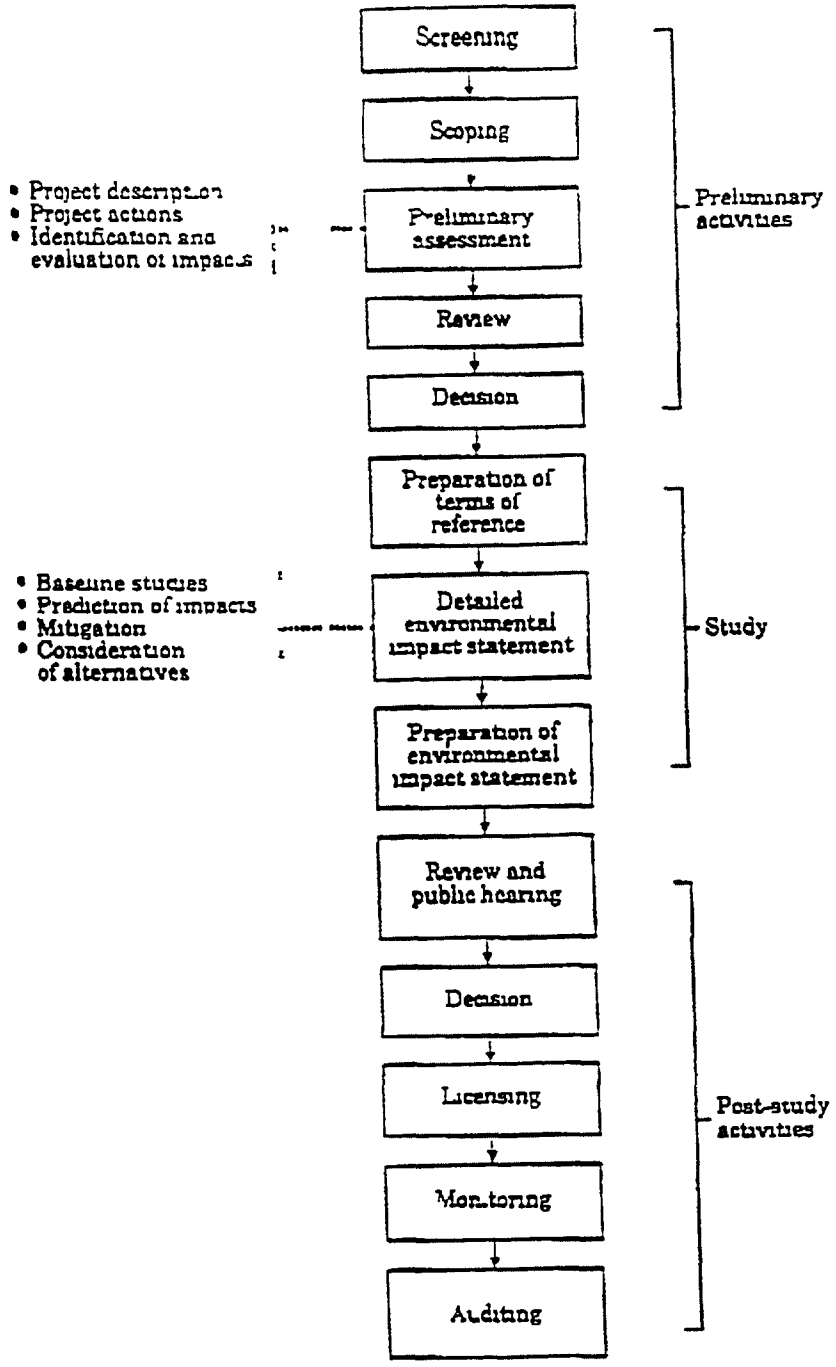

Figure 2. EIA activities

be obtained by project proponents before or following the completion of the assessment Because of the federal system of government, and the strong constitutional role of the states in managing natural resources, the Federal Government saw the need to work in close collaboration with the states on environmental matters Co-operation and co-ordination are achieved through the Environmental Quality Council and the regional offices of the Department of Environment More importantly, the power to grant licences is not concentrated in one body, as in The Philippines and Thailand, but shared between the three tiers of government and the Ministry of Trade and Industry

The experience of Mexico, on the other hand, illustrates vividly the weaknesses

TABLE 5 Institutional arrangements for EIA implementation in selected developing countries

EIA activities	Philippines	Thailand	Korea	Malaysia	China	Mexico	Brazil
Rule setting	6	6	3	6	6	6	6
Screening	2	2	3	2	2	6	2
TOR/scoping	2	2 6	3	2,4 6	1,2 4 5	6	8
Assessment	2	1	3	1/2	1/2	1/2	1
Review	7	6	6	7	7	6	6/7
Licensing	10	3,9	3	8	3	3	8
Monitoring	6	6	3	6	2,3,6	6	6
Type of model	Functionally decentralized	Functionally decentralized	Centralized in lead agency	Functionally decentralized	Hierarchically decentralized	Centralized in environmental agency	Hierarchically decentralized

Key: 1, consultant, 2, project proponent (public and private), 3, lead/responsible/authorizing agency; 4, concerned agencies, 5, the public, 6 environmental agency, 7, independent review committee 8 federal, state local authorities, 9, cabinet, 10, president

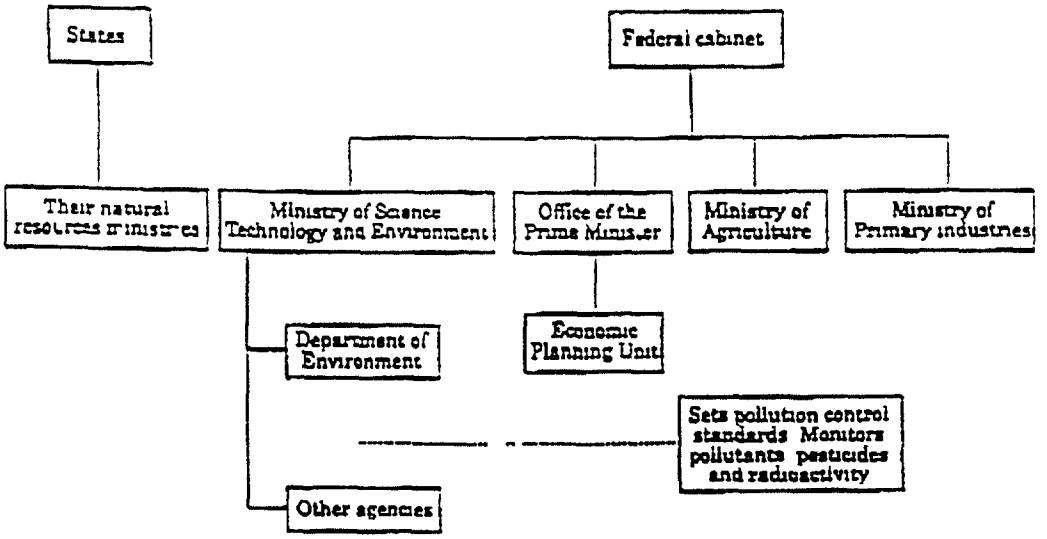

Figure 3 Simplified organizational chart for natural systems management in Malaysia (Source DOE Malaysia, 1987)

inherent in the centralization of EIA roles in the environmental agency Before the establishment, in 1982, of the Ministry of Urban Development and Ecology (Secretaria de Desarolla Urbano y Ecologia—SEDUE) as Mexico's national environmental agency, with responsibilities for rule setting and the co-ordination of the EIA process, the institutional arrangement for EIA was similar to Korea's centralized model, with all functions concentrated in each sectoral agency Although this model has its limitations arising from non-uniformity of EIA guidelines and procedures, each sectoral agency and state enterprise exhibited strong commitment to the EIA system Since 1982, however, all EIA activities, with the exception of assessment and licensing, are concentrated in the environmental agency The public and concerned agencies are not involved, and the review committee is not independent of the environmental agency As in Malaysia, the states and local governments have no environmental agencies The commitment of the sectoral agencies to EIA has since diminished considerably, and SEDUE has had to enter into negotiations and agreements with them for the submission of project EISs for review by SEDUE (Levy, 1987)

5 Procedural frameworks

EIA procedures refer to the sequencing of tasks among participants in the EIA process Procedural issues focus on who sets the rules, who does the screening and scoping who carries out the assessment, who reviews and what is the review process, and the who when and how of public participation EIA procedures, therefore, define the formal structure for carrying out the assessment of the environmental implications of projects and its integration in the project cycle Although EIA can be undertaken without a set of formal procedures, as is the case in Korea and Western Australia, the existence of procedures ensures uniformity and guarantees that all relevant projects are examined for their environmental consequences in a clearly-defined structured manner so that the assessment is thoroughly executed and the results are effectively utilized It also eliminates inconsistencies in the assessment of similar proposals, as well as the personal prejudices, whims and caprices of environmental agency or lead agency officials The absence of a defined assessment procedure also creates uncertainties in the minds of project proponents as to what actions they are expected to take, or what in fact is

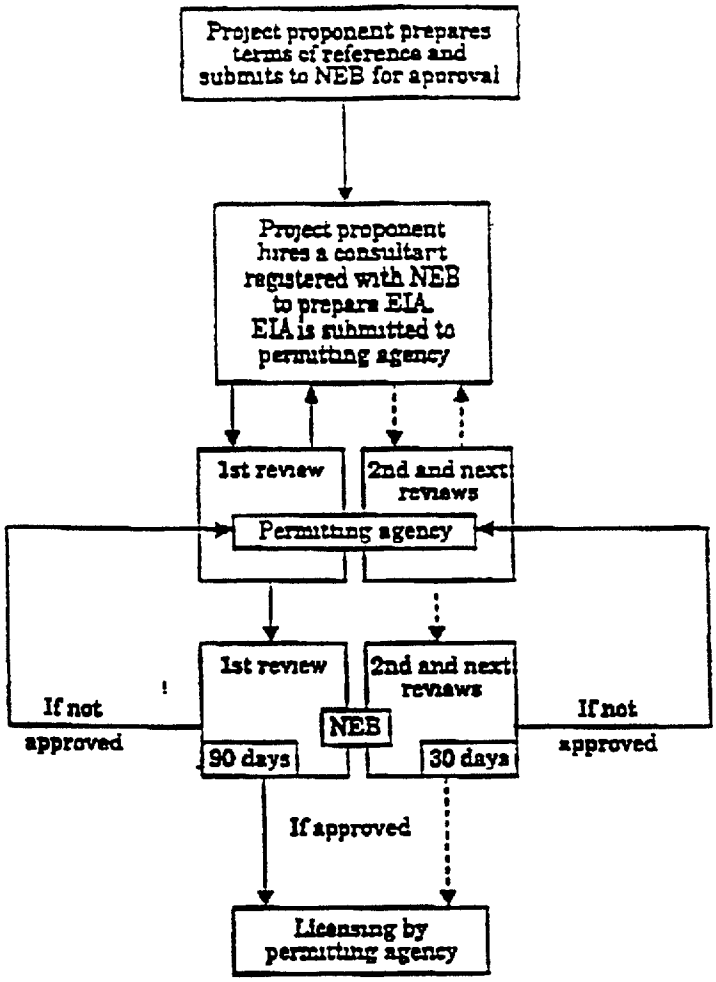

Figure 4 EIA procedural flow for private projects in Thailand

required of them Such a situation provides a fertile ground for corruption, nepotism and trade-offs

Only six of the 19 developing countries with EIA systems have laid-down procedures for environmental assessment; these are The Philippines, Thailand, Malaysia, China, Mexico and Brazil The procedural framework employed by these countries to implement the EIA requirement, however, vary considerably from country to country In fact, each country has its own individual approach to EIA Foreign EIA procedural models have been tried in some of the countries and found to be unworkable because the countries lack the socio–cultural, political and administrative infrastructure to implement and enforce them Consequently, EIA procedures have been modified to suit local conditions, especially the socio–cultural and political environments, indigenous resources and the long-established planning process and development control mechanisms

Thailand has the most elaborate EIA procedure among the developing countries with EIA systems, and she is unique in having two distinct procedural flows, one for private and the other for public projects (Figures 4 and 5), in contrast to the single framework in all other developed and developing countries (see Figures 6 and 7, for example) The procedural flow for private sector development in Thailand has the following steps or phases (Figure 4)

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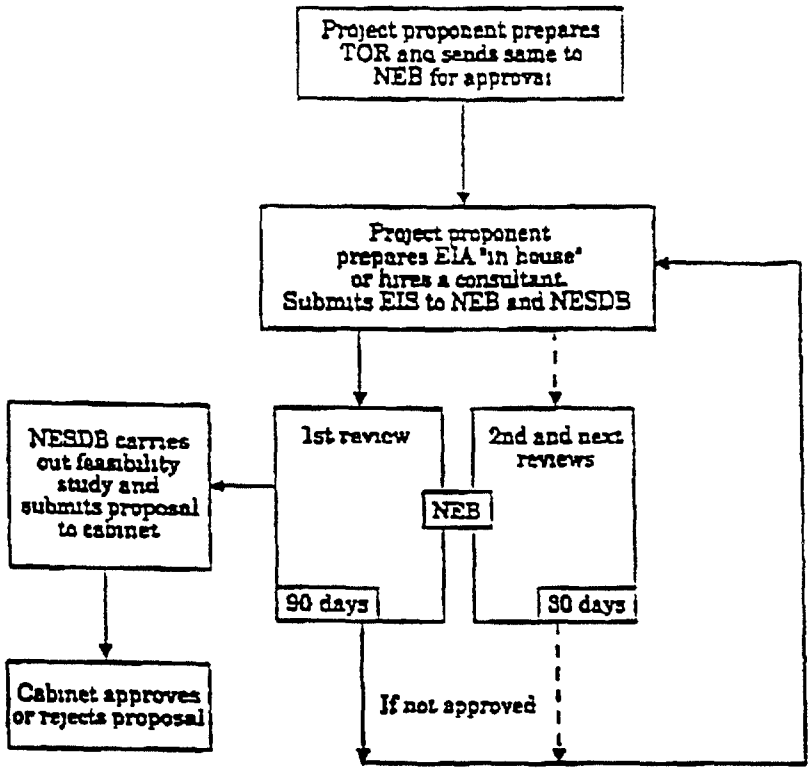


Figure 5 EIA procedural flow for government and state enterprises development projects in Thailand

Phase I Project proponent prepares the terms of reference (TOR) for the EIS study and submits it to NEB for review and modification

Phase II Project proponent then hires an assessor who must be a consultant registered with NEB

Phase III Project proponent submits EIS to NEB through the appropriate permitting agency

Phase IV The Environmental Impact Evaluation Division (DEIE) of NEB reviews the EIS, and the exercise must be completed within 90 days, failing which it is deemed that the EIS has been approved by NEB

Phase V If EIS is not approved, NEB will request for more detailed information, clarification or mitigating measures from the project proponent through the permitting agency If EIS is approved the conditions, if any, are included in the permitting licence

Phase VI After necessary corrections by the project proponent, the permitting agency sends the revised EIS to NEB for a second review which must be completed within 30 days, failing which the EIS is deemed approved

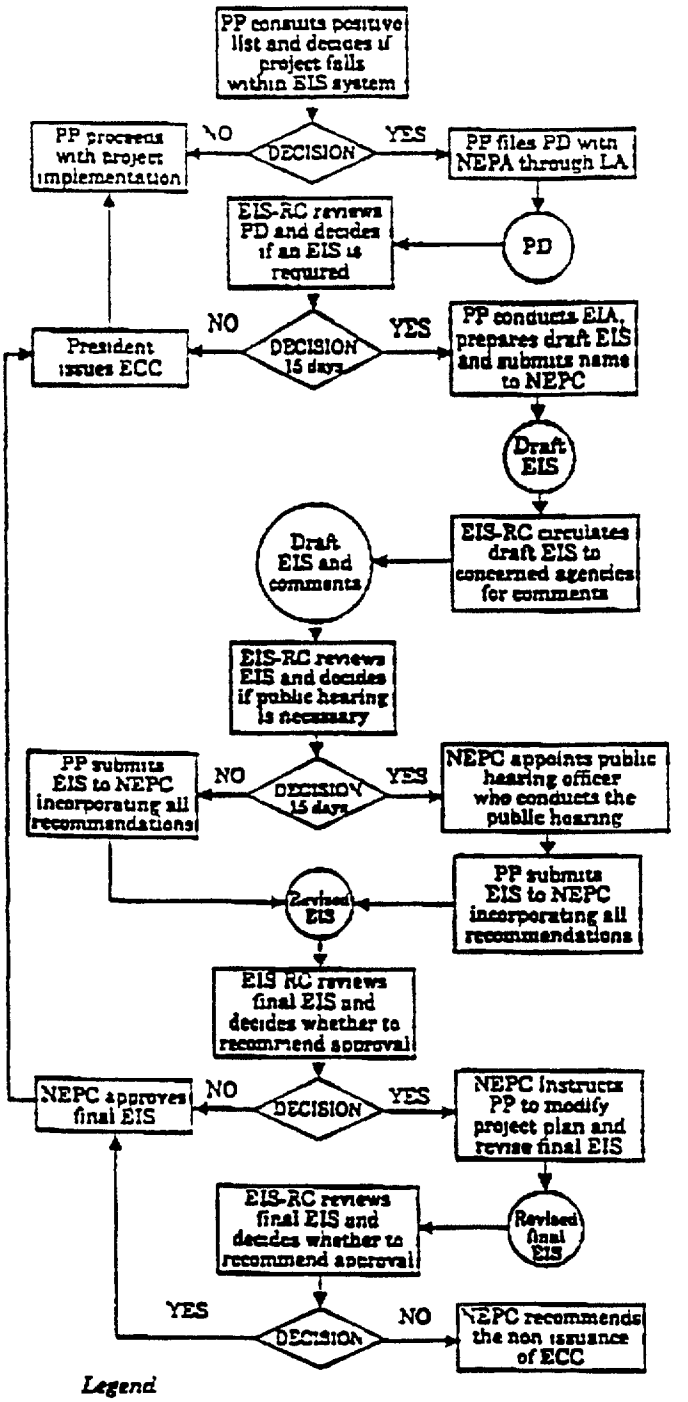
Phase VII When EIS is approved, licensing is done by the permitting agency

Project implementation is subsequently monitored by NEB for compliance

The procedural flow for government projects and state enterprises is significantly different in many respects (Figure 5)

Phase I Government agency sends TOR to NEB for approval

Phase II Government agency carries out the assessment by itself or hires a consulting firm not necessarily registered with NEB



Legend

PP = project proponent
PD = project description
EIS = environment impact statement
ECC = environmental compliance certificate
LA = lead agency
EIS-RC = EIS Review Committee
NEPC = National Environmental Protection Council

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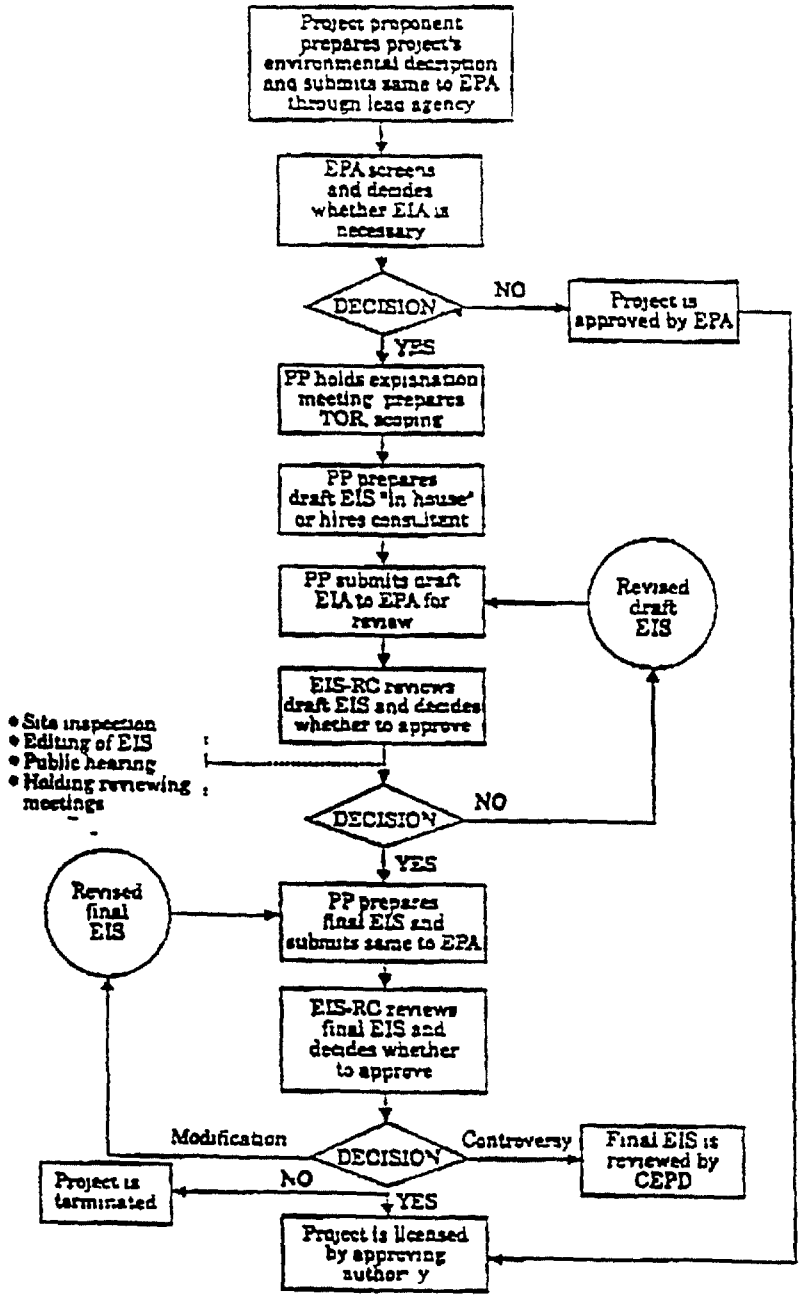
Figure 6 EIA procedural flow in The Philippines.



Legend

PP = project proponent
EIS = environment impact statement
EIS-RC = EIS Review Committee
EPA = Environment Protection Authority
CEPD = Council for Economic Planning and Development

Figure 7 EIA procedural flow in China

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Phase III The agency sends EIS to both NEB and the National Economic and Social Development Board (NESDB), which is in the Prime Minister's Office
Phase IV NEB reviews EIS within the same time frame for private projects
Phase V When EIS is approved, NEB informs NESDB of approval
Phase VI NESDB carries out economic and engineering feasibility studies, incorporating the environmental issues, and submits the project proposal to the cabinet to make the final decision
Phase VII Cabinet approves or rejects the project

If the project proposal is approved, NEB monitors its implementation for compliance

An EIA procedure should be well-structured to ensure the realization of the twin objectives of EIA outlined by Caldwell (1978) in respect of NEPA as the incorporation of environmental values at the earliest stage of planning and decision making (including policy and programme formulation), and the disclosure of environmental consequences of planned actions and increased public scrutiny and involvement. The following are suggested as basic elements therefore, of an EIA procedure

1 The assessment should be conducted in two stages, as in The Philippines, Thailand, Malaysia, China and Mexico, in order to save considerable time and cost involved in detailed assessments. All projects, irrespective of type, scale, threshold or environmental sensitivity, should be subjected to a preliminary or initial environmental assessment or screening using simple methods such as the Leopold matrix (Leopold *et al*, 1971) or checklist to determine whether or not they are likely to have serious environmental impacts Only projects with potentially serious environmental consequences are then subjected to detailed environmental assessment leading to the preparation of an environmental impact statement
2. Scoping should be mandatory, and the public, affected communities and concerned agencies must be involved in the exercise Scoping is an activity designed to identify the key, priority and contentious issues relating to a proposed development or course of action and, therefore should form the basis of the assessment It helps, therefore, in focusing the assessment, thereby saving time and cost More importantly, it provides a much needed opportunity for the consideration of local resources, societal values, preferences and perceptions, political styles and socio-cultural conflicts in resource development Because decisions about development proposals are based on the contents of EISs, the document should provide decision makers with a balanced coverage of economic, social, cultural, as well as biophysical, costs and benefits EIAs which evade socio-cultural issues are bound to make inaccurate predictions Project proponents, therefore, should hold explanatory meetings (as in China, Figure 7) with the local people, representatives of interest groups and relevant government agencies in order to identify the major issues on which the environmental assessment should focus
3 Terms of reference (TOR) should be prepared by the project proponent in consultation with the EIS review committee The TOR is a useful document to project proponents and the review committee in that it specifies the EIS requirements for a given project, thus guaranteeing that the EIS will be suitable for review and evaluation
4 The environmental assessment should be conducted "in-house" by the project proponent or by the use of consultants duly registered with the environmental

agency The rationale for this requirement is that the project proponent is most knowledgeable about his project activities, and, therefore, is better placed than the environmental agency to utilize environmental information effectively to improve project design through the preparation of the EIS as part of project planning The mandatory use of registered consultants as in Thailand and Brazil ensures high-quality environmental research and reporting Any bias, distortions in data collection, analysis and presentation can be easily detected at the review and public-hearing stages The threat of litigation and the ethics of the consultant's profession are adequate deterrents to such bias and distortions

5 The EIS should be circulated to all concerned government agencies This circulation ensures that all relevant environmental issues are satisfactorily addressed in the EIS, thus ensuring the high quality of EISs In Malaysia for example, project proponents must obtain the approval of environment-related concerned agencies of relevant sections of the EIS before or following the completion of the assessment The circulation of EISs to concerned agencies is also an effective way of achieving interagency co-operation essential for the success of the EIA system The EIS should be made available also to the public to ensure that the socio–cultural issues canvassed during the explanatory meeting and scoping have been adequately addressed in the EIS

6 There should be provision for public hearing This hearing provides a forum for a thorough analysis of the conclusions and proposals in the EIS, and a more direct public input into the final EIS on which decisions are to be based. By providing the affected people with a mechanism for presenting their entire range of social, economic and political problems and aspirations to government, public hearings help to guarantee public support and endorsement, thus creating an enabling environment for environmentally-sound decisions to be successfully implemented

The need for the establishment of an appropriate machinery for adequate and effective participation of the public in the EIA process also cannot be overemphasized, in view of the very important distinction between environmental effects and impacts While effects, that is changes resulting from a proposed action, can be objectively predicted, environmental impacts or the desirability of such changes can be valued differently by various interest groups It is important, therefore, that those who will actually experience the effects, both directly and indirectly, have a say in evaluating them The machinery to be established for this purpose depends on the socio–political environment and level of environmental awareness in a country The Guidelines for EIA in Malaysia specify the following methods for obtaining public participation in the EIA process, viz public opinion sampling, public meetings or workshops and regular meeting with a citizens' committee truly representative of the community likely to be directly affected by the project The danger in an open-ended public involvement is that the EIA process may degenerate into a political contest between interested groups with opposing political views

7 Time limits should be set for EIS reviews This limitation ensures that project implementation is not unduly delayed as a result of the EIA requirement

8 In order to ensure that the development proposal is executed in line with measures approved in the EIS, concerned agencies should be involved in monitoring compliance and post-project audits The monitoring and auditing committee should consist of representatives of the environmental agency, concerned agencies, project owner and local people affected by the project

If these yardsticks are employed in evaluating the adequacy of EIA procedures in developing countries, the inevitable conclusion to be drawn is that the procedures suffer from major weaknesses which make the realization of the intent and purpose of EIA difficult to achieve Table 6 shows that the EIA procedural frameworks in Malaysia and China satisfy most of these conditions At the other extreme are Korea and Mexico The most serious weakness of the EIA procedures in all the countries except China is the non-involvement of the public and concerned agencies in scoping. In most of the countries, there is also no provision for public hearing. It can be argued, therefore, that EIA, as practised in the developing countries, cannot achieve one of its major aims, i e the disclosure of the environmental consequences of planned actions and increased public scrutiny and involvement. These shortcomings must be adequately redressed

6. Integration of EIA in the project cycle

The EIA system has been described as a procedure for the identification and disclosure of the environmental consequence of proposed developmental actions, and the incorporation of environmental considerations at the earliest stage in the project cycle to influence planning, design, implementation and management Effective incorporation can only be achieved if, and only if, EIA is a fully internalized element of the planning process (Figure 8) This means that the environmental assessment should be carried out at the inception of a proposed action when there is still a real choice between alternative courses of action, such as alternative sites, designs, feasible strategies of action, technologies for aspects of the project, as well as the alternative to do nothing EIA guidelines should also clearly specify the stage in the project cycle at which each EIA activity (preliminary assessment, detailed assessment, monitoring, etc) is to be carried out, and how the results are to be used in project planning, design, implementation and operation

In most of the developing countries with EIA systems, EIA is conducted more or less as a separate technical exercise divorced from the technical and economic aspects of project planning and design. More often than not, the environmental assessments are conducted at the latest project plan stage when most of the plan details have been finalized and there is little or no opportunity to consider alternatives EIA then becomes a postscript to planning and is used basically as a perfunctory endorsement of public or private actions rather than to influence decisions Even when conducted at the very early stage in the project cycle, neither the project proponent nor the reviewers and lead agencies take the environmental consequences seriously As Evans (1983) has rightly observed in respect of South-East Asia, "It seems that a general misconception prevails that, once the EIA study is completed, the environmental effects of the project are managed" In fact, the EISs produced in Thailand and The Philippines, two countries with the most elaborate EIA systems in the Third World, have been aptly described as "nothing but a collection of unsynthesized biophysical data irrelevant to the choice among real alternatives" (Roque, 1985) It is not surprising, therefore, that the hundreds of EISs submitted to environmental agencies in South-East Asia have had very limited impact in minimizing the environmental consequences of the projects

It is only in Brazil, Malaysia and Mexico that there are adequate arrangements for the integration of EIA in the project cycle In Malaysia, for example, apart from the chart to guide project proponents in the integration of the technical, economic and environmental elements of planning (Figure 9), the EIA guidelines make it mandatory

TABLE 6 Evaluation of EIA procedural frameworks in some developing countries

	Philippines	Thailand	Korea	Malaysia	China	Mexico	Brazil
Use of preliminary or initial environmental assessment for screening	Yes	Yes	No	Yes	Yes	Yes	No
Involvement of the public and concerned agencies in scoping	No	No	No	No	Yes	No	Yes
Preparation of terms of reference	No	Yes	No	Yes	Yes	No	Yes
Conduct of the assessment and preparation of EIS by project proponent with the assistance of consultants	No	Yes	No	Yes	Yes	No	Yes
Circulation of EIS to concerned agencies and made available for public scrutiny	Yes	No	No	Yes	Yes	No	Yes
Provision for mandatory public hearing	No	No	No	Yes	Yes	No	No
Time limits set for EIS review	Yes	Yes	No	Yes	No	Yes	No
Lead and concerned agencies involved in monitoring and auditing	No	No	No	No	Yes	No	No

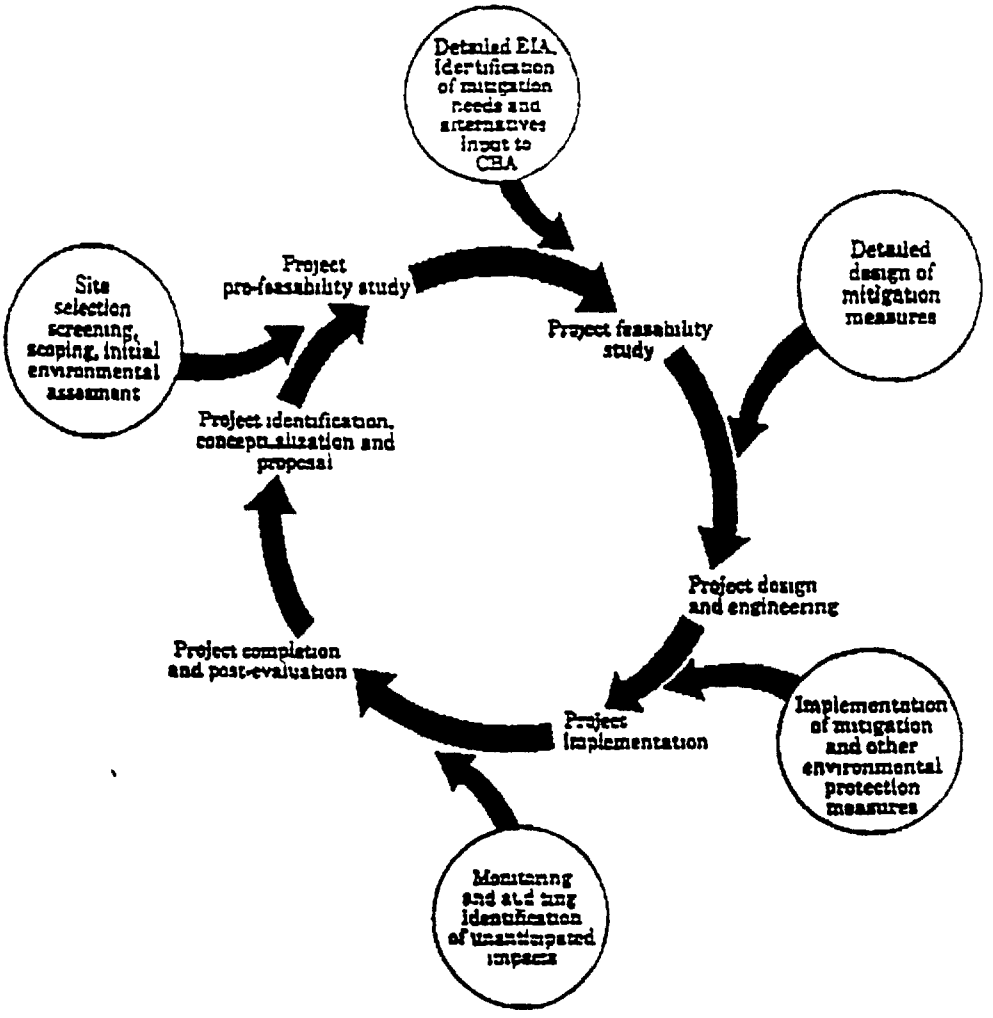

Figure 8 Integrating EIA into the project cycle. (Modified from ADB, 1982)

for project proponents to take the recommendations of the review panel into consideration and incorporate them into the final design of the proposed project. The final project design incorporating these recommendations must also be submitted to the Department of Environment prior to the construction of the project Also importantly, the project proponent "in the course of carrying out such activity, shall provide sufficient proof that the conditions attached to the report (if any) are being complied with, and that the proposed measures to be taken to prevent, reduce or control the adverse impact on the environment are being incorporated into the design, construction and operation of the prescribed activity" (DOE, 1987) In Mexico, also, the EIS must be approved before a project's final design is produced Brazil effectively internalizes EIA in the project cycle by incorporating it into her long-existing three-stage licensing system (Figure 10, Table 7), and there is a built-in mechanism for continuous monitoring every stage of project implementation for compliance with recommendations contained in previous licences

It is suggested that the EIA system should be integrated with the existing planning or development control framework in each country (Ayanda, 1988) The mechanism for this integration should be clearly specified in the EIA guidelines There should also be provision for continuous monitoring of compliance with recommendations, and the

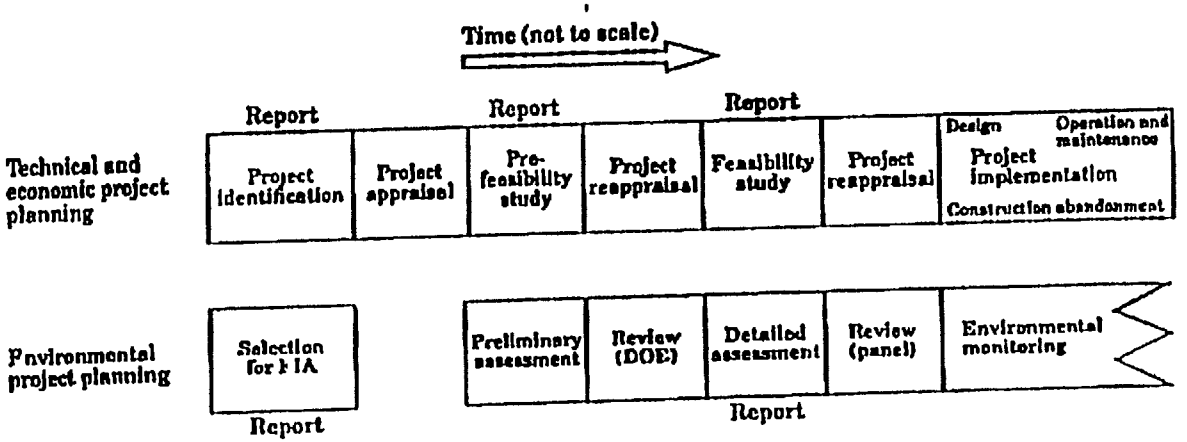

Figure 9 Malaysia s integrated project planning concept (Source DOE Malaysia 1987)

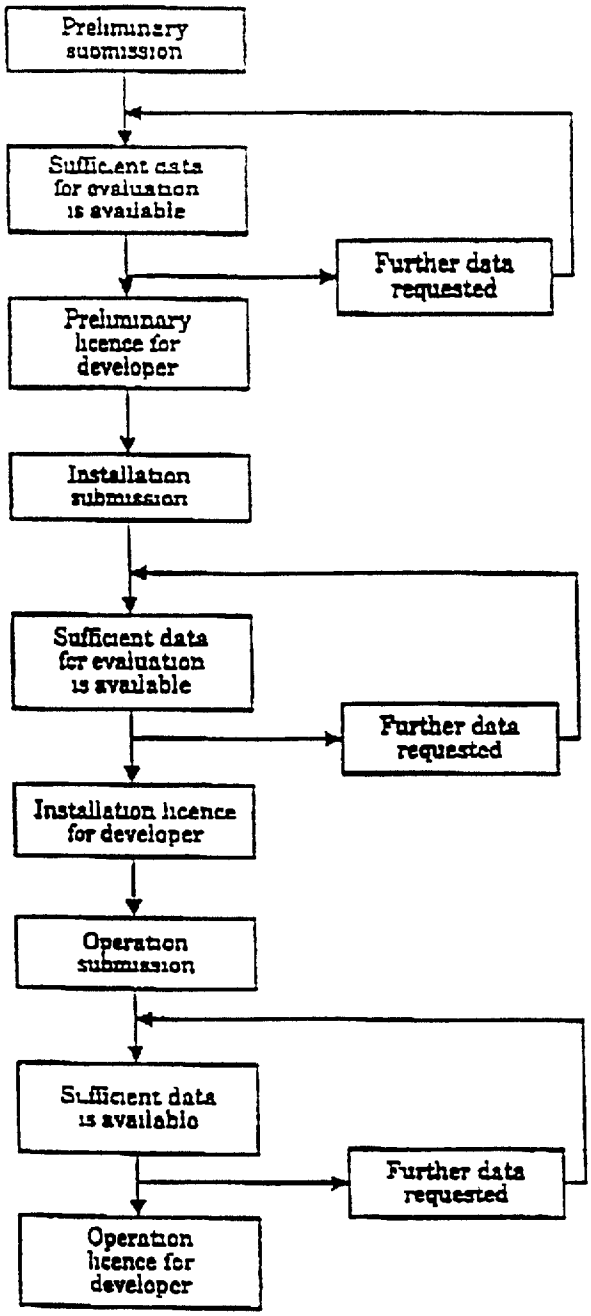

Figure 10 The permit system and EIA in Rio de Janeiro, Brazil (Source Costa and Silveira, 1980)

environmental agency should be empowered to intervene at any stage during project implementation if any of the directives in the licence are not being complied with

7. Summary and conclusion

Although progress in the adoption of EIA as an environmental management tool has been extremely slow in the developing countries because of largely technical issues, there is now a heightened awareness among these countries of the potential benefits of the EIA system In the few countries that have so far established administrative machineries and

TABLE 7 Brazil's national licensing system

Level	Stage	Information required
Provisional	Planning	Proposed project site installation operation federal, state, municipal plans in the project area Environmental impact statement
Installation	Construction	Specifications of the final approved project design Environmental impact statement
Operation	Following inspection of early operation/ pollution control equipment	Is operation as stated in the provisional and installation licences?

legal instruments for the implementation of EIA, however, the performance outcome of the system has been extremely poor This poor performance is attributable to defects in their legislative, administrative, institutional and procedural frameworks, which are inadequate to varying degrees for a process such as EIA with a multi-sectoral character, and which demands for its success, therefore, considerable interagency co-ordination and co-operation, the ability of the environmental agency to enforce and monitor compliance with environmental laws and regulations and to influence investment decisions in both the public and private sectors of the economy, as well as unfettered disclosure of environmental consequences, public scrutiny and involvement The preceding analyses reveal that these basic ingredients of the EIA system are either lacking or inadequately addressed in most of the developing countries with EIA systems

It is argued, therefore, that while the search for simple, cost-effective EIA methodologies and techniques should continue unabated, especially in view of the increasing complexity and rigour of EIA methods and techniques being actively promoted in the developed countries, research efforts in Third World countries should focus more on the creation of an enabling environment for EIA's introduction, and the development of appropriate legislative administrative, institutional and procedural frameworks for effective EIA implementation, given the political and socio–cultural situation in each country In this regard, developing countries can benefit not only from the experience of the developed nations, but also, more importantly, from the experience of the developing countries with about a decade of EIA implementation and with which they share common political and socio–economic characteristics

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Facility Siting Process

An Introduction to Site Selection and Evaluation

This study session will present and describe procedures generally used for power plant site selection The objective of the site selection or evaluation is to identify the most appropriate site or sites for the proposed development This site selection methodology includes procedures used for the determination of siting factors, selection of factor weights, scoring systems to rate sites based on those factors, and sensitivity analyses While the information presented is based on site selection for power plants, this flexible selection methodology could be slightly modified to accommodate other types of developments

An Introduction to Site Selection and Evaluation

Table of Contents

1 0 Introduction 3

2 0 Siting Factors 3

3 0 Comprehensive Site Selection Process Description 5

- 3 1 First Level Screening - Identification of Siting Areas 5
- 3 2 Second Level Screening - Identification and Evaluation of Potential Sites to Candidate Sites 6
- 3 3 Third Level Screening - Evaluation of Candidate Sites to Preferred and Alternate Sites 8
- 3 4 Sensitivity Analyses 9
- 3 5 Site Selection Study Report 10

4 0 Conclusion 10

Table S-1 Potential Site Selection Factors 4

Appendices

Appendix A Example of Figures/Presentations

Appendix B Example Scoring System

Appendix C Example of Factor Weights

Appendix D Alternate Example of Matrix Evaluation

Appendix E Site Selection Methodology - Transparency Copies

Appendix F Technical Paper - Power Facility Site Selection in the 1990s

1 0 Introduction

In developing countries worldwide, lending institutions significantly influence the considerations given to environmental issues Black & Veatch has noticed that, on a global basis, financing institutions and governmental agencies have demonstrated an increased interest in how and why a site is selected They are particularly concerned that a thorough site selection process is performed which adequately addresses and evaluated the anticipated project impacts on the existing environmental and socioeconomic conditions In one extreme example, a governmental agency in southeast Asia denied the approval of an environmental impact assessment because they believed the selection of the project site was based mostly on economics, with few considerations given to environmental impacts The performance of a thorough, well-documented site selection study is an important early step in the project approval process

2 0 Siting Factors

Initially, a project specific list of siting factors are selected and defined Included in this list of factors are the engineering, environmental, economic, and land use considerations which are determined by the project objectives to be important for that specific project A list of potential siting factors is provided in Table S-1 Although this list is meant to be a fairly comprehensive list of possible factors, a specific project may require specific considerations which are not on the list, may not deem some factors important enough for consideration, or may wish to combine a number of related factors together until the overall group is significant enough to consider

Once the major project concerns and considerations are established, an outline of project specific objectives is developed This outline illustrates the screening process, including whether the specific project should include a one, two, or three level screening process This outline should also illustrate the progress from a needed ("must have") criteria to the wanted ("would like to have") throughout the screening levels Black & Veatch typically groups the factors into three general categories Environmental, Engineering, and Costs Each of the factors is placed within one of these categories

Table S-1 - Potential Site Selection Factors

Aesthetics
Air Quality
Community Services
Construction Access
Cooling Tower Effects
Cultural Resources
Ecology (Aquatic, Marine, and Terrestrial)
Economics
Environmental Impacts
Flooding Potential
Fuel Requirements (Type and Access)
Generation Development Plans
Geology/Geotechnical
Land Use and Acquisition
Navigation (Air and Water)
Noise
Permitting
Population Impacts
Public Perception (Acceptability, etc)
Rail Accessibility
Recreation
Site Capacity
Socioeconomics (Labor pool, etc)
System Reliability
Technology
Terrain
Transmission System
Transportation Access
Visual Impacts
Waste Disposal
Water Quality (Ground water, Surface water)
Water Supply (Type, Availability)

As the project progresses from initial screening to final screening, the emphasis generally moves from an initial higher importance on Engineering/Costs issues toward higher importance of environmental criteria as the project nears completion This is because the initial levels of screening have limited the site selection to siting areas which are acceptable from a "needs" standpoint, then other criteria such as environmental constraints can be considered in more detail

In addition, the categorization of criteria is useful in the initial assignment of factor weights and in the development of alternative scenarios in the sensitivity analysis portion of the project

3 0 Comprehensive Site Selection Process Description

The following process description concentrates on a comprehensive regional study which is separated into three basic screening levels However, site feasibility "fatal flaw" evaluations for a selected site or smaller comparative studies include a similar procedure with one or two screening levels

3 1 First Level Screening - Identification of Siting Areas

In the first screening level, the study's focus is narrowed by excluding major portions of a region because of requirements for specified resources or the avoidance of critical environmental or geological factors The second screening level consists of identifying and evaluating potential sites within the remaining siting areas to arrive at a list of candidate sites In the third screening level, a preferred site, which is ranked as most suitable, and an alternate site are selected from the candidate sites

During this first screening level of the siting process, specific criteria associated with the development and operation of the proposed power plant are established These criteria are then used in a sequential manner to eliminate certain geographical areas from further consideration These "must have" technical criteria include access to fuel, transmission lines, and suitable water supplies as well as geological and environmental constraints Geographical areas that satisfy the established requirements are carried forward into the next step as siting areas

The sequencing of these criteria is flexible, however, it is usually advantageous to begin with the criterion that is most easily applied and will exclude significant areas In other words, the "must have" criteria are considered before the "want to have" criteria

Fuel is usually the first exclusionary criterion Coal fueled generating units must be sited for economic fuel delivery by rail, barges, or other means in the quantities required for a specific unit size Similarly, natural gas fueled units must be sited within economic distance of existing gas pipelines with sufficient capacity

The second exclusionary criterion is the distance from suitable transmission lines New transmission lines are expensive to install and are often subject to strict environmental constraints and right-of-way restrictions

The third exclusionary criterion is access to reliable water supplies of suitable quality and quantity The availability of ground and surface water should be investigated, and undependable or poor quality sources excluded For river water supplies, a withdrawal of 10 percent of the flow volume at low flow conditions is considered reasonable

The fourth exclusionary criterion is air quality sensitive areas In the United States, areas designated as PSD Class I or nonattainment for any pollutant, as well as an appropriate buffer zone surrounding the areas, may be excluded from further consideration In addition, the proximity of the site facilities to elevated terrain is also typically considered This last consideration is due to the potential for plume dispersion limitations prior to impact on the terrain

The fifth exclusionary criterion assesses geological structures and features As an example, areas having significant slope would require extensive earthwork so that site development may not be practical In addition, areas with Karst/sinkhole potential or areas with unusually high seismic activity can be excluded from further consideration

3 2 Second Level Screening - Identification and Evaluation of Potential Sites to Candidate Sites

After siting areas (containing "must have" criteria) are identified, the potential sites must then be identified and evaluated consistent with overall site development and environmental impacts The sites are judged relative to project specific factors which typically include the following salient physical and cultural features

- Proximity to linear facilities (road, rail, transmission corridors, water supply, and pipeline corridors) necessary to support plant development
- Topographic factors
- Air quality exclusion zones
- Proximity to urbanized or unincorporated residential/commercial areas

- Proximity to areas of potential use conflicts (such as airport instrument approaches and military security zones) or adverse community acceptance
- Proximity to environmentally sensitive areas (such as a river system having a federal or state "wild" or "scenic" designation, or national or state parks)
- Aesthetic constraints (including noise, open space, and public view/scenic vista) affecting facilities placement or height
- Cultural, terrestrial, or aquatic environmental constraints (including cemeteries, wetlands, or other sensitive habitats) impacting site licensing, development, or operation
- Geological factors

Using information from onsite field reconnaissance and the previously developed knowledge of regional and site specific information, comprehensive descriptions of each candidate site are developed The descriptions must be sufficiently accurate to ensure that the engineering concepts are feasible and appropriate for the sites Specific power plant systems and other items for which detailed site information must be defined include the plant technology, makeup water system, cooling water system, fuel supply and delivery, highway accessibility, transmission interconnection, and transmission system integration/stability

Decision analysis methods are used to systematically evaluate each site in relation to the criteria listed above A weighted scoring matrix is used for comparative evaluations among the sites Weights are assigned to the evaluation criteria based on the perceived relative importance Each site is judged relative to the criterion and assigned a rank from 1 to 5 or 1 to 10, sites with the most favorable characteristics are given a value of 5 or 10 The weights are multiplied by the ranking for each criterion, then summed for a total site weighted ranking score Those sites having the highest overall total weighted ranking score are selected as candidate sites

3 3 Third Level Screening - Evaluation of Candidate Sites to Preferred and Alternate Sites

Within this phase of a siting study, a preferred site and an alternate candidate site are selected Because the site selection is done on a preliminary basis we suggest selecting an alternate site This provides an allowance if future detailed environmental studies indicate a difficulty in permitting or potentially expensive engineering designs become necessary for development at the preferred site

This third level screening includes further evaluations and refinement of the engineering and environmental characteristics of the candidate sites Once this is accomplished, a preliminary conceptual design unique to that candidate site is prepared The conceptual design includes development of a preliminary site arrangement and defines the following key plant design features

- Existing site facilities
- Steam generation system
- Water supply and treatment system
- Wastewater discharge
- Fuel delivery systems
- Air quality control systems
- Heat rejection systems
- Waste handling systems
- Transmission system

The design concepts are prepared considering project specific requirements, environmental design criteria, site criteria, overall plant availability and reliability objectives, and economics Preliminary site arrangement drawings are prepared to show the size and location of key plant facilities and structures, show spatial relationships of the facilities, and indicate roads, transmission lines, pipelines, and conveyors which link offsite systems A linear facility map is often prepared to show the proposed connection routes to the offsite systems

Differential capital and operating costs for the site specific power plant are then estimated using the preliminary conceptual design definitions and site arrangement drawing Key factors that result in significant differences in the initial plant cost include linear facilities (such as rail, roads, pipelines, and electrical transmission), site preparation, and local field labor rates for plant construction The sites may also have differential annual operating costs that warrant review

Decision analysis techniques similar to the weighted ranking method previously described and which incorporate differential capital and operating cost factors can then be used to select a preferred and alternate site

3 4 Sensitivity Analyses

Sensitivity analyses, in which other possible weighting/ranking scenarios are considered, are used to identify the relative strengths and weaknesses of the selected sites Sensitivity analyses are usually performed to determine how siting factors or groups of siting factors affect the total score and ranking of the evaluated sites Sensitivity analyses are conducted by using different sets of factor weights to determined the effect of the overall scores of the sites being evaluated As an example, the total weight of all environmental factors may be doubled, with an associated decrease in engineering and cost related weights Black & Veatch has often found that the present "base case" in the United States and in several studies in Thailand include a 60% Engineering/Cost versus 40% Environmental with the following sensitivity analyses performed to assess the strengths (or weaknesses) of particular sites

	Engineering /Cost	Environmental
Base Case	60%	40%
Environmental Emphasis	40%	60%
Equal Emphasis	50%	50%
Cost Emphasis	70%	30%
(or	80%	20%)

Generally, a base case with two or three sensitivity cases will indicate a site or sites which are particularly sensitive to a group of criteria Typically, the sensitivity analyses are performed by evaluating the influence of a category of siting factors such as environmental considerations However, project specific concerns may dictate the analysis of the site evaluation's sensitivity to a particular factor or factors In these cases, the weight on each factor can be raised in combination or on successive analyses to evaluate the factor's influence on ranking positions

3 5 Site Selection Study Report

A site selection report, including details of the scoring process and tabulation of the scoring results is then developed The report describes the information collected on each site and the evaluations of the respective desirability of the sites that were evaluated during the siting study This study documents the systematic, local site selection procedures used which results in a preferred site and an alternate site for a particular project development This document is then available to support future project approval processes such as the alternatives section of an environmental impact statement

4 0 Conclusion

The objective of this presentation was to describe the site selection process as it is applied to power facility site selection The procedure used will vary bv project, but a general description of the typical procedures outline a framework for all types of power and other industrial facilities This procedure can also be slightly modified and applied to the associated linear facilities (e g, transmission line, pipeline, railroad, and road routes) which can sometimes be significant project considerations due to cost and potential impacts

Site selection has become increasingly important to Owners because of the potential scrutiny of financial lending institutions, governmental agencies, and the public The selection of a site which is acceptable to these entities as a whole is achievable by performing a thorough study which supports project goals while minimizing impacts to the environment

APPENDIX A

EXAMPLE OF FIGURES/PRESENTATIONS

TABLE 4-1 SIGNIFICANT PHYSICAL REQUIREMENTS AND PERFORMANCE INFORMATION FOR THE PROPOSED 400 MW SCCT PLANT [a]

FACTOR	VALUE
Land Requirements	25 acres
Fuel Requirements	
Natural Gas	107,500 scfm
No. 2 Fuel Oil	740 gpm
Raw Water Requirement	700 gpm (1.6 cfs)
Wastewater	166 gpm (0.4 cfs)
Exhaust Flow (lowest at 59 F)	6,900,000 acfm
Exhaust Temperature (lowest at 59 F)	955 F
Air Emissions[b]	
NO_x	1,015 lb/h
CO	650 lb/h
UHC[c]	240 lb/h
Particulate	325 lb/h
SO_2	1,915 lb/h

[a]All values represent "worst case" information for all combustion turbines considered during operation of the 400 MW facility at full load, unless otherwise noted.

[b]Based on use of No. 2 fuel oil with sulfur content of 0.3% by weight.

[c]Unburned hydrocarbons.

406

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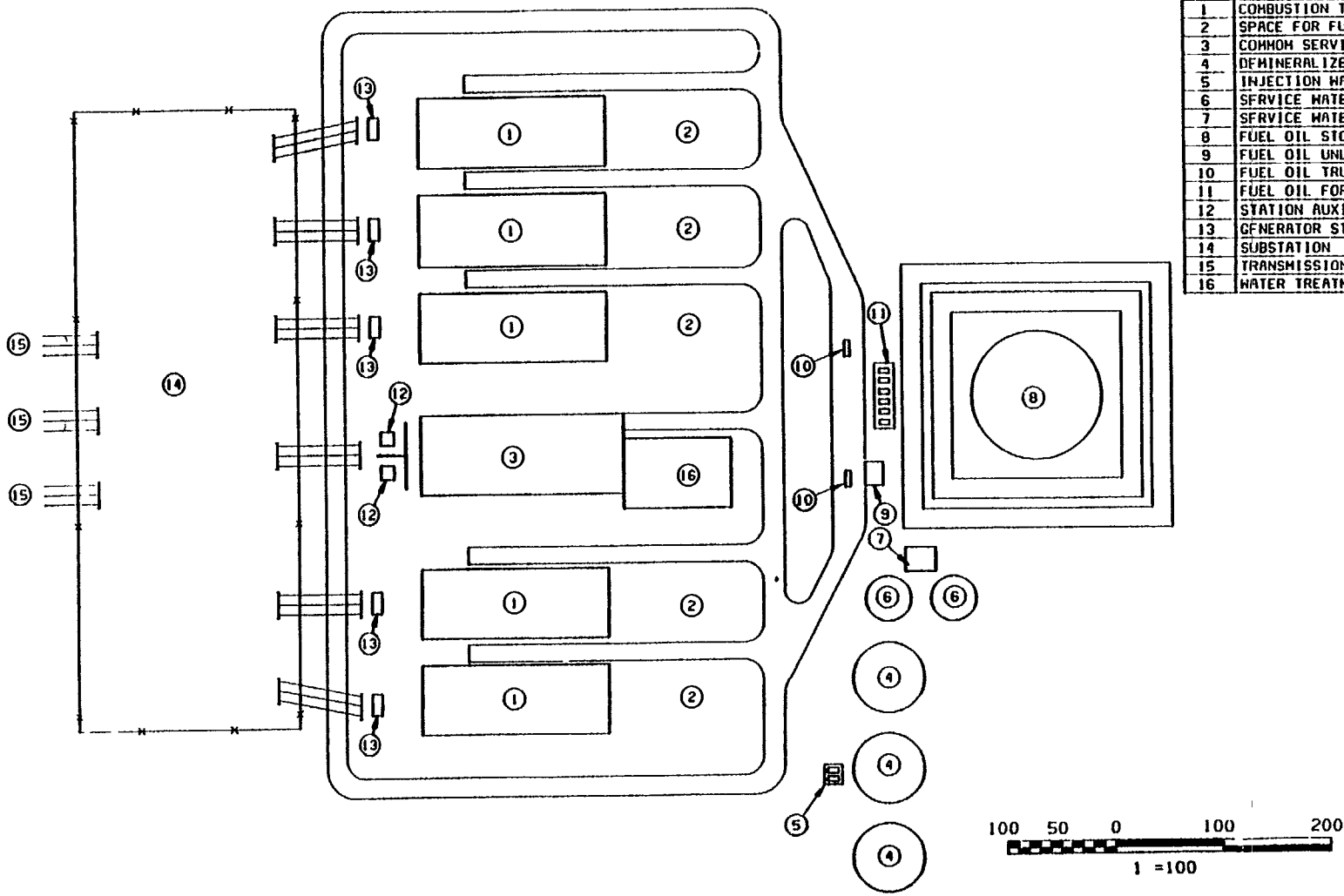


ITEM NO	EQUIPMENT IDENTIFICATION LIST
1	COMBUSTION TURBINE GENERATOR AND AUXILIARIES
2	SPACE FOR FUTURE COMBINED CYCLE EXPANSION
3	COMMON SERVICES BUILDING
4	DEMINERALIZED WATER STORAGE TANK
5	INJECTION WATER FORWARDING PUMPS
6	SERVICE WATER/FIREWATER STORAGE TANK
7	SERVICE WATER PUMP/FIREWATER PUMP HOUSE
8	FUEL OIL STORAGE TANK
9	FUEL OIL UNLOADING PUMPS
10	FUEL OIL TRUCK UNLOADING STATION
11	FUEL OIL FORWARDING PUMPS
12	STATION AUXILIARY TRANSFORMER
13	GENERATOR STEP-UP TRANSFORMER
14	SUBSTATION
15	TRANSMISSION LINES
16	WATER TREATMENT EQUIPMENT

BLACK & VEATCH

ENGINEER JMS | DRAWN BTC | DATE

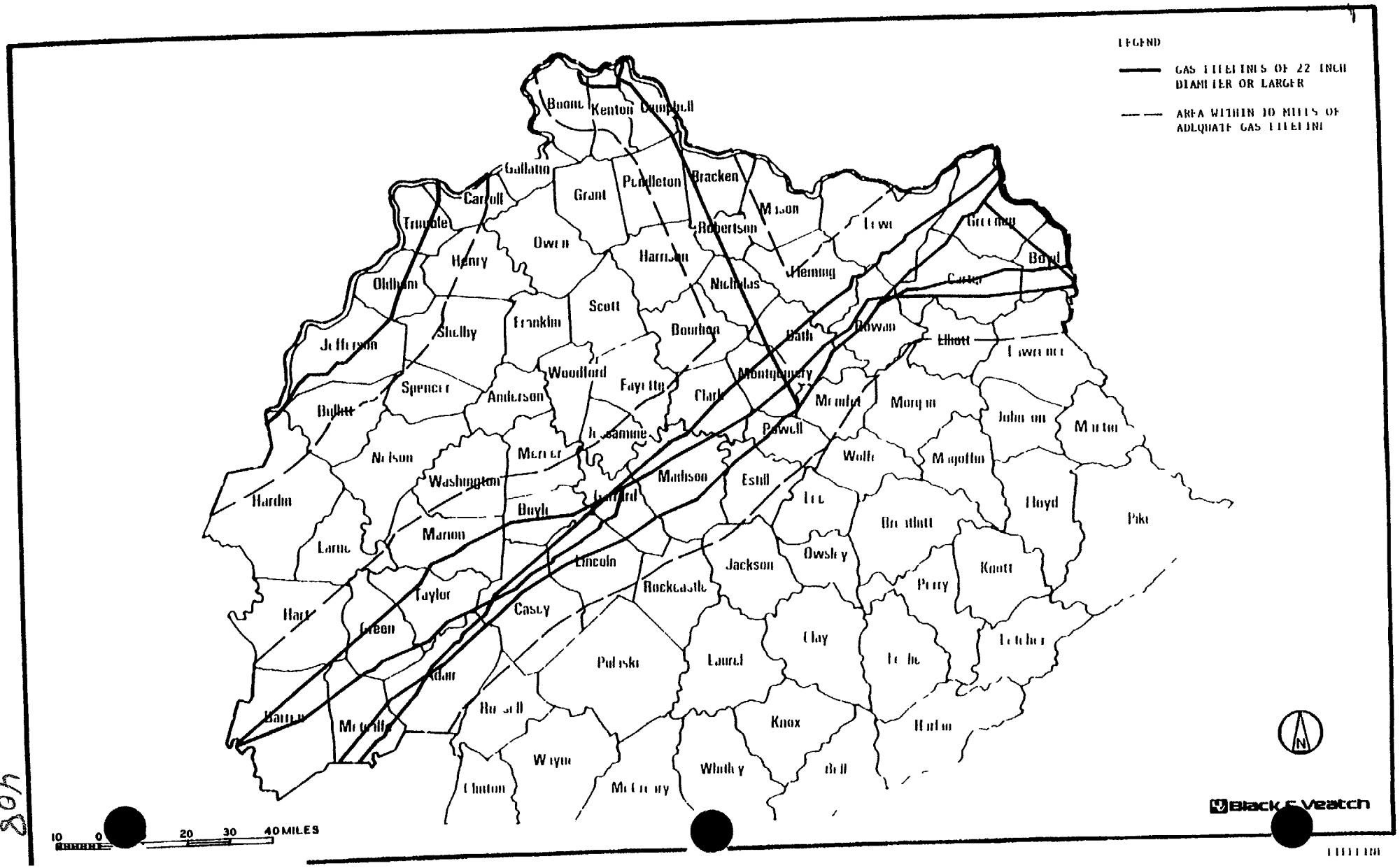
CONCEPTUAL SITE ARRANGEMENT

CODE | AREA

FIGURE 4-1

REV

23GUTHRIE ACAD 10 c7
SL003 B1 1=100
06/90 15 46 28


LEGEND
GAS PIPELINES OF 22 INCH DIAMETER OR LARGER
AREA WITHIN 10 MILES OF ADEQUATE GAS PIPELINE
Boone
Kenton
Campbell
Gallatin
Carroll
Trimble
Grant
Pendleton
Bracken
Mason
Owen
Henry
Oldham
Robertson
Harrison
Nicholas
Fleming
Lewis
Greenup
Boyd
Carter
Scott
Franklin
Shelby
Jefferson
Bourbon
Bath
Rowan
Elliott
Lawrence
Woodford
Fayette
Montgomery
Clark
Menifee
Morgan
Johnson
Martin
Spencer
Anderson
Bullitt
Nelson
Mercer
Jessamine
Powell
Wolfe
Magoffin
Washington
Madison
Estill
Hardin
Boyle
Garrard
Lee
Breathitt
Floyd
Pike
Larue
Marion
Lincoln
Owsley
Jackson
Knott
Perry
Taylor
Rockcastle
Hart
Casey
Green
Clay
Letcher
Pulaski
Laurel
Leslie
Adair
Barren
Russell
Knox
Harlan
Metcalfe
Wayne
Whitley
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Clinton
McCreary
10 0 20 30 40 MILES
Black & Veatch

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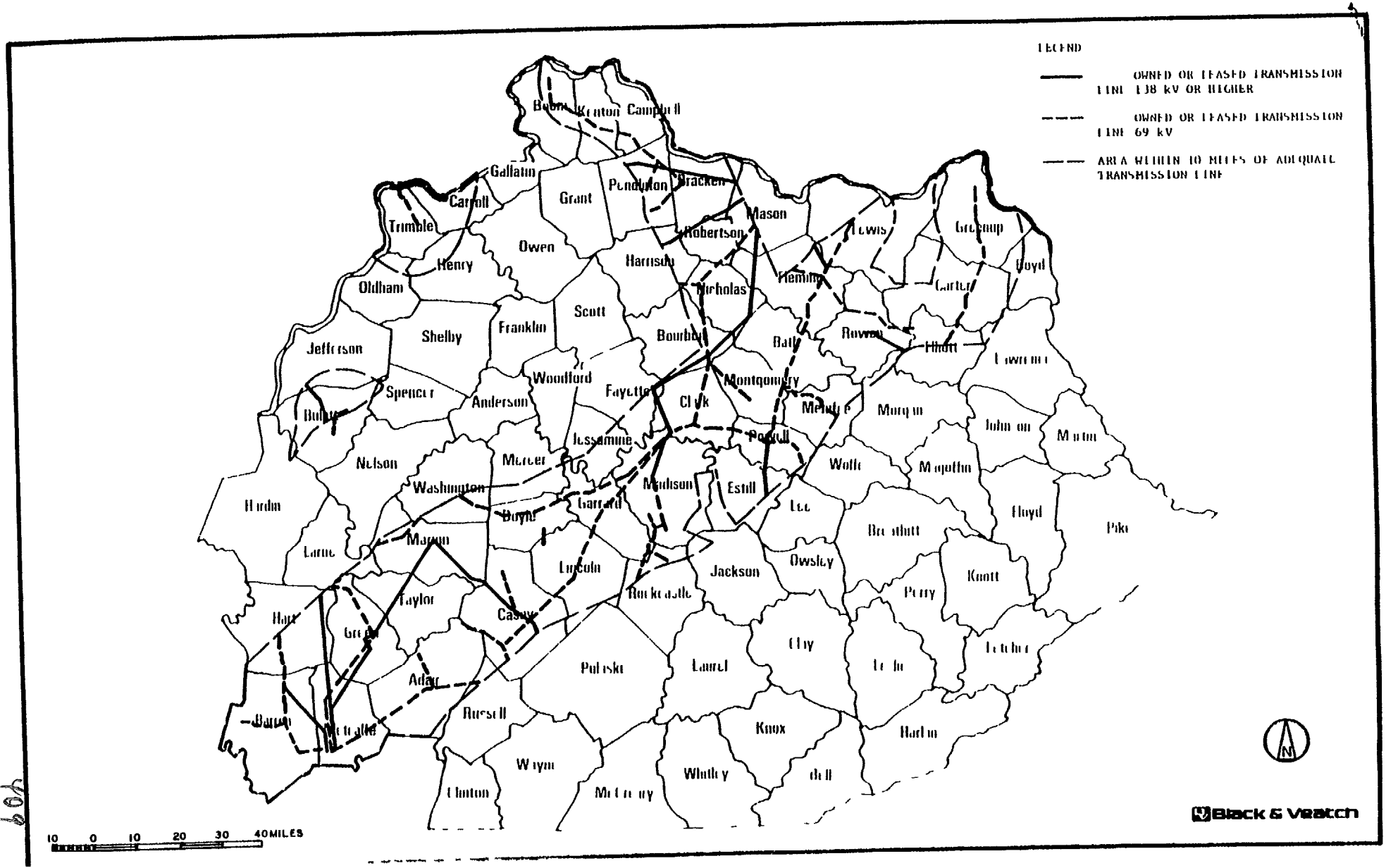
LEGEND
OWNED OR LEASED TRANSMISSION LINE 138 kV OR HIGHER
OWNED OR LEASED TRANSMISSION LINE 69 kV
AREA WITHIN 10 MILES OF ADEQUATE TRANSMISSION LINE
Boone
Kenton
Campbell
Gallatin
Carroll
Trimble
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Bracken
Mason
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Henry
Harrison
Nicholas
Fleming
Lewis
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Spencer
Woodford
Fayette
Montgomery
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Hardin
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Casey
Rockcastle
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Leslie
Letcher
Green
Adair
Pulaski
Laurel
Russell
Knox
Harlan
Barren
Metcalfe
Wayne
Whitley
Bell
Clinton
McCreary
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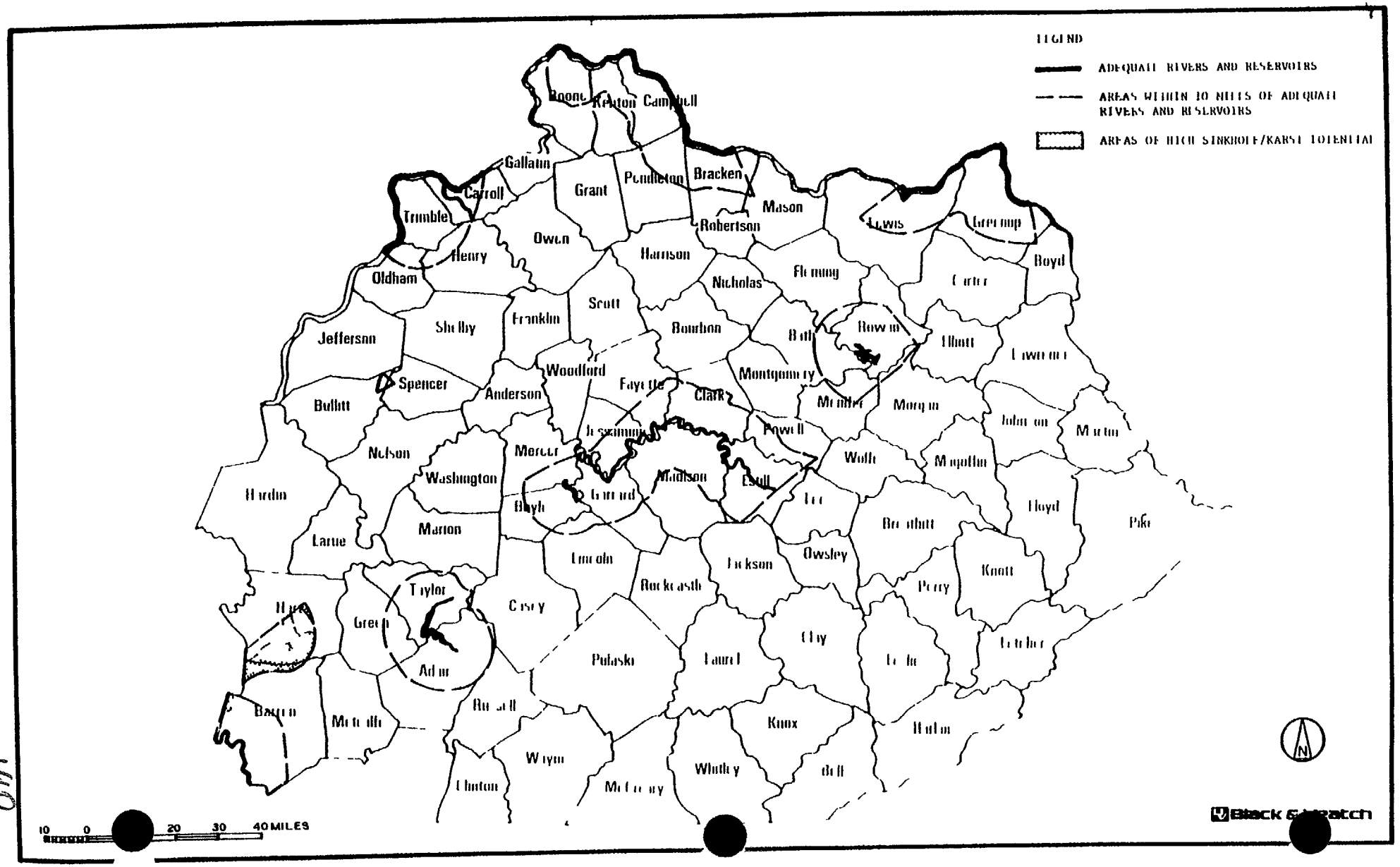
N
Black & Veatch


LEGEND
ADEQUATE RIVERS AND RESERVOIRS
AREAS WITHIN 10 MILES OF ADEQUATE RIVERS AND RESERVOIRS
AREAS OF HIGH SINKHOLE/KARST POTENTIAL
Boone
Kenton
Campbell
Gallatin
Carroll
Trimble
Grant
Pendleton
Bracken
Mason
Robertson
Lewis
Greenup
Boyd
Owen
Henry
Oldham
Harrison
Nicholas
Fleming
Carter
Scott
Franklin
Shelby
Jefferson
Bourbon
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KARST HAZARD ASSESSMENT OF KENTUCKY
SINKHOLE FLOODING AND SINKHOLE COLLAPSE

by

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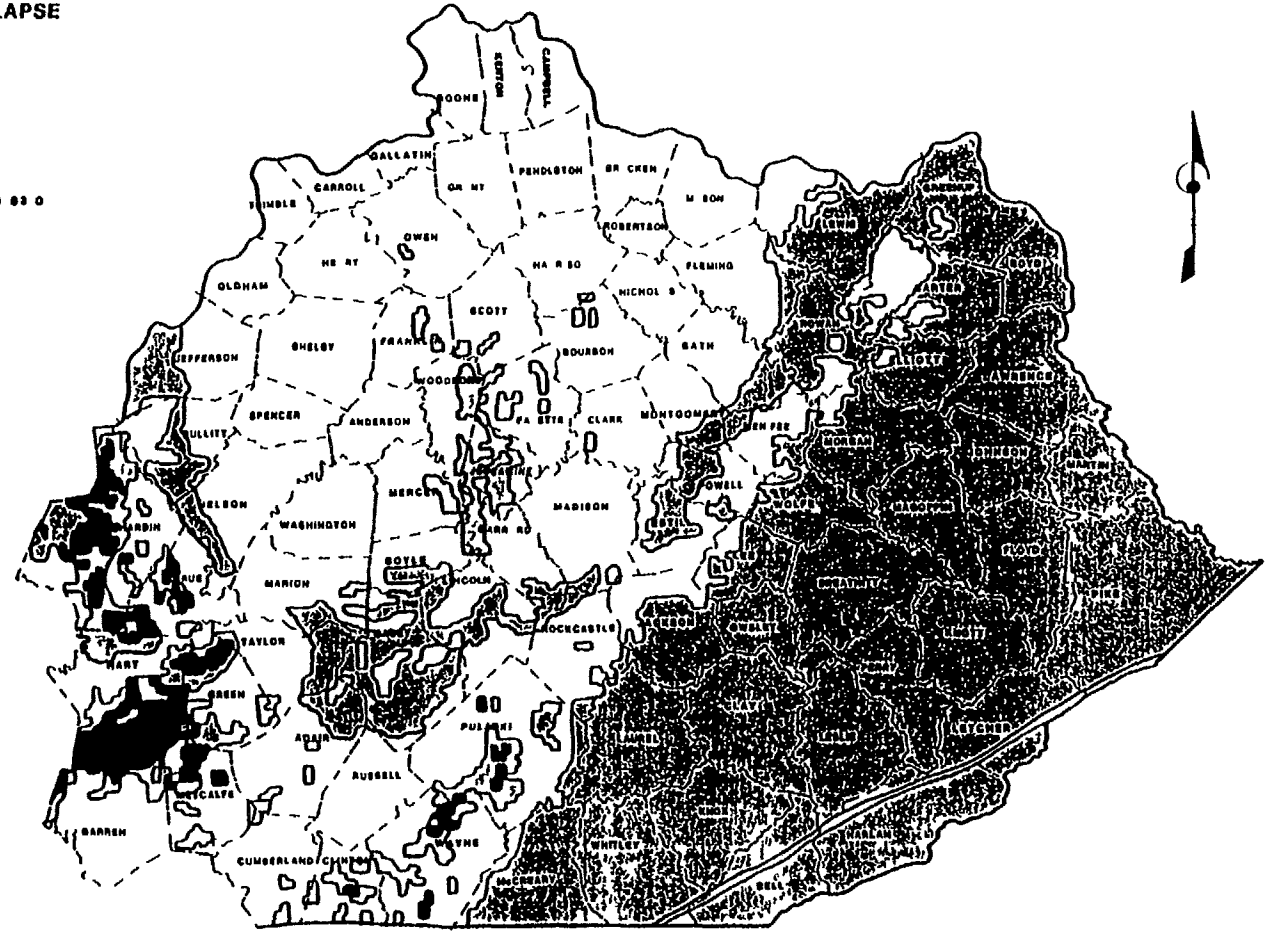
Prepared for

United States Environmental Protection Agency Region IV
345 Courtland Street Atlanta Georgia
Underground Water Source Protection Program Grant No. G004388 83 0

1986



KARST HAZARD ASSESSMENT OF KENTUCKY
SINKHOLE FLOODING AND SINKHOLE COLLAPSE

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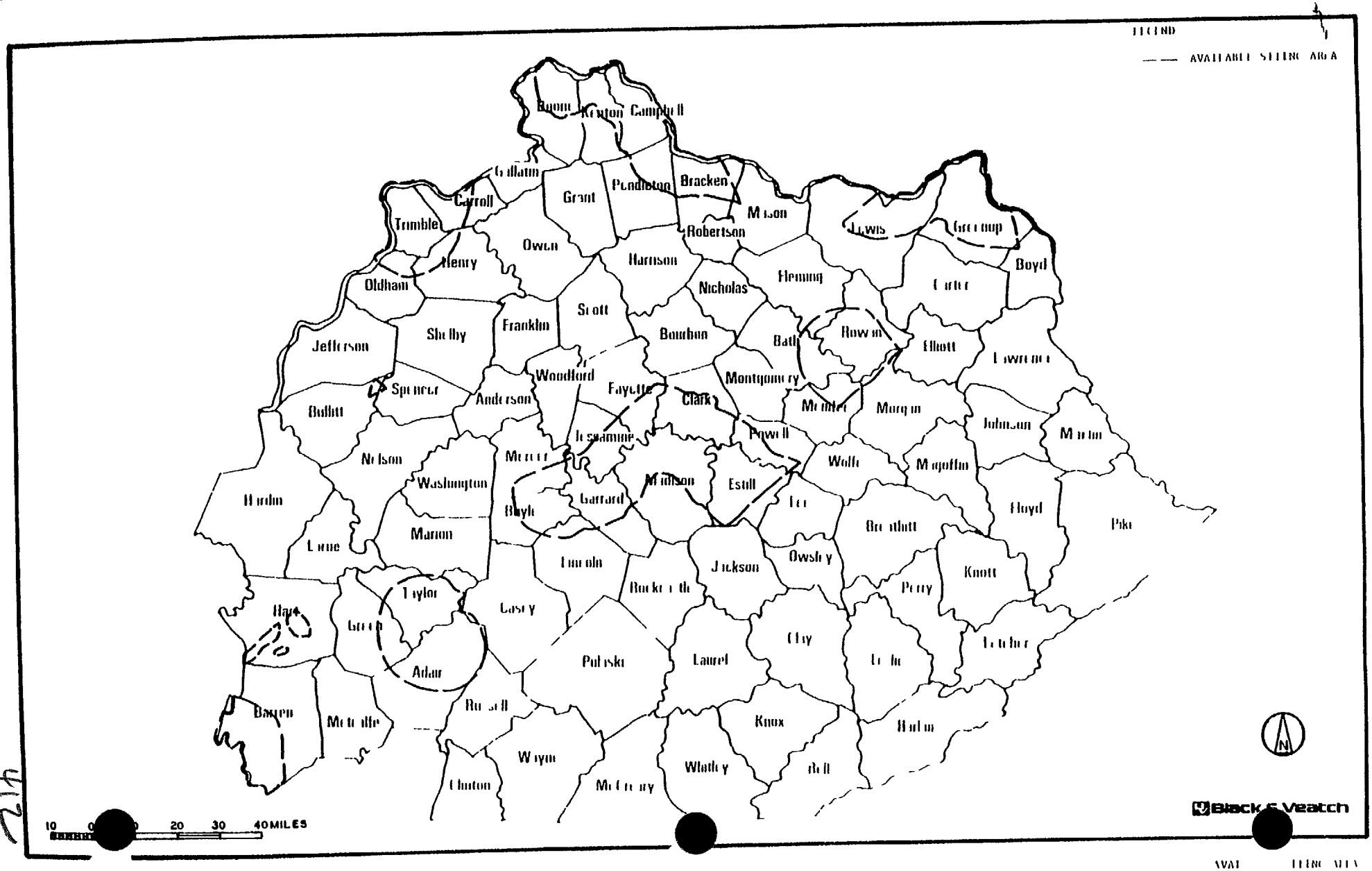

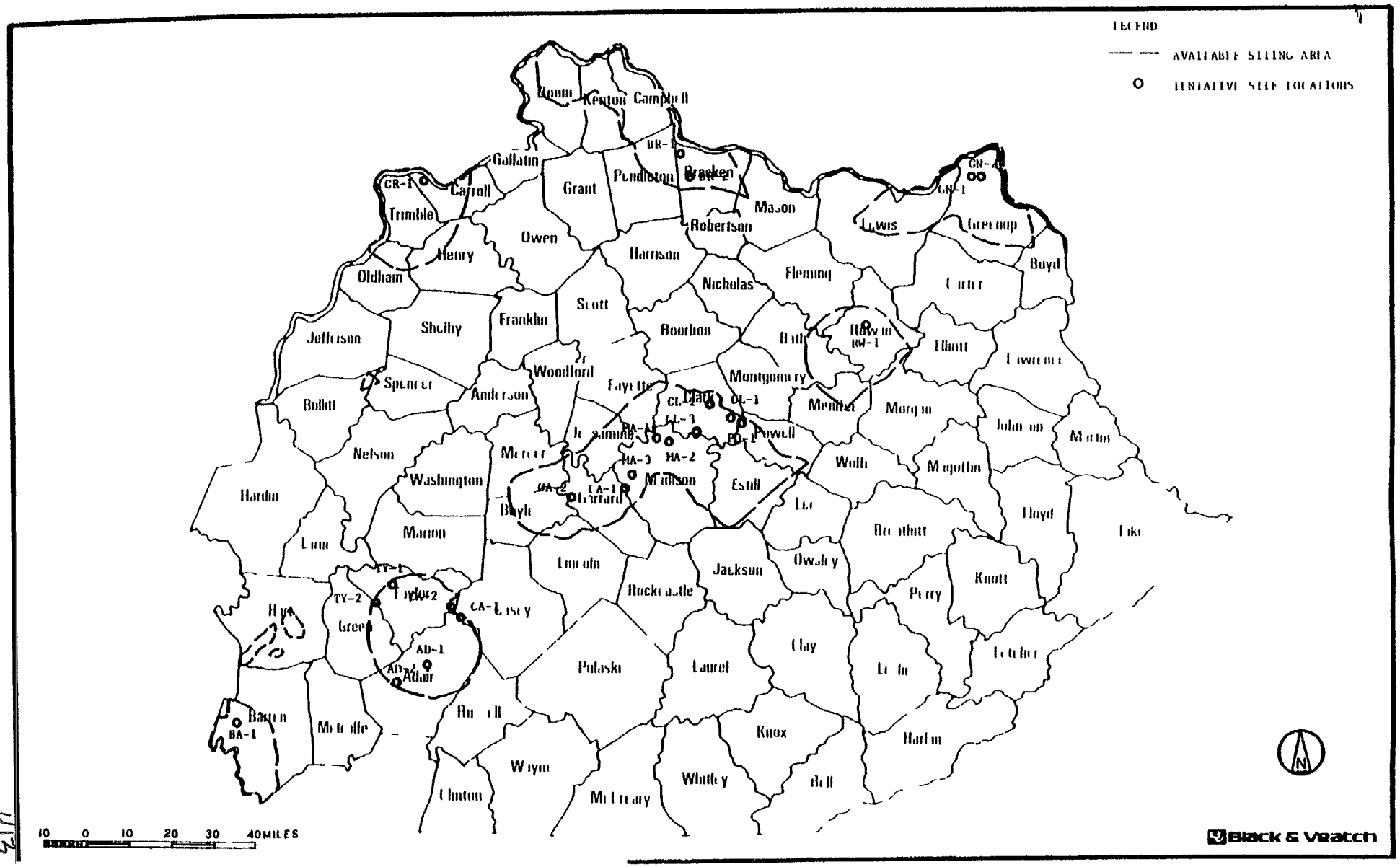
LEGEND
AVAILABLE SITING AREA
TENTATIVE SITE LOCATIONS
Boone
Kenton
Campbell
Gallatin
Carroll
Trimble
Grant
Pendleton
Bracken
Mason
Robertson
Owen
Henry
Oldham
Harrison
Nicholas
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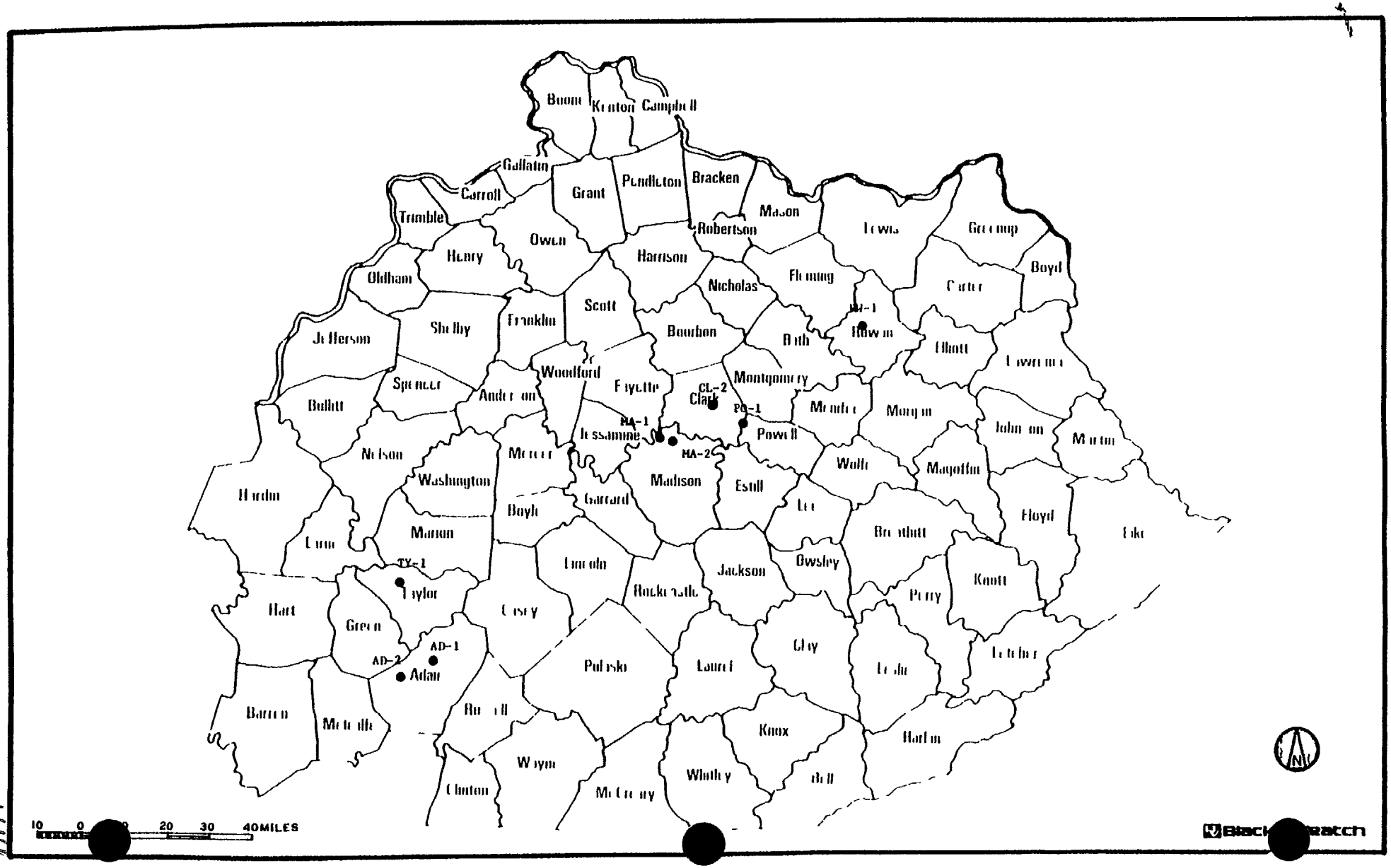
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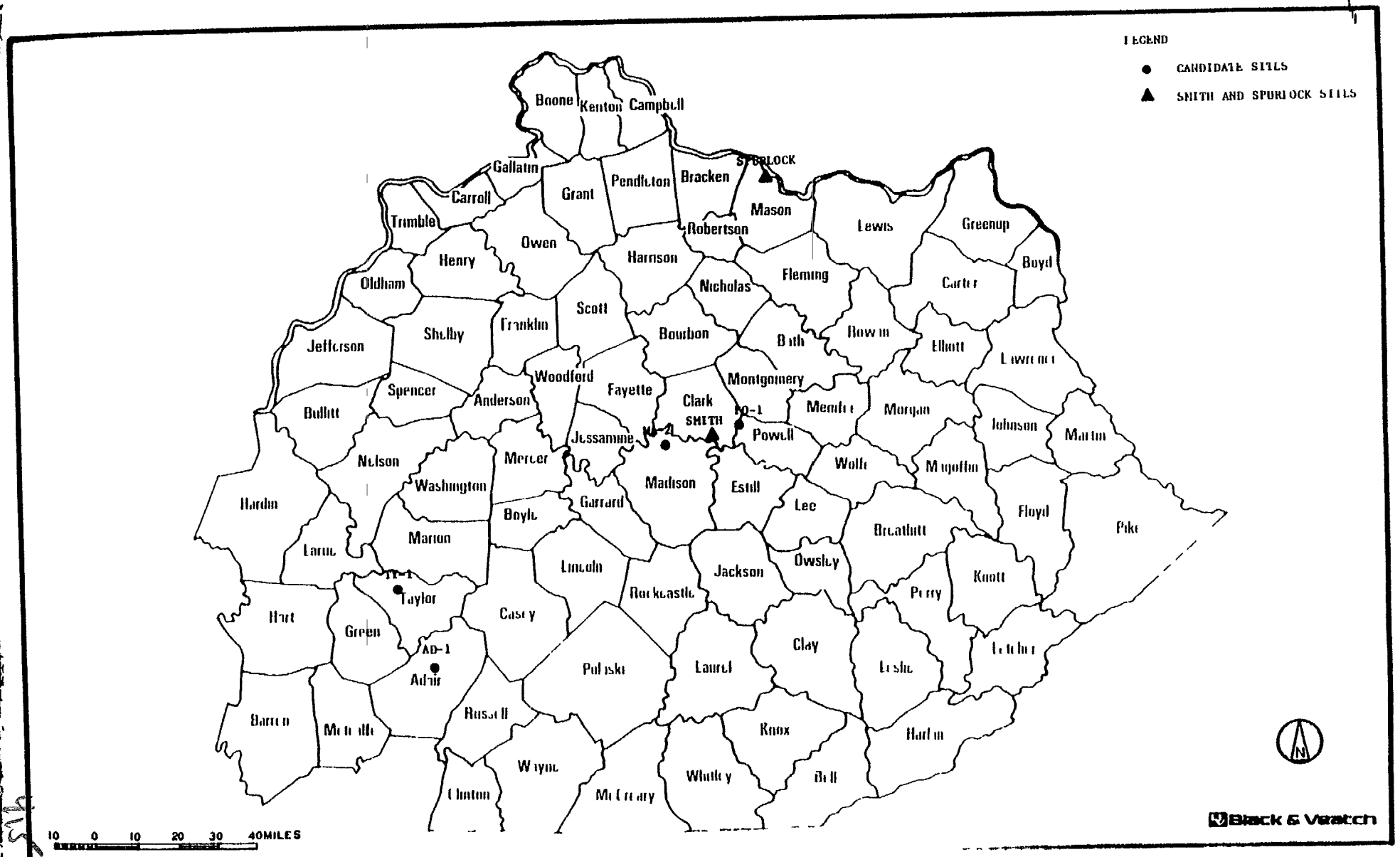
LEGEND
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7.1.1 Site TY-1

This site is located in north central Taylor County about 5 miles northwest of Campbellsville, Kentucky and less than 1 mile northeast of the unincorporated community of Saloma. State Route 744 is adjacent to the south boundary of the site. Site access is from US Highway 68 and Campbellsville via SR 744 to SR 527 or, alternatively, via SR 744 to SR 289. The transmission line from Marion County to Green County is along the site's east boundary. Water supply would probably come from the Green River Lake via pipeline. Alternative water supplies may be available from local rural water districts. The site is located at Tennessee Gas Pipeline Company's (TGP) compressor station No. 96. Five separate pipelines converge through the station (30/30/30/26/24-inch). This could allow the SCCT plant supply pipeline to tap into the high-pressure manifold feeding all five TGP pipelines. The site is generally agricultural land with several farmsteads fronting SR 744. The site profile for Site TY-1 is given in Table 7-1. A map showing the site; the conceptual plant "footprint"; and access routes for roads, water, gas, and transmission is included as Figure 7-2. A map showing the additional transmission facilities required by voltage, and the site's proximity to load centers is included in Figure 7-3.

416

TABLE 7-1. SITE PROFILE SITE TY-1

LOCATION	East of Tennessee Gas Transmission Company's Compressor Station No. 96 at Saloma (Taylor County), KY. USGS Saloma Quadrangle.
TRANSPORTATION ACCESS	Kentucky SR-744 adjacent to south boundary of the site. Local improved road (Sanders-Feather Road) adjacent to east side of site. US-68 approximately 5.8 miles SW at Campbellsville, KY with routing between site and US-68 via SR-527 or, alternatively, via SR-289 at about 7.5 miles.
NATURAL GAS PIPELINES	Tennessee Gas Pipeline Company (TGP) corridor (one 24 and one 26-inch pipelines together with three 30-inch pipelines) adjacent to the site on the NW. Site is adjacent to TGP Compressor Station No. 96 which would allow plant supply pipeline to tap into the high-pressure (downstream) manifold feeding all five TGP pipelines.
WATER SOURCE	Green River Lake (via pipeline) approximately 11 miles SE from site following existing TGP pipeline corridor.
TRANSMISSION	on the east edge of the site. Other transmission facilities in the region include the corridor (leased from TVA) located about 19 miles west of the site. The site would be tied to this TVA line through the substation a total distance of approximately 28 miles. These transmission lines will be adequate for the entire project capacity of 400 MW.
ENVIRONMENTALLY SENSITIVE AREAS	Upland pasture and cropland devoid of wetlands. The nearest sensitive area, Boones Cave, is in the Saloma area. No apparent constraints to development. The closest Kentucky Wild River is a 26 mile segment of the Green River in Mammoth Cave National Park. This river segment is about 35 miles from the site.
LAND USE	Site is agricultural land with farmsteads fronting SR-744. Land use in vicinity is also agricultural (livestock raising and small to medium-scale farms) with limited recreational development. One or two residences may require relocation. No residential subdivision development in the area.

TABLE 7-1 (Continued). SITE PROFILE SITE TY-1

AREA	106 Acres
GEOTECHNICAL	Seismic Zone 1. Low risk of Karst hazard (less than 1 percent sinkholes). No runoff from offsite drainage areas will enter the site, and, due to the upland location, inundation from a 500-year storm is very unlikely.
POPULATION	Site region is rural in character with numerous farmsteads and residences fronting improved roads. Nearest major communities and labor pools are Campbellsville (1990 population 9,577) 5 miles SE, Greensburg (1990) 11 miles SW and Lebanon (5,695) 13 miles NE of the site. Several small unincorporated communities are located within a 10-mile radius from the site.
AIR QUALITY	Site is about 35 miles from Mammoth Cave National Park, the closest Class I area. The nonattainment area closest to the site is about 47 miles away (the Jefferson County ozone nonattainment area).

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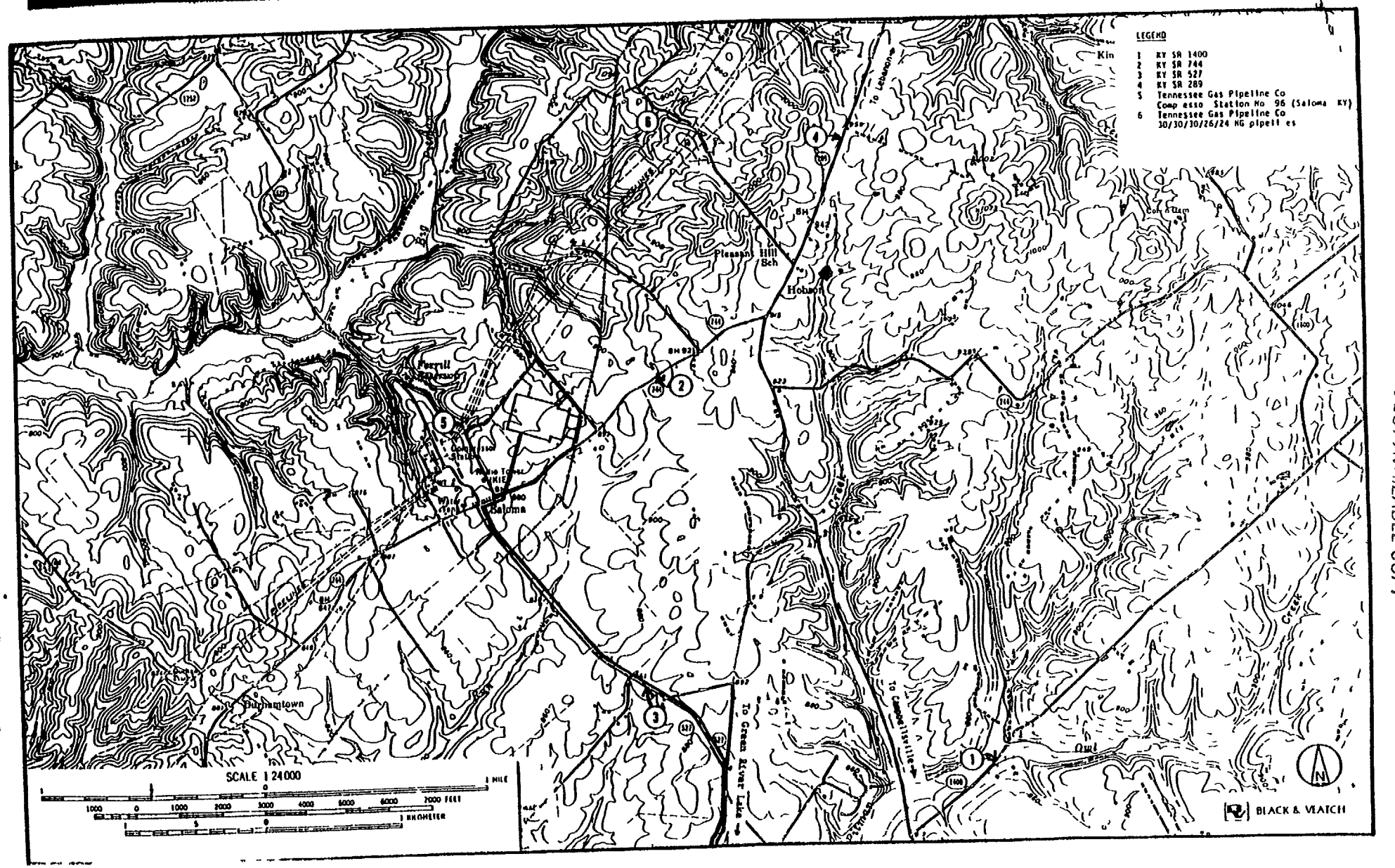

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APPENDIX B

EXAMPLE SCORING SYSTEM

APPENDIX D
STAGE 3 SCORING

This appendix shows preliminary scores assigned to the various evaluation criteria based on best professional judgement as to the relative desirability of the criteria.

SOCIOECONOMICS

Labor Supply

Definition: Proximity of the labor force required to construct the facility. Defined as a town or city of at least 10,000 population or multiple towns summing to at least 10,000.

Score	Criteria
10	Labor force within 20 miles (32.2 km) of the site
7	Labor force within 70 miles (112.6 km) of the site.
4	Labor force within 150 miles (241.4 km) of the site.
0	Labor force over 150 miles (241.4 km) from the site.

Public Services

Definition: Utilities, schools, police and fire protection, housing, health facilities, and other public services in the vicinity of the site that potentially would be impacted by the project.

Score	Criteria
10	Public services 100 percent adequate.
5	Public services 50 to 100 percent adequate.
0	Public services less than 50 percent adequate or less.

Fiscal Conditions

Definition: Government revenues.

421

SOCIOECONOMICS
(Continued)

Score	Criteria
10	Tax revenues will be adequate to pay for 100 percent of increased demand for public services.
5	Tax revenues will be adequate to pay for 50 to 100 percent of increased demand for public services.
0	Tax revenues will be adequate to pay for less than 50 percent of increased demand for public services.

Impact of Project Traffic

Definition: The impact of increased traffic related to the project on existing roads and traffic patterns.

Score	Criteria
10	Less than 5 percent increase in total traffic.
7	Less than 30 percent increase in total traffic.
4	Less than 60 percent increase in total traffic.
0	More than 60 percent increase in total traffic.

Noise Impacts

Definition: The impacts of increased noise levels resulting from the operation of the proposed plant on nearby residences, facilities (including buildings), and population centers.

Score	Criteria
10	No residences or facilities within 2 miles (3.2 km) of the site.
8	No residences or facilities within 0.5 mile (0.8 km) of the site.
6	No residences or facilities within 0.125 mile (0.2 km) of the site.
4	Facilities or one to five residences less than 0 125 mile (0.2 km) from site.

SOCIOECONOMICS
(Continued)

Score	Criteria
1	More than five residences less than 0.125 mile (0.2 km) from the site.
0	More than five residences and one or more facilities less than 0.125 mile (0.2 km) from the site.

Impact on Sensitive Areas

Definition: Parks, state or federal forests, monuments, and recreational areas are considered as sensitive areas.

Scoring: Sites will be scored by assessing the potential impact of the site on sensitive areas in the professional judgement of the evaluator. Sites with no impact or minimum impact will be assigned the score of 10.

LAND USE

Proximity to Residential Development

Definition: Residential development as shown on aerial photography or maps.

Score	Criteria
10	Residential development not affected by site
5	Scattered residential development 1 to 2 miles (1.6 to 3.2 km) from site.
0	Residential development within 1 mile (1.6 km) of site.

Impact on Forested Areas

Definition: Privately owned forests.

Scoring: Sites will be scored according to the impact of the site on forested areas, generally based on the number of acres on the site. Sites with minimum impact will be assigned the score of 10.

Impact on Agricultural Areas

Definition: Areas used for crop or livestock production.

LAND USE
(Continued)

Scoring: Sites will be scored according to the impact of the site on agricultural areas in the professional judgement of the siting specialists. Sites with the highest rating (least impact) will be assigned the score of 10, with other sites assigned relative scores.

Displacement of Residences

Definition: Residences that will be displaced because of the proposed plant.

Score	Criteria
10	No residences will be displaced.
5	One to five residences will be displaced.
0	Over five residences will be displaced.

Important Farmland or Timberland

Definition: Important farmland is land classified by the US Soil Conservation Service as prime farmland. Important timberland is timberland of high commercial value.

Scoring: Sites will be scored by assessing the potential impact of the site on important farmland or timberland in the professional judgement of the siting specialist. Sites with minimum impact will be assigned the score of 10 with other sites assigned relative scores.

ECOLOGY

Terrestrial--Endangered or Threatened Animal Species and Special Habitat Features

Definition: Animal species that are state- or federal-listed as endangered or threatened. Cover types or special habitat features used by nonlisted species of concern.

Score	Criteria
0 to 10	Sites will be scored based on the professional judgement of the site evaluator using criteria such as the diversity and quality of wildlife cover types within 1 mile (1.6 km) of

424

ECOLOGY
(Continued)

Score	Criteria
	the site, and the potential number of listed species likely to use onsite and nearby cover types. Examples of special habitat feature evaluation criteria include dead standing timber, cliffs, nonjurisdictional wetlands, extensiveness of forested cover type, and cover type diversity.

Terrestrial--Habitat Quality

Definition: The value of habitat for the maintenance of wildlife.

Score	Criteria
10	Site is a rural area that has little, if any, vegetation.
8	Site is open field (pasture) with occasional stands of bushes or trees in fence rows or along creeks.
4	Site has prairie-type community (not grazed)
2	Site has forested areas as well as open field areas; understory of bushes, grasses, and forbes; good plant species diversity.

Terrestrial--Endangered or Threatened Plant Species and Unique or High Quality Plant Communities

Definition: Plant species that are state- or federal-listed as endangered or threatened. Community types or special habitats used by nonlisted species of concern.

Score	Criteria
0 to 10	Sites will be scored based on the professional judgement of the site evaluator using criteria such as the diversity and quality of plant communities within 1 mile (1.6 km) of the site, and the potential number of listed species likely to use onsite and nearby communities. Examples of unique or high quality plant community criteria include community uniqueness relative to the area (for example, limestone glades), native species, successional state, disturbance, and diversity.

ECOLOGY
(Continued)

Aquatic--Endangered or Threatened Aquatic Species and Special Habitat Features

Definition: Aquatic species that are state- or federal-listed as endangered or threatened. Aquatic habitats or special habitat features used by nonlisted species of concern.

Score	Criteria
0 to 10	Sites will be scored based on the professional judgement of the site evaluator using criteria such as the diversity and quality of aquatic habitats within 1 mile (1.6 km) upstream, and 10 miles (16.1 km) downstream, of the site, and the potential number of listed species likely to use onsite and nearby waters. Examples of special habitat criteria include high quality headwater streams, streams with high pool-riffle ratios, or acid mine drainage remediation waters.

Aquatic--Effect on Water Quality

Definition: The effects of the discharge or effluents of water quality.

Score	Criteria
10	Discharge to a major river.
7	Discharge to a secondary river.
5	Discharge to a stream.

Wetlands-Permitting

Definition: For dredge and fill permitting purposes, wetlands are defined by regulatory agencies as those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Vegetated wetlands include swamps, marshes, bogs, and similar areas. "Special aquatic sites," as defined by regulatory agency guidelines, also are subject to dredge and fill permitting and include sanctuaries and refuges, mud flats, vegetated shallows, and riffle and pool complexes.

ECOLOGY
(Continued)

Score	Criteria
10	No wetlands or special aquatic sites within 1 mile (1.6 km) of site.
9	No wetlands or special aquatic sites onsite but wetlands or special aquatic sites within 1 mile (1.6 km) of site.
6	Wetlands or special aquatic sites on the periphery of the site (that is, facility can be arranged so as to avoid them).
3	Small amounts of wetlands or special aquatic sites on central portions of the site (that is, facility cannot be arranged to avoid them but filling may be permitted under a nationwide permit).
0	Large amounts of wetlands or special aquatic sites on central portions of site (that is, facility cannot be arranged so as to avoid them).

VISUAL IMPACTS

Visibility from Wilderness, Scenic, Recreational, or Cultural Areas

Definition: The visibility of the proposed plant site from any wilderness, scenic, recreational, or cultural area.

Score	Criteria
10	Site not visible from any wilderness, scenic, historic, cultural, or recreational area.
7	Site partially visible from a wilderness, scenic, historic, cultural, or recreational area.
4	The majority of the site visible in the foreground from a wilderness, scenic, historic, cultural, or recreational area.
0	The site clearly visible from a nearby wilderness area.

Visibility from Urban Areas

Definition: The visibility of a site from urban areas (10,000 population or more) or towns (less than 10,000 population)

427

VISUAL IMPACTS
(Continued)

Score	Criteria
10	Site not visible from any urban areas or towns
5	Site visible from a town.
3	Site visible from an urban area.
0	Site visible from two or more urban areas and one or more towns.

Visibility from Highways or Roads

Definition: The visibility of the site from highways and roads in the area.

Score	Criteria
10	Site not visible from any highway or road.
7	Site visible in middle ground from a secondary road.
5	Site visible in the middle ground from a major highway, or in the foreground from a secondary road.
2	Site clearly visible from a major highway.
0	Site clearly visible from several major highways and secondary roads.

CULTURAL RESOURCES

Archaeological or Historic Resources

Definition: Historic sites listed in the Register of Historic Places or by the State of Kentucky as well as resources that are eligible for listing, but have not been included to date. Archaeologically significant areas identified and listed by the Kentucky State Historic Preservation Officer

Scoring: Sites will be scored according to the potential impact of the site on archaeological significant areas or on historic sites, in the professional judgement of the siting specialist. Sites with minimum impact will be assigned the score of 10, with the other sites given relative scores.

AIR QUALITY

Proximity to PSD Class I Area

Definition: An EPA PSD Class I region.

Score	Criteria
10	More than 50 miles (80.5 km) from site
9	Between 35 and 50 miles (56.4 to 80.5 km) from site.
7	Between 20 and 35 miles (32.2 to 56.4 km) from site.
5	Between 10 and 20 miles (16.1 to 32.2 km) from site.
3	Between 5 and 10 miles (8.1 to 16.1 km) from site.
1	Between 3 and 5 miles (4.8 to 8.1 km) from site.
0	Less than 3 miles (4.8 km) from site.

Proximity to SO_2 Nonattainment Area

Definition: Area designated as nonattainment for sulfur dioxide (SO_2) by the EPA.

Score	Criteria
10	More than 50 miles (80.5 km) from site.
9	Between 35 and 50 miles (56.4 to 80.5 km) from site.
7	Between 20 and 35 miles (32.2 to 56.4 km) from site.
5	Between 10 and 20 miles (16.1 to 32.2 km) from site.
3	Between 5 and 10 miles (8 1 to 16.1 km) from site.
1	Between 3 and 5 miles (4.8 to 8.1 km) from site.
0	Less than 3 miles (4.8 km) from site.

Proximity to O_3 Nonattainment Area

Definition: Airea designated as nonattainment for ozone (O_3) by the EPA.

Score	Criteria
10	Site is outside of all designated or proposed O_3 nonattainment.
5	Site is outside of designated O_3 nonattainment areas, but within a proposed O_3 nonattainment area.
0	Site is within designated O_3 nonttainment area.

AIR QUALITY
(Continued)

Proximity to Elevated Terrain

Definition: Air quality screening-level impacts will be predicted for major terrain features surrounding the proposed site. The rating factor definitions are based on the worst-case predicted terrain impacts in comparison with the applicable PSD increment.

Score	Criteria
10	Less than 25 percent of applicable PSD increment.
7	Between 25 and 50 percent.
4	Between 50 and 75 percent.
1	Between 75 and 100 percent.

ENVIRONMENTAL--TRANSMISSION LINE

Routing of Lines Between Candidate Site and Existing Transmission

Each site will be scored for the following topics according to the scoring system indicated below. The sum of these scores will be used for the overall score for the ENVIRONMENTAL--TRANSMISSION LINE category. The highest overall score will be assigned a value of 10. All other sites' values will be assigned based on the percentage its overall score is to the highest overall score of a site.

Transmission Line Length
Prime Farmland or Timberland
Wetlands
River Crossings
Archeological and Historic Sites
Visual Impacts
100-Year Flood Plain

Transmission Line Length

Definition: The number of miles of new transmission line required for the project.

430

ENVIRONMENTAL--TRANSMISSION LINE
(Continued)

Score	Criteria
10	Less than 1 mile (1.6 km).
8	1 to 3 miles (1.6 to 4.8 km).
6	3 to 8 miles (4.8 to 12.9 km)
4	8 to 13 miles (12.9 to 20.9 km).
2	13 to 20 miles (20.9 to 32.2 km).
0	Over 20 miles (32.2 km).

Prime Farmland or Timberland

Definition: Prime farmland is land classified as such by the US Soil Conservation Service. Timberlands are forest areas with valuable timber stands.

Scoring: Sites will be scored according to the impact of the transmission line on prime farmland or timberland in the professional judgement of the siting specialist. Sites with the least impact will be assigned the score of 10 with other sites assigned relative scores.

Wetlands

Definition: Same as for Ecology section.

Scoring: Sites will be scored based on the impact of the transmission line on wetlands along its length. Sites with the least impact will be scored 10 with relative scores given to the other sites.

River Crossings

Definition: The number of rivers crossed by the transmission line corridor.

Scoring: Sites will be scored according to the number of rivers crossed by the transmission line connecting the site to the EKPC transmission line system. Sites that result in the smallest number of crossings will be scored 10 with relative scores given to other sites.

Archaeological and Historic Sites

Definition: Archaeological and historic sites that are crossed by the transmission line corridor

431

ENVIRONMENTAL--TRANSMISSION LINE
(Continued)

Scoring: Sites will be scored according to the impact of the transmission line on archaeological and historic sites, in the professional judgement of the siting specialist. Sites with the least impact will be assigned the score of 10 with relative scores given to other sites.

Visual Impacts

Definition: That portion of the transmission line corridor that will be visible from any wilderness, scenic, or recreational area; historic or cultural site; highway or road.

Score	Criteria
10	No portion of the transmission line visible from any of the defined areas.
7	The transmission line corridor visible in the distance or partially visible in the foreground.
3	The transmission line corridor is clearly visible and in the near vicinity of one of the defined areas.
0	The transmission line corridor transverses one or more of the defined areas.

100-Year Flood Plain

Definition: The elevation that a river has a 1 percent chance of reaching per year.

Score	Criteria
10	All of the transmission line corridor is above the 100-year flood plain.
5	65 percent or more of the transmission line corridor is above the 100-year flood plain.
0	Less than 65 percent of the transmission line corridor above the 100-year flood plain

ENVIRONMENTAL--WATER PIPELINE

Routing of Pipeline Between Candidate Site and Water Source

Definition: General routing of any necessary water pipeline.

Score	Criteria
0 to 10	Sites will be scored on the professional judgement of the site evaluator using criteria such as pipeline length, ability to follow roads or existing corridors, river crossings, and general quality of disturbed areas.

POTENTIAL FOR FLOODING

Flood Protection

Definition: Protection against a flood with a recurrence frequency of 100 years.

Score	Criteria
10	Entire site is above the 100-year flood elevation.
5	Part of the site is below the 100-year flood elevation. Fill material required for raising site facilities is available from onsite borrow areas.
0	Site is below the 100-year flood elevation. Raising the site facilities will require importing fill material from offsite borrow areas.

TRANSMISSION SYSTEM

Ease of Connecting to Existing Transmission System

Definition: This will be principally based on proximity of site to the existing transmission line and to existing substations.

Scoring: Sites are ranked according to ease of connecting the power plant to the existing transmission system, in the judgement of the siting specialist. The highest ranked sites will be assigned the score of 10 with relative scores given to other sites.

TRANSPORTATION

Proximity to Class I Road

Definition: Proximity to a road and highway system capable of accommodating truck traffic generated by plant construction and operation without significant stress.

Score	Criteria
10	Class I road either onsite or adjacent to site.
9	Class I road within 1 mile (1.6 km) of site.
7	Class I road between 1 mile and 5 miles (1.6 and 8.1 km) of site.
4	Class I road between 5 and 10 miles (8.1 and 16.1 km) of site.
0	Class I road more than 10 miles (16.1 km) from site.

STAGE 3 SCORING METHOD FOR COST COMPARISONS

Some of the principal site comparisons during Stage 3 are on the basis of differential costs--such as capital costs to install facilities, fuel supply costs in terms of $/MBtu, or comparative cost of losses. The method used to score each cost-based comparison will be to assign the point value of 10 to the lowest costs, the value of zero to the highest cost site, and award intermediate point values on the basis of differential costs, as shown in the following example.

	Estimated Cost	Differential Cost	Percent of Maximum Differential	Points Assigned
Site 1	1,200	0	0	0.0
Site 2	300	900	82	8.2
Site 3	760	440	40	4.0
Site 4	100	1,100	100	10.0
Site 5	900	300	27	2 7

434

PLANT COSTS

Plant Area and Site Development

Definition: The estimated cost for a complete 400 MW simple cycle peaking plant at each candidate site. All site-specific differential costs will be included in the estimate, including costs for work performed both on the site and external to the site such as transmission costs, water supply costs, fuel supply costs, water supply costs, and the cost of providing road access to the site.

Scoring: According to the Stage 3 scoring method for cost comparisons.

FUELS REQUIREMENTS

Delivered Cost of Fuel Oil

Definition: The estimated cost of fuel oil delivered to the candidate site.

Scoring: According to the Stage 3 scoring method for cost comparisons.

Delivered Cost of Natural Gas

Definition: The estimated cost of natural gas delivered to the candidate site.

Scoring: According to the Stage 3 scoring method for cost comparisons.

Costs for Water Supply

Definition: The estimated cost of pipeline to supply candidate site's water needs.

Scoring: According to Stage 3 scoring methods for cost comparisons.

Comparative Cost of Losses

Definition: The estimated differential annual cost of losses associated with each candidate site.

Scoring: According to the Stage 3 scoring methods for cost comparisons

APPENDIX C

EXAMPLE OF DISTRIBUTION OF FACTOR WEIGHTS

EVALUATION CRITERIA	Weighting Factor %	EVALUATION SCORES OF FINAL CANDIDATE SITES BASE CASE					
		TY-1	AD-1	MA-2	PO-1	CL-4	MS-1
ENVIRONMENTAL							
1 0 SOCIOECONOMICS							
1 1 Labor Supply	1	7	7	10	10	10	10
1 2 Public Services	1	10	10	10	10	10	10
1 3 Fiscal Conditions (Tax Revenues)	1	10	0	10	0	10	10
1 4 Impact of Project Traffic	1	10	0	10	0	10	0
1 5 Noise Impacts	1	4	5	4	4	8	4
1 6 Impact on Sensitive Areas	1	10	0	10	10	10	9
Weighted Group Total	6	0 51	0 33	0 54	0 54	0 58	0 53
2 0 LAND USE (Station)							
2 1 Proximity to Residential Development	1	10	10	5	10	10	10
2 2 Impact on Forested Areas	1	9	0	9	9	9	7
2 3 Impact on Agricultural Areas	1	8	5	8	8	10	10
2 4 Displacement of Residences	1	5	5	5	5	10	10
2 5 Important Farmland or Timberland	1	5	8	7	6	10	10
Weighted Group Total	5	0 37	0 39	0 34	0 38	0 49	0 47

EVALUATION CRITERIA	Weighting Factor %	EVALUATION SCORES OF FINAL CANDIDATE SITES BASE CASE					
		TY-1	AD-1	MA-2	PO-1	CL-4	MS-1
3 0 ECOLOGY (Station)							
3 1 Terrestrial—Endangered or Threatened Animal Species and Special Habitat Features	2	8	9	8	8	10	7
3 2 Terrestrial—Habitat Quality	1	8	8	8	9	0	4
3 3 Terrestrial—Endangered or Threatened Plant Species and Unique/High Quality Plant Communities		8	9	8	9	10	7
3 4 Aquatic—Endangered or Threatened Species	2	9	9	8	8	0	10
3 5 Aquatic—Wetlands	2	9	9	9	5	9	3
3 6 Aquatic—Effect on Water Quality	2	7	7	7	7	7	10
Weighted Group Total	10	0 8	0 85	0 8	0 74	0 92	0 71
4 0 VISUAL IMPACTS (Station)							
4 1 Visibility from Wilderness Scenic Recreational or Cultural Areas	1	10	10	10	10	10	7
4 2 Visibility from Urban Areas	1	5	10	10	10	10	10
4 3 Visibility from Highways or Roads	1	5	5	5	2	7	5
Weighted Group Total	3	0 2	0 25	0 25	0 22	0 27	0 22

EVALUATION CRITERIA	Weighting Factor *	EVALUATION SCORES OF FINAL CANDIDATE SITES BASE CASE					
		TY-1	AD-1	MA-2	PO-1	CL-4	MS-1
5 0 CULTURAL RESOURCES (Station)							
5 1 Archaelogical or Historic Resources	3	9	9	9	9	10	10
Weighted Group Total	3	0 27	0 27	0 27	0 27	0 3	0 3
6 0 AIR QUALITY							
6 1 Proximity to Class I Areas	2	9	9	10	10	10	10
6 2 Proximity to SO2 Nonattainment Areas	2	10	10	10	10	10	10
6 3 Proximity to O3 Nonattainment Areas	2	10	10	10	10	5	10
6 4 Proximity to Elevated Terrain	3	7	10	10	4	7	1
Weighted Group Total	9	0 79	0 88	0 9	0 72	0 71	0 63
7 0 ENVIRONMENTAL (Linear Facilities)							
7 1 Routing of Lines between Candidate Sites and Existing Transmission Lines	8	7	7	10	9	9	5
7 2 Routing of Water Pipeline between Candidate Sites and Water Source	4	2	7	5	5	10	10
Weighted Group Total	12	0 64	0 84	1	0 92	1 12	0 88
WEIGHTED TOTAL ENVIRONMENTAL	48	3 58	4 01	4 1	3 79	4 39	3 74

EVALUATION CRITERIA	Weighting Factor %	EVALUATION SCORES OF FINAL CANDIDATE SITES BASE CASE					
		TY-1	AD-1	MA-2	PO-1	CL-4 SMITH	MS-1 SPURLOCK
8 0 POTENTIAL FOR FLOODING							
8 1 Flood Protection	2	10	10	10	10	10	5
Weighted Group Total	2	0 2	0 2	0 2	0 2	0 2	0 1
9 0 TRANSMISSION SYSTEM							
9 1 Ease of Connecting to Existing Transmission System	8	6	6	8	7	8	4
Weighted Group Total	8	0 48	0 48	0 64	0 56	0 64	0 32
10 0 TRANSPORTATION							
10 1 Proximity to Class I Road	5	7	10	7	10	9	10
Weighted Group Total	5	0 35	0 5	0 35	0 5	0 45	0 5
WEIGHTED TOTAL ENGINEERING	15	1 03	1 18	1 19	1 26	1 29	0 92
FIRST COSTS							
11 0 PLANT COSTS							
11 1 Plant Area and Site Development	25	9 1	9 5	9 7	9 2	10	0
Weighted Group Total	25	2 275	2 375	2 425	2 3	2 5	0
WEIGHTED TOTAL FIRST COSTS	25	2 275	2 375	2 425	2 3	2 5	0

440

EVALUATION CRITERIA	Weighting Factor %	EVALUATION SCORES OF FINAL CANDIDATE SITES BASE CASE					
		TY-1	AD-1	MA-2	PO-1	CL-4	MS-1
OPERATING COSTS							
12 0 OPERATING COST IMPACTS							
12 1 Delivered Costs of Fuel Oil	4	0	0	0	0	0	10
12 2 Delivered Costs of Natural Gas	3	4 4	10	10	4 4	4 4	0
12 3 Costs for Water Supply	3	10	0	10	10	10	0
2 4 Comparative Cost of Transmission Losses	2	4 9	0	10	4 4	5 2	10
Weighted Group Total	12	0 53	0 6	0 8	0 52	0 556	0 6
WEIGHTED TOTAL OPERATING COSTS	12	0 53	0 6	0 8	0 52	0 556	0 6
WEIGHTED TOTAL STAGE 3	100	7 415	8 165	8 515	7 87	8 736	5 26

EVALUATION CRITERIA	Weighting Factor %	EVALUATION SCORES OF FINAL CANDIDATE SITES EMPHASIZES ENVIROMENTAL FACTORS					
		TY-1	WD-1	WA-2	PO-1	CL-4	HS-1
ENVIROMENTAL							
1 0 SOCIOECONOMICS							
1 1 Labor Supply	1 5	7	7	10	10	10	10
1 2 Public Services	1 5	10	10	10	0	10	10
1 3 Fiscal Conditions (Tax Revenues)	1 5	10	10	10	10	10	10
1 4 Impact of Project Traffic	1 5	10	0	10	0	10	10
1 5 Noise Impacts	1 5	4	5	4	4	8	4
1 6 Impact on Sensitive Areas	5	10	10	10	10	10	9
Weighted Group Total	9	0 765	0 795	0 81	0 81	0 87	0 795
2 0 LAND USE (Station)							
2 1 Proximity to Residential Development	1 5	10	10	5	10	10	10
2 2 Impact on Forested Areas	1 5	9	0	9	9	9	7
2 3 Impact on Agricultural Areas	1 5	8	9	8	8	10	10
2 4 Displacement of Residences	1 5	5	5	5	5	10	10
2 5 Important Farmland or Timberland	1 5	5	8	7	6	10	10
Weighted Group Total	7 5	0 555	0 585	0 51	0 57	0 735	0 705

EVALUATION CRITERIA	Weighting Factor %	EVALUATION SCORES OF FINAL CANDIDATE SITES EMPHASIZES ENVIRONMENTAL FACTORS					
		TY-1	AD-1	MA-2	PO-1	CL-4	MS-1
3 0 ECOLOGY (Station)							
3 1 Terrestrial—Endangered or Threatened Animal Species and Special Habitat Features	3 1	8	9	8	8	10	7
3 2 Terrestrial—Habitat Quality	1 5	8	8	8	9	0	4
3 3 Terrestrial—Endangered or Threatened Plant Species and Unique/High Quality Plant Communities	1 5	8	9	8	9	0	7
3 4 Aquatic—Endangered or Threatened Species	3 1	8	9	8	8	0	10
3 5 Aquatic—Wetlands	3 1	9	9	9	6	9	3
3 6 Aquatic—Effect on Water Quality	3 1	7	7	7	7	7	10
Weighted Group Total	15 4	1 232	1 309	1 232	1 139	1 416	1 095
4 0 VISUAL IMPACTS (Station)							
4 1 Visibility from Wilderness Scenic Recreational or Cultural Areas	1 5	10	10	10	10	0	7
4 2 Visibility from Urban Areas	1 5	5	10	10	10	0	10
4 3 Visibility from Highways or Roads	1 5	5	5	5	2	7	5
Weighted Group Total	4 5	0 3	0 375	0 375	0 33	0 405	0 33

EVALUATION CRITERIA	Weighting Factor %	EVALUATION SCORES OF FINAL CANDIDATE SITES EMPHASIZES ENVIROMENTAL FACTORS					
		TY-1	AD-	MA-2	PO-1	CL-4	MS-1
5 0 CULTURAL RESOURCES (Station)							
5 1 Archaelogical or Historic Resources	4 6	9	9	9	9	0	10
Weighted Group Total	4 7	0 414	0 414	0 414	0 414	0 -6	0 46
6 0 AIR QUALITY							
6 1 Proximity to Class I Areas	3 1	9	9	10	0	10	10
6 2 Proximity to SO2 Nonattainment Areas	3 1	0	10	10	0	0	10
6 3 Proximity to O3 Nonattainment Areas	3	10	10	10	0	5	10
6 4 Proximity to elevated Terrain	4 7	7	10	10	4	7	1
Weighted Group Total	14	1 228	1 369	4	1 . 8	1 04	0 977
7 0 ENVIROMENTAL (Linear Facilities)							
7 1 Routing of Lines between Candidate Sites and Existing Transmission Lines	12 5	7	7	10	9	9	6
7 2 Routing of Water Pipeline between Candidate Sites and Water Source	6 4	2	7	5	5	0	10
Weighted Group Total	18 9	1 003	1 323	1 57	1 4-5	1 755	39
WEIGHTED TOTAL ENVIROMENTAL	74	5 497	6 17	6 311	5 825	5 755	5 752

444

EVALUATION CRITERIA	Weighting Factor %	EVALUATION SCORES OF FINAL CANDIDATE SITES EMPHASIZES ENVIROMENTAL FACTORS					
		TY-1	AD-1	MA-2	PO-1	CL-4	MS-1
8 0 POTENTIAL FOR FLOODING							
8 1 Flood Protection	1	0	10	10	10	0	5
Weighted Group Total	1	0 1	0 1	0 1	0 1	0 1	0 05
9 0 TRANSMISSION SYSTEM							
9 1 Ease of Connecting to Existing Transmission System	4	6	6	8	7	8	4
Weighted Group Total	4	0 24	0 24	0 32	0 28	0 32	0 16
10 0 TRANSPORTATION							
10 1 Proximity to Class I Road	2 5	7	10	7	10	9	10
Weighted Group Total	2 5	0 175	0 25	0 175	0 25	0 225	0 25
WEIGHTED TOTAL ENGINEERING	7 5	0 515	0 59	0 595	0 53	0 645	0 46
FIRST COSTS							
11 0 PLANT COSTS							
11 1 Plant Area and Site Development	12 5	9 1	9 5	9 7	9 2	10	0
Weighted Group Total	12 5	1 1375	1 1875	1 2125	1 15	1 25	0
WEIGHTED TOTAL FIRST COSTS	12 5	1 1375	1 1875	1 2125	1 5	1 25	0

EVALUATION CRITERIA	Weighting Factor %	EVALUATION SCORES OF FINAL CANDIDATE SITES EMPHASIZES ENVIRONMENTAL FACTORS					
		TY-1	AD-1	MA-2	PO-1	CL-4	MS-1
OPERATING COSTS							
12 0 OPERATING COST IMPACTS							
12 1 Delivered Costs of Fuel Oil	2	0	0	0	0	0	10
12 2 Delivered Costs of Natural Gas	1 5	4 4	10	10	4 4	4 4	0
12 3 Costs for Water Supply	1 5	10	10	10	10	10	0
12 4 Comparative Cost of Transmission Losses	1	4 9	0	10	4 4	6 2	10
Weighted Group Total	6	0 265	0 3	0 4	0 26	0 278	0 3
WEIGHTED TOTAL OPERATING COSTS	6	0 265	0 3	0 4	0 25	0 278	0 3
WEIGHTED TOTAL STAGE 3	100	7 4145	8 2475	8 5185	7 866	9 928	6 512

446

EVALUATION CRITERIA	Weighting Factor %	EVALUATION SCORES OF FINAL CANDIDATE SITES EMPHASIZES ENGINEERING COST FACTORS					
		TV-	AD-1	HA-2	PO-1	CL-4	MS-1
ENVIROMENTAL							
1 0 SOCIOECONOMICS							
1 1 Labor Supply	0 5	7	7	10	10	10	10
1 2 Public Services	0 5	0	10	10	10	10	0
1 3 Fiscal Conditions (Tax Revenues)	0 5	0	10	10	10	10	10
1 4 Impact of Project Traffic	0 5	0	10	10	10	10	10
1 5 Noise Impacts	0 5	4	5	4	4	8	4
1 6 Impact on Sensitive Areas	0 5	0	0	10	10	10	9
Weighted Group Total	3	0 255	0 265	0 27	0 27	0 29	0 265
2 0 LAND USE (Station)							
2 1 Proximity to Residential Development	0 5	10	10	5	10	10	10
2 2 Impact on Forested Areas	0 5	9	10	9	9	9	7
2 3 Impact on Agricultural Areas	0 5	8	6	8	8	10	10
2 4 Displacement of Residences	0 5	5	5	5	5	10	0
2 5 Important Farmland or Timberland	0 5	5	8	7	6	10	10
Weighted Group Total	2 5	0 185	0 195	0 17	0 19	0 245	0 235

EVALUATION CRITERIA	Weighting Factor %	EVALUATION SCORES OF FINAL CANDIDATE SITES EMPHASIZES ENGINEERING COST FACTORS					
		TY-1	AD-1	MA-2	PO-1	CL-4	MS-1
3 0 ECOLOGY (Station)							
3 1 Terrestrial—Endangered or Threatened Animal Species and Special Habitat Features	1	8	9	8	8	10	7
3 2 Terrestrial—Habitat Quality	0 5	8	8	8	8	10	4
3 3 Terrestrial—Endangered or Threatened Plant Species and Unique/High Quality Plant Communities	0 5	8	9	8	8	0	7
3 4 Aquatic—Endangered or Threatened Species	1	8	9	8	8	0	10
3 5 Aquatic—Wetlands	1	9	9	9	6	9	3
3 6 Aquatic—Effect on Water Quality	1	7	7	7	7	7	10
Weighted Group Total	5	0 4	0 425	0 4	0 37	0 46	0 355
4 0 VISUAL IMPACTS (Station)							
4 1 Visibility from Wilderness Scenic Recreational or Cultural Areas	0 5	10	10	10	10	10	7
4 2 Visibility from Urban Areas	0 5	5	10	10	10	10	10
4 3 Visibility from Highways or Roads	0 5	5	5	5	2	7	5
Weighted Group Total	1 5	0 1	0 125	0 125	0 11	0 135	0 11

EVALUATION CRITERIA	Weighting Factor *	EVALUATION SCORES OF FINAL CANDIDATE SITES EMPHASIZES ENGINEERING COST FACTORS					
		TY-1	AD-1	MA-2	PO-1	CL-4	MS-1
5 0 CULTURAL RESOURCES (Station)							
5 1 Archaelogical or Historic Resources	1 5	9	9	9	9	10	10
Weighted Group Total	1 5	0 135	0 35	0 35	0 135	0 15	0 15
6 0 AIR QUALITY							
6 1 Proximity to Class I Areas	1	9	9	10	10	10	10
6 2 Proximity to SO2 Nonattainment Areas	1	10	10	10	0	10	10
6 3 Proximity to O3 Nonattainment Areas		0	0	10	0	5	10
6 4 Proximity to Elevated Terrain	1 5	7	10	10	-	7	1
Weighted Group Total	4 5	0 395	0 44	0 45	0 36	0 355	0 315
7 0 ENVIROMENTAL (Linear Facilities)							
7 1 Routing of Lines between Candidate Sites and Existing Transmission Lines	4	7	7	10	9	9	6
7 2 Routing of Water Pipeline between Candidate Sites and Water Source	2	2	7	5	5	10	10
Weighted Group Total	6	0 32	0 42	0 5	0 -6	0 56	0 44
WEIGHTED TOTAL ENVIROMENTAL	24	1 79	2 005	2 05	895	2 95	1 87

EVALUATION SCORES OF
FINAL CANDIDATE SITES
EMPHASIZES ENGINEERING COST FACTORS

EVALUATION CRITERIA	Weighting Factor %	TY-1	AD-1	MA-2	PO-1	CL-4	MS-1
8 0 POTENTIAL FOR FLOODING							
8 1 Flood Protection	2 9	0	10	10	10	10	5
Weighted Group Total	2 9	0 29	0 29	0 29	0 29	0 29	0 145
9 0 TRANSMISSION SYSTEM							
9 1 Ease of Connecting to Existing Transmission System	11 8	6	6	8	7	8	4
Weighted Group Total	11 8	0 708	0 708	0 944	0 825	0 944	0 472
10 0 TRANSPORTATION							
10 1 Proximity to Class I Road	7 4	7	10	7	10	9	10
Weighted Group Total	7 4	0 518	0 74	0 518	0 74	0 666	0 74
WEIGHTED TOTAL ENGINEERING	22 1	1 516	1 738	1 752	1 856	1 9	1 357
FIRST COSTS							
11 0 PLANT COSTS							
11 1 Plant Area and Site Development	36 6	9 1	9 5	9 7	9 2	10	0
Weighted Group Total	36 5	3 3306	3 477	3 5502	3 3672	3 66	0
WEIGHTED TOTAL FIRST COSTS	36 6	3 3306	3 477	3 5502	3 3672	3 66	0

EVALUATION CRITERIA	Weighting Factor %	EVALUATION SCORES OF FINAL CANDIDATE SITES EMPHASIZES ENGINEERING COST FACTORS					
		TY-1	AD-1	MA-2	PO-1	C_-4	MS-1
OPERATING COSTS							
12 0 OPERATING COST IMPACTS							
12 1 Delivered Costs of Fuel Oil	5 8	0	0	0	0	0	10
12 2 Delivered Costs of Natural Gas	4 3	4 4	10	10	4 4	4 4	0
12 3 Costs for Water Supply	4 3	10	10	10	10	10	0
12 4 Comparative Cost of Transmission Losses	2 9	4 9	0	10	4 4	6 2	10
Weighted Group Total	17 3	0 7613	0 86	1 15	0 7468	0 799	0 87
WEIGHTED TOTAL OPERATING COSTS	17 3	0 7613	0 86	1 15	0 7468	0 799	0 87
WEIGHTED TOTAL STAGE 3	100	7 3979	8 08	8 5022	7 865	9 554	4 097

451

APPENDIX D

ALTERNATE EXAMPLE OF MATRIX EVALUATION

02 May 95

TABLE D 1
GENERIC CANDITATE SITE MATRIX EVALUATION

DIFFERENTIAL SITE DEVELOPMENT COSTS COAL FUELED FACILITY

				Site A		Site B		Site C	
Site Development Activity	Unit Cost $1 000 (1994)	Unit	Site Base Amount	Differential Site Amount	Differential Site Cost ($1 000)	Differential Site Amount	Differential Site Cost ($1 000)	Differential Site Amount	Differential Site Cost ($1 000)
Coal Conveyor Ocean	$20,000	km	0 000	Base	$0	2 500	$50 000	0 300	$6 000
Coal Conveyor Land	$8 000	km	0 275	Base	$0	0 300	$2 400	0 275	$2 200
Channel Dredging	$0 0085	m 3	0 000	2,520,000	$21 420	5 110 000	$43 435	4 430 000	$37 655
Circulating Water Canal	$3,800	km	1 500	Base	$0	0 450	$1,710	0 225	$855
Circulating Water Pipeline	$15 900	km	3 000	0 650	$10 335	0 300	$4 770	0 200	$3 180
Intake Structure Dredging	$0 0085	m 3	0 000	Base	$0	1,610,000	$13,685	489 000	$4 157
Railroad Spur	$500	km	1 300	4 000	$2 000	4 800	$2 400	Base	$0
Access Road	$170	km	1 260	1 640	$279	2 240	$381	1 100	$187
Transmission System	1	LS	$113 000 000	1	$71 000	1	$261 000	1	$545,000
Site Development Earthwork	1	LS	0	1	$249 700	1	$31,833	Base	$0
Piling and Foundation	N/A	N/A	$145 000,000	1	($42,000)	1	($28,000)	1	($42,000)
Land Industrial	$100 000	km 2	0 000	4 8	$480 000	N/A	$0	N/A	$0
Land Agricultural	$10,000	km 2	0 000	N/A	$0	5 6	$56,000	5 3	$53,000
TOTAL SITE DIFFERENTIAL DEVELOPMENT COSTS					$792 734		$439,614		$610,234
LOWEST SITE DIFFERENTIAL DEVELOPMENT COSTS ($1,000)					$439,614		$439 614		$439 614
ADJUSTED SITE DIFFERENTIAL COSTS ($1 000)					$353 120		$0		$170 620
SITE DIFFERENTIAL DEVELOPMENT COST SCORE					1 0		10 0		5 7

453

02 May 95

TABLE D 2
GENERIC CANDIDATE SITE MATRIX EVALUATION

OVERALL EVALUATION OF CANDIDATE SITES

NUMERICAL RATINGS OF THE CANDIDATE SITES

		Site A		Site B		Site C	
	RELATIVE WEIGHT	Raw Score	Weighted Score	Raw Score	Weighted Score	Raw Score	Weighted Score
DIFFERENTIAL SITE DEVELOPMENT COSTS	60	1 0	60	10 0	600	5 7	342
ENVIRONMENTAL FACTORS							
Air Quality	9	1	9	6	54	8	72
Support/Linear Facilities	5	7	35	9	45	7	35
Water Quality Thermal	5	8	40	8	40	3	15
Impingement/Entrainment	3	8	24	8	24	3	9
Terrestrial Resources	3	10	30	7	21	6	18
Port Development	2	6	12	8	16	5	10
Existing Land Use	4	7	28	4	16	6	24
Community Acceptance	3	4	12	3	9	3	9
Aesthetics	2	8	16	2	4	7	14
Noise	1	8	8	8	8	6	6
Public Facilities/Services	2	7	14	4	8	4	8
Cultural Resource Impacts	1	10	10	6	6	4	4
ENVIRONMENTAL TOTAL	40		238		251		224
TOTAL SCORE	100		298		851		566

454

02-May-95

TABLE D-3
GENERIC CANDIDATE SITE MATRIX EVALUATION

SENSITIVITY ANALYSIS

	COST SCORE	ENVIR SCORE	BASE CASE	COST EMPH	EQUAL EMPH	ENVIR EMPH
Site A	60	238	298	249	348	397
Site B	600	251	851	888	814	777
Site C	342	224	566	567	565	564

APPENDIX E

SITE SELECTION METHODOLOGY - TRANSPARENCY COPIES

Site Selection Methodology

Site Selection Concept

The site selection process is based upon a systematic consideration of "common sense" elements resulting in the identification of a most appropriate site (or sites) for a particular development.

- Primary considerations are based on the required (or "needed") criteria.

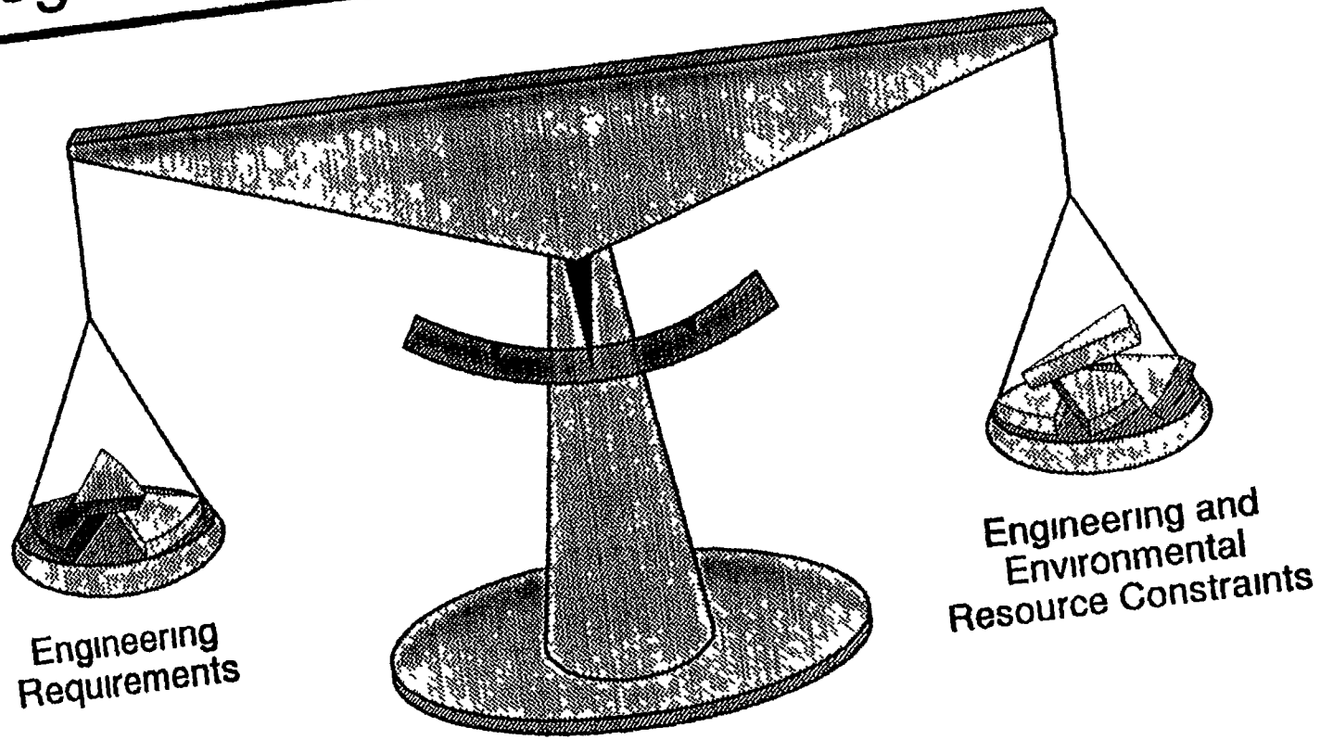
- Secondly, considerations are given to other constraints (or "wanted" criteria).

Consider a simplified power plant schematic.

What ties the power plant to the rest of the world?

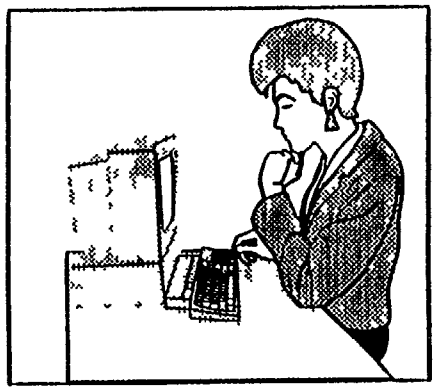
Power, Fuel, Water, and Waste

Strategic Balancing Act

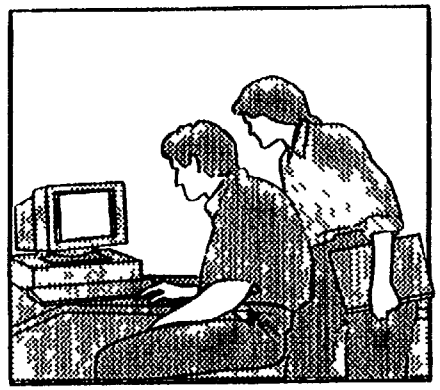


HZK001

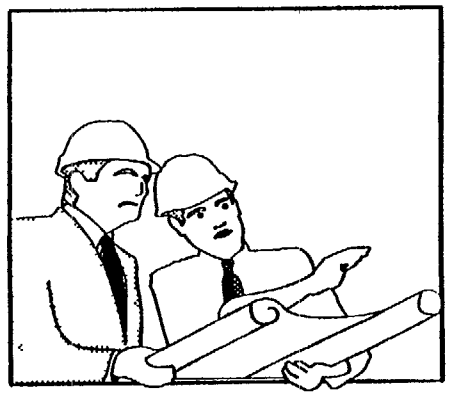
Knowledge/Skill Areas



- Air Quality
- Environment/ Ecology
- Socioeconomics

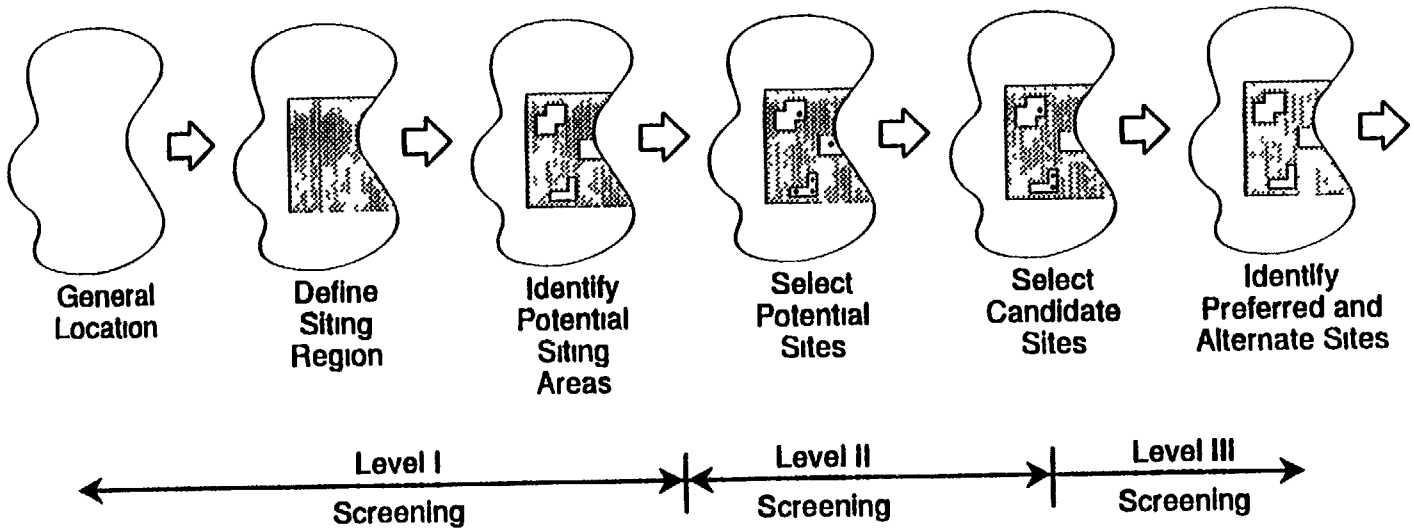


- Legal/ Regulatory



- Site Engineering
- Economics
- Fuel Resources
- Water Supply
- Transmission

The Siting Process



HZK002

Candidate Siting Areas

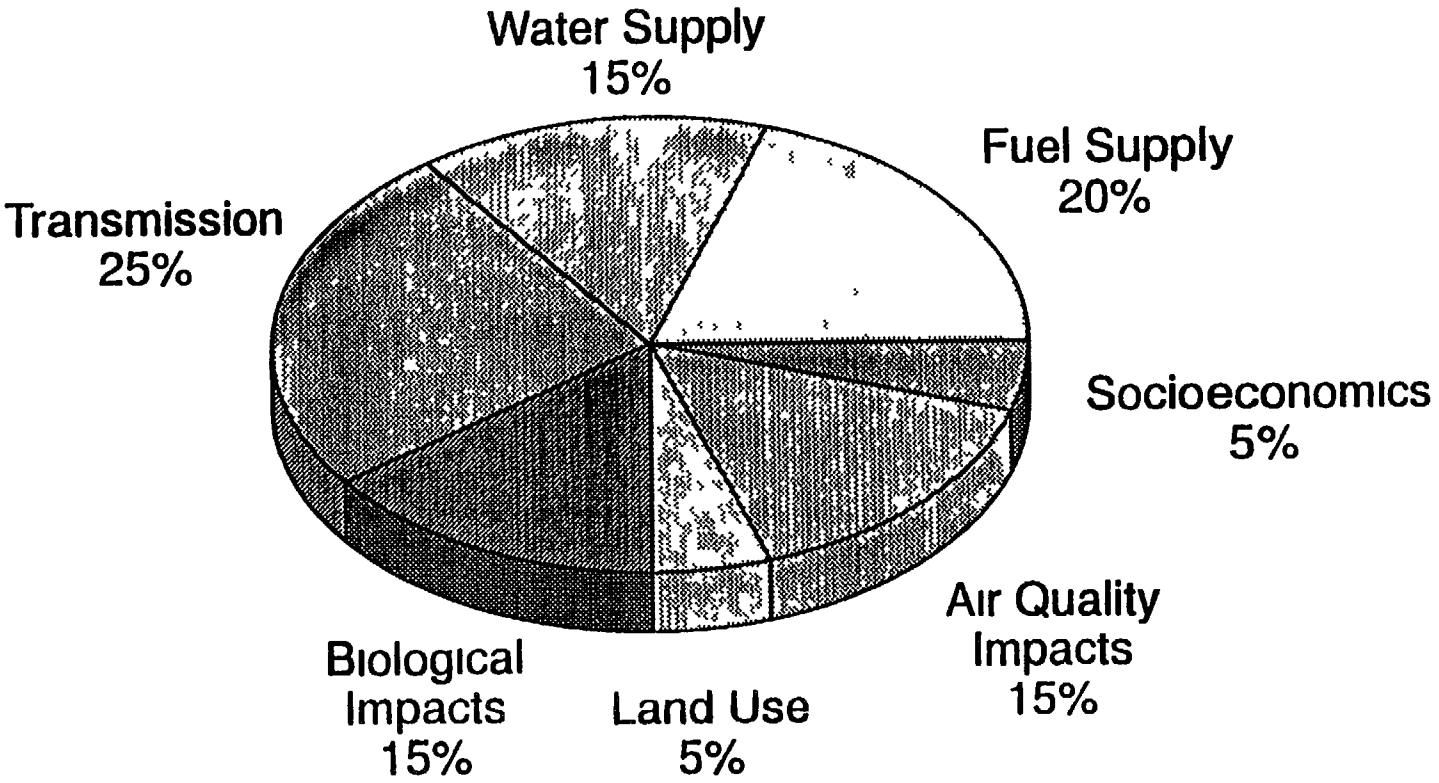
- Determined on "Must Have" Criteria
  - Transmission Line / Load Delivery Proximity
  - Fuel Pipeline / Fuel Transport Proximity
  - Site Topography (Broad Relief)
  - Water Availability

- Screened on "Constraints" Criteria
  - Air Quality
  - Land Use
  - Unsuitable Geologic Features
  - Proximity to Environmentally Sensitive Areas

Criteria Selection

- Air Quality Constraints
- Transmission Access / System Considerations
- Proximity to Fuel Supply
- Water Supply / Wastewater Disposal Constraints
- Existing Land Use
- Terrestrial Ecosystem
- Aquatic Ecosystem
- Socioeconomic Considerations
- Aesthetic / Visual Considerations
- Cultural Resources
- Noise Impacts
- Differential Site Development Costs

Siting Criteria



HZK003P

Differential Site Development Costs

- Transmission Interconnection
- Water Supply / Discharge Pipe
- Fuel Supply
- Site Earthwork
- Land Acquisition

Terms of Reference

Tano Field Development and Power Project

1.0 Background
2.0 Purpose of the Studies
3.0 Regulatory Consultations
4.0 Public Consultations
5.0 Identification and Qualitative Assessment of Environmental Impacts
6.0 Mitigation
7.0 Baseline Data
8.0 Report Format

Terms of Reference

WB Sample TOR for EA of Energy Facilities

1. Introduction
2. Background Information
   - energy sources
   - energy production facilities
   - fuel delivery systems
   - power generating systems
   - transmission systems
   - pollution control systems
   - supplies
   - staffing
   - services
   - planning for emergencies

3. Objectives
4. Environmental Assessment requirements
   - World Bank Operational Directive
   - National laws and/or regulations
   - Regional/provincial/communal regs
   - EA regs of any other financing organizations
5. Study Area
6. Scope of Work
7. Task 1. Describe the proposed project
8. Task 2. Description of the environment
   - Physical environment
   - Biological environment

9. Task 3. Legislative and regulatory considerations
10. Task 4. Determination of the potential impacts of the proposed project
11. Task 5. Analysis of alternatives to the proposed project
12. Task 6. Development of management plan to mitigate negative impacts
13. Task 7. Identification of institution needs to implement environmental assessment recommendations
14. Task 8. Development of a monitoring plan
15. Task 9. Assist in Inter-Agency and public/NGO participation

16. Report

- Executive summary
- Policy, legal and administrative framework
- Description of proposed project
- Description of the environment
- Significant environmental impacts
- Analysis of alternatives
- Mitigation monitoring plan
- Environmental management/training
- Monitoring plan
- Interagency and public/NGO involvement

16. Report (cont.)
    - List of references
    - Appendices
        - List of EA preparers
        - Records of interagency and public/NGO communications
        - Data and unpublished reference documents
17. Consulting team
18. Schedule
19. Other information

Report Format

1. Summary
2. Project Description
3. Policy, Legal, and Administrative Framework
4. Consultations
5. Potential Impacts
6. Qualitative Assessments
7. Alternatives
8. Possible Mitigation
9. Appendices

2.0 Purpose of the Studies

i. Identify national/international environmental policy/regulatory standards

ii. Define/redefine project development scenario

iii. Identify potential effects

iv. Qualitatively analyze potential impacts

v. Recommend mitigation

vi. Recommend baseline monitoring

vii. Alternative approaches and sites

TERMS OF REFERENCE
FOR ENVIRONMENTAL STUDIES
OF TANO FIELD DEVELOPMENT AND POWER PROJECT

1 0 BACKGROUND

The success of Ghana's Economic Recovery Programme, introduced in 1983, has stimulated economic activity and subsequently resulted in a surge in the electricity demand The tight supply and demand balance at times of peak load has been further compounded by the ongoing decommissioning and modernisation of significant hydro-electrical generation capacity To satisfy the energy needs of Ghana and avoid a reliance on power imports a project is under development to introduce approximately 199MW fuelled by indigenous natural gas resources The sponsor of the Tano Field Development is Ghana National Petroleum Corporation (GNPC)

The proposed simultaneous exploitation of both oil and gas reserves in the Tano fields will include a floating production, storage and offloading system to produce and process the oil, and utilise gas turbine technology for electricity generation and delivery into the Volta River Authority (VRA) high voltage grid

The commitment of GNPC to environmental matters has resulted in a requirement for environmental assessment work to be carried out by an independent consultant, _____ _____ Engineering Limited

This Terms of Reference document applies to the consultation and preliminary scoping phases of an Environmental Impact Assessment The results of this study will be used to highlight quantitative work that is required and to provide quantitative assessments of potential impacts At a later stage it is intended that this work as a full Environmental Statement

The study work will include consideration of all aspects of the proposed development and will incorporate both operational and construction impacts

2 0 PURPOSE OF THE STUDIES

The purpose of the environmental work is to

i Identify and collate relevant national and international environmental policy and regulatory standards

ii Define and refine the project development scenario

iii Identify the potential effects that the proposed project would have on all receiving media and surrounding populations This includes socio-economic study of the area

iv Qualitatively analyse potential impacts

v Provide recommendations for additional qualitative work and outline possible mitigation of environmental impacts

vi provide recommendations for baseline monitoring This will not include design of monitoring strategies or establishing monitoring protocols

vii Define and compare potential alternative approaches and alternative sites for justification of final site selection

3 0 REGULATORY CONSULTATIONS

In-country consultations will be held between environmental consultants and regulatory bodies in Ghana These discussions will principally involve the Environmental Protection Council (EPC) which has policy and protocols for Environmental Impact Assessment in Ghana This phase will ensure that the concerns and requirements of national organisations will be incorporated in the assessment procedures

4 0 PUBLIC CONSULTATIONS

Public consultations will be carried out through meetings between GNPC representatives and social specialists, and local community leaders In this way the concerns of populations will be voiced and the developer can ensure that key issues are addressed

The package for public consultations will include a brief project description with some indication of the likely impacts on people living in the vicinity, and a questionnaire developed by environmental consultants as a tool for gauging public opinion and highlighting principal concerns

5 0 IDENTIFICATION AND QUALITATIVE ASSESSMENT OF ENVIRONMENTAL IMPACTS

The project team of qualified environmental scientists will identify the potential environmental impacts through consideration of site visit, public and regulatory consultations, proposed project type, and previous project experience

Using a team of specialists including environmental consultants, safety consultants, engineering disciplines and other relevant experts, the various identified potential impacts will be verified and scored qualitatively

Quantitative assessments such as modelling techniques for air dispersion, noise, water quality, thermal discharges, and hazardous releases will not be included

Examples of potential impact areas consideration may include but not be restricted to

* Air quality
* Aqueous effluent
* Beach loss
* Groundwater contamination
* Noise emissions
* Visual intrusion
* Safety intrusion
* Accidents and transportation
* Socio-Economic impacts
* Conflicting activities
* Trans boundary pollution
* Habitat loss

Impacts will be scored using a system based on duration, extent, magnitude, receptor groups, and sensitivity

6 0 MITIGATION

For each identified significant environmental impact identified the project team will propose potential mitigative options These will be outline descriptions and will not evaluate technical or economic feasibility at this stage

7 0 BASELINE DATE

Scoping for future quantitative studies is a principal objective for this study The availability of baseline measurements and data will be ascertained and the requirement for monitoring will be highlighted

8 0 REPORT FORMAT

The following is a draft table of contents for the study report

1 Summary
2 Project Description
3 Policy, Legal, and Administrative Framework
4 Consultations

5 Potential Impacts
6 Qualitative Assessments
7 Alternatives
8 Possible Mitigation
9 Appendices

The following section contains excerpts from *Guidelines for Environmental Assessment of Energy and Industry Projects*, Volume III of the World Bank Environmental Assessment Sourcebook, 1991

ANNEX 10-1

Sample Terms of Reference (TOR)
An Environmental Assessment of Energy Facilities

Note Paragraph numbers correspond to those in the Sample Terms of Reference (TOR) Outline in Annex 1-3, additional paragraphs are not numbered

1 Introduction This section will state the purpose of the terms of reference, identify the energy development projects to be assessed, and explain the executing arrangements for the environmental assessment Energy development projects include, but are not limited to electric power transmission systems, oil and gas pipelines, oil and gas development, geothermal development, hydroelectric facilities, and thermoelectric power plants

2 Background Information This section will provide pertinent background for potential parties who may conduct the environmental assessment, whether they are consultants or government agencies The section will include a brief description of the major components of the proposed project, a statement of the need for it and the objectives it is intended to meet, the implementing agency, a brief history of the project (including alternatives considered), its current status and timetable, and the identities of any associated projects If there are other projects in progress or planned within the region which may compete for the same resources, identify them within this section

Major components of an energy project to be described herein include, as appropriate energy sources (e g , geothermal aquifer, reservoir, oil/gas field), energy production facilities (e g , well, platform, dam, pump), fuel delivery systems (e g , offshore or overland pipeline, barge, tanker, highway transport, belt conveyor, aerial tramway), power generating systems (e g , turbine, generator), transmission systems (e g , right-of-way, switchyard, substation), pollution control systems (e g , drilling muds and cuttings, stack gas emission control, non-point source emission control, cooling water and wastewater treatment and discharge, ash disposal), supplies (e g , location of stocks of parts and chemicals, transport routes), staffing (e g , numbers of workers, skill requirements), services (e g , fire protection, security, transportation), planning for emergencies, and community involvement (e g , worker housing during construction)

3 Objectives This section will summarize the general scope of the environmental assessment and discuss its timing in relation to other aspects of project preparation, design, and execution This section will identify constraints, if any, regarding the adequacy of existing environmental assessment baseline data and needs to phase additional data collection (e g , over several seasons) and assessment efforts so as not to hinder the rest of the project development schedule

4 Environmental Assessment Requirements This section will identify regulations and guidelines which will govern the conduct of the assessment or specify the content of its report They may include any or all of the following

- World Bank Operational Directive 4 00, Annex A "Environmental Assessment," and other pertinent ODs, OMSs, OPNs, and guidelines,
- national laws and/or regulations on environmental reviews and impact assessments,
- regional, provincial or communal environmental assessment regulations, and
- environmental assessment regulations of any other financing organizations involved in the project

This section will identify design or operating standards which project components must address to be environmentally acceptable This will include, for example, effluent discharge limitations, air emission standards, receiving water quality standards, and occupational health and safety requirements

5 Study Area This section will specify the boundaries of the study area for the assessment Where appropriate, specify the right-of-way (ROW) width and alignment for transmission lines or pipelines. Similarly, specify locations for transmission substations, oil/gas compressor or pump stations For projects which develop energy sources, specify the entire area involved (e g , catchment and floodplain for hydroelectric reservoirs and the production and reserve zones for oil/gas fields)

If there are adjacent or remote areas which should be considered with respect to impacts of particular aspects of the project, identify them For example, when an energy project includes only a thermoelectric power plant and does not include the oil/gas development component, transportation corridors, terminals, and remote processing locations for fuel delivery should be identified

6 Scope of Work In some cases, the tasks to be carried out by a consultant will be known with sufficient certainty to be specified completely in the terms of reference In other cases, information deficiencies need to be alleviated or specialized field studies or modelling activities performed to assess impacts, and the consultant will be asked to define particular tasks in more detail for contracting agency review and approval

7 Task 1. Describe the proposed project Provide information on the following location of all project-related development sites and ROW's, general layout of facilities at project-related development sites; flow diagrams of facilities/operations design basis, size, capacity, flow-through of unit operations, pre-construction activities, construction activities, schedule, staffing and support, facilities and services, operation and maintenance activities, staffing and support, facilities and services, required off-site investments, life expectancy for major components

Provide maps at appropriate scales to illustrate the general setting of project-related development sites and ROW's, as well as surrounding areas likely to be environmentally affected These maps shall include topographic contours, as available, as well as locations of major surface waters, roads, railways, town centers, parks and preserves, and political boundaries Also provide, as available, maps to illustrate existing land use, including industrial, residential, commercial and institutional development, agriculture, etc

8 Task 2. Description of the Environment Assemble, evaluate and present baseline data on the environmental characteristics of the study area Include information on any changes anticipated before the project commences

Physical environment geology (e g , stratigraphy and structure of well fields, seismic history of storage tank areas), topography (e g , drainage patterns around construction areas, view-sheds around facilities), soils (e g , agricultural value, potential use for lining, or soil cover in residue disposal), benthic sediment (e g , level of contamination in offshore areas where pipelines are laid), climate and meteorology (e g , prevailing wind patterns around stacks, precipitation patterns at residue disposal sites), ambient air quality (note input from other major pollutant generators in the area, if any), surface water hydrology (e g , downstream water resources from reservoirs), coastal and oceanic parameters (e g , currents in platform and docking areas), receiving water quality (note input from major pollutant generators in the area, if any), significant pollutant sources in the area and prospects for their mitigation

Biological environment flora (e g , types and diversity), fauna (e g , resident and migratory), rare or endangered species within or in areas adjacent to project-related development sites or ROW's, sensitive habitats, including wetlands, parks or preserves, significant wildlands within or in areas downstream/downgradient of project-related development areas or ROW's (including benthic habitat in areas of offshore pipelines), species of commercial importance in areas affected by the project, including coastal areas at docking facilities

Socio-cultural environment (include both present and projected where appropriate) population (i e , full time and seasonal), land use (i e , year-round and seasonal), planned development activities, community structure, employment and labor market, distribution of income, goods and services, recreation, public health, education, cultural properties (e g , archaeological and historically significant sites), indigenous peoples and traditional tribal lands, customs, aspirations and attitudes

9 Task 3. Legislative and Regulatory Considerations Describe the pertinent regulations and standards governing environmental quality, health and safety, protection of sensitive areas, protection of endangered species, siting, land use control, etc , at international, national, regional and local levels (The TOR should specify those that are known and require the consultant to investigate for others)

10 Task 4. Determination of the Potential Impacts of the Proposed Project Identify all significant changes which the project would incur These would include, but not be limited to, changes in the following employment opportunities, wastewater effluents, thermal effluents, air emissions, land use, infrastructure, exposure to disease, noise, traffic, socio-cultural behavior Assess the impacts from changes brought about by the project on baseline environmental conditions as described above under Task 2

In this analysis, distinguish between significant positive and negative impacts, direct and indirect impacts, and immediate and long-term impacts Include indirect impacts from the increased power supply (e g , industrial expansion and increased urbanization) Identify impacts which may occur due to accidental events (e g , potential rupture of oil pipelines, leakage from a gas pipeline, blow-out of an oil well, tanker collision) Identify impacts which are unavoidable or irreversible

Wherever possible, describe impacts quantitatively, in terms of environmental costs and benefits Assign economic values when feasible

Impact analysis for energy projects should be divided between construction impacts and operation impacts For example, for pipelines there are construction impacts of land clearing (e g , loss of vegetative habitat for wildlife) and operation impacts of pipeline maintenance (e g , use of herbicides) For thermoelectric power plants, there are construction impacts of housing construction workers (e g , market demand changes for local services) and operation impacts of power plant operation (e g , stack gas emissions and effluent discharges)

Characterize the extent and quality of available data, explaining significant information deficiencies and any uncertainties associated with predictions of impact If possible, give the TOR for studies to obtain the missing information For information which could not be obtained until after project execution, provide TOR for studies to monitor operations over a given time period and to modify designs and/or operational parameters based upon updated impact analysis

11 Task 5. Analysis of Alternatives to the Proposed Project The environmental assessment should include an analysis of reasonable alternatives to meet the ultimate project objective This analysis may suggest designs that are more sound from an environmental, sociocultural or economic point of view than the originally proposed project Include the "no action" alternative -- not constructing the project -- in order to demonstrate environmental conditions without it Alternatives should include the following the "no action" alternative (as discussed above), alternative means of meeting the energy requirements, the alternative of upgrading existing facilities, alternative routes and sites, alternative design, and alternative methods of construction, including costs and reliability

Describe how the alternatives compare in terms of potential environmental impacts, capital and operating costs, suitability under local conditions (e g , skill requirements, political acceptability, public cooperation, availability of parts, level of technology), and institutional, training, and monitoring requirements When describing the impacts of alternatives, indicate which impacts would be irreversible or unavoidable and which could be mitigated

To the extent possible, quantify the costs and benefits of each alternative, incorporating the estimated costs of any associated mitigating measures Describe the reasons for selecting the proposed project over the other alternatives

12 Task 6. Development of Management Plan to Mitigate Negative Impacts For the proposed project, recommend feasible and cost-effective measures to prevent or reduce significant negative impacts to acceptable levels Include measures to address emergency response requirements for accidental events

Estimate the impacts and costs of those measures, and of the institutional and training requirements to implement them Consider compensation to affected parties for impacts which cannot be mitigated Prepare a management plan including proposed work programs, budget estimates, schedules, staffing and training requirements, and other necessary support services to implement the mitigating measures

13 Task 7. Identification of Institutional Needs to Implement Environmental Assessment Recommendations Review the authority and capability of institutions at local, provincial/regional, and national levels and recommend steps to strengthen or expand them so that the management and monitoring plans in the environmental assessment are likely to be implemented The recommendations may extend to new laws and regulations, new agencies or agency functions, intersectoral arrangements, management procedures and training, staffing, operation and maintenance training, budgeting, and financial support

14 Task 8. Development of a Monitoring Plan Prepare a detailed plan to monitor the implementation of mitigating measures and the impacts of the project during construction and operation Include in the plan an estimate of capital and operating costs and a description of other inputs (such as training and institutional strengthening) needed to conduct it

15 Task 9. Assist in Inter-Agency Coordination and Public/NGO Participation Assist in coordinating the environmental assessment with other government agencies, in obtaining the views of local NGO's and affected groups, and in keeping records of meetings and other activities, communications, and comments and their disposition (The TOR should specify the types of activities, for example, interagency scoping session, environmental briefings for project staff and interagency committees, support to environmental advisory panels, public forum)

16 Report Provide an environmental assessment report which is concise and limited to significant environmental issues The main text should focus on findings, conclusions and recommended actions, supported by summaries of the data collected and citations for any references used in interpreting those data Detailed or uninterpreted data are not appropriate in the main text and should be presented in appendices or a separate volume Unpublished documents used in the assessment may not be readily available and should also be assembled in an appendix Organize the environmental assessment report according to the outline below (This is the format suggested in OD 4 00, Annex A-1, the TOR may specify a different one to satisfy national agency requirements as long as the topics required in the Bank's directive are covered)

- Executive Summary
- Policy, Legal and Administrative Framework
- Description of the Proposed Project
- Description of the Environment
- Significant Environmental Impacts
- Analysis of Alternatives
- Mitigation Management Plan
- Environmental Management and Training
- Monitoring Plan
- Inter-Agency and Public/NGO Involvement
- List of References
- Appendices
  - List of Environmental Assessment Preparers
  - Records of Inter-Agency and Public/NGO Communications
  - Data and Unpublished Reference Documents

485

17 Consulting Team The environmental assessment requires interdisciplinary analysis The general skills required of an environmental assessment team are environmental management planning, socio-economics, ecology, hydrology/hydrogeology, air quality analysis, water quality analysis For an energy project, the project team will be specified to include specialists appropriate to the type of components in the energy project (e g , for offshore pipelines, an oceanographer and marine biologist, for transmission lines, a terrestrial biologist and cultural resources specialist; for thermoelectric power plants, an air quality modeler and aquatic biologist, for hydroelectric projects, a hydrologist and aquatic biologist) When possible, the TOR should provide an estimate of staff weeks/months required

18 Schedule This section will specify dates for progress reviews, interim and final reports, and other significant events

19 Other Information Include here lists of data sources, project background reports and studies, relevant publications, and other items to which the consultant's attention should be directed

ANNEX 10-2

Sample Terms of Reference (TOR)
An Environmental Assessment of Industrial Facilities

Note Paragraph numbers correspond to those in the Sample Terms of Reference (TOR) Outline in Annex 1-3, additional paragraphs are not numbered

1 Introduction This section will state the purpose of the terms of reference, identify the industrial development project to be assessed, and explain the executing arrangements for the environmental assessment Industrial development projects include, but are not limited to industrial production facilities (e g , chemical, petrochemical, pulp and paper, iron and steel, nonferrous metals, petroleum refining, cement, fertilizer, and food processing plants), raw materials sources (e g., mines and wells, and related handling, processing and storage facilities), raw materials and product transportation facilities (e g , marine terminals, deepwater ports, pipelines, roads, rail), and industrial pollution control facilities (e g , waste minimization systems, hazard reduction and emergency response systems, air emission control, wastewater treatment, residual disposal)

2. Background Information This section will provide pertinent background for potential parties who may conduct the environmental assessment, whether they are consultants or government agencies. The section will include a brief description of the major components of the proposed project, a statement of the need for it and the objectives it is intended to meet, the implementing agency, a brief history of the project (including alternatives considered), its current status and timetable, and the identities of any associated projects If there are other projects in progress or planned within the region which may compete for the same resources, identify them within this section

Major components of an industrial project to be described herein include, as appropriate local and foreign raw material sources (e g , hard rock mines, oil/gas wells, chemical plants, slaughterhouses, produce farms); processing operations (e g , process flow sequence, continuous or batch, size, production), expected markets for products (e g , local and foreign markets), transport systems (e g , roads, pipelines, rail, barge), pollution control systems (e g , source reduction and recycling to minimize wastes, stack gas emission control, non-point source emission control, wastewater treatment and discharge, solid waste disposal, spill prevention), supplies (e g , location of stocks of parts and chemicals, transport routes), staffing (e g , numbers of workers, skill requirements); services (e g., fire protection, security, transportation, medical), and community involvement (e.g , worker housing during construction)

3 Objectives This section will summarize the general scope of the environmental assessment and discuss its timing in relation to other aspects of project preparation, design, and execution. This section will identify constraints, if any, regarding the adequacy of existing environmental assessment baseline data and needs to phase additional data collection (e g , over several seasons) and assessment efforts so as not to hinder the rest of the project development schedule

4 Environmental Assessment Requirements This section will identify regulations and guidelines which will govern the conduct of the assessment or specify the content of its report They may include any or all of the following

- World Bank Operational Directive 4 00, Annex A "Environmental Assessment," and other pertinent ODs, OMSs, OPNs, and Guidelines,
- national laws and/or regulations on environmental reviews and impact assessments,
- regional, provincial or communal environmental assessment regulations, and
- environmental assessment regulations of any other financing organizations involved in the project

This section will identify design or operating standards which project components must address to be environmentally acceptable This will include, for example, effluent discharge limitations, air emission standards, receiving water quality standards, and occupational health and safety requirements

5 Study Area This section will specify the boundaries of the study area for the assessment Where appropriate, specify the right-of-way (ROW) width and alignment for pipelines and transportation corridors for raw material and product shipments For projects including mines and oil/gas wells, include the boundaries of the related ore bodies and well fields, respectively

If there are adjacent or remote areas which should be considered with respect to impacts of particular aspects of the project, identify them For example, where intermediate supplies for a processing operation will be generated at remote facilities, identify the remote facilities (e g , identify the sources of intermediate chemical supplies to be used at a pharaceutical plant), because an added demand for supplies from this remote facility may cause an environmental impact to the remote area

6 Scope of Work In some cases, the tasks to be carried out by a consultant will be known with sufficient certainty to be specified completely in the terms of reference In other cases, information deficiencies need to be identified and alleviated or specialized field studies or modelling activities performed to assess impacts, and the consultant will be asked to define particular tasks in more detail for contracting agency review and approval

7 Task 1. Describe the proposed project Provide information on the following location of all project-related development sites and ROW's, general layout of facilities at project-related development sites, flow diagrams of facilities/operations, design basis, size, capacity, flow-through of unit operations, pre-construction activities, construction activities, schedule, staffing and support, facilities and services, operation and maintenance activities, staffing and support, facilities and services, reclamation activities, such as in mining projects, required off-site investments, life expectancy for major components

Provide maps at appropriate scales to illustrate the general setting of project-related development sites and ROW's, as well as surrounding areas likely to be environmentally affected These maps shall include topographic contours, as available, as well as locations of major surface waters, roads, railways, town centers, parks and preserves, and political boundaries Also provide, as available, maps to illustrate existing land uses

8 Task 2. Description of the Environment Assemble, evaluate and present baseline data on the environmental characteristics of the study area Include information on any changes anticipated before the project commences

Physical environment geology (e g , stratigraphy and structure of well fields, seismic history of storage tank areas, integrity of geological layers protecting potable groundwater supplies), topography (e g , drainage patterns around construction areas, view-sheds around facilities), soils (e g , agricultural value, potential use for lining or soil cover in residue disposal), climate and meteorology (e g , prevailing wind patterns around stacks, precipitation patterns at residue disposal sites), ambient air quality (e g , ability to assimilate emissions and maintain air quality standards), (note input from other major pollutant generators in the area, if any), surface water hydrology (e g , downstream water resources from reservoirs, soil erosion and sedimentation potential, flood hazard potential), water resources (e g , adequacy of water supplies), coastal and oceanic parameters (e g , currents in docking areas, dispersion potential at effluent discharge locations), receiving water quality (e g , ability to assimilate effluent discharges and maintain water quality standards for desired uses), (note input from major pollutant generators in the area, if any), significant pollutant sources in the area and prospect for their mitigation

Biological environment flora and fauna, rare or endangered species within or in areas adjacent to project-related development sites or ROW's, sensitive habitats, including wetlands, parks or preserves, significant wildlands within or in areas downstream/downgradient of project-related development areas or ROW's, species of commercial importance in areas affected by the project, including coastal areas at docking facilities

Socio-cultural environment (include both present and projected where appropriate) population (i e , full time and seasonal), land use (i e , year-round and seasonal), planned development activities, community structure, employment and labor market, distribution of income, goods and services; recreation, public health, education, cultural properties (e g , archaeological and historically significant sites), indigenous peoples and traditional tribal lands, customs, aspirations and attitudes

9 Task 3. Legislative and Regulatory Considerations Describe the pertinent regulations and standards governing environmental quality, health and safety, protection of sensitive areas, protection of endangered species, siting, land use control, etc , at international, national, regional and local levels (The TOR should specify those that are known and require the consultant to investigate for others)

10 Task 4. Determination of the Potential Impacts of the Proposed Project Identify all significant changes which the project would incur These would include, but not be limited to, changes in the

following employment opportunities, wastewater effluents, air emissions, solid wastes, land use, infrastructure, exposure to disease, risk of industrial hazard, noise, traffic, sociocultural behavior Assess the impacts from changes brought about by the project on baseline environmental conditions as described above under Task 2

In this analysis, distinguish between significant positive and negative impacts, direct and indirect impacts, and immediate and long-term impacts Identify impacts which are unavoidable or irreversible Wherever possible, describe impacts quantitatively, in terms of environmental costs and benefits Assign economic values when feasible

Impact analysis for industrial projects should be divided between construction impacts and operation impacts For example, for pipelines, there are potential construction impacts of land clearing (e g , loss of vegetative habitat for wildlife) and operation impacts of pipeline maintenance (e g , use of herbicides) For mines, there are potential construction impacts of land clearing (e g , loss of lands for other uses, such as agriculture), operation impacts of materials handling (e g , dusts from mining and milling, tailings disposal), and reclamation (e g , return of the land to a natural state) For industrial manufacturing plants, there are potential construction impacts of housing construction workers (e g , market demand changes for local services) and operation impacts from process operations (e g , stack emissions, effluent discharges, noises, industrial hazards)

Assess the risk of occurence of potential industrial hazards (e g , accidental spills, fires, explosions, impoundment structural failure, gaseous releases) Consider the ability of the community to provide emergency response services for potential industrial hazards Consider the ability of the community to provide medical services to respond to emergencies Based on the above, assess the potential impacts

Characterize the extent and quality of available data, explaining significant information deficiencies and any uncertainties associated with predictions of impact If possible, give the TOR for studies to obtain the missing information For information which could not be obtained until after project execution commences, provide TOR for studies to monitor operations over a given time period and to modify designs and/or operational parameters based upon updated impact analysis

11 Task 5. Analysis of Alternatives to the Proposed Project The environmental assessment should include an analysis of reasonable alternatives to meet the ultimate project objective The analysis may lead to designs that are more sound from an environmental, sociocultural or economic point of view than the original project proposal The concept of alternatives extends to siting, design, fuels, raw materials and technology selection, construction techniques and phasing, and operating and maintenance procedures Include the "no action" alternative -- not constructing the project -- in order to demonstrate environmental conditions without it Alternatives should include the following the "no action" alternative (as discussed above), alternative means of meeting industrial product requirements, the alternative of upgrading existing facilities, alternative routes and sites, alternative design, and alternative methods of construction, including costs and reliability

be presented in appendices or a separate volume Unpublished documents used in the assessment may not be readily available and should also be assembled in an appendix Organize the environmental assessment report according to the outline below (This is the format suggested in OD 4 00, Annex A-1, the TOR may specify a different one to satisfy national agency requirements as long as the topics required in the Bank's directive are covered)

- Executive Summary
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- List of References
- Appendices
  - List of Environmental Assessment Preparers
  - Records of Inter-Agency and Public/NGO Communications
  - Data and Unpublished Reference Documents

17 Consulting Team The environmental assessment requires interdisciplinary analysis The general skills required of an environmental assessment team are environmental management planning, ecology, socio-economics, ecology, hydrology/hydrogeology, air quality analysis, water quality analysis, transportation planning For an industrial project, the project team will be specified to include specialists appropriate to the type of components in the industrial project as needed (e g , for deepwater ports, an oceanographer and marine biologist, for pipelines, a terrestrial biologist and cultural resources specialist, for industrial manufacturing plants an industrial process engineer, and air quality specialist, for industrial wastewater treatment, a civil/sanitary engineer and aquatic biologist) When possible, the TOR should provide an estimate of staff weeks/months required

18 Schedule This section will specify dates for progress reviews, interim and final reports, and other significant events

19 Other Information Include here lists of data sources, project background reports and studies, relevant publications, and other items to which the consultant's attention should be directed

Describe how the alternatives compare in terms of potential environmental impacts, capital and operating costs, suitability under local conditions (e g , skill requirements, political acceptability, public cooperation, availability of parts, level of technology), and institutional, training, and monitoring requirements When describing the impacts of alternatives, indicate which impacts would be irreversible or unavoidable and which could be mitigated

To the extent possible, quantify the costs and benefits of each alternative, incorporating the estimated costs of any associated mitigating measures Describe the reasons for selecting the proposed project over the other alternatives

12 Task 6. Development of Management Plan to Mitigate Negative Impacts For the proposed project, recommend feasible and cost-effective measures to prevent or reduce significant negative impacts to acceptable levels Include measures for emergency response to accidental events (e g , ruptures, leaks, tanker truck or ship accidents, fires, explosions), as appropriate Estimate the impacts and costs of those measures, and of the institutional and training requirements to implement them Consider compensation to affected parties for impacts which cannot be mitigated Prepare a management plan including proposed work programs, budget estimates, schedules, staffing and training requirements, and other necessary support services to implement the mitigating measures

13 Task 7. Identification of Institutional Needs to Implement Environmental Assessment Recommendations Review the authority and capability of institutions at local, provincial/regional, and national levels and recommend steps to strengthen or expand them so that the management and monitoring plans in the environmental assessment are likely to be effectively implemented The recommendations may extend to new laws and regulations, new agencies or agency functions, intersectoral arrangements, management procedures and training, staffing, operation and maintenance training, budgeting, and financial support

14 Task 8. Development of a Monitoring Plan Prepare a detailed plan to monitor the implementation of mitigating measures and the impacts of the project during construction and operation Include in the plan an estimate of capital and operating costs and a description of other inputs (such as training and institutional strengthening) needed to conduct it

15 Task 9. Assist in Inter-Agency Coordination and Public/NGO Participation Assist in coordinating the environmental assessment with other government agencies, in obtaining the views of local NGO's and affected groups, and in keeping records of meetings and other activities, communications, and comments and their disposition (The TOR should specify the types of activities, e g , interagency scoping session, environmental briefings for project staff and interagency committees, support to environmental advisory panels, public forum)

16 Report Provide an environmental assessment report which is concise and limited to significant environmental issues The main text should focus on findings, conclusions and recommended actions, supported by summaries of the data collected and citations for any references used in interpreting those data Detailed or uninterpreted data are not appropriate in the main text and should

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Ghana Environmental Regulations

EIA Procedures in Ghana

Purpose of EIA:

- To support goals of environmental management and sustainable development.
- To integrate environmental management and economic decisions at an early stage.
- To predict the consequences of a project from the environmental, social, economic, and cultural perspectives and to develop plans to mitigate adverse impacts.
- To provide avenues for the involvement of public, proponents, private and government agencies in the assessment and review of proposed undertakings.

EIA Procedures

1. Registration with EPA
2. Screening (25 days from registration EPA will make decision). One of four decisions made:
   - Objection to project
   - No objection to project
   - Preliminary EA required
   - EIA required
3. Scoping - identifies all key issues of concern. If adverse impacts may result an EIS will be required.

4. Terms of reference
   - Indicates what EIS will include.
   - 10 copies submitted to EPA
   - TOR review outcomes (15 days after receipt:
     - Rejection
     - Revision/modification
     - Acceptance/approval
5. Draft EIS Preparation

6. Draft EIS Review

- 10 copies submitted to EPA
- Copies made available to appropriate District Municipal/Metropolitan Assemblies
- 21-day public notice of EIS publication served by EPA
- If strong public concern, public meeting held by Board

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7. Environmental Permitting Decision

(a) EIS (no more than 150 pages)

- If draft EIS acceptable, final EIS is prepared.
  - 10 copies and a 3.5 floppy diskette (ASCII format) submitted to EPA.
  - Proponent issued Environmental Permit for the project (15 days)
- If EIS is not acceptable, a revised EIS may submitted at late date or further studies may be conducted.

(b) Preliminary Environmental Report (PER)

- Provides sufficient information on project whether EIS is required or not. If EIS required, then Environmental Permit (EP) cannot be issued on the basis of the PER.
- If PER is accepted, then EP is issued.

(c) Registration

- If no information is required beyond registration stage, then EP is issued.

8. Fee - paid prior to receiving EP.

9. Post-Audit - EPA implements during project activities.

10. Environmental Management Plan - after first year of operation, an EMP is submitted every 3 years

11. Annual Environmental Report - Projects covered by EISs and/or EMPs submit annual reports on operations.

12. Penalties

PART IV—ADMINISTRATION AND GENERAL PROVISIONS

20 Organisation of the Agency
21 Executive Director and his functions
22 Appointment of other staff
23 Delegation of power of appointment
24 Expenses of the Agency
25 Accounts and audit
26 Annual report and other reports
27 Request for information
28 Regulations
29 Interpretation
30 Dissolution, repeal and vesting

THE FOUR HUNDRED AND NINETIETH

ACT

OF THE PARLIAMENT OF THE REPUBLIC OF GHANA

ENTITLED

THE ENVIRONMENTAL PROTECTION AGENCY ACT, 1994

AN ACT to provide for the establishment of an Environmental Protection Agency in place of the Environmental Protection Council and for related purposes

DATE OF ASSENT *30th December, 1994*

BE IT ENACTED by Parliament as follows—

PART I—ESTABLISHMENT OF THE ENVIRONMENTAL PROTECTION AGENCY

1. (1) There is established by this Act a body to be known as the Environmental Protection Agency referred to in this Act as the "Agency" Establishment of Agency

(2) The Agency shall be a body corporate with perpetual succession and a common seal and may sue and be sued in its corporate name

(3) The Agency shall for the discharge of its functions have power to acquire and hold any movable or immovable property and to enter into any contract or other transaction

THE ENVIRONMENTAL PROTECTION AGENCY ACT, 1994

ARRANGEMENT OF SECTIONS

PART I—ESTABLISHMENT OF THE ENVIRONMENTAL PROTECTION AGENCY

Section

1 Establishment of Agency
2 Functions of the Agency
3 Ministerial directions
4 Governing body of Agency
5 Tenure of office of members
6 Allowances for members
7 Meetings of the Board
8 Disclosure of interest
9 Committees of the Board
10 Hazardous Chemicals Committee
11 Regional and district offices of the Agency

PART II—ENFORCEMENT AND CONTROL

12 Power of Agency to request for environmental impact assessment
13 Enforcement notice
14 Power of Minister relating to enforcement notice
15 Environment Protection Inspectors and their powers

PART III—NATIONAL ENVIRONMENT FUND

16 Establishment of Environment Fund
17 Object of Fund
18 Management of the Fund
19 Functions of the Board in relation to the Fund

3 The Minister may give to the Agency such directives f a general nature as to the policy to be followed by the gency in the performance of its functions as appear to the Minister to be necessary in the public interest

4 (1) The governing body of the Agency shall be a Board which shall be responsible for the discharge of the functions of the Agency

(2) The Board shall consist of the following members appointed by the President in consultation with the Council of State—

(*a*) a chairman who shall be a person knowledgeable in environmental matters,

(*b*) the Executive Director of the Agency,

(*c*) a representative of the Council for Scientific and Industrial Research, not below the rank of Principal Research Officer,

(*d*) a representative of the Ghana Standards Board, not below the rank of Principal Scientific Officer,

(*e*) a representative, not below the rank of Director from the Ministries responsible for—

(i) Environment,

(ii) Local Government,

(iii) Finance,

(iv) Health, and

(v) Education,

(*f*) a representative of the Association of Ghana Industries, and

(*g*) three other persons at least one of whom shall be a woman

(3) One of the members appointed under subsection (2) (*g*) of this section shall be a person knowledgeable in finance or commerce

(4) The President shall in making the appointments regard to the knowledge, expertise

Tenure of office of members

5. (1) A member of the Board other than the Executive Director shall hold office for a period not exceeding three years and shall on the expiration of that period be eligible for re-appointment

(2) A member of the Board other than the Executive Director may at any time by letter addressed to the President resign his office

(3) A member who is absent from three consecutive meetings of the Board without sufficient cause shall cease to be a member

(4) The Chairman or a member of the Board may be removed from office by the President for inability to perform the functions of his office, for stated misbehaviour or for any other just cause

(5) The Chairman of the Board shall through the Minister notify the President of vacancies that occur in the membership of the Board within one month of the occurrence of the vacancy

Allowances for members

6 The Chairman and the other members of the Board shall be paid such allowances as the Minister, in consultation with the Minister responsible for Finance, may determine

Meetings of the Board

7 (1) The Board shall meet for the despatch of business at such times and in such places as the Chairman may determine but shall meet at least once every three months

(2) The Chairman shall upon the request of not less than one-third of the membership convene a special meeting of the Board

(3) The quorum at a meeting of the Board shall consist of seven members and shall include the Executive Director or the person acting in that capacity

(4) Every meeting of the Board shall be presided over by the Chairman and in his absence by a member of the Board elected by the members present from among their number

(5) Questions before the Board shall be decided by a majority of the members present and voting

2. The functions of the Agency are—

(a) to advise the Minister on the formulation of policies on all aspects of the environment and in particular make recommendations for the protection of the environment,

(b) to co-ordinate the activities of bodies concerned with the technical or practical aspects of the environment and serve as a channel of communication between such bodies and the Ministry,

(c) to co-ordinate the activities of such bodies as it considers appropriate for the purposes of controlling the generation, treatment, storage, transportation and disposal of industrial waste,

(d) to secure in collaboration with such persons as it may determine the control and prevention of discharge of waste into the environment and the protection and improvement of the quality of the environment

(e) to collaborate with such foreign and international agencies as the Agency considers necessary for the purposes of this Act,

(f) to issue environmental permits and pollution abatement notices for controlling the volume, types, constituents and effects of waste discharges, emissions, deposits or other source of pollutants and of substances which are hazardous or potentially dangerous to the quality of the environment or any segment of the environment,

(g) to issue notice in the form of directives, procedures or warnings to such bodies as it may determine for the purpose of controlling the volume, intensity and quality of noise in the environment,

[illegible] guidelines relating to

the discharge of wastes and the control of toxic substances,

(i) to ensure compliance with any laid down environmental impact assessment procedures in the planning and execution of development projects, including compliance in respect of existing projects

(j) to act in liaison and co-operation with government agencies, District Assemblies and other bodies and institutions to control pollution and generally protect the environment,

(k) to conduct investigations into environmental issues and advise the Minister thereon,

(l) to promote studies, research, surveys and analyses for the improvement and protection of the environment and the maintenance of sound ecological systems in Ghana,

(m) to initiate and pursue formal and non-formal education programmes for the creation of public awareness of the environment and its importance to the economic and social life of the country,

(n) to promote effective planning in the management of the environment,

(o) to develop a comprehensive database on the environment and environmental protection for the information of the public,

(p) to conduct seminars and training programmes and gather and publish reports and information relating to the environment,

(q) to impose and collect environmental protection levies in accordance with this Act or regulations made under this Act

(r) to co-ordinate with such international agencies as the Agency considers necessary for the purposes of this Act, and

(s) to perform any other functions conferred on it

(6) The Chairman or the person presiding at a meeting of the Board shall in the event of equality of votes have a second or casting vote

(7) The Board may co-opt any person to act as an adviser at its meetings but no co-opted person is entitled to vote at the meeting

(8) The validity of the proceedings of the Board shall not be affected by a vacancy among its members or by a defect in the appointment or qualification of a member

(9) Except as otherwise expressly provided for under this section, the Board shall determine and regulate the procedure for its meetings

8 (1) A member of the Board who is directly or indirectly interested in any matter being considered or dealt with by the Board shall disclose the nature of his interest at a meeting of the Board and shall not take part in any deliberation or decision of the Board with respect to the matter

(2) A member who fails to disclose his interest under subsection (2) of this section shall be removed from the Board

9 The Board may for the discharge of the functions of the Agency appoint committees of the Board comprising members of the Board or non-members or both and assign to any such committee such functions of the Agency as the Board may determine

10 (1) Without prejudice to section 9 of this Act there is established by this Act a committee of the Board to be known as the "Hazardous Chemicals Committee"

(2) The Hazardous Chemicals Committee shall consist of—

(*a*) the Executive Director who shall be the Chairman,

(*b*) one representative of the—

(i) Ghana Standards Board,

(ii) Ghana Atomic Energy Commission,

(iii) Ghana Cocoa Board,

(iv) Crops Services Department of the Ministry of Food and Agriculture,

(v) Veterinary Services Department of the Ministry of Food and Agriculture,

(vi) Council for Scientific and Industrial Research,

(*c*) three officers from the Agency, and

(*d*) three other persons being persons with specialised knowledge and experience in toxic chemical management

(3) The functions of the Hazardous Chemicals Committee shall be to—

(*a*) monitor the use of hazardous chemicals by collecting information on the importation, exportation, manufacture, distribution, sale, use and disposal of such chemicals,

(*b*) advise the Board and the Executive Director on the regulation and management of hazardous chemicals, and

(*c*) perform such other functions relating to such chemicals as the Board or the Executive Director may determine

11. (1) There shall be established in each regional capital of Ghana and in such districts as the Board may determine regional and district offices of the Agency

Regional and district offices of the Agency

(2) A regional or district office of the Agency shall be provided with such public officers as the Board in consultation with the Public Services Commission shall determine

(3) A regional or district office of the Agency shall perform such functions of the Agency in the region or district as the Board shall direct

PART II—ENFORCEMENT AND CONTROL

12 (1) The Agency may by notice in writing require any person responsible for any undertaking which in the opinion of the Agency has or is likely to have adverse effect on the environment to submit to the Agency in respect of

Power of Agency to request for environ-

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ie undertaking an environmental impact assessment con-
uining such information within such period as shall be
pecified in the notice

(2) Where the Agency issues a notice under sub-section
1), it shall inform any organ or department of government
that has responsibility for the issue of any licence, permit,
approval or consent in connection with any matter affecting
the environment that the notice has been issued, and the
organ or department shall not grant the licence, permit,
approval or consent unless it has been notified by the Agency
that the notice has been complied with

13 (1) Where it appears to the Agency that the activities
of any undertaking poses a serious threat to the environ-
ment or to public health, the Agency may serve on the
person responsible for the undertaking, an enforcement
notice requiring him to take such steps as the Agency
thinks necessary to prevent or stop the activities

(2) An enforcement notice shall specify—

(*a*) the offending activity,

(*b*) the steps required to be taken, and

(*c*) the time within which the steps shall be taken,

(3) The Agency may in an enforcement notice direct
the immediate cessation of the offending activity where
it considers that the circumstances so demand

(4) Any person who acts contrary to an enforcement
notice issued under this section commits an offence and
shall be liable on summary conviction to a fine not exceed-
ing ¢2 million and in default to imprisonment for a term
not exceeding one year

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14 (1) Where a person to whom a notice has been
served under subsection (1) of section 13 fails to comply
with th[illegible]rectives contained in the notice within the sti-
pulated [illegible]e or such further period as the Agency may
[illegible] the Minister, may without prejudice to a prosecu-
[illegible] of [illegible]tion 13, take such steps as
[illegible]nce with the

(2) Where authorized by the Minister acting by virtue of subsection (1), a police officer, an officer of the Agency or any public officer authorised by the Minister may use such force as may be necessary for the purpose of ensuring compliance with the enforcement notice

(3) Any person who hinders or obstructs any person acting under this section commits an offence and shall be liable on summary conviction to a fine not exceeding ¢500,000 or to imprisonment for a term not exceeding six months

(4) Any amount reasonably incurred by the Minister or any institution to prevent or stop the offending activities may be recovered from the person responsible as a civil debt, unless a court considers that the amount was incurred unnecessarily

Environment Protection Inspectors and their powers

15 (1) There shall be appointed by the Board officers designated as Environment Protection Inspectors referred to in this Act as "Inspectors"

(2) An Inspector or any person authorised by the Board may at any reasonable time enter any premises for the purpose of ensuring compliance with this or any other law pertaining to the protection of the environment and shall, if required to do so by the person in charge of the premises, produce his authority to the person

(3) Any person who assaults or obstructs a duly authorized person acting in the execution of his duty under subsection (1) commits an offence and shall be liable on summary conviction to a fine not exceeding ¢500,000 or to imprisonment not exceeding six months or to both

PART III—NATIONAL ENVIRONMENT FUND

Establishment of Environment Fund

16. (1) There is established by this Act a fund to be known as the National Environment Fund referred to in this Act as the "Fund"

(2) The sources of money for the Fund shall be—

(*a*) grants from government for the protection or

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(*b*) levies collected by the Agency in the performance of its functions,

(*c*) donations from the general public, institutions and organisations, and

(*d*) gifts

of 17 Monies of the Fund shall be applied for—

(*a*) environmental education of the general public,

(*b*) research, studies and investigations relating to the functions of the Agency,

(*c*) human resource development, and

(*d*) such other purposes as the Board in consultation with the Minister may determine

age- it of the id 18 (1) The Fund shall be managed and administered by the Board which shall for this purpose include the Controller and Accountant-General or his representative

(2) All monies for the Fund shall be paid into a bank account for the purpose opened by the Board with the approval of the Controller and Accountant-General

(3) The provisions under sections 25 and 26 of this Act on accounts and audit and annual report shall apply to the Fund

Functions of the Board in relation to the Fund 19 (1) The Board shall for the purpose of managing the Fund—

(*a*) formulate policies to generate money for the Fund,

(*b*) determine the allocations to be made towards the objects of the Fund, and

(*c*) determine annual targets of the Fund

(2) The Board may invest such part of the Fund as it considers appropriate in government securities or in such manner as may be approved by the Minister in consultation with the Minister for Finance

[illegible] issued from the Fund shall be [illegible] the Executive

PART IV—ADMINISTRATION AND GENERAL PROVISIONS

Organisation of the Agency 20 The Board may create such departments or divisions in the Agency as the Board may consider necessary for the efficient discharge of the functions of the Agency

Executive Director and his functions 21 (1) There shall be appointed by the President in accordance with the advice of the Board given in consultation with the Public Services Commission an Executive Director of the Agency who shall be the chief executive of the Agency

(2) The Executive Director shall hold office on such terms and conditions as shall be specified in his letter of appointment

(3) Subject to such general directives as the Board may give, the Executive Director shall be responsible for the direction of the work of the Agency and for the day to day administration of the Agency and shall ensure the implementation of the decisions of the Board

(4) The Executive Director may delegate such of his duties as he may determine to any officer of the Agency but the Executive Director shall not be relieved from ultimate responsibility for the discharge of any delegated function

(5) The Executive Director shall act as secretary to the Fund

Appointment of other staff 22 (1) The Agency shall have such other officers and employees as may be necessary for the proper and effective performance of its functions under this Act

(2) Other public officers may be transferred or seconded to the Agency

(3) Appointment of officers of the Agency shall be made by the President in accordance with the advice of the Board given in consultation with the Public Services Commission and upon such terms and conditions as the appointing authority shall determine

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(4) The Agency may engage the services of such experts and consultants as the Board may determine

elegation f power of ppoint- ent

23 The President may in accordance with article 195 (2) of the Constitution delegate his power of appointment of public officers under this Part

xpenses of he Agency

24 Parliament shall annually provide to the Agency such sums of money as may be necessary for the efficient discharge of its functions under this Act

Accounts and audit

25. (1) The Board shall keep books of account and proper records in relation to them and the accounts and records of the Agency shall be in a form approved by the Auditor-General

(2) The accounts of the Agency shall be audited by the Auditor-General within six months after the end of each financial year

(3) The financial year of the Agency shall be the same as the financial year of the government

(4) The Executive Director shall prepare budget estimates for each financial year and present the estimates to the Board for its approval not later than two months before the end of the financial year

Annual report and other reports

26 (1) The Board shall as soon as practicable after the expiration of each financial year but within six months after the end of the year, submit to the Minister an annual report covering the activities and the operations of the Agency for the year to which the report relates

(2) The annual report submitted under subsection (1) shall include the report of the Auditor-General

(3) The Minister shall within two months after the [illegible]pt of the annual report submit a report to Parliament with such statement as he may consider necessary

Request for information

27 (1) The Executive Director or any officer of the Agency authorized by the Executive Director may request in writing from any person or request any person to attend at a time and place specified to give any information which the Executive Director considers reasonably necessary for the purposes of this Act

(2) Any person who—

(*a*) without reasonable excuse fails to provide information requested under subsection (1), or

(*b*) without reasonable excuse refuses or fails to attend as requested under subsection (1), or

(*c*) knowingly provides false information or any information which he has no reason to believe to be true, or

(*d*) obstructs any public officer in the lawful execution of any powers under this Act,

commits an offence and is liable on conviction to a fine not exceeding ₵2 million or to imprisonment for one year or to both

(3) Where an offence is committed under this Act or regulations made under it by a body of persons—

(*a*) in the case of body corporate other than a partnership, every director or an officer of the body shall also be deemed to be guilty of the offence, and

(*b*) in the case of a partnership every partner or officer of that body shall also be deemed to be guilty of that offence

(4) No person shall be deemed to be guilty of an offence by virtue of subsection (3) of this section if he proves that the offence was committed without his knowledge or connivance and that he exercised all due care and diligence to prevent the commission of the offence having regard to all the circumstances

28 (1) The Minister may on the advice of the Board by [illegible] egulations

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(2) Without prejudice to the generality of subsection (1) of this section, such regulation may provide for—

(*a*) standards and code of practice relating to the protection, development and rehabilitation of the environment,

(*b*) the category of undertakings, enterprises, constructions or developments in respect of which environmental impact assessment or environmental management plan is required by the Agency,

(*c*) the type, quantity, conditions or concentration of substances that may be released into the environment,

(*d*) the manufacture, importation, use, collection, storage, recycling, recovery or disposal of substances which may be hazardous to the environment,

(*e*) the disposal of waste generally,

(*f*) the protection of any particular species of fauna and flora,

(*g*) matters in respect of which fees are payable and the amount payable, and

(*h*) matters for which permits are required under this Act

(3) Notwithstanding section 9 of the Statutory Instruments Act, 1959 (No 52) regulations made under this section may impose a penalty not exceeding ₵2 million or imprisonment for a term not exceeding one year or both and in the case of a continuing offence an additional penalty not exceeding ₵200,000 in respect of each day on which the offence is continued

29 In this Act unless the context otherwise requires—

"Board" means the governing body provided for under section 4 (1) of this Act,

"person responsible" in relation to any undertaking, enterprise, construction or development, includes any person at whose order or on whose behalf the undertaking, enterprise, construction or development is being done or will be done,

"premises" includes any building, land, ship, aircraft, caravan but does not include a building or place used exclusively as a dwelling house

Dissolution, repeal and vesting

30 (1) The Environmental Protection Council Decree, 1974 (N R C D 239) and the Environmental Protection Council (Amendment) Decree, 1976 (S M C D 58) are repealed by this Act and accordingly the Council established under that Decree is dissolved

(2) Notwithstanding the repeal under this section any instrument, any permit or order issued under the repealed enactment and in force at the commencement of this Act shall continue in force until altered or revoked under this Act

(3) All rights, assets, properties, obligations, liabilities held for or on behalf of the dissolved Environmental Protection Council and all persons employed for or by the dissolved Council are by this section transferred to the Agency established under this Act

Date of *Gazette* notification 30th December, 1994

FINAL DRAFT

ENVIRONMENTAL IMPACT ASSESSMENT PROCEDURES IN GHANA

ISSUED BY

ENVIRONMENTAL PROTECTION AGENCY

APRIL 1995

511

ACKNOWLEDGEMENTS

The Environmental Protection Agency acknowledges guidance gained from materials from various countries in the form of guidelines procedures and technical papers Notable among these are Australia, Canada Philippines, Thailand, Malaysia Korea, Japan Indonesia, Brazil and United Kingdom

512

Table of Contents

1 0 INTRODUCTION

1 1 Background

1 2 The Need for Environmental Management

2 0 THE ENVIRONMENTAL IMPACT ASSESSMENT PROCESS

2 1 Environmental Impact Assessment in Ghana

2 2 Purpose of Environmental Impact Assessment

3 0 THE EIA PROCEDURES

3 1 Registration

3 2 Screening

3 3 Scoping

3 4 Terms of Reference

3 5 Environmental Impact Statement (EIS) Preparation

3 6 Environmental Impact Statement (EIS) Review

3 7 Environmental Permitting Decisions (EPD)

3 7 1 EIS

3 7 2 Preliminary Environmental Report

3 7 3 Registration

3 7 4 Validity

4 0 POST-AUDIT

5 0 CONSIDERATION FEE

6 0 ENVIRONMENTAL MANAGEMENT PLANS

7 0 ENVIRONMENTAL REPORT

8 0 PENALTIES

APPENDICES

Appendix	1	Definitions
	2	Screening Decisions
	3	Principles for Parties in EIA Process
	4	EIA Application (Registration) Form
	5	Guide for Completing An EIA Application Form
	6	Undertakings Requiring Registration
	7	A. Environmental Critical Projects
		B Environmental Sensitive Areas
	8	Contents of Environmental Impact Statement
	9	Check list of Potential Environmental Impacts to be Considered for Inclusion in EIS
	10	EIS Review Criteria
	11	Environmental Management Plan (EMP) Outline

514

1 0 INTRODUCTION

1 1 Background

The National Environmental Policy aims at ensuring a sound management of resources and the environment and to avoid any exploitation of these resources in a manner that might cause irreparable damage to the environment The policy endorses the preventive approach to environmental management and emphasises the need to promote socio-economic development within the context of prescribed acceptable environmental standards and safeguards In effect it seeks a reconciliation between economic planning and environmental resource development with the view to achieving sustainable national development

The Policy Statement seeks to among other things

i) to ensure environmentally sound use of both renewable and non-renewable resources in the process of national development

ii) to develop procedures for the utilisation of land resources in a manner that will ensure the maximum degree of economy in the use of land and avoid or minimise conflicts

iii) to institute and implement by requiring prior environmental impact assessments of new investments and developments that would be deemed to affect the quality of the environment

1 2 The Need for Environmental Management

Environmental consideration is increasingly taking centre-stage in development planning and policy decision-making process at all levels individuals business enterprises national and global This is due to growing concerns over the damage being caused to the environment by various activities in our quest for social progress and economic development It is now widely accepted that the quality of life is being threatened by the effects of air and water pollution the

destruction of forests degradation of agricultural lands and uncontrolled exploitation of natural resources

Our current destructive paths of development are clearly unsustainable and there is now the need to preserve the integrity and the natural resource base of the environment, both for the present and future generations through effective environmental management interventions and strategies

Environmental Impact Assessment(EIA) is one of the environmental management tools that has the potential to contribute towards the sustainable use of environmental resources It is in recognition of the immense demonstrated potential of EIA, that the Environmental Protection Agency(EPA) Act 490 mandates the Agency to ensure compliance of all investments and undertakings with any laid down environmental impact assessment procedures in the planning and execution of development projects including compliance in respect of existing projects

2 0 THE ENVIRONMENTAL IMPACT ASSESSMENT PROCESS

2 1 Environmental Impact Assessment In Ghana

Environmental Impact Assessment (EIA) is recognised and applied in Ghana to project/ development planning as well as other undertakings as an environmental permitting pre-requisite and a major environmental management tool Procedures now exist which have evolved over time since EIA became a requirement in Ghana in 1989 to screen and evaluate all developments, undertakings projects and programmes which have the potential to give rise to significant environmental impacts

These procedures establish an EIA process of which one principal objective is the requirement to provide enough relevant information to enable the Environmental Protection Agency to set an appropriate level of assessment of any proposed undertaking investment or programme for the necessary review and to facilitate the decision-making process for Environmental Impact Assessment approval The information may be gathered through an environmental impact assessment study and published in an Environmental Impact Statement

(EIS) Preliminary Environmental Report (PER) or just by completing an EIA Registration Form depending on the complexity/nature and location of the proposed undertaking

2 2 Purpose Of Environmental Impact Assessment

The purpose of environmental impact assessment is

(a) to support the goals of environmental management and sustainable development,

(b) to integrate environmental management and economic decisions at the earliest stages of planning an undertaking programme or investment,

(c) to predict the consequences of a proposed undertaking from the environmental, social economic and cultural perspectives and to develop plans to mitigate any adverse impacts,

(d) to provide avenues for the involvement of the public, proponents private and government agencies in the assessment and review of proposed undertakings

3 0 EIA PROCEDURES

3 1 Registration

Every undertaking/development that may have an impact on the environment is required to be registered with the EPA A special form for this purpose Environmental Assessment Form is available at EPA offices the Registrar General s Department the District Municipal and Metropolitan Assemblies (see Appendix 4)

The responsibility for registering an undertaking/development lies with the proponent

The responsibility for determining what constitutes an impact on the environment with respect to an undertaking/development lies with EPA

3 2 Screening

Within 25 days from the time a registration form is received the Environmental Protection Agency will make a decision by placing the undertaking at the appropriate level of assessment

In making the decision at this stage consideration will be given to the following

(i) the location, size and output of proposed undertaking

(ii) the technology to be used

(iii) concerns of the general public

(iv) land use considerations

(v) any other factors relevant to the particular undertaking

A screening report will be prepared summarising the decision reached which could be one of four decisions (see Appendix 2)

(i) objection to the undertaking

(ii) No objection to the undertaking

(iii) Preliminary Environmental Assessment will be required

(iv) Environmental Impact Assessment required

3 Scoping

Whenever the screening result of the initial registration of the proposal or a subsequent Preliminary Environmental Report (PER) indicates that significant adverse environmental impact may result from the undertaking the proponent will be required to submit an Environmental Impact Statement (EIS)

The first step for the proponent is to commission a thorough fact finding evaluation of the proposed (alternative) site(s) and to consult with interested and affected parties such as government officials (relevant ministries departments local authorities etc), traditional authorities and members of the public The objective is to determine how their concerns and others will be addressed in the terms of reference for the EIA Furthermore, the scoping process identifies all the key issues of concern

3 4 Terms of Reference

The proponent prepares draft 'Terms of Reference" (TOR) and submits ten (10) copies to EPA The draft TOR must indicate that the EIS will include

(i) a description of the proposed undertaking and an analysis of the need/reason for the undertaking

(ii) the objective of the undertaking

(iii) other options for carrying out the undertaking

(iv) alternatives to the undertaking

(v) a description of the present environment that would be affected directly or indirectly

(vi) a description of the future environment predicting its condition if the undertaking did not take place

(vii) the impacts that may be caused to the environment by the undertaking

(viii) proposed measures to prevent or mitigate all adverse impacts,

(ix) an evaluation of opportunities and constraints to the environment of the undertaking

(x) a proposal for an environmental management programme to cover constructional, operational and decommissioning stages of the undertaking

(xi) proposals for a programme of public information

The draft TOR will be studied by EPA and where necessary a visit to the site(s) will be made The outcome of the study on the TOR which could either be a rejection or revision/modification or acceptance/approval will be communicated to the proponent within 15 days on the receipt of the TOR

On approval of the TOR the proponent may start work immediately on the preparation of the Environmental Impact Statement.

3 5 Environmental Impact Statement (EIS) Preparation

The proponent commissions detailed Environmental Impact Assessment study involving baseline survey and inventory development proposal options potential impact identification, prediction and evaluation mitigation considerations and commitments as well as a relevant environmental management programme and other contents of the TOR

In the course of gathering data for the EIS preparation the proponent is required to initiate a public information programme for the area likely to be affected by the undertaking Through such a programme, local residents will be fully informed of the nature of the undertaking and its effects on the environment Copies of all reports on original studies undertaken in relation to the EIA will be made available to EPA The concerns of the public shall be recorded and must be addressed in the EIS Public notice of the assessment process for the undertaking

will be issued by EPA through newspaper advertisements and/or by announcements posted in appropriate public places

3 6 Environmental Impact Statement Review

Once the final draft of the Environmental Impact Statement is completed, the proponent shall submit 10 copies to EPA Copies shall be made available to appropriate District Municipal/Metropolitan Assemblies A 21-day public notice of the EIS publication shall be served by EPA for public information and reaction, through media advertisement or posting to appropriate places as part of the review process EPA will collate public views and shall undertake a field/site verification exercise if considered necessary

If a strong public concern over the undertaking is indicated and impacts are extensive and far reaching, EPA shall refer to the Ministry responsible for the Environment to hold public hearing relating to the assessment The Minister would appoint a Board who will organise the public hearing on the proposed undertaking This Board will consist of three to five persons The Chairman will not be a resident of the area affected by the undertaking, but at least one-third of the Board's membership will reside in the geographic area, and the hearings will be held there The information received at these hearings together with the final report and any recommendations of the Board may be made public In the event where public hearing is held on an undertaking the processing of the application may extend beyond the normal 90-day period for processing an application

3 7 Environmental Permitting Decision (EPD)

3 7 1 Environmental Impact Statement (EIS)

Where the draft EIS is found to be acceptable the proponent shall be notified to finalise the EIS Following submission of 10 hard copies of the final EIS and a copy of 3 5 floppy diskette (ASCII format) to EPA the proponent shall be issued an Environmental Permit for the proposed undertaking

If the EIS is not acceptable the proponent may be required to re-submit a revised statement at a later date or to conduct further studies to modify the statement as necessary

3 7 2 Preliminary Environmental Report (PER)

2 The requirement for an PER is to provide sufficient information on the undertaking as a sound basis for the decision-making on whether an EIS is required for the undertaking or not. If the decision indicates that EIS is required then an Environmental Permit cannot be issued on the basis of the PER, and the proponent will accordingly be advised to continue at or re-route through scoping (section 3 3)

If the PER is accepted then an Environmental Permit will be issued to the proponent This does not preclude other licence(s) for carrying out the undertakings

3 7 3 Registration

If the decision indicates that no further information is required beyond the registration proposal stage, then the proponent will be issued with an Environmental Permit for the undertaking

3 7 4 Validity of Environmental Permit

There is a time limit on the validity of the environmental decision by EPA The decision is effective for a period of one year from the date that the proponent is advised of the decision If work has not commenced on the undertaking within that period the original decision becomes void and the undertaking must be re-registered

4 0 FEE

Where the undertaking is approved the proponent shall pay a fee prior to collection of the Environmental Permit The consideration fee shall be determined by EPA

5 0 POST-AUDIT

EPA shall undertake evaluation of positive and negative impacts of the development during implementation of project activities This will allow for compliance enforcement as well as learning from mistakes facilitate impact management and handling unanticipated impacts to aid in the improvement of EIA process and practice

5 1 ENVIRONMENTAL MANAGEMENT PLANS

All undertakings in Ghana shall be covered by Environmental Management Plans (EMPs) After one year of operation, a proponent is expected to submit an EMP every three (3) years (Refer to Appendix 11)

5 2 ANNUAL ENVIRONMENTAL REPORT

Undertakings which have prepared or are covered by EISs and/or EMPs are also expected to submit annual environmental reports on their operations (Refer to Appendix 12)

6 0 PENALTIES

Proponents who fail to comply with the requirements of the Environmental Impact Assessment Procedures shall be subject to the appropriate provisions in the Environmental Protection Agency Act (Act 490)

APPENDICES

APPENDIX 1

DEFINITIONS

Environment

In the context of this document, "Environment" is understood as the whole set of natural or biophysical and man-made or socio-cultural systems in which man and other organisms live work and interact

Environmental Impact Assessment(EIA)

This is a process for the orderly and systematic evaluation of a proposal including its alternatives and objectives and its effect on the environment including the mitigation and management of those effects The process extends from the initial concept of the proposal through implementation to completion and, where appropriate, decommissioning

Environmental Impact Statement (EIS)

This is a document prepared by the proponent to present the case for the assessment of their proposal as part of the environmental impact assessment process

EIS Review Report

This is a document prepared by the assessing authority to review the contents of an EIS to provide environmental advice on the proposal to decision-makers to facilitate decision-making

Environmental Significance

In the EIA context Environmental significance is a judgement on the importance and consequence of anticipated change imposed on the environment by a proposal

Monitoring

Monitoring is a term used in EIA to describe both the checking of the predicted impacts of a proposal in order to improve environmental management practices and to check the efficiency and effectiveness of the EIA process and the reporting of the results

Audit

Audit is a term used in EIA principally to describe the check for compliance with conditions of environmental approval but also as an internal review of environmental management practices by proponents Additionally it is a form of site evaluation for environmental liability before purchase or development by proponents The reporting of results applies to all of these uses of audit

Public

The public includes any individual or group of individuals

Undertaking or Development

An undertaking or development is any enterprise activity project structure building work policy proposal investment legislation plan or programme whose implementation may have a significant environmental impact Also such others as modification extension abandonment demolition or rehabilitation of undertakings and developments fall within this definition

Proponent/Developer

Any person or group of persons who carry out an undertaking or proposes to carry them out whether they be corporations companies agencies groups or individuals are described as proponent/developer A proponent may be either the person or organisation which owns manages controls or finances an undertaking

Preliminary Environmental Report (PER)

A Preliminary Environmental Report is a document which provides detailed information than is contained in the Registration Form especially concerning the effects which the undertaking would have on the environment as defined in the screening report

SCREENING DECISIONS

1 OBJECTION TO THE UNDERTAKING

An objection decision means that the undertaking as indicated in the registration form is not acceptable and must not proceed

An objection to a proposed undertaking or development raised at the screening stage could be due to the following

(a) the result of inappropriate siting,

(b) environmental sensitivity or incompatible landuse, etc

2 NO OBJECTION TO UNDERTAKING

A no objection decision to the undertaking means that the undertaking may proceed as stated in the registration form (of the EIA form) subject to relevant Acts, Bye laws and/or Regulations at any level of Government

APPENDIX 3

PRINCIPLES FOR PARTIES IN EIA PROCESS

PRINCIPLES FOR ASSESSING AUTHORITY (EPA)

a) Provide clear guidance on types of proposals likely to attract environmental impact assessment and on levels of assessment.

b) Provide proposal-specific guidelines (or a procedure for their generation) focused on key issues and incorporating public concerns, and a clear outline of the EIA process Amendments to guidelines should only be based on significant issues that arise after guidelines have been adopted

c) Provide guidance to all participants in the EIA process on criteria for environmental acceptability of potential impacts including such things as the principles of ecologically sustainable development, maintenance of environmental health relevant local and national standards and guidelines codes of practice and regulations

d) Negotiate with key participants to set an assessment timetable on a proposal-specific basis

e) Seek and promote public participation throughout the process

f) Ensure that the total and cumulative effects of using or altering community environmental assets (for example air water, amenity) receive explicit consideration

g) Report publicly on the assessment of proposals

h) Ensure predicted environmental impacts are monitored, the results assessed by a nominated responsible authority and feedback provided to improve continuing environmental management of proposals

i) Ensure that educational opportunities inherent in the EIA process are actively pursued *

PRINCIPLES FOR PROPONENTS

a) Take responsibility for preparing the statement required for assessment of a proposal

b) Consult the assessing authonty and the stakeholders as early as possible

c) Incorporate environmental factors fully into proposal planning including a proper examination of reasonable alternatives

d) Take the opportunity offered by the EIA process to improve the proposal environmentally

e) Make commitments to avoid adverse environmental impacts where possible Otherwise take necessary steps to minimise such impacts

f) Modify environmental management practices in accordance with environmental monitoring results

g) Identify and implement responsible corporate environmental policies strategies and management practices with periodic review *

PRINCIPLES FOR THE PUBLIC

a) Participate in the early stages of the process and evaluation of proposals through offering advice, expressing opinions providing local knowledge proposing alternatives and commenting on how a proposal might be changed to better protect the environment

b) Take a responsible approach to opportunities for public participation in the EIA process including the seeking out of objective information about issues of concern

528

APPENDIX 4

ENVIRONMENTAL PROTECTION AGENCY - GHANA

ENVIRONMENTAL ASSESSMENT - REGISTRATION FORM FORM EA 1

OFFICE USE ONLY	ASSESSMENT NO_____	FILE NO____

1 PROPONENT
Submitted by

_____

Address for correspondence

_____

_____

Contact person_____ **Position**_____

Phone No _____ **Fax No** _____

2 PROPOSED UNDERTAKING/DEVELOPMENT
Title of proposal (General Classification of undertaking)

_____

Description of Proposal (nature of undertaking, unit processes[flow diagram], raw materials, list of chemicals (source, types and quantities), storage facilities, wastes/ by-products (solid, liquid and gaseous)

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

529

Scope of Proposal (size of labour force, equipment and machinery, installed/production capacity, product type, area covered by facility/proposal, market

3 PROPOSAL SITE

Location (attach a site plan/map)

Current zoning

Distance to nearest residential and other facilities

Adjacent land uses (existing & proposed)

Site description

530

4 INFRASTRUCTURE AND UTILITIES

Structures (buildings and other facilities)

Water (source, quantity)

Power (type, source & quantity)

Drainage

Road

Other major utilities (eg sewerage, etc)

5 ENVIRONMENTAL IMPACTS

Potential effects of proposed undertaking on the environment (Both constructional and operational phases)

6 OTHER ENVIRONMENTAL ISSUES

Potential significant risks and hazards associated with the proposal (including occupational health and safety) Give details Detail briefly relevant environmental studies already done and attach copies as appropriate

_____

_____

_____

_____

_____

_____

_____

7 MANAGEMENT OF IMPACTS AND ENVIRONMENTAL ENHANCEMENT MEASURES

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

DECLARATION *I* *hereby declare that the information provided on this form is true to the best of my knowledge*

_____ _____

Signature Date

* Attach additional sheets where space provided is inadequate

532

APPENDIX 5

ENVIRONMENTAL PROTECTION AGENCY

GUIDE FOR COMPLETING AN ENVIRONMENTAL ASSESSMENT REGISTRATION FORM

FORM EA1

The registration form is designed to provide enough relevant information to enable the EPA to set an appropriate level of assessment for a proposal referred to it

It is not expected that this form will be appropriate for all purposes and depending on your proposal a short letter or a more lengthy document may be necessary instead of this form

PROPOSAL

A simple brief description of the proposal is requested and should include input processes end results output quantities and timing

Please include flow diagram if available

LOCATION

A map/site plan is essential

It should indicate the geographic coordinates of site (Longitude and Latitude) elevation and slope of the site, any nearby areas or features of environmental significance (e g proposed or declared reserves water courses wetlands) and adjacent land uses including the nearest homes or areas zoned residential

SERVICES

Details of water supply stormwater drainage power corridors, access to and impact on transport can all be of significance and should be noted where relevant

ENVIRONMENTAL IMPACT

Criteria for assessing a project and setting a level of assessment are

1 The character of the receiving environment
2 The potential impact of the proposal
3 Resilience of the environment to cope with change
4 Confidence of predicting impact

5 Plans policies or other procedures which provide ways to manage potential environmental impact

6 Other statutory decision-making processes which may provide a forum to examine relevant issues of concern

7 Degree of public interest

533

The following potential environmental impacts may be relevant

- effects on geomorphology, land stability and landscape
- effects on drainage and water quality (surface and ground)
- effects on biota
- effects on access and transport systems
- effects on existing services including power water and telephone
- effects on existing community facilities
- effects on existing contingency plans for safety and emergency services
- effects of emissions (gas dust and noise)
- management of solid and fluid wastes and stormwater
- impact on adjacent land uses including any conservation and recreation aspects
- impact of construction and operational activities
- visual impact
- social impact

UNDERTAKINGS REQUIRING REGISTRATION

AGRICULTURAL AND RELATED SERVICES

AGRICULTURE

Livestock Farms

- Community pastures

(a) involving the clearing of land of greater than 40 hectares in area or*

(b) involving the clearing of land located in an Environmentally Sensitive Area

Fruit and Other Vegetable farms

- Management Areas

(a) involving the clearing of land of greater than 40 hectares in area or*

(b) involving the clearing of land located in an Environmentally Sensitive Area

FISHING AND TRAPPING

Fishing

- Fish or shellfish farming in salt water brackish water or fresh water where the proposal includes the construction of shore-based facilities other than wharves

- Permanent traps or weir fisheries salt water

Services Incidental to Fishing

- Fish or shellfish breeding and propagating services or fish or shellfish hatchery services where the proposal includes the construction of shore-based facilities other than wharves

LOGGING AND FORESTRY

LOGGING

Logging

- Management of forested land for the primary purpose of harvesting timber in a concession area

FORESTRY SERVICES

Forestry Services

- Application of pesticides

- Introduction of exotic species of animals plants or microbial agents

- Establishment of forests in previously forested and unforested areas

MINING (INCLUDING MILLING), QUARRYING AND OIL WELLS

MINING

Metal Mines
Non-metal Mines

CRUDE OIL AND NATURAL GAS

Crude Oil and Natural Gas

- Crude oil or petroleum production facilities
- Natural gas production facilities

QUARRIES AND SAND PITS

Stone Quarries

(a) where the total area is greater than 10 hectares, or*

(b) where any portion is to be located within an Environmentally Sensitive Area

Sand and Gravel Pits

(a) where the total area is greater than 10 hectares, or*

(b) where any portion is to be located within an Environmentally Sensitive Area

MANUFACTURING

FOOD

Meat and Poultry Products

- Abattoirs
- Meat fat or oil processing facilities
- Poultry processing facilities

Fish Products

Flours, Prepared Cereal Foods and Feeds

- Feed Mills

BEVERAGES

Distillery Products
Brewery Products
Wines

RUBBER PRODUCTS

Tyres and Tubes
Rubber Hoses and Beltings
Other Rubber Products

PLASTIC PRODUCTS

Foamed and Expanded Plastic Products
Plastic Pipes and Pipe Fittings
Plastic Films and Sheetings
Other Plastic Products

LEATHER AND ALLIED PRODUCTS

Leather and Allied Products

- Leather tanneries

PRIMARY TEXTILES

Man-made Fibres and Filament Yarns
Spun Yarns and Woven Cloths
Broad Knitted Fabrics

TEXTILE PRODUCTS

Natural Fibres Processing and Felt Products
Carpets, Mats and Rugs
Canvas and Related Products
Other Textile Products

WOOD

Sawmill, Planing Mill and Shingle Mill Products Industries

- Sawmills with annual production capacities greater than cubic metres* solid lumber

Veneers and Plywoods

Other Wood Products

- Wood preservation facilities which use hazardous chemicals or similar chemical processes

- Particle board or wafer board production

PAPER AND ALLIED PRODUCTS

Pulp and Paper
Asphalt Roofing
Other Converted Paper Products

PRIMARY METALS

FABRICATED METAL PRODUCTS

TRANSPORTATION EQUIPMENT

Shipbuilding and Repair

- Facilities engaged in building and repairing all types of ships above 4 00 tonnes displacement including marine production platforms for petroleum natural gas or mineral resource extraction

NON-METALLIC MINERAL PRODUCTS

REFINED PETROLEUM PRODUCTS

CHEMICALS AND CHEMICAL PRODUCTS

Industrial Chemicals
Agricultural Chemicals
Plastics and Synthetic Resins
Paints and Varnishes
Soaps and Cleaning Compounds
Other Chemical Products

OTHER MANUFACTURING

Scientific and Professional Equipment

- Photographic films and plates manufacturing

Other Manufactured Products

- Floor tiles, linoleums and coated fabrics manufacturing

CONSTRUCTION

Industrial Construction (Other than Buildings)

- Construction of pipelines for the transmission of oil natural gas and other related products from the source to the point of distribution where

(a) any portion of the pipeline is to be located at a distance greater than 500 metres from an existing right-of-way or

(b) any portion of the pipeline is to be located in an Environmentally Sensitive Area

- Diesel electric power generating plants having a capacity greater than 1 megawatt

- Gas turbine electric power generating plants having a capacity greater than 1 megawatt

- Nuclear electric power generating plants

Highways and Heavy Construction

A Roads

B Waterworks and Sewage System

(1) Construction of trunk pipelines for transmission of water from the source to the point of distribution

(2) Construction of trunk sewer pipelines

(3) Construction of trunk sewer pipeline outfalls

C Hydroelectric Power Plants and Related Structures

(1) Construction of dams and associated reservoirs

(2) Inter - or intra-basin water transfers

(3) Construction of hydroelectric power developments

COMMUNICATION AND OTHER UTILITIES

OTHER UTILITIES

Other Utilities

- Establishment of waste disposal sites

- Establishment of facilities for the collection storage or disposal of hazardous waste materials

WHOLESALE TRADE

PETROLEUM PRODUCTS, WHOLESALE

Petroleum Products Wholesale

- Establishment of petroleum products storage facilities

OTHER PRODUCTS, WHOLESALE

Waste Materials Wholesale

- Establishment of facilities for the purpose of assembling breaking up sorting or wholesale trading of scrap junk or waste material of any type

SERVICES

SERVICES

Economic Services Administration

- Resource conservation and management programmes involving introductions of exotic species of animals or plants for any purpose

- Resource conservation and management programs involving introductions of native species of animals or plants into areas where those species do not occur at the time of the proposed introduction

- Designation of Land for cottage development or other recreational development

ACCOMMODATION, FOOD AND BEVERAGE SERVICES

ACCOMMODATION SERVICES

Establishment of Recreation and Vacation Camps

OTHER SERVICES

AMUSEMENT AND RECREATIONAL SERVICES

Commercial Spectator Sports

- Establishment of horse racetrack operations
- Establishment of racetrack operations for motorized vehicles

Sports and Recreation Clubs and Services

- Establishment of facilities including trails
- Establishment of outdoor firearm ranges
- Establishment of manna operations
- Establishment of facilities including trails for motorized recreational vehicles

Other Amusement and Recreational Services

APPENDIX 7

A ENVIRONMENTALLY CRITICAL PROJECTS

1 AGRICULTURE

(a) Land development for agriculture purposes not less than 40 hectares

(b) Agricultural programmes necessitating the resettlement of 20 families or more

2 AIRPORT

(a) Construction of all airports or airstrips as well as the enlargement of existing airports or airstrips

3 DRAINAGE AND IRRIGATION

(a) Construction of dams and man-made lakes

(b) Drainage of wetland

(c) Irrigation schemes

4 LAND RECLAMATION

Coastal land reclamation

Dredging of bars estuaries

5 FISHERIES

(a) Construction of fishing harbours

(b) Harbour expansion

(c) Land based aquaculture projects

6 FORESTRY

(a) Conversion of hill forest land to other land use

(b) Logging or conversion of forest land to other land use within the catchment area of reservoirs used for water supply irrigation or hydro-power generation or in areas adjacent to forest wildlife reserves

(c) Conversion of wetlands for industrial housing or agricultural use

7 HOUSING

Human settlement development projects

Housing development

8 INDUSTRY

(a) Chemical - Where production capacity of each product or combined products is greater than 100 tonnes/day*

541

(b) Petrochemicals - All sizes or raw materials requirements of 100 tonnes/day or greater*

(c) Non-ferrous - Smelting
Aluminium - all sizes
Copper - all sizes
Others - producing 50 tonnes/day and above product

(d) Non-metallic - Cement

Lime - 10 tonnes/day and above burnt lime rotary kiln or 50 tonnes/day and above vertical kiln *

(e) Iron and Steel

(f) Shipyards

(g) Pulp and Paper

9 INFRASTRUCTURE

(a) Construction of hospitals

(b) Industrial estate development

(c) Construction of roads and highways

(d) Construction of new townships

(e) Construction of railways

10 PORTS

(a) Construction of ports

(b) Port expansion involving an increase of 25 percent or more in handling capacity per annum

11 MINING

(a) Mining and processing of minerals in areas where the mining lease covers a total area in excess of 10 hectares

(b) Quarries

Proposed quarrying of aggregate limestone silica quartzite sandstone marble and decorative building stone within 3 kilometres radius of any existing residential commercial or industrial areas or any area earmarked for residential commercial or industrial development

(c) Sand dredging

12 PETROLEUM

(a) Oil and gas fields development

(b) Construction of off-shore and on-shore pipelines

(c) Construction of oil and gas separation processing handling and storage facilities

(d) Construction of oil refineries

(e) Construction of product depots for the storage of petrol gas or diesel which are located within 3 kilometres of any commercial, industrial or residential areas

13 POWER GENERATION AND TRANSMISSION

(a) Construction of steam generated power stations

(b) Dams and hydroelectric power schemes

(c) Construction of combined cycle power stations

(d) Construction of nuclear-fueled power stations

(e) Erection of Power Transmission lines

14 RESORT AND RECREATIONAL DEVELOPMENT

(a) Construction of coastal resort facilities or hotels with more than 40 rooms

(b) Hill top resort or hotel development.

(c) Development of tourist or recreational facilities in national parks

(d) Development of tourists or recreational facilities on islands in surrounding waters

15 WASTE TREATMENT AND DISPOSAL

(a) Toxic and Hazardous Waste

i) Construction of incineration plant
ii) Construction of recovery plant (off-site)
iii) Construction of wastewater treatment plant (off-site)
iv) Construction of secure landfills facility
v) Construction of storage facility (off-site)

(b) Municipal Solid Waste

i) Construction of incineration plant
ii) Construction of composting plant
iii) Construction of recovery/recycling plant
iv) Construction of municipal solid waste landfill facility
v) Construction of waste depots

(c) Municipal Sewage

i) Construction of wastewater treatment plant
ii) Construction of marine outfall
iii) Night soil treatment

16 WATER SUPPLY

(a) Construction of dams impounding reservoirs

(b) Groundwater development for industrial agricultural or urban water supply

17 ENVIRONMENTAL CONSERVATION MANAGEMENT

a) Decision to remove "designated status from an area designated for wildlife conservation and management

b) Decision of policy actions on

(i) wildlife conservation and management

(ii) forest conservation and management,

(iii) watershed conservation and management

(iv) commercial exploitation of fauna and flora

B ENVIRONMENTALLY SENSITIVE/CRITICAL AREAS

1 All areas declared by law as national parks, watershed reserves, wildlife reserves and sanctuaries including sacred groves

2 Areas with potential tourist value

3 Areas which constitute the habitat of any endangered or threatened species of indigenous wildlife (flora and fauna)

4 Areas of unique historic archaeological, or scientific interests

5 Areas which are traditionally occupied by cultural communities

6 Areas prone to natural disasters(geological hazards, floods, rainstorms earthquakes, landslides volcanic activity etc)

7 Areas prone to bushfires

8 Hilly areas with critical slopes

9 Areas classified as prime agricultural lands

10 Recharge areas of aquifers

11 Water bodies characterized by one or any combination of the following conditions

(a) tapped for domestic purposes

(b) within the controlled and/or protected areas

(c) which support wildlife and fishery activities

12 Mangrove areas characterised by one or any combination of the following conditions

(a) with primary pristine and dense growth

(b) adjoining mouth of major river system

(c) near or adjacent to traditional fishing grounds

(d) which act as natural buffers against shore erosion strong winds and storm floods

APPENDIX 8

CONTENTS OF ENVIRONMENTAL IMPACT STATEMENT

Proponents should discuss the scope of an environment impact assessment before its preparation An environmental impact statement is expected to be prepared in line with the final terms of reference agreed with EPA and must include inter alia, the following

a) a description of the proposed activity and an analysis of the need for the activity,

b) a consideration of the alternatives to the proposed activity, including the alternative of not proceeding with the proposed activity,

c) an analysis of the site selection procedure for the proposed activity including a statement of the reasons why the proposed site was chosen and the consideration of alternative sites

d) an identification of existing baseline environmental conditions including socio-economic aspects and other areas of major concern,

e) a description of potential positive and negative impacts of the proposed activity from the environmental social economic and cultural perspectives for different phases of the development (pre-construction construction operational, decommissioning as appropriate)

f) an analysis of the significance of the potential impacts as identified under clause (e) particularly as they relate to human health

g) the plans that have been or will be developed to mitigate the potential negative impacts as identified under clause (e) particularly as they relate to waste prevention minimisation and recycling

h) the plans that have been or will be developed to monitor environmental impacts that are predicted to occur and the plans that have been or will be developed to monitor proposed mitigation measures

i) the contingency plans that have been or will be developed in order to respond to unpredicted negative impacts

j) How the proponent implemented the agreed programme of public consultation in respect of the undertaking

k) any other information that the EPA considers necessary to assess the proposed activity

Generally EIS should not be more than 150 pages (excluding appendices) except those prepared for "exceptional' projects likely to cause a wide range of significant impacts

A non-technical executive summary of no more than 10 pages must be included at the beginning of the Environmental Impact Statement

The EIS should include maps plans tables ,graphs diagrams and other illustrative material that would make easy appreciation of the content of the EIS

CHECKLIST OF POTENTIAL ENVIRONMENTAL IMPACTS TO BE CONSIDERED FOR INCLUSION IN ENVIRONMENTAL IMPACT STATEMENTS

The Terms of Reference (TOR) for an Environmental Impact Statement may cover any or all of, and need not be restricted to, the following impacts of the pre-construction, construction operational and, where relevant, the decommissioning phases of a proposal and associated secondary developments

i) air, water and land (soil) pollutant concentrations at various locations from a source or sources,

ii) direct ecological changes resulting from these pollutant concentrations as they relate to species, communities and habitats of concern,

iii) alterations in ecological processes such as transfer of energy through food chains, decomposition and bioaccumulation which might affect species communities and habitats,

iv) ecological consequences of direct destruction of existing habitat(s) from actions such as dumping vegetation clearance and fillings etc

v) noise and/or vibration levels

vi) odour;

vii) increased traffic generation and resulting pollution ecological impacts and potential for increase in accidents,

viii) changes in socio-cultural and socio-economic patterns covering

a) decline in existing and/or potential use of valued resources arising from (i)-(iv) above and social/economic consequences

b) direct/indirect employment generation

c) in-migration and resulting demographic changes

d) infrastructure provision (roads schools, health facilities etc)

e) local economy,

f) cultural changes (including possible conflict) arising from foreign in-migrants and/or tourists,

g) changes/constraints on existing and/or potential land use(s) in the project area,

ix) health consequences of any or all of the above

This checklist is not exhaustive and it is general in its coverage It is to be used primarily, to assist formulation of TORs During discussions to prepare TORs it should be possible to specify particular aspects of concern for example that the effects of ground level concentrations of SO_2 and particulate are to be examined for their effect on (i) human health and (ii) agricultural production (iii) a rare plant species

EIS REVIEW CRITERIA

REVIEW GRADES

A Excellent no tasks left incomplete
B Good only minor omissions and inadequacies
C Satisfactory despite omissions and inadequacies
D Parts are well attempted, but must as a whole be considered just unsatisfactory because of omissions and/or inadequacies

E Poor significant omissions or inadequacies
F Very poor important tasks poorly done or not attempted

REVIEW CRITERIA

1 Description of the development, the local environment and the baseline conditions

1 1 Description of the development

The purpose and objectives of the development should be explained The description of the development should include the physical characteristics, scale and design as well as quantities of material needed during pre-construction construction and operational phases

1 2 Site description

The area of land affected by the development should be clearly shown on a map and the different land uses of this area clearly demarcated The affected site should be defined broadly enough to include any potential effects occurring away from the construction site (e g dispersal of pollutants traffic, changes in channel capacity of water courses as a result of increased surface run off etc)

1 3 Residuals

The types and quantities of waste matter energy and residual materials and the rate at which these will be produced should be estimated The methods used to make these estimations should be clearly described and the proposed methods of treatment for the waste and residual materials should be identified Waste should be quantified wherever possible

1 4 Baseline conditions

A description of the environment as it is currently and as it could be expected to develop if the project were not to proceed Some baseline data can be gathered from existing data sources but some will need gathering and the methods used to obtain the information should be clearly identified Baseline data should be gathered in such a way that the importance of the particular area to be affected can be placed into the context of the region or surrounding and that the effect of the proposed changes can be predicted

2 Identification and evaluation of key impacts

2 1 Identification of impacts

The methodology used to define the project specification should be clearly outlined including details of consultation with expert bodies (e g Planning Authorities NDPC Research Institutions Commissions, Local Authorities Ministries Departments Regulatory Agencies etc) and the public and reference to panel of experts guidelines checklists matrices

previous best practice examples of environmental impact assessments on similar projects (whichever are appropriate) Consideration should be given to impacts which may be positive or negative cumulative, short or long term permanent or temporary direct or indirect The logic used to identify the key impacts of the development on human beings, flora and fauna, soil water, air, climate, landscape material assets cultural heritage, or their interaction should be considered

2 2 Prediction of impact magnitude

The size of each impact should be determined as the predicted deviation from the baseline conditions, during the pre-construction and construction phases and during normal operating conditions and in the event of an accident when the proposed development involves materials that could be harmful to the environment (including people) The data used to estimate the magnitude of the main impacts should be clearly described and any gaps in the required data identified

The methods used to predict impact magnitude should be described and should be appropriate to the size and importance of the projected disturbance Where possible, estimates of impacts should be recorded in measurable quantities with ranges and/or confidence limits as appropriate Qualitative descriptions where necessary should be as fully defined as possible (e g 'insignificant" means not perceptible from more than 100m distance)

2 3 Assessment of impact significance

The significance of all those impacts which remain after mitigation should be assessed using the appropriate national and international quality standards where available Where no such standards exist the assumptions and value systems used to assess significance should be justified and the existence of opposing or contrary opinions acknowledged

3 Alternatives and mitigation

3 1 Alternatives

Alternative sites should have been considered where they are practicable and available to be developed The main environmental advantages and disadvantages of these should be discussed and the reasons for the final choice given Where available alternative processes designs and operating conditions should have been considered at an early stage of project planning and the environmental implications of these outlined

3 2 Mitigation

All significant adverse impacts should be considered for mitigation and specific mitigation measures put forward where practicable Mitigation methods considered should include modification of the project compensation and the provision of alternative facilities as well as pollution control It should be clear to what extent the mitigation methods will be effective Where the effectiveness is uncertain or depends on assumptions about operating procedures climatic conditions etc data should be introduced to justify the acceptance of these assumptions

3 3 Commitment to mitigation

Clear details of when and how the mitigation measures will be carried out should be given When uncertainty over impact magnitude and/or effectiveness of mitigation over time exists monitoring programmes should be proposed to enable subsequent adjustment of mitigation measures

4 Communication of results

4 1 Presentation

The report should be laid out clearly with the minimum amount of technical terms An index, glossary and full references should be given and the information presented so as to be comprehensible to the non specialist Also maps, diagrams, tables etc where appropriate should complement text. Technical information should be provided in the appendix

4 2 Balance

The environmental impact statement should be an independent objective assessment of environmental impacts and not a best case statement for the development Negative impacts should be given equal prominence with positive impacts and adverse impacts should not be disguised by euphemisms or platitudes Prominence and emphasis should be given to predict large negative or positive impacts

4 3 Non technical executive summary

There should be a non technical executive summary outlining the main conclusions and how they were reached The summary should be comprehensive containing at least a brief description of the project and the environment an account of the main mitigating measures to be undertaken by the developer and a description of any remaining or residual impacts A brief explanation of the methods by which these data were obtained and an indication of the confidence which can be placed in them should be included

APPENDIX 11

OUTLINE FOR PREPARING ENVIRONMENTAL MANAGEMENT PLAN (EMP) FOR MANUFACTURING INDUSTRY

1 **Introduction**

- Current trends in industry, competition baseline benchmark management goals

2 **Policy on the Environment, Health and Safety**

- Legal/Regulatory requirements with regard to your operations
- Objectives
- Options for achieving objectives (aim is to find those which are both practicable and environmentally acceptable)
- Evaluation of Options - advantages and disadvantages for environment (include both quantitative and qualitative evaluation)

3 **Strategy**

- Goals
- Objectives and Targets
- Priorities
- Costed Programme/budget

4 **Production Activities**

- Source and Type of Raw Materials
- Processing
- Purchasing
- Packaging
- Distribution
- etc

5 **Environmental Management Issues**

- Selection of production process
- Production planning
- Energy management savings and choices
- Water management and savings
- Raw materials savings choices and transportation

550

- Waste avoidance, minimization recycling, reuse transportation and disposal

- Prevention and limitation of environmental accidents

- Pollution types (visual, audial, thermal, solid liquid gaseous including odour) into environmental media (air, land and water), effects (long/short term, global/local, cumulative/one-off)

- Established procedures for responding to emergency situations

6 **Programme to Meeting Requirements**

- Management structure Organisation and Personnel - Eg officer responsible for EMP/Allocation of management responsibities and means to achieve targets

- Staff information training and participation on environmental issues

- Community relations - External Information and public participation including dealing with public complaints

- Life cycle of programme

7 **Implementation of Environmental Management Plan**

- Regulatory

- Good management practices

- Voluntary codes

- Monitoring achieved performance against targets

8 **Environmental Management Audit**

- Periodic activity to check on past and current environmental performance

9 **Environmental Management Reviews**

Re-examination of management system as well as policy objectives targets, etc

The company shall submit an EMP every 2 years The plan will cover 5 years and shall comprise a 2-year EMP and a 3-year rolling plan for the subsequent years

The company shall submit to the Environmental Protection Agency an annual environmental audit report at the end of each calendar year

NB Please attach site layout and design

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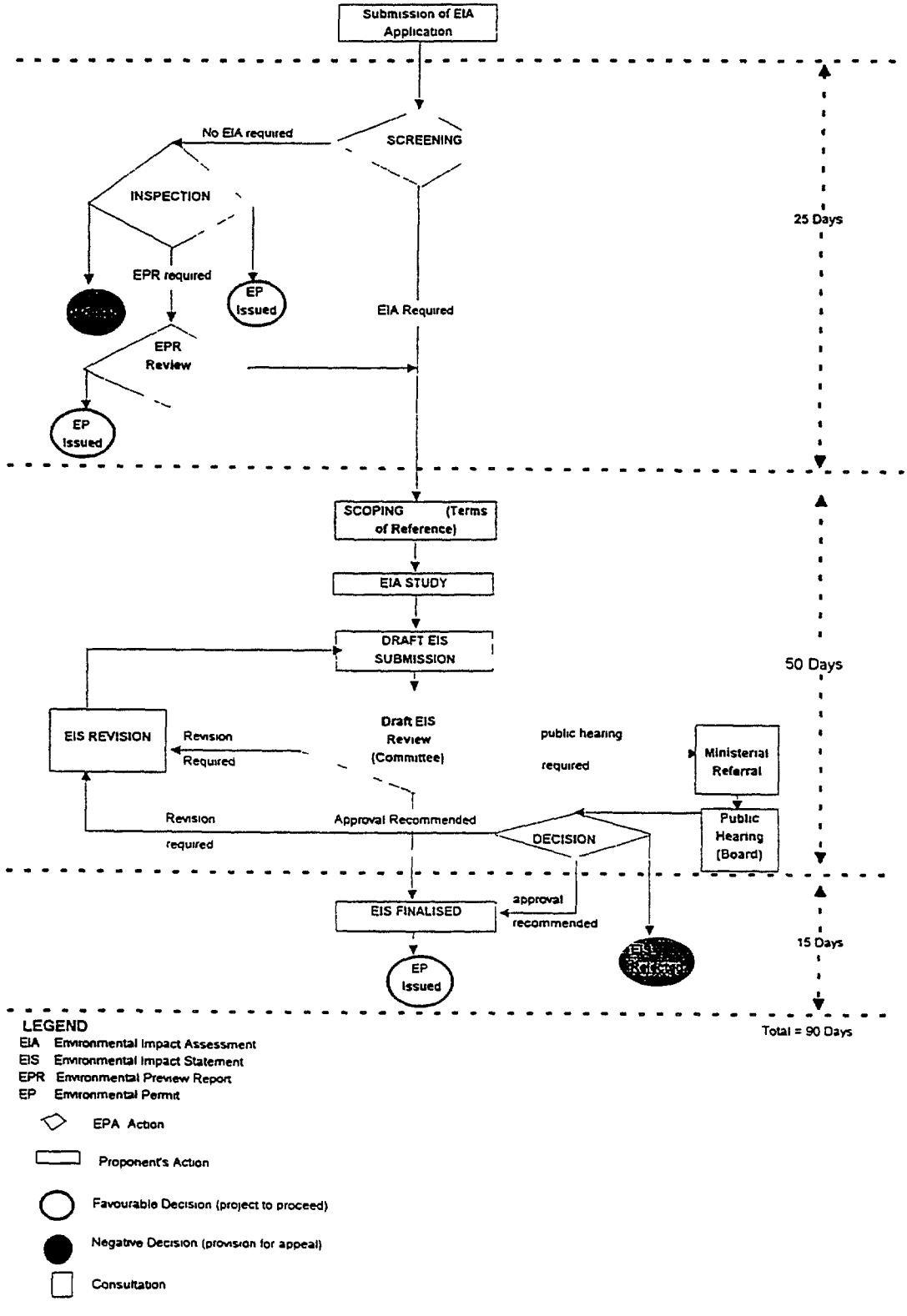
THE EIA PROCEDURE IN GHANA



LEGEND

EIA Environmental Impact Assessment
EIS Environmental Impact Statement
EPR Environmental Preview Report
EP Environmental Permit

EPA Action

Proponent's Action

Favourable Decision (project to proceed)

Negative Decision (provision for appeal)

Consultation

BEST AVAILABLE COPY

552

Sample EIA/EIS Outlines

Suggested Outline for Environmental Assessment

1 0 INTRODUCTION

2 0 NEED FOR THE PROJECT

3 0 PROJECT DESCRIPTION
- 3 1 Site Description
- 3 2 Description of Proposed Facility
  - 3 2 1 Site Layout
    - 3 2 1 1 Site Arrangement
    - 3 2 1 2 Water Supply Pipeline Corridor
  - 3 2 2 Power Generation Equipment
    - 3 2 2 1 Combustion Turbine Generator
    - 3 2 2 2 Heat Recovery Steam Generator
    - 3 2 2 3 Steam Turbine Generator
  - 3 2 3 Air Quality Control
  - 3 2 4 Heat Rejection System
  - 3 2 5 Fuel Supply and Storage
    - 3 2 5 1 Fuel Types and Quantities
    - 3 2 5 2 Fuel Supply Sources
    - 3 2 5 3 Fuel Storage Facilities
  - 3 2 6 Water Supply and Treatment
    - 3 2 6 1 Facility Water Uses and Quantities
    - 3 2 6 2 Water Supply Pipeline and Intake Structure
    - 3 2 6 3 Water Treatment
  - 3 2 7 Chemical Supply and Storage
    - 3 2 7 1 Chemical Types and Uses
    - 3 2 7 2 Chemical Storage and Handling
  - 3 2 8 Wastewater Treatment and Discharge
    - 3 2 8 1 Wastewater Sources and Quantities
    - 3 2 8 2 Wastewater Treatment and Disposal
  - 3 2 9 Solid Waste Management
    - 3 2 9 1 Solid Waste Sources and Types
    - 3 2 9 2 Solid Waste Disposal
  - 3 2 10 Electric Transmission Facilities
  - 3 2 11 Transportation Facilities
  - 3 2 12 Cost of Facility
- 3 3 Analysis of Alternatives
- 3 4 Regulatory Requirements

4 0 EXISTING ENVIRONMENT
- 4 1 Air Quality
  - 4 1 1 Existing Climatological Conditions
  - 4 1 2 Existing Air Quality Conditions
- 4 2 Geology and Soils

4 3 Water Resources
4 3 1 Existing Water Supplies and Uses
4 3 1 1 Ground Water
4 3 1 2 Surface Water
4 3 2 Existing Water Quality
4 3 2 1 Ground Water
4 3 2 2 Surface Water
4 4 Terrestrial Resources
4 4 1 Botanical Resources
4 4 1 1 Species Composition and Community Types
4 4 1 2 Wetlands
4 4 1 3 Species of Special Concern
4 4 2 Wildlife Resources
4 4 2 1 Habitat Types
4 4 2 2 Species Composition
4 4 2 3 Species of Special Concern
4 5 Aquatic Resources
4 5 1 Aquatic Habitat
4 5 2 Fish Communities
4 5 3 Invertebrate Communities
4 5 4 Species of Special Concern
4 6 Transportation
4 6 1 Existing Trafficways
4 6 2 Existing Traffic Volumes and Patterns
4 7 Land Use
4 7 1 Existing Land Uses and Land Use Plans
4 7 2 Existing Zoning Restrictions
4 8 Recreation
4 8 1 Existing Facilities
4 8 2 Existing Usages
4 9 Socioeconomics
4 9 1 Demographics
4 9 2 Housing
4 9 3 Wages and employment
4 9 4 Existing Public Facilities and Services
4 10 Cultural Resources
4 10 1 Archaeological Resources
4 10 2 Historic Resources
4 11 Aesthetics
4 12 Noise
4 13 Hazardous Wastes

5 0 ENVIRONMENTAL IMPACTS
5 1 Air Quality
5 1 1 Construction
5 1 2 Operation

5 2 Geology and Soils
- 5 2 1 Construction
- 5 2 2 Operation

5 3 Water Resources
- 5 3 1 Construction
- 5 3 2 Operation

5 4 Terrestrial Resources
- 5 4 1 Botanical Resources
  - 5 4 1 1 Construction
  - 5 4 1 2 Operation
- 5 4 2 Wildlife Resources
  - 5 4 2 1 Construction
  - 5 4 2 2 Operation

5 5 Aquatic Resources
- 5 5 1 Construction
- 5 5 2 Operation

5 6 Transportation
- 5 6 1 Construction
- 5 6 2 Operation

5 7 Land Use
- 5 7 1 Construction
- 5 7 2 Operation

5 8 Recreation
- 5 8 1 Construction
- 5 8 2 Operation

5 9 Socieconomics
- 5 9 1 Construction
- 5 9 2 Operation

5 10 Cultural Resources
- 5 10 1 Construction
- 5 10 2 Operation

5 11 Aesthetics
- 5 11 1 Construction
- 5 11 2 Operation

5 12 Noise
- 5 12 1 Construction
- 5 12 2 Operation

5 13 Hazardous Wastes

6 0 MITIGATION
- 6 1 Air Quality
- 6 2 Geology and soils
- 6 3 Water Resources
- 6 4 Terrestrial Resources
- 6 5 Aquatic Resources
- 6 6 Transportation

6 7 Land Use
6 8 Recreation
6 9 Socioeconomics
6 10 Cultural Resources
6 11 Aesthetics
6 12 Noise
6 13 Hazardous Wastes

7 0 Environmental Management Plan
7 1 Requirement
7 2 Plan Outline
7 3 Resources
7 4 Reporting
7 5 Emergencies

8 0 UNAVOIDABLE ADVERSE IMPACTS

9 0 AGENCY CONSULTATION PROCESS

10 0 LITERATURE CITED

Appendix I Sources of Data and Information
Appendix I(a) Terms of Reference for the Environmental Impact Assessment Study
Appendix I(b) (Draft) National Environmental Impact Assessment Regulations
Appendix I(c) Sri Lankan and Selected National Environmental Standards and Guidelines
Appendix I(d) Analyses of Lanka Heavy Diesel Oil and Chemical Naphtha
Appendix I(e) Water Quality Analyses and Monitoring Data
Appendix I(f) Ambient Air Quality Studies
Appendix I(g) Noise Level Survey
Appendix I(h) Terrestrial, Aquatic, and Socioeconomic Surveys
Appendix I(i) Plants Recorded from the Project Site
Appendix I(j) Animals Recorded from the Project Area

Appendix II References
Appendix III List of Preparers
Appendix IV Comments Made by Public, NGOO, and Other Agencies

PORT DICKSON POWER SDN BHD.

ENVIRONMENTAL IMPACT ASSESSMENT INCLUDING RISK AND HAZARD ANALYSIS

FOR THE PROPOSED

NATURAL GAS FUELED POWER STATION AT TG. GEMOK, PORT DICKSON

VOLUME I : ENVIRONMENTAL IMPACT ASSESSMENT

October, 1993

BIRO RUNDINGAN DAN KEMBANGAN
(BUREAU of CONSULTANCY and DEVELOPMENT)
UNIVERSITI KEBANGSAAN MALAYSIA
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558

TABLE OF CONTENTS

Page No

TABLE OF CONTENTS

EXECUTIVE SUMMARY

RINGKASAN EKSEKUTIF

SUMMARY OF POTENTIAL IMPACTS AND MITIGATION MEASURES

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

CHAPTER 1 INTRODUCTION

1 1	General	1-1
1 2	Project Initiator	1-3
1 3	Legal Requirement	1-3
1 4	Authorisation	1-4
1 5	Statement of Need	1-5
1 6	Site Justification	1-8
1 7	Outline of Document	1-10

CHAPTER 2 PROJECT DESCRIPTION

2 1 Introduction 2-1

2 2 Location 2-2

2 3 Description of the Proposed Power Station 2-2
- 2 3 1 Proposed Gas Turbine Power Station 2-2
- 2 3 2 Principle of Operation of Gas Turbine 2-3
- 2 3 3 Proposed Combined Cycle Power Station 2-3
- 2 3 4 Main Components of the Combined Cycle System 2-4
- 2 3 5 Natural Gas Supply 2-4
- 2 3 6 Distillate Fuel Supply 2-5
- 2 3 7 Cooling Water System 2-6
- 2 3 8 Waste Disposal Management 2-8
- 2 3 9 Control and Instrumentation 2-9
- 2 3 10 Start-up, Testing and Commissioning of the Gas Turbine Power Plant 2-10

2 4 Project Schedule 2-14

CHAPTER 3 EXISTING ENVIRONMENT. PHYSICAL SYSTEM

3 1 General 3-1

3 2 Topography and Land Use 3-1

3 3 Geology and Geotechnics 3-2

3 4 Climate 3-4
- 3 4 1 General 3-4
- 3 4 2 Surface Wind 3-4
- 3 4 3 Rainfall 3-5
- 3 4 4 Temperature 3-5
- 3 4 5 Relative Humidity 3-5
- 3 4 6 Solar Radiation 3-6
- 3 4 7 Fog 3-6
- 3 4 8 Sumatras 3-6

3 5 Air Quality 3-6
- 3 5 1 Emission Inventory 3-6
- 3 5 2 Results of Monitoring Done by DOE 3-7
- 3 5 3 Result of Monitoring Done by TNB 3-7
- 3 5 4 Current Air Quality Monitoring 3-8
- 3 5 6 Odour and Smoke 3-10

560

3 6 Noise 3-11
3 6 1 Measuring Equipment 3-11
3 6 2 Existing Noise Level 3-11

3 7 Hydrology and Groundwater 3-12
3 7 1 Hydrology 3-12
3 7 2 Existing Groundwater 3-13

3 8 Water Quality 3-13
3 8 1 Locality and Sources of Pollution 3-13
3 8 2 Sampling Locations 3-14
3 8 3 Sampling Methods 3-14
3 8 4 Laboratory Analytical Methods 3-15
3 8 5 Results and Discussion 3-15

3 9 Infrastructure 3-16
3 9 1 Electric Power Supply 3-16
3 9 2 Telecommunication 3-16
3 9 3 Education Facilities 3-16
3 9 4 Health Facilities 3-17
3 9 5 Fire Brigade 3-17

CHAPTER 4 EXISTING ENVIRONMENT· BIOLOGICAL SYSTEM

4 1 Vegetation and Flora 4-1
4 1 1 The Project Site and its Nearby Areas 4-1
4 1 2 The Proposed Access Road 4-3
4 1 3 The Proposed Route for Liquid Fuel Pipeline 4-4
4 1 4 The Proposed Route of Gas Pipeline 4-4
4 1 5 The Proposed Route of Cooling Water Intake and Discharge Pipelines 4-5

4 2 Terrestrial Wildlife 4-5

4 3 Freshwater Vertebrates 4-6

4 4 Marine Communities 4-6
4 4 1 Plankton 4-6
4 4 2 Benthic Communities 4-7
4 4 3 Fisheries Resources 4-7

4 5 Habitat of Special Interest 4-7

CHAPTER 5 EXISTING ENVIRONMENT SOCIO-ECONOMIC SYSTEM

5 1 Introduction 5-1

5 2 Study Area and Methodology 5-1

5 3 Existing Population and Settlement Pattern 5-2

5 4 Social and Economic Characteristics 5-3

5 5 The Results 5-5

5 6 Educational Facilities Utilities and Amenities 5-6

5 7 Expressed Opinion and Perception with Regards to the Project 5-7

5 8 Revealed Preference Towards Mitigating Measures 5-9

CHAPTER 6 POTENTIAL IMPACTS AND MITIGATING MEASURES DURING CONSTRUCTION

6 1 Basis of Assessment 6-1

6 2 List of Construction Activities with Potential Impact 6-2

6 3 Potential Impacts on Environmental Components and Mitigating Measures 6-3
- 6 3 1 Land 6-3
- 6 3 2 Air Quality and Micro-Climate 6-14
- 6 3 3 Noise 6-18
- 6 3 4 Water Quality 6-23
- 6 3 5 Biological Systems 6-25
- 6 3 6 Socio-economy 6-29

362

CHAPTER 7 POTENTIAL IMPACT AND MITIGATING MEASURES DURING OPERATION

7 1 List of Operational Activities with Potential Impacts 7-1

7 2 Potential Impacts on Environmental Components and Mitigating Measures 7-2
- 7 2 1 Land 7-2
- 7 2 2 Air Quality and Micro-Climate 7-5
- 7 2 3 Noise Level 7-12
- 7 2 4 Thermal Plume of Warm Water and Chlorine Discharge from the Once-Through Cooling System 7-17
- 7 2 5 Water Quality 7-20
- 7 2 6 Biological Systems 7-25
- 7 2 7 Socio-Economic System 7-28

CHAPTER 8 ENVIRONMENTAL QUALITY MANAGEMENT PROGRAMME

8 1 Introduction 8-1

8 2 Design Guidelines 8-1
- 8 2 1 Atmospheric Emissions 8-2
- 8 2 2 Wastewater Discharge 8-2
- 8 2 3 Noise 8-2
- 8 2 4 Aesthetics 8-3

8 3 Construction Guidelines 8-3

8 4 Operation and Maintenance Guidelines 8-4
- 8 4 1 Air, Water and Noise 8-4
- 8 4 2 Operation Practices 8-4

8 5 Inspection Procedures 8-6
- 8 5 1 Inspection by Authorities 8-6
- 8 5 2 Inspection by Plant Operator 8-7

8 6 Environmental Monitoring Programme 8-10
- 8 6 1 Noise Monitoring 8-10
- 8 6 2 Water Quality Monitoring 8-10
- 8 6 3 Air Quality Monitoring 8-11

CHAPTER 9 EMERGENCY RESPONSE PLAN

9 1 Introduction 9-1

9 2 Responsibility 9-2

9 3 Plant Preparedness 9-2

9 4 Action for Fire 9-3

9 5 Action for other Emergency 9-4

CHAPTER 10 CONCLUSIONS

LIST OF CONSULTANTS

REFERENCES

ACKNOWLEDGEMENTS

APPENDIX A INVITATION FOR PROPOSALS

APPENDIX B NOISE GUARANTEE

564

SITHE/INDEPENDENCE POWER PARTNERS, L.P.

DRAFT
ENVIRONMENTAL IMPACT STATEMENT

Volume 1

INDEPENDENCE STATION COGENERATION FACILITY

Prepared by Black & Veatch

June 1992

56

Contents

Executive Summary 1

1 0 Purpose, Public Need, and Benefits 1-1

1 1 Project Background 1-1

1 2 Federal and New York State Laws and Policy Support Independence Station 1-2

1 3 New York State Energy Plan 1-5

1 4 Satisfying Future System Capacity Requirements 1-12

1.5 Necessity of the Project for Alcan Rolled Products Company 1-14

1 6 Benefits 1-17

1 7 The State Energy Plan Analytical Framework for Energy-Only Contracts 1-21

Attachment 1-A Niagara Mohawk Wheeling Contract

Attachment 1-B Niagara Mohawk Letter Regarding Capacity

Attachment 1-C Con Edison Contract

Attachment 1-D Qualifying Facility Application

Attachment 1-E Correspondence from Alcan

Attachment 1-F Gas Transport Routes

Attachment 1-G NYSPSC Ruling on LRACs and Staff-Proposed LRACs

Attachment 1-H Comparison of Net Present Value--Hydro Quebec

Attachment 1-I Comparison of Net Present Value--Con Edison

Attachment 1-J Comparison of Net Present Value--Niagara Mohawk

2 0 Project Description 2-1

2 1 Site 2-1

2 2 Facility 2-14

2.3 Raw Materials 2-56

2 4 Summary of Required Permits and Approvals 2-66

Attachment 2-A Water Service Agreement

Attachment 2-B Status of State Environmental Quality Review

566

Contents (Continued)

3 0	Environmental Setting		3-1
	3 1	Geology, Soils, and Topography	3-1
	3 2	Meteorology and Air Quality	3-5
	3 3	Water Resources	3-44
	3 4	Terrestrial Ecology	3-67
	3 5	Aquatic Ecology	3-96
	3 6	Threatened and Endangered Species	3-146
	3 7	Transportation	3-156
	3 8	Land Use	3-164
	3 9	Socioeconomics	3-172
	3 10	Cultural Resources	3-193
	3 11	Noise	3-213
	3 12	Recreation	3-221
	3 13	Aesthetics	3-225
	3 14	Gas and Electric Transmission Facilities	3-228
	3 15	Hazardous Wastes	3-230
	Attachment 3-A	COE Wetlands Correspondence	
	Attachment 3-B	Threatened and Endangered Species Consultations	
	Attachment 3-C	Endangered, Threatened, and Special Concern Species of New York State	
4 0	Potential Impacts of Construction		4-1
	4 1	Geology, Soils, and Topography	4-1
	4 2	Air Quality	4-2
	4.3	Water Resources	4-8
	4 4	Terrestrial Ecology	4-11
	4 5	Aquatic Ecology	4-24
	4 6	Threatened and Endangered Species	4-29
	4 7	Transportation	4-32
	4 8	Land Use	4-43
	4 9	Socioeconomics	4-44
	4 10	Cultural Resources	4-52
	4 11	Construction Noise	4-53
	4 12	Recreation	4-56

	4 13	Aesthetics	4-58
	4 14	Electric and Gas Transmission Facilities	4-60
	Attachment 4-A	Traffic Volumes	
5 0	Potential Impacts of Operation		5-1
	5 1	Geology, Soils, and Topography	5-1
	5 2	Air Quality	5-1
	5 3	Water Resources	5-75
	5 4	Terrestrial Ecology	5-91
	5 5	Aquatic Ecology	5-97
	5 6	Threatened and Endangered Species	5-112
	5 7	Transportation	5-113
	5 8	Land Use	5-115
	5 9	Socioeconomics	5-132
	5 10	Cultural Resources	5-136
	5 11	Operational Noise	5-136
	5 12	Recreation	5-141
	5 13	Aesthetics	5-142
	5 14	Electric and Gas Transmission Facilities	5-155
6 0	Mitigation Measures		6-1
	6 1	Geology, Soils, and Topography	6-1
	6 2	Air Quality	6-2
	6 3	Water Resources	6-3
	6 4	Terrestrial Ecology	6-8
	6 5	Aquatic Ecology	6-12
	6 6	Threatened and Endangered Species	6-17
	6 7	Transportation	6-18
	6 8	Land Use	6-25
	6 9	Socioeconomics	6-27
	6 10	Cultural Resources	6-28
	6 11	Noise	6-28
	6 12	Recreation	6-29

568

Contents (Continued)

	6 13	Aesthetics	6-29
	6 14	Electric and Gas Transmission Facilities	6-30
	Attachment 6-A	Correspondence Regarding Disposal of Construction Wastes	
7 0	Unavoidable Adverse Environmental Impacts		7-1
	7 1	Short-Term Impacts	7-1
	7 2	Long-Term Impacts	7-2
8 0	Irreversible and Irretrievable Commitment of Resources		8-1
	8 1	Fuels and Materials	8-1
	8 2	Groundwater Consumption	8-3
	8 3	Land Use, Wetland Conversion, and Water Usage	8-3
9 0	Growth Inducing Aspects of the Proposed Action		9-1
	9 1	Community Development and Land Use	9-1
	9 2	Economic Growth	9-2
	9.3	Support Facilities	9-4
	9 4	Industrial and Business Development Potential	9-4
10 0	Effects of the Proposed Action on Use and Conservation of Energy Resources		10-1
	10 1	Proposed Energy Sources and Alternatives	10-1
	10.2	Anticipated Short-Term/Long-Term Levels of Energy Consumption	10-2
	10 3	Indirect Effect on Energy Consumption	10-3
	10 4	Energy Conservation Measures	10-4
11 0	Project Economic Analysis		11-1
	11.1	Existing Economic Conditions	11-1
	11 2	Future Economic Conditions with the Project	11-1
	11.3	Future Economic Conditions Without the Project	11-3

567

Contents (Continued)

12 0	Alternatives	12-1
12 1	The No-Action Alternative	12-1
12 2	Alternative Fuels and Technologies	12-3
12 3	Alternative Sites	12-6
12 4	Alternative Construction/Operation Scheduling	12-8
12 5	Alternative Land Uses	12-9
12 6	Water Supply Alternatives	12-10
12 7	Air Pollution Control Alternatives	12-11
12 8	Transmission Line Alternatives	12-15
12 9	Wastewater Discharge Alternatives	12-16
12 10	Cooling Alternatives	12-18
13 0	References	13-1
14 0	List of Preparers	14-1

Appendix A Letter of Intent and Previous Property Ownership
Appendix B October 8, 1991, Public Meeting
Appendix C Wetland Impact Areas
Appendix D Independence Station Summary of Emissions and Energy Balance
Appendix E Preliminary Erosion and Sedimentation Control Plan
Appendix F Alterations and Additions to the Electric Transmission Grid in New York State
Appendix G Natural Gas Supply/Delivery Information
Appendix H Material Safety Data Sheets
Appendix I Air Permit Application, Including the Ambient Air Quality Impact Analysis
Appendix J Response to NYSDEC Comments to Air Permit Application and Associated Revisions to the Application
Appendix K Structural-Archeological Assessment Form
Appendix L Coastal Consistency Determination and Assessment Forms
Appendix M Recreation and Resource Management Plan
Appendix N Storm-Water Management and Erosion Control Plan

570

Examples of Development Bank Guidelines

African Development Bank

S72

African Development Bank Environmental Assessment Guidelines

Questionnaire Impacts of Mining						
Key Impacts	Significant	Minor	None	Mitigative Measures		Remarks
				Yes	No	
Loss of natural vegetation and wildlife habitat						
Loss of scenery						
Changes in hydrology						
Soil degradation						
Pollution						
Social impacts						
Loss of land and resettlement						

Questionnaire Impacts of Dams and Hydropower Projects						
Key Impacts	Significant	Minor	None	Mitigative Measures		Remarks
				Yes	No	
Changes in hydrology						
Resettlement						
Loss of agricultural lands						
Loss of infrastructure and housing						
Loss of natural vegetation and wildlife habitat						
Aquatic weed growth						
Diseases						
Loss of scenery						
Soil erosion						

Questionnaire Impacts of Industry						
Key Impacts	Significant	Minor	None	Mitigative Measures		Remarks
				Yes	No	
Air pollution						
Water Pollution						
Soil pollution						
Changes in hydrology						
Soil erosion						
Social impacts						
Loss of scenery						
Conflicts in land use						

Questionnaire Impacts of Power Transmission Lines						
Key Impacts	Significant	Minor	None	Mitigative Measures		Remarks
				Yes	No	
Loss of natural vegetation						
Loss of land and resettlement						
Loss of scenery						
Social impacts						

Questionnaire Impacts of Oil and Gas Distribution Lines						
Key Impacts	Significant	Minor	None	Mitigative Measures		Remarks
				Yes	No	
Loss of natural vegetation						
Loss of land and resettlement						
Interruption of wildlife and cattle migration						
Pollution						

Questionnaire Impacts of Road and Railway Projects						
Key Impacts	Significant	Minor	None	Mitigative Measures		Remarks
				Yes	No	
Pollution						
Changes in hydrology						
Soil erosion						
loss of natural vegetation and wildlife habitat						
Social impacts						

Questionnaire Impacts of Ports, Harbors, and Coastal Structures						
Key Impacts	Significant	Minor	None	Mitigative Measures		Remarks
				Yes	No	
Coastal erosion and siltation						
Pollution						
Social impacts						
Loss of land and resettlement						

AFRICAN DEVELOPMENT BANK
AFRICAN DEVELOPMENT FUND

ENVIRONMENTAL ASSESSMENT GUIDELINES

MAY, 1992

581

FOREWORD

The Bank Group's Environment Policy Paper was adopted in 1990 by the Boards of Directors, with the overall objective of ensuring environmental viability of investment projects in the Bank Group's Operational Program. With the adoption of the Policy, the next step was to translate environmental concerns into actions, i e operational guidelines that would guide staff in the analysis of the environmental effects of projects

Traditionally, viability of the Bank Group's funded projects and programs was mainly based on technical and economic criteria Environmental soundness was, nevertheless, implicit in the technical and economic viability of these investment projects The Environment Policy highlights the need to cater more explicitly for the environmental dimension in the overall evaluation of the viability of investment projects and programs In this regard, the guidelines are an aid towards the screening of all the projects in the Bank Group's Lending Program with the view to determining their environmental classification on the basis of the likely environmental impact

The Guidelines presented in this paper are primarily for the internal use of the Bank staff They should not be seen as additional bureaucratic layers on the path of the lending program, but rather flexible procedures that will be regularly revised in the process of their implementation and in light of changing global environment in which the Bank Group operates

The Guidelines were prepared by HASKONING firm, a Dutch Consulting firm under funding by the Government of the Netherlands They were edited and finalized by the Environment and Social Policy Division of the Central Projects Department

Management would welcome comments and suggestions from the relevant staff on the use of these Guidelines during their implementation

Abidjan, Côte d'Ivoire,
May 1992

Table of Contents

FOREWORD I

1 INTRODUCTION 1

11 Background 1
12 Objective of Environmental Assessment Guidelines 1
13 Environmental Assessment Principles 2
13 1 Environmental Assessment in The Project Cycle 2
13 2 Environmental Screening 3
13 3 Environmental Impact Assessment (EIA) Study 3
13 4 Mitigating Measures 4
13 5 Environmental Management 5
13 6 Environmental Monitoring 5
13 7 Environmental Auditing 6
14 Organization of Document 6

2 TECHNICAL ENVIRONMENTAL ASSESSMENT GUIDELINES 8

21 Concepts for Environmental Screening 8
21 1 General 8
21 2 Project Categories 8
21 3 Project Location 9
22 Initial Environmental Examination (IEE) 10
23 Scoping of Environmental Impacts 12
24 Main Environmental Impacts From Different Types of Projects 12
24 1 Agriculture and Rural Development 12
24 1 1 General Agriculture 13
24 1 2 Irrigation 14
24 1 3 Forestry 16
24 1 4 Pesticides 19
24 1 5 Livestock 21

583

24 1 6 Fisheries 22
24 1 7 Public Health 24
24 1 8 Education 25
24 2 Industry and Infrastructure 25
24 2 1 Dams and Hydropower 25
24 2 2 Mining 28
24 2 3 Industry 30
24 2 4 Construction of Buildings 32
24 3 Public Utilities 33
24 3 1 Water Supply 33
24 3 2 Solid Waste Management and Sanitation 34
24 3 3 Power Transmission Lines 35
24 3 4 Oil and Gas Distribution Lines 36
24 4 Transportation 37
24 4 1 Road and Railway Projects 37
24 4 2 Ports Harbours and Coastal Structures 38
24 4 3 Airports 40

3 PROCEDURAL ENVIRONMENTAL ASSESSMENT GUIDELINES . 41

31 General 41
32 Project Cycle 41
32 1 Pre-identification Phase 42
32 2 Project Identification 42
32 3 Project Preparation 42
32 4 Project Appraisal 42
32 5 Project Implementation and Supervision 43
32 6 Post-evaluation 43
33 Activities Related to The Project Cycle 43
33 1 Pre-identification 43
33 2 Project Identification 44
33 2 1 Project Offer and Pre selection 44
33 2 2 Identification and Selection 45
33 3 Project Preparation 46
33 3 1 Preparation of Feasibility Study and EIA 47
33 3 2 Execution of Feasibility Study and EIA 47
33 4 Project Appraisal 47
33 4 1 Appraisal Mission 47
33 4 2 Negotiations Approval and Fulfilment 48
33 5 Project implementation and Supervision 48

584

	33 5 1	Monitoring	48
	33 5 2	Supervision	49
	33 5 3	Execution of Rehabilitation Measures	49
	33 5 4	Feedback	50
	33 5 5	Completion	50
33 6	Post evaluation		50
	33 6 1	Project Finalization	50
	33 6 2	Feedback	51

ANNEX 1 SUGGESTED TERMS OF REFERENCE FORMAT FOR EIA STUDIES

ANNEX 2 SUGGESTED OUTLINE OF AN EIA REPORT

ABBREVIATIONS

ADB	African Development Bank
ADF	African Development Fund
AsDB	Asian Development Bank
ECP	Environmental Country Paper
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EPCP	Economic Prospect Country Paper
ESA	Environmentally Sensitive Area
IADB	Inter American Development Bank
IEE	Initial Environmental Examination
IES	Initial Environmental Screening
NGO	Non-Governmental Organization
NTF	Nigeria Trust Fund
OECD	Organization for Economic Cooperation and Development
OECF	Overseas Economic Cooperation Fund
RMC	Regional Member Country
TAF	Technical Assistance Fund
TOR	Terms of Reference
UN	United Nations
WB	World Bank

585

1. INTRODUCTION

1.1. Background

In June 1990 the Boards of Directors of the African Development Bank Group approved the Environment Policy Paper outlining the general and specific environmental policies that have to be taken into account in the lending programmes and projects To facilitate the translation of these policies into action environmental guidelines for each sector or sub-sector were considered essential

In April 1991 the Bank initiated action for the preparation of environmental assessment guidelines and environmental assessment procedures

The environmental assessment guidelines are meant for incorporation in the environmental evaluation process at every stage of the project cycle Methods to assess expected environmental impacts are combined with administrative procedures so that the results of the environmental assessment would become an integral part of project planning and decision-making

1.2. Objectives of Environmental Assessment Guidelines

The overall objective of environmental assessment guidelines is to integrate an assessment process of environmental issues into ADB Group development projects and programmes This would ensure that the Bank Group is financing sustainable development in RMCs which combines economic growth with poverty reduction and the protection of the environment

The technical environmental guidelines and assessement procedures envisage

- to serve as a working tool for Bank staff and officials of Regional Member Countries (RMCs) to assess environmental impacts of lending programmes and projects

- to introduce a step-wise approach for environmental screening of projects and ensure that this is carried out in conformity with the project cycle,
- to ensure that during the various stages of the project cycle, and in the related documents due attention is paid to the environmental aspects,
- to provide a better understanding of the mitigative measures required for a given environmental issue

The key to sound environmental management and sustained development is the use of procedures to assess the environmental impacts of the Bank s lending programmes and projects Environmental assessment procedures are needed in any organization whose activities impinge on the environment

As for procedures supporting the application of technical environmental assessment guidelines their objectives are

- to ensure the application of technical guidelines in all relevant stages of the project cycle,
- to streamline the use of the technical guidelines in departments responsible for the implementation of projects and programmes

1.3. Environmental Assessment Principles

1 3.1. Environmental Assessment in The Project Cycle

The Environmental Assessment Guidelines were conceived with the following two fundamental premises in mind, after consultation with the relevant Bank Staff

- environmental assessment procedures should be linked as much as possible with existing procedures in the Bank Group and should take into account initiatives which are to be developed in the near future and
- loans and project officers will categorize projects in the identification phase thus identifying further action to be taken at the earliest stage These officers should be able to

appraise environmental aspects with the aid of the technical guidelines and the use their own expertise

The analysis of environmental impacts is a dynamic process that must be initiated at the earliest stage of a proposed development activity Information on environmental impacts which may be caused by a project, must be incorporated in the project cycle and evaluated regularly during the implementation phase Various stages in environmental consideration of the project cycle are briefly discussed

1.3.2. Environmental Screening

Environmental screening is carried out during project identification Screening by means of Initial Environmental Examination (IEE) is an early warning system to help identify those projects which need further attention due to their impacts on the environment While some projects will require an Environmental Impact Assessment study others have impacts which can easily be diminished or abolished by applying mitigative measures or changing the project design to some extent The result of environmental screening will be included in the Project Brief as "Environmental Issues"

1.3.3. Environmental Impact Assessment (EIA) Study

Environmental Impact Assessment is a tool for the evaluation and analysis of projects on their environmental impacts It provides the organized transfer of relevant information to the appropriate decision-makers The systematic description and quantification of environmental impacts improves the cost-benefit analysis of the proposed project

If a project requires a full-scale Environmental Impact Assessment, the EIA study should be executed by a team of experts especially selected for this task The present guidelines provide the ADB Group staff with the information necessary to prepare Terms of Reference (TOR) for an EIA study of a particular type of project However, the TOR will have to be specific not only for the kind of project activities that are proposed but also for the area in which the project is imple-

mented Annex 1 presents a general format for the TOR of an EIA study

An EIA report can range broadly in scope and depth but it normally includes at least the following

- proposed project activities
- existing environment
- project options
- impacts of the project on the environment with emphasis on significant impacts, and
- mitigative measures

The information presented in the report snould be accessible to all parties involved Therefore, a clear presentation of conclusions is of crucial importance A general outline of an EIA report is given in Annex 2

The EIA report gives all parties concerned an opportunity to contribute to the project preparation and design The EIA is a participatory process and as such it is particularly important that the priorities and concerns of the local population are taken into consideration This can be achieved most effectively by working in close consultation with NGOs and local institutions at all stages of the project cycle

1 3 4. Mitigating Measures

The proposition of mitigative measures should prevent or reduce each of the adverse impacts identified as being significant for a particular project Mitigative measures may consist of modifications in project design (e g change of project site), introduction of new project elements (e g pollution control, environmental monitoring) and offer of compensation, e g financial compensation for loss of housing and land

Often costs are involved when environmental protection measures are incorporated in the project design and implementation The additional costs for an environmentally sound

project should be considered when calculating and planning the overall costs and funding of the project When considering the additional cost of mitigative measures it is necessary to realize that investing in environmental protection at the present will often prevent much higher costs for clean-up in the future

1.3.5. Environmental Management

The next step for the ADB Group is not only to prevent environmental damage (through screening, EIA and mitigation) but to plan for an improvement in environmental quality by proposing environmental management plans One objective of the Bank Group environment policy is to foster the sustainibility of natural resources to meet long-term needs To attain effective environmental and natural resource management a competent legislative and institutional frameworks are required in RMCs Another important factor is the improvement of local participation by considering and building on existing initiatives when planning environmental management projects and programmes Presently, the Bank Group is involved in the preparation of a number of National Environmental Action Plans (NEAPs) in various RMCs, which attempt to address the above questions

1 3.6 Environmental Monitoring

Environmental monitoring is needed in development projects to

- check that the planned mitigative measures are implemented
- ensure that legal standards for pollutants are not exceeded, and
- provide early warning of environmental damage, so that actions may be taken to reduce the harmful impacts on the environment

Environmental monitoring should be limited to those parameters that provide information on the performance of the environmental protection measures incorporated in the pro-

ject Monitoring should also include measurement of parameters which reflect the actual magnitude of impacts identified as significant

1 3.7. Environmental Auditing

After project completion the actual impacts of project operation the accuracy of the predictions, the effectiveness of the mitigative measures and the functioning of the established monitoring programme should be determined and evaluated through a proper auditing Environmental auditing refers to the organization and analysis of the monitoring data to assess possible changes in the environment as a result of project implementation Comparison of actual and predicted impacts provides information on the effectiveness of the environmental impact assessment executed before implementation of the project

1.4. Organization of this Document

A Technical Environmental Assessment Guidelines

After the general information given in this introductory chapter the Technical Environmental Assessment Guidelines are presented in Chapter 2 In section 2 1 1 the purpose of including environmental assessment at an early stage in the project cycle is discussed The main criteria used for environmental screening of the projects are defined in sections 2 1 2 and 2 1 3 Section 2 2 outlines a stepwise approach to the environmental screening process This section is accompanied by a checklist essential for the Initial Environmental Examination In section 2 3, the process of scoping environmental impacts is discussed

The last part of Chapter 2 (section 2 4), is meant to be an aid in identification and projection of key environmental impacts that may occur as a result of a particular type of project An outline is given of the main environmental impacts for each type of project Moreover questionnaires are presented for the

591

main types of projects to help determine the significance of the key environmental impacts for each individual project

B. *Procedural Environmental Assessment Guidelines*

Chapter 3, presents the Procedural Environmental Assessment Guidelines, and proposes procedures for the implementation of the environmental assessment processes in various stages of the project cycle These procedures are based upon the environmental policy of the Bank Group, the organizational set-up of the Bank Group operations and the technical environmental assessment guidelines

2. TECHNICAL ENVIRONMENTAL ASSESSMENT GUIDELINES

2.1. Concepts for Environmental Screening

2.1.1 General

Environmental assessment is a flexible procedure, of which the scope, depth and analytical techniques may vary from project to project The detail and sophistication of the environmental assessement must be appropriate to the nature and magnitude of the expected impacts

The purpose of environmental assessment is to ensure that the development options under consideration are environmentally sound and sustainable As economic, financial, institutional and technical analyses are part of the project preparation, so is environmental assessment If potential environmental problems are identified at an early stage during project planning, environmental degradation and economic losses that may result from poor project planning can be avoided

2.1.2. Project Categorization

Each project will be screened for possible environmental impacts at the beginning of the identification phase of the project cycle It is important that environmental consequences of a project are recognized early in the project cycle, for it is easiest and least costly to expand, reject or substantially modify a project proposal at this stage

During the Initial Environmental Examination (IEE), a project will be assigned to Category I, II or III, defined as follows

Category I Projects which may have significant environmental impacts, requiring detailed field review and an Environmental Impact Assessment (EIA) study

Category II Projects with limited environmental impacts, or impacts that can be mitigated by applying specific measures or changes in the project design,

Category III Projects not anticipated to result in adverse environmental impacts, for which environmental assessment is normally unnecessary

The IEE checklist (figure 1) presents an overview of various project activities and their anticipated project category. It should be noted that a particular project may comprise different development activities In that case, the project components with the most serious impact on the environment should be analyzed during the IEE

Studies lead to projects development A clear distinction is therefore made between projects and studies The categorization applies to projects only Studies will not be classified, rather, the Environment and Social Policy Division will assist Operations Departments to ensure that the terms of reference for each study be properly screened and that it takes into account environmental considerations

2.1.3. Project Location

After categorization, it is important to determine whether the selected project site is located in an Environmentally Sensitive Area (ESA) Certain activities could be relatively harmless as such, but would have considerable environmental impacts when implemented in a vulnerable environment. Environmentally Sensitive Areas, as illustrated by the IEE checklist in figure 2 1, are areas that require particular protection for different reasons Ecosystems with high species diversity, such as a tropical forest, or areas which harbour endangered or endemic species should be avoided by project activities As far as the cultural environment is concerned, sites which present unique historical or archaeological value are classified as ESAs Concerning the physical environment, unique landscape features, which should be preserved, also belong to this category

2.2. Initial Environmental Examination (IEE)

Generally the information available at the identification stage in the project cycle will allow assignment of a project to one of the categories classified in the IEE checklist according to the nature and magnitude of the environmental impacts (figure 1)

Project location is the other criterion on which classification is based It should be noted that a site visit may be required if based on the available information it cannot be decided whether a project belongs to Category I or II Projects listed under Category II but located in or close to Environmentally Sensitive Areas (ESAs) will be assigned to Category I and are therefore subject to EIA The Environmental Impact Assessment (EIA) study will identify evaluate and predict environmental effects for the information of decision-makers For those projects which require a more detailed environmental assessment Terms of Reference (TOR) for an Environmental Impact Assessment study (EIA) should to be prepared (see Annex 1)

For projects mentioned under Category II that are not located in an ESA a full-scale EIA study is not mandatory However, mitigative measures or changes in project design may be required depending on the nature and magnitude of the environmental impacts It may be necessary to refer to available literature (the ADB Group, specifically the Environment and Social Policy Division has collected on this subject)

Projects in Category III with no impacts or beneficial impacts on the environment are cleared for further processing However, if a project includes any physical intervention with negative environmental impacts the project is rerouted to Category II

Conclusions from the IEE recommendations for mitigative measures and a description of further actions required should be contained in the Project Brief

595

Figure 1: Initial Environmental Examination Checklist

Category I

❒ **Agriculture and Rural Development**
- Reclamation and new land development
- River-basin development
- Large-scale irrigation and drainage
- commercial logging
- Large-scale agriculture/mariculture

❒ **Industry and Infrastructure**
- Dams and hydropower
- Mining (including oil and gas)
- Large scale industrial plants
- Thermal power development
- Manufacture and transportation of hazardous materials (e g pesticides)
- Projects which pose serious accident risk
- Large-scale urban water supply and sanitation
- Large-scale power transmission
- Oil and gas pipelines
- Roads and railways construction
- Ports, harbours and coastal structures
- Airports
- Large-scale tourism development

then

❒ **Environmentally Sensitive Areas.**
- Coral reefs
- Mangrove swamps
- Small islands
- Tropical rainforests
- Areas with erosion-prone soils (e g mountain slopes)
- Areas prone to desertification (and and semi and zones)
- Natural conservation areas
- Wetlands of national or international importance
- Areas which habour protected and/or endangered species
- Areas of unique scenery
- Areas of particular scientific interest
- Areas of particular historic or archaeological interest
- Areas of importance to threatened ethnic groups

Category II

❒ **Agriculture and Rural Development**
- Reforestation/afforestation
- Land and soil management
- Small scale irrigation and drainage
- Small scale aquaculture/mariculture

❒ **Industry and Infrastructure**
- Mini-hydro power development
- Small scale industry development
- Small scale power transmission
- Renewable ennergy development
- Telecommunication facilities
- Rural water supply and sanitation
- Public facilities (hospitals, schools, housing, etc)
- Small scale tourism development
- Road rehabilitation

but, if the project is located in or close to

then

physical interventions in the environment

Category III

- Institutional development
- Health programmes
- Family planning programmes
- Nutrition programmes
- Education programmes
- Environmental programmes

but, if the project involves

596

2.3. Scoping of Environmental Impacts

It is unlikely that all environmental impacts that may arise from a particular type of activity will be of significance or be a cause of concern Therefore, the scoping process (see questionnaires in section 2 4) will help identify those environmental impacts that should be considered for mitigation or that should be included in the EIA study If potential environmental impacts or risks require mitigative measures and if those measures are easily identified, they should be recorded during the project identification phase Several sources of information are available on mitigative measures that are specific for a particular type of project

2.4. Main Environmental Impacts From Different Types of Projects

In the present section the main environmental impacts that may be caused by a particular type of project are discussed These key impacts are listed in questionnaires, which are intended to highlight the significance of the impacts for each type of development activity

Most projects consist of several components, e g mining may be accompanied by road development, construction of buildings, water supply or sanitation It is necessary to identify the possible impacts of these components by referring to all relevant questionnaires

2.4.1. Agriculture and Rural Development

The aim of agricultural projects is generally to increase the quantity and/or quality of production This can be achieved either by increasing the area under cultivation or by intensifying production on existing farmlands through increased labour input mechanization use of high yielding varieties use of fertilizers and pesticides and irrigation

Agricultural development programmes often involve rural development Integrated rural development refers to multi-

sectoral projects which may include agriculture forestry, infrastructure development and/or provision of public utilities For each of these components the environmental impacts should be assessed

2.4 1 1 General Agriculture

Agricultural development always brings about changes in the natural environment, and often wildlands are changed into farmlands to produce cash crops The original vegetation cover is removed and habitat for fauna is lost, resulting in a decrease of biodiversity

General impacts from agriculture include

Loss of natural vegetation and wildlife habitat

The most drastic changes in vegetation cover result from extensive forest clearing for agriculture, particularly serious in the case of tropical forests

Soil erosion

After removal of vegetation cover the soil is exposed to rain and wind erosion This may eventually lead to leaching of nutrients and loss of topsoil The rate at which erosion occurs varies greatly, depending on climate soil characteristics and terrain (steepness of slope)

Soil acidity

Shortage of arable lands increasingly leads to reclamation of mangrove areas for agriculture, usually to cultivate rice In general, soils reclaimed from a brackish water environment, such as mangrove soils contain sulphurous compounds that are oxidized when exposed to air over extended periods This may result in the development of acid sulphate soils which need corrective measures to be fit for crop growth

Water pollution

Organic pollution of water may occur to a certain degree from dumping plant remains into streams and canals, but the main pollution will be caused by fertilizers and pesticide residues Nutrient-enrichment of water will eventually result in excessive growth of algae or macrophytes Water pollution by agro-chemicals not only affects the aquatic ecosystem, but also, when certain concentrations are attained makes the water unfit for other use Drinking water from groundwaters

either too much or too little irrigation Soluble salts in the soil surface will accumulate to such extent that their concentrations become toxic to plants Salinization occurs to some extent in all irrigated areas but is most commonly associated with arid or semi-arid zones

Water-related diseases

The slowly running or stagnant water in irrigation canals provides a habitat for vectors that transmit diseases such as malaria schistosomiasis and filariasis Aquatic vegetation, developing in the canals serves as a substrate for the snail vector of schistosomiasis and for breeding of mosquitoes which transmit malaria or filariasis

Soil erosion

Irrigation schemes often require land clearing and levelling in the preparation stage Removal of trees and shrubs, which act as wind-breaks and soil stabilizers, can accelerate soil erosion

Water-logging

Water-logging a common phenomenon in irrigated areas, occurs when groundwater saturates the plant root-zone Small pores between soil particles, normally filled with air, become saturated thus preventing the exchange of oxygen between the plant roots and the soil Water-logging can be the result of poor drainage of irrigated lands, but in some places it is a natural phenomenon

Resettlement

In the construction phase of an irrigation project some land-holders or tenants may have to be relocated to provide space for the physical facilities of the project (reservoirs, pump stations water conveyance structures) Moreover, existing field configurations or land-use may not be compatible with the proposed irrigation scheme in which case boundaries or land-use practices must be altered to meet the needs of system design

may be affected by contamination with nitrates as a result of excessive use of nitrogenous fertilizers

Questionnaire Impacts of General Agriculture						
Key Environmental Impacts	Significant	Minor	None	Mitigative Measures		Remarks
				Yes	No	
Loss of natural vegetation and wildlife habitat						
Soil erosion						
Soil acidity						
Water pollution						

2 4 1 2 Irrigation

Irrigation schemes often draw their water from lakes and artificial reservoirs from river diversion, or from groundwater Delivery of the water may rely on gravity or pumps, and the water may reach the fields through irrigation canals In addition to specific impacts from irrigation general impacts from agricultural activities should be taken into account These can be due to

Changes in hydrology

Irrigation schemes based on pumped groundwater are likely to lower the water-table in the vicinity, and marginal wells may dry up and cause undesirable social impacts In coastal plains, extraction of groundwater may cause the intrusion of seawater into freshwater aquifers Diversion of surface water for irrigation purposes will reduce the amount of water available for use downstream from the irrigated area Irrigation schemes also affect existing water-use patterns and priorities

Water pollution

Water draining from irrigated fields is likely to contain residues of pesticides and fertilizers, which may not only affect aquatic life but also reduce the value of the water downstream as a source for drinking water Also, potable water from groundwater may be affected by contamination with nitrates, as a result of excessive use of fertilizers

Salinization

Salinization is caused by the double action of evaporation and capillary movements in the soil It can be the consequence of

Introduction of plant pests

Monocultures provide an ideal habitat for outbreaks of plant pests The uniformity of species also allows rapid spread of infestation

Questionnaire Impacts of Forestry Reforestation/afforestation						
Key Environmental Impacts	Significant	Minor	None	Mitigative Measures		Remarks
				Yes	No	
Changes in existing ecosystem						
Depletion of groundwater						
Introduction of plant pests						

ii) Commercial Logging

Logging (tree-cutting for lumber) results in an overall decrease in area covered by forest vegetation In general, the magnitude of the adverse impacts depends on the scale of the deforestation that is if clear-cutting or selective cutting is applied

Loss of natural vegetation and wildlife habitat

Cleared forest areas are easily invaded by weeds or undesirable tree species Selective cutting of trees reduces the biodiversity of the forest, it may lead to complete disappearance of a particular tree species Removal of individual large trees may cause mechanical damage to other vegetation The elimination of animals as a result of logging can interfere with the regeneration of tree and other plant species that depend on particular animal species for pollination or seed dispersal The increased accessibility of the forest will encourage poaching and illegal wood cutting

Soil erosion

Clearing accelerates soil erosion especially in sloping areas, and on forest roads and trails As a result of soil erosion, the sediment load in streams will augment thus shortening the useful life span of dams, reservoirs and lakes

Desertification

Forest clearing in arid or semi-arid regions for commercial timber is likely to initiate the desertification process

Changes in hydrology

An increase in the amount of surface run-off from denuded and compacted soils will bring about changes in river flow regime Downstream flooding may result from the increased duration and volume of peak flows Changes in flow rates and

Questionnaire Impacts of Irrigation						
Key Environmental Impacts	Significant	Minor	None	Mitigative Measures		Remarks
				Yes	No	
Changes in hydrology						
Water pollution						
Salinization						
Water related diseases						
Soil erosion						
Water logging						
Resettlement						

2 4 1 3 Forestry

The guidelines for forestry encompass reforestation/afforestation commercial logging and forest-based industries

i) Reforestation/afforestation

Reforestation practices aim at wood production, protection of the soil water regime and the prevention of soil erosion A major characteristic of reforestation therefore is that it can enhance environmental quality, for it is a means of stabilizing soil and hydrological systems Trees are also planted to rehabilitate wastelands The environmental hazards of tree planting are mainly related to species selection monocultures and the scale of the plantation

Changes in existing ecosystem

Introduction of new tree species will bring about shifts in the balance of the existing ecosystem Replacement of the original tree species by exotic trees may deprive some animal species of food and shelter

Depletion of groundwater

Reforestation and afforestation in semi-arid areas may locally deplete soil moisture lower the water-table and result in decreased groundwater and base flow Water-supply in the surrounding area may be affected by the lowered water-table The magnitude of the impact depends on the water demand of the selected species and the scale of the plantation

602

volumes in streams cause stream channel erosion, thus contributing to downstream siltation and sedimentation

Water pollution

The improper use and disposal of wood preservatives, fuels and lubricants during logging operations can lead to water contamination The water solutions of some wood preservatives e g those of CCA preservatives (mixtures of copper, chromium and arsenic salts) are toxic Floating logs, treated with wood preservatives or other chemicals, also contaminate freshwater

Climatic changes

The large scale disappearance of tropical forests contributes to global climatic change through the increase of atmospheric carbon dioxide and the greenhouse effect Locally, loss of forest decreases the water retention capacity of soils, which eventually can lead to reduction in cloud cover and rainfall depending on the scale of deforestation

Noise

Animal life is disturbed by noise from tree-cutting and the presence of man

Social impacts

Deforestation affects people who traditionally depend on the forest for their living The improved access to the forest may lead to the spread of spontaneous settlements and shifting cultivation in forest areas

Questionnaire Impacts of Forestry Commercial logging						
Key Environmental Impacts	Significant	Minor	None	Mitigative Measures		Remarks
				Yes	No	
Loss of natural vegetation and wildlife habitat						
Soil erosion						
Desertification						
Changes in hydrology						
Water pollution						
Climatic changes						
Noise						
Social impacts						

iii) Forest-based Industries

Mechanical wood processing includes sawmills, veneer and plywood factories Another wood-based industry is the pulp and paper industry All these activities are accompanied by deleterious environmental effects For possible environmental impacts from wood-processing industries see Guidelines for Industry

2 4 1 4 Pesticides

Pesticides play an important part in plant protection and in the protection of animal and human health If pesticides are used excessively they present a hazard to people, animals and the environment in general Pesticides include

- insecticides to combat harmful insects
- herbicides to control weeds
- fungicides to control fungal diseases
- rodenticides to control rats and mice,
- molluscicides to control snails

Pesticide manufacture is covered by the guidelines for industry

Chlorinated hydrocarbons such as **DDT, Aldrin, Chlordane** and **Heptachlor** are very stable and tend to accumulate in the food chain Application of these products should be banned whenever possible Other pesticides used in Africa and known to cause serious intoxications and adverse impacts on the natural environment are **Parathion,** often used to replace chlorinated hydrocarbons presents a high acute toxicity **Dieldrin/Endrin,** highly toxic, killing at the same time both the insect pest and non-target species The use of **Ethylene-dibromide (EDB)** a proven carcinogen, and **DBCP** should be restricted to cases where no substitutes exist for the considered application **Toxaphene, Endrin, Lindane, DECP** and **BCH** are suspected of long-range chronic effects and should be equally avoided

Main criteria for assessing the environmental impact of a particular pesticide are its toxicity and degree of biodegradability The mobility of a pesticide is its ability to move from one environmental compartment to another

Air pollution

Large scale aerial application of pesticides may represent the greatest potential hazard to the environment

Soil pollution

Transported by water infiltrating in the soil pesticide residues may accumulate and affect soil organisms, including micro-organisms which play a prominent part in soil fertility

Water pollution

Water draining from irrigated fields is likely to contain residues of pesticides or fertilizers which may not only affect aquatic life but also reduce the value of the water downstream as a source for drinking water Also drinking water-supply from groundwater may be affected by contamination with nitrates as a result of excessive use of nitrogenous fertilizers

Impact on human health

The magnitude of this impact depends on the acute and chronic toxicity of the product and its tendency to accumulate in the food chain

Bioaccumulation

This impact depends on the degree of biodegradability of the pesticide applied In the case of persistent types of pesticides, animals at the end of the food chain such as carnivorous mammals predatory fishes and birds of prey, may be killed as a result of bioaccumulation of the toxic substance

Questionnaire Impacts of Pesticides

Key Environmental Impacts	Significant	Minor	None	Mitigative Measures		Remarks
				Yes	No	
Air pollution						
Soil pollution						
Water pollution						
Impact on human health						
Bioaccumulation						

2 4 1 5 Livestock

In arid and semi-arid regions main land-use often consists of livestock keeping and nomadic pastoralism Cattle is usually pastured in marginal areas too unproductive for crop cultivation These areas are easily degraded, especially when the number of cattle exceeds the carrying capacity of the land Year round grazing in the same area, made possible by permanent water-supply for the cattle, often results in overgrazing, and eventually the disappearance of all vegetation cover

Soil erosion

In many pastoral areas it is common practice to burn the grass at the end of the dry season to decrease the incidence of pests such as tsetse fly and ticks and secondly, the release of inorganic nutrients This type of burning increases soil erosion especially on hill and mountain slopes

Desertification

Establishment of large ranching projects implies a high concentration of animals on a restricted surface of land Without separate fodder production and fodder preservation for the dry season, the cattle will have to depend on the vegetation available in the area If the number of animals exceeds the carrying capacity of the land the resulting overgrazing will favour the desertification process

Social impacts

Pastoralists will be affected by the establishment of closed pastures Usually, they will occupy the most productive areas, thus compelling pastoralists to survive on a smaller area of inferior quality

Depletion of water supply

Use of wells and boreholes to supply cattle with water may lower the water-table level to such an extent that in the area less water is available for humans Secondly, an indirect effect is the risk of raising the soil salinity or affecting the soil pH

Questionnaire Impacts of Livestock						
Key Environmental Impacts	Significant	Minor	None	Mitigative Measures		Remarks
				Yes	No	
Soil erosion						
Desertification						
Social impacts						
Depletion of water supply						

2 4 1 6 Fisheries

As part of the living environment, fishery resources are sensitive to disturbance and pollution resulting from human activities Fishery activities may also affect other sectors of the environment

A distinction has to be made between capture fisheries (exploiting wild stocks of fish) and aquaculture (fish farming)

i) Capture Fisheries

The most productive areas for fishing are areas of high biological productivity, such as estuaries, coral reefs and zones of oceanic upwellings Lakes and rivers can also support major fisheries

As a biologically renewable resource, fish stocks are vulnerable to overexploitation Often the same fish and shrimp stocks are exploited by both the in-shore artisanal fishery and the industrial coastal fisheries In many areas fish harvesting has already reached or exceeded maximum sustainable yields, due to increased fishing

Changes in aquatic ecosystem

There are complex interactions between different fish species and between fish and other aquatic organisms Changes in the numerical balance between fish species, as a result of selective fishing methods can cause significant shifts in faunal composition

Depletion of species

Overfishing, especially when selective fishing is applied, may lead to a severe decline of a particular species Populations of non-target species are also affected in particular when non-selective gear is used Accidental catches of endangered species such as marine mammals and turtles, may seriously affect the survival of these species

Destruction of natural habitat

Some fishing methods, such as dynamiting and trawling over coral reefs, cause severe and long-term damage to the bottom substrate and the organisms it harbours

Questionnaire Impacts of Fisheries Capture fisheries						
Key Environmental Impacts	Significant	Minor	None	Mitigative Measures		Remarks
				Yes	No	
Changes in aquatic ecosystem						
Depletion of species						
Destruction of natural habitat						

ii) Aquaculture

Depending on the cultured species, fish and shrimp farming can be effectuated in fresh brackish or marine waters Depending on the scale at which aquaculture activities take place they can have more or less adverse impacts on the environment

Water pollution

Discharge of nutrient-rich water from the culture ponds in the surrounding waters may lead to eutrophication Also, pollution may be caused by antibiotics and pesticides used in aquaculture Furthermore wastes from processing plants may be dumped into the natural waters

Water-related diseases

Stagnant water in the ponds provide a habitat for snails and breeding of mosquitoes that are vectors for diseases

Introduction of exotic species

Release or accidental escape of exotic species from the fish ponds may have an impact on the existing aquatic fauna and flora (e g Tilapia)

Conflicts in water-use

Freshwater requirements for aquaculture may be in conflict with water demands for agriculture

608

Loss of natural habitat

Aquaculture projects based on marine species are currently implanted in a brackish water environment, such as mangrove swamps As a result of fish pond construction, natural habitat and nursery area for important fishery resources is lost

Questionnaire Impacts of Fisheries Aquaculture						
Key Environmental Impacts	Significant	Minor	None	Mitigative Measures		Remarks
				Yes	No	
Water pollution						
Water related diseases						
Introduction of exotic species						
Conflicts in water use						
Loss of natural habitat						

2 4 1 7 Public Health

Health programmes can have environmental impacts, if they include components which affect the physical environment construction of buildings waste disposal use of hazardous chemicals etc

Environmental impacts of the construction of health care facilities are discussed in the section on the construction of buildings

The discharge of toxic and infectious wastes may have a major impact on the environment It may lead to pollution through inadequately treated wastes comprising a variety of hazardous and toxic chemicals including radioactive materials Hospitals and clinics produce contaminated wastes, such as infected operating materials sewage and linen

Vector eradication programmes may also have significant environmental impacts due to the effects of the pesticides used For adverse environmental impacts of vector control by chemicals see the section on pesticides

2 4 1 8 Education

The environmental impacts of education programmes vary according to the components involved Physical interventions in the environment from education programmes are mostly related to the construction and use of schools (see sections on construction of buildings, and water supply)

The environment may be polluted to some extent by toxic, hazardous or radioactive materials used in educational laboratories (refer to the sections on pesticides and solid waste and sanitation)

2.4 2. Industry and Infrastructure

This section has been subdivided into Industry and Infrastructure (section 2 4 2) Public Utilities (section 2 4 3), and Transportation (section 2 4 4) Most projects will be comprised of several components, and reference to other sections may therefore be necessary

The aim of industry and infrastructure is generally to provide a physical framework for economic development and/or social improvement This can be achieved by either constructing new infrastructure, upgrading old facilities or through strengthening of the institutions involved

The adverse environmental effects of large industry and infrastructure projects are easier to mitigate than those of small- or medium-scale projects The scope of control over several small industries in one project is smaller than that over one large project, while for example the resulting pollution may be of the same intensity

2 4 2 1 Dams and Hydropower

Dams are built and reservoirs are created for·

- ❒ electric power generation,
- ❒ water-supply for irrigation domestic and industrial uses, and

- flood control

The environmental impacts of dams constructed for any of these purposes or a combination, of these are similar

Dam projects are highly complex and are likely to require a full-scale EIA The nature of the adverse impacts is mainly determined by project siting The magnitude of the environmental impacts usually depends on the size of the reservoir Mini-hydro schemes have considerably less impact on the environment than projects involving large dams However, the cumulative impact of a large number of mini-hydro projects on the same river should not be underestimated

Changes in hydrology

Dam operation activities have an important impact on the downstream river flow In coastal areas, a considerable decrease in river flow may cause saline waters to penetrate further upstream and therefore may affect the flora and fauna of the lower river and the river banks Changes in flow rates and volumes in streams cause stream channel erosion, contributing to downstream siltation and sedimentation

Resettlement

The magnitude of the resettlement impact depends on the number of people living in the future reservoir area, who have to be relocated Both tangible and intangible types of impacts must be highlighted

Loss of agricultural land

If agriculture exists in the future reservoir area, arable land will be lost as a result of inundation The magnitude of the impact depends on the area of the land and the value of the crops under production

Loss of infrastructure and housing

The magnitude of this impact depends on the number and value of human settlements lost when the reservoir area is flooded Infrastructure such as electrical transmission lines and roads may be interrupted by flooding of the area

Loss of natural vegetation and wildlife habitat

The magnitude of this impact is determined by the area of natural vegetation that will be lost due to inundation and also by the vegetation type A number of wild animals living in the

reservoir area will disappear as a result of habitat destruction

As a stretch of river is transformed into a lake, species characteristic of running waters will disappear as a result of loss of riverine habitat Furthermore, the roads built for the dam project will provide increased access to the region where the project is implemented Natural vegetation and wildlife will be affected by wood cutting, hunting, and other secondary activities

Aquatic weed growth

Criteria to consider for prediction of possible aquatic weed growth are 1) the occurrence of pest plant species in the region and 2) the trophic status of the future lake If vegetation is cleared prior to flooding of the reservoir area, nutrient input from decomposing vegetation will be less

Diseases

During the construction phase diseases may be introduced in the project area by workers, hired from elsewhere After flooding of the reservoir, new vegetation may develop in the lake area which may provide a habitat for vectors of diseases such as schistosomiasis and malaria

Loss of scenery

Quarrying of construction material can locally disfigure the landscape

Soil erosion

Removal of vegetation cover at the site of borrow pits exposes the soil to erosion processes

612

Questionnaire Impacts of Dams and Hydropower Projects						
Key Impacts	Significant	Minor	None	Mitigative Measures		Remarks
				Yes	No	
Changes in hydrology						
Resettlement						
Loss of agricultural lands						
Loss of infrastructure and housing						
Loss of natural vegetation and wildlife habitat						
Aquatic weed growth						
Diseases						
Loss of scenery						
Soil erosion						

2 4 2 2 Mining

Most mining projects have significant environmental impacts The effects of surface mining methods are most visible a large land area is cleared and soil is removed Subsurface mining however may produce vast amounts of spoil which are dumped near the mine site Both may cause severe pollution problems if the mine material is toxic Dust generated by the mining activities may also pose a significant problem Off-shore exploitation affects the seabed and marine life, and poses the risk of significant marine pollution

Mining is often accompanied by some form of processing the impacts of these activities are covered in the section on industry Quarrying for construction material has similar effects as open-cast mining but usually on a smaller scale

Loss of natural vegetation and wildlife habitat

Surface mining leads to a significant disruption of the natural environment It often takes place in previously inaccessible areas therefore sometimes near or in Environmentally Sensitive Areas The magnitude depends also on the size of the excavated area

6.13

Vegetation and animal life can be significantly affected by clearing for mining and transport facilities, especially in tropical forest areas Access to the to the area is increased, also for settlers and natural vegetation and wildlife will be affected by agricultural practices hunting and woodcutting

Loss of scenery

Mining has significant visual impacts, locally Open-cast mining implies the displacement of large amounts of rock and soil Underground mining wastes are dumped above ground as spoil slag or tailings

Changes in hydrology

Underground and surface drainage patterns are altered irrevocably The quantity of water in aquifers in the vicinity can thus be seriously affected

Soil degradation

The removal of trees and shrubs which act as wind-breaks and soil stabilizers can accelerate soil erosion and lead to landslides Subsurface working may lead to soil subsidence

Pollution

The material excavated in the mines is often toxic Its toxicity and concentration determine the significance of the impact Furthermore blasting may cause dust pollution Particles may be transported over long distances by wind or water

Social Impacts

Noise and vibration from blasting or drilling reach high levels, affecting the local population and the workers Hearing of workers is impaired by extended high noise levels Serious accidents may occur, because mining often involves blasting and use of heavy equipment Excavated areas may cave in, especially dangerous in underground mining The improved access to the forest may lead to the spread of spontaneous settlements and shifting cultivation in forest areas

Loss of land and resettlement

The land which is mined is lost for other purposes People living at the project site must be resettled because the land is needed for mining and for the allocation of a buffer zone

614

Questionnaire Impacts of Mining						
Key Impacts	Significant	Minor	None	Mitigative Measures		Remarks
				Yes	None	
Loss of natural vegetation and wildlife habitat						
Loss of scenery						
Changes in hydrology						
Soil degradation						
Pollution						
Social impacts						
Loss of land and resettlement						

2423 Industry

Environmental impacts of industrial development activities start with the construction of the plant and sometimes due to additional infrastructure for example access roads The impacts mostly short-term compared to the long-term impacts of manufacturing are described in other sections of these guidelines

Industrial processing relies on the input of natural resources, such as raw materials, energy and water The conversion of raw materials to various products requires transport from the source via the industrial plant to the market (these environmental impacts are covered in the section on transportation) Industrial manufacturing generates residues which are either re-used or discarded as wastes Toxic wastes may kill species either directly or indirectly through accumulation in the food chain and cause long-term environmental problems

Agro-industries are based on the products of agriculture fishery and forestry They produce mainly organic wastes If they are released in rivers and lakes their decomposition may create oxygen deficiency leading to the death of aquatic organisms The nutrient input from mineralization of organic wastes accelerates the eutrophication process in natural water bodies Nutrient-enrichment of water will eventually result in excessive growth of algae or macrophytes

615

Chemical industries use and produce a wide variety of compounds For example fertilizer industries produce nitrates and phosphates which if released in natural waters contribute to eutrophication Others discharge chemicals which reduce the oxygen concentration in water, affecting aquatic life The use and discharge of toxic and hazardous chemicals, such as some pesticides, pose significant risks for humans and the food chain

Heavy metals produced and discharged by the **metallurgical industry** are mostly toxic to human and animal health They accumulate in the food chain and in body tissue

The production of **thermal power** by burning fossil fuel has environmental effects similar to heavy industry Significant effects are air pollution from soot dust particles the toxic gases such as oxides of nitrogen and sulphur; water pollution from wastes and cooling water and excessive noise

Air pollution

The manufacturing process causes emissions of gaseous and particulate pollutants from incineration processes and volatile chemicals The magnitude of the impact depends on the concentration and toxicity of the emitted chemicals and on the sensitivity of the surrounding area especially in the direction of the prevailing wind

Water pollution

The discharge of effluent from the manufacturing process and by accidental spills can severely pollute water resources The significance of the water pollution depends on the toxicity and concentration of effluent Cooling water causes thermal pollution which affects aquatic organisms

Soil pollution

The wastes from the manufacturing process which are dumped without precautions may cause soil pollution

Changes in hydrology

Site preparation and construction change the hydrological balance and drainage patterns at the project location and may lead to flooding or erosion downstream

Soil erosion

During construction and operation of the plant solid wastes may be dumped in landfills These activities may result in significant erosion especially when performed on steep slopes

Social impacts

Site preparation construction and operation activities produce noise and vibration nuisances to the local population and workers High or continuous sound levels cause damage to hearing The smell emanating from some raw materials, products and wastes causes considerable discomfort to the local population and workers Inhabitants of the project site must be resettled because the land is needed for the construction of the industry building and for a buffer zone The land is lost for other purposes

Loss of scenery

The presence of large industrial plants and the emission of smoke and dust have a significant negative impact on the landscape

Conflicts in land use

The land on which the industrial construction is built is lost for other purposes Any existing infrastructure is lost or degraded by construction

Questionnaire Impacts of Industry

Key Impacts	Significant	Minor	None	Mitigative Measures		Remarks
				Yes	No	
Air pollution						
Water pollution						
Soil pollution						
Changes in hydrology						
Soil erosion						
Social impacts						
Loss of scenery						
Conflicts in land use						

2 4 2 4 Construction of Buildings

The construction of buildings accompanies various types of projects The significance of the environmental impacts is determined directly by the site location and the dimensions

of the structures Indirectly building activities may lead to activities covered elsewhere, such as quarrying for building materials and the construction of access roads

Loss of land and resettlement The land used for construction, is lost for other purposes such as agriculture The infrastructure on the spot is lost or degraded by construction Inhabitants of the project site must be resettled, because the land is needed to provide space for the physical facilities of the project

Soil erosion Removal of vegetation for cut and fill operations may cause soil erosion especially if it entails extensive areas or construction on sloping terrain

Pollution Site preparation and construction cause dust and exhaust fumes from construction equipment, and some soil pollution, for example from oil spills from construction vehicles Groundwater and surface water quality decline due to these activities

Loss of scenery The construction of high buildings may disfigure the landscape if they can be seen from afar

Questionnaire Impacts of Construction of Buildings						
Key Impacts	Significant	Minor	None	Mitigative Measures		Remarks
				Yes	No	
Loss of land and resettlement						
Soil erosion						
Pollution						
Loss of scenery						

2.4.3. Public Utilities

2 4 3 1 Water Supply

Water-supply projects are executed mainly for their beneficial health impact But, if not properly designed and executed they may have negative health impacts The use of groundwater as source of water-supply leads to somewhat different environmental impacts than the use of surface water Construction

618

of reservoirs has similar effects as dam and hydropower projects

Changes in hydrology

Severe prolonged groundwater extraction affects the amount of water available for other uses and leads to soil subsidence In the coastal zone prolonged groundwater extraction may lead to saline intrusion in the aquifer Abstraction of surface water diminishes the amount of water available for other purposes This also leads to conflicts between users of water

Pollution

Water purification plants purify raw water and produce polluted sludge Chlorine disinfectants may pollute the environment and endanger worker s health

Water-related diseases

The creation of reservoirs for water-supply may create habitats and breeding grounds for vectors of malaria or schistosomiasis

Questionnaire Impacts of Water-supply						
Key Impacts	Significant	Minor	None	Mitigative Measures		Remarks
				Yes	No	
Change in hydrology						
Pollution						
Water related diseases						

2 4 3 2 Solid Waste Management and Sanitation

Solid waste management and sanitation projects should improve environmental conditions, if designed and executed well Environmental effects of solid waste management are mainly due to dumping in landfills or insufficient treatment The main problems caused by sanitation facilities stem from inadequate treatment of human excreta, domestic and industrial wastes before their discharge into the environment Also, during operation connecting points of sewers always leak to some extent

Pollution

The discharge of residual organic wastes from treatment plants into natural waters leads to eutrophication and oxygen depletion The impact depends on the concentration and

toxicity of the remaining wastes Landfill of hazardous solid wastes results in significant soil pollution

Water related diseases

The discharge of liquid residues from sewage treatment poses a significant health threat if pathogens are not removed by treatment This also applies to the deposit of residual sludge on agricultural lands, which contaminates agricultural products with pathogens Sewage containing toxic and hazardous industrial wastes threatens the health and safety of workers

Odours

Treatment and pumping plants generate off-odours, a nuisance to workers and the local population

Loss of land and resettlement

The land used for solid waste disposal or sewerage treatment often lies in or near municipal areas A considerable amount of land may be needed for the facilities and as buffer-zone

Questionnaire Impacts of Solid Waste Management and Sanitation

Key Impacts	Significant	Minor	None	Mitigative Measures		Remarks
				Yes	No	
Pollution						
Water related diseases						
Odours						
Loss of land and resettlement						

2 4 3 3 Power Transmission Lines

Power transmission lines accompany the construction of power-producing and power-consuming plants Urban development may also include this activity The significance of the effects is largely determined by the scale and site of the activity

Loss of natural vegetation

Land clearing for power transmission lines leads to a large-scale destruction of natural vegetation because it is a linear development For high voltage lines a wide strip must be kept free of vegetation This may prove a considerable barrier for plants and animals thus decreasing the size of their habitat and disrupting distribution patterns

Loss of land and resettlement

The transmission lines need a considerable amount of free space causing conflicts in land-use The land is lost for other purposes Inhabitants of the project site must be resettled, because the land is needed for the physical structures and for the allocation of a buffer zone

Loss of scenery

The landscape is disfigured by the lines and their supporting pylons

Social impacts

Contact with power cables may kill humans and animals They also produce electromagnetic radiation, harmful to people living nearby

Questionnaire Impacts of Power Transmission Lines						
Key Impacts	Significant	Minor	None	Mitigative Measures		Remarks
				Yes	No	
Loss of natural vegetation						
Loss of land and resettlement						
Loss of scenery						
Social impacts						

2 4 3 4 Oil and Gas Distribution Lines

The construction of oil and gas distribution lines generally accompanies the mining of fossil fuels Industrial and urban development often include this activity The significance of the effects is largely determined by the scale and site of the activity

Loss of natural vegetation

Land clearing for distribution lines leads to a large-scale destruction of natural vegetation, because it is a linear development

Loss of land and resettlement

If pipelines are laid above ground the land is lost for other purposes Inhabitants of the project site must be resettled because the land is needed for the physical structures If the pipelines are laid underground residents have to be relocated temporarily

621

Interruption of wildlife and cattle migration

If pipelines are laid above ground, the migration routes of wildlife and nomadic pastoralists may be interrupted

Pollution

During operation connecting points always leak to some extent Punctures or ruptures in oil and gas pipelines may cause explosions, poisoning and pollution

Questionnaire Impacts of Oil and Gas Distribution Lines						
Key Impacts	Significant	Minor	None	Mitigative Measures		Remarks
				Yes	No	
Loss of natural vegetation						
Loss of land and resettlement						
Interruption of wildlife and cattle migration						
Pollution						

2.4.4. Transportation

2 4 4 1 Road and Railway Projects

Due to the social and economic changes following improved transportation it has far reaching environmental effects which are difficult to predict The direct impacts covered below may therefore understate the environmental impacts in the long-term

Road and railway projects have predominantly similar environmental impacts and are therefore reviewed together New road or railway development has more significant impacts on the environment than the upgrading of an existing road

Pollution

Road traffic and trains produce air pollution and dust, affecting the environment and human health The significance of the impact depends on the volume of traffic and the average volume of exhaust per automobile or train The rainwater running off road surfaces and rail tracks carries spills and dust contaminating water and soil

Changes in hydrology

Often natural drainage is altered by embankments and tunnels for roads and rails This impoundment of water affects the groundwater level

Soil erosion

Road and railway construction activities affect soil stability, particularly on slopes, and may lead to erosion and landslides As a result of soil erosion, the sediment load in streams will increase

Loss of natural vegetation and wildlife habitat

Clearing of vegetation will take place before road and railway construction The magnitude of the impact depends on the area of vegetation cover removed, on the type of vegetation, and decrease in wildlife habitat The road or railway can interrupt migration routes, separating animals from their breeding or feeding grounds

Social impacts

Construction and use especially of roads cause considerable noise and vibration, disturbing workers and the local population Arable lands are lost and inhabitants of the project site must be resettled because the land is needed for construction

Questionnaire Impacts of Road and Railway Projects

Key Impacts	Significant	Minor	None	Mitigative Measures		Remarks
				Yes	No	
Pollution						
Changes in hydrology						
Soil erosion						
Loss of natural vegetation and wildlife habitat						
Social impacts						

2 4 4 2 Ports, Harbours and Coastal Structures

Due to the socio-economic changes following port and harbour development far reaching environmental effects difficult to predict can occur The construction of any coastal installation will interfere with wave behaviour water movements and deposition patterns Dredging of harbours and channels continues during operation thus causing regular disruption of the sea bed The development of a port or

harbour also implies increased demand on roads or railways and on water-supply and sanitation facilities (see relevant section)

Coastal erosion and siltation

Construction activities destroy or alter islets, sand banks, coral reefs and river and sea beds The altered hydrography changes the sediment transport deposits build up before the obstacles and erosion increases in their lee Riverbanks and coastlines are affected for example, leading to a permanent loss of habitat for flora and fauna, thus affecting fishery resource development

Pollution

Construction often leads to pollution from silt run-off, but discharges and spillage from ships have a more significant impact Dredging activities cause turbulence another type of pollution affecting aquatic life

Liquid and solid wastes may be discharged directly into the sea if disposal facilities are inadequate Pollution affects aquatic organisms and thus fisheries The risks associated with leakages, spills and accidents are significant if hazardous materials are involved

Social impacts

Noise and vibration accompany construction and operation activities, affecting workers and the local population If the construction area is already populated resettlement is necessary to provide space for the road or railway and for a buffer zone

Loss of land and resettlement

Land reclamation for development of port facilities may result in the displacement and relocation of the local population Arable land, infrastructure and natural vegetation is lost The impact depends largely on the extent of area needed for physical structures and for a buffer zone

Questionnaire Impacts of Ports, Harbours and Coastal Structures						
Key Impacts	Significant	Minor	None	Mitigative Measures		Remarks
				Yes	No	
Coastal erosion and siltation						
Pollution						
Social impacts						
Loss of land and resettlement						

2443 Airport

Airports cause major large scale environmental impacts they require vast stretches of land and cause air pollution and noise Due to the social and economic changes they bring, airports have far reaching environmental effects, which are difficult to predict Large amounts of water are used during operation therefore the impacts mentioned for water-supply and sanitation projects must also be considered The construction of an airport also implies increased demand on roads or railways (see relevant section)

Pollution

Aircraft exhausts and the handling of fuel cause considerable air pollution Run-off water carries undesirable suspended particles polluting water and soil

Loss of land and resettlement

A large area of natural arable or populated land may be lost to the airport a surrounding buffer zone and along approach and take-off routes Inhabitants of the project site must be resettled Airplanes generate considerable noise at the airport and along flight routes

Changes in hydrology

Construction of runways and access roads impedes natural drainage due to their large impermeable areas Levelling and infilling during construction have the same effect

Questionnaire Impacts of Airports						
Key Impacts	Significant	Minor	None	Mitigative Measures		Remarks
				Yes	No	
Pollution						
Loss of land and resettlement						
Changes in hydrology						

3. PROCEDURAL ENVIRONMENTAL ASSESSMENT GUIDELINES

3 1. General

The fundamental premise of these environmental assessment guidelines is that the Bank Group as a development financing partner has a major role in enabling improved environmental management and promoting sustained development in the RMCs This part of the document addresses the procedural environmental assessment guidelines for use within the Bank Group As such they are essential tools for the environmental assessment decision-making process

The procedural guidelines for environmental assessment will eventually become an integral part of the Operations Manual used by Bank Group staff engaged in programme and project operations

3.2. Project Cycle

A critical appraisal of options for the inclusion of procedural environmental assessment guidelines into the operations of the Bank Group must should with an analysis of the project cycle Project and programme proposals reach the Bank Group from the following sources

- As a request for financing from the RMCs
- As a result of a Bank Group identification mission
- Following a general mission to the country by Bank Group staff
- As an invitation for co-financing extended to the Bank Group by other institutions

Although sometimes projects come into existence along other lines the Bank Group project cycle generally comprises the following stages

3 2 1. Pre-identification Phase

Before projects are identified in the first phase of the project cycle a macro-economic study is conducted, aimed at reviewing the major economic fiscal and financial features of the country, evaluating its past performance bottlenecks and development prospects The results of the analysis are laid down in Economic Prospect and Country Programming Papers (EPCPs) that are updated every three years The EPCP serves as an important tool for analysis of selected sectors Sectoral analysis makes it possible to highlight the priority sectors and sub-sectors likely to benefit from Bank Group financing

3 2 2 Project Identification

Although sometimes projects offered for financing to the Bank Group already comprise a full feasibility study, many projects are identified during missions of Bank Group officials and staff to the RMCs A critical review of a sample of projects revealed that environmental impacts are often not considered

3.2.3. Project Preparation

This phase prepares the necessary documentation and data for the appraisal of the loan by Bank Group staff It includes both in-house and external collection of information and basic data resulting in a feasibility study report that addresses technical financial and economic issues So far, the environmental soundness of only a few loan applications has been studied

3.2 4. Project Appraisal

This is an essential stage in the project cycle which leads to a decision to retain or reject the project The major technical, economic financial and institutional aspects which form the main components of the project are evaluated and brought together in the appraisal report Environmental aspects have usually not been considered so far systematically

The appraisal report is submitted to internal and inter-departmental working groups and the Loans Committee for discussion, before the project is negotiated and presented to the Board of Directors Prior to Board approval, the negotiation with the lender must be completed

3.2.5. Project Implementation and Supervision

Project implementation starts when the negotiated conditions precedent to the first disbursement have been fulfilled by the lender The fulfilment of the conditions of the loan can sometimes take long Under the conditions, one can also include items such as a national environmental policy, environmental legislation or the strengthening of a ministry concerned with environment

Possible problems during implementation are usually noticed in the progress reports and may be solved during supervision missions by the project officer An important tool for supervision is the appraisal report So far supervision has concentrated on technical realizations and disbursement of the loan Little attention is given to the environmental impacts mainly because the issue is hardly addressed in the appraisal report

3.2.6. Post-evaluation

This is the last stage of the project cycle Its purpose is to assess the project s impact, taking into account the initial objectives and comparing these to the achieved results The post-evaluation report is discussed internally prior to approval by the Board of Directors Thereafter, the project or programme is considered terminated So far, environment has not been an issue in post-evaluation of projects and consequently no feedback has been given to newly initiated projects

3.3. Activities Related to The Project Cycle

3.3.1. Pre-identification

The activities during this phase fall outside the project cycle proper, because they cannot be associated with one single

628

project Reports covering the economy and environment of one country play an important role during the project cycle of many projects The impact of this phase on the whole project cycle makes it necessary to include it in the study of procedural environmental assessment guidelines

Environmental Country Programming

The key activity in pre-identification comprises the preparation of Environmental Country Papers (ECPs) The ECP serves as a tool for decision-making Such papers should be concise (25 pages) and cover a limited number of topics of importance for environmental screening or for use in identification, preparation appraisal and implementation of projects

The preparation of a set of ECPs for all RMCs of the Bank Group is a major task. However, where possible use should be made of already existing information Once the full set of documents for each RMC is ready, its updating and modification may be required periodically Papers must be updated annually and reassessed at least every three years These papers would serve as inputs into the Economic Perspectives and Country Programming Papers (EPCPs)

3.3 2. Project Identification

Project identification is the first phase of the project cycle It starts with the submission of a loan application by the RMC and ends when the project is entered in the pipeline

3 3 2 1 Project Offer and Pre-selection

The actions related to project offer and pre-selection refer to all activities before the identification mission Although projects are sometimes offered together with a complete feasibility study for the majority the procedure starts with an application by the RMC for a range of sectors and projects to be considered The Bank Group evaluates the applications and makes a selection of projects for further consideration The selection of potential projects considered for financing is based on those sectors earmarked in the EPCP and for priority sectors the Bank Group financial support

The procedural environmental assessment guidelines may require that projects considered as potential for financing are initially distinguished in two groups, notably in Category I + II or in Category III in accordance with the IEE For projects in Categories I + II it may be necessary to plan a detailed review of environmental aspects in order to determine the exact Category and to identify significant impacts

The loans and project officers are responsible for environmental screening The Project Brief, IEE checklist and the ECP serve as decision-making tools for the categorization of projects Back-up may be requested from the Environment and Social Policy Division

3 3 2 2 Identification and Selection

In many cases an identification mission to the RMC is undertaken by the relevant staff to collect additional information so that the project can be entered in the pipeline It may be necessary to request an environmentalist for back-up in determining key environmental issues The environmentalist may also be included in the identification mission team to identify the exact category of a project and the extent of the impacts

A final decision on the category of the project may be made after the identification mission The environmental assessment guidelines require a decision on the category of the project whether the project falls in Category I (those requiring a full-scale EIA) or in Category II (those requiring well defined mitigative measures)

The project and loans officers in the Operations Departments, assisted by environmental specialists, are responsible for the environmental scoping This process is important because it identifies the key issues on which to focus attention and resources, when preparing a feasibility study or when planning mitigative measures These key issues should be considered in the TOR for EIA The information collected during

identification missions and the IEE checklists serve as decision-making tools

Sometimes loan applications are presented by RMCs together with an executed feasibility study, and an identification mission may not be necessary However, up to now, an EIA is not part of the documentation submitted together with the application Therefore, for environmental screening and scoping purposes, an identification mission with limited scope may still be required to identify the exact category of the project.

The next step of importance for the procedural environmental assessment guidelines is the preparation of the mission report and the Project Brief The conclusions of the IEE, key impacts from the questionnaires and further action to be taken, must all become an integral part of the Project Brief An environmental specialist may assist on environmental issues in the preparation of project briefs

Apart from active support in the screening and scoping process the involvement of environmental specialists from the pool of experts in the Environment and Social Policy Division is required in the inter-departmental working group review and the Coordinating Committee meeting

3 3.3. Project Preparation

This phase of the project cycle deals with the preparation and execution of feasibility studies and/or project designs Sometimes RMCs submit projects to the Bank Group that have already been studied and designed before, with financial assistance of other donors Normally the project is then appraised without further study However, in many such instances the impact on the natural and cultural environment has not been considered or studied, so that an additional EIA or development of mitigative measures remains to be carried out

3 3 3 1 Preparation of Feasibility Study and EIA

In the preparation of a feasibility study the category of the project is important, because the budget and TOR for a full-scale EIA are different and more elaborate than for development of mitigative measures

Once the budget and TOR for the feasibility study (with EIA) and/or design (with mitigative measures) are approved by the internal and the inter-departmental working groups, the green light is given for the EIA study It is essential that environmental specialists participate actively in the inter-departmental working group in order to scrutinize the TOR for the environmental studies

3 3 3 2 Execution of Feasibility Study and EIA

During the execution of the feasibility study (with EIA) and/or design of project, (with mitigation) the activities are the full responsibility of the RMC Consequently, the involvement of the Bank Group s environmental specialists is minimal

3.3.4. Project Appraisal

In the project appraisal stage the project is assessed for its technical financial economic environmental and gender relations components

3 3 4 1 Appraisal Mission

The preparation and execution of the project appraisal mission is the task of the project officers in the sectoral departments, with some guidance from the environmental specialists in the Environment and Social Policy Division Environmental specialists may be included in the team visiting the RMC for the appraisal of environmentally sensitive projects The contribution of the environmental specialists will normally be confined to advising or scrutinizing the report

3 3 4 2 Negotiations, Approval and Fulfilment

During negotiations of the terms of the loan and the approval by the Boards of Directors, contributions from the environmental specialists are minimal The environmental appraisal of the application should have been settled before it reaches this stage in the appraisal phase The Bank Group management has established a system which requires summaries of EIA to be submitted to the Boards of Directors 120 days before the project is presented to the Boards for approval

3.3.5. Project Implementation and Supervision

During project implementation and supervision one important issue is environmental monitoring The process provides data to project and loans officers, making it possible to judge the impacts on the environment For a small number of projects this may lead to corrective measures and/or changes in project design

3 3 5 1 Monitoring

The scope of environmental monitoring is to follow the effect of the project on the natural and cultural environment Which relevant parameters must be monitored as defined in the EIA report (for Category I) and recommended mitigative measures report (Category II) This process yields data and parameters that should be examined by Bank Group staff when the project is supervised in order to judge the performance from an environmental point of view

The environmental monitoring data and parameters should be included in the quarterly progress reports that the RMC submits to the Bank Group These reports should be scrutinized carefully by an environmental specialist to appreciate the quality of the collected data and the methods used In case of any doubt attention must be given to any deficiency during the supervision field visits Monitoring of a project may lead to the conclusion that the project has more negative impacts than expected Therefore it may be necessary to propose rehabilitation

3 3 5 2 Supervision

Supervision is important and is normally performed by the responsible project officer During the supervision missions to the RMCs the project officer normally acts alone The value and nature of environmental parameters collected in the monitoring process may not always be clear to him Therefore, it is important that during the preparation of such missions, consultation is held with environmental specialists In some instances, it may be essential to include an environmental specialist in the mission team

The consultation of environmental specialists is required when preparing a mission report for an environmentally sensitive project The findings of the mission report are an important tool for the design of rehabilitation measures The mission report should be cleared by the inter-departmental working group

3 3 5 3 Execution of Rehabilitation Measures

The mission report is an important instrument to initiate any change in the monitoring process as well as in the project itself The result of monitoring may require modifications in the monitoring plan in order to follow the impacts on the natural and cultural environment as required It is also possible that project components have to be modified to minimize environmental effects

It is almost impossible to provide conclusive evidence on the number of projects that need rehabilitation It is estimated that 25% of the projects may need corrections in project components during their lifespan No estimate is provided for the number of projects that require changes in the scope of environmental monitoring, the number is likely to be much higher

3 3 5 4 Feedback

The process of using data from environmental monitoring and supervision when designing and executing projects is important, because it allows for learning from previous mistakes

In order to make optimal use of such information all relevant monitoring and supervision data and parameters must be fed to a database

3 3 5 5 Completion

For every project a completion report is prepared by the RMC This report serves as basis for the preparation of the Bank's completion report However, in many cases the information supplied by the RMC is insufficient so that a field visit is required to collect missing information Responsibility for the completion of field visits and reports lies with the Operations Departments However, input from environmental specialists may be important for the identification of specific environmental issues to be considered The completion report passes the usual review by internal and inter-departmental working groups before it is used as a starting point in the post-evaluation process

3.3.6. Post-evaluation

The post-evaluation phase has no direct implications for the loan itself but serves as a reference for future activities of the Bank Group During this phase the positive and negative points are evaluated and this allows learning from past mistakes

3 3 6 1 Project Finalization

Responsibilities in the post-evaluation phase shift from the operations departments to the operations evaluation office (OPEV) The first step embodies a critical examination of the project completion report that aims for the identification of issues for further examination Because OPEV lacks adequate expertise for environmental auditing, it is recommended that environmental specialists from the pool in the Environment and Social Policy Division support OPEV staff

Based on the critical examination of the project completion report an Issue Paper is written In this paper the need for an operational audit is evaluated An environmental audit should be considered as part of the operational audit making the

635

latter one package covering technical financial, procedural, environmental and gender issues The Issue Paper should pay due attention to the need for an environmental audit

In most cases a post-evaluation field visit is necessary for the preparation of the operational audit Depending on possible impacts on the natural and cultural environment one may consider including an environmental specialist in the team visiting the RMC In this respect, much depends on the progress report and the supervision field visits that were executed during the previous phases

The operational audit report is reviewed in the usual manner by the internal and inter-departmental working groups before examination by the Board of Directors After this, the project is considered closed

3 3 6 2 Feedback

The process of using data from the operational audit and in more detail from the environmental audit, when future projects are designed and executed, is considered important because it allows for learning from previous mistakes In order to make optimal use of such information, it is proposed that all relevant post-evaluation data and parameters are also stored in a database

SUGGESTED TERMS OF REFERENCE (ToR) FORMAT FOR EIA STUDIES

1 Introduction

a) Purpose of terms of reference

b) Responsible party for preparing the EIA report

2 EIA Guidelines

General guidelines to be followed and the procedure to be used in preparing the EIA report should be provided

3 Background Information

a) General background studies and reports that are available might be described

b) Specific background studies and reports related to the project and the location of the project might be listed or described

4 Specific EIA Guidelines

a) Specific environmental effects

The environmental components which need detailed or further study should be listed The indicators of each listed component to be measured or assessed might be specified

b) Mitigative measures

EIA reports should propose mitigative measures for all adverse effects including discussion of alternative approaches and recommendations

c) Monitoring

EIA reports should propose a monitoring programme for assessing the actual impacts during the project s operation and beyond

d) EIA study proposal

The following should be mentioned in the proposal

i) work tasks each specific task to be done should be sufficiently described

ii) study schedule the proposed plan for carrying out the EIA study should be indicated,

iii) review sessions periodic reviews of the work during study might be needed

iv) printing or reproduction of the EIA report provision of a budget for printing and reproduction of the report as well as the number of copies required should be indicated,

v) study team expertise and specialists needed for the proposed project study team should be described

5 Time Constraints

a) EIA report the time required for the EIA report to be completed (e g within 3-12 months)

b) EIA study proposal the deadline for the EIA proposals (and tenders) to be submitted should be stated

6 Budget

The estimated budget allowance for the EIA study and report for the proposed project may be given

7 EIA Report Format

8 Other Relevant Information

SUGGESTED OUTLINE OF AN EIA REPORT

Executive Summary

Concise discussion of significant findings and recommended actions

1 Introduction

A clear statement is needed as to which public or private organization has initiated the project If the EIA has not been carried out in-house the name of the consulting or other organization that carried out the EIA should be given

The statement of need should outline the background to the project and the reasons for it being proposed It should also establish the social and/or economic need for the project

2 Project Description

The project description should include, but not necessarily be confined to the following aspects

- description of the project in terms of raw materials, processes equipment and products
- maps flow diagrams and photographs wherever necessary,
- a summary of the technical economic and environmental features essential to the project

3 Existing Environment

The description of the existing environment should include discussion on

- conditions in qualitative and quantitative terms of the physical biological and human environment before the implementation of the project
- spatial boundaries within the environment that is under consideration

639

- environmentally sensitive areas of special or unique scientific socio-economic or cultural value

4 Projects Options

Within the constraints of the aim and broad economic, technical and environmental factors, there are a number of available project options in terms of size, technology, layout, raw materials, energy sources or even products The principal features of each option should be given, and the economic, technical and environmental advantages and disadvantages of each should be discussed and evaluated The "no project" option should also be included in the discussion If more than one location option is available these too should be discussed and compared

5 Environmental Impacts

This section should describe how both beneficial and adverse significant impacts are expected to occur Consideration should be given to possible cumulative, synergistic or antagonistic environmental effects The discussion should state

- the source of the impact (e g oil-fired furnace chimney emissions)
- the nature of the impact (e g visual aesthetics, human health),
- why the impact is judged to be significant unknown or otherwise,
- in cases of unknown significance of impact any course of action considered to assess the impact
- any special emphasis to be given to any significant residual impact e g an impact that is still considered to be significant even after mitigating measures have been taken

6 Mitigative Measures

This section should discuss all the design measures that have been adopted into the project plan to reduce or to eliminate significant potential environmental impacts The discussion

should also include an economic evaluation of the design measures adopted and of those considered but rejected

7 Conclusions

Appropriate conclusions should be drawn in each section of the EIA report It is useful, however, to have the conclusions summarized in a series of brief statements referring to relevant sections of the report

8 References

Scientific and technical publications used and quoted in the report should be listed

World Bank

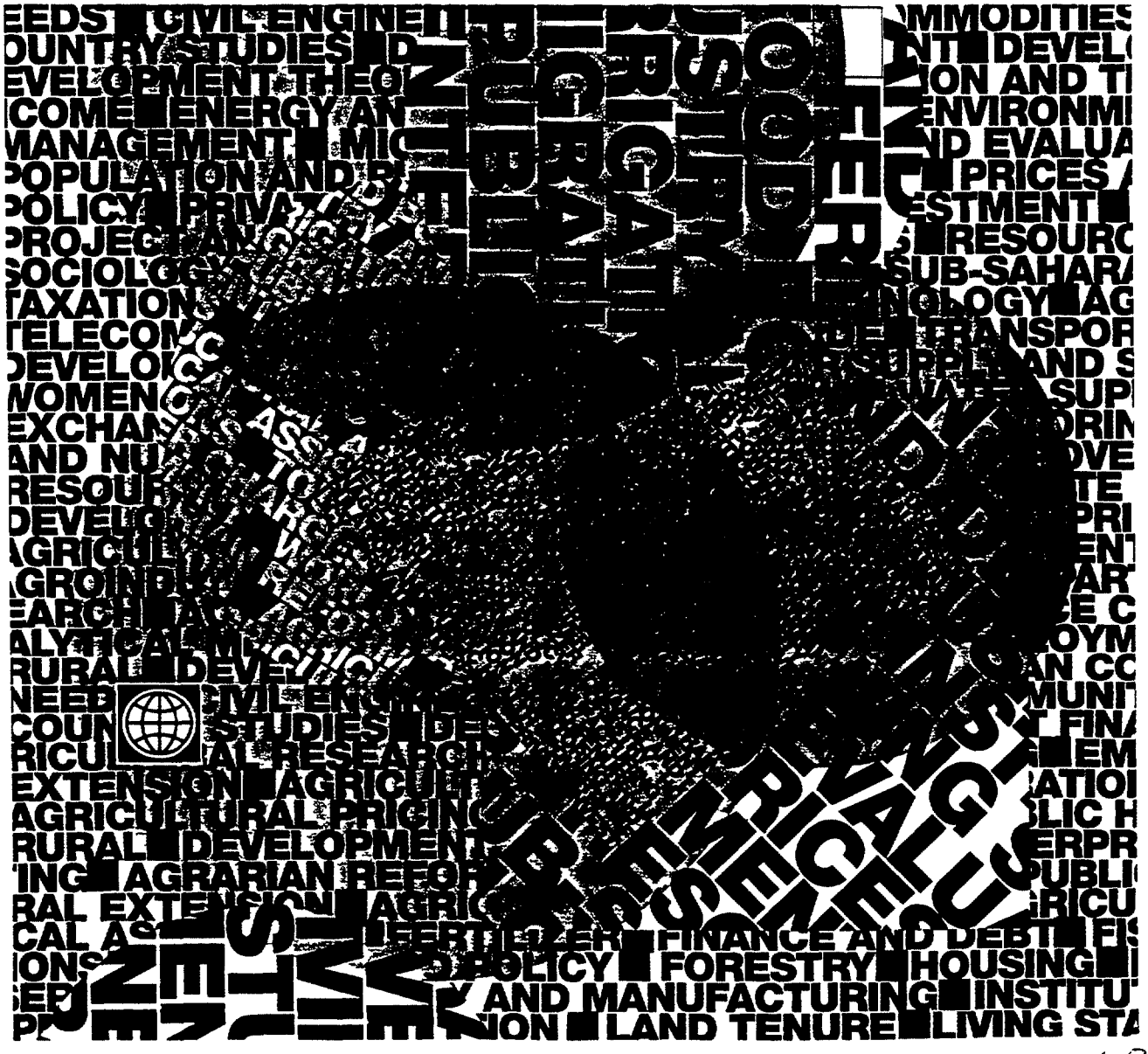
642

WORLD BANK TECHNICAL PAPER NUMBER 139

Environmental Assessment Sourcebook

Volume I
Policies, Procedures, and Cross-Sectoral Issues

Environment Department



643

CHAPTER 1

THE ENVIRONMENTAL REVIEW PROCESS

1 The purposes of the Bank's policy and procedures for environmental assessment (EA) are to ensure that development options under consideration are environmentally sound and sustainable and that any environmental consequences are recognized early and taken into account in project design. The precise operational meaning of "sustainable" is still being clarified, but some guidelines are suggested in Annex 1-5 As concern has grown worldwide about environmental degradation and the threat it poses to human well-being and economic development, many industrial and developing nations, as well as donor agencies, have incorporated EA procedures into their decision-making. Bank EAs emphasize identifying environmental issues early in the project cycle, designing environmental improvements into projects; and avoiding, mitigating, or compensating for adverse impacts. By following the recommended EA procedures, designers, implementing agencies, borrowers, and the Bank are able to address environmental issues immediately, thereby reducing subsequent requirements for project conditionalities and avoiding costs and delays in implementation due to unanticipated problems

2. The Bank's EA policy is set out in Operational Directive 4 00, Annex A (October 1989). The full text of the Environmental Assessment Operational Directive (EA OD) is provided in Annex 1-1. EA begins with screening, in which the Bank task manager (TM), in collaboration with the Regional Environment Division (RED), evaluates the project or project components according to the magnitude and sensitivity of the environmental issues raised. Screening determines the type of environmental analysis to be conducted for the project, ranging from no further analysis to a full EA EA or other analyses are the responsibility of the borrower, but Bank staff are available to assist wherever requested, such as in determining the scope of work and developing terms of reference (TORs).

ENVIRONMENTAL REVIEW, POLICIES, AND PRINCIPLES

3 Throughout the remainder of this Sourcebook, the term "environmental review" refers to the process just described, from screening at identification through evaluation after the last disbursement, or after implementation is complete Environmental review may entail preparation of a full EA, a more limited environmental analysis, or no further analysis at all, depending on the results of screening.

4. The terms "environmental assessment" or "EA" identify the more intensive examination which is required for lending operations that have diverse and significant environmental impacts. Formal EAs should cover the topics listed in Annex A-1 to the EA OD, including project description, baseline data, environmental impacts, analysis of alternatives, mitigation plan, environmental management and training requirements, monitoring plan, interagency coordination, and consultation with affected communities and local nongovernmental organizations (NGOs).

5. Environmental review is required for all Bank loans and credits except sectoral adjustment loans and structural adjustment loans. Sector investment projects and the investment component of hybrid loans and credits are subject to the environmental review requirement. "Bank" in this instance refers to IBRD and IDA; IFC has developed similar environmental review procedures appropriate to the nature of its investment operations.

6. EA is a flexible process, designed to suit the entire range of Bank projects and the different circumstances of its borrowing countries. There is no fixed inventory of issues to be examined in any

particular EA, instead, the Bank's procedure relies on screening, environmental reconnaissance, and discussions between Bank and borrower to identify the critical issues and to establish the scope of the EA The EA OD also calls for interagency coordination and consultation with affected groups and local (NGOs) at an early stage to ensure that all significant environmental issues are covered

7 "Environment" is broadly defined by the Bank as "the natural and social conditions surrounding all mankind, and including future generations" (as amplified in Operational Manual Statement [OMS] 2 36, para 3) The EA OD reflects this scope in setting procedure for evaluating impacts on health, cultural property, and indigenous peoples as well as on the natural environment Sociocultural effects of projects, such as new land settlement, involuntary resettlement and induced development, are also to be included in the environmental review

8 The Bank directive integrates EA or other environmental analysis into project preparation, including project selection, siting, and design decisions In most cases, an EA should form part of the overall feasibility study This facilitates incorporation of the findings into selection of sites and technology, designs and implementation plans For projects which would have major environmental impacts, the Bank recommends that the borrower retain independent experts not affiliated with the project preparation or feasibility study team to conduct the EA However, specialists responsible for the EA as a separate task should work closely with the feasibility and design team

9 EAs provide numerous opportunities for coordinating environmental work in the country, and should be linked to other environmental strategies, action plans, and free-standing projects EA provides a formal mechanism for interagency coordination and for addressing the concerns of affected groups and local NGOs EA can help strengthen environmental management capability in the country, and Bank staff should take advantage of opportunities to use it for that purpose

ENVIRONMENTAL REVIEW AND THE PROJECT CYCLE

Overall Relationship to the Project Cycle

10 The Bank's environmental review is intimately linked to the project cycle As Figure 1 1 shows, environmental review begins with screening at the time of project identification Scoping and preparation of the EA occur in tandem with or as integral parts of the pre-feasibility and feasibility studies The final EA is sent to the Bank by the Borrower prior to appraisal If the EA is satisfactory to both borrower and the Bank, it forms the basis for the RED's decision on environmental clearance and the environmental conditions to be negotiated with the borrower, some or all of which are incorporated into the loan agreement The EA may be adequate for the purposes of appraisal, but the Bank review may reveal needs for additional analyses before clearance can be given and negotiations undertaken) Supervision includes monitoring the project's environmental performance and compliance with relevant conditions agreed on between the Bank and the borrower After implementation is complete, the Project Completion Report (PCR) includes evaluation of both the impacts that actually occurred and the effectiveness of mitigation measures. The Operations Evaluation Department (OED) again audits selected projects possibly some years after the PCR

645

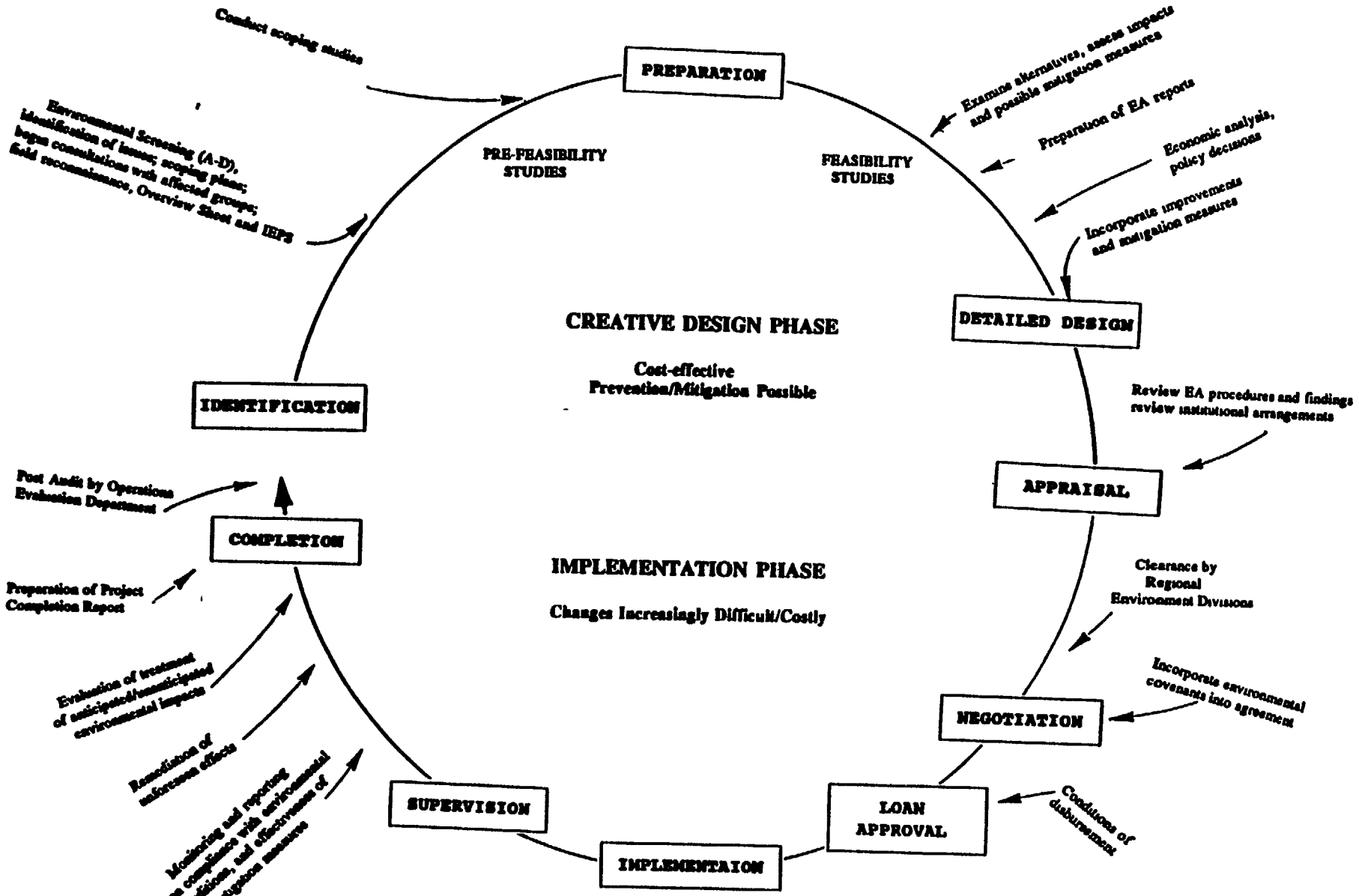


Figure 1.1. Environmental Assessment and the Project Cycle

Screening

11 Environmental screening is the responsibility of the TM, with advice and assistance from the RED An essential part of screening is to identify which aspects of a project are not environmentally significant and which therefore can prudently be dropped from further consideration. Its purposes are to ensure that the appropriate amount of attention is devoted to the environmental aspects of the proposed project from the very outset of the project cycle, to identify as much as possible the key environmental issues, and to determine the type of environmental analysis which is needed so that those issues (and others which may arise) can be addressed effectively in project planning, design, and appraisal

12 Screening is carried out at the time of identification Projects are assigned to one of four categories on the basis of the nature, magnitude and sensitivity of the environmental issues, and so designated in the Initial Executive Project Summary (IEPS)

Category A	EA is normally required, as the project may have diverse and significant environmental impacts
Category B	More limited environmental analysis is appropriate, as the project may have specific environmental impacts
Category C	Environmental analysis is normally unnecessary, as the project is unlikely to have significant environmental impacts
Category D	Environmental projects for which separate EAs are not required, as environment is a major focus of project preparation

13 Annex A-3 of the EA OD lists the types of projects or components which commonly fall into each category Certain types of projects almost always fall into a particular category -- thermal and hydropower development, for example In other project types, the category depends on scale and on other factors such as the status of environmental management capability in the country Large-scale irrigation and drainage projects are usually Category A, whereas small-scale projects of the same type may fall into Category B Category B projects are a diverse group, and the scope of the environmental analysis may vary -- from a detailed study of certain components that is almost as complex as that for an "A" project, to a routine check that project design conforms to applicable standards Category C projects may not be entirely devoid of environmental impacts, in a health project, for example, the design may have to provide for disposal of medical wastes

14 Other outputs of the screening process are the key environmental issues, the type of environmental analysis recommended, and a preliminary schedule for conducting that analysis This information is incorporated into the IEPS and discussed at the IEPS meeting The meeting results in decisions regarding type, timing, and major issues for the environmental review, unless those decisions have to be deferred pending receipt of additional information It is helpful in reviewing the environmental information to include a map in the IEPS showing the geographical location of the proposed project.

15. Results of screening are also reported to the Bank's executive directors in the Monthly Operational Summary (MOS) Overview sheets (Table 1 1) have been designed to record the information necessary for preparing the MOS In addition to basic data on the project and a description of its principal components, the sheets record the project category (A,B,C, or D), the major environmental issues, proposed actions (such as special studies to be conducted, environmental components to be added, other environmental work to be done in the sector), the projected date for completion of the environmental assessment or other analysis, and a report on the current status of that analysis The TM prepares the draft overview sheet, which is then reviewed by the RED Once any revisions are agreed and made, the overview sheet is cleared by the Sector Operations Division (SOD) or Country Operations Division (COD) chief, signed by the RED chief, and forwarded to be processed for the next MOS The complete overview sheet appears in the MOS, for Category A projects, only header information is shown for Category B Overview sheet information is updated whenever the Executive Project Summary (EPS) is revised, whenever the project category is changed (for instance, because a component with significant impacts is deleted) or whenever there are other significant changes in the information on the sheet Overview sheets are made final at the Final Executive Project Summary (FEPS) stage

16 In some cases, screening requires reconnaissance by Bank environmental specialists or consultants in order to develop a full understanding of the pertinent environmental issues and the items which need to be included in any further environmental analysis Where site visits are necessary, as is normally the case in sensitive areas or with complex environmental issues, REDs assist the TM in preparing terms of reference (TORs) for the mission Often a product of this mission is a draft of the TORs for the EA or other environmental analysis Annex 1-2 contains sample TORs for a reconnaissance mission

17 It is good practice for the TM to keep the borrower informed of the initial results of the Bank's screening The EA OD specifies that the Bank should review the results with the borrower, especially with regard to the type of environmental review required and its general scope, schedule, and implementing arrangements

Preparing for an Environmental Assessment

18 It is the borrower's responsibility to prepare TORs for the EA or other analysis and to obtain the necessary experts to carry it out The Bank is available to assist the borrower as necessary The task of determining the scope of the EA is critical, and is therefore one in which the Bank normally participates It is important not only to cover the environmental issues known at the inception of the study, but also to allow breadth and flexibility so that new issues can be identified and, if significant, addressed However, it is also important to frame the investigation so that time and resources are concentrated in the areas where potential impacts are likely to be found There are many examples of EAs in which massive amounts of money and effort were expended in collecting and reporting data on every aspect of the environment and producing voluminous reports in which there was much insignificant and irrelevant information than there were findings of significance The Bank intends that EAs be useful to decision-makers in the country and to Bank staff in determining whether or not to proceed with a given project and how to implement the project efficiently This means that the work must be focused on the issues which are critical to such decisions

Table 1.1. Example of a Completed Overview Sheet

ENVIRONMENTAL OVERVIEW OF PROJECTS IN THE IBRD/IDA LENDING PROGRAM

PROJECT ID: 4SRIPA082
COUNTRY: SRI LANKA
PROJECT: Local Government Development
EST BOARD DATE: February 91
TOTAL PROJECT COST: US$36.0 m
LOAN/CREDIT AMOUNT: US$25.0 m

FY AND STATUS: FY91
SECTOR: Infrastructure/Urban
EST APPRAISAL DATE: May 1990
MANAGING DIVISION: AS1IN
TASK MANAGER: Patrick McCarthy

ENVIRONMENTAL IMPACT CLASSIFICATION: B
PROJECT DATE FOR COMPLETION OF ENVIRONMENTAL ASSESSMENT: To be determined during sub-project appraisal, as necessary

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MAJOR PROJECT COMPONENTS: Support to the restructured Local Loans Development Fund (LLDF) as a vehicle for financing the investment requirements of Local Authorities (LAs). Project will consist of (a) line of credit to the LLDF; and (b) technical assistance and training for LAs. Subloans would finance (a) social infrastructure projects, e.g., roads and sidewalks, parks and playgrounds, drainage, street lighting; and (b) revenue generating projects, e.g , offices, markets, trade centers and slaughterhouses.

MAJOR ENVIRONMENTAL ISSUES: A number of sub-projects which may be proposed for financing would likely have adverse environmental impacts. An integrated part of the sub-project appraisal process by the LLDF, and by the Bank over the specific free limit sub-loan, would be an environmental appraisal. The loan proposal would have to be modified to the extent necessary to accommodate environmental issues before a loan is granted.

PROPOSED ACTIONS: Where loan proposals would clearly demonstrate an adverse environmental impact if implemented, the urban local authority would be requested to amend its proposal accordingly. This could take into account, for example, providing adequate sanitation for offices, market complexes etc., or re-siting slaughterhouses.

STATUS OF EA (IF ANY): A draft environmental issues paper for Sri Lanka has been prepared. The first report would likely include recommendations for a strategy to be adopted by the Government to prioritize environmental investments.

REMARKS: Overall, the project is expected to have a positive environmental impact as the LLDF appraisal process will include addressing environmental issues.

SIGNATURE: _____
Iain T. Christie
Chief, Infrastructure Operations Division
Asia Country Department One

SIGNATURE: Gloria Davis
Gloria Davis
Chief, Environmental Division
Technical Department

C49

19 In determining the scope of an EA, it is useful to consult with sources besides the borrower, the implementing agency or organization, and the technical experts In addition, other government agencies can provide valuable perspective They often have special information about the region and proposed site(s) of the project, and may be able to identify potential intersectoral impacts which should be examined Consequently, the EA OD recommends that an interagency meeting be held soon after the decision is made to prepare an EA, and that at least one more be held when the EA is completed and submitted for review by the government At the initial meeting, participants should agree on arrangements for ongoing coordination

20 The concerns of communities affected by the project and of local nongovernmental organizations (NGOs) with environmental interests also should be covered in the EA These groups can provide information useful for the EA, in fact, sometimes they are the only source of detailed knowledge about the local study area Chapter 7 provides guidance for discussions obtaining the informed views of affected communities and for involving them and local NGOs in EA (see para 51)

21 An EA may already have been developed under official procedures of the country or a co-donor to the project Such EAs should be examined and where elements appear to be missing or inadequate, Bank TMs may call for selective and enhancing studies Where the Bank and another donor are co-financing a project, TMs should clarify at the beginning which EA procedures--of the borrower, Bank or co-donor--will be used to ensure that EA OD requirements are met

22 TMs, assisted as necessary by RED staff, should review the detailed TORs before the EA begins, paying particular attention to the provisions for interagency coordination and community involvement and to the design of baseline data collection programs The latter are often the most expensive aspect of EA, and borrowers should seek the advice of experts in design of environmental or sociological data collection programs to avoid three pitfalls (a) collecting data that are not relevant to the decisions to be made, (b) sampling the correct parameters but timing the observations incorrectly or making an insufficient number of observations for an acceptable representation of the phenomena being studied, and (c) omitting key parameters from the program Avoiding these pitfalls at the outset minimizes the risk of reaching the end of a program, which might extend over an entire year or more, and discovering that the expended time and money have been wasted Annex 1-3 contains a sample of a "generic TOR" which can be used in preparing project-specific ones

23 The TM should also review the EA implementation schedule with the borrower, to determine whether it is consistent with key decision points in project preparation and provides for adequate integration of findings into feasibility studies and designs The Bank can also advise borrowers about obtaining consultants and funding for EA, as discussed later in this chapter (paras 58-71)

Conducting the Environmental Assessment

24 Carrying out the actual EA is the borrower's responsibility The government or project sponsor arranges for the EA, they often select consultants or an institution to conduct the analyses When it is necessary to use international experts to supply skills not available in the borrowing country, the Bank encourages involvement of local consultants as well, in order to take advantage of local knowledge and to strengthen their capability for future EA work

25 EA is most effective when even preliminary findings are made available early in the preparation process At that time, alternatives which might be desirable from an environmental viewpoint (sites, technologies, etc) can be considered realistically, and implementation and operating plans can be designed to respond to critical environmental issues in the most cost-effective manner Later on, making a major design change or selecting an alternative proposal--or deciding not to proceed at all with a project--become very expensive Even more costly are delays in implementation of a project because of environmental issues which were not considered during design Consequently, integration between EA and feasibility studies and design work is essential (See Chapter 7 for further discussion of dissemination of EA findings)

26 The EA implementation plan should provide for frequent coordination meetings between EA and feasibility study teams to exchange information on environmental issues and the responses they require Preliminary drafts of the key sections of the EA and working papers on specific issues are also useful modes of communication between the teams, especially when key decisions are made as preparation proceeds Most successful EAs have thorough mid-term reviews

27 The TM should agree with the borrower on which drafts, if any, the Bank wishes to see, and when At a minimum, however, the TM should review a final draft, with RED assistance, in order to ascertain that the issues of importance to the Bank have been addressed, to obtain any clarification needed, and to provide other comments to the borrower in the interest of having information on all the critical environmental issues ready before appraisal Since, in practice, some final EAs may be available only shortly before appraisal, preliminary review at an appropriate interim stage (for example, when the significant environmental issues are all identified and mitigating measures described) is highly desirable as well This will ensure that the scope of the EA is correct, that communication between designers and the EA team is occurring, and that changes are actually being made in the project to address environmental concerns In general, most major concerns become known within the first few months, the remainder of the EA period focusses on mitigating measures

28 The EA schedule must specify submission of the final EA report to the Bank for detailed examination prior to the start of project appraisal Annex A-1 of the EA OD is a sample report outline As general guidance, the main text of the report should not exceed 100 pages The report should provide an Executive Summary highlighting the significant findings and recommended actions (in order of importance), in relatively non-technical language and not more than 20 pages in length More detailed information, such as summaries of baseline data, model results, records of community involvement activities and reports of special studies, should be placed in a separate volume as a technical annex to the main report

29. The Bank recommends that interim EAs and related studies be released to interested agencies and to affected communities, and to NGOs involved in project preparation It encourages member countries to prepare EAs on this basis. However, as the EA is the property of the borrower, public release of the document can only be made with the borrower's consent

Environmental Assessment Review and Project Appraisal

30 The borrower should review the EA to ensure that the consultants or agency staff followed the TORs and met both Bank and country requirements The TM, assisted by RED staff, should also review the adequacy of the EA report, checking especially the following items

- Were the TORs followed?
- Are the items required by the EA OD included?
- Is the Executive Summary adequate? Decision-makers may read only the summary, therefore it must present the significant impacts (in order of importance), clarifying which are unavoidable and which are irreversible, the measures which can be taken to mitigate them; the cumulative effect of impacts, and the requirements for monitoring and supervision.
- Are recommendations clearly stated in the Executive Summary?
- Is the project outline description complete, insofar as the aspects which can affect the environment are concerned?
- Are project alternatives described?
- Is the baseline study section in the main report concise and useful to readers who are not specialists in the scientific disciplines covered? Does the section give an overall picture of present conditions and trends, and include ongoing and proposed development activities in the study area? Does it provide comments on the quality of the data and the completeness of the database?
- Is there consideration of probability in the section in which impacts are predicted and evaluated? Are potential impacts mentioned that were expected *a priori* but not found? Are significant impacts analyzed in more detail than less significant ones? Is sufficient justification provided for dropping topics from further consideration?
- Do mitigating measures both control adverse impacts and enhance project benefits? Are the institutional arrangements for implementing the measures defined? Are the costs of implementing all its recommendations adequately budgeted in the cost tables?
- Where monitoring programs are described, are the reasons for and costs of the monitoring activities covered? Is there a description of the institutional arrangements for carrying out the work, evaluating the results, and initiating any necessary action to limit adverse impacts disclosed by monitoring?
- Will the project be in compliance with Bank directives and policies on environmental matters, such as involuntary resettlement, cultural properties and wildlands?
- Are proposals for institutional strengthening and training adequate?

652

- Is there documentation of community involvement, including an overview of the issues raised and their disposition?
- In general, is the report free of jargon, and are technical terms defined where they occur or in a glossary?
- Where existing databases, planning studies, other EAs, scientific papers, etc , are used as information sources, are the references given?

31 Bank staff review in detail the EA findings and recommendations and include in the Final Executive Project Summary (FEPS) a summary of the EA status, the major environmental issues, and how those issues have been or will be addressed It notes any proposed environmental conditionalities.

32 The appraisal mission reviews the EA with the borrower, resolves any remaining environmental questions, assesses the capacity of country institutions to implement EA recommendations, determines whether the EA findings have been properly addressed during project preparation, and discusses environmental conditionalities to the loan agreements The Staff Appraisal Report (SAR) and President's Report (PR) contain summaries of the EA and its main findings An annex to the SAR should provide a more complete summary, including (but not limited to) baseline conditions, alternatives considered; significant impacts and preventive, mitigative or compensatory actions, capability of environmental institutions and steps to strengthen them, environmental monitoring arrangements, and consultations with affected groups and local NGOs Any necessary changes in country or agency environmental policy should also be stated in the SAR

33 The RED chief issues formal environmental clearance for the project, based on the information presented in the SAR and the EA Clearance is a necessary prerequisite to the Regional Vice President's authorization to begin negotiations In the negotiations themselves, the issues and actions critical to environmental soundness and sustainability in the project are discussed, and appropriate covenants are incorporated into loan or credit documents

Implementation and Supervision

34 EA recommendations provide the basis for supervising the environmental aspects of project implementation The borrower is obliged to implement measures to mitigate anticipated environmental impacts, to monitor programs, to correct unanticipated impacts, and to comply with any environmental conditionalities Procedures for start-up and continuing operation of the project will normally specify these agreements, as well as measures to protect the health and safety of project staff Proper staffing, staff training, and procurement of spare parts and equipment to support preventive, predictive and corrective maintenance are also necessary elements of implementation

35 Supervision is an essential aspect of the Bank's environmental review, since the environmental clearance decision is based in part on the assumption that mitigating measures and other provisions will be fully implemented and will be effective in avoiding or controlling adverse impacts that might otherwise

have made the project unacceptable for Bank support Supervision is carried out through a combination of the following

- reports required from the borrower on compliance with environmental conditionalities, status of mitigating measures, results of monitoring programs and other environmental aspects of the project,
- oversight by line agency with responsibility for the sector, and/or by environmental management, land use control, resource conservation, or permit-issuing agencies at the local, regional or national level,
- early warning by the borrower's staff about impending unforeseen impacts,
- Bank supervision missions to review implementation of environmental provisions, corrective actions taken to respond to impacts, and compliance with environmental conditionalities, including institutional strengthening components, and
- site visits by Bank environmental specialists or consultants as required to supervise complex environmental components or respond to environmental problems

36 Annex D-2 of OD 13 05 "Project Supervision," contains guidelines for supervision reports Paragraph 36 prescribes the general content for the section on environment In reporting on the environmental aspects of projects, Bank staff should cover critical environmental data (e g , violations of environmental quality standards or pollutant discharge limits), descriptions of impacts observed, progress on mitigating measures, the status of monitoring programs (especially those for detecting new impacts), progress on institutional strengthening, and adherence to environmental conditionalities

37 OD 13 05 encourages TMs to exhaust all means of persuasion before resorting to contractual remedies when the borrower is not meeting obligations of loan, guarantee or credit agreements Such obligations include implementation of environmental components or mitigation measures and adherence to environmental conditionalities The contractual remedies available include informal or formal suspension of disbursements under loans or credits, cancellation of all or portions of outstanding loan or credit balances, and acceleration of maturity These are described in Articles VI and VII of "General Conditions Applicable to Development Credit Agreements" and "General Conditions Applicable to Loan and Guarantee Agreements " OD 13 40 "Suspension of Disbursements" and OD 13 50 "Cancellations" set forth guidelines and procedures to be followed in exercising these remedies

Completion and Evaluation

38 At the conclusion of a project (after the last disbursement), the PCR is prepared and submitted to the Operations Evaluation Department (OED) The borrower is responsible for submitting information that will be the basis of the report It is important that environmental information be included so that the Bank's environmental review process can be improved as necessary, and progress toward funding of projects that are environmentally sound and sustainable can be monitored and maintained The EA OD requires that the PCR include a description of the impacts that actually occurred, a determination for each as to whether or not it was anticipated in the EA report (if one was required), and evaluations of the effectiveness of mitigating measures and of institutional strengthening and training Additional items useful in evaluating environmental review include

654

- discussion of the extent to which recommendations of the EA or other environmental analysis were followed,
- an assessment of the extent to which environmental review influenced decision-making during project preparation, appraisal, negotiation, and implementation,
- particular problem areas to be considered in future environmental review work,
- an assessment of project operation and maintenance, as it affects the environment (e g , functioning of pollution control equipment, compliance with effluent or emission limits, status of staff training programs), and
- evaluation of the benefits which resulted from environmental components of the project

REGIONAL AND SECTORAL ENVIRONMENTAL ASSESSMENTS

39 EA procedures may be applied to development activities other than specific projects EA can be adapted to regional or sectoral scales and used to assess impacts of sector-wide programs, multiple projects, or development policies and plans A regional or sectoral EA can reduce the time and effort required for project-specific EAs in the same region or sector by identifying issues, initiating baseline data collection, and assembling existing data in advance, or in certain cases, by eliminating the need for the project-specific EA altogether

Regional Environmental Assessments

40 Regional EAs are desirable when a number of development activities are planned or proposed for a relatively localized geographic area, such as several projects in one watershed (see Table 1 2) They serve a number of useful purposes, for example

- definition of study areas in terms which make environmental sense (e g , river catchment basin, airshed, coastal zone),
- selection of sustainable development patterns from alternatives in a region under development pressure (e g , the coastal zone), or being programmed for development for the first time,
- identification of cumulative impacts of different activities (e g , the combined effects on receiving water quality of the effluents of several municipal and industrial treated wastewater discharges), and design or implementation schedule changes and other measures to avoid or mitigate them,
- identification of environmental interactions or conflicting demands on resources among projects in which the impacts of one project may reduce the benefits of another, and of measures to avoid such a result,
- formulation of criteria for environmentally sustainable development in the region, including treatment of environmentally sensitive areas and resources, site selection criteria, design criteria, region-specific measures to mitigate adverse impacts, and land-use planning guidelines,
- identification of monitoring data needs and definition of data collection programs to support EA and development decisions, and
- examination of policy alternatives and institutional elements needed for achieving sustainable development in the region

6 55

Table 1.2. Regional Environmental Assessment for Exploration and Production of Hydrocarbon in Coastal Alabama and Mississippi (USA)

The purposes of this EA were to identify the effects of generic unit actions and the cumulative impacts of the issuance of permits for hydrocarbon resource development projects in a coastal area over a thirty-year period and to expedite the permit issuance process Generic unit actions investigated included site preparation, well completion, gathering system construction, and gas treatment facility operation Alternative means of undertaking each action were considered Environmental effects were determined for each unit action, and these were used as the basis of the cumulative impacts analysis. The U S Army Corps of Engineers was lead agency, 12 other agencies participated

In the cumulative analysis, it was assumed that the impacts would be a function of the different unit activities occurring together at various sites in the region at one time A number of development scenarios were used in this analysis, not as predictions but rather as a means to establish limits within which future development would occur Potential adverse impacts included loss of wetland values for sites not located in a waterway (unless the alternatives of using platforms for drilling and trestles for access were selected), removal of vegetation from pipeline rights-of-way, temporary turbidity with possible damage to oyster and sea grass beds, and loss of benthic habitat at open water drilling and pipeline sites extending for one to two years after completion of construction Operation of facilities would contribute to air pollution Loss of well control or oil pipeline rupture could have an extensive impact on regional ecosystems, commercial and sport fishing, and tourism Loss of gas well control or gas pipeline rupture could release hydrogen sulfide, a hazard to public health and safety, and to nearby plant and animal communities

The EA concluded with a number of products.

- a set of impact-limiting assumptions applicable to all sites, e g , no discharge of cuttings, drilling fluids, formation waters
- a set of nine general permit conditions which, if met, development to proceed without site-specific permit application
- a designated part of the study area in which no general permit would apply, requiring site-specific permit applications
- a list of environmentally preferred drilling and construction techniques
- a regional monitoring program

656

41 Regional EAs fit into the Bank project cycle in a number of ways, depending on which of the above purposes are being met They can

- serve as planning tools, assisting in the identification of environmentally sound projects,
- contribute to implementation strategies which take into account the combined impacts of a set of projects already being pursued, and
- assist in project preparation by supporting plans and designs which are sensitive to cumulative impacts, synergisms, interactions, and competition for natural and sociocultural resources

42 Regional EAs contribute to the efficiency of project preparation by reducing the time and effort spent on project-specific EAs At the least, a regional EA will have defined the major issues that need to be considered in studying individual projects (and perhaps prepared the TORs for the studies), and will have assembled existing environmental data It may also have initiated monitoring programs to remedy data deficiencies which would otherwise delay the project-specific EA When the regional EA has developed criteria and guidelines for individual projects and institutional arrangements for ensuring their implementation, the need for project-specific EAs may be eliminated altogether, or reduced to more limited studies of environmental effects unique to the individual projects

Sectoral Environmental Assessments

43 Like regional EAs, a sectoral EA can be used to examine the cumulative impacts of multiple projects planned in the same sector Sectoral EAs usually address the mixture of projects proposed for the next few years For example, in a power sector, a program including three coal-fired plants, two major hydroelectric stations, a loss reduction component, and a major institution building and training component may be studied They may address several large Category A projects together (e g , thermoelectric power), or a number of small projects (e g , run-of-river hydropower) that may not warrant EAs individually When applied in this way, sectoral EAs offer the same advantages as regional EAs and have a comparable relationship to project-specific EAs They can, in some cases, substitute for project-specific EAs, by producing guidelines and criteria for the design and implementation of projects in the sector More often, they will result in identification of the major environmental issues in the sector and development of a data base, enabling project-specific EAs to proceed more expeditiously (See Tables 1 3 and 1 4 for examples of sectoral EAs)

44 A variant of this application, often called a "programmatic" EA, is the use of a sectoral EA to assess the impacts of a sector-wide program, such as locust control These are programs that will be replicated at a variety of locations, and for which the impacts are more or less the same at any location (see Table 1 5) A programmatic EA may include among its outputs guidelines for conduct of the activity and site-specific questions which must be answered before initiating the activity

45 The other purposes of sectoral EAs are somewhat different

- review of the environmental impacts of sector investment alternatives, e g , centralized or decentralized wastewater treatment, expansion of existing power generation capacity versus construction of new facilities,

Table 1.3. Pakistan Drainage Sector Environmental Assessment

The government of Pakistan has undertaken a 21-month sectoral EA of its national drainage program, with grant funding from Japan and leadership by the Water and Power Development Authority Its products are to be (a) an environmental assessment for a national drainage program which is intended to relieve widespread waterlogging and salinity problems, and (b) a "framework concept" for the program, emphasizing institutional arrangements and procedures to facilitate the efficient planning, design, implementation, operation and maintenance of drainage schemes

The scope of work requires the EA consultant to address engineering, environment, health, institutions, policy and programs in the entire Indus Basin, in all areas with existing and proposed irrigation and drainage facilities, and in all natural resource areas adjacent to or affected by irrigation and drainage programs and projects The consultant must evaluate existing drainage systems, estimate future drainage requirements, and predict significant impacts, such as water quality changes in receiving waters, health hazards from irrigation or drainage systems, and deterioration of land quality resulting from irrigation The consultant is required to identify environmentally acceptable drainage alternatives and possible mitigation and enhancement measures, including reuse of drainage water and treated effluent to minimize drainage

Institutional components of the EA are to be recommendations on linkages between environmental agencies, improved sustainability in terms of cost recovery and effective operation and maintenance, planning procedures for drainage systems, and training programs The "framework" emphasizes flexible approaches to improve efficiency in identification, planning, construction, operation and maintenance of drainage facilities

The EA core team is composed of a team leader (planner, engineer, or economist), a drainage engineer, a resource economist, an institutional specialist, and an ecologist Together, they account for 165 of the estimated 220 staff weeks Other specialists, with participation ranging from two to seven staff weeks each, include a chemist, microbiologist, soil scientist, hydrogeologist, training specialist, social scientist, environmental health specialist, environmental engineer, anthropologist, irrigation engineer, and entomologist

- evaluation of the environmental effects of sector policy changes, e g , implementation of industrial waste minimization standards, pricing water to reflect true cost of service, requiring energy conservation to offset new generating capacity needs, modification of criteria for reuse of treated effluents, differentiation between new sources and existing sources in setting air emission standards, and use of alternative fuels for fossil-fuel power and heating plants; and

658

Table 1.4. Nigeria Multi-State Roads Project Sectoral Environmental Assessment

The Nigerian road network consists of interstate highways managed by the Federal Ministry of Works and Housing (FMWH), secondary roads managed by State Ministries of Works (SMOWs), and rural roads administered by Local Government Councils International assistance has concentrated on rural roads in agricultural development projects and on the Federal highways. The State system includes 30,000 km of secondary roads, 10,000 km of which are paved Many of them, constructed or last upgraded in the 1970s, urgently require rehabilitation followed by an effective program of routine maintenance

The Government of Nigeria is preparing a project for a five-year program of road maintenance in selected states It would finance repair of priority roads, paving of high-priority unsurfaced roads, routine maintenance, and an institutional development and training component. The project is being prepared by a Coordination Unit within FMWH, in collaboration with selected SMOWs

An environmental reconnaissance was conducted by a consultant and staff members from FMWH and FEPA (the Nigerian Federal Environmental Protection Agency), to provide focus to project preparation studies It established baseline conditions in the selected states, identified the environmental issues associated with road upgrading/rehabilitation and maintenance in each state, and recommended ways in which EA could be incorporated into the project planning process. Recommendations included (a) surveying and environmental screening and ranking of proposed subprojects, (b) preparation by FEPA of EA guidelines for secondary roads, (c) preparation of EAs for subprojects likely to have a major impact, and (d) review and revision of standards contract specifications to require environmental safeguards, such as reseeding and embankment protection, and research by FMWH to propose measures to address the most important problems, such as gully erosion

The reconnaissance study also addressed the institutional capacity of FEPA, FMWH, and the SMOWs to carry out the work identified It recommended EA training for FEPA staff, training for FMWH and SMOW design engineers in general environmental practices, in-service training for construction supervisors, and joint FEPA/FMWH workshops on specific aspects of the problem of land degradation

- assessment of (i) requirements in the sector for environmental review, implementation of environmental management and mitigation measures, and monitoring programs, (ii) the capacities of sectoral institutions to carry out those activities, and (iii) needs for training, development of guidelines, or other aspects of institutional strengthening.

46 When used in these three ways, sectoral EAs provide information which can most effectively be used to plan sector strategies, investment programs, and institutional strengthening efforts They relate to the project cycle from the beginning by contributing to the identification of projects which are consistent with sustainable development in the sector

659

Table 1.5. "Programmatic" Environmental Assessment for Locust Control

Consultants prepared a programmatic EA for the United States Agency for International Development (USAID) for locust control in Africa which had the following objectives

- to describe the impacts of current and projected locust and grasshopper programs, with specific reference to pesticide use,
- to evaluate alternative control measures and mitigative actions which may have less adverse impacts, and
- to provide comprehensive recommendations to ensure that environmental concerns are fully addressed in future control programs

The 32 programmatic recommendations included preparing an inventory and mapping program of environmentally sensitive areas, prohibiting spraying in human settlements and environmentally fragile areas, selecting pesticides with the least impact on non-target species, monitoring selected organisms, and soil and water for pesticide residues, supplementing control techniques with a strong technical assistance component, assisting countries in disposal of obsolete pesticides, testing biological control in the field, and providing training and equipment.

ALTERNATIVES TO ENVIRONMENTAL ASSESSMENT

47 Bank policy in the EA OD allows for flexibility and alternatives to EA in projects where the range of environmental issues is comparatively narrow and the issues can be understood and managed through less extensive analysis These are typically smaller projects, not located in environmentally sensitive areas They usually fall into Category B in the screening process Reconnaissance and informal scoping are normally completed, followed by the design of preventive or mitigating measures Alternatives include

- specific design criteria to safeguard the environment that will be applicable, for example, to rural electrification, rural water and sanitation, small-scale irrigation systems,
- pollution control standards or effluent and emission limits for small-scale industrial plants;
- "best practice" standards for certain activities, such as small-scale irrigation,
- integrated pest management programs for agricultural projects which do not involve major irrigation or land development,
- reliance on local government permit programs covering actions such as siting, construction, operation, pollutant discharge, and waste disposal,

- preparation of environmental manuals, and institutional strengthening and training, and
- application to individual projects of design criteria, guidelines, and standards developed in regional or sectoral EAs

48 Alternatives to EA allow the effort devoted to environmental considerations to be commensurate with the magnitude of potential impact It is important to remember, however, that their acceptability in any given situation depends in part on the environmental policy and regulatory structure in the country and the institutional capabilities of the borrower and the government It will not be effective, for example, to manage the environmental impacts of small- and medium-scale industry by pollution control standards and design criteria if inspection, monitoring, and enforcement functions are weak Similarly, relying on "best practice" or integrated pest management for agricultural projects will be unsatisfactory where there is no effective agricultural extension service and inspection In these cases, unless an institutional strengthening component with a high probability of successful implementation can be included in the project, a project-specific EA should be conducted

INSTITUTIONAL ASPECTS OF ENVIRONMENTAL ASSESSMENT

Interagency Coordination

49 Interagency coordination is crucial to effective EA because environmental issues, in their complexity and variety, are often intersectoral and regional, even international The authority and responsibility to deal with them--to collect information, prepare plans, approve designs, issue permits, allocate resources, develop budgets, monitor progress and regulate activities--is spread over a number of agencies at all levels of government An EA team needs to take advantage of all major information sources and specialized knowledge Successful implementation of EA recommendations will depend on the capabilities of the institutions involved in environmental management

50 Interagency coordination is best achieved through interagency meetings at key points in the EA schedule A meeting at the time of scoping is vitally important to inform all interested agencies about the project and the intention to prepare an EA, to seek their views throughout the process, to identify issues, to discuss any special types of analysis required, data sources and management procedures, responsibilities and schedules, and to draft TORs for the EA At that meeting, the participants should agree on a schedule for additional meetings and other means of communication and coordination It is also appropriate to hold a meeting when the draft final report is submitted for government review. Other meetings--such as a mid-term review--are very useful in complex EAs Circulation of interim drafts on issues of special interest to other agencies is an effective means of interagency coordination TMs should attend at least the initial meeting, and in any case should ensure that the borrower includes adequate interagency coordination in the EA process

Involvement of Affected Groups and Local NGOs

51. The EA OD states that borrowers are expected to take the views of affected groups and local NGOs fully into account in project design and implementation, and in particular during the preparation

of EAs Community involvement is important in order to understand the nature and extent of potential impacts, especially the sociocultural, and to assess the suitability and acceptability of various measures that might be used to prevent or mitigate impacts, or to compensate affected groups for unavoidable ones Community involvement is also useful in the analysis of the distribution of project costs and benefits Moreover, a genuine effort to provide the public with information about a project and to solicit public reactions and suggestions leads to projects that are more acceptable and more likely to be supported. There are many different ways to foster community involvement, not all of which will be appropriate in any given situation Chapter 7 amplifies this topic and provides guidelines for successful community involvement

Strengthening Environmental Capabilities

52 The ultimate success of EA depends on strengthening environmental capability in agencies and organizations concerned with natural resource management and environmental protection Projects with major potential impacts normally require institutional strengthening and training components, not only in the organization executing the project but in the line agency and other governmental departments or ministries as well Involvement of these units throughout the EA process is a logical element of institutional strengthening, since it provides on-the-job training and continuity which will contribute to successful implementation of EA recommendations It is also important to use local expertise (supported by international consultants where necessary) in preparing EAs, so that country EA capability is strengthened

53 Because EA requires analysis of the institutional requirements for implementation of environmentally sound projects, it often recommends institutional strengthening that extends beyond the project itself Thus, there may be linkages between EAs and sector or country environmental strategy, policy, legislation and organization Institutional strengthening is often the most important part of project work However, there are limitations to what can be accomplished in a single project, besides strengthening the agencies directly involved

54 TMs should take advantage of opportunities to produce an incremental improvement in institutional capacity outside the boundaries of the project--including line ministry staff in an EA training course for the implementing agency, for example--but there will often be need for strengthening beyond that which can reasonably be included TMs should ensure that any such recommendations emerging from an EA are brought to the attention of colleagues concerned with sectoral policy planning and with formulation of environmental action plans (EAPs), environmental issues papers (EIPs), and country strategy Chapter 5 discusses the strengthening of local capabilities and institutions

Financial Intermediary Lending

55 The Bank increasingly supports development projects through loans to financial institutions, for onlending to sub-borrowers The subprojects may be in a single sector, in the case of sector investment loans, or in more than one sector The details of the subprojects are usually not known at the time of appraisal Under these circumstances, the EA OD makes it clear that the participating organizations must fulfill the requirements for environmental review Chapter 6 addresses alternative approaches for environmental reviews in financial intermediary lending.

662

MANAGEMENT OF ENVIRONMENTAL ASSESSMENT

Cost and Time to Prepare Environmental Assessments

56 The time required to prepare an EA, and the resulting cost, vary with the type, size and complexity of the project, the characteristics of its physical, sociocultural and institutional settings, and the amount and quality of environmental data already available EAs need as much time as the feasibility study, of which EA is essentially a part Therefore, EAs can take from less than six months to more than 18 months to complete, but many require about 12 months EAs conducted according to Bank procedures do not delay projects, on the contrary, in many cases, they have shortened the total time from identification to operation, by revealing promptly environmental issues that might have halted work altogether, had they emerged at a later stage Whether or not a particular EA actually delays a project depends largely on how well it is coordinated with feasibility studies and other preparation activities

57 EA preparation cost rarely exceeds one percent of the total capital cost of the project and is frequently less than that The cost of implementing mitigating measures can range from 0 to 10 percent of total project cost, with 3 to 5 percent being common These estimates do not take into account possible cost savings that result from implementing EA recommendations that reduce or avoid the costs of environmental impacts or allow environmental objectives to be met in a more cost-effective manner For example, project-induced epidemics of malaria or schistosomiasis, ignoring the costs in human misery, may cost millions (US$) to bring under control, compared to the relatively minor costs of preventing them

Sources of Financing

58 It is the borrower's responsibility to conduct and finance EAs, and in general, they are financed in the same way as feasibility studies EAs can be considered part of project preparation costs and funded through Project Preparation Facilities, or through grants from various environmental trust funds Other possible sources of EA funding are international NGOs and major foundations with environmental interests In the case of financial intermediary lending, where the participating institutions have to carry out much or all of the entire environmental review, technical assistance components can be incorporated into the project to set up the procedures and organization The routine costs thereafter become the responsibility of the participating institutions

Procurement of Consultants

59 Although there are countries where government agencies themselves are capable of preparing EAs, the usual method is for the borrower to obtain specialist consultants, just as they often do for feasibility studies EAs require interdisciplinary analysis and are therefore prepared by teams members work together in the field The disciplines listed below are generally represented on the core team for any EA

- project manager often a planner, social or natural scientist, or environmental engineer, has experience in preparing several, similar EAs, has management skills and sufficiently broad

training and/or experience to be able to provide overall guidance and to integrate the findings of individual disciplines,

- ecologist or biologist (aquatic, marine or terrestrial specializations, as appropriate),
- sociologist/anthropologist has experience with communities similar to that of the project;
- geographer or geologist/hydrologist/soils scientist; and
- urban or regional planner has experience in developing countries

If the project is in the agricultural sector, an agronomist, land-use specialist, forest scientist, or fisheries biologist, as appropriate, should be included in the core team For industrial or energy projects, an engineer with the corresponding expertise (such as in pollution control) will be needed

60 The core team needs to be supported by various specialists depending on the project and its setting Table 1 6 shows some of the specialties that should be called upon

61. EA specialists can be obtained from a variety of sources Large international environmental consulting firms have many of the necessary disciplines on staff or in subconsultant arrangements, and can form and manage teams for any EA There are also smaller firms that specialize in EA and manage EAs They are more likely to need subconsultants to fill out EA teams

62 The expertise of local consulting firms varies from country to country Frequently a local firm will be able to provide experts (e g , from local universities or institutions) to participate in an EA as a core team member of a specialist It is less common, at present, to find local firms with experience and capability to carry out an EA on their own. Where such firms do exist, they should be seriously considered for EA projects Where they do not, the Bank is committed to using the EA process to promote and develop such capabilities Therefore, local firms should be participants in EAs being managed by international firms This provides the local staff with on-the-job training, and provides the international staff with essential local knowledge and experience

63. Other sources of experts include research institutions (e g , marine institutes, tropical medicine research centers, national research institutions), colleges and universities, academies of science and technology, government agencies in the country and in other countries (loans and exchanges may be possible), and NGOs.

64 The method for selecting consultants depends on the source of finance The Bank has published its procedures in Use of Consultants by World Bank Borrowers and by The World Bank as Executing Agency. Guidelines The borrowing country may have established procedures for obtaining consultants for studies and design projects, or for EA Other donors may be involved and they, too, have procedures. TMs should review such procedures to ensure that they are generally consistent with the Bank's objectives

65. When the Bank is funding the EA directly, the Guidelines should supersede the borrower's procedures In any case, the Bank's recommended method for procuring consulting services is for the borrower to invite proposals from a short list of three to six firms or joint ventures and to follow formal procedures to select the best qualified The REDs may be requested to assist TMs in advising the borrowers, where appropriate.

Table 1.6. Specialists Related to Environmental Assessment

Natural Resource	Subcomponent	Specialist
Air	Air quality Wind direction/speed Precipitation/humidity Temperature Noise	Air quality/pollution analyst Air pollution control engineer Meteorologist Noise expert
Land	Land capability Soil resources/structure Mineral resources Tectonic activity Unique features	Agronomist Soils engineer Soils scientist Civil engineer Geologist Geotechnical engineer Mineralogist Mining engineer Engineering geologist Seismologist
Water	Surface waters Groundwater regime Hydrologic balance Drainage/channel pattern Flooding Sedimentation	Hydrologist Water pollution control engineer Water quality/pollution analyst Marine biologist/engineer Chemist Civil/sanitary engineer Hydrogeologist
Flora and fauna	Environmentally sensitive areas wetlands, marshes, wildlands, grasslands, etc Species inventory Productivity Biogeochemical/nutrient cycling	Ecologist Forester Wildlife biologist Botanist Zoologist Conservationist
Human	Social infrastructure/ institutions Cultural characteristics Physiological and psychological well-being Economic resources	Social anthropologist Sociologist Archaeologist Architect Social planner Geographer Demographer Urban planner Transportation planner Economist

66 The Bank can assist and advise the borrower in the procurement process on request The Bank does not ordinarily take part in preparing short lists (except in very unusual cases, which are covered in the Guidelines), evaluating proposals, or negotiating contracts However, the Bank reviews TORs and short lists, and will guide borrowers to sources of information on available consultants The Bank officially approves TORs, short lists and draft contracts only when it is funding the EA

67. It is sometimes useful to prepare the short list by soliciting letters of qualifications from a longer list of consultants This yields a short list made up of firms which are both qualified to perform the work and interested in being considered to perform it It is not necessary when the borrower develops an adequate list without it

68 The selection process should be based primarily on technical competence and experience The Guidelines allow the use of price as a selection criterion only under very restricted circumstances It is highly unlikely that such circumstances would apply to an EA, as such studies are inherently complex, with outputs that are difficult to specify completely in advance

69 Under technical competence, the borrower should examine the following

- the experience in EA of the firm or joint venture,
- the adequacy of the proposed work plan in terms of demonstrated understanding of the project, responsiveness to the TORs, and effective management of the work, and
- the qualifications of the personnel to be assigned, in terms of education, training and experience, suitability to perform the duties to be assigned, language skills, successful EA experience in similar situations, experience in developing countries, and experience in the particular country or region

70 If overseas firms are used, the REDs and the CD Environmental Coordinators can package assignments so that the experts' time and cost can be shared by several projects in the region Packaging opportunities within one CD can reap major cost savings

71 The Bank normally comments on the successful proposal before the borrower begins negotiations, and on the contract before it is executed Negotiation often results in changes to the consultant's proposed work plan or EA team, to best suit the needs of the borrower and the project

CONCLUSION

72 EA is a tool to assist TMs in making good decisions to screen projects efficiently for their environmental impacts, to clarify to governments what is needed for sustainable projects, and to design them effectively If EA is approached positively as an opportunity to find out a lot about a project before costly problems arise, the combined experience gained Bank-wide will produce increasingly flexible and cost-effective procedures It is in that spirit and with that goal that this Sourcebook is offered

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Operational Directive 4 00, Annex A: Environmental Assessment

Introduction

1 This annex outlines Bank policy and procedures for the environmental assessment (EA) of Bank investment lending operations,[1] and related types of environmental analysis EA is a flexible procedure, which can vary in breadth, depth, and type of analysis, depending on the project It may be carried out at one point in time, stretched over a year to account for seasonal variations, or done in discrete stages

2 For the purpose of this annex, EA covers also project impacts on health, cultural property, and tribal people, and the environmental impact of project-induced resettlement [2] EAs utilize the findings of country environmental studies and action plans which cover nationwide issues, the overall policy framework, legislation, and institutional capabilities in the country

Purpose and Nature of EA

3 The purpose of EA is to ensure that the development options under consideration are environmentally sound and sustainable, and that any environmental consequences are recognized early in the project cycle and taken into account in project design EAs identify ways of improving projects environmentally, and minimizing, mitigating, or compensating for adverse impacts By alerting project designers, implementing agencies, and borrower and Bank staff to issues early, EAs (a) enable them to address environmental issues in a timely and practical fashion, (b) reduce the need for project conditionality, because appropriate steps can be taken in advance or incorporated into project design, and (c) help avoid costs and delays in implementation due to unanticipated environmental problems EAs also provide a formal mechanism for inter-agency coordination and for addressing the concerns of affected groups and local nongovernmental organizations (NGOs) In addition, they can play a major role in building environmental capability in the country

4 Like economic, financial, institutional, and engineering analyses, EA is part of project preparation, and is therefore the borrower's responsibility Close integration of EA with these other aspects of project preparation ensures that (a) environmental considerations are given due weight in project selection, siting, and design decisions, and (b) carrying out EAs does not unduly delay project processing

Types of Environmental Analysis

Project-Specific EAs

5 Project-specific EAs are used to analyze specific investment projects (e g , dams, factories, irrigation systems) with significant environmental issues The detail and sophistication of analysis should be commensurate with the expected impacts A project-specific EA should normally cover (a) existing environmental "baseline" conditions, (b) potential environmental

1 References to the Bank include IBRD and IDA loans include credits Investment lending covers specific and sector investments including rehabilitation loans through financial intermediaries and the investment component of hybrid loans Sector and structural adjustment loans are not covered by this annex but are subject to the general policies in OMS 2 36 *Environmental Aspects of Bank Work* (to be reissued as OD 4 00 *Environmental Policies*) IFC is developing similar procedures for environmental review which reflect the special circumstances of its work Bearing in mind its special circumstances MIGA will cooperate with the Bank to ensure to the extent possible that the objectives of the directive are met in its operations

2 For Bank policies regarding such impacts see (a) OPN 11 03, *Management of Cultural Property in Bank-Financed Projects* to be reissued as OD 4 50 *Cultural Property* (b) OMS 2 34 *Tribal People in Bank Financed Projects*, to be reissued as OD 4 40 *Tribal People* and (c) OMS 2 33 *Social Issues Associated with Involuntary Resettlement in Bank Financed Projects* and OPN 10 08 *Operational Issues in the Treatment of Involuntary Resettlement in Bank Financed Projects* to be reissued as OD 4 30 *Involuntary Resettlement*

impacts, direct and indirect,[3] including opportunities for environmental enhancement, (c) systematic environmental comparison of alternative investments, sites, technologies, and designs, (d) preventive, mitigatory, and compensatory measures, generally in the form of an action plan, (e) environmental management and training, and (f) monitoring To the extent possible, capital and recurrent costs, environmental staffing, training, and monitoring requirements, and the benefits of proposed alternatives and mitigation measures, should be quantified Annex A1 gives a sample outline for a project-specific EA report, and Annex A2 is a checklist of specific issues to be covered where relevant

Regional and Sectoral EAs

6 Regional EAs are used where a number of significant development activities with potentially cumulative impacts are planned for a reasonably localized area In such cases, they are generally more efficient than a series of project-specific EAs, and may identify issues that the latter might overlook (e g , interaction among effluents, or competition for water or land) Regional EAs compare alternative development scenarios, and recommend environmentally sustainable growth rates and land use patterns and policies The study area is normally defined on a physical and/or biological basis (e g , airshed, habitat type, river basin), and may sometimes extend across national boundaries, however, regional EAs with an institutional focus might follow administrative boundaries instead

7 Sectoral EAs are used for the design of sector investment programs They are particularly suitable for reviewing (a) sector investment alternatives, (b) the effect of sector policy changes, (c) institutional capacities and requirements for environmental review, implementation, and monitoring at the sectoral level, and (d) the cumulative impacts of many relatively small, similar investments which do not merit individual project-specific EAs

8 In some cases, regional or sectoral EAs cover all the normal requirements of project-specific EAs More often, the latter are still needed for major investments (see para 14 concerning sector investment loans), but the regional or sectoral EAs will have identified the relevant issues, collected much of the data, and, in general, greatly reduced the work needed in the project-specific EAs

Alternatives to EAs

9 Alternative approaches that focus on a narrower range of issues are acceptable for many types of projects, especially smaller ones and those not in environmentally sensitive areas These approaches may be more effective in integrating environmental concerns into the borrower's planning process Such alternative approaches include

(a) integrated pest management programs for many agricultural projects which do not involve major irrigation or land development,

(b) specific environmental design criteria and pollution standards for small- or medium-scale industrial plants, and

(c) specific environmental design criteria and construction supervision programs for small-scale rural works projects

Other examples of projects for which alternative approaches are generally acceptable are listed in Annex A3, para 3, under "Category B "

Consideration of Global Issues

10 A number of specialized agencies—inside and outside the U N system—carry out scientific investigations of global environmental issues (ozone depletion, global warming, hazardous wastes, etc) The Bank keeps fully abreast of findings, primarily through its Principal Adviser, Science and Technology, and draws upon prevailing views

3 Indirect impacts are the induced consequences of the project which occur later or in another part of the environment e g if a river is channelled or dammed its capacity for self purification may be reduced and the original aquatic ecosystem damaged or destroyed

in developing its own environmental, economic, and sectoral policies, with a view to minimizing possible adverse impacts on global systems such as the atmosphere and oceans While EAs should collect or refer to the relevant data, the Bank does not normally expect global environmental issues to require separate analysis in project-specific EAs Such issues should, however, be addressed where relevant in policy and sector work

Institutional Aspects of Projects

Inter Agency Coordination

11 Because environmental issues generally involve national, regional, and local government agencies, and cover a broad range of responsibilities (wildlife, health, water and land use, tourism, etc), coordination among government agencies is crucial This is best achieved through inter-agency meetings at key points in the EA cycle The first meeting, normally held soon after the decision to prepare an EA, identifies the issues, types of analysis required, sources of relevant expertise, responsibilities and schedule for the EA, and mitigating measures to be considered Another meeting should normally be held when the EA report is completed and submitted for final government review

Involvement of Affected Groups and Nongovernmental Organizations

12 The Bank expects the borrower to take the views of affected groups and local NGOs[4] fully into account in project design and implementation, and in particular in the preparation of EAs This is important in order to understand both the nature and extent of any social or environmental impact, and the acceptability of proposed mitigation measures An approach which has proven effective in many countries is to expand the initial inter-agency meeting (para 11) into a "forum" or "scoping session" with representatives of affected groups and relevant NGOs Similar consultations after the EA report is completed are also a valuable way to obtain feedback on the report and to increase community cooperation in implementing the recommendations

Strengthening Environmental Capabilities

13 The ultimate success of EA depends upon the development of environmental capability and understanding in the agencies concerned Projects with major potential impacts normally require the establishment or strengthening of in-house environmental units for the project (located or represented on site), the implementing agency and the ministry Involvement of these units throughout the EA process (a) ensures that the agency s/ ministry's knowledge and perspective are taken into account in the EA, (b) provides on-the-job training for the staff, and (c) provides continuity for the implementation of the EA's recommendations Such projects normally need to include an institutional development and training component for such units In addition, to help develop EA capability in the country, the Bank should (a) encourage the use of local expertise in EA preparation (in association with international consultants, where appropriate), and (b) help arrange EA training courses for local specialist staff and consultants

Sector and Financial Intermediary Lending

14 For sector investment loans and loans through financial intermediaries, subproject details may not be known at the time of project appraisal In such cases, the project implementing institutions will need to screen subprojects (see para 18) and carry out environmental analyses consistent with this directive To ensure that this can be done, the Bank should appraise the implementing agencies' capabilities for EA, and strengthen them where necessary The appraisal mission should also indicate the proper division of responsibility for preparing and reviewing EAs between the ultimate borrower, the financial

4 See OD 14 70 *Involving Nongovernmental Organizations in Bank-Supported Activities* for the Bank s overall approach to NGOs

intermediary or sector agency, and the agencies responsible for environmental regulation

Environmental Advisory Panels

15 For major projects with serious and multidimensional environmental concerns, the Bank should explore with the borrower whether the latter needs to engage an advisory panel of independent, internationally recognized, environmental specialists, to review and advise on, *inter alia*, the terms of reference (TOR) and findings of the EA, the implementation of its recommendations, and the development of environmental capacity in the implementing agency/ministry Such a panel should meet at least once a year until the project is operating routinely and environmental issues have been addressed satisfactorily [5]

EA Procedures

Overview

16 Though EA preparation is the responsibility of the borrower, the task manager (TM) in the Bank assists and monitors the EA process, with support mainly from the Regional environment division (RED) The borrower and the Bank should agree as early as possible on the selection of consultants or borrower staff to prepare the EA, and the EA procedures, schedule, and outline Major steps in the EA process normally include (a) screening, (b) decisions based on the Initial Executive Project Summary (IEPS), (c) notification to the Board through the Monthly Operational Summary (MOS), (d) preparation of TORs for the EA, (e) EA preparation, (f) EA review and incorporation of environmental measures into the project, (g) supervision, and (h) ex post evaluation.

17 Since project and country conditions, national legislation, and institutional experience vary among borrowers, both the borrower and the Bank must exercise judgement in using these procedures to design and implement projects which are both environmentally and economically sound, and consistent with the environmental laws, policies, and procedures of the borrower The Environment Department (ENV), Legal Department, and the REDs maintain information on these requirements

Screening

18 Projects/components should be screened at identification by the TM, with advice from the RED, and assigned to one of the following categories based upon the nature, magnitude, and sensitivity of environmental issues

Category A—EA is normally required as the project may have diverse and significant environmental impacts

Category B—More limited environmental analysis is appropriate, as the project may have specific environmental impacts

Category C—Environmental analysis is normally unnecessary

Category D—Environmental projects, for which separate EAs may not be required, as environment would be a major focus of project preparation

Annex 3 gives illustrative lists, to be applied flexibly, of the type of project/component in each category

Initial Executive Project Summary

19 In the IEPS, the TM, in consultation with the RED, should (a) identify key environmental issues, (b) indicate the category (A-D) and the type of environmental analysis recommended, and (c) provide a preliminary EA schedule If an EA is not likely to be available prior to appraisal, the

5 See OD 4 00 Annex B *Environmental Policy for Dam and Reservoir Projects* para. 18 for more details on the selection and functions of the panel.

612

IEPS should propose special procedures to address the situation The IEPS meeting would confirm the type, timing, and issues of environmental analysis (although in the event of inadequate information, the decision may be deferred)

Monthly Operational Summary

20 The TM should ensure that the MOS, which is used to alert the executive directors to forthcoming projects, contains the following information as soon as available (a) the category assigned (A-D), (b) the main issues to be examined, (c) whether agreement with the borrower has been reached on EA preparation, and (d) the EA schedule The MOS entry should be updated whenever appropriate to reflect the progress of the EA, and the related Bank and borrower decisions

Preparation of TORs for the EA

21 Following the IEPS meeting, the Bank should discuss with the borrower the scope of the EA, and assist the borrower, as necessary, in preparing TORs for the EA For this purpose, a field visit by Bank environmental staff is generally desirable The Bank should ensure that the TORs provide for adequate inter-agency coordination (para 11) and consultation with affected groups and local NGOs (para 12)

EA Preparation

22 An EA for a major project typically takes 6-18 months to prepare and review EA drafts should be available at key points in the project cycle The final EA should be available prior to appraisal, to minimize the risk of project design changes and resultant delays at a late stage

23 In most cases, the EA should form part of the overall feasibility study, so that the EA's findings are directly integrated into project design However, the EA is normally prepared separately by specialists For projects which would have major impacts, such as large dams or projects involving large scale resettlement, it is recommended that the borrower retain independent experts not affiliated with the project Borrowers may request Bank assistance for financing EAs through a Project Preparation Facility (PPF) advance,[6] or from the Technical Assistance Grant Program for the Environment EAs generally account for 5-10 percent of the cost of project preparation

24 For some projects, a full year of baseline data is desirable to capture the seasonal effects of certain environmental phenomena, however, so as not to delay critical project decisions, short-term monitoring should be used to provide conservative estimates of environmental impacts, while longer-term data collection is being undertaken Since special care in designing the baseline monitoring program is warranted, the borrower should be encouraged to discuss the matter with the Bank

EA Review and Project Appraisal

25 The borrower should submit the final EA report to the Bank prior to Bank appraisal The EA report is the borrower's property, but the Bank encourages the borrower to release relevant information to appropriate interested parties The Final Executive Project Summary should summarize the EA's status and describe how major environmental issues have been resolved or are to be addressed, noting any proposed conditionality The appraisal mission should review both the procedural and substantive elements of the EA with the borrower, resolve any issues, assess the adequacy of the institutions responsible for environmental management in light of the EA's findings, and determine if the EA's recommendations are properly addressed in project design and economic analysis

Loan Documents

26 The EA procedures followed and the EA's main findings should be explained briefly in the text of the Staff Appraisal Report (SAR) and the

6 See OMS 2 15 *Project Preparation Facility* to be reissued as OD 8 00

Memorandum and Recommendation of the President An SAR annex should summarize the EA more fully, covering, *inter alia*, environmental baseline conditions, alternatives considered, mitigating and compensatory actions, capability of environmental units and measures to strengthen them, environmental monitoring arrangements, and the borrower's consultations with affected groups and NGOs These factors will provide the basis for the RED's formal environmental clearance prior to the authorization of negotiations by the Regional vice president Measures critical to sound project implementation may require specific loan conditionality

Supervision

27 EA recommendations provide the basis for supervising the environmental aspects of project implementation Compliance with environmental conditionality, the status of mitigating measures, and the findings of monitoring programs should be part of borrower reporting requirements and project supervision When major issues arise, special supervision missions with adequate environmental expertise may be needed

Ex Post Evaluation

28 The project completion report[7] submitted to the Operations Evaluation Department should evaluate (a) environmental impacts, noting whether they were anticipated in the EA report, and (b) the effectiveness of mitigating measures taken and of institutional development and training

7 See the OPNSV memoranda, *Guidelines for Preparing Project Completion Reports*, June 7 1989, and OMS 3 58 *General Guidelines for Preparing Project Completion Reports*, which are to be combined and reissued as OD 13 55, *Project Completion Reports*

Sample Outline of a Project-Specific EA Report

1 EA reports should be concise and limited to significant environmental issues The detail and sophistication of analysis should be commensurate with the potential impacts The target audience should be project designers, implementing agencies, and borrower and Bank staff

2 The EA report should include

(a) *Executive Summary* Concise discussion of significant findings and recommended actions

(b) *Policy, legal, and administrative framework* within which the EA is prepared The environmental requirements of any cofinanciers should be explained

(c) *Project description* in a geographic, ecological, social, and temporal context, including any off-site investments that may be required by the project (e g , dedicated pipelines, access roads, power plants, water supply, housing, and raw material and product storage facilities)

(d) *Baseline Data* Dimensions of the study area and description of relevant physical, biological, and socio-economic conditions, including any changes anticipated before the project commences Current and proposed development activities within the project area (but not directly connected to the project) should also be taken into account

(e) *Environmental Impacts* The positive and negative impacts likely to result from the proposed project should be identified and assessed Mitigation measures and the residual impacts that cannot be mitigated should be identified Opportunities for environmental enhancement should be explored The extent and quality of available data, key data gaps, and uncertainties associated with predictions should be identified/estimated Topics that do not require further attention should be specified

(f) *Analysis of Alternatives* Proposed investment design, site, technology, and operational alternatives should be compared systematically in terms of their potential environmental impacts, capital and recurrent costs, suitability under local conditions, and institutional, training, and monitoring requirements To the extent possible, for each of the alternatives, the environmental costs and benefits should be quantified, and economic values attached where feasible

(g) *Mitigation Plan* Feasible and cost-effective measures which may reduce potentially significant adverse environmental impacts to acceptable levels should be proposed, and the potential environmental impacts, capital and recurrent costs, and institutional and training requirements of those measures estimated The plan (sometimes known as an "action plan" or "environmental management plan") should provide details on proposed work programs and schedules, to ensure that the proposed environmental actions are in phase with engineering activities throughout preparation The plan should consider compensatory measures if mitigation measures are not feasible or cost-effective

(h) *Environmental Management and Training* The existence, role, and capability of environmental units at the on-site, agency and ministry level should be assessed, and recommendations made concerning the

375

establishment and/or expansion of such units, and the training of staff, to the point that EA recommendations can be implemented

(i) *Monitoring Plan* regarding environmental impacts and performance The plan should specify the type of monitoring, who would do it, how much it would cost, and what other inputs (e g , training) are necessary

Appendices

(i) *List of EA preparers*—individuals and organizations

(ii) *References*—written materials used in study preparation This is especially important given the large amount of unpublished documentation often used

(iii) *Record of Inter-Agency/Forum Meeting*, including list of both invitees and attendees Where the views of affected groups and local NGOs were obtained by other means, these should be specified

Checklist of Potential Issues for an EA

Where applicable, EAs should address the following issues, which are subject to the Bank policies and guidelines identified below

(a) *Agrochemicals* The Bank promotes the use of integrated pest management (IPM) and the careful selection, application, and disposal of pesticides (see OPN 11 01, *Guidelines for the Selection and Use of Pesticides in Bank-Financed Projects and their Procurement when Financed by the Bank*, to be reissued as OD 4 00, Annex C, *Agricultural Pest Management, and Selection and Use of Pesticides*) The use of fertilizers, due to their impacts on surface and groundwater quality, must also be carefully assessed

(b) *Biological Diversity* The Bank promotes conservation of endangered plant and animal species, critical habitats, and protected areas (para. 9b, OMS 2 36, *Environmental Aspects of Bank Work*, and OPN 11 02, *Wildlands Their Protection and Management in Economic Development*, to be reissued as OD 4 00, Annex D, *Wildlands Their Protection and Management*)

(c) *Coastal and Marine Resources Management* Guidelines are available from the Environmental Department (ENV) on the planning and management of coastal marine resources including coral reefs, mangroves, and wetlands

(d) *Cultural Properties* OPN 11 03, *Management of Cultural Property in Bank-Financed Projects* (to be reissued as OD 4 50, *Cultural Property*), confirms the Bank's commitment to actively protect archaeological sites, historic monuments, and historic settlements

(e) *Dams and Reservoirs* OD 4 00, Annex B, *Environmental Policy for Dam and Reservoir Projects*, provides specific guidance for addressing environmental issues in the planning, implementation, and operation of dam and reservoir projects

(f) *Hazardous and Toxic Materials* Guidelines are available from ENV on the safe manufacture, use, transport, storage, and disposal of hazardous and toxic materials

(g) *Induced Development and Other Socio-Cultural Aspects* Secondary growth of settlements and infrastructure, often referred to as "induced development" or "boomtown" effects, can have major indirect environmental impacts, which relatively weak local governments may have difficulty addressing

(h) *Industrial Hazards* All energy and industry projects should include a formal plan to prevent and manage industrial hazards (See *Techniques of Assessing Industrial Hazards—A Manual*, World Bank Technical Paper No 55)

(i) *International Treaties and Agreements on the Environment and Natural Resources* EAs should review the status and application of such current and pending treaties and agreements, including their notification requirements The Legal Department maintains a list of international treaties, and could obtain, whenever required, information on applicable law in individual countries

(j) *International Waterways* OD 7 50, *Projects on International Waterways* provides guidance This OD exempts from notification requirements rehabilitation projects which will not affect the quality or quantity of water flows

(k) *Involuntary Resettlement* OMS 2 33, *Social Issues Associated with Involuntary Resettlement in Bank-Financed Projects*, and OPN 10 08, *Operations Issues in the Treatment of Involuntary Resettlement in Bank-Financed Projects* (to be reissued as OD 4 30, *Involuntary Resettlement*), provide guidance

(l) *Land Settlement* Due to the complex physical, biological, socioeconomic, and cultural impacts, land settlement should generally be carefully reviewed (see OD 4 31, *Land Settlement*, to be issued)

(m) *Natural Hazards* EAs should review whether the project may be affected by natural hazards (e g , earthquakes, floods, volcanic activity), and should propose specific measures to address these concerns when appropriate (see OD 8 50, *Emergency Recovery Assistance*, to be issued)

(n) *Occupational Health and Safety* All industry and energy projects, and projects in other sectors where relevant, should include a formal plan to promote occupational health and safety (*Occupational Health and Safety Guidelines*, World Bank, 1988)

(o) *Tribal Peoples* OMS 2 34, *Tribal People in Bank-Financed Projects* (to be reissued as OD 4 40, *Tribal People*), provides specific guidance for addressing the rights of tribal peoples, including traditional land and water rights

(p) *Tropical Forests* The Bank co-authored the Tropical Forest Action Plan (published in 1984), up-to-date information is available from ENV OPN 11 02, *Wildlands Their Protection and Management in Economic Development* (to be reissued as OD 4 00, Annex D), also addresses issues relating to tropical forests

(q) *Watersheds* Bank policy is to promote protection and management of watersheds as an element of lending operations for dams, reservoirs, and irrigation systems (OD 4 00, Annex B, *Environmental Policy for Dam and Reservoir Projects*, para 6)

(r) *Wetlands* The Bank promotes conservation and management of wetlands (e g , estuaries, lakes, mangroves, marshes, and swamps) This is covered by OPN 11 02 on wildlands (see (s) below)

(s) *Wildlands* The Bank is committed to protect wildlands, including through compensatory measures when lending could result in adverse impacts (see OPN 11 02, *Wildlands Their Protection and Management in Economic Development*, to be reissued as OD 4 00, Annex D, *Wildlands Their Protection and Management*)

678

Environmental Screening

Introduction

1 The task manager, in consultation with the Regional environment division, is responsible for screening a proposed project to determine the appropriate type of environmental analysis, based on the nature, potential magnitude, and sensitivity of the issues The categories below, based upon prior Bank staff experience, are strictly illustrative Alternatives to EA are acceptable where they are expected to result in an environmentally sound project

2 *Category A Projects/Components Which May Have Diverse and Significant Environmental Impacts—Normally Require EA*[1]

(i) Aquaculture/Mariculture (large scale),

(ii) Dams and Reservoirs,[2]

(iii) Electrical Transmission (large scale),

(iv) Forestry,

(v) Industrial Plants (large scale) and Industrial Estates,

(vi) Irrigation and Drainage (large scale),

(vii) Land Clearance and Leveling,

(viii) Mineral Development (including oil and gas),

(ix) Pipelines (oil, gas, and water),

(x) Port and Harbor Development,

(xi) Reclamation and New Land Development,

(xii) Resettlement,[3]

(xiii) River Basin Development,

(xiv) Rural Roads,

(xv) Thermal and Hydropower Development,

(xvi) Tourism (large scale),

(xvii) Transportation (airports, railways, roads, waterways),

(xviii) Urban Development (large scale),

(xix) Urban Water Supply and Sanitation (large scale),

(xx) Manufacture, Transportation, and Use of Pesticides or other Hazardous and/or Toxic Materials,[4] and

(xxi) Projects which Pose Serious Accident Risks [5]

3 *Category B Projects/Components which may Have Specific Environmental Impacts—More Limited Environmental Analysis Appropriate*

Projects in this category normally require more limited environmental analysis than an EA

1 Except generally for projects directed to rehabilitation improved operation and maintenance and limited upgrading of facilities
2 See OD 4 00 Annex B *Environmental Policy for Dam and Reservoir Projects*
3 While OMS 2 33 *Social Issues Associated with Involuntary Resettlement in Bank Financed Projects* (to be reissued as OD 4 30 *Involuntary Resettlement*) covers the social aspects of resettlement, the environmental implications of the resettlement itself can be major
4 In some cases adherence to existing directives is an acceptable alternative to an EA (e g OPN 11 01 *Guidelines for the Selection and Use of Pesticides in Bank-Financed Projects and their Procurement when Financed by the Bank*, to be reissued as OD 4 00 Annex C *Agricultural Pest Management, and Selection and Use of Pesticides*) Certain materials (e g PCBs) are not to be used in Bank projects and other materials (e g asbestos) are to be used only under extremely restricted conditions A Restricted Toxic Materials List (RTML) will be available from ENV and updated periodically
5 See *Techniques of Assessing Industrial Hazard—A Manual* World Bank Technical Paper No 55

This directive was prepared for the guidance of staff of the World Bank and is not necessarily a complete treatment of the subjects covered

679

A wide range of environmental guidelines, developed by a number of organizations, are applicable In addition, specific environmental pollution standards or design criteria can be developed for individual projects

(i) Agroindustries (small scale),

(ii) Aquaculture and Mariculture (small scale),

(iii) Electrical Transmission (small scale),

(iv) Industries (small scale),

(v) Irrigation and Drainage (small scale),

(vi) Mini Hydro-Power;

(vii) Public Facilities (hospitals, housing, schools, etc),

(viii) Renewable Energy,

(ix) Rural Electrification,

(x) Telecommunications,

(xi) Tourism (small scale),

(xii) Urban Development (small scale), and

(xiii) Rural Water Supply and Sanitation

4 *Category C Projects/Components which Normally Do Not Result in Significant Environmental Impact—Environmental Analysis Normally Unnecessary*

Opportunities to enhance environmental benefits should be sought in these projects

(i) Education (except school construction),

(ii) Family Planning,

(iii) Health (except hospital construction),

(iv) Nutrition,

(v) Institutional Development, and

(vi) Technical Assistance

5 *Category D Environmental Projects*

Projects with a major environmental focus may not require a separate EA, as environment would be a major part of the project preparation

6 *Emergency Recovery Projects*

Because emergency recovery projects (a) need to be processed rapidly, and (b) seek mainly to restore existing facilities, they normally would not require a full EA However, the extent to which the emergency was precipitated and/or exacerbated by inappropriate environmental practices should be determined, and corrective measures built into either the emergency project or a future lending operation [6]

680

ANNEX 1-2

Sample Terms of Reference (TOR) for Environmental Reconnaissance

1 **Background information.**

- Brief project description and alternatives considered in its planning
- Description of site geographical and state of development (developed vs greenfield)
- Potential impacts of project
- Purpose of overall mission to which expert will be assigned (project preparation, appraisal)
- Types of other experts on mission
- People and institutions whom expert should meet
- Mission timing
- Expected output of mission
- Background documents, including maps (as annexes)

2 **Technical aspects.**

(a) **Objectives of the expert services.** A brief statement to ensure that all parties understand the purposes of the expert services and what is to be delivered upon its completion

(b) **Issues for study.** Describe the key issues to be studied by the expert

(c) **Scope of study.** Describe here the nature and extent to which the expert will examine the issues Include phrase "not necessarily limited to" as indication that the expert is to identify and, after authorization, to work on other issues of importance should they emerge

(d) **Government's role in EA.** If not done by others it may be desirable for the expert also to appraise the government's role and capabilities to carry out and deliver environmental assessments and to recommend how this may be implemented and, if necessary, strengthened

(e) **Content of outputs.** Background, analysis, findings, recommendations, further actions, with timing and cost estimates

(f) **Form of outputs.** (Section of Aide Memoire, sections of other reports, free-standing report.)

3 **Administrative aspects.** (These could be in the letter of solicitation and not duplicated here if in the letter)

- Mission timing
- Expected person-days of effort at home for background reading, in field, in Washington, home for report writing, and maximum number of paid days

ANNEX 1-3

Sample Terms of Reference (TOR) for Environmental Assessment (Name of Project Category)

Note· Comments in **[brackets and bold face type]** in this TOR Outline indicate where content may have been included, excluded or modified in the project-specific sample TORs (see Annex 1-3A) When combined, the TOR Outline and the project-specific sample TORs provide comprehensive guidance for TOR preparation Paragraph numbers in each text correspond for ease of reference

1 Introduction This section should state the purpose of the terms of reference, identify the development project to be assessed, and explain the executing arrangements for the environmental assessment

2 Background Information Pertinent background for potential parties who may conduct the environmental assessment, whether they are consultants or government agencies, would include a brief description of the major components of the proposed project, a statement of the need for it and the objectives it is intended to meet, the implementing agency, a brief history of the project (including alternatives considered), its current status and timetable, and the identities of any associated projects If there are other projects in progress or planned within the region which may compete for the same resources, they should also be identified here

3 Objectives This section will summarize the general scope of the environmental assessment and discuss its timing in relation to the processes of project preparation, design, and execution

4 Environmental Assessment Requirements This paragraph should identify any regulations and guidelines which will govern the conduct of the assessment or specify the content of its report They may include any or all of the following

- World Bank Operational Directive 4 00, Annex A "Environmental Assessment," and other pertinent ODs, OMSs, OPNs, and Guidelines,
- national laws and/or regulations on environmental reviews and impact assessments,
- regional, provincial or communal environmental assessment regulations, and
- environmental assessment regulations of any other financing organizations involved in the project

5 Study Area Specify the boundaries of the study area for the assessment (e g , water catchment, airshed) If there are any adjacent or remote areas which should be considered with respect to

682

6 Scope of Work In some cases, the tasks to be carried out by a consultant will be known with sufficient certainty to be specified completely in the terms of reference In other cases, information deficiencies need to be alleviated or specialized field studies or modelling activities performed to assess impacts, and the consultant will be asked to define particular tasks in more detail for contracting agency review and approval Task 4 in the Scope of Work is an example of the latter situation

7 Task 1. Description of the Proposed Project Provide a brief description of the relevant parts of the project, using maps (at appropriate scale) where necessary, and including the following information location, general layout, size, capacity, etc , pre-construction activities, construction activities, schedule, staffing and support, facilities and services, operation and maintenance activities, required off-site investments, and life span

[Note: there may be particular types of information appropriate in the description of the project category you are concerned with. Please specify them here.]

8 Task 2. Description of the Environment Assemble, evaluate and present baseline data on the relevant environmental characteristics of the study area Include information on any changes anticipated before the roject commences **[Annotate or modify the lists below to show the critical information for this project category, or that which is irrelevant to it. You should particularly avoid compiling irrelevant data.]**

(a) Physical environment geology, topography, soils, climate and meteorology, ambient air quality, surface and groundwater hydrology, coastal and oceanic parameters, existing sources of air emissions, existing water pollution discharges, and receiving water quality

(b) Biological environment flora, fauna, rare or endangered species, sensitive habitats, including parks or preserves, significant natural sites, etc , species of commercial importance, and species with potential to become nuisances, vectors or dangerous

(c) Socio-cultural environment (include both present and projected where appropriate) population, land use, planned development activities, community structure, employment, distribution of income, goods and services, recreation, public health, cultural properties, tribal peoples, and customs, aspirations and attitudes

9 Task 3. Legislative and Regulatory Considerations Describe the pertinent regulations and standards governing environmental quality, health and safety, protection of sensitive areas, protection of endangered species, siting, land use control, etc , at international, national, regional and local levels (The TOR should specify those that are known and require the consultant to investigate for others)

10 Task 4. Determination of the Potential Impacts of the Proposed Project In this analysis, distinguish between significant positive and negative impacts, direct and indirect impacts, and immediate and long-term impacts Identify impacts which are unavoidable or irreversible Wherever possible, describe impacts quantitatively, in terms of environmental costs and benefits

683

Assign economic values when feasible Characterize the extent and quality of available data, explaining significant information deficiencies and any uncertainties associated with predictions of impact If possible, give the TOR for studies to obtain the missing information **[Identify the types of special studies likely to be needed for this project category.]**

11 Task 5. Analysis of Alternatives to the Proposed Project Describe alternatives that were examined in the course of developing the proposed project and identify other alternatives which would achieve the same objectives The concept of alternatives extends to siting, design, technology selection, construction techniques and phasing, and operating and maintenance procedures Compare alternatives in terms of potential environmental impacts, capital and operating costs, suitability under local conditions, and institutional, training, and monitoring requirements When describing the impacts, indicate which are irreversible or unavoidable and which can be mitigated To the extent possible, quantify the costs and benefits of each alternative, incorporating the estimated costs of any associated mitigating measures Include the alternative of not constructing the project, in order to demonstrate environmental conditions without it

12 Task 6. Development of Management Plan to Mitigate Negative Impacts Recommend feasible and cost-effective measures to prevent or reduce significant negative impacts to acceptable levels Estimate the impacts and costs of those measures, and of the institutional and training requirements to implement them Consider compensation to affected parties for impacts which cannot be mitigated Prepare a management plan including proposed work programs, budget estimates, schedules, staffing and training requirements, and other necessary support services to implement the mitigating measures

13 Task 7. Identification of Institutional Needs to Implement Environmental Assessment Recommendations Review the authority and capability of institutions at local, provincial/regional, and national levels and recommend steps to strengthen or expand them so that the management and monitoring plans in the environmental assessment can be implemented The recommendations may extend to new laws and regulations, new agencies or agency functions, intersectoral arrangements, management procedures and training, staffing, operation and maintenance training, budgeting, and financial support

14 Task 8. Development of a Monitoring Plan Prepare a detailed plan to monitor the implementation of mitigating measures and the impacts of the project during construction and operation Include in the plan an estimate of capital and operating costs and a description of other inputs (such as training and institutional strengthening) needed to carry it out

15 Task 9. Assist in Inter-Agency Coordination and Public/NGO Participation Assist in coordinating the environmental assessment with other government agencies, in obtaining the views of local NGO's and affected groups, and in keeping records of meetings and other activities, communications, and comments and their disposition (The TOR should specify the types of activities, e g , interagency scoping session, environmental briefings for project staff and interagency committees, support to environmental advisory panels, public forum)

684

16 Report The environmental assessment report should be concise and limited to significant environmental issues The main text should focus on findings, conclusions and recommended actions, supported by summaries of the data collected and citations for any references used in interpreting those data Detailed or uninterpreted data are not appropriate in the main text and should be presented in appendices or a separate volume Unpublished documents used in the assessment may not be readily available and should also be assembled in an appendix Organize the environmental assessment report according to the outline below

- Executive Summary
- Policy, Legal and Administrative Framework
- Description of the Proposed Project
- Description of the Environment
- Significant Environmental Impacts
- Analysis of Alternatives
- Mitigation Management Plan
- Environmental Management and Training
- Monitoring Plan
- Inter-Agency and Public/NGO Involvement
- List of References
- Appendices
  - List of Environmental Assessment Preparers
  - Records of Inter-Agency and Public/NGO Communications
  - Data and Unpublished Reference Documents

(This is the format suggested in OD 4 00, Annex A-1, the TOR may specify a different one to satisfy national agency requirements as long as the topics required in the Bank's directive are covered)

17 Consulting Team

[Environmental assessment requires interdisciplinary analysis. Identify in this paragraph which specializations ought to be included on the team for the particular project category.]

18 Schedule Specify dates for progress reviews, interim and final reports, and other significant events

19 Other Information Include here lists of data sources, project background reports and studies, relevant publications, and other items to which the consultant's attention should be directed

685

Case Studies

Thermoelectric Station

Sample Outline of a Project-Specific EA Report

1 EA reports should be concise and limited to significant environmental issues The detail and sophistication of analysis should be commensurate with the potential impacts The target audience should be project designers, implementing agencies, and borrower and Bank staff

2 The EA report should include

(a) *Executive Summary* Concise discussion of significant findings and recommended actions

(b) *Policy, legal, and administrative framework* within which the EA is prepared The environmental requirements of any cofinanciers should be explained

(c) *Project description* in a geographic, ecological, social, and temporal context, including any off-site investments that may be required by the project (e g , dedicated pipelines, access roads, power plants, water supply, housing, and raw material and product storage facilities)

(d) *Baseline Data* Dimensions of the study area and description of relevant physical, biological, and socio-economic conditions, including any changes anticipated before the project commences Current and proposed development activities within the project area (but not directly connected to the project) should also be taken into account

(e) *Environmental Impacts* The positive and negative impacts likely to result from the proposed project should be identified and assessed Mitigation measures and the residual impacts that cannot be mitigated should be identified Opportunities for environmental enhancement should be explored The extent and quality of available data, key data gaps, and uncertainties associated with predictions should be identified/estimated Topics that do not require further attention should be specified

(f) *Analysis of Alternatives* Proposed investment design, site, technology, and operational alternatives should be compared systematically in terms of their potential environmental impacts, capital and recurrent costs, suitability under local conditions, and institutional, training, and monitoring requirements To the extent possible, for each of the alternatives, the environmental costs and benefits should be quantified, and economic values attached where feasible

(g) *Mitigation Plan* Feasible and cost-effective measures which may reduce potentially significant adverse environmental impacts to acceptable levels should be proposed, and the potential environmental impacts, capital and recurrent costs, and institutional and training requirements of those measures estimated The plan (sometimes known as an "action plan" or "environmental management plan") should provide details on proposed work programs and schedules, to ensure that the proposed environmental actions are in phase with engineering activities throughout preparation The plan should consider compensatory measures if mitigation measures are not feasible or cost-effective

(h) *Environmental Management and Training* The existence, role and capability of environmental units at the on-site, agency, and ministry level should be assessed, and recommendations made concerning the

establishment and/or expansion of such units, and the training of staff, to the point that EA recommendations can be implemented

(i) *Monitoring Plan* regarding environmental impacts and performance The plan should specify the type of monitoring, who would do it, how much it would cost, and what other inputs (e g , training) are necessary

Appendices

(i) *List of EA preparers*—individuals and organizations

(ii) *References*—written materials used in study preparation This is especially important given the large amount of unpublished documentation often used

(iii) *Record of Inter-Agency/Forum Meeting*, including list of both invitees and attendees Where the views of affected groups and local NGOs were obtained by other means, these should be specified

Operational Directive

Checklist of Potential Issues for an EA

Where applicable, EAs should address the following issues, which are subject to the Bank policies and guidelines identified below

(a) *Agrochemicals* The Bank promotes the use of integrated pest management (IPM) and the careful selection, application, and disposal of pesticides (see OPN 11 01, *Guidelines for the Selection and Use of Pesticides in Bank-Financed Projects and their Procurement when Financed by the Bank*, to be reissued as OD 4 00, Annex C, *Agricultural Pest Management, and Selection and Use of Pesticides*) The use of fertilizers, due to their impacts on surface and groundwater quality, must also be carefully assessed

(b) *Biological Diversity* The Bank promotes conservation of endangered plant and animal species, critical habitats, and protected areas (para. 9b, OMS 2 36, *Environmental Aspects of Bank Work*, and OPN 11 02, *Wildlands Their Protection and Management in Economic Development*, to be reissued as OD 4 00, Annex D, *Wildlands Their Protection and Management*)

(c) *Coastal and Marine Resources Management* Guidelines are available from the Environmental Department (ENV) on the planning and management of coastal marine resources including coral reefs, mangroves, and wetlands

(d) *Cultural Properties* OPN 11 03, *Management of Cultural Property in Bank-Financed Projects* (to be reissued as OD 4 50, *Cultural Property*), confirms the Bank's commitment to actively protect archaeological sites, historic monuments, and historic settlements

(e) *Dams and Reservoirs* OD 4 00, Annex B, *Environmental Policy for Dam and Reservoir Projects*, provides specific guidance for addressing environmental issues in the planning, implementation, and operation of dam and reservoir projects

(f) *Hazardous and Toxic Materials* Guidelines are available from ENV on the safe manufacture, use, transport, storage, and disposal of hazardous and toxic materials

(g) *Induced Development and Other Socio-Cultural Aspects* Secondary growth of settlements and infrastructure, often referred to as "induced development" or "boomtown" effects, can have major indirect environmental impacts, which relatively weak local governments may have difficulty addressing

(h) *Industrial Hazards* All energy and industry projects should include a formal plan to prevent and manage industrial hazards (See *Techniques of Assessing Industrial Hazards—A Manual*, World Bank Technical Paper No 55)

(i) *International Treaties and Agreements on the Environment and Natural Resources* EAs should review the status and application of such current and pending treaties and agreements, including their notification requirements The Legal Department maintains a list of international treaties, and could obtain, whenever required, information on applicable law in individual countries

(j) *International Waterways* OD 7 50, *Projects on International Waterways* provides guidance This OD exempts from notification requirements rehabilitation projects which will not affect the quality or quantity of water flows

(k) *Involuntary Resettlement* OMS 2 33, *Social Issues Associated with Involuntary Resettlement in Bank-Financed Projects*, and OPN 10 08, *Operations Issues in the Treatment of Involuntary Resettlement in Bank-Financed Projects* (to be reissued as OD 4 30, *Involuntary Resettlement*), provide guidance

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690

(l) *Land Settlement* Due to the complex physical, biological, socioeconomic, and cultural impacts, land settlement should generally be carefully reviewed (see OD 4 31, *Land Settlement*, to be issued)

(m) *Natural Hazards* EAs should review whether the project may be affected by natural hazards (e g , earthquakes, floods, volcanic activity), and should propose specific measures to address these concerns when appropriate (see OD 8 50, *Emergency Recovery Assistance*, to be issued)

(n) *Occupational Health and Safety* All industry and energy projects, and projects in other sectors where relevant, should include a formal plan to promote occupational health and safety (*Occupational Health and Safety Guidelines*, World Bank, 1988)

(o) *Tribal Peoples* OMS 2 34, *Tribal People in Bank-Financed Projects* (to be reissued as OD 4 40, *Tribal People*), provides specific guidance for addressing the rights of tribal peoples, including traditional land and water rights

(p) *Tropical Forests* The Bank co-authored the Tropical Forest Action Plan (published in 1984), up-to-date information is available from ENV OPN 11 02, *Wildlands Their Protection and Management in Economic Development* (to be reissued as OD 4 00, Annex D), also addresses issues relating to tropical forests

(q) *Watersheds* Bank policy is to promote protection and management of watersheds as an element of lending operations for dams, reservoirs, and irrigation systems (OD 4 00, Annex B, *Environmental Policy for Dam and Reservoir Projects*, para 6)

(r) *Wetlands* The Bank promotes conservation and management of wetlands (e g , estuaries, lakes, mangroves, marshes, and swamps) This is covered by OPN 11 02 on wildlands (see (s) below)

(s) *Wildlands* The Bank is committed to protect wildlands, including through compensatory measures when lending could result in adverse impacts (see OPN 11 02, *Wildlands Their Protection and Management in Economic Development*, to be reissued as OD 4 00, Annex D, *Wildlands Their Protection and Management*)

Environmental Screening

Introduction

1 The task manager, in consultation with the Regional environment division, is responsible for screening a proposed project to determine the appropriate type of environmental analysis, based on the nature, potential magnitude, and sensitivity of the issues The categories below, based upon prior Bank staff experience, are strictly illustrative Alternatives to EA are acceptable where they are expected to result in an environmentally sound project

2 *Category A Projects/Components Which May Have Diverse and Significant Environmental Impacts—Normally Require EA*[1]

(i) Aquaculture/Mariculture (large scale),

(ii) Dams and Reservoirs,[2]

(iii) Electrical Transmission (large scale),

(iv) Forestry,

(v) Industrial Plants (large scale) and Industrial Estates,

(vi) Irrigation and Drainage (large scale),

(vii) Land Clearance and Leveling,

(viii) Mineral Development (including oil and gas),

(ix) Pipelines (oil, gas, and water),

(x) Port and Harbor Development,

(xi) Reclamation and New Land Development,

(xii) Resettlement,[3]

(xiii) River Basin Development,

(xiv) Rural Roads,

(xv) Thermal and Hydropower Development,

(xvi) Tourism (large scale),

(xvii) Transportation (airports, railways, roads, waterways),

(xviii) Urban Development (large scale),

(xix) Urban Water Supply and Sanitation (large scale),

(xx) Manufacture, Transportation, and Use of Pesticides or other Hazardous and/or Toxic Materials,[4] and

(xxi) Projects which Pose Serious Accident Risks [5]

3 *Category B Projects/Components which may Have Specific Environmental Impacts—More Limited Environmental Analysis Appropriate*

Projects in this category normally require more limited environmental analysis than an EA

1 Except generally for projects directed to rehabilitation improved operation and maintenance and limited upgrading of facilities
2 See OD 4 00 Annex B *Environmental Policy for Dam and Reservoir Projects*
3 While OMS 2 33 *Social Issues Associated with Involuntary Resettlement in Bank-Financed Projects* (to be reissued as OD 4 30 *Involuntary Resettlement*) covers the social aspects of resettlement, the environmental implications of the resettlement itself can be major
4 In some cases adherence to existing directives is an acceptable alternative to an EA (e g OPN 11 01 *Guidelines for the Selection and Use of Pesticides in Bank-Financed Projects and their Procurement when Financed by the Bank*, to be reissued as OD 4 00 Annex C *Agricultural Pest Management, and Selection and Use of Pesticides*) Certain materials (e g PCBs) are not to be used in Bank projects and other materials (e g asbestos) are to be used only under extremely restricted conditions A Restricted Toxic Materials List (RTML) will be available from ENV and updated periodically
5 See *Techniques of Assessing Industrial Hazard—A Manual* World Bank Technical Paper No 55

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696

A wide range of environmental guidelines, developed by a number of organizations, are applicable In addition, specific environmental pollution standards or design criteria can be developed for individual projects

(i) Agroindustries (small scale),

(ii) Aquaculture and Mariculture (small scale),

(iii) Electrical Transmission (small scale),

(iv) Industries (small scale),

(v) Irrigation and Drainage (small scale),

(vi) Mini Hydro-Power;

(vii) Public Facilities (hospitals, housing, schools, etc),

(viii) Renewable Energy,

(ix) Rural Electrification,

(x) Telecommunications,

(xi) Tourism (small scale),

(xii) Urban Development (small scale), and

(xiii) Rural Water Supply and Sanitation

4 *Category C Projects/Components which Normally Do Not Result in Significant Environmental Impact—Environmental Analysis Normally Unnecessary*

Opportunities to enhance environmental benefits should be sought in these projects

(i) Education (except school construction),

(ii) Family Planning,

(iii) Health (except hospital construction),

(iv) Nutrition,

(v) Institutional Development, and

(vi) Technical Assistance

5 *Category D Environmental Projects*

Projects with a major environmental focus may not require a separate EA, as environment would be a major part of the project preparation

6 *Emergency Recovery Projects*

Because emergency recovery projects (a) need to be processed rapidly, and (b) seek mainly to restore existing facilities, they normally would not require a full EA However, the extent to which the emergency was precipitated and/or exacerbated by inappropriate environmental practices should be determined, and corrective measures built into either the emergency project or a future lending operation [6]

693

ANNEX 1-2

Sample Terms of Reference (TOR) for Environmental Reconnaissance

1 **Background information.**

- Brief project description and alternatives considered in its planning
- Description of site geographical and state of development (developed vs greenfield)
- Potential impacts of project
- Purpose of overall mission to which expert will be assigned (project preparation, appraisal)
- Types of other experts on mission
- People and institutions whom expert should meet
- Mission timing
- Expected output of mission
- Background documents, including maps (as annexes)

2 **Technical aspects.**

(a) **Objectives of the expert services.** A brief statement to ensure that all parties understand the purposes of the expert services and what is to be delivered upon its completion

(b) **Issues for study.** Describe the key issues to be studied by the expert

(c) **Scope of study.** Describe here the nature and extent to which the expert will examine the issues Include phrase "not necessarily limited to" as indication that the expert is to identify and, after authorization, to work on other issues of importance should they emerge

(d) **Government's role in EA.** If not done by others it may be desirable for the expert also to appraise the government's role and capabilities to carry out and deliver environmental assessments and to recommend how this may be implemented and, if necessary, strengthened

(e) **Content of outputs.** Background, analysis, findings, recommendations, further actions, with timing and cost estimates

(f) **Form of outputs.** (Section of Aide Memoire, sections of other reports, free-standing report.)

3 **Administrative aspects.** (These could be in the letter of solicitation and not duplicated here if in the letter)

- Mission timing
- Expected person-days of effort at home for background reading, in field, in Washington, home for report writing, and maximum number of paid days

ANNEX 1-3

Sample Terms of Reference (TOR) for Environmental Assessment (Name of Project Category)

Note Comments in **[brackets and bold face type]** in this TOR Outline indicate where content may have been included, excluded or modified in the project-specific sample TORs (see Annex 1-3A) When combined, the TOR Outline and the project-specific sample TORs provide comprehensive guidance for TOR preparation Paragraph numbers in each text correspond for ease of reference

1 Introduction This section should state the purpose of the terms of reference, identify the development project to be assessed, and explain the executing arrangements for the environmental assessment

2 Background Information Pertinent background for potential parties who may conduct the environmental assessment, whether they are consultants or government agencies, would include a brief description of the major components of the proposed project, a statement of the need for it and the objectives it is intended to meet, the implementing agency, a brief history of the project (including alternatives considered), its current status and timetable, and the identities of any associated projects If there are other projects in progress or planned within the region which may compete for the same resources, they should also be identified here

3 Objectives This section will summarize the general scope of the environmental assessment and discuss its timing in relation to the processes of project preparation, design, and execution

4 Environmental Assessment Requirements This paragraph should identify any regulations and guidelines which will govern the conduct of the assessment or specify the content of its report. They may include any or all of the following·

- World Bank Operational Directive 4 00, Annex A "Environmental Assessment," and other pertinent ODs, OMSs, OPNs, and Guidelines,
- national laws and/or regulations on environmental reviews and impact assessments,
- regional, provincial or communal environmental assessment regulations, and
- environmental assessment regulations of any other financing organizations involved in the project

5 Study Area Specify the boundaries of the study area for the assessment (e g , water catchment, airshed) If there are any adjacent or remote areas which should be considered with respect to

6 Scope of Work In some cases, the tasks to be carried out by a consultant will be known with sufficient certainty to be specified completely in the terms of reference. In other cases, information deficiencies need to be alleviated or specialized field studies or modelling activities performed to assess impacts, and the consultant will be asked to define particular tasks in more detail for contracting agency review and approval Task 4 in the Scope of Work is an example of the latter situation

7 Task 1. Description of the Proposed Project Provide a brief description of the relevant parts of the project, using maps (at appropriate scale) where necessary, and including the following information location, general layout, size, capacity, etc , pre-construction activities, construction activities, schedule, staffing and support, facilities and services, operation and maintenance activities, required off-site investments, and life span

[Note: there may be particular types of information appropriate in the description of the project category you are concerned with. Please specify them here.]

8 Task 2. Description of the Environment Assemble, evaluate and present baseline data on the relevant environmental characteristics of the study area Include information on any changes anticipated before the roject commences **[Annotate or modify the lists below to show the critical information for this project category, or that which is irrelevant to it. You should particularly avoid compiling irrelevant data.]**

(a) Physical environment geology, topography, soils, climate and meteorology, ambient air quality, surface and groundwater hydrology, coastal and oceanic parameters, existing sources of air emissions, existing water pollution discharges, and receiving water quality

(b) Biological environment flora, fauna, rare or endangered species, sensitive habitats, including parks or preserves, significant natural sites, etc , species of commercial importance, and species with potential to become nuisances, vectors or dangerous

(c) Socio-cultural environment (include both present and projected where appropriate) population, land use, planned development activities, community structure, employment, distribution of income, goods and services, recreation, public health, cultural properties, tribal peoples, and customs, aspirations and attitudes

9 Task 3. Legislative and Regulatory Considerations Describe the pertinent regulations and standards governing environmental quality, health and safety, protection of sensitive areas, protection of endangered species, siting, land use control, etc , at international, national, regional and local levels (The TOR should specify those that are known and require the consultant to investigate for others)

10 Task 4. Determination of the Potential Impacts of the Proposed Project In this analysis, distinguish between significant positive and negative impacts, direct and indirect impacts, and immediate and long-term impacts Identify impacts which are unavoidable or irreversible Wherever possible, describe impacts quantitatively, in terms of environmental costs and benefits

Assign economic values when feasible Characterize the extent and quality of available data, explaining significant information deficiencies and any uncertainties associated with predictions of impact If possible, give the TOR for studies to obtain the missing information **[Identify the types of special studies likely to be needed for this project category.]**

11 Task 5. Analysis of Alternatives to the Proposed Project Describe alternatives that were examined in the course of developing the proposed project and identify other alternatives which would achieve the same objectives The concept of alternatives extends to siting, design, technology selection, construction techniques and phasing, and operating and maintenance procedures Compare alternatives in terms of potential environmental impacts, capital and operating costs, suitability under local conditions, and institutional, training, and monitoring requirements When describing the impacts, indicate which are irreversible or unavoidable and which can be mitigated To the extent possible, quantify the costs and benefits of each alternative, incorporating the estimated costs of any associated mitigating measures Include the alternative of not constructing the project, in order to demonstrate environmental conditions without it

12 Task 6. Development of Management Plan to Mitigate Negative Impacts Recommend feasible and cost-effective measures to prevent or reduce significant negative impacts to acceptable levels Estimate the impacts and costs of those measures, and of the institutional and training requirements to implement them Consider compensation to affected parties for impacts which cannot be mitigated Prepare a management plan including proposed work programs, budget estimates, schedules, staffing and training requirements, and other necessary support services to implement the mitigating measures

13 Task 7. Identification of Institutional Needs to Implement Environmental Assessment Recommendations Review the authority and capability of institutions at local, provincial/regional, and national levels and recommend steps to strengthen or expand them so that the management and monitoring plans in the environmental assessment can be implemented The recommendations may extend to new laws and regulations, new agencies or agency functions, intersectoral arrangements, management procedures and training, staffing, operation and maintenance training, budgeting, and financial support

14 Task 8. Development of a Monitoring Plan Prepare a detailed plan to monitor the implementation of mitigating measures and the impacts of the project during construction and operation Include in the plan an estimate of capital and operating costs and a description of other inputs (such as training and institutional strengthening) needed to carry it out

15 Task 9. Assist in Inter-Agency Coordination and Public/NGO Participation Assist in coordinating the environmental assessment with other government agencies, in obtaining the views of local NGO's and affected groups, and in keeping records of meetings and other activities, communications, and comments and their disposition (The TOR should specify the types of activities, e g , interagency scoping session, environmental briefings for project staff and interagency committees, support to environmental advisory panels, public forum)

16 Report The environmental assessment report should be concise and limited to significant environmental issues The main text should focus on findings, conclusions and recommended actions, supported by summaries of the data collected and citations for any references used in interpreting those data Detailed or uninterpreted data are not appropriate in the main text and should be presented in appendices or a separate volume Unpublished documents used in the assessment may not be readily available and should also be assembled in an appendix Organize the environmental assessment report according to the outline below

- Executive Summary
- Policy, Legal and Administrative Framework
- Description of the Proposed Project
- Description of the Environment
- Significant Environmental Impacts
- Analysis of Alternatives
- Mitigation Management Plan
- Environmental Management and Training
- Monitoring Plan
- Inter-Agency and Public/NGO Involvement
- List of References
- Appendices
  - List of Environmental Assessment Preparers
  - Records of Inter-Agency and Public/NGO Communications
  - Data and Unpublished Reference Documents

(This is the format suggested in OD 4 00, Annex A-1, the TOR may specify a different one to satisfy national agency requirements as long as the topics required in the Bank's directive are covered)

17 Consulting Team

[Environmental assessment requires interdisciplinary analysis. Identify in this paragraph which specializations ought to be included on the team for the particular project category.]

18 Schedule Specify dates for progress reviews, interim and final reports, and other significant events

19 Other Information Include here lists of data sources, project background reports and studies, relevant publications, and other items to which the consultant's attention should be directed

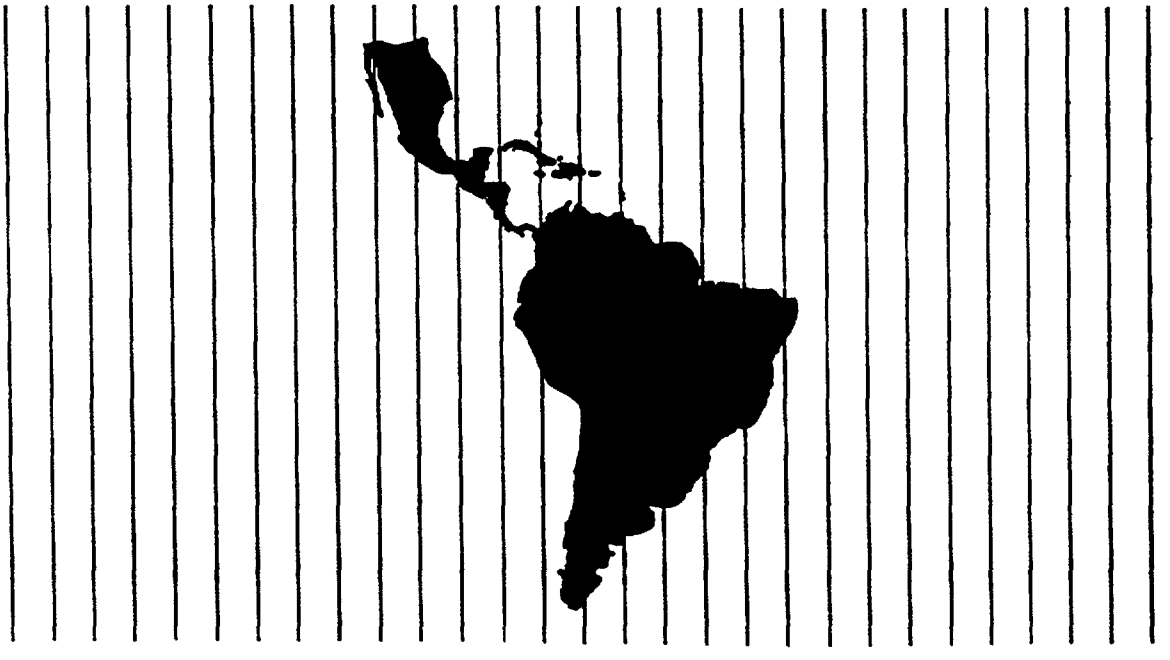
698

Case Studies

LATIN AMERICAN
ENERGY ORGANIZATION

INTER-AMERICAN
DEVELOPMENT BANK

GUIDE FOR ASSESSING THE ENVIRONMENTAL IMPACT OF THERMOELECTRIC STATIONS



Quito - Ecuador
April 1994

700

SUBPROGRAM I:
ENVIRONMENT

CASE STUDY:
THERMOELECTRIC POWER GENERATION

ENVIRONMENTAL AUDIT REPORT OF THE PLANTA CENTRO THERMOELECTRIC POWER STATION IN VENEZUELA

TABLE OF CONTENTS

1 INTRODUCTION 127

2 DESCRIPTION OF THE AREA OF THE PROJECT 129
2 1 Atmosphere 129
2 1 1 Meteorology 129
2 1 2 Air Quality 133
2 2 Water 137
2 2 1 Physical and Chemical Oceanography 137
2 2 2 Sea Ecology 140
2 2 3 Fresh Water Hydrological System 143
2 3 Land Ecology 145
2 4 Human Ecology 147

3 DESCRIPTION OF THE PROJECT 148
3 1 General Aspects of the Electric Power System in Venezuela 148
3 2 Description of the Power Plant's Installations 149

4 IDENTIFICATION OF ENVIRONMENTAL IMPACTS 154
4 1 Air 155
4 2 Water 160
4 3 Land Ecosystem 163
4 4 Marine Ecology 165

5. MITIGATION MEASURES 168
5 1 Atmosphere 169
5 1 1 Mitigation of High Short-Term Concentrations of SO_2 and Metals 169
5 1 2 Total Particles in Suspension 169
5 2 Water 170
5 2 1 Mitigation of Impacts Caused by the Disposal of Toxic Effluents 170
5 3 Land Environment 172
5 3 1 Mitigation of the Effects of Runoff and Erosion 172

6. MONITORING AND RECENT EVOLUTION OF THE ENVIRONMENTAL SITUATION 172
6 1 Atmosphere 173
6 1 1 Sulphur Dioxide 173
6 1 2 Nitrogen Dioxide 173
6 1 3 Total Suspended Particulates 174
6 1 4 Metals 174
6 2 Land Ecosystem 174
6 3 Water 176

7. INSTITUTIONAL AND LEGAL ASPECTS 177

8. MAIN CONCLUSIONS AND RECOMMENDATIONS 180

9. REFERENCES 181

1. INTRODUCTION

The present report is the result of a joint effort between the Electric Power Administration and Development Utility (Compañía Anónima de Administración y Fomento Eléctrico—CADAFE) of the Republic of Venezuela and the Latin American Energy Organization (OLADE), within the framework of Cooperation Agreement ATN/SF-3603-RE between OLADE and the Inter-American Development Bank (IDB), aimed at supporting the member countries of both organizations to incorporate environmental factors into regional energy development planning

The specific objective of this document is to illustrate, with a concrete example, the real problems of inserting a project into the environment, related costs, and the available mitigation alternatives oftentimes improvised and implemented in accordance with the environmental notions and practices that prevailed at the time of construction In addition to transmitting the experiences of the institutions involved in developing the projects, the present study will attempt to demonstrate how financially feasible changes in the original design could have resolved environmental problems that currently jeopardize the very existence of the project and whose ex-post mitigation requires large investments

Fortunately, the Planta Centro Thermoelectric Power Plant, completed in 1983, had available an environmental impact study **"Assessment of the Environmental Impacts To Be Exerted by the Construction and Operation of Planta Centro I Phase II".** As a result of this study, it was possible to identify and assess the magnitude of the alterations that construction and operation of the power plant would exert on the surrounding environment, as well as to identify alternative mitigating actions and necessary monitoring plans for coping with the adverse effects stemming from the power plant

Nevertheless, the study omits some important aspects which today are required for environmental impact studies, in particular those related to the socio-cultural and economic impacts as well as the health conditions of the affected population It does, however, allow for a highly detailed classification of the physical components and fauna, and the condition of the environment prior to the power plant's operation, which is indispensable for any study of this type

It is well known that environmental concerns have gathered momentum in Venezuela, far more than in any other country in the region Since 1976, it has a special ministry focusing on this area, which has enabled passing a series of laws and standards that are among the most progressive in Latin America and the Caribbean Among these, the Criminal Law for the Environment should be emphasized In this law, crimes against the environment are specified and the corresponding penalties established This is another important reason for presenting this case study

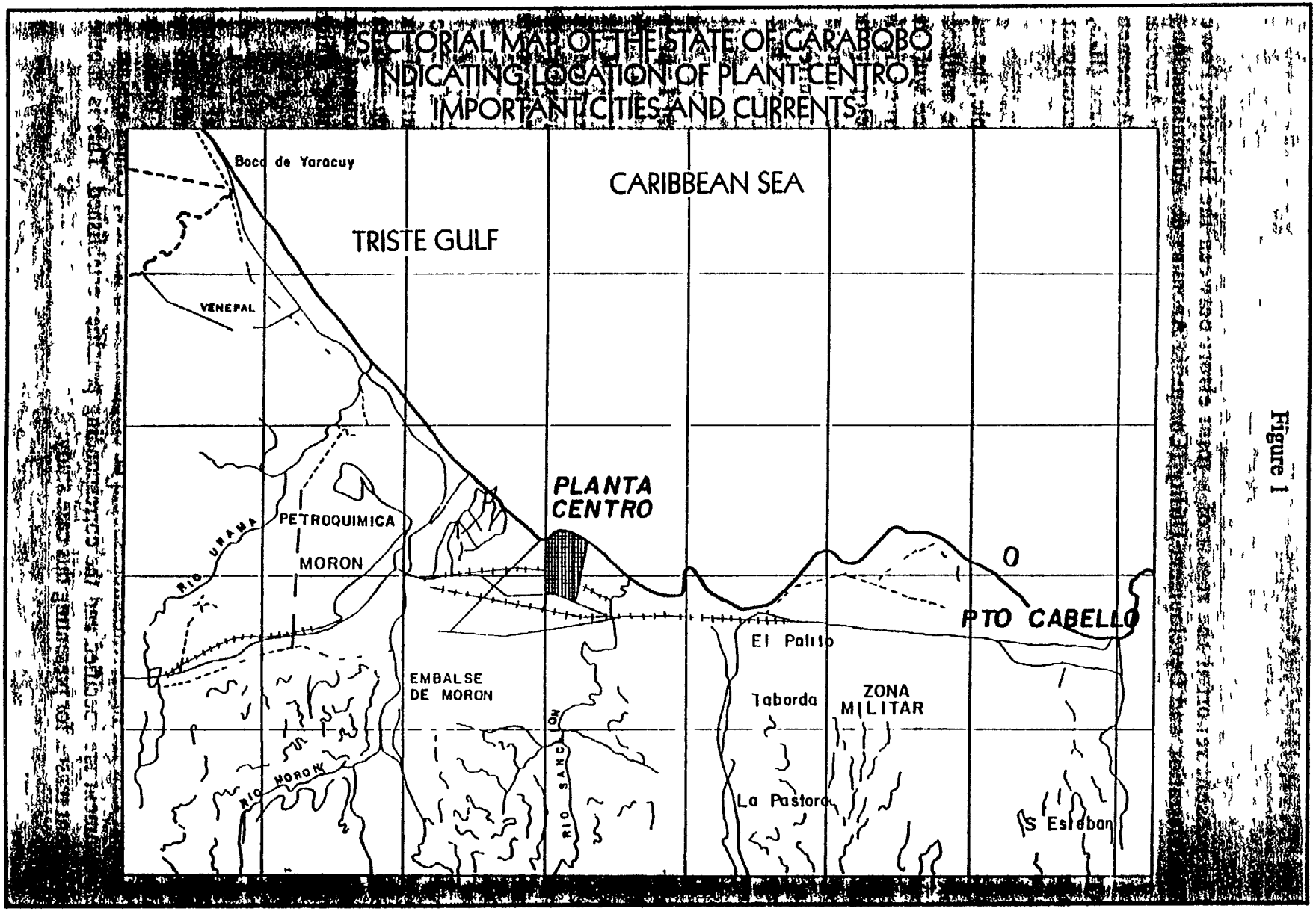

SECTORIAL MAP OF THE STATE OF CARABOBO
INDICATING LOCATION OF PLANT CENTRO,
IMPORTANT CITIES AND CURRENTS
Boca de Yaracuy
CARIBBEAN SEA
TRISTE GULF
VENEPAL
PLANTA
CENTRO
PETROQUIMICA
MORON
RIO URAMA
PTO CABELLO
El Palito
EMBALSE
DE MORON
Taborda
ZONA
MILITAR
RIO MORON
RIO SANCHON
La Pastora
S Esteban

Figure 1

704

The current environmental audit report is based on the above-mentioned environmental impact study, as well as later studies carried out by CADAFE, which allowed the original information to be updated and some of the initial hypotheses that had been set forth to be verified

The Latin American Energy Organization (OLADE) would like to thank CADAFE for its invaluable support and for the contribution of its technical experts and the information which allowed this work to be carried out

2. DESCRIPTION OF THE AREA OF THE PROJECT

The Planta Centro Thermoelectric Power Station is located in Punta Morón, on the Caribbean coast, about 18 kilometers to the west of the city of Puerto Cabello This is a highly industrial zone situated between the El Palito Refinery (which has the capacity to process 105,000 barrels per day) toward the east and the Moron Petrochemical Compound toward the west (Figure 1) Although not densely populated, this area is run through by a series of highways that have heavy traffic of all sorts of vehicles, during most of the year

Assessment of the ecosystem's conditions in the Punta Moron area, before the power plant was commissioned, was based on analyses carried out between 1975 and 1977, and subsequently on analyses in the measuring stations as indicated in Figure 2, during the power plant's test period (1978-1979), when the first two units, out of the five units that the power plant now has, began operating Most of the pollutant concentration measurements were conducted during these years The studies and measurements included atmosphere, hydrosphere, land ecology, marine ecology, and human ecology These studies provided the basis for assessing the environmental impacts stemming from the construction and subsequent operation of the power plant

2.1 Atmosphere

2.1 1 Meteorology As a result of the environmental study that was carried out, the area's climatic and meteorological conditions may be summarized as follows

The annual average temperature is 27 5°C with a minimum of 25°C, recorded between 6 00 and 7 00 a m , whereas maximum temperatures of around 30 9°C occur between 13 00 and 15 00

The annual average relative humidity is 87 6%, with monthly fluctuations of 10% below or above this figure, a minimum of 72 7% in February, and a peak of 82 4% in April and June The maximum percentage of relative humidity (90 6%) occurs at 6 30 a m , while the minimum (63 7%) is recorded at 16 00

Solar radiation, with an average duration of 12 hours of sunlight per day (from 7 00 to 19 00), it reaches its maximum total value of 48 5 langleys per hour at 13 00 This last

705

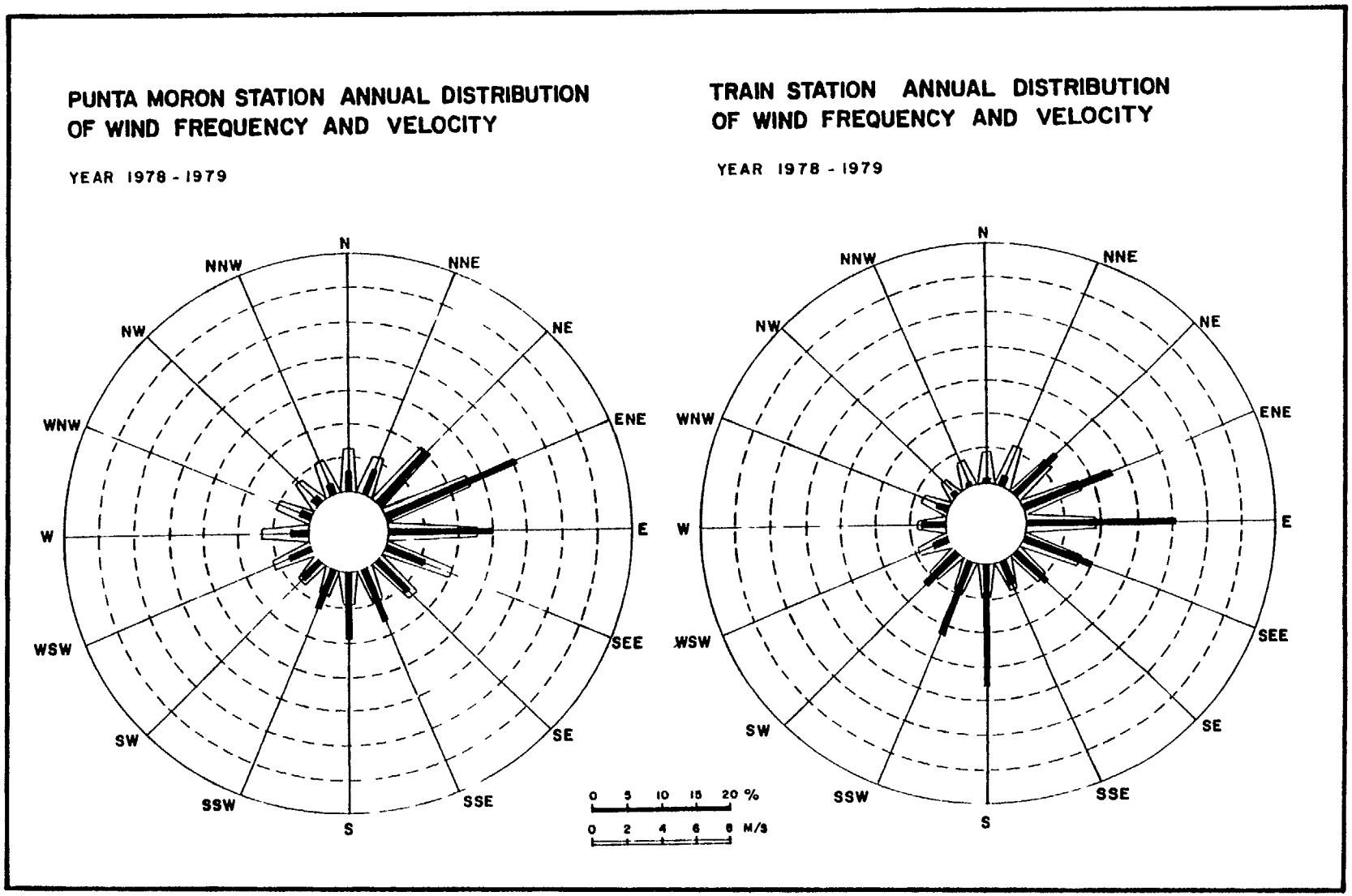

PUNTA MORON STATION ANNUAL DISTRIBUTION
OF WIND FREQUENCY AND VELOCITY
YEAR 1978 - 1979
TRAIN STATION ANNUAL DISTRIBUTION
OF WIND FREQUENCY AND VELOCITY
YEAR 1978 - 1979
N
NNE
NE
ENE
E
SEE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
0 5 10 15 20 %
0 2 4 6 8 M/S

Figure 2

variable is very important for estimating the cloudiness, which in turn allows calculating atmospheric stability, which controls the dispersion of the pollutants discharged through the power plant's stacks

Precipitation was estimated using records of less than one year, which is not enough to obtain representative The information did confirm the historically known existence of two quite different seasons a rainy season between May and November, and a dry one between December and April

The rainy days were examined as well as the hours when it rained Most rains in the area of Moron occur during the late hours of evening and night, just when the prevailing southerly wind brings rain clouds from the mountains

Between 1978 and 1979, wind speed and direction were measured at ground level, at both Punta Moron and the train station This period is extremely short to characterize a variable as random as the wind Nevertheless, the measurements taken and the experience of the area's inhabitants enabled the following important conclusions to be reached the highest wind speeds are recorded in the afternoon (between 15 00 and 18 00) and the lowest in the early hours of the morning In Punta Moron, wind speed is generally low during the night and early in the morning

Figure 2 graphically shows wind speed and direction information at the two measurement stations mentioned In Punta Moron, the prevailing wind direction is east-northeast (ENE), 20% of the time, with an annual average speed in this direction of 4 72 meters per second, whereas at the train station, the most frequent winds blow eastwardly, also 20% of the time, but with a slower average speed of 2 8 meters per second

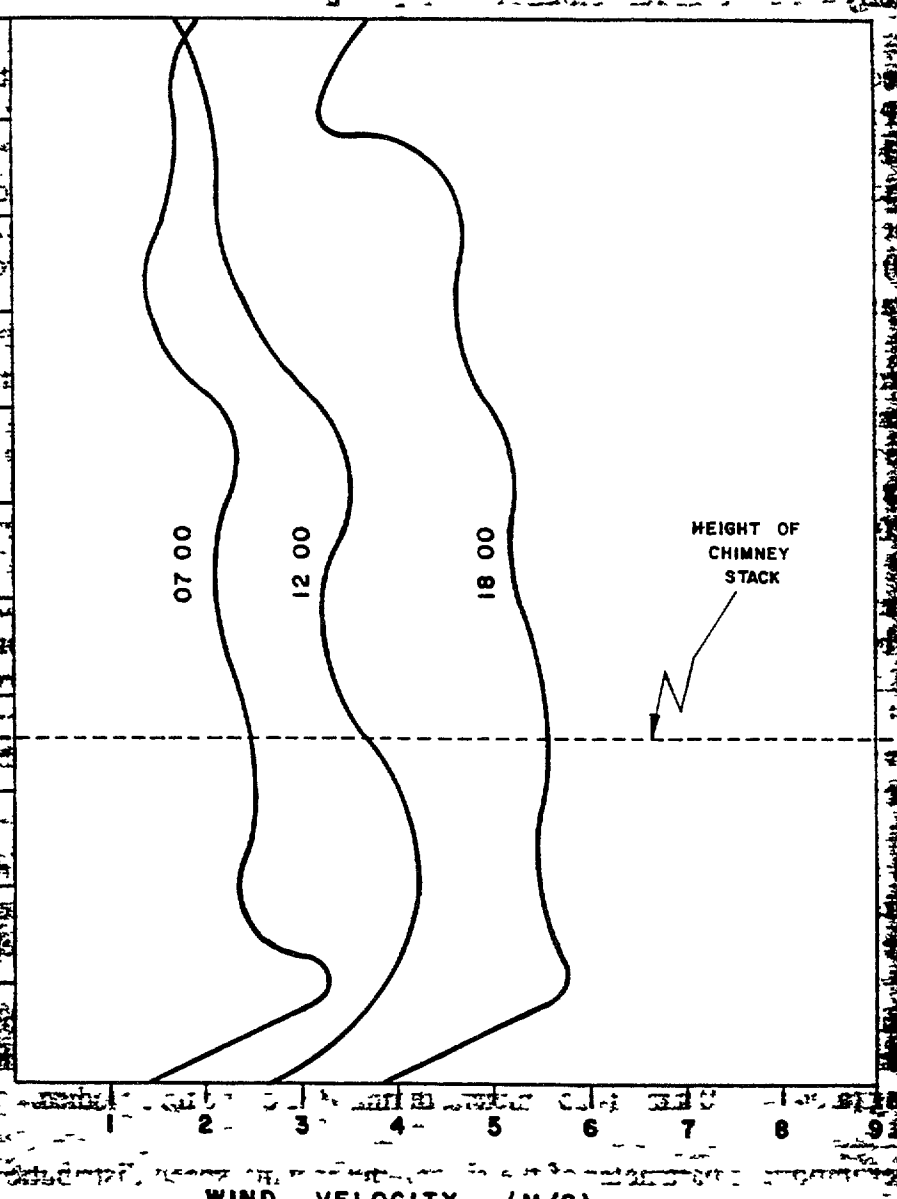
In short, between the late hours of the afternoon and the early hours of the morning, a night breeze, which gradually covers the area under study, emerges from the mountains When the sun rises, this pattern is interrupted and by the end of the morning a sea breeze prevails once again The easterly wind directs the stack's plume towards the coast Meanwhile, when the wind comes from the south throughout the area, the plume tends to drift towards the ocean, especially between May and August

In the atmosphere (300 to 500 meters), there is very little variation and the air can be classified as neutral (number 6), whereas the lower layer (150 to 300 meters) maintains a relatively stable behavior (number 3) between 3 00 and 8 30, which indicates night inversions and/or an isothermal layer which usually develops in the area of study After mid-afternoon, a new mixture is obtained in the area, classified as having highly neutral stability Study of the temperature gradient of the upper layers determined that the height of the mixture in the morning (around 7 30 a.m) is 350 meters, during 70% of the time studied

Another important parameter of the air column is wind speed distribution Wind speed at the height of the chimney stack (170 meters) was 3 3 meters per second, whereas the speed at ground level was 2 3 meters per second Figure 3 shows wind speed distribution according to height at 7 00 a m , 12 00 noon, and 3 00 p m This figure suggests that the

Figure 3

WIND VELOCITY MEASURED FROM THE SURFACE
TO A HEIGHT OF 550 METERS AT PUNTA MORON
AT 7:00 AM, 12 NOON, AND 6 00 PM



708

strong prevailing wind in the afternoons blows east-northeast and usually occurs in the air stratum into which the power plant discharges its polluting gases

2 1.2 Air Quality. Between 1978 and 1979, a program was carried out to measure the main atmospheric pollutants, in order to establish a framework of reference for air quality in the power plant's pre-operative period The concentration of ozone, sulfur dioxide, hydrocarbons, suspended particles, heavy metals, sulphates, and nitrogen dioxide was measured Although these measurements were performed when Unit 1 was already operating, it is considered that the data that were obtained were only slightly affected by Planta Centro emissions, since this unit never operated at over 30% of it total generating capacity These measurements can therefore be used as reference values to determine pre-construction conditions

It is important to point out that during the period in which these measurements were being taken, the Morón Petrochemical Compound, located near the power plant, was not operating at full capacity In addition, the work that was being done during this same period to enlarge the El Palito Refinery, located in the eastern part of Punta Moron, did not offer an adequate framework for determining the levels of many of the pollutants before the start of the project, which under normal conditions, should have been higher than those measured

Sulphur Dioxide

SO_2 levels were measured at the refinery, the train station, and the school Table 1 summarizes the results obtained from the measurements, for average values for 1, 3, and 24 hours The latter indicates that the maximum annual average and the maximum 24-hour average occurred at the station located in the school, some 12 4 kilometers from the power plant However, maximum values for 1 and 3 hours were greater at the train station, located at only 5 2 kilometers from the power plant

Table 1
SULPHUR DIOXIDE CONCENTRATIONS

SITE	ANNUAL ARITH METIC µg/m3	OCCURRENCE 1 HOUR (maximum non overlapping) µg/m3		OCCURRENCE 3 HOURS (maximum non overlapping)		24 HOURS (date of occurrence) µg/m3*		STANDARDS	
		1st max. (date)	2nd max (date)	1st max (date)	2nd max (date)	1st max (date)	2nd max. (date)	3 hours 1300µg/m3	24 hours 365 µg/m3
Refinery	11	47 (3/15/79	40 (4/2/79)	87 (3/16/79)	87 (3/16/79)	183 (7/17/79)	131 (8/17/79)	0	0
Train Station	10	41 (1/7/79)	32 (1/16/79)	144 (1/7/79)	118 (1/8/9)	210 (1/5/79)	196 (12/26/78)	0	0
School	13	49 (3/22/79)	44 (3/23/79)	131 (4/3/79)	122 (4/3/79)	187 (3/23/79)	183 (4/6/79)	0	0

709

Table 2
CONCENTRATION OF TOTAL PARTICLES IN SUSPENSION
INTEGRATED AVERAGE FOR 24 HOURS
(micrograms per cubic meter)

DATE OF SAMPLE	REFINERY	PALMA SOLA	TRAIN STATION	SCHOOL
08/25/78	69 93	76 42	84 62	47 80
08/31/78	47 88	43 80	39 84	32.76
09/06/78	65 40	78 12	82 77	56 98
09/12/78	54 50	62 56	49 82	32 48
09/25/78	58 60	48 62	47 31	39 88
10/08/78	40 03	56 92	52 66	37 34
10/21/78	72 85	75 74	72 21	50 42
11/03/78	66 40	58 44	56 70	46 43
11/16/78	55 54	66 75	60 73	38 67
11/19/78	109 20	81 70	61 90	64 60
12/13/78	99 55	87 69	69 52	51 47
12/25/78	56 97	30 34	61 71	23 06
01/07/79	45 67	35 88	58 76	26 82
01/20/79	42 81	68 29	28 45	30 45
02/02/79	80 24	114 14	67 65	55 10
02/25/79	84 71	93 43	68 70	49 17
03/01/79	86 10	111 17	78 47	141 24
03/15/79	100 26	71 37	54 91	46 24
03/29/79	471 25	86 44	79 14	49 63
04/12/79	138 04	64 30	62 29	44 07
04/29/79	77 96	72 26	81 22	54 39
05/08/79	113 45	95 81	69 96	62 24
05/23/79	158 20	62 44	73 72	51 21
06/05/79	105 08	56 47	59 87	32 18
06/19/79	127 71	84 87	92 92	61 82
07/05/79	51 53	77 43	80 16	37 61
07/10/79	88 20	75 56	77 68	45 50
07/28/79	67 50	83 99	83 72	47 63
08/10/79	167 20	71 32	75 54	47 99
Geometric Annual Average	82 17	69 45	55 84	38 43
Arithmetic Average for the 3 months of samples	58 5	63 2	61 3	45 5

710

Examination of the data from the three stations for September and October 1978 indicate that the best estimate for the SO_2 reference concentration level in the area, before the station was commissioned, is 8 0 micrograms per cubic meter

Total Suspended Particles (TSP)

Table 2 presents the individual TSP values for the year under study, their geometric and arithmetic averages Since the United States Environmental Protection Agency (EPA) sets the primary standard for TSP concentrations at 75 micrograms per cubic meter, it may be concluded that concentration levels at the refinery are harmful for human health and that those at Palma Sola were very close to being harmful

Average values were strongly influenced by the power plant's construction, expansion of the El Palito Refinery, and construction of the El Palito-Morón Highway and are surely higher than those that actually existed before 1978-1979

Heavy Metals

Table 3 shows the concentrations measured for lead, nickel and vanadium, at the four above-mentioned stations Lead was the only one of the three metals analyzed for which we had a standard (1 5 micrograms per cubic meter as a quarterly arithmetic mean, for both primary and secondary standards) The quarterly arithmetic means for lead did not surpass the standard during the period under study The highest quarterly average was observed at the refinery, as a combination of its own emissions and those of the vehicles travelling on the nearby highway

Nickel concentrations were rather low during August and November, with an upward tendency starting in December Values at the refinery were generally greater than those at the other three stations

High concentrations of vanadium were not observed In fact, they were lower than the ones for nickel, which is quite surprising in view of the high vanadium content of Venezuelan crude oils and considering that the highest values were not recorded at the refinery

The dates on which the highest daily values for vanadium were recorded coincided with the dates for the highest daily values for nickel, which suggests that these pollutants have a common source of emission

Sulphates

Metal sulphates and sulfuric acid aerosol are by-products of the natural catalytic conversion which SO_2 undergoes as a result of its interaction with humidity, solar radiation and other pollutants

One of the products stemming from these complex reactions is sulphur trioxide (SO_3), a substance which easily converts basic oxides into sulphates and, in addition, reacts with water to form sulfuric acid This process is at the origin of the acid rain phenomenon

711

Table 3
HEAVY METAL CONCENTRATIONS
(micrograms per cubic meter)

DATE OF SAMPLE	EL PALITO REFINERY			PALMA SOLA			MORON TRAIN STATION			ALPARGATON FARM SCHOOL		
	LEAD Pb	NICKEL Ni	VANADIUM V	LEAD Pb	NICKEL Ni	VANADIUM V	LEAD Pb	NICKEL Ni	VANADIUM V	LEAD Pb	NICKEL Ni	VANADIUM V
08/25/78	0 446	0 001	0 003	0 100	0 001	0 0	0 086	0 003	0 003	0 200	0 001	0 003
09/06/78	0 442	0 001	0 001	0 240	0 0	0 003	0 110	0 007	0 003	0 297	0 0	0 002
10/08/78	1 155	0 0	0 0	0 265	0 001	0 003	0 117	0 001	0 004	0 438	0 0	0 002
11/03/78	1 146	0 0	0 003	0 320	0 005	0 004	0 276	0 001	0 005	0 414	0 003	0 003
12/13/78	0 600 0 967*	0 010 0 003	0 003 0 002	0 505 0 63	0 002 0 003	0 004 0 604	0 287 0 227*	0 001 0 001	0 001 0 003	0 417 0 423	0 001 0 001	0 001 0 002
01/07/79	0 807	0 244	0 004	0 184	0 003	0 006	0 094	0 0	0 015	0 186	0 012	0 018
02/02/79	0 596	0 001	0 002	0 154	0 006	0 007	0 101	0 003	0 007	0 200	0 002	0 005
03/01/79	0 496 0 633	0.238 0 161	0 025 0 010	0 059 0 132	0 023 0 011	0 007 0 007*	0 076 0 090	0 023 0 009	0 025 0 016	0 200 0 194	0 020 0 011	0 006 0 010
04/12/79	0 130	0 384	0 010	0 018	0 062	0 002	0 126	0 63	0 033	0 002	0 218	0 010
05/09/79	0 696	0 146	0 016	0 158	0 013	0 012	0 249	0 0	0 024	0 170	0 067	0 027
06/05/79	1 274 0 700	0 125 0 218	0 005 0 010	0 225 0 134	0 027 0 034	0 011 0 008	0 215 0 197*	0 007 0 023	0 006 0 021	0 320 0 184	0 021 0 102	0 005 0 014
07/05/79	0 957	0 009	0 007	0 176	0 010	0 002	0 227	0 004	0 004	0 228	0 003	0 009

Quarterly arithmetic average of lead for the three preceding months.
Quarterly arithmetic average of nickel and vanadium for the preceding [illegible] NAAQS for nickel and vanadium.

712

According to the measurements taken, the concentration of sulphates in the power plant's pre-operational period was fixed at 4 micrograms per cubic meter

Ozone

Ozone measurements were conducted at the Alpargaton Farm School, located 15 5 kilometers from the power plant This spot was chosen because precursor pollutants (SO_2, NO_x, hydrocarbons, etc) have to remain in the atmosphere for a certain period of time to form ozone Since the prevailing east-northeast-east wind blows from the ocean, the air should have little ozone when it passes over the main sources of emission For this reason, any level of ozone observed at the school station could be considered the result of the NO_x and hydrocarbon emission from Moron and Puerto Cabello

The reference level of ozone for the power plant's pre-operational period was 25 micrograms per cubic meter, which is a relatively low value

Nitrogen Dioxide

The majority of nitrogen oxides emitted into the air as a result of the combustion is in the form of nitric oxide (NO), which converts to nitrogen dioxide (NO_2) in the atmosphere The annual arithmetic mean was 4 7 micrograms per cubic meter, which is a very low value compared with the annual average standard of 100 micrograms per cubic meter However, it is important to note that the other two sources of ozone emissions—the refinery and the petrochemical complex—were not operating at full capacity

Hydrocarbons

In this area, the main sources of hydrocarbon emission are the refinery, the petrochemical complex, and the emission from motor vehicles It is estimated that the main source of these emissions in Planta Centro are the fuel storage tanks The values vary between 241 4 micrograms per cubic meter in August 1978 to 867 micrograms per cubic meter in March 1979 The pre-operational base-line level for hydrocarbons in the area of Punta Moron is less than 1,000 micrograms per cubic meter, which is already above current standards

Table 4 shows the base-line concentrations of the main atmospheric pollutants in the area of Planta Centro Thermoelectric Power Plant

2.2 Water

2.2.1 Physical and Chemical Oceanography The oceanographical parameters for the area of Punta Moron are summarized below and are considered typical of the Venezuelan seashore

Table 4 BASE LINE CONCENTRATIONS OF ATMOSPHERIC POLLUTANTS IN THE AREA OF PUNTA MORON	
POLLUTANT	**REFERENCE CONCENTRATIONS ($\mu g/m^3$)**
Sulphur Dioxide	8
Total Particles in Suspension	55
Lead	0 4
Nickel	0 003
Vanadium	0 0025
Sulphates	4
Ozone	25
Nitrogen Dioxide	4 7
Total Hydrocarbons	1,000

Sea bottom topography, or bathymetry, shows that Punta Morón emerged as the result of rocky geological formations extending up to 300 meters out into the ocean from the jutted coast and some 500 meters along the shore The reclining rock creates a flat area which mitigates the action of the waves on the western shore

Analysis of bottom sediments reveals that the farther away from the shore they are located the smaller is their average diameter from 0 2 mm in the beach sands to 0 007 mm at 14 or 20 meters deep The sands have a high content of mica, which is carried by the rivers flowing into the sea around Punta Moron, after running through areas rich in mica slates characteristic of this zone The western section of Punta Morón is characterized by limestone reefs whose length had already been affected by the construction of piers and jetties, at the time of the study

As expected, surface temperature distribution proved to be quite constant, varying between 26°C and 28°C Temperature distribution depending on the depth is typical of flat areas exposed to strong winds In June, the difference in temperature in a column of water, at a depth of 20 meters, is 2°C, whereas in December with faster wind speed, the temperature differential is reduced to only 0 2°C at the same depth

In the Punta Moron area, as in the Caribbean Ocean, the waves and meteorological tides are determined by the trade winds, the atmospheric pressure at sea level, and tropical cyclones The trade winds are considered the most important variable for predicting the systems of waves and surface currents These blow along the coast in a northeastern and east-northeastern direction at least 60% of the time—and, generally, more than 80% of the time—reaching maximum speeds in January and April The tides are of small magnitude, as in most Caribbean coasts, with a height of 0 15 meters and a minimum of -0 12 meters above average sea level, with exceptional tides of 0 643 meters in the case of storms and hurricanes

According to measurements carried out in the area of Punto Morón, the sea is divided into two well-defined layers with in terms of current direction, rotation patterns, and speeds The upper layer is 4 to 7 meters deep and the lower layer from 7 to 11 meters The characteristics of the upper layer are particularly important for understanding the thermal distribution resulting from the discharge into the sea of the power plant's cooling waters The currents of the upper layer showed a constant clockwise rotation pattern, generally between 14 00 and 16 00 and then counter-clockwise between midnight and 6 00, so as to complete the cycle

Waves are mainly influenced by wind patterns, although the area's topography also exert an influence Taking into consideration that the prevailing winds in Punta Morón are northeast-east, 80% of the time the waves will come from the east-northeast-east and 10% of the time from the northeast-east Groundswells caused by storms are moderate due to the topography of Punta Moron, producing a large area where the inferior and upper layers mix together The study of this phenomena is important for determining the thermal plume produced by the power plant's cooling water

There is a wide range of variability of suspended solids and turbidity in space and time They are strongly dependent on the waves, and in December they can measured up to 120 mg/l while in August they are around 20 mg/l

Total phosphorus concentration is permanently high, with an average of 2 micrograms per liter, compared with an average of 1 microgram per liter usually observed in the Caribbean Sea Nitrogen compounds and organic nitrogen also show higher than average levels for tropical seas Nitrate values fluctuate between 4 4 and 6 5 micrograms per liter, which are concentrations five or six times higher than those found in the Venezuelan Caribbean, while organic nitrogen concentrations vary between 2 and 3 micrograms per liter The values found suggest the presence of sewage water as well as waste waters from industries and/or neighboring towns

The pH, another important parameter for determining water quality, presented almost constant behavior all year round, with variations of around 10% over the average of 7 9

The BDO_5 values for this type of environment—well-mixed aerobic—should not exceed 10 mg/l, and if possible not surpass 5 mg/l In the 1978-1979 measuring campaign, average values of 3 mg/l were observed Wide differences in dissolved oxygen (DO) in terms of spatial or temporal distribution were not apparent, it fluctuated around 6 mg/l, which is considered a normal value and equivalent to 70% of the saturation value

Concentrations of the most toxic metals (mercury, arsenic, lead, and cadmium) presented alarmingly high values, probably due to the "El Palito" Refinery and the petrochemical complex Mercury concentration was irregular but high (around 3 ppb), compared with the 0 03 ppb in seawater The most probable origin of this high mercury concentration is the chlorine soda factory of the petrochemical complex, as the Venezuelan crude oils do not have appreciable concentrations of mercury Samples drawn from the waste waters discharged by this plant indicate levels of more than 25 ppb and 3,000 ppb in the muds at the bottom

715

Traces of arsenic were not detected in any of the samples Cadmium registered average values of 0 13 ppm (with extremes of 0 05 and 0 24 ppm) which is about 1,000 times the natural concentration of seawater As Venezuelan crude oils show low levels of this metal, this concentration is probably due to local sources of cadmium, generally associated with the painting industry, batteries, and the from the electro-plating industry

Lead is regularly detected in all the samples, with an average value of 1 0 ppm This is high especially in view that non-polluted marine waters present lead levels of 0 03 ppm These high values are linked to the intense traffic of vehicles on the roads which run through the zone and the high levels of tetraethyl lead (TEL) in Venezuelan gasoline during those years

Other less toxic metals such as iron, vanadium, nickel, copper, and zinc were detected in the ashes and effluents of the Planta Centro Thermoelectric Power Plant Nickel and vanadium concentrations are within the normal range for seawater The average in unpolluted seawater was established between 4 6 and 10 ppb This is probably due to the anticorrosive treatment in the power plant's cooling system, which uses iron sulphate

In the analysis carried out, the seawater in the area of Punta Moron showed a low concentration of oils and lubricants This seems contradictory in view of the refinery's proximity, the disposal of sewage waters from the neighboring populations, and the presence of sea traffic related to Puerto Cabello The levels of total coliforms in the area studied did not present an alarming situation, since only 15% of the samples surpass the standard of less than 230 NMP required by Venezuelan law

As a result of the analysis of sea sediments, a high level of lead was detected, with vanadium and nickel levels very close to reference levels

Table 5 provides the average values of the metal concentrations obtained during the sampling campaign

2.2 2 Sea ecology Of the species caught during the sample-collecting period, those belonging to the following families are noteworthy Engranlidae, Clupeidae, coastal Carangidae, Gobudae, Sciaenidae, Solelidae, Sclelidae Clinidae, Bleunidae, and Triglidae among the bottom-living benthic coastal fish In general, the majority of the specimens caught near the beach were sexually immature, which suggests that the zone is an important area for species growth and development Very few of the species captured in deep waters (40-50 meters) were the same as those captured near the coast during the sample gathering Thus, it can be asserted that the community of fish near the coast is essentially different from that which inhabits the deeper waters

The sampling program was extended to include a study on the benthic invertebrates The results of these analyses indicated that between 60 and 100% of the individuals were accounted for bv ten species, with the prevailing species being the Annelids and the Polychaete

716

Table No 5

LEVELS OF METALS IN NATURAL BODIES OF WATER AND IN PUNTA MORON

		PUNTA MORON		
METAL	IN WATER	MINIMUM	AVERAGE	MAXIMUM
Sodium (Na)	10 463 ppm	13 578 ppm	16 799 ppm	
Potassium (K)	380 ppm	304 ppm	424 ppm	515 ppm
Calcium (Ca)	400 ppm	310 ppm	619 ppm	890 ppm
Magnesium (Mg)	1 350 ppm	880 ppm	1 250 ppm	1 925 ppm
Arsenic (As)	2 6-3 ppb	ND	ND	ND
Boron (B)	4 500 ppb	4 45 ppm	10 45 ppm	20 ppm
Cadmium (Cd)	0 02-0 11 ppb	0 05 ppm	0 13 ppm	0 24 ppm
Chromium (Cr)	0 04-0 2 ppb	0 01 ppm	0 13 ppm	0 140 ppm
Copper (Cu)	1 3 ppb	0 01 ppm	0 08 ppm	0 308 ppm
Iron (Fe)	4 6-10 ppb	0 01 ppm	0 05 ppm	3 77 ppm
Lead (Pb)	0 03 ppb	ND (0 3 ppm)	0 68 ppm	1 4 ppm
Manganese (Mn)	0 4 2 ppb	ND (0 005 ppm)	0 04 ppm	0 58 ppm
Mercury (Hg)	0 03-0 1 ppb	ND (0 4 ppb)	0 46 ppb	5 1 ppb
Nickel (Ni)	2 7 ppb	0 64 ppb	4 72 ppb	31 8 ppb
Vanadium (V)	1 9 2 ppb	ND (0 02 ppb)	0 21 ppb	1 4 ppb
Zinc (Z)	2 ppb	ND (0 01 ppm)	0 05 ppm	0 337 ppm

N D = Not detected

A total of 111 species of benthic sea algae were detected with prevalence of the Rhodophyta and Chlorophyta groups In those stations located at the outlet of the discharge channel, where temperatures are as high as 36 6°C permanent colonies of algae were not detected, although on several occasions a sudden appearance of bluish-green algae (algal bloom) was observed. When Planta Centro began operating, the majority of the algae community disappeared in front of the entrance of the intake channel

The Thallasia meadow—which in Punta Moron is about 400 meters long by 2 meters wide—was affected by the dredging for the construction of the intake systems and the jetties, which left it more exposed to currents and tides Considerable settling was observed and by the time the study was conducted leaf damage and growth stunting could be noted Temperature is also crucial for these plants, since at 35°C they begin to die Preliminary studies however, indicate that Thallassia does not play an important role in feeding the fish in that zone

Marine ecology studies also included a study on the mangroves in the area, in order to detect possible changes mainly due to the pollution which could affect them in the case of possible oil spills from Planta Centro The mangroves in the area of the study are dominated by the red mangrove tree (Rhizophora mangrove)

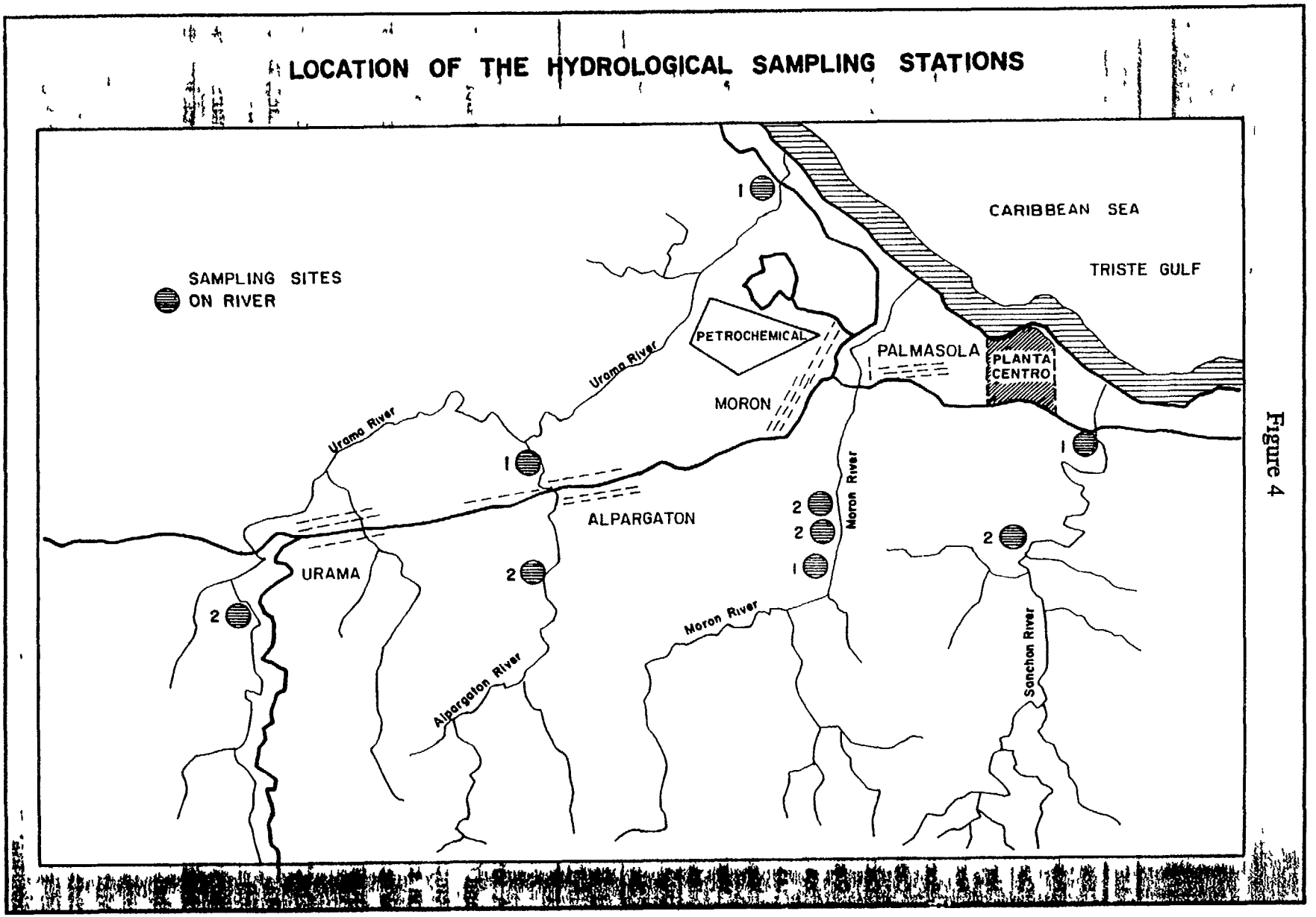

LOCATION OF THE HYDROLOGICAL SAMPLING STATIONS
SAMPLING SITES
ON RIVER
CARIBBEAN SEA
TRISTE GULF
PETROCHEMICAL
PALMASOLA
PLANTA CENTRO
MORON
ALPARGATON
URAMA
Urama River
Urama River
Moron River
Moron River
Alpargaton River
Sanchon River
1
2

Figure 4

2 2.3 Fresh water hydrological system The surface water system, of interest to the power plant at Planta Centro, involves the Sanchon, Morón, Alpargaton, and Urama rivers Although the area includes other rivers, these four determine the area's surface hydrological system (Figure 5) The main characteristic of all these rivers is their irregularity, and in general, it can be asserted that they are nothing more than streams whose flow depends on the rain that has fallen just hours before

According to the above characteristics, the levels of suspended sediments in the rivers are high during the rainy months, when the torrential rains carry away large amounts of soil The ground water table is very near the surface with a ground water flow toward the northwest of Punta Moron, where the intake channel is located The salinity of the ground waters is similar to that of the surface waters

There are two small natural ponds in the land occupied by the Planta Centro the first is located in the western sector of the area and the second in the central zone Both are shallow, with little dissolved oxygen, slightly brackish, and with high water temperatures (29°C) during the day

Concentration of toxic metals, dissolved oxygen (DO), and sulphates

In the Sanchón River, the closest one to the power plant, significant levels of arsenic, chromium, and mercury were not detected at the measuring stations located upstream High concentrations of lead and cadmium, however, were found Dissolved oxygen registered values of 6 mg/lt

Measurements taken in the Moron River, west of Planta Centro, revealed concentrations of lead, iron, vanadium, zinc, cadmium, and mercury Lead was systematically found in all the samples distributed in both space and time, with values that were occasionally high The presence of both metals was mainly attributed to the intense automobile traffic and the proximity of the petrochemical plant

Ponds

In the western pond, there was no evidence of the existence of arsenic or mercury However, there were levels of cadmium, chromium, copper, iron, nickel, lead vanadium and zinc Using the criteria established for fresh water bodies, the concentration of cadmium was 5 to 20 times higher than the maximum limit of 0 01 mg/l and the lead was 20 to 265 times higher than the level established by law (0 05 mg/l) In the central pond, which is closer to the power plant, the levels of the metals were less than those of the western lake and only iron and lead presented levels above those set by the standards As for the pH, it varied very little among the rivers, 7 1 to 7 45 with seasonal variation of approximately 6% The ponds have a higher pH (between 7 5 and 8 0)

In short a comparative analysis of fresh water bodies leads to the conclusion that the four rivers, as well as the two lakes, indicates lead levels that largely surpassed the maximum levels permitted by law, especially in the sampling sites near the highway and the refinery

718

Table 6
Analysis of Coals
(percentage in mass)

	Residual Humidity	Ashes	Volatile Material	Fixed Coal	Heat producing Power cal %	Sulphur in mass	Swelling Index	Index of the quant. being ground
Piles	3 91	18 90	35 38	41.81	6147	1 43	1 00	46 00
Trucks	3 71	17.97	37 42	40 90	6274	1 63	1 00	46 00
Strip 1	3.84	18 77	36 16	41.23	6147	1.52		
Strip 2	3.75	16.80	37 14	42.31	6423	1 80		
Strip 3	3 82	18.28	33 79	44 11	6309	1 40		
UNIT I 1992								
Mill 1	2.62	21 76	35.86	39 76	6011	1 32		
Mill 3	2.59	22.21	35 14	40 06	6035	1.30		
Compound	2.20	21.99	35.96	39.85	6016	1.32	1 00	
UNIT III 1992								
Mill 2	1 85	20.84	36 04	41.27	6200	1.32		
Mill 3	2.09	21 43	35.28	41.20	6161	1.29		
Mill 4	2.00	20.91	35.54	41.55	6228	1.30		
Compound	2.07	20.95	35.59	41.39	6208	1 30	1 00	
COMPOUNDS 1991								
Unit I	2.72	17 66	37.01	42.61	6308	1.53	1 00	
Unit II	2.96	17 67	37.58	41 79	6324	1.56	1 00	
Unit III	2.66	17 10	38 18	42.06	6424	1.61	1 00	

Table 7
ANALYSIS OF THE CONCENTRATIONS CALCULATED THROUGH THE PTMAX 1/ MODEL AS A FUNCTION OF WIND VELOCITY FOR THE FIVE UNITS AT FULL LOAD

TYPE OF STABILITY	WIND VELOCITY (m/s)	FREQUENCY OF OCCURRENCE ON AN ANNUAL BASIS (%)	FREQUENCY OF OCCURRENCE WITH A NORTH-NORTHEAST WIND ON AN ANNUAL BASIS (%)	MAXIMUM CONCENTRATION 2/ (ug/m³)	DISTANCE FROM THE MAXIMUM CONCENTRATION (km)
2	5 0	4.2	1 4	1 391	2 9
3 3/	5 0	6.9	2 6	956	6 4
3	7 0	1 9	0 4	1 019	5 1
4 3/	5 0	5.9	2.2	238	39 1
4	7 0	8.2	3 4	284	27 8
5 3/	2 0	19 0	0 6	415	74 5
5	3 0	18 0	1.2	356	59 5
5	4 0	13 0	3 7	315	51.2

1/ These are short term forecasts (1 hour) Some combinations of conditions (for example stability class 2 and wind speed of 5 meters per second) will not be observed for more than 1 hour in Moron

2/ The base concentration of 8 micrograms per cubic meter should be added to these maximum forecast concentrations

3/ These three (3) cases were also forecast with the PTDIS and will be discussed in the following section

719

Finally, mercury, which is mainly related to the wastes from the petrochemical complex, shows a geographical distribution pattern that tends to confirm this hypothesis

2.3 Land Ecology

An area of 500 hectares was selected where the greatest environmental impacts would occur as a result of the construction and operation of the Planta Centro Thermoelectric Power Plant, especially in the direction of prevailing winds Here, extensive field work was carried out for sample collecting and analysis of the most adequate indicators for assessing the pre-operational condition of the terrestrial ecosystem and subsequently monitoring the evolution of the environmental situation when the power plant began operating

The soils in the area of Punta Moron are not very compact, in some areas the water table rises to the surface and creates flooded areas The main components are fine sands and mud, with abundant mica and silty material The soils slope gently and are highly permeable, with a 10- to 24-centimeter layer of organic matter From the agricultural standpoint, the soils are frequently flooded during the rainy season due to the lack of natural drainage Before the power plant's construction, Punta Moron underwent several deforestation processes to make way for agricultural and livestock raising activities This deforestation was further enhanced by the construction of the power plant, access roads, and transmission lines, thus increasing erosion

The geology of the area is rather uniform, with metamorphosed cretaceous formations in the mountain range towards the coast, with the presence of mica, limestone, and quartz gneiss, typical of this formation Punta Morón is formed by delta-like and marine alluvial plains, with a rather sandy subsoil It is assumed that, in other eras, the sector that today occupies this plain was an inland extension of the Triste Gulf

The chemical analysis of the soils (Table 6)—which is important for assessing the deposition of certain metals stemming from the power plant's emissions—revealed high concentrations of lead, vanadium, and nickel

Habitats

In the area of Punta Morón, the following habitats can be defined forests, land that has been intervened by man, cultivated zones, areas used by man, service roads and bodies of water These are briefly described below

In 1975, woods covered 36% of the 5,000 hectares considered to be the project's area of influence. In order of importance are the pre-montane forests, dry tropical forests, and corridor forests (Table 7) The pre-montane forest covers the northern strip of the mountain range in front of the area under study and is mainly formed by primary plant life with a height of 16 to 20 meters The dry tropical forest consists of a rather compact mass of bushes and trees between 8 and 15 meters high, most of which are deciduous Many spiny plants are found here, mainly cacti When the forest encounters wet edaphic associations, such as the flow of the Sancho River, corridor forests are formed with giant trees more than 20 meters high

720

The land that has been intervened presents a great variety of derivations such as cleared ground, ground with undergrowth such as trees and bushes, weeds and bushes, etc , all of which have as a common heritage that of having suffered alterations caused by man for use in agricultural or livestock-raising purposes In some cases, this land has undergone a slow recovery process, although not to the point of recuperating the original forest, as some of the soil components have been eliminated due to erosion The areas for growing crops is small, as agriculture is not an important economic activity in this area The majority of the crops are subsistence farming, among which corn, cassava, and papaya

In this area there are numerous industrial complex that are of great regional importance. The development of these industries includes the formation of an important network of highways connecting the center of the country with the west In addition to these highways, there are the trains oil pipelines, transmission lines, and obviously the populated areas of Punta Morón

Conditions of the plant life

An analysis of infrared aerial photographs, taken in 1979 shortly before the first unit of the power plant began operation, showed that the majority of the vegetation in the area was in good conditions Two area, however, that had plants that were seriously affected were detected the first to the west of the Morón Petrochemical Plant, and the second to the west of the El Palito Refinery (dead plants near the petrochemical plant)

Other habitats outside the area under study

Some 35 kilometers toward northwest from Planta Centro is the Morrocoy National Park It has an extension of about 32,000 hectares, characterized by dry tropical forest which serves as a sanctuary for the reproduction and protection of bird species Another important nearby habitat is the city of Puerto Cabello, which is 18 kilometers to the east of the power plant, and is the most important populated center in the zone The airport is to the northwest of the city, located even further west on the beach was the city's cremator, a highly polluted area which has since then been removed

Fauna

At the time the study was conducted, the fauna in the area was made up of different communities of small arthropodal organisms and small vertebrates, especially rodents, there were also cattle, sheep, and pigs The selection of certain indicative species and the study of those most common in the area contributed immensely to assessing and monitoring the emissions discharged from the power plant's operations

During the campaign for capturing these animals, eight species of small mammals were identified, especially rodents However, there is some evidence that there are more than 25 species of small mammals in the Punta Moron ecosystem

The highest concentrations of vanadium, nickel and lead were found in the hearts and kidneys of certain marsupials (Didelphis), higher than in any other species, while the greatest concentration of copper was found in the liver of sheep (ovis), which suggests the use of these species for monitoring the concentration of these metals The high copper concentrations in sheep liver indicates that some individuals could be suffering from some sort of contamination from this metal

Birds were also studied, it was determined that there are some 120 species typically linked to aquatic habitats such as ducks (Deudrocygna autumnalis and Anasdiscors) and numerous breeding places, as well as rare species of herons (Ardea Cocoi) One of the most important habitats for the birds of that area is the pond inside Planta Centro Birds use the mangroves in the lake as a night shelter A large amount of amphibians were also noted, specially during the rainy season In addition, there were reptiles, especially lizards

In Punta Moron there are no endangered species, or species in danger of extinction

2.4 Human Ecology

Morón is the most important inhabited center within the power plant's area of direct influence The urbanized zone in 1979 is estimated at more than 700 hectares The drainage system of the Moron River (in a northern-southerly direction) and the Puerto Cabello-Barquisimeto railway (in an east-westerly direction) run through this area, which is bound on the north by the coastal marine swamps which are of no interest for tourism, on the south by the mountainous region, on the east by flooded areas, and on the west by marginal lands with an irregular terrain

Morón's existence dates back to the sixteenth century Until 1954, its economy was based on agriculture and to a lesser degree on commerce As of 1954, with the creation of the Venezuelan Petrochemical Institute, a period of growth began in Moron, which included the installation of the following industries

- Venezolana de Pulpa y Papel, 1957 (paper)
- Refineria Mobil, 1960 (oil refinery)
- Volkswagen, 1963 (automobile)
- Tripoliven, 1972 (chemical)
- Planta Centro, 1075 (thermoelectric)
- Productos Halogenados de Venezuela, 1975 (halogenous products)
- Ferro-Aluminio, 1976 (iron and aluminum)
- Military Industries, 1967

722

From the economic standpoint, Moron can be categorized as the industrial zone of Puerto Cabello Industrial activities generate 80% of direct employment In addition to the urban sections, there are also areas dedicated to grazing land for sheep and small farms for growing subsistence, which are not part of any land management planning

The rapid urban growth of the last few decades, prior to the construction of the power plant, has led to a series of unplanned changes, within the area of study, which directly altered the geography of the terrain, and the quality of the air, water, flora and fauna These actions were mainly due to the process of industrial development in the area, which took place without any control or planning measures, such as the petrochemical complex and the unorganized urbanization of Morón

3. DESCRIPTION OF THE PROJECT

3.1 General Aspects of the Electric Power System in Venezuela

At the beginning of the nineties, about 60% of the energy generated by the Venezuelan electric power system came from hydropower plants, especially from the Guri power plant on the Caroní River located in the eastern part of the country This hydropower plant has an installed capacity of 10,000 MW and is one of the largest in the world. During the last thirty years (1960-1990), the installed electric energy generation capacity from water sources, rose from 277 to 10,580 MW

During the above-mentioned time period, thermoelectric power also registered a significant surge in order to meet the country's electric power needs for industrialization and modernization programs that were started in the sixties By 1990, thermoelectric energy reached 7,435 MW

Despite the economic crisis that affected the country and all of the region between 1980 and 1990 electricity consumption recorded an average annual growth of 4 79% This is considered moderate, compared with an annual average growth of 12 2% during 1970-1980

A large part of the fast growth in electricity demand was due to the implementation of large mining projects in the western zone near Guyana The large industrial complexes for processing bauxite and iron granted impetus to consumption by heavy industry as a whole, boosting their consumption of electricity by an annual average of 14 5% between 1970 and 1980

Between 1980 and 1990, electrical consumption by heavy industry increased its participation in total electricity consumption from 30 to 36% Another sector with a large share of electricity consumption is the residential sector, which has maintained an almost constant share of 21% throughout all the period studied This sector's evolution, however, has had a wide range of variations in growth rates over the years

723

Power consumption growth prospects for the nineties, in terms of sector consumption, seem to follow historical trends, enhanced by the future development of megaprojects in aluminum and petroleum On the basis of this assumption, the interannual average growth of power demand is estimated at 6 7%, it is expected that most of this demand will be met by the hydropower development of the upper and lower Caroni River, where some additional 14,000 MW have been identified, to be harnessed by the implementation of only six projects

New thermoelectric power plants are not envisaged over the medium term About 60% of existing generating capacity has reached or is about to reach the end of its useful life span For this reason, electric power companies have plans to upgrade or retrofit units for the purpose of extending their useful life, improving their efficiency, reducing production costs, and postponing new investments

There have been financial constraints in power utilities for more than a decade This type of constraint has induced most of these companies to consider upgrading or retrofitting the thermoelectric power plants, among these plans, there is the upgrading of Planta Centro which, with its 2,000 MW, accounts for about 27% of the country's total thermoelectric generation capacity

3.2 Description of the Power Plant's Installations

The Planta Centro thermoelectric power plant has a total generating capacity of 2,120 MWe, distributed in five groups groups 1 and 2 have 400 MWe each and groups 3, 4, 5 have a capacity of 440 MWe each They use the steam/turbine system, designed for burning heavy fuels, mainly fuel oil 6, although group 2 has modifications which allow it to also burn natural gas

Figure 5 indicates the geographical location of Planta Centro, the distribution system, and its area of influence

For ease of description, a thermoelectric power plant's installations can be grouped into the following components a) main electromechanical equipment, b) auxiliary equipment, and c) civil constructions Maintenance activities are included as integral part of project activities, because without them the power plant cannot operate normally (Figure 6)

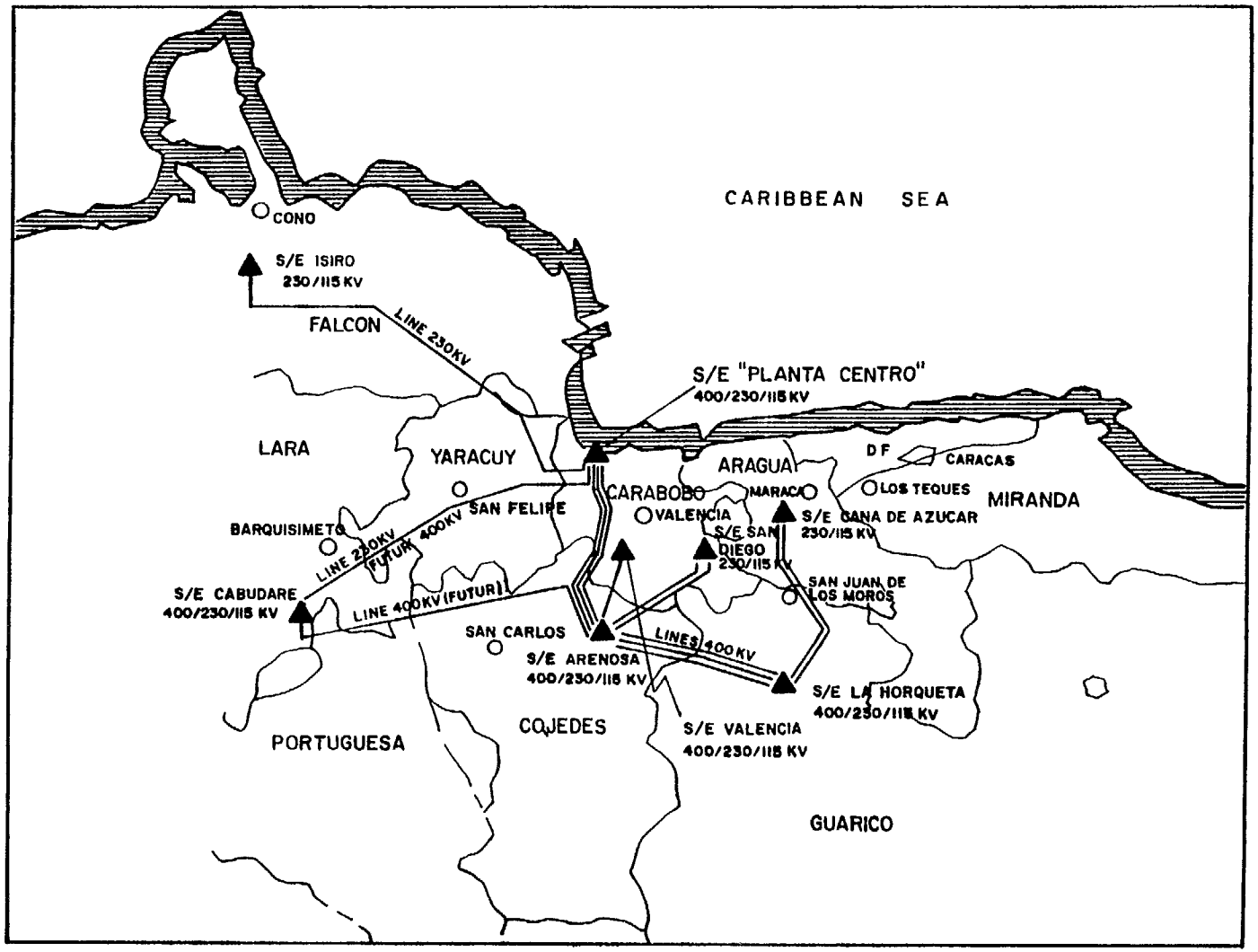
a In the case of a power plant of this type, the main electromechanical equipment consists of the boilers, turbines, condensers, generators, and transformers, which constitute the basic equipment for operating the thermodynamic cycle needed for electricity generation

The steam generator equipment or boiler, in each one of the groups, uses natural water circulation of two types and 24 burners, with a 1,225 tons per hour capacity in the case of units 1 and 2, and with a 1 430 tons per hour in groups 3, 4, and 5

724

Figure 5

GEOGRAPHICAL LOCATION OF THE PLANTA CENTRO THERMOELECTRIC POWER PLANT WITH ITS ASSOCIATED SYSTEM AND AREAS OF INFLUENCE



725

Figure 6

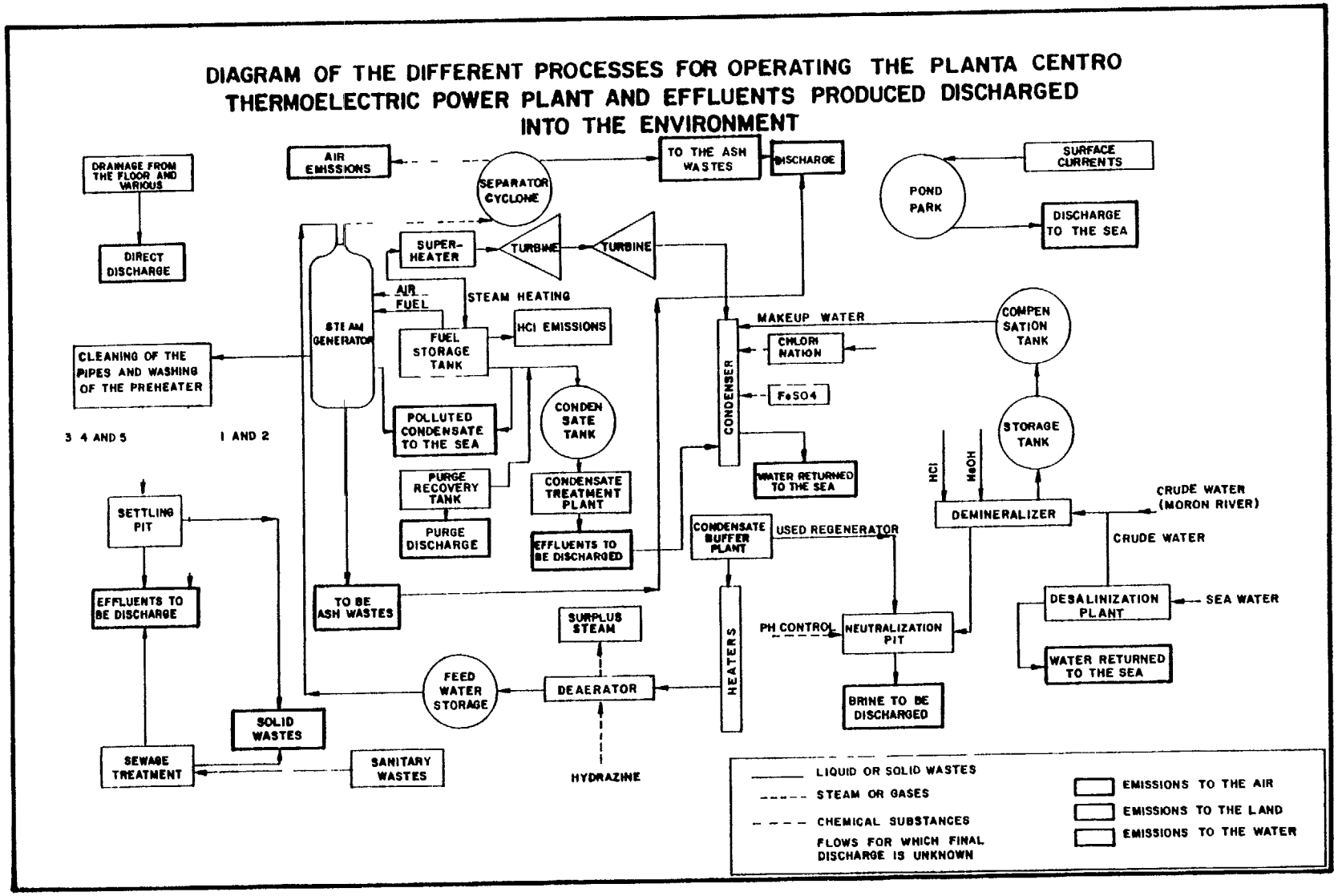


DIAGRAM OF THE DIFFERENT PROCESSES FOR OPERATING THE PLANTA CENTRO THERMOELECTRIC POWER PLANT AND EFFLUENTS PRODUCED DISCHARGED INTO THE ENVIRONMENT
DRAINAGE FROM THE FLOOR AND VARIOUS
DIRECT DISCHARGE
AIR EMISSIONS
SEPARATOR CYCLONE
TO THE ASH WASTES
DISCHARGE
SURFACE CURRENTS
POND PARK
DISCHARGE TO THE SEA
SUPER-HEATER
TURBINE
TURBINE
AIR
FUEL
STEAM HEATING
STEAM GENERATOR
FUEL STORAGE TANK
HCl EMISSIONS
MAKEUP WATER
COMPEN SATION TANK
CHLORI NATION
FeSO4
CONDENSER
CLEANING OF THE PIPES AND WASHING OF THE PREHEATER
POLLUTED CONDENSATE TO THE SEA
CONDEN SATE TANK
STORAGE TANK
3 4 AND 5
1 AND 2
WATER RETURNED TO THE SEA
HCl
NaOH
PURGE RECOVERY TANK
CONDENSATE TREATMENT PLANT
CRUDE WATER (MORON RIVER)
DEMINERALIZER
SETTLING PIT
PURGE DISCHARGE
EFFLUENTS TO BE DISCHARGED
CONDENSATE BUFFER PLANT
USED REGENERATOR
CRUDE WATER
EFFLUENTS TO BE DISCHARGE
TO BE ASH WASTES
SURPLUS STEAM
PH CONTROL
NEUTRALIZATION PIT
DESALINIZATION PLANT
SEA WATER
WATER RETURNED TO THE SEA
FEED WATER STORAGE
DEAERATOR
HEATERS
BRINE TO BE DISCHARGED
SOLID WASTES
SEWAGE TREATMENT
SANITARY WASTES
HYDRAZINE
LIQUID OR SOLID WASTES
STEAM OR GASES
CHEMICAL SUBSTANCES
FLOWS FOR WHICH FINAL DISCHARGE IS UNKNOWN
EMISSIONS TO THE AIR
EMISSIONS TO THE LAND
EMISSIONS TO THE WATER

726

They produce superheated steam with a temperature of 540°C and 180 bars of pressure The flue gases transmit heat through the system of superheaters, reheaters, economizers, and preheaters of air, all of which are needed to improve the combustion's global efficiency

Before being taken to the stack, the hot gases pass through a heat exchanger (preheater), where they transfer part of their energy to the entrance gases The high sulphur and ash content in these gases provokes scaling and deposits in the exchanger's pipes This makes constant periodic cleaning necessary, using steam and chemical agents (soda and phosphates) The muds contained in the cleaning water after the cleaning process contain alkalis, sulphates, metals and tar

Finally, the flue gases are discharged into the atmosphere through a stack 170 meters high In units 1 and 2, before reaching the stack, the gases pass through cyclone separators, where the larger particles are separated from the gases

Every two or three years, the boilers are washed using steam and chemical agents to prevent the formation of deposits The waste water, about 200 cubic meters, is sent directly to the discharge channel

Following the production cycle, the superheated steam leaves the generator and enters into the turbines These are of the condensation type with intermediate reheating and regulation stages with four casings one high-pressure, one medium-pressure and two low-pressure When these expand, they produce the mechanical energy needed to move the generator where the final transformation into electrical energy occurs With an exit voltage of 24 and 26 kilowatts (kW), the voltage needed for its transmission through the power transformers is high There are 10 transmission lines from the transformers 3 of 400 kW, 9 of 230 kw and 6 of 115 kw, which carry electricity to consumption centers

At the outlet of the turbine's last phase, the low-temperature, low-pressure steam enters into the condenser, where it is condensed and cooled Here the caloric content corresponding to the cooling waters is transmitted into the steam, thus completing the thermodynamic cycle

The power plant's cooling system uses a once-through system, where the sea water is pumped through a piping system directly into the condenser There, it absorbs part of the heat contained in the steam coming out of the turbines, thus increasing its temperature about 9°C, it is then returned to the sea through a discharge channel The cooling system consists of the intake and discharge apparatus for the sea water, pumping stations, circulation pipes, and an anticorrosive cleaning system

The cooling system was designed to pump 144 cubic meters per second, almost twice the 76 1 cubic meters per second needed at full load (2,000 MWh) This entailed the construction of jetties and breakwaters about 400 meters out into the

727

sea, about five meters above average sea level, thus creating a small harbor or basin that diminishes the turbidity of the intake area

On the other hand, the discharge channel is protected by two parallel breakwaters about 300 meters out into the sea at a depth of 7 meters and which take the cooling water out into the ocean to prevent the discharge water's temperature from being minimal

In order to prevent the formation of animal and plant colonies (mollusks and algae) in the circulation pipes, a chlorine-based biocide is intermittently injected on a daily basis, in concentrations of 1 ppm and 5 ppm for one-hour periods per canal The waste chlorine is carried directly into the sea through the discharge channel In the cooling system, corrosion in the circulation pipes due to the sea water is prevented by injecting, at the entrance to the condenser, 1 ppm of iron sulphate per line

b The auxiliary equipment consists of systems that are not part of the thermodynamic cycle per se but are indispensable for the operating cycle, among which pumping stations, emergency equipment, etc The auxiliary equipment also includes the equipment needed to meet the needs stemming from managing the power plant, such as clean water and sewage treatment plants, storage tanks, etc

Other auxiliary systems are different types of water treatment plants, among which the desalination plant, a demineralizer, a condensate buffer, and another for sewage waters The desalination plant reduces the content of sea water solids and supplies crude water for the power plant's consumption, due to the scarcity of fresh water in that area The demineralizing plant eliminates mineral salts (chlorides, sulphates, sodium, etc) from the crude water that will be used in the main equipment, so as to avoid scaling and solid deposit formation, and it also has the capacity to replace all of the water lost during the operation of the main thermodynamic cycle The purpose of the condensate buffer plants is to reduce even further the concentration of impurities in the water used in the main boilers

The lack of a sewage system in the area required the building of a sewage water treatment plant to meet the needs of the power plant's technical and administrative personnel These are two plants, of the prolonged aeration type, with a total capacity of 128,960 liters/day Once the treatment process is finished, the inert biological effluents are dumped into the sea through the discharge channel

Storage tanks the fuel storage system for Planta Centro has a total capacity of 265,244 cubic meters, distributed among 9 vertical-type tanks with a metal-plate supported roof located in a zone adjacent to the generator units to the southwest of the main building

The fuel for filling these tanks is transported by using an oil pipeline which connects the power plant to the nearby El Palito Refinery

In addition to the main storage tanks described above, there is a system of filtered fuel tanks, or daily fuel tanks, which are the ones that directly feed the boilers

c The main civil works are the adaptations or modifications made to the grounds and the buildings needed for operating the power plant Among these are the grading the land, drainage works, access roads, administrative buildings, breakwaters, water intake and discharge systems for the cooling water, and the dock

The drainage works inside the power plant's grounds are capable of safely eliminating eventual fuel spills, as well as the drainage water from the storage tanks, into small density separation tanks (API type), where part of the oils is recovered, while the water is carried out to the sea through the external drainage channel

One of the most important civil constructions is the dock, built within the power station's area It has installations needed to discharge 20,000 barrels of fuel per hour Due to PDVSA policies, fuel from the El Palito Refinery is received only through the Corpoven-Planta Centro polyduct, and therefore this dock has not been used to date

4. IDENTIFICATION OF ENVIRONMENTAL IMPACTS

This chapter intends to identify and subsequently assess the different alterations that the power plant's construction and operation produced on the different environmental components (atmosphere, water, land, and human ecology) using cause-and-effect matrix techniques which facilitate visualizing the environmental impacts

The potential values of the different pollutants and effluents were compared with the current Venezuelan standards and/or regulations whenever possible When there were no standards, environmental criteria from world agencies, such as the United States Environmental Protection Agency (EPA) and European agencies, were used

As a result, three impact severity levels were determined and have been set forth in the cause-and-effect matrices These levels are low level (L), which involves a simple identification of the impact but does not imply major investigation, moderate (M), which indicates an alert for possible danger, meriting observation and, in exceptional cases, requiring the implementation of some mitigation measures, and high (H), which is equivalent to a danger sign and requires immediate mitigation measures along with a monitoring plan

It is important to point out that, for all the measurements, the power plant's maximum operation (2,120 MWh) was taken into account It is well known, a thermoelectric power plant such as Planta Centro, for operational reasons, does not function at more than 75% total generating capacity Therefore, the results presented below should be viewed as the

729

worst possible case scenarios Due to different circumstances involving the operation of the national integrated system, until 1992 Planta Centro functioned at an average annual capacity of 600 MWh

4.1 Air

Operation of Planta Centro will lead to an increment in the pollutants already existing in the region such as sulphur dioxide (SO_2), suspended particulate matter (SPT), nitrogen oxide (NO_2), light hydrocarbons and heavy metals, which are emitted by the El Palito Refinery, the Morón Petrochemical Complex, and also motor vehicle traffic In order to calculate these values, mathematical models for transportation and dispersion were used as well as the values of the pre-operational concentrations of the different pollutants

Forecasting models were mainly used to determine SO_2 concentrations, which is considered the worst atmospheric pollutant stemming thermoelectric power plants Afterwards, SO_2 concentration patterns were analyzed to study concentrations of TSP and heavy metals The use of SO_2 patterns for forecasting other pollutants is based on two assumptions The first is that both particulate matter as well as metal particles have a negligible vertical speed component Therefore gravity influences them very little and their dispersion behavior is similar to that of a gas The second assumption is that SO_2 does not undergo any significant chemical transformation within a 15-kilometer radius around the power plant

Forecasts for nitrogen oxides and volatile hydrocarbons were not made, since these products undergo rapid chemical reactions in sunlight and other gases present in the atmosphere, which impedes using an adequate forecasting model

Potential SO_x Emissions

Two short-term models were used to predict average hourly concentrations and another long-term one to predict average annual concentrations Short-term models enable the estimation of maximum concentration at ground, as well as the distance from the point of highest concentration for each atmospheric stability and wind speed condition The long-term model permits forecasting ground-level concentration, based on monthly arithmetic averages using meteorological data and data on emissions during annual periods

Under normal conditions, these forecasting models for fixed specific sources can achieve a precision factor of 200, and from 20 to 40% under ideal conditions of application, that is, under stationary meteorological conditions of wind direction and speed and atmospheric stability In long-term models, uncertainties tend to be eliminated when averaging time series of longer periods, resulting in more homogeneous and precise estimates for annual average dispersions than shorter-term estimates

In 1979, with one unit of the power plant operating, maximum concentrations at the El Alpargatón School were measured on days in which atmospheric measurements had been carried out at great heights, so as to calibrte the short-term models, with a precision of 20, 40 and 200% according to the prevailing atmospheric conditions at that time

730

Theoretically, this was what had been expected In addition, the model was simplified using only one emission outlet, instead of the three stacks that actually exist, which leads to concentration forecasts that are higher than those actually expected because of the flotation effect in multiple stacks, which increases the plume's elevation, thus decreasing the concentration at ground level

Table 8 presents the results of the PTMAX forecasting model for different conditions of atmospheric stability and wind speed and also indicates the percentage of hours each

TABLE No 8

SUSPENDED PARTICLE EMISSIONS

CHARACTERISTICS		UNITS 1 & 2	UNITS 3, 4 & 5	ALL 5 UNITS
Tacoa residual fuel		Tacoa resid	Tacoa resid	
Specific gravity (kg/lt)		0 98	0 98	0 98
Sulfur content (%)		2 9	2 9	2 9
Fuel Consumption				
(T/hr)		93 21	96 02	474 48
(lt/hr)		95,112	97,980	484,164
No of Stacks		1	1 for 3 & 4, 1 for 5	3
Particle Emissions without Collectors				
(gr/sec)		105 8	108 9	538 3
(MT/day)		9 14	9 41	46 51
(T/day)		10 07	10 37	51 27
With 60% Collection				
All units with collectors	(gr/sec)	42 3	43 6	215 3
	(MT/day)	3 66	3 77	18 60
	(T/day)	4 03	4 15	20 51
Units 1 & 2 with collectors, 4 & 5 without	(gr/sec)	42 3	108 9	411 3
	(MT/day)	3 66	9 41	35 54
	(T/day)	4 03	10 37	39 17

730

year that each of these combinations occurs One column also establishes the number of hours that the wind blows in an east-northeasterly direction, carrying the plume to the population of Morón It is also apparent that stabilities of types 2 and 3, which occur at the end of the morning and beginning of the afternoon, lead to high concentrations of SO_2 in the vicinity of Morón

Three different atmospheric conditions were established with the PTDIS model, using hourly meteorological data and taking into account the height of the atmospheric mixture, in other words, the distance from the ground to the lower layer of the temperature inversion zone, which limits the elevation of the plume and influences determination of ground-level concentrations The characteristics of the three conditions analyzed can be summarized as followed

Under stability conditions (classes 1 and 2), there will be no infringement of the three-hour air quality standards Under slightly unstable atmospheric conditions (class 3), with a maximum concentration of 957 micrograms per cubic meter at 6 4 kilometers from the power plant, the standards will not be infringed either, although only one emission point, instead of three, is assumed, leading to an overestimation of ground-level concentrations

The results of the long-term model are annual arithmetic averages and are therefore very different from the concentrations obtained from the two short-term models

A series of measurements taken at the Morón train station during the first year of operation for units 1 and 2 confirmed that the model's forecasts were 200% higher, which was considered fairly reasonable taking into account its limitations Finally, the maximum expected annual concentration—25 5 micrograms per cubic meter—is within the limits established by the EPA for air quality

Emissions of total suspended particulates (TSP)

Total suspended particulates (TSP) also include suspended particulates with a diameter under 500 micrometers Their long stay in the air makes them similar to gases in terms of carrying behavior and dispersion in the atmosphere, therefore the results from the SO_2 prediction models can also be used for TSP

Table 8 summarizes the results of TSP emission characteristics, under the different operating assumptions for the Plant Centro units emphasizing in units 1 and 2 the existence of cyclonic separators of particulates with a 60% efficiency, which mainly retain large-sized particulates

Considering the pre-existing concentration of 61 3 micrograms per cubic meter, it is apparent that the hourly average would be within the 24-hour standard Using a pre-existing annual average concentration of 55 micrograms per cubic meter, the AQDM model used for forecasting annual average TSP concentrations does not expect to exceed the standard of 75 micrograms per cubic meter

732

Emissions of Toxic Metals

Based on the contents of certain toxic metals contained in Venezuelan crude oils, the carrying and dispersion patterns of vanadium, nickel, lead, manganese, chromium, and copper were analyzed with the same models used for forecasting SO_2 and TSP concentrations obviously taking into account the reasons for the emission and the real content of these metals in the fuels used by the power plant It is important to point out that, at the moment of conducting the studies, there were no international standards for some of these metals and therefore, different references were used

Vanadium

Vanadium emissions increased by a factor of 100 once Planta Centro reached full load Although very few countries have established standards for levels of vanadium, standards do exist for environmental concentrations of V_2O_5 for 24-hour periods

The estimates made using the forecasting models and the measurements lead to the conclusion that maximum vanadium concentrations for 24-hour periods could surpass the value of the most demanding standard of 2 0 micrograms per cubic meter Its measurement should be considered a parameter to be included in future monitoring programs

Nickel

The results of the models forecast that nickel levels stemming from the operation of the Planta Centro thermoelectric power plant would be on the order of 25% of the long-term value established by the only standard that could be consulted However, it is expected that concentrations will increase by as high as tenfold compared to pre-existing levels for 1979 It is possible that in the future maximum 24-hour concentrations harmful to health will take place Based on existing information, it is estimated that nickel emissions, as a result of Planta Centro's operation, could exert a high impact over the short term and a moderate impact over the long term

Lead

It is estimated that total lead emissions from Planta Centro, operating at full capacity, would be about 8 kg/day, depending on the lead content of the fuels used The results of a forecasting model simulation were as follows $2\ 27 \times 10^{-4}$ micrograms per cubic meter for the annual average, $5\ 4 \times 10^{-3}$ micrograms per cubic meter for the three-hour average, and 0 017 micrograms per cubic meter for the one-hour average, with a pre-operational concentration of 0 4 micrograms per cubic meter The results of the measurements taken in 1978-1979 did not show any significant increase in the atmospheric concentration of lead and confirm the model's forecasts that the power plant's operation lead to insignificant increases in already existing levels of lead Furthermore, none of the known standards were exceeded

Manganese, chromium, and copper

The manganese and manganese oxide (MnO_2) emissions do not exceed existing international standards, and the concentrations forecast by the models are so much lower than the standards that they are considered negligible For chromium, the models yield concentrations that are well below established standards, and in contrast to most other metals, there are no measurements of its pre-operation concentrations Nevertheless, it was deemed that chromium would not greatly affect the region's air quality This also holds true for copper concentrations

Carbon monoxide (CO)

As a rule, CO emissions in the air are a problem in cities, where buildings obstruct the dispersion of these gases, produced mainly by traffic CO emission standards for power plants are generally established as a maximum percentage of the total volume of gases emitted French standards specify that CO emission should not be over 0 05% of total volume of gases produced by the power station's operation In Planta Centro, carbon monoxide represents 0 002% of total gases, and it is therefore considered that it will exert a small impact on air quality

Nitrogen oxides (NO_x)

The importance of analyzing nitrogen oxides and hydrocarbons involves the fact that both emissions are precursors to the so-called photochemical agents, such as ozone They are transformed through reactions with other compounds in the presence of sunlight This makes it difficult to include them in carrying and dispersion models, such as those used for analyzing SO_2 and toxic metals

It is estimated that Planta Centro, working at full load, will emit 1,830 kg/h of nitrogen oxide, while the standards for this type of power plant establish a maximum of 2,574 kg/h Measurements confirm that NOx concentrations meet the established standards and their impact on air quality is considered moderate Nevertheless, it is recommended that periodic control measurements be carried out, taking into account the presence of other industries in the zone

Hydrocarbons

Most emissions of hydrocarbons stemming from operating Planta Centro come from the fuel storage tanks It was expected that hydrocarbons emissions will increase when the power plant begins operating at full capacity Its impact on air quality, however, is considered moderate

Oxidants

As previously mentioned, concentrations of ozone (O_3), the main oxidant, depend on concentrations of nitrogen oxides (NO_x) and hydrocarbons (HC) in the atmosphere In

addition to the polluting emissions from Planta Centro's operation, there are important sources of emissions in the zone, such as the refinery, the petrochemical complex, and automobile traffic Measurements taken prior to the power plant's implementation, at a sufficient distance so as to produce the expected photochemical reactions, revealed an ozone level of 167 micrograms per cubic meter as the maximum reading in one hour, which is equivalent to 70% of the standard established in the United States With Planta Centro operating at full capacity, both the concentrations of NO_x and hydrocarbons will increase, consequently creating concentrations of ozone that will exceed established standards

Sulphates

Based on the forecasts and measurements of sulphate concentrations in the atmosphere before Planta Centro was commissioned and the first units began operating, sulfate levels could exceed maximum concentration standards of 25 micrograms per cubic meter, once the power plant begins functioning at full capacity At the same time, they will cause rising concentrations of particulates, since sulphates become apparent in this manner This would also lead to an increase in acid rain Therefore, the environmental impact of sulphate formation from operating the power plant should be considered as moderate

Visual aspects

Operation of Planta Centro could affect the visibility of the Punta Moron region, mainly because of the plume's direction, possibly affecting both air and ground traffic During the power plant's first year of operation, and depending on atmospheric conditions during afternoon hours, it was observed that the plume occasionally fell to ground level The repercussion of Planta Centro on the visibility was qualified as moderate

4.2 Water.

The evolution of water environment changes produced by the power plant at Punta Morón is quite complex and requires the analysis of a wide range of aspects involving this problem The intake and discharge systems affect the physical conditions of the coast; the use of sea water for the cooling system changes certain characteristics of ocean's chemistry Solid and/or atmospheric effluents can affect the courses of surface and/or ground waters

The methodology used for assessing the hydrological effects and water quality during construction and operation of Planta Centro was based on the matrix indicated in Table 9 This matrix has been enlarged to show the detailed interactions between the power plant's activities

The environmental assessment used a variety of methods, ranging from direct observation and measurements to computerized forecasting models In addition, the interactions within the marine environment were subdivided into two categories physical and chemical The physical oceanographical characteristics that were assessed included bathymetry, ocean floor materials, temperature, density and salinity, ocean currents, tides, and waves, and the transport of sediments to the shore

The project's actions affecting the bathymetry include the construction of the cooling

Table 9

CAUSE AND EFFECT MATRIX FOR THE AQUATIC ENVIRONMENT

	CHARACTERISTICS OF THE WATER	CONSTR	Emission to the air	Emission to the Land	IMPACT OF THE PROJECT						
					Emissions into the Water					Maint Plant	Accidents
					Cooling Water Intake	Cooling Water Discharge	Biocide Discharge	Sanitary Wastes Discharge	Over flow Water	Maint Work	Spills
PHYSICAL OCEANO GRAPHY	Bathymetry	X			X	X					
	Matter from the ocean floor	X				X					
	Temperature/density/ salinity	X				X			X		X
	Currents/tides/waves	X			X	X					
	Sediments carried to shore	X			X	X					
CHEMICAL OCEAN	Salinity	X							X	X	
	Turbidity	X				X			X		
	Nutrients	X		X		X	X	X			
	BDO/CDO/Dissolved Oxygen	X		X		X	X	X	X	X	X
	Chemical Composition	X	X	X		X	X		X	X	X
	Composition of the substrata			X		X	X	X	X	X	X
	pH		X	X						X	X
	Pathogens						X	X			
FRESH WATER HYDROL	Surface water system	X		X					X	X	
	Ground water system	X		X					X		
FRESH WATER QUALITY	Salinity								X		
	Chemical Composition	X	X	X					X	X	X

Note The X indicates significant interaction between the items and the headings

136

water intake and discharge systems These interactions occur because the movements of sea bottom materials change the bathymetric contours of the offshore zone During the power plant's operation, the contours of the bottom were affected by the transport of sediments near the intake and discharge systems These effects were classified as high and moderate, respectively

During construction, there were cases of hydrographical changes affecting water circulation or shore salinity Permanent changes, however, were not observed and therefore this effect was considered to be low During power plant operation, the water is discharged at 8 8 ºC and affects an area of several hectares around the discharge channel The analysis also showed that, with 4 or 5 units in service, the thermal plume will collided with the sea bottom This effect is classified as moderate

Slight effects are expected from the interaction between construction of the cooling water intake and discharge channels with the currents, tides, and waves

The transport of sediments to the shore would potentially be affected by three project actions construction, intake of water for the cooling system, and disposal of the cooling water into the sea The drift towards the shore in the area of the power plant is from east to west The construction of the jetties might have affected these movements, with definite zones of growth and erosion observed

Salinity was assessed regarding runoff waters and maintenance operation, both interactions were classified as low impact Because of the area involved, the discharge of the cooling water will affect the turbidity of the water layer near the discharge outlet This impact on the environment is classified as low

During construction, erosion had a moderate influence on the transport of nutrients The high-temperature cooling water and the discharge of biocides along with the entrainment of organisms all interacted to cause death in microorganisms, cell damage, and an increase in nutrient levels These interactions are classified as moderate The nutrients contained in the sanitary discharges are negligible and do not produce significant effects

Oxygen demand (OD) was only minimally affected by the construction and was only slightly to moderately affected by the power plant's normal operations Among the normal operations assessed cooling water and runoff are deemed to cause moderate effects

The effects of construction on the sea's chemical composition and substrata are moderate, those stemming from air emissions and ash and solid waste disposal are low, whereas those from the discharge of biocides and runoff are moderate

Interactions with the cooling water were considered severe over the short term and chronic over the long term Few effects were foreseen over the short-term, as the acute levels of toxicity were not exceeded However, long-term accumulations will produce moderately adverse effects

The cooling water dumped into the sea produced low-level effects over the short term but high impacts on the sediments in the long run The effects of biocides discharged were low, as well as those caused by the sanitary wastes and the runoff, due to the small amounts of materials dumped Accidents, especially oil spills, would exert high impacts on the marine environment

The pH can be affected by many of the power plant's activities Based on available information, the effect of emissions into the air are classified as low level due to the dispersion However, the maintenance of the power plant has a high impact due to the nature of the discharges and the lack of treatment in units 1 and 2

The activity of the inner pond was slightly affected by the changes in the patterns and the amounts of runoff water Calculations show that toxic concentration threshold will be exceeded due to heavy metals when the power plant functions at full load The effects due to ash and waste deposits are classified as low

4 3 Land Ecosystem

Forty-four interactions that could eventually exert an impact on the ecosystem of Punta Morón's land and surroundings were assessed The results are shown in Table 10 and are summarized below

Absorption of high SO_2 concentrations through the ground over short periods is not expected to be high Therefore, the impact from these short periods of exposure is expected to be moderate A low impact is expected in the long run

Vegetation as well as animals, including man, will be severely affected if they are exposed to short periods of high SO_2 concentrations For long periods of exposure, it is expected that the vegetation will present moderate problems while animals will only display mild effects Due to the size of the particulates emitted by Planta Centro, it is estimated that they will exert moderate impacts in the long run on the soil, vegetation, animals and ecological descendants It is recommended, however, that this parameter be studied more thoroughly as existing information is not totally reliable

The impacts produced by emissions of toxic metal particulates, vanadium, and nickel on the soils are considered moderate The impact on the vegetation would be high for vanadium and moderate for nickel Through toxicological information drawn from available scientific literature, it was determined that the impacts on the animals would be from moderate to high for both of these metals

Given Planta Centro's low nitrogen oxide emissions and on the basis of measurements taken during the study period, the impact of nitrogen oxides on the ecosystem on the whole is considered to be mild

The impacts of hydrocarbons emissions on the soil, vegetation, and ecological succession were evaluated in terms of ozone The impact can be moderate on the

Table 10
CAUSE AND-EFFECT MATRIX ON THE LAND ECOLOGY OF PUNTA MORON AND ADJACENT ZONES

	SO2	PARTICLES IN SUSPENSION	PARTICLES DANGEROUS METALS		NITROGEN OXIDE	HYDROCARBONS	OZONE
			V	Ni			
Soils	M / L	L / M	M	M	L / L	–	H
Vegetation	H / M	M / M	H	M	L	–	H
Animals	H / M	M / M	H	M	L	M	H*
Ecological Succession	H / M	M / M	H	L		H	H

	SULPHATES	BODIES OF MECHANICAL WATER	BODIES OF TOXIC WATER	CONSTRUCTION	ACCIDENTS	MAINTENANCE
Soils	H*			H	L	–
Vegetation	H*	H	H	H	L	H
Animals	H	H	H	H	L	–
Ecological Succession	H	H	H	L	–	–

1 / 2

1 Effects due to short exposure periods

2 Effects due to long exposure periods

H: high

M: moderate

L: low

* Qualitative assessment that requires more information

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739

animals of the area, although it is necessary to discriminate between the different groups of hydrocarbons to analyze the effect of each one in particular

Ozone and sulphates, at high concentrations, are converted into degrading or scouring agents for exposed surfaces, in particular deforested The forecasts for the area under study may be higher than the reference standards if the power plant operates at full capacity Therefore, when this occurs, the impact on the soils can be high Likewise, the impact of ozone on plants, animals, and ecological succession could also result in a high impact due to the high concentrations foreseen, in addition to the synergic effect of this element with other pollutants Nevertheless, the evaluation was qualitative and more information is needed to predict actual damage

As a consequence of water being constantly dammed up in the internal pond of Planta Centro, a series of changes have occurred in the vegetation—including a modification of the plant community—causing an impact that can be classified as high Changes in vegetation have led to severe changes in the diversity of bird species that used to live in the pond Because of this, the interaction is also considered as having a high impact on the animal species associated with the internal pond

As for the impacts produced by the accumulation of toxic elements on the pond's aquatic fauna and flora, they would be high for nickel as its concentrations in the water are in the upper toxicity range for this metal All of the other metals considered are not expected to have important impacts

The impact of construction on the soils was high as a result of the deforestation of extensive areas and changes in their topography, nutrient cycles and micro- and macro-organisms were affected by erosion and other factors In general, the impacts on animal varieties are high, as a series of habitats that sheltered and maintained certain animal species of that zone have disappeared In addition, the noise from the machinery during construction and later during operation of the Planta Centro affected and continued to affect animal behavior

As for the ecological succession, the impact was higher, as existing patterns were altered in different habitats, between 1974 and 1975 before Planta Centro and, in 1979, after Planta Centro began to operate

The impact from the use of herbicides and insecticides to maintain green areas will be low if appropriate dosage recommendations are followed Regarding maintenance of vegetation in the strips located under the transmission lines, the impact was high around the internal pond because a large number of trees had to be removed

4.4 Marine Ecology

A total of 25 interactions between construction and operation of the Planta Centro and the marine ecology were assessed (Table 11)

Table 11 MARINE ECOLOGY MATRIX				
CHARACTER ISTICS OF THE MARINE ECOLOGY	CAUSATIVE AGENT			
	CONSTRUCTION	TRANSPORTATION TO THE SHORE OF SEDIMENTS	TEMPERATURE	CURRENTS
Plankton		X	X	
Fish			X	
Sea grass and benthic algae	X	X	X	X
Benthic invertebrates	X	X	X	X

CHARACTER-ISTICS OF THE MARINE ECOLOGY	CAUSATIVE AGENT			
	TOXIC EFFLUENTS	COLLISION	INDUCTION	ACCIDENTS
Plankton	X		X	X
Fish	X	X		X
Sea grass and benthic algae				X
Benthic invertebrates	X	X		X
Mangroves				X

Construction activities affected sea grasses, algae, and benthic invertebrates The dredging of sediments from the sea bottom for the intake channel and the construction of jetties for the intake and discharge systems resulted in the loss of complete communities which occupied those areas Since these activities took place before the initiation of base-line studies, it was not possible to quantify the impact level The large rocks that were used for building the jetties, however, have provided a new habitat for a variety of algae and invertebrates Therefore, the overall effect of construction on the above-mentioned communities was classified as low

Sediments accumulated in the area between the intake and discharge channels due to the construction of the breakwaters for both these channels, which led to the loss of sea grasses and benthic algae The species of algae that colonized the large breakwater rocks of the intake channel compensated for this loss of habitat and biomass Likewise, it is believed that benthic invertebrates that live in this zone can adapt to a certain accumulation of sediments, but if this accumulation were to continue, species composition could be altered due to a change in the size of the sediment's particles All these impacts are considered to be mild for the ecosystem

Based on available data and observations, the global impact of shore sedimentation on all areas was classified as mild except for the area occupied by the Thalassia community to the west of the intake where, qualitatively speaking, the impact can be considered moderate

The water discharged with a difference in temperature estimated at +8 8°C will interact with the following components of the marine ecosystem meroplankton, fish and free-swimming crustaceans, and benthic invertebrates The meroplankton in the area of

741

discharge will be hauled by the thrust of the thermal plume Nevertheless, due to the rapid cooling of discharge water, which will reach a temperature of 2°C over the natural average in less than one minute, its impact on the plankton is classified as low

Open-sea fish and free-swimming crustaceans will avoid the thermal plume area and, therefore, the effect on these components of the marine ecosystem is classified as mild, since the sea bottom area, under the isothermal effects of +3°C, is about 7,000 square meters and, according to base-line data, fish density in this area is very low

Sea currents may interact with the community of sea grasses and benthic algae in the proximity of the discharge channel In addition, construction of the breakwater for the intake channel might have sufficiently disrupted the pattern of sea currents among the benthic algae and grasses to generate currents that will erode these plant communities Since sufficient data are not available for a conclusive evaluation, additional studies will be required For now, however the impact is classified as moderate

Due to the speed of exit from the discharge channel, the thermal plume at first will sink and hit the bottom Therefore, a limited area of the sea bottom, as well as the benthic organisms living there will be affected The amount of fine sediments that will be dragged should not be detrimental to coral reefs, which are located about 800 meters to the northeast of the outlet of the discharge channel Therefore, the overall effect of the currents generated by the speed of the thermal discharge on the benthic community has been classified as mild

Operating and maintaining the power plant entails dumping metallic and non-metallic compounds into the sea through the discharge channel, these compounds are potentially toxic for sea-water organisms The impact caused by different effluents on each one of the communities analyzed is shown in Table 12 It is evident that all the high impacts occur during maintenance operations

It was determined that it was very likely that marine species would collide with the meshing of the intake channels, leading to the death of most specimens On the basis of data from energy power plants in other countries and other studies, Planta Centro will only destroy 5% of the fish eggs and larva that pass through its condensers This impact was considered as moderate for the marine ecosystem of Punta Moron

Finally, the only potentially serious accident that could exert an impact on the marine ecosystem in the proximity of Punta Moron and the mangrove swamps of Tucacas would be an oil spill As expected, the level of this impact would depend on the amount of oil spilled Sea organisms are sensitive to petroleum concentrations as low as 10 micrograms per liter, when they are affected they display behavioral and physiological alterations On certain occasions, mollusks for human consumption can absorb the carcinogenic components of petroleum Therefore, considerable efforts should be made to avoid oil spills in the waters of Punta Moron

Table 12
SUMMARY OF THE LEVELS OF IMPACTS THAT THE DIFFERENT TOXIC EFFLUENTS WOULD CAUSE ON THE MARINE FAUNA IN PUNTA MORON

SUBSTANCE	PLANKTON	FISH	BENTHOS
Cadmium	L	L	L
Chlorine	M	M	M
Chromium	L	L	L
Copper	L/H	L/H	M/H
Iron	M/M	L/H	M/M
Nickel	L/H	L/H	L/M
Zinc	L/H	L/H	L/M
Ammonia	L/H	L/H	L/L
Vanadium	L/H	L/H	L/H
Total solids in suspension	L/H	L/H	L/H
Total dissolved solids	L	L	L
Sulphates	L	L	L
BDO	L	L	L

L Low impact or no impact at all

M Medium impact

H High impact

X/X Impact due to normal operation/impact due to maintenance

5. MITIGATION MEASURES

The adoption of mitigation measures depends on the level or severity of the impact identified These levels are defined as high (H), moderate (M) or low (L), as indicated in Chapter 4

It is also important to point out the fact that the mitigation measures—those recommended and those adopted—are based on assumptions of full-capacity energy generation (2,000 MW)

743

5.1 Atmosphere

5.1 1 Mitigation for Cases of High Short-term Concentrations of SO_2 and Metals To cope with eventual high short-term concentrations of SO_2 and metals (one to three hours), a power plant operation strategy known as Intermittent Control Strategy (ICS) is implemented It involves an adequate supply of low-sulfur fuel (not more than 1 10% by weight) to feed the boilers in case of an episode of high concentration

The procedure consists in not surpassing an average of 1,300 micrograms per cubic meter of SO_2 over a three-hour period, by means of external monitoring of the power plant At full load and under slightly unstable conditions (atmospheric stability, class 1, 2 or 3), with moderate winds ($\leq$ 5 m/sec), episodes of high concentrations during one-to-three-hour periods may occur, with a zone of maximum concentration at ground level at a point between 3 and 7 kilometers southwest and south-southwest from the power plant This can be verified around the month of March, mostly at noon and on clear days It is estimated that these conditions occur 9 6% of the year

The ICS strategy also allows reducing the maximum annual concentration of SO_2 by 10% In addition, since nickel and vanadium levels in the reserve fuel are also low, the particulate concentration of these metals in the atmosphere will also be proportionally reduced over short periods

An alternative mitigating measure, regarding high nickel and vanadium concentrations, consists of injecting magnesium oxide during combustion so as to obtain magnesium vanadate, which is easier to collect than the vanadium pentoxide (V_2O_5) found in the fuel With this technique, it is possible to retain 35 to 40% of the V_2O_5 in the ash as well as an equivalent proportion of other metallic oxides, such as those of nickel

The use of magnesium oxide also has the advantage of reducing the concentrations of sulphur trioxide (SO_3) which is responsible for corrosion problems and highly visible plumes The injection of magnesium additives increases the amount of oxides, sulphates, sulphites, vanadates, and carbonates in the ash

5.1 2 Total Particles in Suspension. To date, due to the low plant factor of Planta Centro, there have been no episodes of high concentrations of particles However, if the level of production is to be increased, cyclone separators will have to be installed in units 3, 4, and 5, with the same efficiency level as those in units 1 and 2, so as to comply with the established standards for this pollutant

Regarding SO_2 reduction measures, u$_s$e of a fuel with a lower sulphur content is also effective for reducing the total concentrations of particles

It was deemed that the emission of particulates during construction was exerting a moderate impact over the short run and a mild one in the long run In order to mitigate these impacts, trucks were used to spray water on the ground cleared of vegetation during the dry season

5.2 Water

5.2.1 Mitigation of Impacts Caused by the Disposal of Toxic Effluents Most discharges stemming from the power plant's operating process do not require mitigation measures The periodic maintenance of the boilers described in section 3 2, however, can exert negative long-term effects on the marine fauna In order to lessen the effect of chemical agents used for cleaning the boilers, the waste-carrying water is taken to a treatment pit, where its pH is adjusted to between 8 and 8 5 so as to induce the precipitation of the heavy metals, coagulation/flocculation and settlement, before being dumped into the sea

5.2.1.1 Anticorrosive Additives Another problem that must be dealt with because of its long-term harmful effects on the marine fauna is the injection of iron sulphate, which is used as an anti-corrosive additive In Planta Centro, Fe_2SO_4 is administered intermittently, in dosages that vary between 0 1 and 0 5 ppm, thus maintaining ferrous ion concentrations at below recommended limits and also protecting the heat exchanger's pipes from marine corrosion

5.2.1.2 Biocides The impact on the marine fauna and flora stemming from concentrations of biocides used for controlling the growth of marine organisms in the heat exchanger's pipes is classified as low Intermittent chlorination produces chlorine concentrations that can endanger marine life in the sea-discharge area Average values do not surpass 10 micrograms per liter at 800 meters from the discharge site, always with the five units operating at full capacity

If studies on marine fauna, however, reveal that biocides exert an important impact on aquatic life, the use of alternative biocides is recommended, such as chlorine dioxide, ozone, bromine-chloride, or else the dechlorination of effluents before they are dumped into the sea All of these alternatives are more expensive than the control method currently used

5 2.1.3 Oil Spills Accidental oil spills into the sea are also possible, either during unloading of the carriers or leaks from the storage tanks or from the drainage channels that eventually lead to the sea These impacts are considered high level and therefore require mitigation measures

Mitigation of these accidents is carried out by means of an Oil Spill Prevention and Countermeasure Control Plan (SPCCP) The plan's two main elements are first, the implementation of measures and procedures for preventing or minimizing spills, and second, a contingency plan in case of an oil spill

It is important to realize that an eventual oil spill not only endangers the local ecosystem, but also the power plant itself since petroleum flowing into the intake channel would cause costly damages to the cooling system The use of these is the most effective method for containing and obstructing the spread of the oil spill The power plant has a floating barrier to protect the intake channel

745

In the case of widespread oil spills, PDVSA's Large Oil Spill Contingency Plans would be triggered PDVSA [1] has the necessary equipment to face large-scale episodes of this type (recovery ships, barriers, absorbers, etc)

In order to deal with oil spills in the power plant's storage yard, there are 9 API separators, each one with a capacity of 54 cubic meters The design of the separators takes into account maximum precipitation characteristics over a 24-hour period during the last 20 years

5 2.1.4 Collision of organisms with the intake channel's meshing The system for preventing the entry of organisms through the intake channel consists of movable meshing and a pit in which the organisms fall into and from which they are evacuated according to need

In order to increase the survival factor for the organisms and reduce the hours needed for verification and cleaning, a pit can be used which drains upwards and thus the organisms can be evacuated to a retention tank and returned into the sea

5 2 1.5 Damming of the waters Modifications in the area's natural drainage at first caused damming up of surface waters, leading to the death of certain plant species that could not withstand the flooding and consequently to the elimination of the associated fauna This stagnation of the waters resulted in the growth of unwanted plant species, thus transforming the original habitat

The first area affected by the damming up of waters was a 33-hectare dry tropical forest area, located to the east of the power plant, as a result of obstruction from the dumping of waste stemming from construction of the power plant, along the old train tracks to Moron The second affected zone was the internal pond at Planta Centro around the mangrove This is an important area for local bird species, and its modification may have affected them substantially

This problem was overcome, however, by building drainage systems to restore the ecosystem's original conditions Nevertheless, some plants were irreparably damaged

In any case, it is essential to implement a lake management program, accompanied by maintenance and cleaning of the drainage channels and the floodgate, since they are easily filled up by sediments and organic matter entrained by the water

5.2.1.6 Other Impacts Two other impacts that affect the physical oceanography are redistribution and transport of sediments and thermal collision, deemed to be moderate and low, respectively, in terms of impact

The intake and discharge channels produced significant changes in the sedimentary structures of the marine zones adjacent to the power plant Since the intake channel is designed for a water flow equivalent to twice the power plant's needs at full capacity, with gradients and a cross-section designed to produce a water speed of 1 meter per

second, the studies carried out after the power plant's construction did not reveal major changes in the distribution of the sediments around the intake channel The construction of breakwaters and drainage channels for runoff has altered the shore's sediment-carrying pattern

The impacts caused by the thermal plume are considered mild and do not require mitigation measures The synergic effect of temperature with concentrations of different toxic substances coming from the power plant, however, can exert broader negative effects on the marine fauna and flora than those foreseen, a monitoring program is therefore necessary

Studies were not conducted to assess the sociocultural impact of Planta Centro's construction and operation on the inhabitants of the Morón area Likewise, epidemiological studies were not conducted to determine the incidence of respiratory diseases linked to atmospheric pollution, nor did any specific studies focus on poisoning from heavy metals

5 3 Land Environment

5 3.1 Mitigation of the effects of runoff and erosion Impacts produced by erosion and runoff were classified as moderate Nevertheless, certain mitigation measures should be adopted, as they could exert a severe impact on the ecosystem

To cope with these impacts, during construction, a detailed runoff and erosion control plan was prepared, it involved a replanting program to ensure a protective strip or buffer zone of vegetation, separating the beach from the area occupied by the power plant and preventing the direct discharge of runoff into the sea The same system is used for mitigating the impact of runoff into the drainage channels

6. MONITORING AND RECENT EVOLUTION OF THE ENVIRONMENTAL SITUATION

The quality of the environment in the Punta Morón area, as a result of Planta Centro, has been influenced by the combination of two factors that have lessened the environmental impacts projected during the assessment phase

a The policy of operating the interconnected power system, which favored hydroelectric generation, especially after the third phase of the Guri hydropower plant was commissioned in 1983 As a result of this policy, between 1984—when the last unit of Planta Centro began to operate—and 1991, the annual utilization factor of this power plant never surpassed 34%, with average monthly loads no higher than 800 MW and instant loads no greater than 1,500 MW

b Planta Centro's own operational policy Throughout the power plant's entire operational lifetime, low-sulfur fuels (from 1 3 to 1 5%) were always used, instead of those originally envisaged with a sulphur content between 2 5 and 2 9% This policy was adopted because this type of fuel was available from the El Palito Refinery and because of its production strategy In addition, since 1990, unit 2 was converted to natural gas

The above-mentioned factors contributed to substantially reducing the originally identified impacts on air and water environments, however, because of the power plant's location in a highly industrialized area and thermoelectric power plant recovery plans—which over the short term will increase the share of thermoelectric generation in overall power generation—constant air and water quality monitoring is required At present, this is not systematically done In addition, the cyclone separators in units 1 and 2 were shut down shortly after they began operating, due to corrosion problems

In 1989, as a result of an initiative by CADAFE, an environmental assessment study was carried out in Planta Centro, it was used to assess the impacts caused by the power plant after 10 years of operating The study consisted of a campaign for measuring SO_2, total particles, and metals These measurements were done on the same sites in which the original measurements were taken in 1978 In addition, plant health was analyzed and the area affected by deforestation was assessed, the results are summarized below

6.1 Atmosphere

6 1 1 Sulphur dioxide The maximum annual average value was registered at the site nearest to the source, the Romulo Gallegos School, with a value of 66 9 micrograms per cubic meter which is quite close to the Venezuelan standard of 80 micrograms per cubic meter This concentration level, although not dangerous, is within a range that would require a systematic monitoring system, including other stations from which it would be possible to monitor other emission sources, such as the refinery In the two other stations, Palma Sola and Alpargaton, the averages were below the standard of 80 micrograms per cubic meter

The simulation conducted with the dispersion models revealed an acceptable accuracy when compared with real data, especially during the second semester of the year The samples taken during the first months of the year—when the worst meteorological conditions for the dispersion of pollutants were observed—displayed differences with the estimated values from the models However, it is important to point out that these simulations were conducted assuming full-capacity operation and the use of fuels with sulphur contents much higher than those actually used, it is therefore feasible that there are other sulfur dioxide emission sources, whose share might be even greater than that of the thermoelectric power plant itself This possibility is logically applicable to other pollutants

6.1 2 Nitrogen Dioxide The results from the measurements showed very low values for this pollutant in the three measuring stations The maximum daily value of 33

748

micrograms per cubic meter was registered at the El Alpargatón School on May 18, and the highest values prevailed in March and June The Venezuelan NO_2 standard establishes a limit of 100 micrograms per cubic meter for 50% of the measurements and 300 micrograms per cubic meter for 5% of the measurements

It is important to point out that the monitoring proposals recommended by the environmental impact study—the installation of measuring devices that would alert the power plant's operators of high concentration episodes—were never implemented because of the low levels of pollutants

6.1 3 Total suspended particulates Concentrations of total suspended particulates comply with national standards The average maximum daily values, of 131 micrograms per cubic meter, were registered at the El Alpargatón School, although a similar value was detected at the Romulo Gallegos School In both measuring stations, all the values over legally permissible levels occur between March and June, analogous to the pattern for SO_2 and NO_2

6.1 4 Metals. Metals in suspended particulates were measured in four sampling sites The metals measured were lead, nickel, vanadium, cadmium, copper, and chromium

The average value of lead obtained over the period 1988-189 was 0 26 microgram per cubic meters, which is under the value of 0 35 microgram per cubic meter obtained in 1978-1979, both values are below the ceiling of 1 5 micrograms per cubic meter

The average value for vanadium obtained in 1988-1989 was 0 072 micrograms per cubic meter, which was higher than the value of 0 0088 micrograms per cubic meter obtained in 1978-1979, although both values are below the 0 1 micrograms per cubic meter recommended in the present Guide in reference g

The average value of nickel obtained in 1988-1989 turned out to be 0 069 micrograms per cubic meter, which was slightly higher than the value of 0 048 micrograms per cubic meter for 1978-1979, although both were far below the 10 micrograms per cubic meter recommended in the present Guide in reference ,g

The average values of cadmium, chromium, and copper were 0 011 micrograms, 0 029 micrograms, 0 1469 micrograms per cubic meter, respectively Compared with their corresponding reference values of 0 1 microgram per cubic meter, it turns out that only the copper concentration is higher

In short, it is recommended that the metal sampling should be included in successive samplings to see their evolution over time

6.2 Land Ecosystem Assessing the environmental impact of Planta Centro's operation on the fauna and flora of the Punta Moron area required aerial photography analysis and field work The main conclusions can be summarized as follows

Flora

No indication of deterioration due to the emissions from the power plant was detected in the vegetation of the zone under study The density of trees per hectare, in the zones where samples were taken in 1979, remained almost unchanged except for some revegetation in some sites

The variety of lichens in the area was also studied with the idea of possibly using them as bio-indicators for pollution Their health condition was not affected by atmospheric pollution

The most important impact stemming from the first 12 years of Planta Centro's operation was undoubtedly the deforestation caused by its construction and laying of the transmission lines These deforested areas are well located, but very conspicuous, as the vegetation was almost totally eliminated The growth of Moron's population has led to severe deforestation on the hillsides southwest of the city

Fauna

The direct deforestation caused by the power plant's construction, without a doubt, constitutes the most important factor in the loss of the local fauna's habitat

Disappearance of the internal pond within the power plant's perimeter is perhaps the most important loss directly stemming from the construction of Planta Centro, in particular for the aquatic birds that used it as a sanctuary and breeding place

Studies to determine its effects on mammals revealed that there was a great similarity with the variety of species found in 1979

The effect of Planta Centro on the mammals in the area of influence cannot be attributed to the atmospheric pollution caused by the SO_2 or particle emissions, but rather to environmental changes due to the deforestation largely stemming from urban growth, agriculture, and the construction of infrastructure

Another important impact resulting from the power plant's operation on the land ecosystem is the disposal of the ashes (bottom ash)

From the start of the operation up to 1987, the ashes that accumulated in the boilers and in the cyclone separators were transported in sealed drums and carried by truck to a permanent solid waste fill established by PDVSA

As of 1987 the recommendation to use magnesium oxide as a fuel additive was adopted in order to reduce the emissions of vanadium and other metal oxides Currently, the ash and slag with high contents of vanadium are sold to a company, which periodically picks them up from the power plant to recover the vanadium, thus earning additional income for Planta Centro

6.3 Water Water monitoring after the power plant began operation has been confined to the marine environment and in particular the area affected by the discharge channel

The last report on the water, prepared in 1992, recorded values of BDO, CDO, and suspended solids that exceeded Venezuelan standards for discharges into the coastal marine environment A high level of organic matter was observed in the waters of the channel, supposedly stemming from the waste water treatment plant It is important to point out, however, that in the specific case of Planta Centro, the standards are not wholly applicable as the plant's effluents consist of sea water used for cooling processes and it has been verified on many occasions that the sea water employed has high values of BDO, CDO, and suspended solids, similar to those found at the exit of the discharge channel

The concentrations of metals, greases, biocides, pH and other parameters comply with the standards set by law

To avoid spills into the sea from boiler cleaning operations, the recommendation was adopted to connect the drainages of units 3, 4, and 5 with the treatment pit of units 1 and 2

For the anti-corrosive treatment, 1 ppm of iron sulphate is injected for each of the water circulation lines, one hour per day Since the plant has always operated at a low load, however, it was generally necessary to inject the additive only to half of the lines and as a consequence the iron sulphate values registered in the discharge channel were very much lower than those originally envisaged for a full-capacity operation The anticorrosive treatment is alternated with dosages of chlorine as a biocide, which is added at a rate of 5 ppm per line, one hour per day, to prevent marine organisms from staying in the condenser tubes

Oil spills

Even though the power plant has its own pier for unloading petroleum derivatives, it has never been used since Planta Centro is fed by an oil pipeline connecting it directly to the El Palito Refinery which supplies all the fuel necessary for its operation Therefore, there have never been any oil spills into the sea If a large oil spill were to occur, the Mutual Help Committee would intervene This committee is comprised of most industries from the Punta Morón area The Venezuelan petroleum industry provides the facilities needed for this type of contingency

Finally, it is important to point out that the collision of marine organisms in the retention nets of the intake channel, especially in March, requires the mechanical removal of large volumes of organisms that die daily and over a period of almost 30 days For this operation, the load level of units has to be reduced

Table 13
Air Quality Standards[a]

Pollutants	Sampling Period	µg/m³	ppm
SO_2	Annual average[b] 24 continuous hours	80 365[c]	0 03 0 14
Particles in Suspension	Annual geometrical average[b] Average 24 continuous hours	75 260[c]	–
Carbon Monoxide	Average 8 continuous hours 1 continuous hour that should not be exceeded	10 000 40 000	9 35
Hydrocarbons (without methane) (expressed in methane)	Average 3 continuous hours	160	0 24
Total oxidants (such as ozone)	Average 1 continuous hour	240	0 12
Nitrogen Dioxide	Annual Average[b]	100	0 05

a) The pollutant concentrations are calculated for conditions of 1 atmosphere and 298°K.
b) Calculated on the basis of continuous 24-hour measurements.
c) 24-hour average which should not be surpassed more than once a year

Table 14
Maximum Limits of Emission for
Fuel-Oil-Fired Thermoelectric Power Plants

Pollutant	mg/m³	Observations
SO_3	4,500	Any power
Solid Particles	250 175 150	Power < 50 MW Power 50-250 MW Power > 250 MW
Capacity	1 in Ringelmann scale unit	Values not above 2 in the Ringelmann scale for periods of 2 min/h
Carbon Monoxide	1,150 ppm	Any industrial installation that uses fuel oil

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752

7. INSTITUTIONAL AND LEGAL ASPECTS

The Ministry for Environmental and Natural Renewable Resources (MARNR) has existed in Venezuela since 1976 It was created with enactment of the Environmental Law that same year, with the general objective of defining an environmental policy and establishing standards for environmental quality to ensure the sustainable exploitation of natural resources

Within this Ministry, the Environmental Management Department and the Environmental Research Department are in charge of environmental pollution studies The first of these departments coordinates the programs for improving environmental quality and deals with environmental conflicts stemming from industrial concentrations The Environmental Research Department principally monitors and measures pollutants, and studies and evaluates standards

As of April 1992, by means of Decree 2,213, the MARNR is empowered to require—according to its own criteria—Environmental Impact Assessments (EIAs) for investment projects (including different forms of electricity generation) Approval of the EIA is part of normal construction concession and authorization procedures The Ministry will request the interested party to present some terms of reference, the general contents of which are found in the above-mentioned decree

To ensure compliance with EIA recommendations, those in charge of the project will be required to set up guarantees from banks or endorsing firms in behalf of the country

When the presentation of an EIA is considered necessary, it must eventually be approved by the MARNR and it will become a document open to public consultation In any case, all of the projects included in the list in Chapter II of Decree 2,213 are bound to fill out a questionnaire, which constitutes an Environmental Impact Statement (EIS)

Other decrees involving electric power plants are Nos 2,211 and 2,216 governing the handling of dangerous wastes and non-dangerous solids, which affect, for example, the disposal of ash with a high metal content, No 2,217 governing noise pollution, No 2,220 governing activities capable of provoking changes in water flows, obstructions, and sedimentation problems, and especially Nos 2,224 and 2,225 establishing the standards for the liquids dumped into bodies of water and atmospheric pollution, respectively

To ensure compliance with the above-mentioned decrees, the Criminal Environmental Law was passed in January 1992 It classifies premeditated or accidental actions, which deteriorate natural resources, human health and comfort, as crimes punishable by law with sanctions that range from imprisonment to carrying out community work The includes Article 44, which establishes sanctions with prison sentences from 6 months to 2 years and fines from 300 to 600 days of minimum wages for violations of air quality standards

753

a Continuous Noise Equivalent (Leq)

Diurnal Period	Nocturnal Period
6 30 to 21 30	21 30 to 6 29
75 dBA	65 dBA

b Noise level that cannot be exceeded for more than 10% of measurement time

Diurnal Period	Nocturnal Period
75 dBA	65 dBA

8. MAIN CONCLUSIONS AND RECOMMENDATIONS

From what has been said, it can be concluded that—owing to Planta Centro's low utilization factor to date and the use of low-sulfur fuels—the environmental impacts in the area of influence, after 10 years of operation, can generally be classified as mild or low-moderate, if construction-related impacts are also taken into account

The most important general conclusion is that the location of the power plant in one of Venezuela's largest industrial centers, in the midst of highly polluting industries, along with the pollution produced by intense automobile traffic on the highways and roads running through the area, requires a complete inventory of all pollution sources This study would help to identify the major sources of emission for specific pollutants (SO_2, NO_2, CO, metals, etc) and consequently would foster the adoption of more specific mitigation measures for determined establishments

Another essential aspect, as a result of the above-mentioned general conclusion and the high levels of some of the pollutants in the area of Punta Moron, is the need to establish a monitoring network that includes at least the systematic measurement of sulphur dioxide, total particulates, and lead, as concentrations of these parameters are already reaching values requiring observation This type of network can only be implemented in cooperation with all the industries in the area—including CADAFE—coordinated by the Ministry for the Environment and Natural Renewable Resources and with the participation of other public entities such as the Ministry of Health and the Ministry of Transportation and Communications An arrangement of this nature would allow sharing the costs that such a network implies

At the same time, it is recommended that the Ministry of Health carry out an epidemiological study on the health of the area's inhabitants, focusing on industrial pollution, it can initially be limited to analyzing the pollution stemming from elements whose concentrations are above legally permissible standards This recommendation is particularly important for lead as its concentrations in sediments and interior waters were hazardous even in the measurements taken more than 10 years ago

754

Air quality standards and emissions of fixed sources directly affecting the operation of a thermoelectric plant are presented in Tables 13 and 14 These standards must be complied with by existing installations, projects that are being implemented, and those in the planning phase

Air standards are divided into 1) air quality and 2) emission limits Air quality refers to concentrations that can only be exceeded during an established fraction of time, whereas the limit on emissions is the maximum concentration permissible from the stack or flue, aimed at protecting human health These standards also establish the analytical methods for sample taking

The standards for discharge into the marine-coastal environment establish that these discharges can occur in areas where there is a rapid mixing of the liquid spilled into the receptor body Maximum limits and range of variation of the main physical-chemical parameters linked to thermoelectric production in marine-coastal environments are summarized in Table 15 In addition, standards establish that the temperature of discharge into the marine environment of liquid effluents with a different temperature than the receptor body in the area of the thermal mixture, should not be greater than 3°C compared to that of the receptor body

The levels of environmental noise in Type V zones—which corresponds to the area where Planta Centro is located—should respect the values shown below, until the United States standards of 85 dBA for industrial environments is adopted

Table 15
Maximum Limits and Ranges for the most Common Thermoelectric Generation Pollutants of the Marine-Coastal Environment

Physical-Chemical Parameter	Maximum Limit or Range
Mineral oils and hydrocarbons	20 mg/l
Total copper	1 0 mg/l
Total chromium	2 0 mg/l
BDO_5	60 mg/l
CDO	600 mg/l
Total nickel	2 0 mg/l
pH	6-9
Total lead	0 5 mg/l
Solids in suspension	60 mg/l
Zinc	10 mg/l
Chlorate Biocides	0 05 mg/l

755

The specific recommendations for Planta Centro are closely linked with the general conclusions and recommendations, especially if the power plant's utilization factor is increased Although, during its more than 10 years of operation, the power plant has not been Punto Morón's main source of atmospheric pollution and the probable conversion of its five units to burn natural gas would preclude the need to adopt additional mitigating measures, CADAFE must nevertheless promote an inventory of pollution sources and the establishment of a monitoring network

If the decision is made to continue generating electricity with fuel oil, it would be advisable to repair the cyclone separators of units 1 and 2, in addition to installing this equipment, with specifications of no less than 60%, in units 3, 4, and 5

Although the results of the dispersion models provide a good estimate of the concentrations of pollutants, in the worst of cases since full-capacity data (2,000 MW) were used, it is advisable to conduct a simulation with real generation data so as to better calibrate the models In addition, future simulations must also include other sources of pollution The results of models used to simulate the emission and transport of pollutants from only one source of emission, in an area where there are other sources of contamination that are probably more important than Planta Centro, are of little use

Likewise it is recommended to continue the systematic monitoring of water quality in the area of the discharge channel for the parameters specified by the MARNR, at least twice a year

Finally, the provisions of Venezuelan environmental legislation and the requirements of international financial organizations justify the creation of an environmental unit within the organizational structure of CADAFE The immediate task of this unit would be to conduct environmental assessments in existing installations and to prepare the terms of reference for the environmental impact assessments of new projects

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LATIN AMERICAN
ENERGY ORGANIZATION

INTER-AMERICAN
DEVELOPMENT BANK

GUIDE FOR ASSESSING THE ENVIRONMENTAL IMPACT OF HYDROPOWER STATIONS

Quito, Ecuador
November 1994

758

Hydropower Station

759

ANNEX 2

CASE STUDY 1

SOCIO-ENVIRONMENTAL MEASURES AT THE ITAIPU HYDROPOWER STATION

CONTENTS

		Page
1.	INTRODUCTION	89
2.	HISTORY	89
3.	THE ITAIPU DAM AND THE PARANA RIVER BASIN	91
3 1	Location	92
3 2	Hydrology	92
3 3	Climatology	92
3 4	Geology	92
3 5	Edaphology	92
4.	GENERAL DESCRIPTION OF THE PROJECT	93
4 1	The Dam	93
4 2	Hydropower Station	93
4 3	Reservoir	93
5.	PREVENTIVE AND CORRECTIVE ENVIRONMENTAL ACTIONS	95
5 1	Archeological and Historical Surveys	95
5 2	Inventory of Forest Resources	95
5 3	Water Environment Impact Assessment	96
5 4	Research on Fish Population	99
5 5	Wildlife Inventory	99
5 6	Wildlife Rescue	99
5 7	Climate Studies	100
5 8	Expropriation and Resettlement of Population	100
5 9	Regional Insertion (Relocation of Infrastructure in the Reservoir's Area)	101
6.	SOCIO-ENVIRONMENTAL CONSOLIDATION ACTIONS	102
6 1	Conservation Principles	102
6 2	Limnology	103
6 3	Climate Variations	104
6 4	Consolidation of the Buffer-Strip	104
6 5	Establishment of Conservation Units	106

761

6 6 Repopulation of Wildlife 106
6 7 Fishing Management 107
6 8 Development of Netting Tanks 108
6 9 Studies on Downstream Fishing Channels for Egg-laying 110
6 10 Rescue of Fish Caught in Turbines 111
6 11 Health and Sanitation 112
6 12 Sanitary Education 112
6 13 Epidemiological Surveillance 113
6 14 Management of Microbasins 113
6 15 Ecomuseum 116
6 16 Natural History Museum 117
6 17 Environmental Study and Research Center 118
6 18 Iguaçu Environmental Education Center (CEAI) 118

7 REGIONAL DEVELOPMENT 119
7 1 Council for the Development of Waterfront Municipalities 120
7 2 Enjoyment of Environmental Benefits 120

8. INSTITUTIONAL COORDINATION OF THE ENVIRONMENTAL PROGRAMS 124

9 ITAIPU'S SOCIO-ENVIRONMENTAL POLICY 125

10 REFERENCES 127

762

1. INTRODUCTION

The Itaipú Hydroelectric Complex has a strong inter-relationship with its surroundings and with regional integration in terms of environment and development

The synergism between the two is governed by the region's integrated planning and the environmental actions implemented in projects, programs, and research, in the reservoir's entire area.

Environmental measures involve 21 different fields of action (Figure 1), all of them interrelated, aimed at mitigating the reservoir's detrimental effects and preserving its multiple uses, promoting self-sustainable development, and improving the quality of life of the populations living along its banks

2. HISTORY

On June 22, 1966, the Iguaçu Act was signed by Brazil and Paraguay This was the beginning, 25 years ago, of a series of decisions that would eventually culminate in the commissioning of the Itaipu Hydropower Station

As a result of the agreement, the Joint Brazilian-Paraguayan Technical Commission was created, in 1973 it issued Special Report No 4 "Acknowledgment of the Project's Ecological Effects " This report presented the main probable environmental effects stemming from the proposed alternative

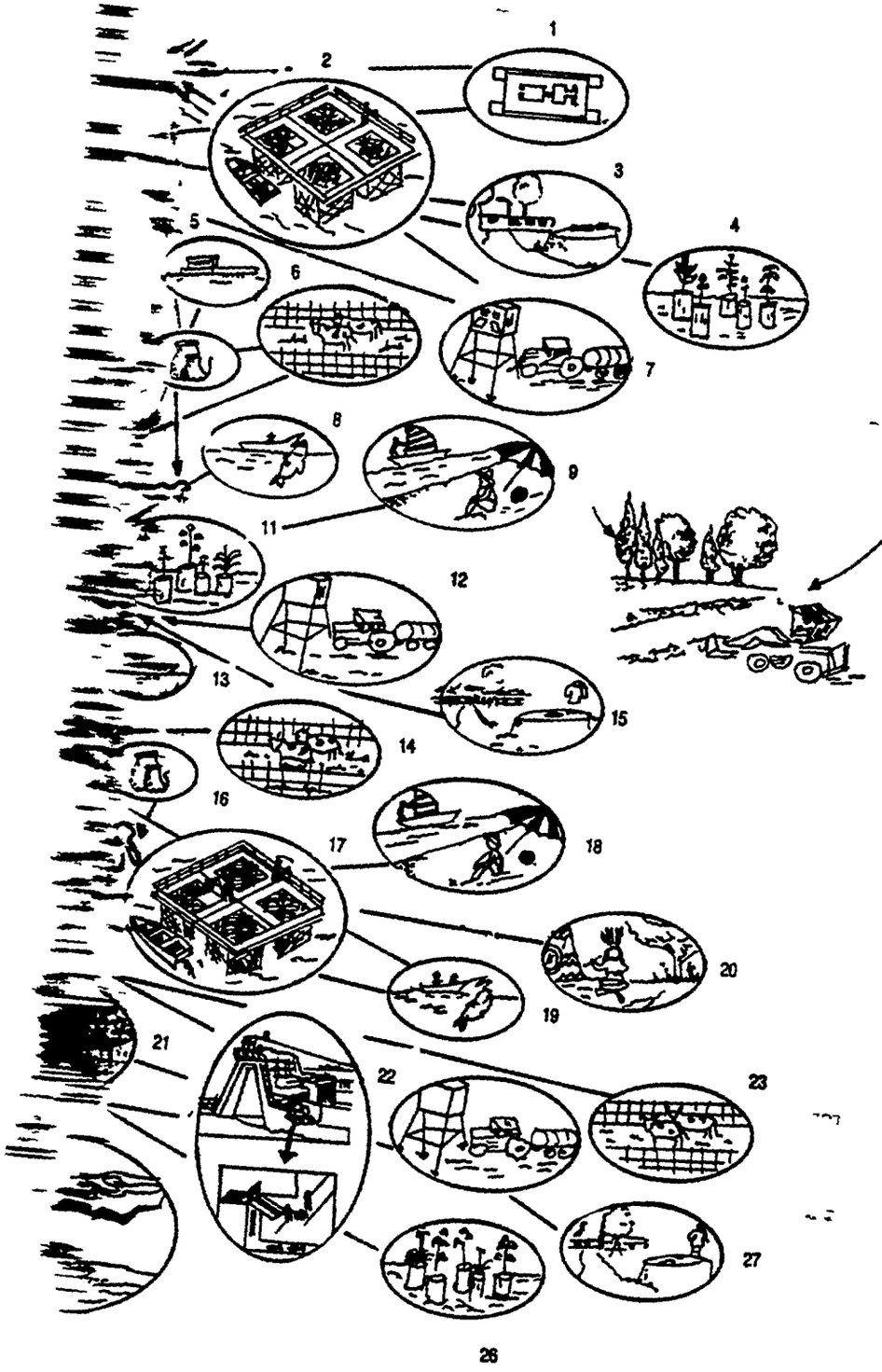
In May 1974, the Binational Itaipú Entity was formed Its internal regulations established that environmental preservation as well as preventive, corrective and conservational measures of the natural resources and sanitary conditions of the area of hydroelectric exploitation and reservoir came under the jurisdiction of the Coordination Board

In order to meet these responsibilities a specific structure was created to prepare and implement the Basic Environmental Conservation Plan, approved by the Executive Board in 1975

This Plan classified the environmental actions into three interrelated fields physical, biotic and social The latter includes cultural aspects such as archaeology, history and its multiple possible uses, and the prevention of endemic diseases and sanitation Questions regarding expropriations and resettlement were handled by the Legal Department of the Itaipu Entity

The Basic Plan, as established by this document was substituted in 1982 by the Executive Plan for the Reservoir's Area This Plan, in addition to directives, recommended the Socio-Environmental Policy of the Entity and the Procedural Standards for environmental issues

Figure 1
ENVIRONMENTAL MEASURES



764

3. ITAIPU DAM AND PARANA RIVER BASIN

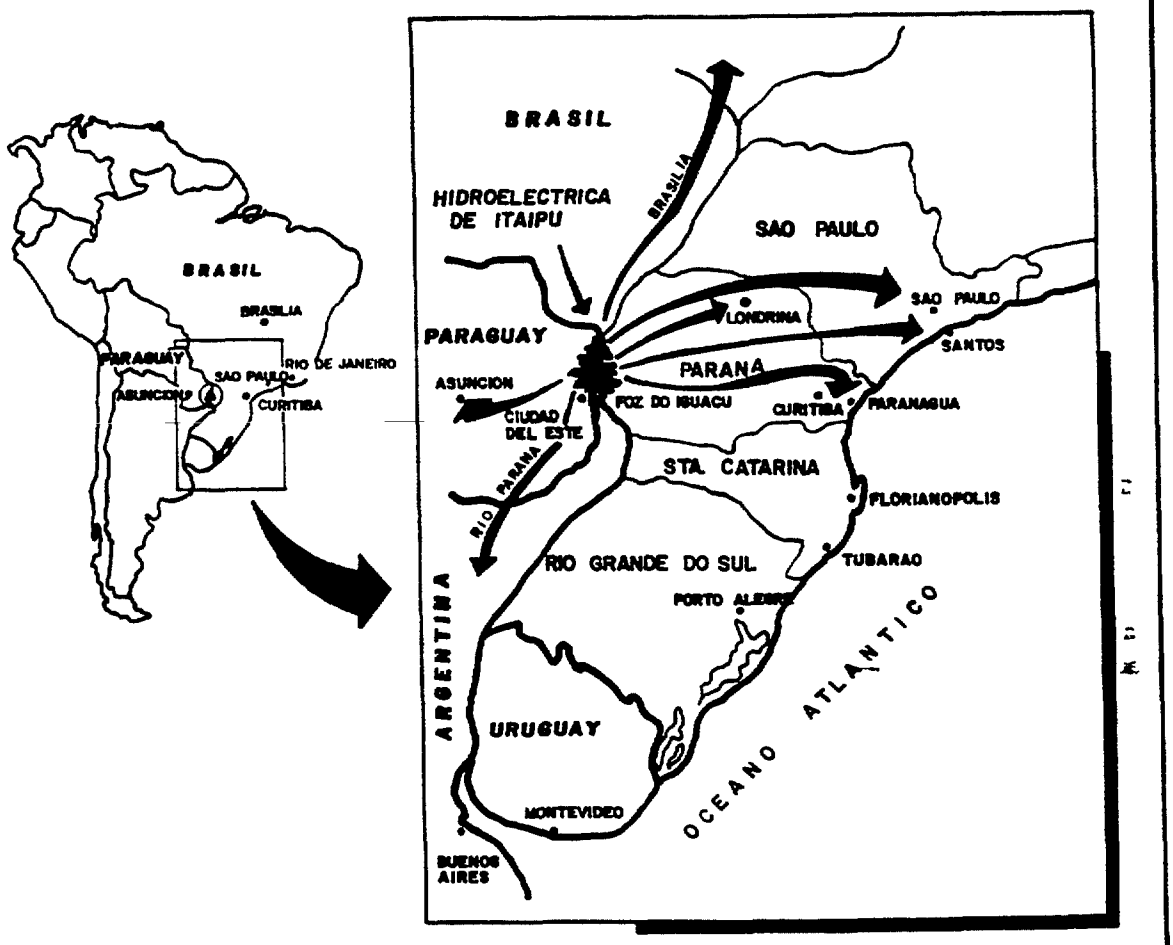
3.1 Location

The Itaipú hydropower station takes advantage of the hydroelectric potential of the stretch of the Paraná River adjacent to the Brazil and Paraguay Likewise, the sovereignty of this natural resource is shared by the two countries

The dam is located 23 5 kilometers from the mouth of the Iguaçu River, which in turn constitutes the border between Brazil and Argentina.

Therefore, Itaipú is the most downstream of all the other hydropower stations, either already existing or under construction, in the Brazilian part of the Paraná River Basin (Figure 2)

Figure 2
Location of Itaipu



765

3.2 Hydrology

The drainage area of the Paraná River to the Itaipu Dam amounts to 820,000 square kilometers, which accounts for nearly 25% of the River Plate Basin

In the area of Itaipú, the Paraná River runs for an approximate distance of 151 kilometers in a general north-south direction The original channel had a deep gully, dug in basalt, which started at the head of the Reservoir at "Salto Grande de Sete Quedas," or Guaíra Waterfall

The 120-meter difference in level has two stretches with different slopes The first 40 kilometers, where the waterfalls were located, were the steepest, they are now under water Afterwards there are various slopes rendering any navigation between the former localities of Port of Adela, Port of Mendes and Guaíra impracticable Over the rest of the stretch, a progressive broadening of the banks can be observed

In the area of the dam, the Paraná River has a depth that fluctuates around 45 meters during normal flow, with a width of nearly 400 meters The flattest area of this place is formed by a rocky bank in the middle of the river called Itaipu Island which, during periods of less water discharge, rose above the water level and was about 250 meters long and 80 meters wide The annual average discharge recorded in Guaíra over a 62-year period is 9,319 cubic meters per second The river's flow fluctuates between a minimum of 2,852 (October 1945) and a maximum of 39,790 cubic meters per second (June 15, 1983)

3.3 Climatology

The climate of the Project's region is subtropical, with an annual average temperature of 21°C, ranging from a maximum of 40°C to a minimum of -4°C Average annual rainfall is on the order of 1,650 mm, with average evaporation on the order of 1,000 mm

3 4 Geology

The regional geology is typical of the general highlands that occupy a large part of the southwestern and southern Brazil and eastern Paraguay It is characterized by its uniformity, with thick basaltic horizontal discharges uniformly intersected by layers of cracks It is also known as the "Paraná Trap"

On the site of the project, the slopes of the channel on above the river's water level are very steep nearly 70 meters high Afterwards, the topography on both banks becomes soft and undulating until it reaches a plateau at an elevation of 250 meters above sea level

3.5 Edaphology

In the Guaíra region where the head of the Reservoir is located, in the Parana River there is the southern tip of the Caiúa sandstones The types of soil found farther south are quite different, the percentage of clay is under 15%, which makes them highly susceptible to erosion The soils found around and under the Reservoir, called red latosols or structured pink soil, have on the order of 80% clay and are more resistent to entrainment

4. GENERAL DESCRIPTION OF THE PROJECT

4.1 The Dam

The main concrete dam of the Itaipú Project is of the gravity-spillway variety and has a length of 1,064 meters, its maximum elevation above sea level is 225 meter, with a maximum height of 196 meters measured from the lowest point in its foundation For its construction, 6 5 million cubic meters of concrete were used

The lateral dam on the right side, with 986 meters, is of the buttress type and connects the spillway with the main dam From the spillway, an land embankment of 875 meters, reaches the natural ground

The powerhouse is connected to the natural terrain on the left bank by means of a rockfill dam followed by another dam which is earth-filled and is 4,278 meters long

4.2 Hydropower Station

The station's power rating is 12,600 megawatts, obtained through 18 generators at a ratio of 9,333 kilowatts per flooded square kilometer The water intake is located in the upper part of the main dam. Each generator has a Francis-type turbine with a power rating of 715 megawatts Nominal discharge per turbine is 700 cubic meters per second with an average nominal fall of 112 9 meters

The power generated is transmitted through 8 aerial lines of 525 kV (four of 50 Hz, which feed a substation on the right bank, and four others of 60 Hz, on the left bank) The interconnection to the Brazilian transmission system occurs in alternate current with a voltage of 765 kV

The Paraguay substation supplies the system of that country while allowing any surplus power to be used to feed the Brazilian system, by continous-current transmission

4.3 Reservoir

At the normal maximum water level (elevation of 200 meters), the Reservoir has a gross capacity of 29 billion cubic meters Of this volume, 38 6% corresponds to stationary waters below the adduction level The tree-covered surface has 1,350 square kilometers, of which 43% are on Paraguayan territory and 57% in Brazilian (Figure 3)

The proportion of flooded land to installed capacity is 0 107 square kilometer per megawatt, and the coefficient for affected population is 3 64 inhabitants per megawatt At the foot of the dam, the depth reaches 170 meters in the old channel Average depth is of 21 meters

To fill the water basin, which began in October 1982, ten days were required for the water level to reach the spillway's crest line

767

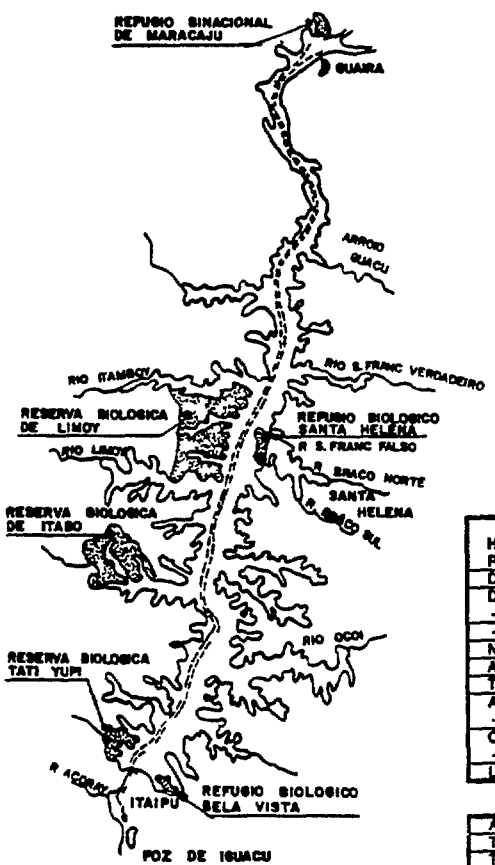
Around the Reservoir, a tree-covered environmental buffer-strip was established, with an average width of 285 meters on both banks This strip includes a legally established 100-meter area for permanent preservation, in compliance with Brazilian and Paraguayan forest-protection laws There is also a 5-meter buffer-strip, measured vertically from the reservoir's level to a height of 225 meters above sea level

The buffer-strip covers about 63,376 hectares and extends along a a dividing line of 2,919 kilometers

With the formation of the lake, 66 islands emerged, of which 44 are located on the Brazilian side The largest of these was for the Santa Helena Biological Refuge All of these islands are for permanent preservation and therefore no human settlement has been authorized

Six special units were created with the purpose of ensuring biodiversity of both flora and fauna two Biological Reserves of Limoy and Itavó, three Biological Refuges of Santa Helena, Bela Vista, and Tati Yupi, and the Maracajú Binational Park These units amount to a total of 32,367 hectares

Figure 3
Map of the Reservoir



Hydraulic basin of the Parana River above the axis	820,111 Km2
Difference in levels	20 m.
Depth of reservoir	
-AVERAGE	215 m.
-MAXIMUM	170 m.
Nominal capacity	12,600 MV
Average discharge	9,070 m3/S
Total surface area of reservoir	1,459 Km2
Area of the Reservoir	
-LONGITUDINAL AXIS	151 Km
Operational level of Reservoir	
-ABOVE SEA LEVEL	220 m.
Large upstream dams	44

Area of polygonal cover	2,919 Km
Total area of the buffer-strip	63,376 ha.
Total width of buffer-strip	285 m
Biological Reserves and Refuges	6
Total Area	32,367 ha
Total number of islands	66
Left bank	44

768

5. PREVENTIVE AND CORRECTIVE ENVIRONMENTAL ACTIONS (prior to the formation of the reservoir)

The section on ecological effects of the 1973 feasibility studies had the good foresight of pointing out those areas where possibilities of environmental problems might exist The Entity's Basic Environmental Conservation Plan recommended that the scope of these studies be broadened so as to verify the effective risks of negative impacts and how to solve them

There ensued, therefore, a period of inventories, surveys and studies in the social, biological and physical areas.

5 1 Archeological and Historical Surveys

Archaeological surveys were started in 1975 Over a seven-year period, 237 sites were discovered and 171,449 various relics and remains were retrieved, classified into phases and traditions, and dated, the oldest ones dating back to the year 6,100 B C

The difficult reconstruction of the culture of these people was based on artifacts and instruments used by these groups in their daily living Among the material found, there are many arrowheads, pieces of polished quartz, used as male ornaments called "tembetás", and glass beads bearing witness to contacts between the native population and the Europeans

Research continued on the banks of the Paraná River, in Guaíra, where the discovery of a large number of new sites justified the creation of an environmental preservation area where a primitive village could be constructed At the same time, historians were contracted to research the history of modern settlement in this region, based on documents and local observations This work led to the publication of a book entitled "Mensus, Obrageros e Colonos", which narrates the evolution of the western part of Parana from the time of white slavery for exploiting maté-herbs by foreign developers, until the beginning of present settlements

5.2 Inventory of Forest Resources

Forest inventory on the Brazilian bank, conducted by the School of Forests of the Federal University of Parana, identified the native plant varieties From these, it recommended those species that were most suitable for reforesting the islands, the buffer-strip, and the refuges, by accumulating, enriching, and recovering the affected sectors

The flora surveys identified the natural regeneration trends among the wild fruit species New techniques for planting were recommended

One of the inventory's proposals was to concentrate trees in those areas where there was a major risk of damage, such as the dividing border with Brazil where a tree wall was planted

The tree wall was begun in 1979, using nearly one million saplings from 49 different species in an area occupied by annual agricultural crops, in lands that had not yet been expropriated Even now this tree wall continues to have a pleasing visual effect and is effective for the work being carried out in the buffer-strip

Even before the reservoir's creation, sites that later on became islands were reforested This reduced costs due to the ease of access at that time

The inventory of woods and forests measured the potential timber that would be flooded In Brazil, this area did not exceed 8% The former owners were authorized to extract this timber over time, which meant there was only a small amount of trees at the time the reservoir was filled

In this regard, the inventory carried out on the right bank confirmed a large vegetation potential There were doubts as to the effects of these forests on the quality of the reservoir's waters Studies measured the potential of the oxygen demand provoked by different quantities of plant material It was concluded that mayor eutrophication problems should not be expected

Then, as a measure to favor future multipurpose use of the water, it was decided that there would be a sectoral logging of 80 hectares of these forest lands, up to 20 meters wide As foreseen, remaining plant wastes did not damage the quality of the water

Until 1991 more than 140,000 saplings were planted and 90,000 bushes in the 5,134 residences of the three housing complexes on the Brazilian side On the Paraguayan side, there are seven housing complexes with a current total of 2,124 residences where more than 200,000 tree saplings of different species were used

To supplement the foresting programs, three large nurseries were set up in Brazil and one in Paraguay

5.3 Water Environment Impact Assessment

In order to evaluate the probable impact that the transformation of the Paraná River's flow would have on the water environment, in 1973 the Itaipú Entity initiated studies during the project's feasiblity stage, starting with a monitoring of sedimentation in the area under study

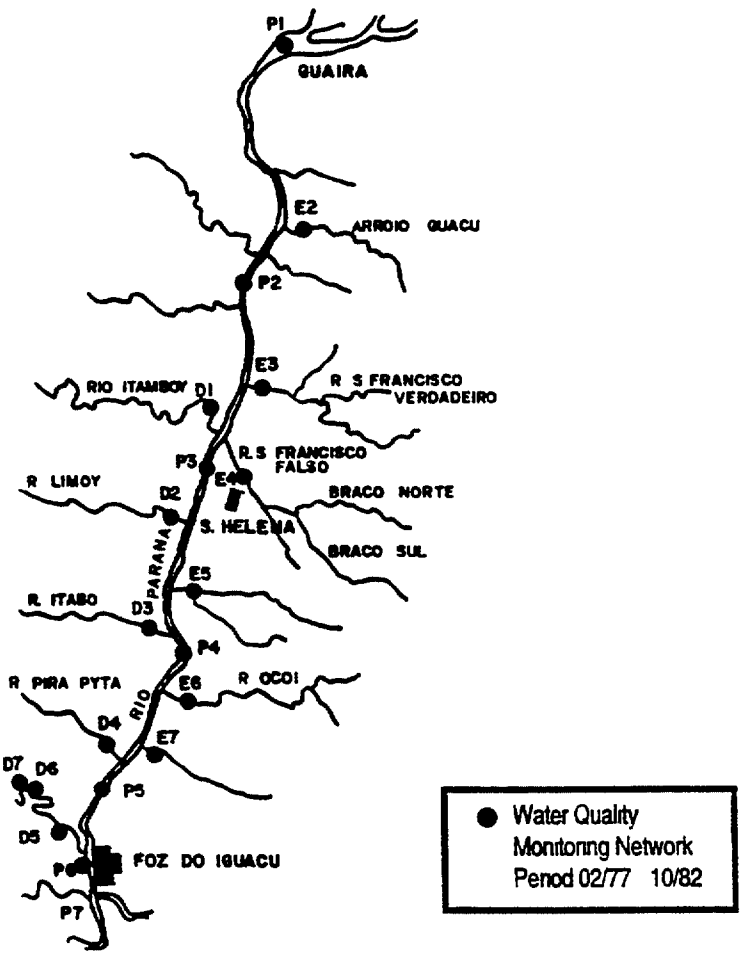
Starting in 1977, with the hiring of an Environmental Consortium (COMAM), consisting of CETESB (Sao Paulo), ARH now referred to as IAP (Curitiba) and HIDROCONSULT (Asuncion), the following programs were initiated limnology (physical-chemical, hydrobiological, bacteriological, eutrophication, pesticide and metal waste assessments), sedimentation, and ichthyology The stretch of the Paraná River and its tributaries within the Itaipú Project area were also monitored

Likewise, at the close of the contract with the COMAM, studies continued to be conducted by means of agreements and independent contracts with those or other institutions, enabling a follow-up of any eventual alterations that the new ecosystem might undergo

The water quality assessment of the Paraná River began with a monitoring of 20 sampling sites (Figure 4) where almost 60 parameters were measured on a monthly basis

These limnological studies are still being carried out, obviously with various adjustments in terms of frequency, methodology and location of the sampling sites for physical-chemical, biological, heavy metal, and agro-toxic parameters in water, bottom sediments, and fish

Figure 4
Water Quality



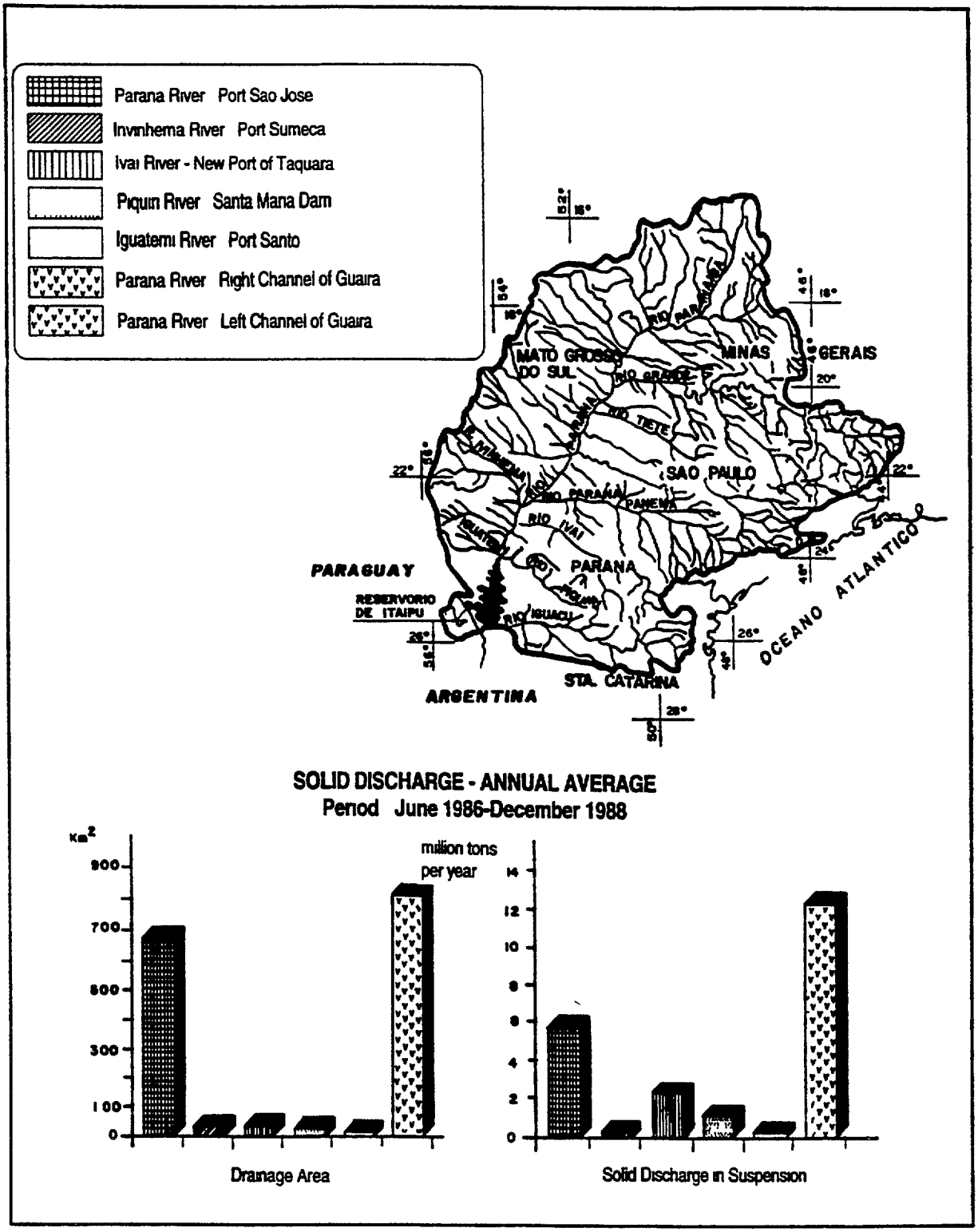
This limnological information provides a highly valuable historical series as a result of the transformation of the river into a reservoir

Regarding the sedimentology (1972-1974), the Paraná River Studies Group calculated that the amount of sediments carried was 27 million tons per year From 1977 to 1979, the COMAM conducted sediment-measuring studies and estimated that they amounted to 12 million tons per year Once the reservoir had already been created, in 1986-1989 the Environmental Geology and Engineering firm (GEA) calculated that sediments amounted to 14 million tons (Figure 5)

In all of the studies carried out, sediment concentrations were determined outside the rainy season Therefore keeping in mind that 70% of the sediments are carried during high rainfall periods and the major differences in the results a correct prognosis as to the reservoir's silting time would be difficult to make Nevertheless, on the basis of the consultancy work of Hans Albert Einstein and James A Harder, and adjusting the value of 27 million to 45 million tons per year due to the nonlinearity of the concentration function x liquid discharge and other unknowns, silting time, at a height of 197 meters above sea level, would be 340 years

771

Figure 5
Parana River Basin



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5.4 Research on Fish Population

Ichthyology research—using all types of fishing equipment—determined the variety of fishes existing in the ecosystem's different water environments

Among these, the areas upstream and downstream from the Iguaçu Falls and its tributaries in the region of direct influence should be highlighted Of these, 117 species were exclusive to the Paraná River, of which 60 were only found downstream from the falls and 13 upstream, with 44 varieties common to both stretches of the river In the tributaries, there were 12 fish species

A great alteration was expected in the existing fish community when the reservoir was created However, species like the "dourado" or "surubim", and others of commercial importance, did not disappear from the lake

5.5 Wildlife Inventory

Another project identified the wildlife on the land that would be flooded This work had greater emphasis in Paraguay, where the adjacent woods sheltered a greater number of animals

Thus, observations and work began before cutting down the remaining woods, facilitating the capture of more than 2,000 land animals over a two-year period Armadillos, deers, along with other animals, were captured and taken to the Alvorada Temporary Biological Refuge

The observations in Brazil and the inventory in Paraguay helped determine the number of people, the type of equipment, and the amount of material needed for the subsequent rescue operation

The participation of the Itaipu Entity in other rescue campaigns carried out in Foz do Areia, Santiago Falls, and Agua Vermelha was crucial in the training provided for handling the rescued animals

Training in using tranquilizers, containment, veterinary attention, and other procedures for handling the wildlife was provided to the teams in the Alvorada Temporary Refuge and later on in the Bela Vista Biological Refuge The Alvorada Refuge was created in an area of residual forests, in a land that was being opened up when it was decided that Itaipú would be flooded This area was expropriated before the others, which facilitated its settlement Six months prior to the beginning of the flooding, the animals and equipment were transferred to the Bela Vista Refuge

5.6 Wildlife Rescue

The Mymba Kuera Operation used a total of 33 teams with 11 operational centers from where the boats would depart each dawn returning later with the animals

In Brazil, the vehicles took the animals to the Bela Vista Biological Refuge for selection and eventually veterinary care In Paraguay, the destination of these animals were the reserves closest to the rescue points

773

There were 36,450 animals from 54 species rescued on both sides—a relatively small number in view of the reservoir's dimensions This was probably due to the previous deforestations and the chances given to the animals to relocate on their own on the banks Of the animals that were rescued, the majority lived in trees There were 4,760 snakes of the Bothropus and Crotalus genus captured, as well as "jararacas" and rattlesnakes, they were all sent to the Butantá Institute in Sao Paulo The rest of the animals were released in biological refuges and reserves where, due to the previous human settlement, there was little existing fauna.

Operation Mymba Kuera mobilized a total of 800 people, 31 vehicles, 30 motor boats, and 1 helicopter, in addition to 250 working hours per person and 20,740 liters of fuel There were no accidents

5 7 Climate Studies

Even in this phase, a series of meteorological data was analyzed in order to characterize regional microclimate patterns and its generating factors and to detect the variations taking place as a result of the reservoir's creation

5.8 Expropriation and Resettlement of Population

Likewise, during the stage preceding the reservoir's formation, measures were taken to resettle the inhabitants and works carried out to maintain the road infrastructure, supply electricity, and ensure communication between the communities and land-holdings that would remain isolated because of the reservoir

This work was intensified between 1975 and 1981 The processes involving inventories, evaluations, legal support for ownership regulations, negotiations, follow-up on the gradual departure of expropriated persons, and all other related work were successfully carried out

In Brazil, 6,900 rural properties and 1,600 urban ones were expropriated, involving around 40,000 people The 684 tenant families and 40 rural outposts were relocated Two communities—a religious community with 40 families (199 persons) and an indigenous community of 19 families—were relocated

Subsequent investigations confirmed that these expropriated Brazilians resettled in accordance with current migratory fluxes toward Paraná (86%), Mato Grosso (8 89 %) and Santa Catarina (1 16%) (Figure 6) The rest migrated to other states The relocation process required 136 buses and 219 trucks

In Paraguay, there were 1,324 expropriations For different reasons, ranging from missing documents to disagreements regarding compensations, only 16 cases in Brazil were taken to court and 28 in Paraguay

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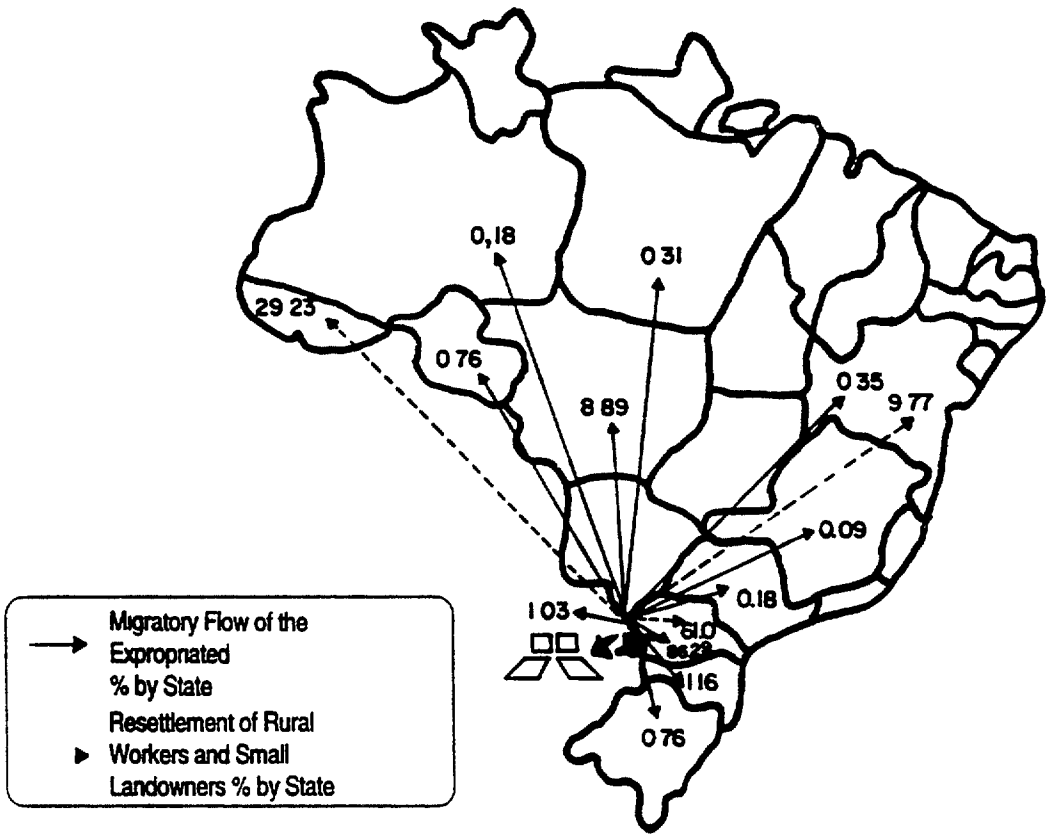
Figure 6
Migratory Flow of Expropriated Persons - Percentage by State



5 9 Regional Insertion (Relocation of Infrastructure in the Reservoir's Area)

The infrastructure established in the area of the future reservoir was designed to solve the expected cases of isolation In order to have a notion of the scope of the problem, suffice it to say that 40 new bridges were built, the largest was of pre-stressed concrete with an extension of over 500 meters The total length of all the bridges built amounted to 1,264 meters

To re-establish interrupted connections and improve transportation conditions in the affected region, the Itaipu Entity opened and graded 231 kilometers of roads, put gravel on another 930 kilometers, and paved an addition 77 kilometers with asphalt The Entity also constructed the port facilities for the traffic between Guaira and Guaira Falls, where the customs buildings was built

Other tasks involved the transfer and remodeling of schools, the exhumation of tombs to cemeteries away from the affected area, the reconstruction of churches and recreational areas, the relocation of telephone and electric power lines, etc This work was necessary to assist the municipalities that were not prepared to receive the large numbers of inhabitants being resettled over a short period of time

775

In addition, other works were carried out in the reservoir's area of direct influence The Special Program for Western Paraná (PRODOPAR) provided the financing for these tasks in Brazil This program was conceived to implement a set of projects aimed at coping with the Project's impact on the region, avoiding the social problems and structural distortions that had already been observed in other similar undertakings, and promoting regional development

This Program was implemented between 1975 and 1982, many projects were carried out, generating expectations for other projects that could not be implemented because of the progressive reduction of available resources

Likewise, the Government of Paraguay allocated resources to deal with similar problems on the right bank, alongside those that the Binational Entity had laid aside for this type of actions

6. SOCIO-ENVIRONMENTAL CONSOLIDATION ACTIONS (prior to the formation of the reservoir)

In the early hours of October 13, 1982 the gates of the by-pass channel structure were opened, closing off the course of the Paraná River It took less than two weeks for the water to rise from 100 meters to 205 81 meters above sea level, the water remain stable at this level until June 1984, at which time the reservoir was filled and reached the operating level of 219 60 meters above sea level Thus, the phase of effective impacts concluded

6 1 Conservation Principles

In order to comply with what had been agreed upon in the Executive Plan for the Reservoir Area, several socio-environmental projects were implemented, with the following conservational guidelines

a To coordinate alternative uses so as to ensure the permanent and wide range of uses of natural resources, especially water, so that no single use hampers the development of others, as a whole

b To consider social interests, so that the largest number of users can take advantage of the benefits stemming from the reservoir on a permanent basis

c To protect and maintain essential ecological processes, identified in the trophic chains of bank and lake environments that are part of the living system that man depends on

d To preserve nature, with its entire genetic variety, by protecting significant samples of original environments or by recreating environments adequately re-arranged and protected

On the basis of the above-mentioned criteria, consolidation measures involved two converging approaches the first was ecological, aimed at supporting the establishment of the new environment; and the second was economic, linked to the implementation of alternative uses compatible with the primary function of generating hydroelectricity in the reservoir and geared to extending benefits to adjacent communities

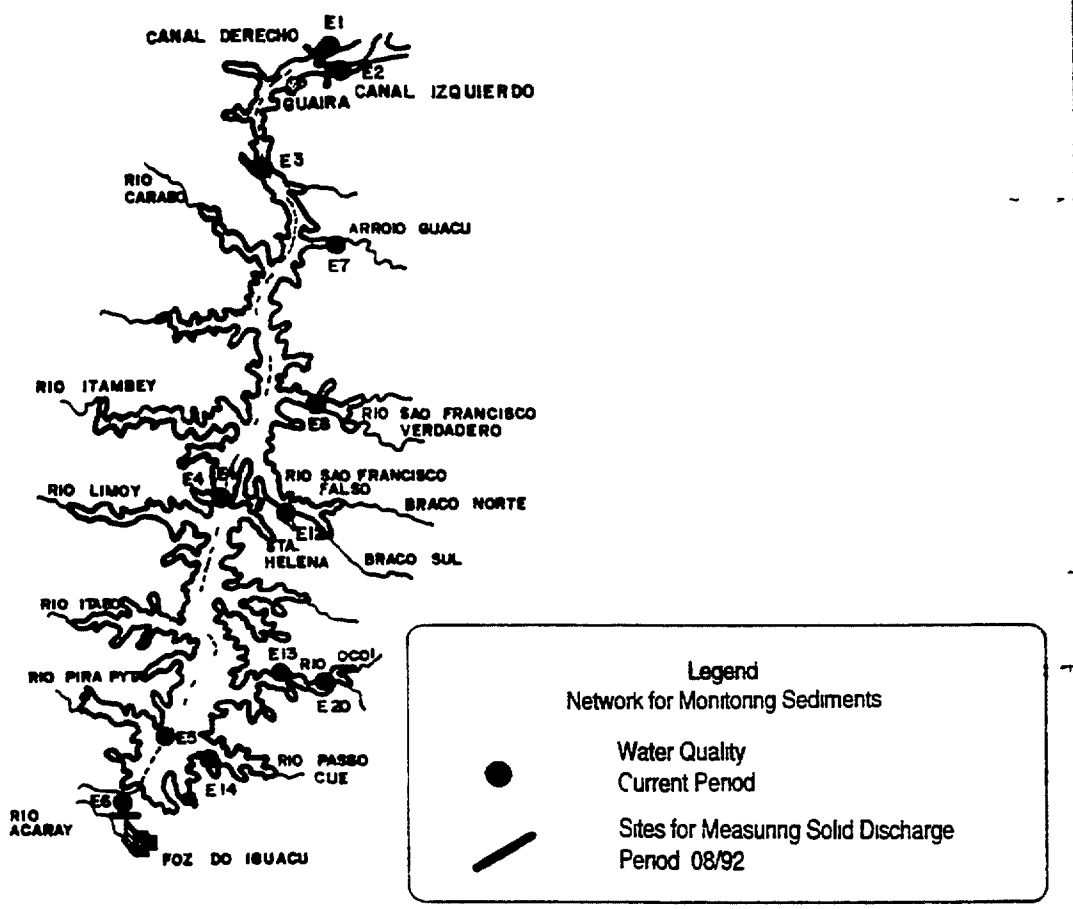
776

6.2 Limnology

This monitoring includes studying the impact provoked by the reservoir on the water environment, evaluating the behavior of the quality of incoming water, the dammed water of the reservoir, and outflowing water, and characterizing the causes, effects and consequences of the alterations suffered, keeping in mind water life, multiple uses, and electricity generation These studies are carried out by monitoring the physical-chemical and biological parameters as well as those for heavy metals and agrotoxics in the water, bottom sediment and fish, all of which are inputted into a large data bank These data provide a back-up for the Itaipu Entity and the two governments, for the national and international community, in view of the considerable scientific subsidies that are needed for this area of engineering They have been converted into a highly valuable historical bank of data of interest to both the electric power sector and environmental sciences

On the basis of the evaluation of all the parameters analyzed over these years, it can be asserted that the waters of the Itaipu Reservoir are within the tolerance limits for water life and multiple uses (Figure 7)

Figure 7
Monitoring of Sediments and Water Quality



6.3 Climate Variations

The Institute for Environmental Sanitation of the Pontifical Catholic University of Paraná (ISAM/PUC) carried out interpretive studies of the data generated by Itaipú's meteorological stations, taking into consideration the four years prior to the formation of the reservoir and comparing this data with the ensuing nine years It arrived at the following conclusion

A small, statistically negligible rise in temperature, relative air humidity, and wind, limited to the municipalities adjacent to the reservoir, was observed (see Table 1)

Table 1 Climate Variation

	1979/1982	1982/1991
Mean air temperature	21 00°C	21 50°C
Minimum mean air temperature	16 30°C	16 60°C
Relative air humidity	76 0 %	77 0 %
Thermal amplitude	13 5°C	11 10°C
Winds	Calm	Breeze

In 1983, a sudden drop in thermal amplitude was recorded, after the Reservoir had reached its maximum level, this shift stabilized the following month and has maintained the same level until now

6 4 Consolidation of the Buffer-Strip

Good water conditions and erosion control of the agricultural areas on the banks will be achieved by means of a buffer-strip (Figure 8) On the Paraguayan side, the banks have generally kept their native flora On the Brazilian side, a program for restoring the woods is being implemented Since the forest around the lake provides sustenance for wildlife, it must have the subtropical rainfall characteristics of the original woods Because of this, preferably native varieties indicated in the above-mentioned forest inventories are being planted

The restocking nurseries produce 112 native species, of which 45 are wild fruit trees Besides these, there are more than 16 other fruit-bearing varieties that are not native

To date, in the Brazilian area, which has an area of 28,000 hectares, 14 0 million saplings have been planted

The reforesting should have started when the Reservoir was formed However, economic reasons did not permit this project to start until two years later Once started it was done through the agroforestry system with the participation of hundreds of landowners on the banks of the reservoir

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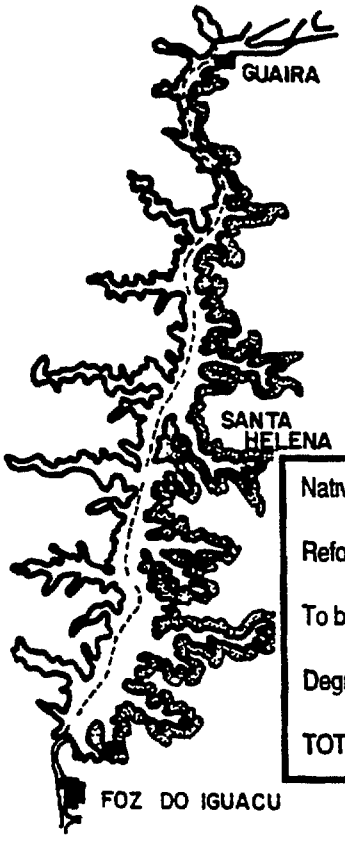
Figure 8
Buffer-Strip



Native Plants/Natural Regeneration	9,230 hectares = 34%
Reforested Areas	14,780 hectares = 54%
To be reforested	2,970 hectares = 11%
Degraded areas	155 hectares = 1%
TOTAL	27,135 hectares = 100%

The curtain formed by the planted forested clearly defined the dividing lines and made it easier for the neighbors of Itaipu to cultivate in the buffer-strip after the forests were planted By means of a Commitment Agreement, those interested received a concession to reforest the buffer-strip in areas of 3 meters by 5 meters between the saplings Nearly 1,500 farmers cultivated strips of corn and yucca, without any toxic materials, until the time when the shadows cast by the trees started interfering with the farming

Almost four years later, it became impossible to farm this land and grow crops, all attempts to do so were abandoned In this manner Itaipu managed to plant 8 million trees, free of charge, while allowing the participants to obtain financial benefits

Relatively few did not fulfill the agreement by not reforesting, or after doing it, cutting down the trees to prepare for a new harvest In view of the positive results obtained, these few cases did not invalidate the program

779

Among the subjective achievements of the program, was the advantage of having ensured the good will of most farmers regarding the buffer-strip This good will is important for the area's preservation, especially in view of the relative frequency of field and forest fires in this region

Starting in 1985, planting was intensified through hired reforesters Using the entity's resources, the unforested areas and the plantings that had previously failed as well as those areas where fires had destroyed trees, became the target of reforestation, leading to the planting of more than 4 1 million saplings

These works as well as supervision of the Band are being continuously monitored by 10 teams, involving 18 public officials, most of whom are forestry or agricultural experts, as well as the Entity's physical safety team, consisting of 15 agents

In response to the future need for more dense forests in the future, there are currently 19 joint experiments with EMBRAPA in order to study the development of 86 native Brazilian forest species

6.5 Establishment of Conservation Units

Six locations were destined for conservation units so as to preserve the natural heritage of the areas affected by the lake through environmental conservation, research and education As was previously mentioned, there are two biological reserves, Limoy and Itavó in Paraguay, with 15,702 hectares and 13,807 hectares, respectively, three Biological Refuges, Bela Vista with 1,780 hectares, Santa Helena with 2,245 hectares, both in Brazil, and Tati Yupi with 2,269 hectares on the other bank, and the Maracaju Binational Park which has 1,356 hectares Each unit is treated differently depending on the alterations caused by man during the period of its creation

The Santa Helena Refuge had forest remains of no more than five hectares surrounding a swamp All of the rest consisted of agricultural lands which produced up to three harvests a year The area was reforested and is now being enhanced The fauna of this Refuge is varied and abundant, even though it is still being acclimatized, as the forest has not yet reached full maturity

The Bela Vista Refuge had forest wastes, without any wood of commercial value The Tati Yupi Refuge as well as the Itavó and Limoy Reserves had an excellent forest cover, when they were created The Maracajú Binational Park is in the process of being planted

These conservation units are showing signs of complete regeneration, consolidating the recovery efforts carried out there, which has been confirmed by the return of wildlife The appearance of typical swamp animals using the buffer-strip and the Itaipú refuges as migratory corridors should be emphasized

6 6 Repopulation of Wildlife

The return of fauna is confirmed in Brazil through wildlife inventory and biology programs, the first focusing on mammals and another one on birds Investigations have already identified 273 bird species and 68 mammal species on the Paraguayan bank The species of most interest for conservation management to be adopted in the buffer-strip and the Brazilian refuges have been identified by these inventories

Although suitable conditions exist because of the forest development on the banks of the lake, incentives must be granted to ensure wildlife resettlement For this task a zoo was established on the Paraguayan side, which has been working with various jungle species with success, notably the "cachorro vinagre" (*Speoticus venaticus*), a rare and endangered animal On the Brazilian side the Itaipu Wildlife Breeding Place was established, and it is recognized by the IBAMA as adequate for carrying out biological and reproductive studies on native animals for their introduction back into nature

After four years, the results of the breeding place are encouraging At present, there are 371 animals belonging to 55 species, and it was possible to reproduce, among others, a special deer (*Mazama rufina*), in danger of extinction in Brazil Other cases of reproduction have occurred with the tapir, "queizada", "cateto", and the "papagaio principe-negro" (black-prince parrot) Various animals have already been placed in the Refuge, among them the "tucano de bico-verde" (green-billed toucan)

These results testify to the efficiency of the management In this way, the objective of ensuring land biodiversity is ensured as well as water diversity, as will been seen below

6 7 Fishing Management

The change in the course of the Paraná River also implied a change in its lotic waters (fluvial) and lentic waters (lake) with direct effects on water life, affecting the composition and structure of the fish communities in the region

The fish survey carried out before the formation of the Reservoir reveals the existence of 114 species, with 102 of them downstream from the falls and 52 upstream

The fish caught after the dam was built (November 1983 to December 1991) revealed the presence of 172 species, of which 83 were registered around the Reservoir, 64 above the falls and 72 in the area of influence

An analysis of aquatic life includes the biology of the dominant species, the difference in the composition of present populations with the ones that existed beforehand, the tendencies and the potential for future adaptations, and techniques and restrictions for fishing species for commercial purposes Areas were identified for egg-laying, hatcheries, reproduction cycles, nutritional dynamics, stock of fishes and certain periods when limits on the number of fish captured should be imposed, all with the view to guide the management decisions for this resource

A census of the fishermen and their socioeconomic conditions were included Necessary environmental instructions began, going over new techniques, approaching inconvenient methods and restrictions as to fishing in the Reservoir The studies of fish biology have subsidized the preparation of specific legislation

With the increase in primary production, after the formation of the Reservoir, foraging species proliferated, benefitting the development of many varieties of commercial interest Thus, the expected increase in fishing production was proven, estimated at 1,730 tons per year, and the ichthyological diversity was maintained (Figure 9)

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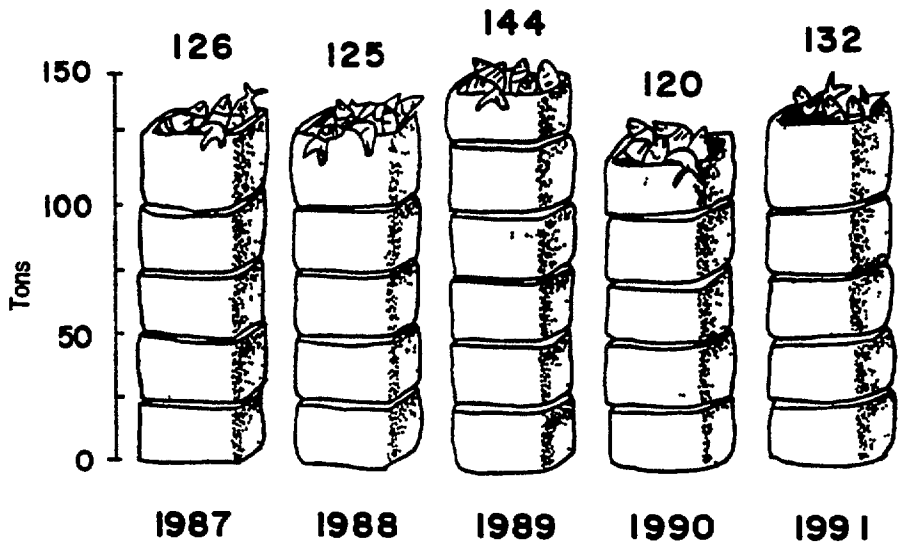
Figure 9
Fishing Production at the Itaipu Reservoir



It was observed that the tributaries were highly important in reproductory migration (Figure 10) The trophic conditions of the reservoir helped to shelter and develop young samples, which assumed the characteristics of the "place of feeding" of the school of the species

The Itaipu Aquaculture Station was recently built (end of 1988) in order to research the artificial reproduction of native species and their development and support the fishing economy through intensive breeding methods

The first results obtained in this Station were eggs laid by the "Pacu" (*Piaractus mesopotamicus*), by the "Curimba" (*Prochilodus scrofa*), by the "Pintado" or "Surubim" (*Pseudoplatistoma corruscans*), by the "Jundiá" (*Rhandia quelen*) and by the "Dourado" (*Salminus maxillosus*)

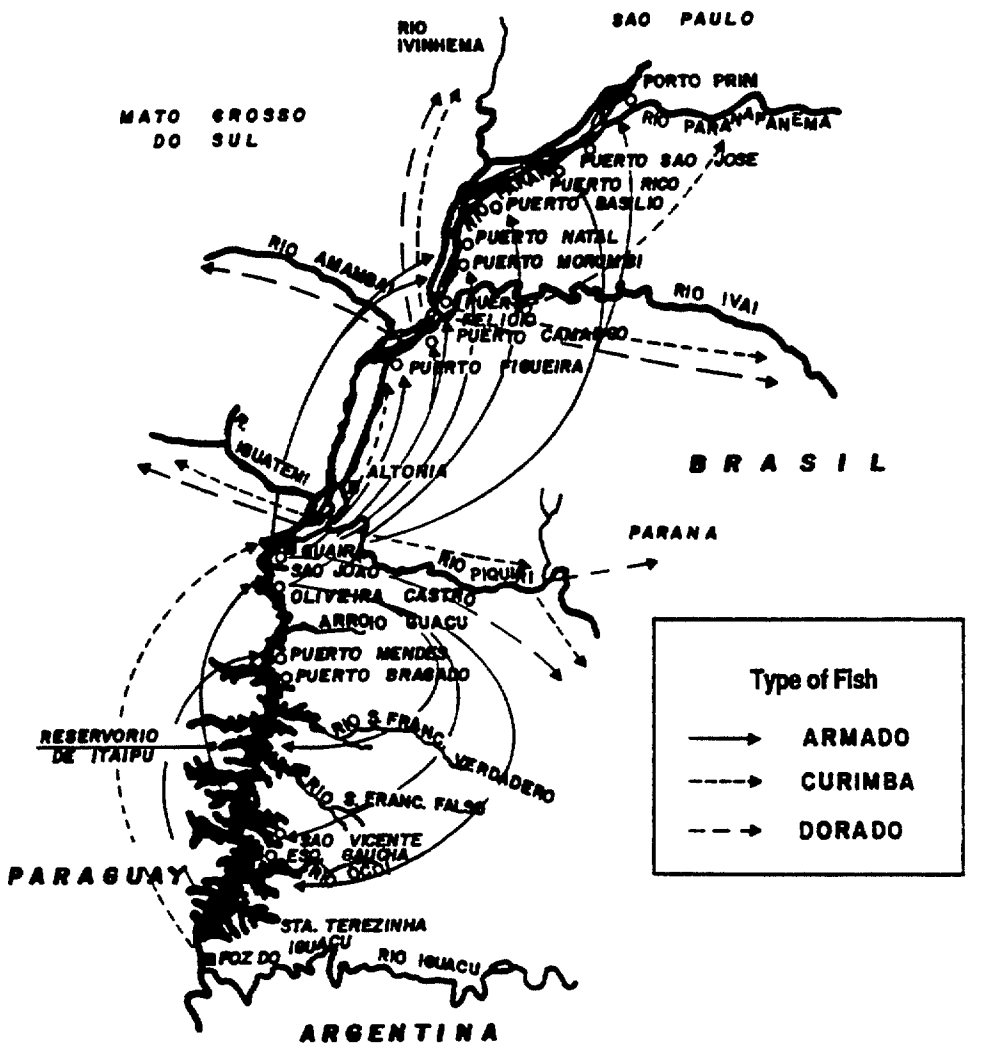
6 8 Development of Netting Tanks

The development of systems for intensive fish farming, through floating structures, referred to as netting tanks, can increase the reservoir's fishing capacity, accelerate the time for fishing the cultivated fish through feeding technology developed in Itaipu, for various native species studied

Notable results were obtained with the "Pacu" (*Piaractus mesopotamicus*), "Piracanjuba" (*Byrcon orbignyanus*) and the "Dourado" (*Salminus maxillosus*), and more recently with the "Curimba" (*Prochilodus scrofa*) and the "Armado" (*Pterodoras granulosus*)

782

Figure 10
Migration of Fish in Itaipu



The netting tanks (Figure 11), even though dependent on some resources for their establishment, allow for intensive breeding, with their own low-cost inputs and techniques that lead to a substantial return

The trophic state of the waters, the reservoir's progressive stabilization, the application of techniques, the selection of species, and the use of nutrients have converted this resource into a highly interesting activity in Itaipu This equipment certainly is applicable to other reservoirs, with the necessary adjustments

To give an idea of the scope of this activity, if in Itaipu only three hectares of netting tanks were established, it would be possible to increase the gain obtained through fishing, currently estimated at US$3 65 million, to US$16 89 million per year

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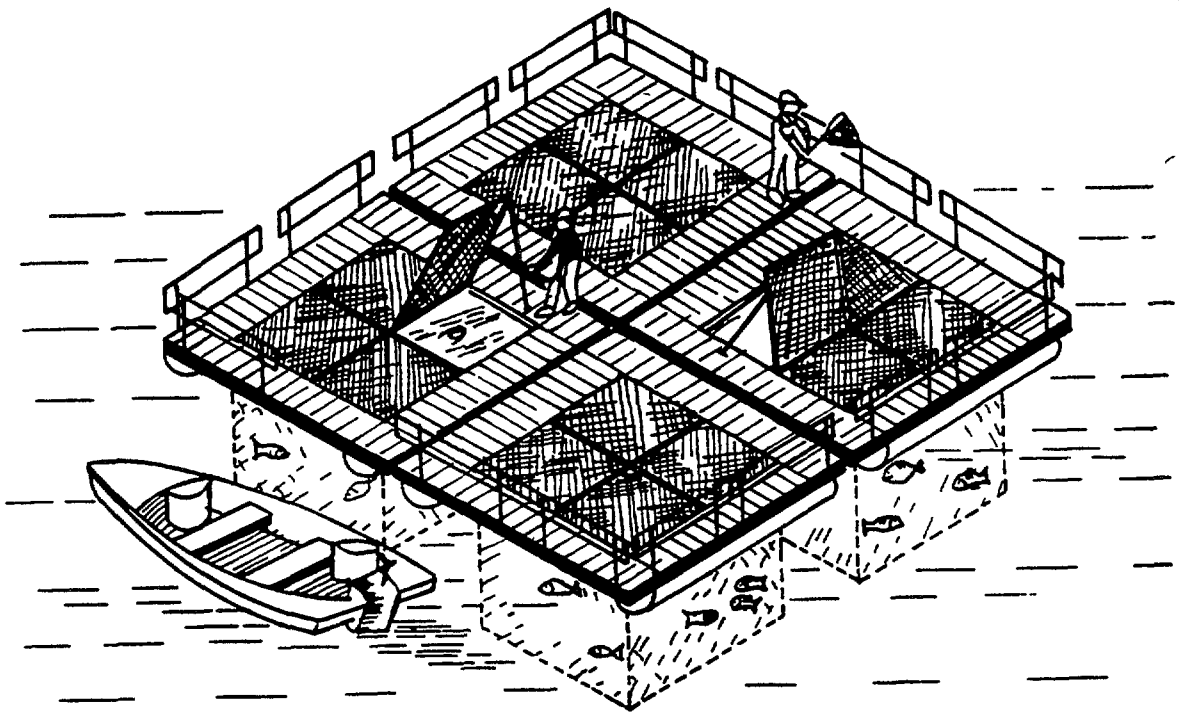
Figure 11
Netting Tanks



6.9 Studies on Downstream Fishing. Channels for Egg-laying

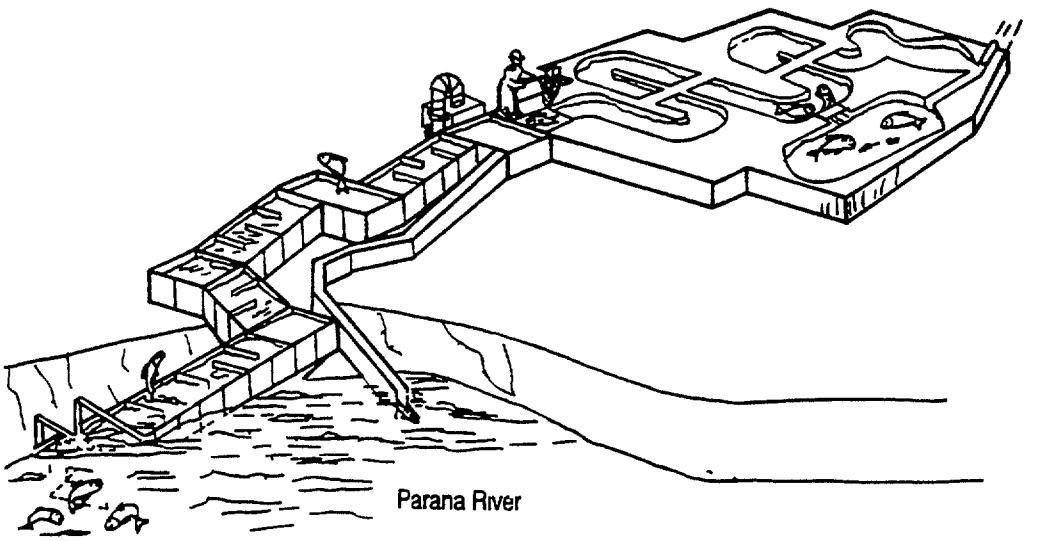
The impact on the downstream fish community is considerable When the spillway is open, the extreme oxygenation affects the life of the eggs and the larvaes resulting from reproduction that has occurred near the dam which is an unsurmountable obstacle for upstream migrations

When the spillway is closed and all the volume of water is being used for generating electricity—which still does not occur for a sufficiently long period of time to analyze downstream effects, the turbined waters taken from a mean depth of 34 meters, may display low levels of dissolved oxygen, provoked by the thermal and chemical stratification observed in some months of the year This can be equally dangerous to reproduction, as has already been seen in other dams

To minimize the impact in this downstream stretch of the dam, the Itaipú Binational Entity has been studying alternatives for recovering this area's fish population Because of the topographical conditions of the dam's height and financial reasons, surveys were carried out to build a fish migration channel for fish The developed project is composed of a group of structures (Figure 12) (ladders, channel, and side lake), which, by attracting the migratory schools, will minimize the environmental impact on "reophilic" species, thus promoting the increase of fishing production downstream from the dam The first stage of the already initiated project consists of an experimental model for the collection of technical and scientific data aimed at definitely establishing the egg-laying channel This stage already demonstrated significant data with the increase in the different species of fish

784

Figure 12
Migratory Channel for Egg-Laying of Fish



6.10 Rescue of Fish Caught in Turbines

In 1987, the rescue operation was started for fish caught in turbines in the waters retained in the ducts of the hydropower station Until 1991, 68 such operations where carried out, with a total of 24,995 fish captured (Table 2) These are released in the reservoir or downstream Depending on the species, they are measured, weighed and marked, for studies as to migratory routes and periods The rescue operations for fish caught in turbines is activated each time that the machines are shut down for maintenance

Table 2. Rescue Operation for Fish in Turbines

Year	Number of Operations	Number of Fish
1987	4	2,500
1988	21	3,580
1989	15	13,571
1990	14	2,231
1991	14	3,113
TOTAL	**68**	**24,995**

185

6.11 Health and Sanitation

Similar to the physical-biological aspects, analyses were also carried out on socioeconomic and cultural aspects The areas that demanded the most efforts in the environmental area were those related to epidemiology and sanitation, control of agrotoxic effects, erosion control and environmental education

The sanitation program involves pest control services (insects and rats) in the housing complexes of the Entity and in the hydropower station, follow-up on the quality of drinking water supplied to dwellers, and, in the area of the reservoir, technical and educational assistance to dozens of small communities and schools

Immunopreventable disease control was intensified so that the number of cases declined or remained stable at acceptable levels, despite the significant rise in population at Foz de Iguaçu

In 1975, on the Paraguayan bank, an agreement between the Itaipú Binational Entity and the Ministry of Public Health and Social Welfare was signed in order to undertake the Epidemiological Surveillance Program

6.12 Sanitary Education

With the new environment, programs and projects were started to improve the quality of living through the recovery of household fountains and wells for collective use, adequate handling of sources of household pollution, and cleaning and disinfecting the above-mentioned springs of water through analytical, physical, chemical or bacteriological control

In the entire area of the municipalities adjacent to the reservoir, a household water evaluation program is being carried out Technical-scientific studies to date reveal high levels of bacteriological and chemical contamination (83 and 32%, respectively) in the water samples of surface wells, mines and some artesian wells The area covered by the study includes rural schools, properties and microcommunities

Poor water quality stems largely from the lack of protection for the springs, as well as the proximity to polluted sources such as septic tanks, garbage dumps, manure heaps, etc

Itaipú, with local municipalities, has been carrying out improvements by rebuilding wells and transforming them into "Model Wells"

Wells and water reservoirs are being cleaned and disinfected, as well as monitored by means of analyses During the recovery of springs, intense work in sanitary education has also been carried out, involving students, teachers, and the community as a whole It is worth noting that this program has triggered the so-called multiplier effect in the community, which usually leads to the adoption of the sanitation system by individuals, public municipal agencies, rural schools, and cooperatives

To date, 32 wells have been recovered in schools, for the benefit of 7,651 persons

786

6 13 Epidemiological Surveillance

As a complement to these actions, the support given to the health agencies has led to permanent epidemiological surveillance, with entomological research including the search for the aedes aegypti (yellow fever), anopheles (malaria), and phlebotomus sandfly (leishmaniasis) and the snails of the Biomphalaria genus (schistosomiasis) as well as the evaluation of the density of the vectors for endemic diseases in the region

The projects being carried out as a result of the 1971 Sanitation Agreement between Brazil and Paraguay on Health in the tripartite border, have been followed up by the Itaipú Entity Recently, the Epidemiological Surveillance Program, with the health agencies, involved the community to create municipal cholera-prevention committees, which endeavored to identify the existing risk factors in all of the reservoir's areas of influence, in addition to alerting the population about the transmission, prevention, and treatment of the disease

6 14 Management of Microbasins

This area focuses on fighting against water pollution (reservoir and tributaries), as well as natural sedimentation and the degradation of green areas, to ensure the survival of the flora and fauna and promote the multiple use of the reservoir's sources of earnings

Preventive, corrective, and surveillance measures are being adopted by means of technical orientation and operation applications

These activities are promoted by the Technical Cooperation Agreement signed between the local municipalities and the Itaipu Entity and based on the Protocol of Intentions of 1991 It involves the neighboring communities, local government agencies, and state institutions for environmental defense

The area focused on in the 12 municipalities to date amounts to 35,0000 hectares, benefitting 7,300 properties (Figure 13)

Management of the micro-basins involves

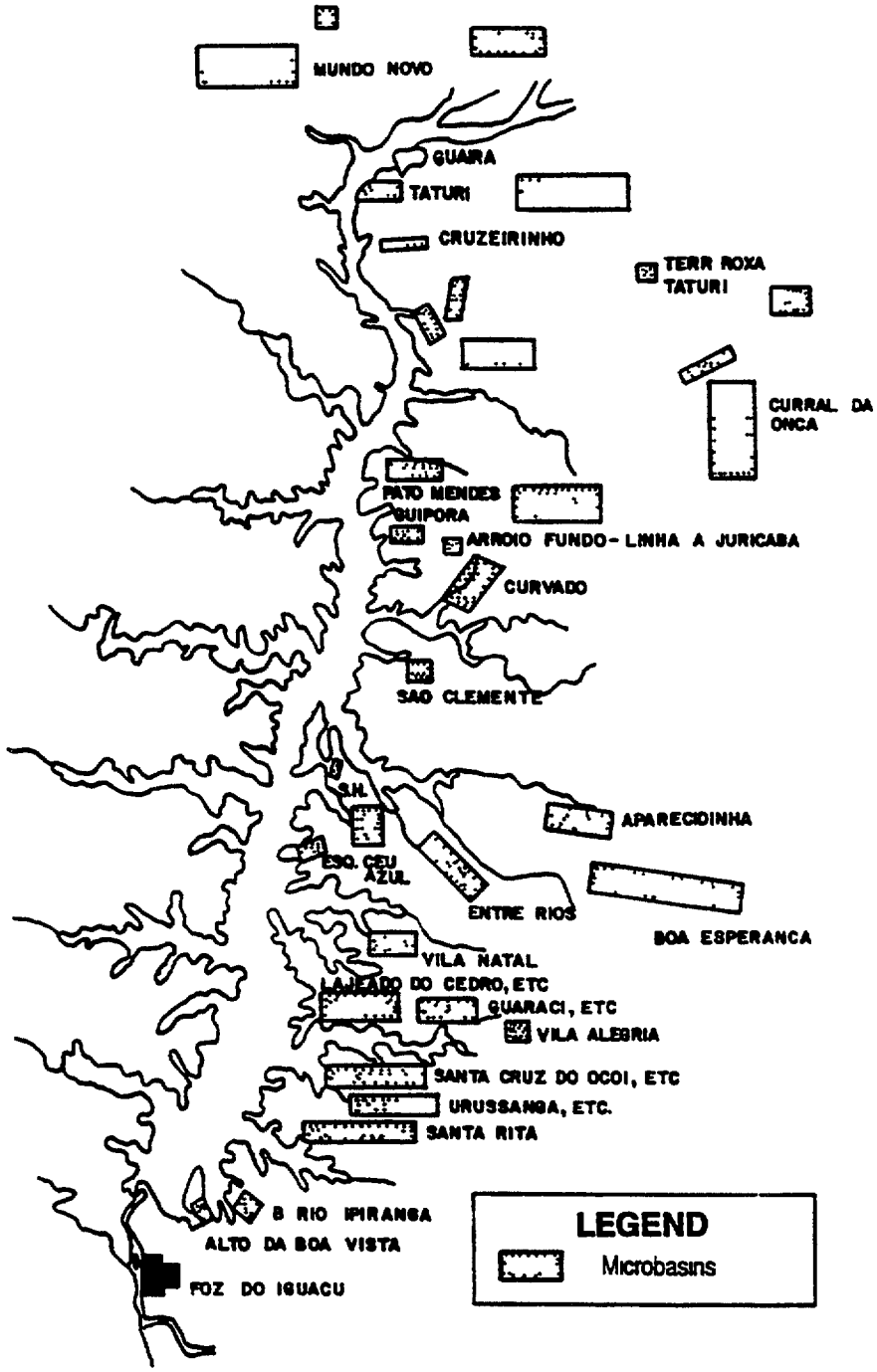
Soil conservation

Taking into account the high level of mechanization in regional agriculture and the consequent degradation of the soil, which has contributed to accelerating erosion, the Itaipú Binational Entity, by means of agreements with neighboring municipalities, is carrying out conservation efforts through its microbasin program.

Since agricultural expansion has been slower on the right bank, erosion control programs have only started recently

Terracing is complemented with straightening out the roads, the construction of anti-erosion trenches or mounds and rain water catchment basins, reforestation along the waterfronts, including reforestation promoted by ADEAM, an environmental association of Maringá. Rows of windbreaking trees have as yet to be planted, in the future, this will be done jointly with official agricultural and forestry development institutions

Figures 13
Microbasin Program



288

Formation of woods on the banks

The waters from the direct tributaries are highly important because they carry agrotoxics and nutrients into the reservoir Therefore protection of these riverbanks is necessary A contract was signed with ADEAM, it requires enforcement of the Forestry Law in those properties outside the jurisdiction of Itaipu through which bodies of water run

In addition to receiving explanations on the ecological and economic benefits of planting woods on the water's edge, landowners are informed of their legal obligation to maintain the banks of the rivers forested under penalty of legal action

The costs of this program for Itaipu are limited to reimbursing the cost of transportation and personnel hired to establish contacts with the landowners In addition, part of these expenditures (for supplying the saplings) was covered by the state forest supervision agency, formerly ITCF To date, 1,270 properties have been visited On these properties 1 2 million saplings have been planted on the banks of 36 tributary rivers

This work is carried out as a complement to soil conservation activities, in the reservoir's area of direct influence

Community water supply

These installations are aimed at storing water to supply agricultural equipment (pulverizers), thus preventing the farmers from taking water directly from the tributaries or from the reservoir itself when the water backs up as it frequently does, which would pollute the body of water

These supplies are fed by water wheels, windmills or even by gravity Next to each supply tank, which up to now have been owned and run by the communities, a place has been set aside for storing empty containers of agrotoxic chemicals (Figure 14) The location of the supply tanks in the community is selected by the Soil Conservation Commissions of the municipalities

Awareness-raising addressed to the population about the value of these installations is leading to growing participation of communities and local municipalities promoting the emergence of new units in other sites away from the lake

The supply project is also involved in reducing the number and surface area of the watering strips which have been opened in the buffer-strip for cattle from neighboring properties to gain access to the lake for drinking water

Catching the water and distributing it directly to the livestock will increase the forest continuity of the buffer-strip and reduce many of the current sites contaminated by animal wastes on the banks of the reservoir

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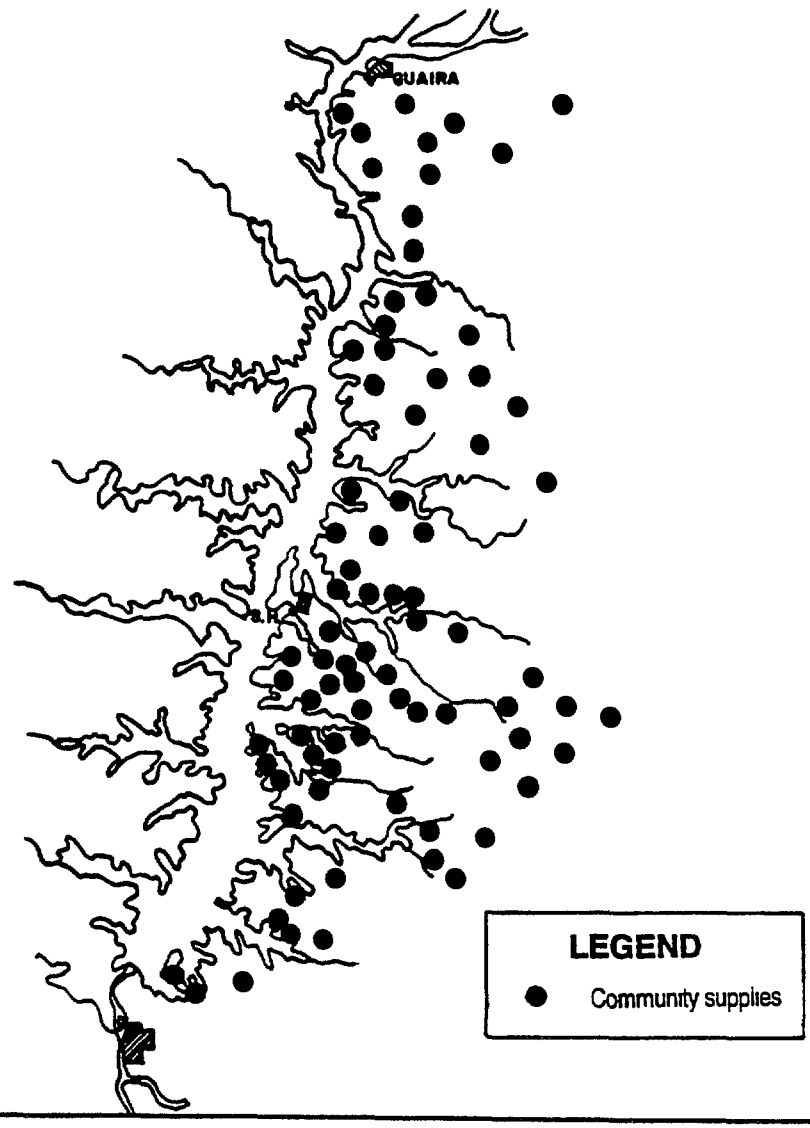
Figure 14
Community Water Supply



6.15 Ecomuseum

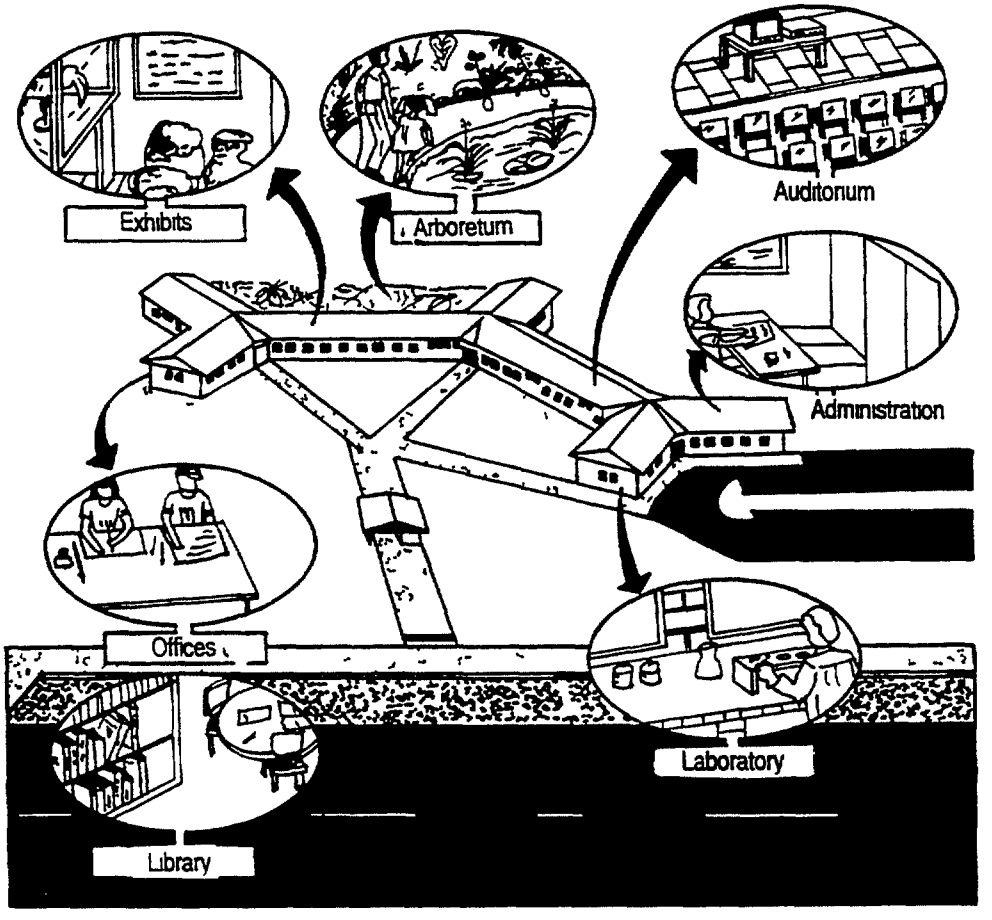
Itaipu's Ecomuseum (Figure 15), opened in 1987, has as its basic objective, to exhibit the ties between man, his work, and the environment, in the area embracing the Itaipú Binational Reservoir, in defense of cultural and scientific values in an effort of interaction with the regional community

In its programs, the Ecomuseum brings to life the region's historic evolution by means of archaeological relics, historical documents, and samples of the fauna and flora, which are part of its permanent exhibition

Besides its inherent museum-related activities, the Ecomuseum promotes a dynamic attitude by conducting environmental training activities involving students teachers, and the community as a whole

790

Figure 15
Ecomuseum



At the same time, there are temporary and travelling exhibits, focusing on issues of interest to Itaipú and the region The reservoir's neighboring municipalities are visited, and thus the Ecomuseum consolidates the basic concepts of environmental awareness

The Ecomuseum welcomes an average of 32 000 visitors per year (Brazilians and foreigners) In 1991, there were 16 463 participants in environmental education programs

6 16 Natural History Museum

The Natural History Museum provides special environmental orientation and education programs

791

These activities are geared to teaching, and raising the awareness of, the population aware about accessible practices for protecting natural resources and the environment Manuals catalogues and booklets have been prepared and distributed for this purpose

The average number of visits is around 17,000 persons per year, of whom more than half receive some sort of environmental education, mostly students

The archaeological and historical-cultural studies which began in 1975 to recover the archaeological remains of the area to be submerged, as well as the region's historical-cultural information, have enriched the archives of the Museum, which today has 12,831 biological samples and 39,259 archaeological pieces

6.17 Environmental Study and Research Center

In order meet the need for human resources training in environmental issues, as well as to create global technology, the Itaipú Binational established the Environmental Study and Research Center (Centro de Estudos e Pesquisas Ambientais da Itaipú Binacional), in accordance with the objectives of the Itaipu/CNPq Agreement

The Environmental Study and Research Center of the Itaipú Binational Entity is aimed at conducting environmental research, education, and dissemination activities, it has premises to accommodate the laboratory instruments available in Itaipú and a team of researchers In the Binational Entity there are other laboratories with appropriate physical structure, which will be integrated as external units into the Environmental Study and Research Center

During the first stage of operation (1992-1994), 26 university scholarships and 45 high-school scholarships are expected to be granted The technology developed in Itaipú must be preserved and transferred to the national and international scientific community for the enrichment of science and technology

6.18 Iguaçu Environmental Education Center (CEAI)

The CEAI is being created with the technical and financial support of the Ministry of Education, and it was established in a tripartite effort between Itaipu, the municipality of Foz do Iguaçu and UNIOESTE-FACISA

The project covers the 12 municipalities of the reservoir's area and transcends state and even national boundaries, since it also involves the countries that form part of MERCOSUR (Southern Cone Common Market)

The CEAI is aimed at training and developing human potential in the areas of formal education (professors and specialists), informal education (environmental associations, labor unions, cooperatives, and professionals in the fields of politics, business and communication), nonformal education (professors and technicians in schools like SENAI, SENAC, and the Creativity Centers)

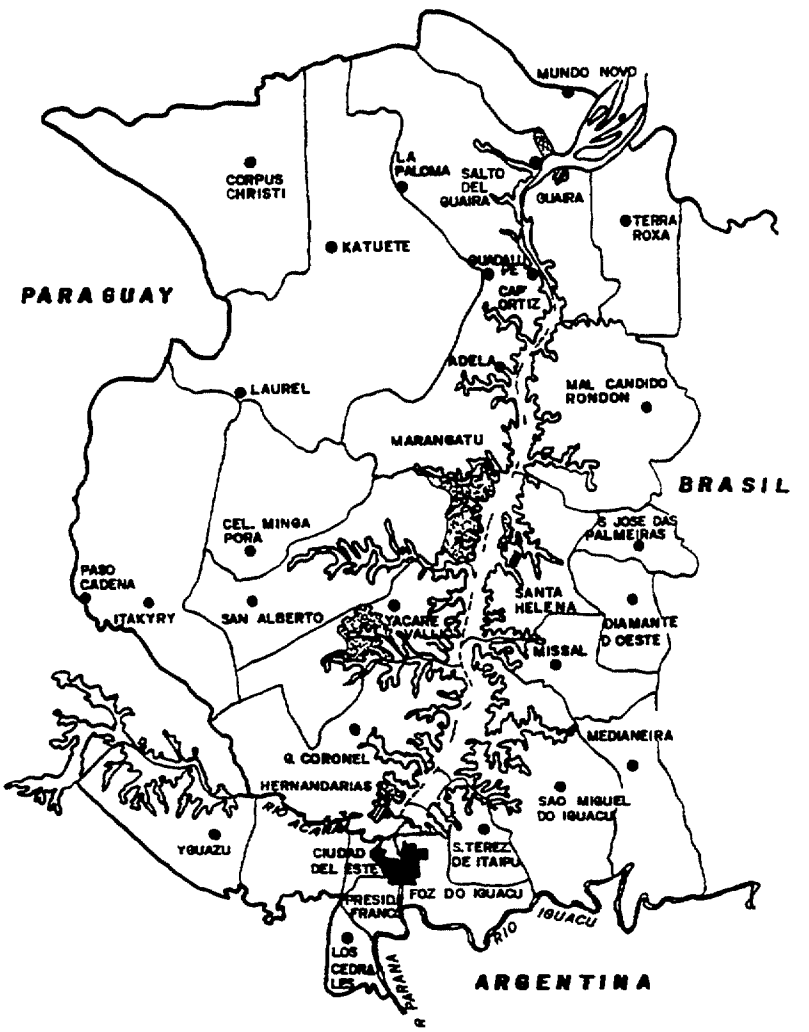
The CEAI functions as a managing center for generating know-how about pedagogical experiments combined with daily experience, in other words, teachers and other multiplier agents, after being trained by the CEAI, will apply their knowledge in their schools and communities

7. REGIONAL DEVELOPMENT

The formation of the Itaipu reservoir in 1982 triggered a series of environmental and socioeconomic phenomena These aspects are perfectly foreseeable as a result of the changes in the region's general features (12 municipalities on the left bank of Brazil and 13 municipalities on the right bank of Paraguay) (Figure 16)

The same has been occurring with the urban centers located in the vicinity of the dam, which have adapted their socioeconomic activities to physical-environmental changes Among these changes, some deserve special attention since they may negatively affect both the dam and the region as a whole and may curtail the region's growth because of the physical deterioration of the area (lake + banks + surroundings)

Figure 16
Neighboring Municipalities of Lake Itaipu



793

The basic support element is the physical-territorial layout (regional and urban), based on planning and the definition of suitable parameters for land use and settlement, to ensure that the different socioeconomic activities are not mutually impaired but rather contribute toward consolidating a regional economic integration that can attract new investments and guarantee both quality of living and high quality of the raw material, that is, water

Regarding this, the Itaipu Binational has tightened its relations with neighboring municipalities and has attempted to update the standards for using and settling the lake's banks as well as the urban and rural land in the area of the hydropower station

This effort is aimed at ensuring the region's self-sustainable development, based on a tripartite combination of economic growth, social equity, and the best use of available natural resources

7.1 Council for the Development of Waterfront Municipalities

The Council for the Development of Waterfront Municipalities of Lake Itaipu was formalized in 1989 in order to organize, plan, and orient the economic development of the area on the edge of the lake created by the Itaipú dam

In 1987-1989, before its creation, different works were carried out in the region aimed at making the community affected by the construction of the hydropower station aware of the need for a group capable of representing them Trade associations, rural labor unions, regional groups, etc participated

Its objectives are mainly geared to promoting the participation of society and the interaction of its members with respect to the proposals, projects, and discussions that are presented in a common plan or one involving the region's interests

The Council is regional and brings together 12 municipalities, whose objectives are directly linked to environmental preservation and the region's rational development Its structure is based on the three economic sectors (primary, secondary and tertiary), through their agricultural, industrial, and business associations, in addition to municipalities and town councils The Itaipu Binational is itself an effective member of the Council, in view of the need to preserve the banks and the quality of the lake's waters, an interest shared by the municipalities located along the banks It must also foster inter-institutional linkages and strive to integrate the municipalities, otherwise all technical efforts would become difficult

Itaipu's presence in this decision-making forum consolidates the idea of joint coparticipation in finding solutions to specific or general regional problems within the Council Other important aspects that will be analyzed by the Council involve urban and rural groupings (Figure 17) and the creation of MERCOSUR (Southern Cone Common Market), which the Council will eventually have to take into account

7.2 Enjoyment of Environmental Benefits

In order to meet the region's socioeconomic and cultural needs and aspirations, Itaipú granted concessions for community and private projects, developed in keeping with principles of conservation

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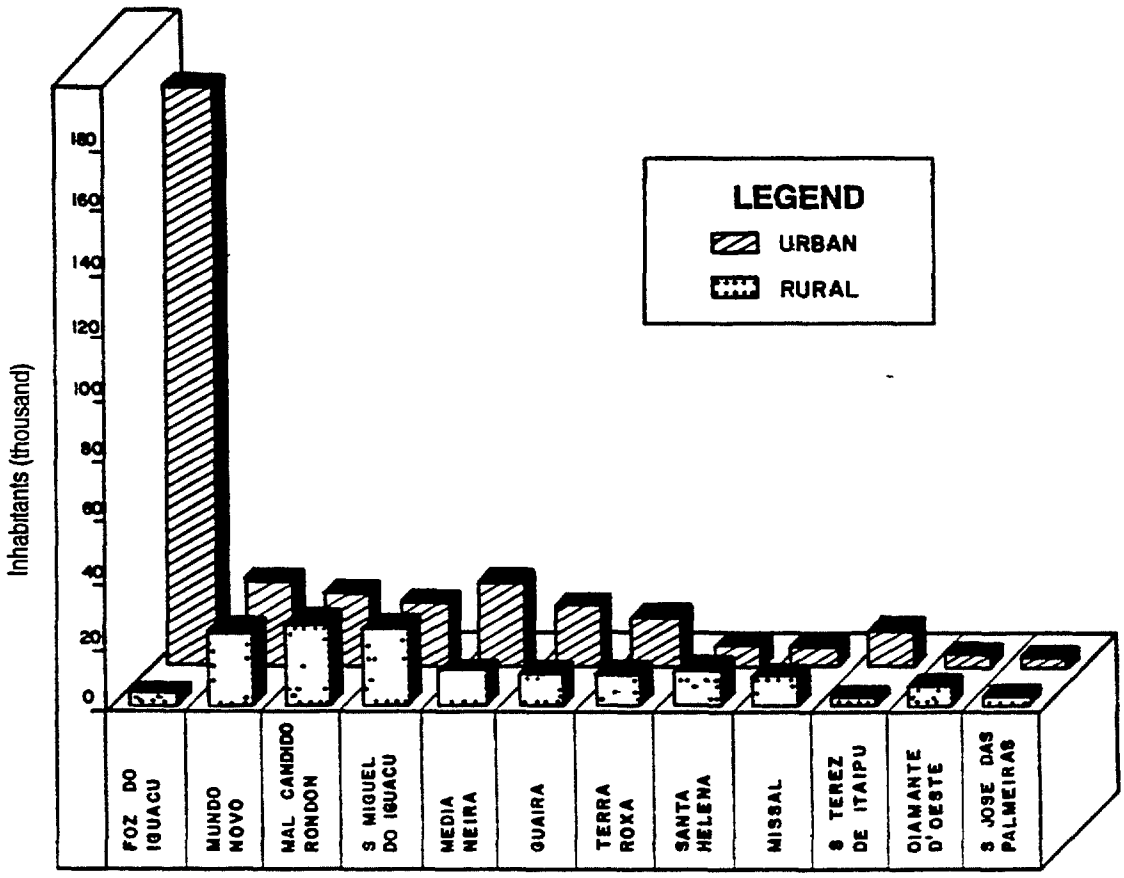
Figure 17
Rural and Urban Population of Neighboring Municipalities



The concessions involved tourism and recreation, navigation, water catchment for urban, industrial and rural use and fishing These projects are closely analyzed by experts from both the Entity and federal and state environmental institutions

7 2.1 Tourism and Recreation

Concessions were granted so that the municipalities surrounding the lake could provide beach facilities (Figure 18), including restaurants camping areas, docks, sports and parking areas, bathrooms, port authorities, services such as water, light, and sewage, etc The artificial beach is the main attraction

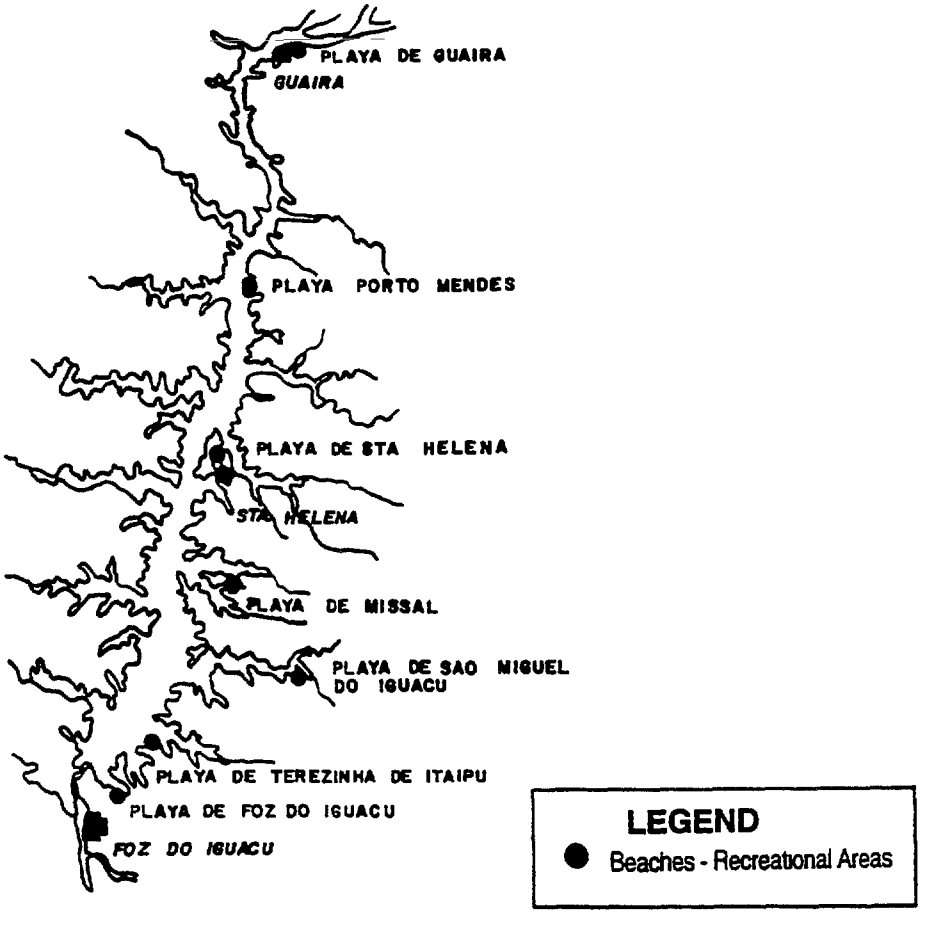
795

The beaches have been visited by a great number of users, especially during summer vacation, with high seasons on weekends and holidays On the beaches of Santa Helena, Santa Terezinha de Taipua and Sao Miguel do Iguaçu, the number of people reached a peak of 35,000 during Mardi Gras holidays (Carnaval) in 1991

Special events such as gastronomic or music festivals, regattas and sailing competitions have attracted the highest number of people at the clubs and beaches During summer weekends the number of people visiting the above-mentioned sites is around 15 000

The construction of these beaches was done with resources from PRODOPAR and from the municipalities with Itaipu ceding the area and also giving indications as to the conditions and restrictions for its use These criteria involve urban settlement, erosion control, and waste treatment

Figure 18
Recreational Areas



796

7.2.2 Navigation

Navigation is controlled by the official Brazilian and Paraguayan agencies, which also cover hygiene, pollution, safety and contraband

Itaipu is in charge of handling docking facilities, located in the buffer-strip, so ships can dock to load, unload and conduct maintenance

To date, areas for eight ports and commercial docks have been granted They are used for carrying cereals and sand

For repairing and building small and medium-sized boats, three areas were granted for shipyards where maintenance is conducted for the existing fleet

Studies are being carried out to determine navigation routes, which will eventually be provided with signals, always taking into account the reservoir's dual nationality

On the highway between Foz do Iguaçu and Guaira, in Santa Helena, the bridge over the Sao Francisco River, constructed by Itaipu, has a height of 12 meters over the water level so that freight ships may pass under it

7.2.3 Water supply

Housing Complex C and the hydropower station are supplied by water from the reservoir using conventional water treatment methods Currently this is the most important use as far as water for human consumption is concerned The water supply system for Foz do Iguaçu was inaugurated by SANEPAR, on September 26, 1992

The Aquaculture Station and the channel for egg-laying are supplied directly--by gravity--by some of the community supply tanks

Requests for water catchment for irrigation purposes and for industry are still uncommon However, more than 400 farmers directly use the water for supplying drinking water for their livestock, using their own troughs

7.2 4 Fishing

At present, about 664 professional licensed fishers make their living from the fish in the Itaipú Reservoir This community is linked to three fish colonies Foz do Iguaçu (Z-12), Guaíra (Z-13) and Marechal Cândio Rondon (Z-15) Fifty-eight percent of the professionals began their fishing activities after the reservoir was created

Since the direct needs of these professionals depend on the reservoir's, Itaipú has tried to maintain the best of relations with the fishers Therefore Itaipu has tried to instill in them conservationist attitudes that will increase fish yields and ensure high-quality fish, thus leading to higher economic earnings for the professionals and high environmental quality of the Reservoir

This has been achieved by providing training on new fishing techniques (some developed by Itaipú) and specialized orientation

Professors of the State University of Maringa Foundation (Fundacao Universidade Estadual de Maringá) participate in these programs along with experts from Itaipú

The netting-tanks have attracted institutions with greater financial capacity, such as the municipal cooperatives and prefectures, which will gradually disseminate this fish breeding method

8. INSTITUTIONAL COORDINATION OF THE ENVIRONMENTAL PROGRAMS

The role of Itaipú as coordinator of the projects in the area of the Binational Reservoir is peculiar Its status as owner of the expropriated lands, along with the fact that its management is shared by two countries, generates a complex administration that is adapted to the specific characteristics of both member countries

This administration plans and monitors uses and services on each bank, compiles information and material, and conducts technical analyses, studies, and data classification and interpretation, generally with the support of specialists and professors from different institutions, depending on the specialty of each environmental management project

Its many managerial attributions include the execution of works and services projects, environmental monitoring and supervision, and coordinating these projects with municipal, state, and federal government institutions (on both banks) Among the official state, federal, and private institutions, the following should be indicated

- Forest Research Center of Paraná
- National Council for Scientific and Technological Development (CNPq)
- National Foundation for the Indian (FUNAI)
- Maringá State University Foundation (FUEM)
- Electromon Consortium (Paraguay)
- Hidroconsult SRL (Paraguay)
- Technological Research Institute of Paraná
- Environmental Institute of Paraná (IAP)
- Butantá Institute of Sao Paulo
- Paraná Forest Institute
- Ministry of Public Health (Paraguay)
- Zoo of Sao Paulo
- Wildlife Research Society (SPVS)
- Superintendency of Public Health Campaigns (SUCAM)
- Catholic University of Paraná
- Federal University of Paraná, School of Forest Engineering
- National University of Asunción
- Brazilian Company for Research on Farming and Animal Husbandry (EMBRAPA)

- Environmental Sanitation Technology Company (CETESB), Sao Paulo
- R Pereira Consulting Firm
- Dr Geraldo Fogel Consulting Firm
- National Consortium of Engineering Consultants (CNEC)
- Environmental Sanitation Technology Company (SANEPAR)
- Constecca
- Brazilian Tourism Company (EMBRATUR)
- University Movement for Economic and Social Development (MUDES Foundation)
- Foundation for Public Health Services (SESP)
- Sao Paulo Institute for Technological Research
- Geology and Environmental Engineering Ltd (GEA)
- Ministry of Education and Religious Affairs (Paraguay)
- Monitor S A
- Mosca, Basic Sanitation and Pesticide Control, Ltd
- Secretariat for National Historic and Artistic Heritage
- Superintendency of Southern Region Development (SUDESUL)

9. ITAIPU'S SOCIO-ENVIRONMENTAL POLICY

a. Itaipú recognizes the right of human beings to enjoy a healthy environment and freedom, one of its duty is to preserve and improve environmental quality for present and future generations, striking a balance between rights and duties

The right to enjoy the benefits of an environment suitable for life goes hand in hand with the duty to conserve it and improve it

Regarding this, the Entity orients and manages the reservoir's natural resources, along with environmental education activities

b. Itaipu needs rational planning, aimed at preserving earth's natural resources, including subsoil, soil, water, air, fauna and flora, as well as the most representative sectors of the ecosystems, to ensure the welfare of the populations living along the banks and in the area of influence

Plans and projects of any type or dimension, prepared or implemented under the responsibility of Itaipú, always incorporate environmental factors The implications of planning for the environment are managed, to the extent possible, along with sanitation and conservation actions

c. Itaipú keeps pace with the economic and social development of the reservoir area as well as the outlying regions and assumes responsibility for preserving and managing the local wildlife and flora, as well as their habitats

This approach is called sustainable development, which is the outcome of rational planning and the need to reconcile progress with environmental concern and with the protection of the lake's ecosystem, where the islands, the local Indian reservation, and the biological refuges, such as the buffer-strip, are considered the focus of ongoing preservation activities

d Itaipú acknowledges the need to provide basic housing services for human groups, whether temporary or permanent, pre-existing or drawn by the construction and operation of the hydroelectric, in compliance with the environmental standards recommended by the competent institutions of Brazil and Paraguay

Environmental conservation should be taught to the youths and adults of these populations, who have in common living together around the lake, using them as vectors for environmental education with a view to the formation of a well-informed public opinion in a collective awareness-raising effort, developed by means of community participation

e Itaipu emphasizes socio-environmental studies and investigations of the hydroelectric project, so that they will be taken into account in all decision-making stages of management and be reflected in the station's construction and operation

Concern for mankind is of prime importance and involves taking into account the minimum levels needed for a dignified, decent, and civilized life in terms of feeding, clothing, housing, education, health, sanitation, recreation and work security

f Itaipu strives to raise public awareness that an ecologically balanced environment is for the common good, defending the environment comes under the jurisdiction of the public sector and therefor the power utilities

The Entity is aware that it should work with public authorities and the region's community to advocate principles ensuring ecological balance by means of integral relations To achieve this, it attempts to establish its own standards for defending and improving the environment and to complement government laws and regulations, at the municipal, state, and federal levels

g. Itaipu constantly promotes the idea that the environmental management of power projects strives to involve the affected communities in top-level decision making

The Entity seeks to prevent possible conflicts and disseminates standards that are consistent with the environmental legislation of both countries, promoting the public acceptance of environmental actions

h. Itaipu has adopted a realistic vision the environment is not viewed as an untouchable sacred object but rather the theater of operations where the biota is acting and developing in the midst of social actors

On the basis of this pragmatic approach, without prejudices of any kind, the Entity promotes self-sustainable development and ecological equilibrium in keeping with the regulations of the municipalities, states, and federal government in which it plays an important role

i Itaipu develops and fosters research, with emphasis on assessing and analyzing environmental situations and data for the purpose of harmonizing man's actions with nature

Implementation and monitoring of actions carried out in the area of the Reservoir are always preceded by the corresponding research and analysis, focusing special attention on the use of non-polluting technologies

800

j. Itaipú fulfills its environmental activities in strict compliance with the legal mandates of the two countries, and nor does it hesitate to subject its own management to the norms established by those mandates

Meanwhile, the Entity reserves the right and the duty to specify norms that are adapted to its own particularities Inspired by past examples and the lessons that have been drawn from experience, it should bear in mind that administrative actions must never prevail over environmental conservation

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CASE STUDY II

ENVIRONMENTAL AUDIT REPORT FOR THE DEL BAYANO HYDROPOWER STATION IN PANAMA

TABLE OF CONTENTS

		Page
1	INTRODUCTION	133
2	GENERAL CHARACTERISTICS OF PANAMA	133
3	CHARACTERISTICS OF THE ELECTRIC POWER SYSTEM	136
4	DESCRIPTION OF THE PROJECT AREA	138
5	THE BAYANO RIVER DAM AND BASIN	139
	5 1 Location	139
	5 2 Hydrology	139
	5 3 Climatology	141
	5 4 Edaphology	141
	5 5 Geology	142
	5 6 Vegetation	142
	5 7 Fauna	142
6	DESCRIPTION OF THE PLANT AND FACILITIES	142
	6 1 Dam	142
	6 2 Hydropower plan	142
	6 3 Reservoir	143
7	CORROSION	144
8	POPULATION DISPLACEMENTS	144
	8 1 Ethnic aspects	145
	8 2 Moving and Relocation Program	146
	8 3 Criteria for the Relocation	146
	8 4 Complementary Socio-environmental Activities	148
	8 5 Evolution of Problems After the Resettlement	148
	8 6 Effects on the Indigenous Population	148
9	CONSIDERATIONS ON THE FISH FAUNA	150
	9 1 Influence on Ocean Ichthyofauna	151
	9 2 Fishing Potential	151
10	INSTITUTIONAL AND LEGAL ASPECTS	152
11	WEEDS	153
12.	BRIEF ANALYSIS OF RISKS	155
13	INFECTIOUS DISEASES VECTORS AND HOSTS	155
	13 1 Vectors	157
	13 2 Hosts	159
14	SOCIO-ENVIRONMENTAL ASPECTS	160
15	REFERENCES	162

804

1. INTRODUCTION

This assessment was prepared as a result of the joint efforts between the Institute of Hydraulic Resources and Electrification (IRHE) of the Republic of Panama and the Latin American Energy Organization (OLADE), within the framework of Technical Cooperation Agreement ATN/SF-3603-RE subscribed between OLADE and the Inter-American Development Bank (IDB) Its purpose is to help member countries of both bodies to incorporate the environmental dimension in regional energy development planning

The specific objective of this document is to provide a concrete example of the real problems faced in relating projects to the environment, as well as the costs and proposed mitigation alternatives, which often are improvised, according to environmental concepts and practices usually used during the construction phase Besides sharing the experience of the institutions involved in developing projects, an intent is made to show how changes in the original design, acceptable from the standpoint of costs, might have resolved environmental problems that today endanger the existence of the projects themselves and whose further mitigation now involves large investments

Though originally there was environmental impact study for the Bayano hydropower project, the magnitude and complexity of the changes on the environment and human ecology in the region of the project were evident from the very beginning, with no other precedent like it since the construction of the Panama Canal

In fact, the construction of Bayano is the first experience of this type on the part of Panamanian public institutions in the construction of this type of works The identification of social-environmental problems generated a positive debate among the country's technical and academic community, who had no previous experience in the field and created a higher degree of awareness among the IRHE personnel regarding the importance of the environmental management of this type of projects This allowed for better planning of the Estrella-Los Valles and Fortuna hydropower developments, from the environmental standpoint

Five years after the hydropower plant went into operation, IRHE organized a round table discussion to analyze the problems caused by the presence of the reservoir Most of this report is based on the results obtained there Later on, the growth of water weeds in the reservoir and the complexity of relations between the indigenous ethnic groups and the colonists that had emigrated from the western part of the country and that live in the Bayano region forced the electric company to constantly monitor and update the situation on these situations

The Latin American Energy Organization (OLADE) wishes to express its gratitude and acknowledge the invaluable support provided by the Institute of Hydraulic Resources and Electrification (IRHE) through its technical committee without which it would have been impossible to carry out this study

2. GENERAL CHARACTERISTICS OF PANAMA

The Republic of Panama occupies a long territory in the parallel sense, with a total area of 75,517 square kilometers in the southeastern section of the Central American isthmus The Panama isthmus is the narrowest section of land between the Caribbean Sea and the Pacific Ocean This characteristic

was what made it possible to build the interoceanic canal of the same name at the beginning of this century

The geological evolution of this territory began 130 million years ago, toward the end of the Secondary Era (Cretaceous Period), where periods of high volcanic activity alternated with sedimentary periods and some igneous intrusions The characteristics and dynamics of the environment have been influenced by two main physical facts its location in the inter-tropical zone and the position of its territory on the Panama tectonic microplate

The Central Mountain Range runs through the country from west to east This is a mountain center of volcanic origin that reaches considerable heights, particularly in its western part, of over 3,000 meters above sea level The eastern section of the country, including the Canal region, has a series of sedimentary basins surrounded by ancient volcanic mountains of little height The narrowest sections of the isthmus are found in this region

The Central Mountain Range, in addition to experiencing bioclimatic changes due to its altitude, divides most of the country in two slopes The one on the side of the Caribbean, which is narrow, rainy and with jungle characteristics, experiences rainfall of over 4,000 millimeters The Pacific slope, which is broader, has a climate with a marked dry season where the lowest rainfall in the country has been registered which, in average, only reaches 1,000 millimeters

In addition to the advantages of its geographical locations, its many natural passes for international transportation, the port and ichthyological resources of its coasts and seas, Panama has mineral reserves, mainly copper, manganese and iron, forestry resources and 1 73 million hectares of arable land Its hydrological resources are significant, since it has hydropower potential estimated at 3,700 MW,m of which barely 15% has been exploited to date There are also good possibilities for river-marine navigation systems

With approximately 2 5 million inhabitants, Panama is the country with the lowest population density in the Central American isthmus Its geographical location allows it to have a very dynamic commercial and service sector Over 40% of Gross National Product (GNP) stems from these activities, whereas agriculture barely accounts for 10% and industry 9% With a per capita GNP of US$1,705, Panama is among the mid- to high-income countries in the region

Environmental Aspects

Upon the arrival of the Spaniards in Panama in 1502, the native inhabitants had already colonized and started to use the natural environment, from the low and dry lands of the Pacific coast to the mountains and islands on the Caribbean There were relatively quite a few societies with enough capacity to manage diversified and sometimes intensive agricultural systems

Spanish colonization—the first and for over 30 years the only on firm land—upset the spatial organization created by the indigenous peoples during thousands of years Since the time of the conquest, the central region of the isthmus was organized as an active zone for international trade, centered around the cities of Portobelo, in the Caribbean, and Panama in the Pacific, which formed the basis for the country's urban-commercial development In the central plains, a rural society developed, based on a primitive agriculture and extensive cattle-raising, with low population density

806

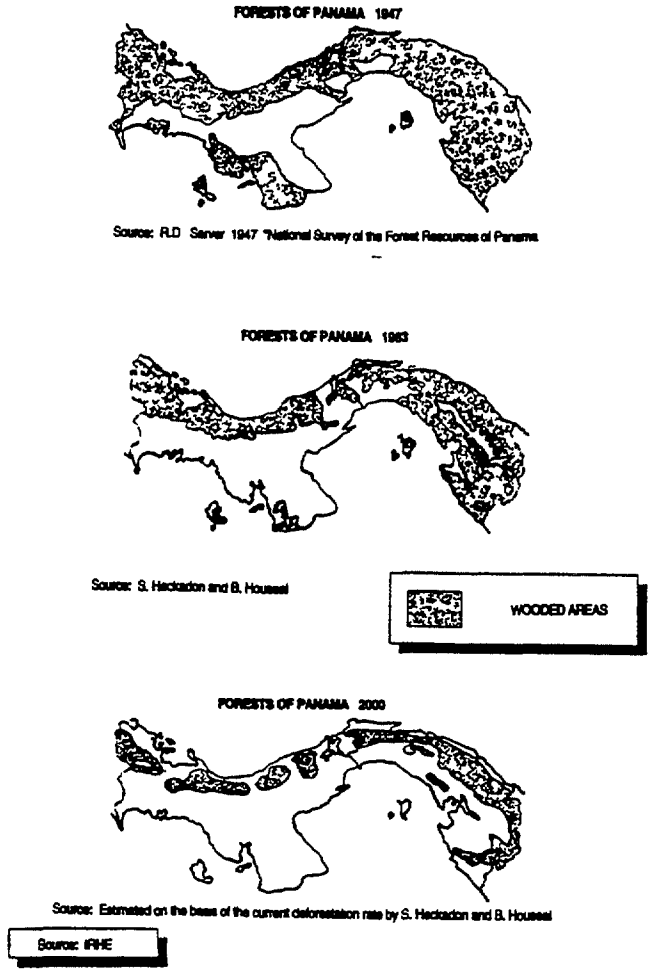
The relatively low population density of Panama, compared to the high population densities that characterize most of the Central American and Caribbean countries, should not lead one to believe that the country does not experience serious environmental problems related to the development style that prevailed the last few decades

Deforestation

The destruction of the forestry wealth, with consequences for the soil and natural habitats, are the main problems the country faces It is estimated that between 1947 and 1990, the forest surface of Panama decreased from 70 to 25% of its total surface, with a deforestation rhythm of 70,000 hectares a year If this rhythm continues, it is estimated that by the year 2000 only 10% of the country will still be covered with forests

Deforestation, followed by burning, a practice inherited from the American Indian population, is additionally responsible for the deterioration of air quality during the dry season, and of the disappearance of numerous plant and animal species (Figure 1)

Figure 1
THE ADVANCE OF FOREST DESTRUCTION IN PANAMA



Water pollution

No quality standards exist in Panama to regulate the discharge of waste water Water streams that run through large urban centers in the country are severely contaminated from industrial and residential sewage and garbage Though 99% of the urban population has sewage services, none of the cities has treatment plants for sewage water In rural areas, continental waters are contaminated with agricultural pesticides and industrial effluent from sugar and coffee mills and from food industries

The most important problems of marine pollution are related to the pouring of waste water and oil spills along the coast The Panama bay represents the most critical case of marine pollution in the country The most recent estimates suggest that 40 million tons of sewage water reaches the Panama Bay annually As a consequence, the levels of coliforms in some sectors reaches 150,000 NMP/100 ml, which exceeds by several orders of magnitude the acceptable levels to be allowed as a recreational zone or to propagate wildlife

Hydrocarbon pollution is linked to their refining, transportation and storage In 1986, a large oil spill took place when 50,000 barrels of oil spilled from a storage tank at the refinery, close to the city of Colon, on the Caribbean side of the Panama Canal This spill, considered to be the largest in Tropical America, seriously affected a broad sector of mangrove swamps and coral reefs Another zones where rather large spills have taken place are the end points of the trans-isthmus pipeline, in the western part of the country This pipeline transports most of the Alaska crude oil to the East coast of the United States Another source of marine pollution is the intense traffic of ships crossing the Canal throughout the year

Land pollution and deterioration

One of the consequences of deforestation and of the bad use of the land is erosion, mainly of the soil on very inclined slopes By 1970, it was estimated that 1 2 million hectares of land were degraded By 1987, the area of land affected by erosion amounted to 2 million hectares Erosion and the sedimentation of lakes are problems of growing concern, due to the consequences on the operation of the Canal and of the hydropower plants

The pollution of urban and agricultural land is due largely to the lack of adequate sanitary controls, the incorrect disposal of household and industrial garbage and the growing use of pesticides About 39% of human settlements in the country do not have formal garbage collection systems The cities of Panama and Colon produce annually 100,000 tons of garbage, without any adequate system for final disposal to date

3. CHARACTERISTICS OF THE ELECTRIC POWER SYSTEM

Panama's electricity generation system is dominated by plants of hydraulic origin In 1991, they accounted for 75% of the 713 MW of total capacity available generation The main hydropower plant is the Fortuna plant with 300 MW, located in the western part of the country, where the largest hydropower potential of the country is concentrated In 1990, this plant provided 49% of the total gross production of the interconnected system The second plant in importance is the Bayano hydropower plant, located in to the east of Panama City, with an installed capacity of 150 MW In 1991, it provided 21% of the total gross electricity generation The Estrella-Los Valles complex, with an installed capacity of 90 MW, completes the group of hydropower plants

The thermal power group is formed by the Bahía Las Minas plant, of 150 MW, located close to the city of Colon, on the extreme of the Panama Canal that faces the Atlantic, 80 MW located on the outskirts of Panama City and small-capacity diesel groups located usually in the interior of the country The thermal group as a whole at the moment faces a precarious situation, since only 182 of the 333 MW of installed capacity are really available

The Panama transmission system has 514 km of 230-kV double-circuit lines In addition, there is a 64-km long, 230-kV single-circuit line that interconnects with Costa Rica

The transmission system is longitudinal, with 70% of the load concentrated in the capital city, 400 km away from the Fortuna-Estrella-Los Valles hydropower complex It has a joint capacity of 390 MW (55% of the capacity available at the national level) This configuration experiences problems for the transfer of reactive and instability under load conditions The subtransmission system, at 115 kV, covers areas where important loads concentrate, with 156 double-circuit lines and 129 km of single-circuit ones

In 1990 the electric power consumption at the national level reached 2 055 GWh, with a maximum demand of 464 MW Consumption grew at an annual average rate of 5 9% between 1981 and 1987 However, consumption over the lat three years has decreased for all sectors In 1990, consumption accounted for 94% of what was recorded in 1987 During the last decade, the share of the metropolitan area in total consumption has decreased from 69 to 64%, and this level was maintained during 1989 and 1990

During 1990, the sectors with the highest electric power consumption at the national level were the residential (31%), commercial (30%) and government (13%) sectors During the last ten years, the residential sector has assumed more relative weight, whereas the participation of the commercial sector has decreased, particularly after 1987, due to the economic crisis Studies carried out affirm that the most important end uses are linked to refrigeration and air conditioning This participation in consumption seems to be growing with time, and it is estimated that they could account for 60% of total consumption

Another characteristic of the Panamanian electric system is the high level of losses In 1990, the total level of losses of the interconnected system accounted for 25 2% of net electricity generation This figure is broken down into 13% of technical losses and 12 2% of nontechnical losses It should be mentioned that the percentage of total losses has been increasing continuously during the last few years, especially in 1989 and 1990, due to the increase of nontechnical losses It is estimated that the latter amount to US$40 million a year and are equivalent to the generation of a 100 MW plant with a 40% utilization factor

Panama has recently faced occasional lacks of electric supply, when prolonged dry seasons involve a reduction of generation at the hydropower plants or when damages at the thermal power plants occur, as a consequence of the strong dependance on hydropower generation Since 1990, the service has been rationed and it is estimated this will continue until 1997, if unfavorable hydrological conditions are verified and the rehabilitation plans for existing facilities are carried out

The IRHE forecasts that the annual growth rate of consumption at the national level will be from 5 3% to 8 0% until 1996 For this, an expansion plan has been prepared that contemplates an annual average growth of 5% (Table 1)

Table 1
Generation Expansion Projects

Year	Project
1992	- Rehabilitation of Pielstick No 1, 2, 3 and 4 - Repairs Bahía Las Minas No 1
1993	- Rehabilitation Las Minas No 2
1994	- Fortuna High Dam
1996	- Diesel low speed 60 MW
1997	- 30-MW steam plant
1998	- 50-MW steam plant - Estí Phase I 70 MW
1999	- 60-MW gas turbine
2000	- Estí Phase II 46 MW

The project of the Fortuna high dam, for which the construction contract was signed in September of 1991, will allow increasing generation by almost 300 GWh a year, that is 11% of the country's total gross generation It is hoped that this project will be operational by 1995 As can be seen, the expansion does not contemplate the installation of new generation units until 1996 Up to that year, the plan is based on repairing and rehabilitating existing plants

4. DESCRIPTION OF THE PROJECT AREA

The Bayano hydropower project is located about 120 km to the northeast of Panama City, on the river of the same name The Bayano plant was the first large hydropower plant to be built in Panama. Its construction, which began during the decade of the seventies, opened up a period of national energy policies that encouraged the construction of this type of plant, in a country that does not produce oil and which at that time depended 100% on that energy source for its electric production

The Bayano hydropower project also initiated a learning and awareness-raising process among the IRHE's technical staff and the national scientific community, based on concrete experience of the environmental implications of hydropower projects This process also extended to civil society and to the communities directly affected by the reservoir

Though among the preliminary studies made before construction there was no environmental impact assessment, it was evident from the very beginning that the environmental impacts caused by the construction on the local ecosystem were complex and far reaching

Historical Background

In 1958, the Power and Light Panamanian Company that supplied Panama City and Colon with electricity hired a consulting firm to carry out a preliminary assessment of hydropower projects, to be able to supply the system's demand in the future The project on the Bayano river was identified as the most attractive one from the economic standpoint

With the creation of the IRHE in 1961, the Bayano project received a new impulse to begin with the feasibility study, to use the Bayano river for irrigation and power generation purposes The final report, finished by mid-1963, recommended the construction of the project From that moment on, decisions came to a standstill related to the nationalization process of electric services that began in 1969 and ended in 1973

The decision to build the Bayano hydropower plant, the largest piece of infrastructure in the country after the construction of the Panama Canal was made in 1969 In December 1971, the construction of the civil works began, and operation started in 1976

5. THE BAYANO RIVER DAM AND BASIN

5 1 Location

The Bayano hydropower plant uses the energy potential of the river of the same name, which originates in the mountain range that divides the provinces of Darién and the eastern part of the province of Panama and to the east the interoceanic canal, running about 160 kilometers from east to west to open out into the Panama bay (Figure 2)

The site of the dam is easily accessible from Panama City, along the Pan-American highway, about 80 kilometers away

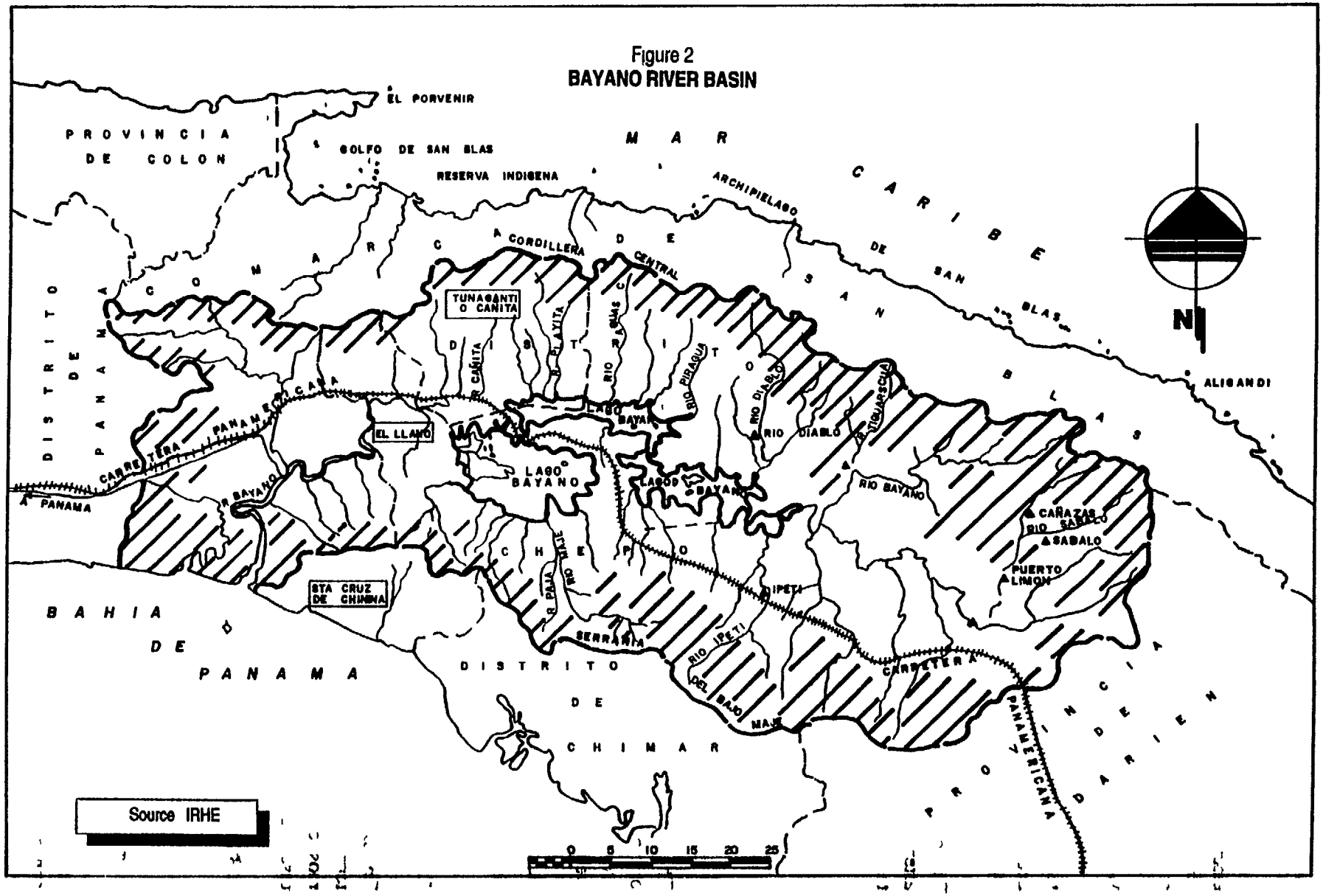
5.2 Hydrology

The Bayano river basin is approximately 3,650 km^2, an area that accounts for 4 6% of the national territory Before the construction of the plant, the Bayano river was one of the bodies of water that most contributed to the Panama Gulf (about 5 billion m^3/year), by itself accounting for 17% of total discharge into the Panama Gulf This is equivalent to approximately 7 km^3 of fresh water from the Bayano river that was introduced annually to the Gulf, with suspended matter estimated at about 2,000 to 3,000 tons

The Bayano river, with an average annual flow of 170 m^3/second, receives the inflow of 115 tributaries and in its lower part is affected by tides, the effects of which are registered as far as the town of El Llano, 65 kilometers upstream from its outlet

Small boats (cayucos) are able to navigate throughout the year on the part between El Llano and the convergence of the Mamoni river a section of about 20 kilometers long From El Llano to the union with the Mamoní river, navigation is possible only during the rainy season, due to the presence of sand

Figure 2
BAYANO RIVER BASIN



banks and rocks Downstream, starting at the place where the Mamoni river joins the Bayano and until its outlet, the Bayano becomes gradually deeper and wider

5.3 Climatology

The most important physical-climatic characteristics of the basin are the following according to the Thornthwaite classification, 60% of the basin has a humid megathermal climate with no lack of humidity, 30% has a perhumid megathermal climate and 10% a perhumid mesothermal climate The average annual temperature is 25°C and the annual average relative humidity is 85%

The rainfall distribution in the basin of the reservoir has two clearly different seasons a rainy one that goes from May to November and a dry season between December and April

The rainfall pattern in the area depends on the position of the intertropical convergence zone upon the Panama isthmus, to which a band of weak and variable winds are associated, along with masses of cumuliform clouds and frequent and intense showers The intense winds from the North that affect the Panama isthmus between February and March displace the intertropical convergence zone to the south, causing a dry season to take place Toward the end of April, when the winds from the north decrease in intensity, the intertropical convergence zone once more covers the isthmus, causing the rainy season

From what has been presented so far, it is clear that the climatology of the zone depends on the position of the intertropical convergence zone, which is in turn regulated by the winds from the north

In general, the rainfall in the basin is minimal between January and March (less than 75 mm/month), whereas from April on the rain increases notably, reaching maximum monthly amounts of over 400 mm/month in places close to the Majé highlands Average rainfall in the basin is 2,500 mm, much higher than the national average of 1 700 mm

The intensity of solar radiation has an inverse relationship to rainfall Radiation levels during the dry season go up to 500 Langleys/day, whereas during the rainy season it fluctuates between 350 and 430 Langleys/day

5.4 Edaphology

Though not many soil studies have been carried out in the Bayano basin, in general they can be classified as Class VII, according to the SCS system of the U S Department of Agriculture, with a predominance of Tropepts, Ortents and Alfisoles, derived mainly from shale, siltstone and sandstone, all of them with a tendency to erode These soils are inadequate for agriculture and their use is mainly restricted to grazing

The land in the basin is formed by 30 to 75% of slopes, making the efficient development of agriculture difficult Along with the loss of the forest coverage, this has caused a growing erosion problem, thus contributing to the sedimentation of the reservoir of the hydropower plant

813

5.5 Geology

From the geological standpoint, the Bayano basin is formed of lava and andesite-basaltic pyroclasts from the ocean, with an outcropping of a small granodioritic encroachment of the upper Cretaceous The igneous whole is also resistent and forms an outcropping in a stratigraphic band along the Majé mountain range

The geomorphological units that exist in the area are described as follows

- Lows hills and mountains, with slopes of 30 to 40% belonging to the ocean complex, formed by shale, siltstone and sandstone

- High hills

5.6 Vegetation

Seventy-five per cent of the Bayano river basin is covered with tropical subperrenial-leaf forests a very heterogenous forest with very continuous dosel at about 35 meters high, a sparse coppice forest except in well-lit zones, regular amount of epyphytes, vines, etc Fifteen per cent is a subtropical perennial-leaf forest, 5% a highland perennial-leaf forest and the remaining 5% consists of crops, savannah, and secondary pioneer vegetation

5 7 Fauna

Studies carried out show the existence of an enormous animal wealth in the Bayano basin, ostensibly of reptiles, amphibians, Chiroptera, birds, insects and large mammals Since 1972, studies on the transmission of arborivus has helped considerably to understand the fauna of the basin

Within the most common species we can find the "ñeque" (Dasyprocta punctata), peacock (Crax rubra), peccary (Tayassu tajacu), rabbit (Sylvilagus brasiliensis), green iguana (Iguana), wild pig (Tayassu pecari), pheasant (Ortalis cinereiceps) partridge (Tinamus major), white-tail dove (Leptotila veneauyi), white-faced monkey (Cegus capucinus), sloth (Choleopus hoffmania), tapir (Tapirus bairdii), painted rabbit (Agouti paca)

6. DESCRIPTION OF THE PLANT AND FACILITIES

6 1 Dam

The development is formed by a dam and 75-meter-high by 45-meter-long concrete gravity spillway, with a 25-meter-high auxiliary dam that can contains a volume of water of up to 5 billion cubic meters at its maximum level (62 m) In the construction of the dam, 600,000 square meters of concrete and 110,000 tons of cement were used

314

6 2 Hydropower plant

At the moment, the facility is formed by two 75-MW units, with space for two further units in the future of equal capacity, which produce an annual average of 600 GWh

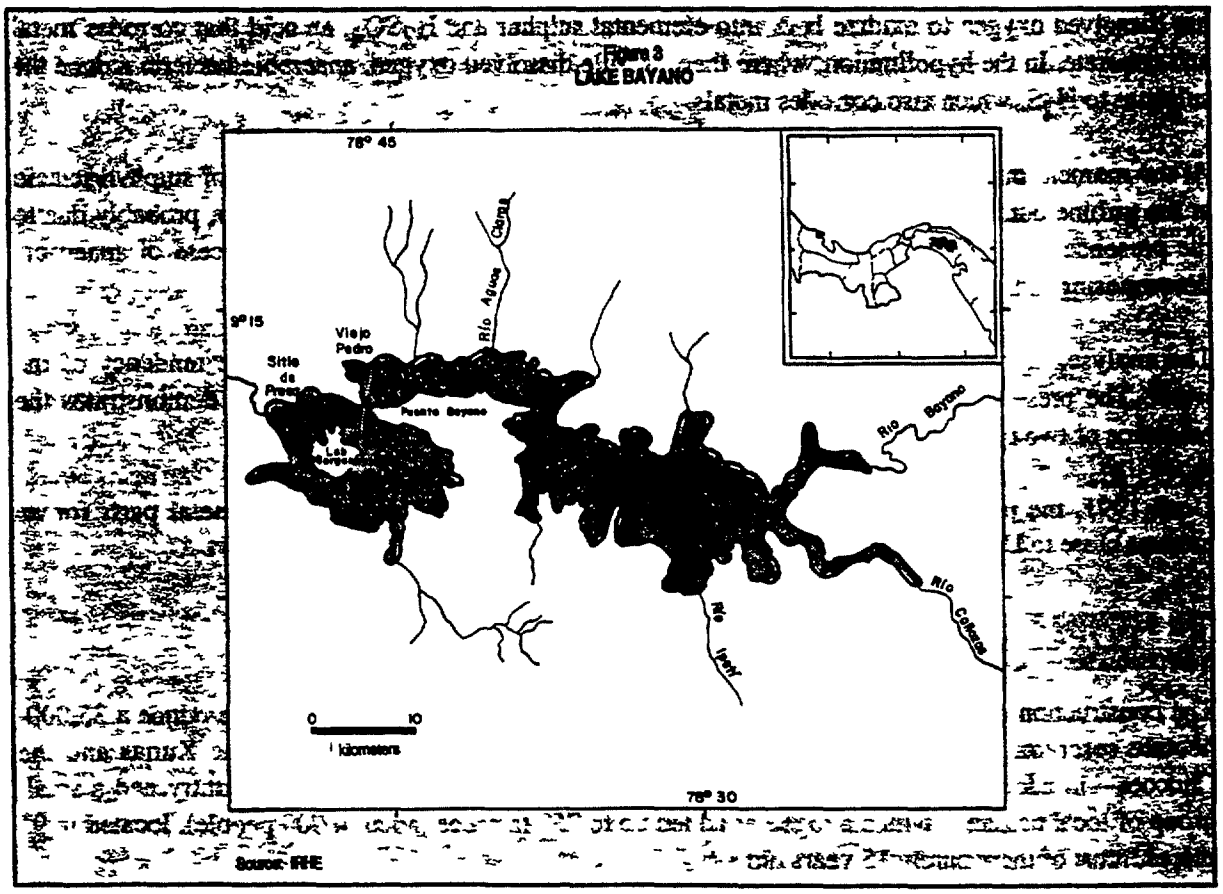
The energy means consists of 4 access pressure pipes that cross the main dam in the direction of the engine room The electric power is produced by two Francis type vertical turbines and their respective 96 6-MVA coupled generators It is further transmitted from an elevating substation next to the engine room, through a 230-kW double-circuit transmission line, to Panama City

6.3 Reservoir

The Bayano reservoir has a maximum storage capacity of 5 billion m^3, with a water mirror surface of 360 km^2, which allows the interannual regulation of power generation (Figure 3)

The reservoir, at the site of the dam, has a depth close to 60 meters The water levels fluctuate according to the rainfall and the use of the flow for electricity generation The lowest levels are usually registered between May and August, whereas the maximum level, of about 60 meters, takes place in December, after the heavy rains of October and November

The reservoir's bathymetry is not known though it can be said, in general terms, that the maximum depth in the Majé, Aguas Claras and Río Diablo whirlpools comes close to 20 meters



7. CORROSION

Due to the appearance of corrosion problems in the plant's electric-mechanical equipment, in 1978 the IRHE carried out a study to analyze the relationship between this problem and the quality of the water in the reservoir to be able to adopt preventive measures and adapt maintenance operations

The reservoirs of hydropower plants trap heat and nutritive elements Turbined water comes from the bottom or deep parts of the lake, for which reason it is always colder, has a higher saline content, is rich in nutritive elements but poor in oxygen The surface level, on the other hand, is warmer and is retained by the lake, a factor which aggravates the loss due to evaporation

Not all artificial lakes have thermal stratifications, since the water's mixture capacity is determined by the wind, river flow, bathymetry and the effect of thermal stratifications and the effect caused by plant takes In addition, the thermal stratifications, as they depends on solar radiation, rainfall evaporation-transpiration and other climatological variables, are seasonal

The Bayano lake experiences thermal discontinuity in the site of the dam during the dry season This discontinuity forms a layer that increases in depth from 10 to 15 meters, between February and April Under these circumstances, the upper layer of higher temperature water (epilimnion) floats over the bottom one (hypolimnion), with a lower temperature and lower density, with appreciable differences in the physical-chemical characteristics of the layers

The higher presence of oxygen in the epilimnion favors the growth of aerobic sulphurous bacteria that use dissolved oxygen to oxidize H_2S into elemental sulphur and H_2SO_4, an acid that corrodes metal and concrete In the hypolimnion, where there is little dissolved oxygen, anaerobic bacteria reduce the sulphate to H_2S, which also corrodes metals

At the moment in which the above mentioned study was carried out, the formation of sulphydric acid at the turbine outlet was evident and a blackish coloring could be noted in the water, probably due to the presence of metallic sulphurs that would prove the existence of an active process of anaerobic decomposing in the bottom of the lake

The analyses revealed indexes that indicated a high aggressiveness and corrosive tendency of the water The presence of elemental sulphur in turbine No 1 and of sulphuric acid demonstrates the existence of two types of corrosion aerobic and anaerobic

Until 1991, the problem of corrosion in Bayano caused expenses in repairs of metal parts for an amount close to US$10 million, mainly due to having to replace the substation coolers

8. POPULATION DISPLACEMENTS

The construction of the hydropower plant on the Bayano river, whose dam would produce a 35,000-hectare reservoir, caused the displacement of two native population groups—the Kunas and the Chocoes—in addition to local immigrant peasants from the western part of the country and a small group of local peasants, which altogether added up to 753 families (about 4,000 people), located in 95 places, most of them barely 15 years old

816

The moving and resettlement program was carried out between December 1974 and June 1975, through the Bayano Integral Development Project—later known as the Bayano Corporation—with the participation of a group of ecologists, engineers, sociologists, anthropologists and economists Along with the affected population, they plant and carried out the relocation

The problem of forced displacement caused by the flooding of the Bayano reservoir is not the first or most important experience of this type in the country The construction of the Panama Canal, between 1904 and 1914, flooded 43,000 hectares of the most densely populated zone in the isthmus, to form the Gatun lake, which for a long time was the largest of all artificial lakes in the world However, the Bayano experience is unique due to its complexity and because it is the first experience for the Panamanian institutions and scientific community in this matter

8.1 Ethnic aspects

From the ethnic-cultural standpoint, the population that lived in the Bayano basin was divided into four groups two of them indigenous (Kunas and Chocoes) and the other two hispanic-mestizo and African mestizo peasants However, from the standpoint of their way of relating to the environment, which is a relationship defined basically by their productive orientation, their were two groups indigenous and colonists

From the quantitative standpoint, 58% of the inhabitants in the basin were colonists, 28% Kunas and the remaining 14% Chocoes However, this did not indicate the degree in which the displacement would affect the different groups

The Kunas and Chocoes had an ancestral relationship of complete dependance on the river and the rain forest that surround it In the case of the colonists, their tendency to convert the tropical jungles into grazing areas for cattle-raising development denoted a completely different attitude with regards to the jungle In 1973 before the construction of the Bayano hydropower plant was finished, over half of the 4,000 inhabitants in the basin were colonists that had migrated from the western part of the country and who, during a 10-year period had cut down 10,000 to 12,000 hectares for pastures

In comparison, the Kunas, protected by the reservation created in 1934 and part of which was to be flooded by the reservoir carried out their traditional economic activities linked mainly to a subsistence agriculture, combining it with some commercial crops (fruit and vegetables) Their sociocultural system was closely linked to the jungle, which formed part of their values and world vision

Like the Kunas, the Chocoes practiced subsistence agriculture and their culture had resulted in large part from their adaptation over history to the rain forest This was the smallest group, less integrated to Panamanian society and therefore more vulnerable It seems that the emigration of the Chocoes to the Bayano area dates back to the forties The Chocoes historically had conflicts with the Kunas, who had traditionally disputed their settlement in the Bayano region

It is important to note the historical enmity between the Kunas and Chocoes Until recently, relations in the Bayano zone have been very tense In fact, the Kunas attempted on several occasions to expel the Chocoes from the Bayano area, both through legal means as well through economic and social pressure Attempts have even been made to evict them forcibly on several occasions, the Chocoes' crops have been burnt shortly before harvest and their boats have been stolen, destroyed, damaged or let loose downstream.

817

The African mestizo peasant or "Bayanero" group was really a minority located in the area of Calle Larga, close to the site of the dam They also practiced subsistence agriculture, marketing vegetables and doing extensive cattle-raising At the moment an which construction of the hydropower plant took place, this group was already linked through family ties to the hispanic-mestizo group

A fifth group could be mentioned, formed by the temporary population that participated in the construction of the plant, the workers of the Panamerican highway and wood concessionaires, most of these Colombian, in charge of cutting down and extracting the wood administrated by the Bayano Corporation

8.2 Moving and Relocation Program

The relocation program involved moving a total of 3,461 persons from the different ethnic groups mentioned above, grouped together in 565 families and distributed in 95 different settlements As was indicated above, 58% of these persons were settlers that lived in 65 of the towns that had to be evacuated

The fact that most of the people to be displaced were formed by colonists partially facilitated moving operations In effect, most of these colonists were emigrants from the western part of the country and therefore were not as rooted to the land as opposed to the indigenous groups, whose relationship to the jungle is ancestral In addition, their culture allowed them a better position in negotiating with state bodies and they were more willing to accept indemnization or to emigrate to other zones

From the quantitative standpoint, the most important figures in the moving and relocation program were seen in October 1975, three years after project construction began The most affected group was of the Chocoes, since almost all of them had to be relocated To this we should add that this was the most vulnerable cultural group, due to their type of social organization and traditional isolation

In October 1975, 88% of the families of colonists and Chocoes had been moved, whereas this proportion among the Kuna families barely reached 28% In effect the Kuna communities showed the most resistance to the relocation

8.3 Criteria for the Relocation

In planning the population's relocation program, the following criteria were used

- Cultural diversity of each group and identification of their most important economic activities
- Recognition of the need to return the population to its productive activities in the least time possible
- Avoid possible exodus of the population to the cities

Based these criteria, the following tasks were set

- Identification of the relocation areas

818

- Inventory of goods (land, permanent crops, houses, improvements made, etc)
- Assistance in health and education
- Technical advice to build housing and obtain construction materials
- Technical advise in agricultural matters
- Compensation (direct or indirect)
- Transportation for the relocation

Analysis of the Results of Moving and Relocation

In spite of this being the first experience of this kind, IRHE was aware from the very beginning of the complexity of the problem of moving and relocating the people since it was an area where, at that moment spontaneous colonization was increasingly expanding with settlers coming from the western provinces of the country, and their frequent conflicts with the indigenous population of the area in some cases had been tragic

The critical phase of the move took place between the end of 1974 and the first half of 1975 because of the mistrust shown by the indigenous groups especially the Kunas, regarding the resettlement program in spite of the fact that the IRHE specialists that had participated in planning the move had kept continual contact with the different groups that were affected

The indigenous groups, especially the Kunas and in lesser degree the Chocoes, decided to settle within the basin area in new locations chosen by their communities with the advise of IRHE and the Bayano Corporation The decision of the indigenous people was supported by both organizations based on the criteria that adaptation to the new conditions of the resettlement could be carried out with less distress and in a shorter time

In the case of the Choco population at the end of March 1974 a critical point was reached because the aim of relocating these communities on the Membrillo river in the Darien province had failed This failure occurred because it had been impossible for the Chocoes to settle in the locations originally planned due to the presence of an insect known as the African black fly or "Morrongoy " This forced them to abandon the site soon after the resettlement operation had started and most of the people had been moved to the new location

The African black fly that is found in the Bayano region is of the *Simulium sanguineum* species which avidly attacks humans and domestic animals during the day Its sting creates a typical erythematous swelling with a defined haemolytic center accompanied with an intense itching In addition to the discomfort from the bites these flies are known vectors that spread onchocerciasis

The great density of Morrongoy flies in the new settlement sites made it extremely difficult to work during the day On the other hand, no effective measure to control these flies was known since insecticides proved to be useless This forced the people to definitely abandon the site and created hard feelings and mistrust on behalf of the indigenous community regarding the resettlement process

819

The settlers, most of whom raised cattle, did not pose major difficulties The basins of the most important rivers feeding the Bayano river were cleared of settlers and cattle Approximately 55% of the settlers that left resettled within the district and purchased land with resources from the commodities that were indemnified (generally via indirect sale) In 1975, 90% of the settlers that had to be displaced had accepted the indemnity

8 4 Complementary Socio-environmental Activities

At the same time, the relocation program covered other basic aspects of the affected population such as food, education, health and assistance for production activities

Food A subsidized food program was established for the affected population at the relocation sites for a period of 6 months before the first harvest The provision of subsidies was initiated at the beginning of 1975 and continued with consecutive monthly supplies throughout the established period

Education Jointly with the Ministry of Education, a school at Partí was created and school materials were supplied The assignment of two teachers was also achieved A school for the area of Ipeti was also created in the resettlement area of the Choco indians

Health With the support of the medical team from the Bayano Project at that time and of the Health Center of Chepo, field trips for medical assistance and vaccination were carried out during the period before relocation This allowed assessing health conditions of the population and taking preventative measures to avoid health problems during relocation Additionally, a medical exam and yellow fever vaccination campaign was carried out as well as the construction of wells at each relocation site

8.5 Evolution of Problems After the Resettlement

After 1975, when the resettlement operations and the building of the Bayano hydropower plant had concluded, the population of settlers increased by 75% to 100% The temporary villages that had been established to lodge the construction workers of the Bayano hydropower plant and the Pan-American highway, such as La Nicora and El Puente, became permanent and increased in size afterwards In the area of Tortí, in the eastern section of the basin, three new colonization points appeared Higueronal, Playa Chuzo and Cañazas

During the years after the displacement of the almost 4,000 original inhabitants of the basin, migration of new settlers increased to the point that in 1978 the population within the basin area was estimated at 3,000 not including the great number of workers of the Inter-American Company and the Bayano Corporation

8 6 Effects on the Indigenous Population

The indigenous population was unquestionably the most affected by the construction of the dam, but the great social organization level of the Kunas played a favorable role for the readaptation process, and functioned at the same time as an efficient element for pressuring and negotiating with the governmental organizations However, the low level of leadership of the Chocoes in the area was not able to face in an organized way all the problems that arose during the displacement

820

The most important effects of the relationship of the indigenous population with its environment as a result of the displacement were the following

- The loss of the most fertile land in the lower parts of the valley that would be flooded by the reservoir, which directly affected the production of certain traditional crops (cacao, avocado, banana, etc) and determined the need of more work per acre of land at the new locations

- Dependency on income from the compensations andother services provided by the government

- Estrangement, at least temporarily, from the network of economic and social relationships with other communities

- The political organization of the Kunas, which is the basis for community life and the life of society in general, suffered the impact of the changes, causing latent internal political contradictions to surface The same thing can be said of the Chocoes, but with more serious effects because their lower social organization level endangered the group's very existence

- Isolation of the communities from each other and other populations in the area with the resulting unbalance in the economic and social relationships of the population

- Disappearance or increased distance to certain traditional sources of raw material (such as the "guágara' used for house roofing and the 'naguala" used for basket making), as well as the increase of distance to water sources, which implied the digging of new wells and the eventual change in personal hygiene

- The Ministry of Agriculture Development (MIDA) reported having received several petitions of Kuna Indians to exploit lumber, which is unusual among this indigenous community These individual petitions were objected by the Kuna leadership since this practice was considered to oppose the customs and internal cohesion of the community

- Petitions to use the pasture lands that had been left by the previous settlers were also received This kind of activity, new for them was also objected by the Kunas, mainly because they relate it to the destruction of the jungle

- Increase in the supply of jewels and other luxury items, and the monetization of the economy

821

9. CONSIDERATIONS ON THE FISH FAUNA

The transformation of a lotic ecosystem by the damming up of the water flow affects aquatic animal and plant communities because of the modification of vital aspects such as food availability, physical and chemical water conditions (temperature, cloudiness, oxygen demand, pressure, flow, etc) and spawning sites

From experience in tropical areas, it is well-known that the impact of damming is noticed in the reduction of the diversity of species, resulting mainly from the eutrophication of the water This phenomenon is usually accompanied by the accumulation of soluble nutrients and insoluble sediments which begin the deterioration of the capacity of the reservoir

Once the reservoir has been configured physically, the phase of colonization begins in which those species that can best adapt to the new lentic environment survive This stage is associated with a high biological productivity since the abundance of available organic matter guarantees the food for the different species of fish

Five years after the formation of the Bayano reservoir, 13 species belonging to 6 families were detected The studies undertaken before the construction of the reservoir revealed the existence of 61 species belonging to 26 families, this meaning a reduction of 79% in the number of species

Although the species in the lake have been favored by the abundant availability of food, their dispersion has been limited by physical and chemical factors, mainly by the concentration of oxygen in the water column In the Bayano lake, the 1 mg O_2/liter isoline is approximately 10 meters deep, thus indicating that the fish need to locate in more shallow water and disperse horizontally

Of the 13 species found in the lake, 8 are omnivorous, 4 are carnivorous and 1 herbivorous The omnivorous species obtain the most their food from the abundant plant material, detritus and animal biomass, however, 90% of the captures performed during the period of the study were omnivorous fish This fact may be explained by the greater capability of these species to adapt to the new food supply in the lake

The herbivorous fish, jointly with the omnivores, comprise the greatest part of the animal biomass in the lake Generally speaking, the lake's trophic chain has become integrated to mitigate the unbalance of the ecosystem This is confirmed by the presence of many aquatic weeds which make the existing unbalance between primary and secondary production evident

While attempting to compensate the existing balance, several vital parameters of the fish populations are modified, such as length, weight, reproduction rate and feeding habits Another way of compensation of the ecosystem consists in modifying the inter and intra-specific relations A clear example of this is the great number of parasites found on the captured fish

The eutrophication process of the lake is still growing, mainly because of agriculture and livestock raising activities in the area While these conditions continue to prevail the reservoir will remain in an unstable situation and the ichthyological diversity will remain near today's levels, with prevalence of omnivorous species

822

9 1 Influence on Ocean Ichthyofauna

The construction of the reservoir had at least two main direct effects on the ocean fauna The first is related to the interruption of periodic migration that several ocean species, usually Euryalina , carry out several miles up the rivers to fulfill vital stages of their life cycle The second effect has to do with the reduction of nutrients that the river used to supply the ocean and that were essential for the reproduction and growth of many ocean species

In 1980, five years after the formation of the reservoir, 12-13 year old sharks of the species *C leucas* were caught at the lake Adult sawfish (*Pristis perotteti*) of both sexes and in good condition ready for reproduction were also caught These two highly Euryalina and Elasinobranchii species are found in shallow coastal waters throughout tropical America Both species freely invade almost all fresh water masses that are accessible including coastal lakes, canals and rivers

There is also evidence of the presence of other ocean fish such as the "róbalo" (*Centropomus pectinatus*) and the 'roncador' (*Pomadasys bayanus*), which are highly Euryalina species that commonly advance far into fresh water streams

9 2 Fishing Potential

The Bayano basin, before the construction of the hydropower plant, supported subsistence fishing activities practiced mainly by the indigenous population, which made up part of their protein diet Now the changes created by the reservoir have drastically reduced fishing activity at the Bayano river

The omnivorous species *Brycon argentus*, known locally as "sábalo", is the most appreciated by the river population, although others are also fished such as the "peje perro" (*Hoplia*) and "guavina" (*Gomiomorus maculatus*), some of which are important for sports, although no fish culture project has been considered to foster subsistence or sport fishing and it is still an alternative to be considered

The lake's potential is estimated at 2,000 metric tons per year, accounting for a yield of 63 2 kg/ha/year, which is considered an excellent value for a tropical lake Although these are preliminary estimates, the experimental captures conducted during the study reveal values close to the theoretical estimates

To a certain extent, fishing at the lake could contribute to the appropriate management of the intra-specific relations of the fish species, preventing the population from reaching maximum densities and keeping production within acceptable ranges by increasing the probabilities of survival of fingerlings and small fish

The change generated by the reservoir does not favor the fishing methods used by the indigenous people (harpoon and hook) which are more appropriate for lotic environments Likewise, the fact of not having appropriate boats limits the population's fishing capacity

823

10. INSTITUTIONAL AND LEGAL ASPECTS

Before initiating the construction of the Bayano reservoir in 1971, Cabinet Decree 123 of May 8, 1969 declared the land in the area known as Upper Bayano, i e the land above the reservoir, not subject to expropriation This decree stipulated a polygon for the protection of 112,000 hectares, designating it as an **Hydropower Reserve** and appointing IRHE as directly responsibile for appropriately controlling forestry exploitation and land use

With the purpose of taking care of the problem of the transfer and relocation of the population that had to be moved from the areas that would be flooded, the Integrated Development Project for Bayano, or simply the Bayano Corporation, was created in May 1973 as a branch of the Agriculture Development Ministry, which was later converted into the Bayano Integrated Development State Corporation by Law 93 on December 22, 1976 with additional special functions for the economic development of the upper part and most of the lower part of the river's basin with exception of the lands belonging to the Indigenous Reservations

Law 93 classified all lands above the site of the reservoir as a Forest Reserve and allowed profitable use of a great part of the areas that would be flooded through multiple forestry concessions

Decree No 5 of April 23, 1982 regulated the expropriation of rural lands in the Bayano area which belonged to the State, with the exception of the indigenous lands, establishing that the woodlands and forests belonging to the State could not be expropriated By the recommendation of the Renewable Natural Resources Institute (INRENARE), these lands should be considered as protection or special forests However, final expropriation of the lands was subject to the decision of the Bayano Integrated Development Corporation It was also established that the lands with 20% to 45% and greater inclinations should be recommended for forestry

On August 3, 1984 an agreement was signed between the Ministry of Agriculture Development and the Kuna de Madungandi community, regulating the management of renewable natural resources in the area belonging to the community and establishing that the use of natural resources in the area should be jointly decided by the Bayano Corporation, the INRENARE and the Kuna Congress in the area.

Within the IRHE, a Group for the Control of Aquatic Weeds was created to take care of the problems caused by the rapid proliferation of aquatic weeds since the beginning of the formation of the reservoir in 1976 This Group later served as the basis for the creation of the Hydrographic Basin Management Department

Because of the many social problems that were created from relocating the settlers and indigenous population of the area and aggravated by the constant migration of new settlers, an Inter-institutional Technical Committee was created in October 1986 to coordinate the activities, which had often been contradictory, of the institutions involved in the management of the Bayano basin This Committee smoothed the way for the creation of the Bayano Commission to which a high decision level was granted and which substituted the Bayano Corporation in its responsibilities for the management, control and development of the basin This Commission established the following as priority areas of attention the indigenous area, the agriculture areas, the reservoir's polygon of protection which had been established by IRHE, and the water protection forest areas of the Majé and Cañazas mountain ranges

824

Figure 4
TYPES OF HABITAT IN LAKE BAYANO

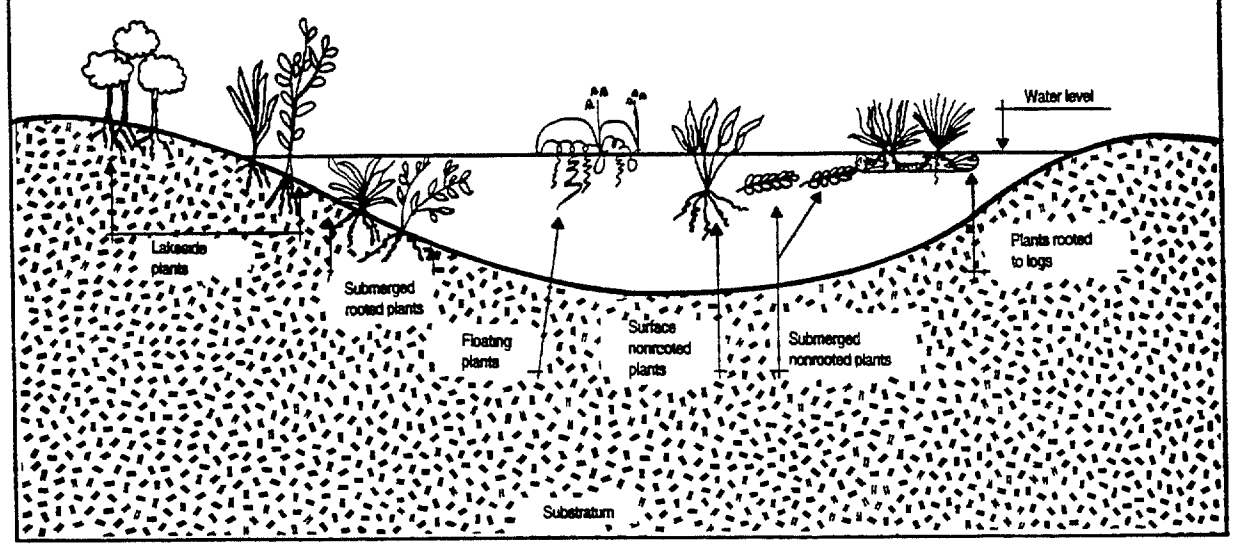
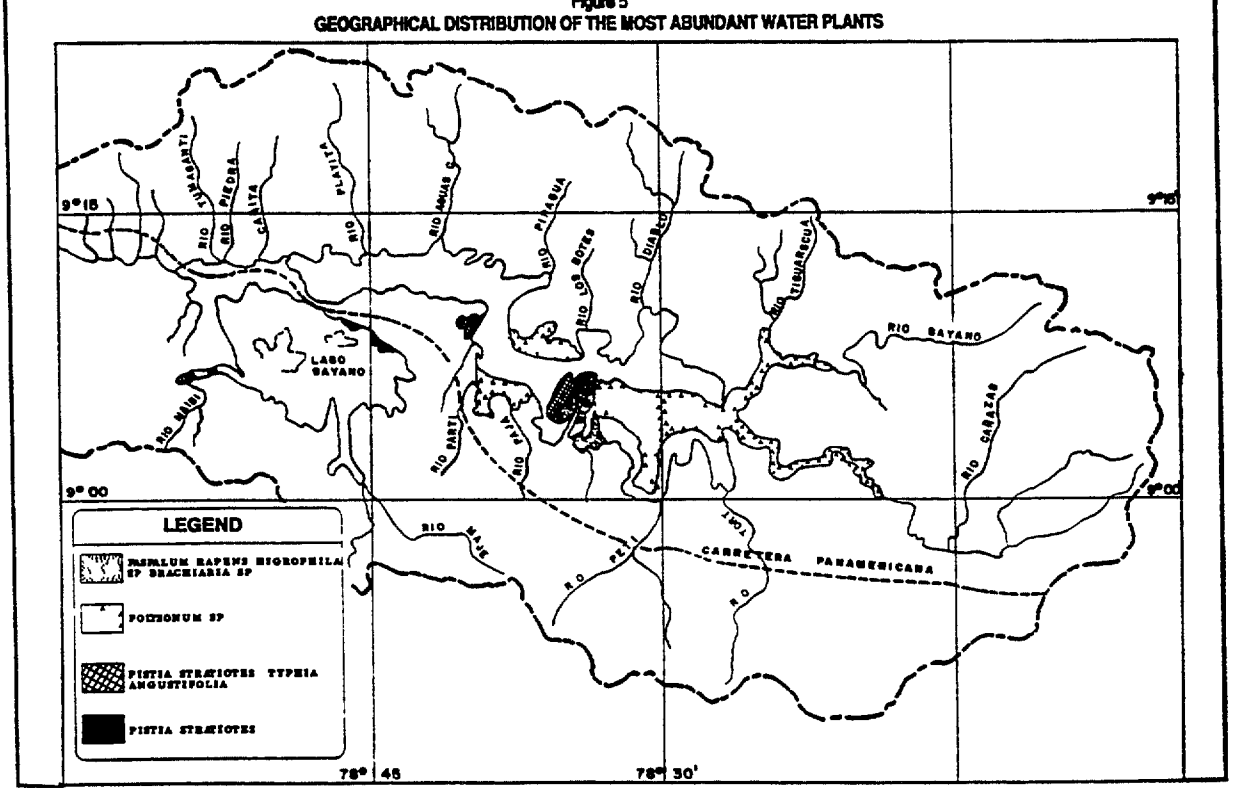


Figure 5
GEOGRAPHICAL DISTRIBUTION OF THE MOST ABUNDANT WATER PLANTS



825

The evolution of the institutional and legal aspects related to the protection and management of the Bayano basin shows the complexity of the economic, social and ethnic interests involved in this region rich in forests and animals but facing fast destruction The expectations arising from the creation of the Bayano Corporation and the INRENARE were not accomplished, and the causes and consequences of the destruction of the basin's forests still persist, aggravated even more by the lack of action, the increase of spontaneous migration and commercial exploitation of the forests

Although the creation of the Bayano Commission in 1986 seems to have been a good step for improving the management of the Bayano basin, the proposal of privatizing the Bayano Corporation could create an institutional gap and encourage colonization and irrational exploitation of the basin's natural resources, in addition to the potential ethnic conflicts that could arise since this is an indigenous area

Throughout the historical evolution of the problem, the IRHE has been technically and legally subordinated to the Bayano Corporation and the INRENARE in the protection of the basin Decree No 5 of 1982, which regulated the expropriation of land in the basin, was unable to halt the exaggerated growth of spontaneous colonization and irrational forest exploitation However, the eventual approval of the law proposal that would create the Madungandí Indigenous Territory and which is being studied by the Legislative Assembly, would allow IRHE a better legal position to organize the management and protection of the basin by allowing it to operate in the Kuna Reservation which comprises 180,000 hectares of land in the northern area of the basin equivalent to 46% of the basin's total area

However, Law 93 excluded, among others, the lands of the Maje river basin which supplies the Bayano river with 30% of its water Considering the intention of privatizing the Bayano Corporation which has been announced by the Government, it is of fundamental importance that the 40,000 hectares of woodland remnants of the Maje River's basin be protected under Law 93 In this sense, IRHE has initiated actions so that these woodlands be declared natural protection areas and prevent their destruction

However and as experience has shown, adequate legislation is not sufficient to achieve the conservation of the basin Supposing that the institutional interests reach agreement in relation to the management of the basin, it is essential that IRHE's Basin Management Department be technically and administratively strengthened, providing it with greater financial and human resources to face the tasks involved in preserving the Bayano basin

In the context of institutions that have to do with the management of the basin, because of the existence of the reservoir and because of the operation costs involved in the maintenance of the hydropower plant and the reservoir, there is no doubt that IRHE is the organization that has more interest in protecting the basin

11. WEEDS

One of the ecological imbalances that arose after the formation of the Bayano reservoir was the rapid proliferation of several aquatic weeds that covered the water's surface extensively during the first weeks after closing the gateways of the plant creating navigation problems and endangering people's health since they are an ideal habitat for mosquitoes that carry infectious disease (Figures 4 and 5)

826

The proliferation of aquatic weeds is a direct consequence of the lake's eutrophication, which initially resulted from great amounts of organic matter being decomposed from the vegetation that was covered by the reservoir's water The presence of aquatic weeds is characteristic of tropical artificial lakes when the bed has not been cleaned properly before flooding

At the beginning of the formation of artificial lakes in tropical areas there is always excessive growth of weeds which, as the lake stabilizes itself, gets weaker until it reaches equilibrium, the level of weed invasion depends on the degree of eutrophication of the lake In the case of the Bayano reservoir, the colonization of riverside lands for agriculture production and population expansion constantly increases the level of eutrophication of the lake, which in turn nourishes weed growth

12. BRIEF ANALYSIS OF RISKS

A complete analysis of the dangers entailed for the Bayano hydropower plant should also include the risks that the very presence of the plant directly or indirectly represents to the environment Uncontrolled migration, the resulting destruction of the jungle in the area of the Bayano river, and the very existence of the reservoir have affected the region's bio-climatic balance generating droughts and floods—previously considered natural phenomena—strongly linked to man-induced disturbances

In the case of earthquakes because of the characteristics of this phenomenon, types of human occupation have no direct relation to the cause of the risk History shows that Panama has not experienced any great earthquake disasters in spite of its being considered an area of seismic danger because of its tectonic situation

Frequent seismic activity around the Isthmus' coasts and neighboring areas has an explanation in the fact that the Panama micro-plate is located at the junction of the Nazca and Cocos micro-plates on the Pacific with the Caribbean plate (Figure 6) Tectonic activity of these plates determines seismic activity in the area However the studies show that the dam's site and the whole area of the Bayano reservoir are located in a low earthquake risk area (Figure 7)

Regarding floods, the Bayano reservoir exerts a great regulating influence over the periodic floods that affect the basin The last one occurred in 1966 killing 120 persons and causing great economic losses as a result of damaged crops and infrastructure However, because of the great degree of deforestation caused by spontaneous colonization in the area of the Bayano River's basin, the studies classify it as an area with danger of flooding

13. INFECTIOUS DISEASES: VECTORS AND HOSTS

In 1974, IRHE made a study, which included field studies to assess the health situation of the basin's population mainly in relation to diseases which could potentially be dangerous and were caused by the flooding of the reservoir and the relocation of the population in other areas of the basin Because of the attitude of the Kuna Indians that live in the intermediate and upper areas of the Bayano River, who have always objected the presence of strangers, this is one of the less known areas in Panama

227

Figure 6
HIGH, MEDIUM, AND LOW SEISMIC IMPACT AREAS

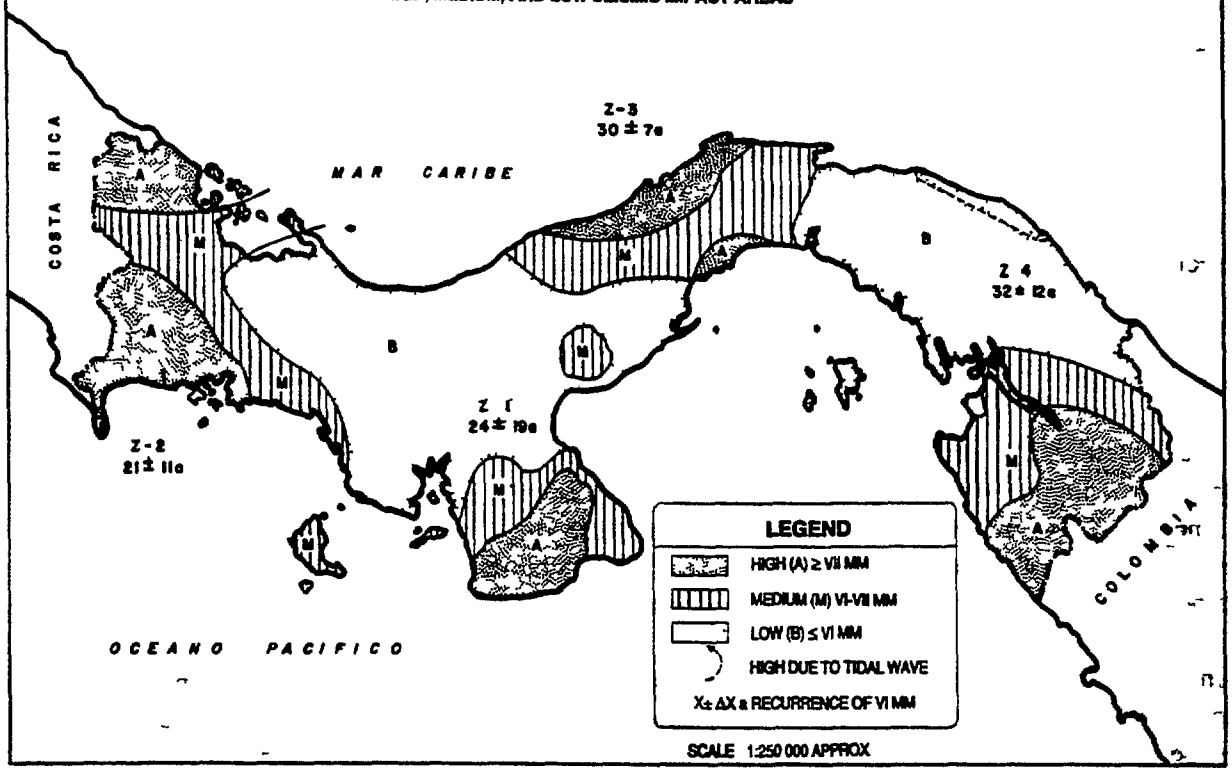
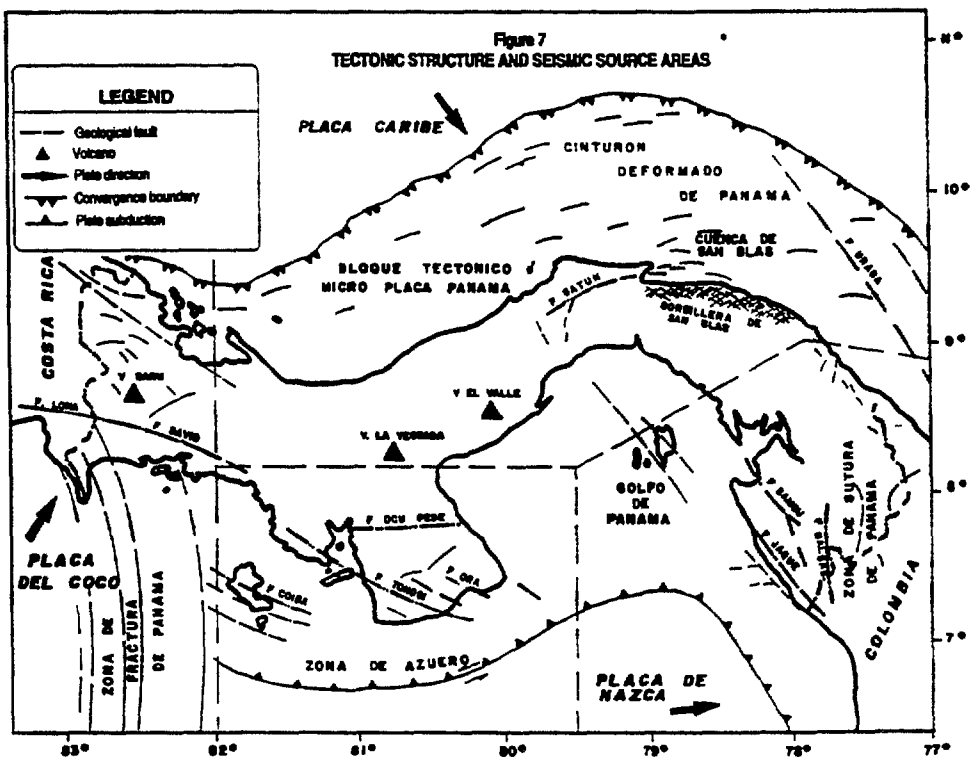


Figure 7
TECTONIC STRUCTURE AND SEISMIC SOURCE AREAS



828

The tropical humid climate of the Bayano basin favors the presence of a wide variety of tropical disease vectors and hosts, whose populations could be affected by environmental changes generated by the construction of the Bayano hydropower plant

The diseases that were taken into consideration were those more closely related with the flooding of the reservoir and those which represented a higher potential danger for the hydropower plant workers and local population that had to be relocated

13 1 Vectors

Chagas' Disease

The first of these groups of vectors related with the transmission of Chagas' disease is the Triatominae subfamily, commonly known as "chinches mamones " These insects are usually found in the leaves of recently roofed houses and they attack humans and domestic animals at night

Triatominae insects do not transmit Chagas' disease through biting but by the contamination of mucous membranes or skin wounds with faeces For this reason, in spite of the fact that a high percentage of captured insects were infected with *Trypanosoma cruzi*, laboratory analysis resuls of several thousands of inhabitants of the basin highly exposed to the biting of these insects revealed an infection rate of less than 1% However, in the riverside regions of the Gatun Lake, where the jungle has been destroyed, the infection rate of Chagas' disease among humans reaches 30%

Probably the low incidence of Chagas' disease among the population of the Bayano River is related to with the presence of the jungle which determines that the transmitting insects remain less time in the houses throughout their cyclic movements from their natural jungle habitat to the houses and back again, resulting in low probabilities of human infection

The Rodnius family, which is the most common insect vector family in the Bayano area, is resistant to DDT insecticides which had been used in the country to control malaria, however, Dieldrin and benzene hexachloride are highly effective and are the preferred control substances

There are also other Triatominae insects in the Bayano area, such as *Panstragylus rufotuberculatus* and *Panstragylus geniculatus*, which are related to Chagas' disease, the former prefers tree mammals as hosts, and the latter is related with armadillos with which they carry out a transmission cycle

Malaria

The *Anopheles albimanus* mosquito is considered the main malaria vector in Panama. In the Bayano basin, high densities of this insect were found in the temporary worker camps located at the Majé and Majecito rivers At the beginning of the rainy season, the density of these mosquitoes is high enough to cause malaria outbreaks

Insecticide fumigation inside the houses proved to be inefficient to control the adult mosquito population and the distribution of Aralen and Primaquina drugs among the workers, which have suppressive, preventative and curative effects, was preferred Fumigation of water puddles and deposits around the camps up to a distance of one kilometer with diesel or green Paris oil was also carried out

Aquatic weed proliferation at the reservoir, especially of *Hydrilla* and *Najas*, created an ideal environment for the reproduction of *Anopheles*, since its larvae find appropriate protection from their natural enemies by residing among the leaves Although no epidemiological studies were carried out later, the main problem reported by the Kuna Indians living in the area of the reservoir in relation to the aquatic weeds was the proliferation of mosquitoes High concentrations of *Anopheles* were also reported in the areas where the population was relocated by the project, in Chichebre and most of all in the southern part of the Pan-American highway

The main breeding grounds for this mosquito are the swamps formed by the flooding of rivers and by uncontrolled irrigation practices of certain crops such as rice, which can cause severe outbreaks such as the one that occurred in the Los Santos Province in 1945 while initiating the service of an experimental irrigation project at the La Villa River The best permanent control for this mosquito is the construction of good drainage systems

Encephalitis

In the Bayano region high densities of *Aedes* mosquito have been found which are responsible for the transmission of several types of encephalitis, since immediately after the formation of the reservoir and before its stabilization, favorable conditions existed for its proliferation In spite of the fact that up to this moment there has been no outbreaks of this disease, the Ministry of Health periodically monitors the area for *Aedes* mainly because of its relation with breakbone fever (hemorrhagic dengue)

Another species related with the transmission of encephalitis is *Mansonia* which is not found in great densities in the Bayano area. However, since the proliferation of aquatic weeds offers an ideal habitat for the growth of its larvae, a monitoring program during the first years of the plant's operation was implemented

The *Culex* species, which also transmits several types of encephalitis, was detected having low concentrations, which did not entail an immediate danger for the population living in the area. However, the proliferation of aquatic weeds generates a potential danger of population increases of certain *Culex* species and concomitant encephalitis outbreaks

Yellow Fever

In the area of the Bayano River the presence of different species of *Haemagogus* mosquito at high densities was detected, which is an important transmitter of yellow jungle fever through the chain established between mosquitoes and tree mammals, mainly monkeys, which either die or become immunized against the disease

Yellow jungle fever is not endemic to Panama and the virus is introduced to the country through its eastern border at intervals of 7 to 9 years depending on the life cycle and survival period of its hosts Expansion waves of the disease occur during the rainy seasons when adult mosquito density is high enough If the dry season is particularly severe the transmission chain is broken

In the Bayano area, yellow jungle fever outbreaks were reported in 1942, 1964 and 1974 Taking the disease's life cycle and the climatic conditions into account, a new outbreak could have been expected by 1981 or 1982 However, the vaccination campaigns promoted by the Ministry of Health during and after the construction of the Bayano hydropower plant eliminated that possibility

830

Another species able to transmit yellow fever and that is relatively abundant in the jungle areas of the Bayano River is the mosquito of the *Sabethes* species, which bites humans on jungle ground all year round Up to this moment no effective control measure is known against this mosquito

Leishmaniasis

In the Bayano area the presence of Flebotominea insects of anthropophilic habits is also frequent, which are locally known as "chitras aliblancas" and which are important vectors of leishmaniasis and of the so-called "Panama three-day fever " Of these species the most common one, *Lutzomyia panamensis*, attacks humans avidly in the jungle and in shaded places during the daytime as well as at night Its preference to keep close to the ground in the jungle makes it especially dangerous for timber cutters and agriculture workers that work at the edge of the jungle

Other less dangerous species that prefer tree tops, such as *Lutzomyia trapidoi* and *L. gomezi*, are also present in the Bayano region

13.2 Hosts

Yellow Fever

Most of the monkeys in the Bayano region are an important link in the transmission cycle of yellow fever Some species, such as the white-face monkeys, rarely get sick or die, but yet others, such as the well known howling monkeys, are susceptible to the infection and have high mortality rates For this reason they are used as indicators of yellow fever outbreaks During the 1973 outbreak that occurred in the Bayano area, the people who contracted the disease invariably had found dead monkeys of this species in the jungle

Another species which in other times was found in high numbers in the Bayano basin but that is now only found in the most unaccessible parts of the basin because it lost its original natural habitat, is the black spider monkey, which is highly susceptible to yellow fever infections but rarely dies, being this the reason for being one of the best indicator animals to monitor any recent infection wave, since specimens of this species show high immunity values which may be easily detected through serologic surveys

Chagas' Disease

Finally, *Saguinus geoffroyi*, commonly known as the "titi" monkey and that is a very popular pet, seems to be a natural host of the Chagas' disease In the study carried out before the construction of the hydropower plant, 30% of the examined specimens showed to be infected by *T cruzi*

Another hosting animal of *T cruzi* is *Dasypus novemcintus* or armadillo, which locally is very appreciated for its meat This mammal plays an important role in the Chagas' disease transmission cycle, although it has also been recently discovered that the armadillo easily contracts leprosy (Hansen's bacillus)

Leishmaniasis

The Bradypodidae family, better known as sloths, are the main hosts for the jungle cycle of leishmaniasis

831

14. SOCIO-ENVIRONMENTAL ASPECTS

In the late forties a migration process began in Panama coming from the southern, central and western rural areas of the country towards its eastern regions, with the cities of Panama and Colón and the areas near the Panama Canal as its first destinations Overexploitation of agriculture and cattle raising and the increase of population size that took place on the Pacific side of the country caused severe environmental deterioration the destruction of forests and the loss of topsoil and agriculture productivity undid the production basis of agriculture society in those areas

In the fifties a new migration stage took place in the country which was characterized by the colonization of the eastern forests, commonly known as the "new agricultural frontier " This new way of occupying the Panamanian territory resulted from the expulsion of the population from its original lands and cities from the impossibility of producing and surviving Similar to the first stage, it was an unplanned migration process

The immediate effect of the expansion of the agricultural frontier was the deforestation of extensive tropical woodland areas According to certain studies it is estimated that between 1947 and 1990 Panama's forests decreased from 70% to 25% of the total national territory at an average rate of 70,000 hectares per year In less than 45 years Panama destroyed 65% of its forests If this deforestation rate should continue, by year 2000 only 10% of the country's territory will be covered with forests

From the sixties on, a rapid economic modernizing process took place promoted by the government which affected almost all of the production sectors and social classes Commercial agriculture was technified and plantation agriculture (banana and sugar cane) was mechanized, which included big rice and corn producers During this period the construction of infrastructure works also took place, such as highways and hydropower plants such as the Bayano plant This process, however, took place by sacrificing the ecosystems greatly, and by 1980, 80% of the main hydrographic basins of the country were deforested at varying degrees

One of the immediate consequences of deforestation is the loss of soil and erosion Most of the jungle areas in Panama cover abrupt lands with low fertile clay soils that, once their vegetation has been eliminated, are washed away by intense rainfall and become useless for agriculture production and cattle raising Of the tropical American countries, Panama is one of the most severely affected ones by erosion

As a direct result of deforestation, the erosion process during the last three decades has had an alarming progress According to FAO, in the sixties the extension of used and eroded land was 500,000 hectares, while 20 years later eroded land covered between 1 3 and 1 8 million hectares By the year 2000, it is possible that the deteriorated area may amount to 2 million hectares, equivalent to 30% of the national territory

The construction of the Bayano hydropower plant took place, in historic terms, in the middle of this process of expansion of the agricultural frontier towards the eastern part of the country, and is contemporary with the construction of the eastern section of the Pan-American highway that will join Panama with Colombia

832

The construction of this section of the highway and the almost simultaneous construction of the Bayano hydropower plant accelerated the spontaneous colonization process that had begun in the mid-fifties with the resulting destruction of extensive tropical jungle areas that were converted into pasture lands for cattle, used for subsistence crops or to exploit wood species

The migration wave toward the Bayano basin, which in 1990-1991 was already important, became even faster with the construction of the hydropower plant It has been estimated that between 1970 and 1990, 30% of the Bayano basin forests were destroyed

IRHE believes that the colonization process grew even faster since 1990 with the colonization of virgin lands located at the Maje River basin, which feeds the Bayano River and contributes with approximately 30% of the reservoir's annual volume. The new settlers come from the western part of the country as well as from the Columbian department of Chocó that is on the border with Panama. From that year on military surveillance that could be observed years ago in the area has almost disappeared

The total population of the upper Bayano basin is estimated at 14,114 inhabitants, 30% of which live near or at the lake During the last 20 years the population of the basin grew threefold, with a significant increase from 1980 to 1990 when the area's population grew by 70% Almost the entire population growth (95%) is now located in the El Llano jurisdiction, which is in the lower part of the basin and has access through to the Pan-American highway

One of the most important features of this population growth in the upper basin of the Bayano River is that it dispersed itself in a very extensive area, as the great number of new settlements suggests Between 1970 and 1990 the number of human settlements in the El Llano jurisdiction increased from 79 to 143

This population growth dispersion, mainly fed by migration coming from the southwestern provinces (Los Santos, Herrera and Veraguas), has its explanation on the need for occupying lands for agriculture and cattle production Between 1971 and 1991 the total number of agriculture farms recorded by National Surveys in the El Llano and Cañita jurisdictions increased from 159 to 970, most of them especially for cattle raising In this period the number of heads of cattle increased fivefold

833

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834

ENVIRONMENTAL AUDITING

Compliance Auditing

Environmental Auditing Defined

- Systematic
- Documented
- Periodic
- Objective

835

Environmental Auditing

- Why Audit?
- Advantages and Disadvantages
- Types of Audits
  - Compliance Audit
  - Liability or Risk Management Audit
  - Industrial Property Purchase Audit
- Management Support is Critical

Environmental Auditing

- Corporate Environmental Policy
  - Commitment to Environmental Excellence
  - Cooperation with Government
  - Public and Employee Safety
  - Investing in Solutions
  - Information and Training
  - Policies, Procedures, Plans, etc

836

Environmental Auditing

- Audit Objectives
  - Regulatory Compliance
  - Training
  - Evaluate Personnel Performance
  - Evaluate Resource and Budget Allocations
  - Identify Liabilities
  - Preventative Maintenance

Environmental Auditing

- Audit Objectives (continued)
  - Communicate Environmental Expectations
  - Evaluate Subcontractor Performance
  - Test Emergency Responsiveness
  - Identify Cause for Problems
  - Identify Opportunities for Pollution Prevention, Recycling, etc

Environmental Auditing

- Developing an Audit Program
  - Establish Company Objectives and Policy
  - Identify Audit Coordinator and Other Team Members
  - Develop Audit Tools
  - Train the Audit Team
  - Test the Audit Program

Environmental Auditing

- Developing an Audit Program
  - Establish the Schedule
  - Conduct the Audits
  - Evaluate Effectiveness
  - Implement a Continuing Audit Program

Environmental Auditing

- Managing the Audit Program
  - Performance Reporting
  - Staff Management
  - Quality Assurance

Environmental Auditing

- Audit Coverage
  - Air Emissions
  - Wastewater Discharges
  - Stormwater Discharges
  - Solid Wastes
  - Hazardous Wastes
  - PCBs

Environmental Auditing

- Audit Coverage
  - Hazardous Materials
  - Petroleum and Oil Storage and Handling
  - Pesticide Management
  - Drinking Water
  - Worker Health and Safety

Environmental Auditing

- Audit Procedures
  - Pre-Audit Activities
  - On-Site Activities
  - Post-Audit Activities

Environmental Auditing

- Pre-Audit Activities
  - Audit Planning
  - Notify the facility
  - Background Information Review
    - Facility
    - Reports and Records
    - Waste Generation, Storage, Treatment, Disposal, etc
    - Requirements and Regulations

Environmental Auditing

- Pre-Audit Activities
  - Review Relevant Regulations
  - Define Audit Scope and Team Responsibilities
  - Review Audit Protocols and Checklists

Environmental Auditing

- On-Site Activities
  - Remember to Document Everything
  - Arrival and Opening Conference
  - Records & Document Review
  - Staff Interviews and Physical Inspections
  - Post-Audit Debriefing

Environmental Auditing

- Post-Audit Activities
  - Data and Information Management
  - Follow Up Data Collection
  - Audit Report Preparation
    - Executive Summary
    - Audit Location
    - Audit Dates
    - Auditors
    - Reason for Audit
    - Facility Map

Environmental Auditing

- Post-Audit Activities
  - Audit Report Preparation
    - Background Information
    - Level of Compliance Reporting
      - Regulatory Deficiency
      - Procedural Deficiency
      - Significant Deficiency
      - Major Deficiency
      - Minor Deficiency

Environmental Auditing

- Post-Audit Activities
  - Legal Review
  - Identify Follow Up Activities

Environmental Auditing

- Legal Protection and Confidentiality for Audits
  - Attorney-Client Privilege
  - Company Maintained Confidentiality

Environmental Auditing

- Training Auditors
  - Selecting Trainers and Trainees
  - Selecting Training Techniques
  - Keys to Successful Training
    - Be Prepared
    - Make It Fun
    - Evaluate the Program
    - Give Trainees a "To Do" List

V. Environmental Auditing -- Compliance Auditing

Note Much of the text for this section of this manual was taken from the following sources

1 David McGraw, P E , ***Environmental Auditing and Compliance Manual,*** Van Nostrand Reinhold, New York, 1993

2 Lawrence B Cahill, and Raymond W Kane, ***Environmental Audits,*** Government Institutes, Inc , Rockville, MD, 1991

A INTRODUCTION

The term "environmental audit" can be interpreted in many different ways Some environmental professionals define an environmental audit as a systematic, documented, periodic, and objective review by regulated entities of facility operations and practices related to meeting environmental requirements A review of the four key terms in this definition help to give meaning to the term "environmental audit" and provide a baseline against which any auditing program can be evaluated

Systematic--An environmental audit must be based on a consciously organized approach for ensuring that all environmental factors are considered The purpose of this factor is that audits should be consistent and comparable over time and among different facilities or sites One of the fundamental components of this approach is often the use of checklists or protocols

Documented--The results of the audit must be documented if the audit is to have any impact, such as calling the attention of upper management to problems that need the commitment of additional resources, or prodding operational personnel into improving their procedures It is also important to provide management with a written list of items that need a response or corrective action

Periodic--If an environmental audit program is to have a beneficial effect, the audited entities must understand that there will be audits on a regular basis that will include a follow up on the deficiencies noted in the audit report, and an evaluation to see if recommendations have been implemented

Objective--The audit must be performed by independent personnel outside of the functions that are being audited Although self-audits can be a useful tool for internal management, there is too strong a tendency of human nature to not report bad news, thus resulting in audits which tend to be incomplete, inaccurate, or biased In addition, personnel with production responsibilities often do not have the background or training to recognize all of the compliance issues that may apply to their operation

945

Why Audit?

The decision to conduct an environmental audit typically results from the need to satisfy one or more of the following objectives

- Determining the status of compliance with environmental requirements
- Identifying potential liabilities of the company and its officials
- Tracking the costs (monetary, manpower, and resources) of complying with environmental requirements
- Identifying and enhancing the environmental awareness of employees
- Evaluating the performance of employees responsible for environmental compliance
- General investigation

Advantages and Disadvantages

Environmental audit programs are characterized by advantages and disadvantages

Advantages

- Better compliance with environmental requirements
- Increased environmental awareness among employees
- Better performance by employees responsible for environmental compliance
- Potential cost savings
- Potential reduction in liability and penalties (See example sentencing guidelines)
- Better community relations

Disadvantages

- Monetary, manpower, and resource cost of the audit
- Disruption to facility operations
- Potentially damaging discoveries
- Potentially increased liability for failure to resolve problems identified in the audit

846

B TYPES OF ENVIRONMENTAL AUDITS

The structure and approach of any environmental audit should be consciously developed to reflect the objectives of the audit There are as many approaches to environmental auditing as there are reasons for instituting an environmental audit

Environmental audits and auditing programs can be instituted for a variety of reasons the most common, and the standard for environmental audits, is the compliance audit which is undertaken to evaluate the conformance of a facility with a specific set of regulations An audit of this type closely parallels the same process that a government regulator would follow if inspecting the facility It is important to note that this type of audit is not intended to replace environmental compliance systems but to verify that they are in place and functioning properly

Another type of audit that may be conducted or combined with a compliance audit is a liability or risk management audit A liability audit goes beyond strict compliance with the laws and regulations to look at activities that, while they may be in compliance with today's requirements, may also be creating risks or liabilities in the long term For example, the disposal of hazardous waste in a proper landfill may be legal but may create long-term liabilities

Another type of environmental audit focuses on liability associated with property transfers These types of audits are addressed later in this manual

847

C MANAGEMENT SUPPORT

For an environmental audit to be effective, it is imperative to have explicit top management support for environmental auditing, and commitment to follow up on audit findings Management support may be demonstrated by a written policy articulating upper management commitment to the auditing program and for compliance with all pertinent requirements including corporate policies and permit requirements as well as statutes and regulations

Management support for the auditing program should also be demonstrated by thorough follow up on audit findings to correct identified problems and prevent their recurrence

848

D CORPORATE ENVIRONMENTAL POLICY

Businesses, corporations, companies, etc that engage in activities that may have an environmental impact also need systems of guidance If the organization you work for does not have effective systems of guidance or principles of conduct with regard to environmental concerns, you should encourage the following

- Develop and issuance of an environmental policy statement
- Formulation and wide distribution of environmental strategies that support the environmental policy statement and are consistent with your environmental ethics
- Development of environmental objectives, plans, programs and procedures
- Environmentally motivated training and regular meetings
- Integration of environmental costs as a necessary part of the business plan

A company's operating philosophy is reflected in its environmental policy statement A strong policy is the heart of responsible environmental programs Developing good environmental policies and strategies are as challenging as they are rewarding A suitable environmental policy statement, for instance, might read like this

"Because our company has a strong regard for environmental protection, product stewardship and safety concerns, we will conduct our activities in such a manner as to protect the physical environment, our employees, our customers, and the general public We will comply with environmental, stewardship and safety laws and regulations, and will develop and implement programs to insure compliance We will be both responsible and responsive in our efforts relating to environmental protection, product stewardship and employee safety

Where our company becomes aware of environmental and product safety risks not covered by existing laws or regulations, we will develop our own good faith standards and practices based on comprehensive and relevant scientific data We will cooperate with the public, government, industry and employees in identifying environmental, product stewardship and safety goals and in developing effective control programs Each operating unit of the company is expected to be guided by this policy in forming plans, setting objectives, and conducting their day-to-day activities "

In order to institute environmental protection, effective strategies must be designed Management strategies could, for example, be patterned after these broad statements of commitment

- We will encourage and support the development of strong, but reasonable, environmental, product stewardship and safety legislation and regulations

- We will welcome opportunities to provide our expertise to government programs to help insure that legislative and research programs are effective in addressing environmental, product stewardship and safety concerns

849

- We will recognize that favorable public opinion regarding the company's environmental protection, product stewardship and safety posture is an essential factor in the conduct of our business

- We will ensure that the design and operation of company facilities reflects consideration of the need to protect the environment, our employees our customers and the general public

- We will ensure that proposed environmental, product stewardship and safety measures provide effective solutions to the problems they are designed to correct

- We will give a high degree of consideration to environmental protection, product stewardship and safety requirements in the company's planning cycle and investment proposals

- We will obtain and disseminate pertinent information to allow the company to stay alert to, and abreast of, environmental protection, product stewardship and safety trends and problems

- We will develop appropriate responses in the form of plans procedures, programs and projects to address environmental product stewardship and safety concerns

Developing environmental policies and strategies is not so difficult It is the effective implementation and continued dedication to the commitments embodied in those policies and strategies that is the real challenge

850

E AUDIT OBJECTIVES

The potential purposes and uses of the results of an environmental auditing program are numerous Objectives that can be met or promoted through environmental audits include the following

- Evaluation of basic regulatory compliance as would be anticipated during an inspection by a regulatory agency
- Function as a training exercise for facility personnel expecting a regulatory compliance inspection
- Assist facility personnel in allocating their time resources to the environmental problems and issues that need to be resolved
- Provide an evaluative tool for corporate management in reviewing the performance of plant personnel
- Assist in the budgeting and allocation of resources both within a facility and at a corporate level
- Provide a mechanism for identifying potential long-term liabilities which may arise out of environmental practices
- Develop organizational environmental policies which implement regulatory requirements, and provide management guidance for environmental hazards not specifically covered in regulations
- Train and motivate facility personnel to work in an environmentally acceptable manner, and to understand and comply with government regulations and internal environmental policy
- Communicate relevant environmental developments expeditiously to facility and other personnel
- Require third parties working for, with, or on behalf of the organization to follow its environmental procedures
- Ensure that personnel are available to carry out environmental (especially emergency) procedures
- Incorporate environmental protection into written operating procedures
- Apply best management practices and operating procedures
- Institute preventive and corrective maintenance systems

851

- Evaluate causes behind any serious environmental incidents, and establish procedures to prevent future occurrences
- Identify opportunities for pollution prevention, recycling, reuse, or substitution of less hazardous materials

852

F DEVELOPMENT AND MANAGEMENT OF AN ENVIRONMENTAL AUDIT PROGRAM

Management of an environmental audit program can be divided into two equally important parts program development and program management The following subsections outline an approach for developing an environmental audit program and identify management techniques used to control, assess, and evaluate the program

STEPS TO DEVELOPING A PROGRAM

The following steps provide a guideline for developing and implementing an environmental audit program Each step is discussed in greater detail in the following subsections

- Establish company objectives and policy
- Identify audit coordinator and other audit team members
- Develop audit tools
- Train the audit team
- Test the program
- Establish the review schedule
- Conduct the audits
- Evaluate the effectiveness of the environmental audit team and program
- Implement a continuing audit program

Establish Company Objectives and Policy

The success of an audit program will depend upon the support from senior company management The explicit support of senior management will make certain that the environmental audit program receives support through out all levels of the company Typically the first step in program development is the creation and distribution of a policy statement The policy statement should be in the form of a letter or memorandum from the senior company manager to the company staff It should describe and support the initiation of an environmental auditing program and should also provide a tentative schedule for implementing the program

In addition to the policy statement, a mission statement for the auditing program should be developed The mission statement should establish the goals of the program For example, an environmental auditing mission statement may read as follows

The mission of [company's name] environmental auditing program is as follows

- To ensure that [company's name] will continue to operate in compliance with environmental laws, regulations, and standards by routine surveillance and periodic formal audits
- To enable [company's name] to establish and maintain awareness and understanding of the environmental community, its issues, its concerns, its legislation, and its technology
- To ensure that [company's name] will manage its environmental affairs so as to make it socially responsive and openly willing to balance community attitudes and values against its own interests while continuing to comply with environmental regulations

853

Identify Audit Coordinator and Other Audit Team Members
A next step in developing an environmental audit program would be to identify who will comprise the audit team and how it will be organized Depending upon the size of the company and man power resources available the audit team can be comprised of full-time corporate auditors to plant staff For larger, multidivision companies, there can be a variety of options, including

- Full-time corporate auditors with corporate legal counsel
- Part-time auditors selected from various divisions and disciplines
- A small corporate oversight group with auditing responsibility

Even in smaller companies, who will participate on the auditing team must be determined Although there is no standard organizational solution, it is recommended that the audit team be comprised of individuals familiar with the operations and processes of facilities being audited

Generally, environmental auditors should posses or have ready access to the knowledge, skills, and disciplines needed to accomplish audit objectives Each individual auditor should comply with the company's professional standards of conduct Auditors, whether full-time, part-time, or consultants should maintain their technical and analytical competence through continuing training and education

Develop Audit Tools
Tools useful in auditing include the following

- Policy statement and mission statement
- Pre-visit questionnaires
- Site visit protocols and checklists
- Audit reporting guidelines

Each of these tools should be developed in a standardized way to ensure consistency among audits and should be developed to be compatible with the types of facilities being audited Eventually, these tools should be incorporated into an audit manual which can not only serve as the working document but can also be used as a training manual for employees

Train the Audit Team
A certain amount of training of the audit team will be required to successfully implement an environmental audit program The extent of the training will vary depending upon the organizational structure and background of the auditing team Typically, there are three main choices for audit team training

- Send team members to publicly available courses on environmental auditing
- Hire out-of-house consultants to come in and train the team members
- Use experienced staff and team members to train new team members

If possible, training should focus on the following areas

- Corporate environmental policy
- Legal and regulatory requirements
- Use of audit protocols and checklists
- Pre-inspection preparation

854

- Site audit techniques
- Post-inspection activities

Although training can be accomplished through a variety of means, a combination of lecture, problem solving, and role playing is recommended

Testing the Audit Program
Once the audit team is established, audit tools developed and training completed, the audit program should be tested Typically, the program would be tested by conducting audits on one or more company facilities If possible, the audit coordinator should select a large, complex facility and a small, simple facility for the team to audit By evaluating the performance of the audit team on the various types of facilities, the audit coordinator should be able to identify the strengths and weaknesses of the audit team For those weaknesses identified, the audit coordinator should work with the audit team to improve the audit performance

Establish the Review Schedule
Once the program has been fully tested, a schedule for auditing all of the company's facilities should be established In addition, the schedule for future audits should also be tentatively established

Conduct the Audits
Once all the preparatory tools are in place and the auditing schedule has been established, the facility audits should actually be conducted ***Refer to Subsection G and Subsection H below***

Evaluate Effectiveness
Upon completing an audit, the audit team should evaluate its own performance and the effectiveness of the audit tools developed for the facility In addition, the audit coordinator should evaluate the performance of the team If problems or deficiencies in the audit program or team are identified, an action plan and schedule for rectifying the problem should be developed, and it should be the responsibility of the audit coordinator to ensure that the action plan is carried out

Implement a Continuing Audit Program
Although the initial purpose of an audit program may be seen as means of evaluating compliance with environmental requirements, it cannot be a one-time effort The key to a successful environmental audit program is to follow up with periodic audits The future audits will not only provide for a continuing assessment of the status of environmental compliance, but will also provide a means of checking whether environmental issues identified in previous audits have been rectified

855

MANAGING THE ENVIRONMENTAL AUDIT PROGRAM

Once the environmental audit program has been established, it is incumbent upon the audit coordinator to make sure that the program is successful The following techniques, which can be used in making an environmental audit program successful, are discussed in the following subsections

- Performance Reporting
- Staff Management
- Quality Assurance

Performance Reporting

Not only should senior management of the company be involved in establishing the environmental audit policy and mission statements, but they should also be involved in success's and failures of the environmental audit program Because an environmental manager may not have the authority within the company to approve environment expenditures or sufficiently influence company personnel to comply with the environmental audit program, performance reports should be made to a senior manager who has such authority

The key to making reports to management is designing a report that provides useful information efficiently Most senior managers will not have the time or desire to read an entire audit report, and even if they did, they may not have the environmental training sufficient to evaluate the report and make strategic conclusions It is recommended that reports to management be brief and that tables or graphs be used where possible to convey the maximum amount of information in the minimum number of pages Reports may typically contain the following type of information

- Number of audits completed per type of facility or company organizational unit
- Highlights of audit results focusing on the issues and liabilities most affecting the company and recommended solutions
- Summaries of noncompliance trends and recommended solutions
- Summaries of company success identified through the audit program (e g , identify how long a company facility has gone without a compliance violation)
- Examples of specific instances where the audit program findings and recommendations have resulted in significant cost savings (e g , major potential fines avoided or substitution of hazardous materials with nonhazardous materials)

Presenting this information in a concise, digestible format will aid the environmental audit program manager's efforts to establish and maintain corporate credibility for the audit program

Staff Management

Even when there is strong senior management support for the environmental auditing program, the role of an environmental auditor can be difficult Because much of an auditor's responsibility involves evaluating the performance of the company's environmental and operational staff, constantly having to evaluate coworkers in written reports can become a stressful or tiring task In addition, auditing may require the auditor to spend many days away from home auditing various facilities

856

In order to maintain a motivating environment for auditors, the program manager may want to try to attempt to initiate some of the following efforts to counter the downside of auditing

- **Staff Rotation**--By rotating the auditing responsibilities to various staff members on a regular basis, a company can help to ensure that the auditors will be fresh and enthused In addition, staff rotation can help to spread environmental awareness among many people through out the company
- **Establish Career Paths**--In addition to staff rotation, it is important to convince senior management and potential auditing staff that an environmental auditing position should be a logical step in one's career with the company and not a "dead end" position If possible, service as an environmental auditor should be a part of individual corporate development and promotion goals If service as an environmental auditor becomes incorporated as one of the rungs in the corporate promotion ladder, it will have the added benefit of creating a sense of environmental awareness in the company managers of the future
- **Continuing Education**--Because keeping up with environmental requirements and trends can be an overwhelming task, it will be important to provide opportunities to the environmental auditors to improve and enhance their auditing skills Participation in technical environmental seminars will help to maintain a well trained and knowledgeable staff, and will enable the auditors to discuss auditing issues with their professional peers

Quality Assurance

One of the key challenges with any program is assuring that it meets or exceeds its stated objectives Assuring a quality program requires regular reviews of performance One way to accomplish this is to have an annual self-evaluation Some of the self-evaluation criteria may include the following

- Did we meet our environmental auditing objectives?
- What aspects of our objectives did we accomplish?
- Where did we exceed our objectives and why?
- Where did we fail to meet our objectives, and why?
- What changes should we make in the environmental auditing program?

In addition to self-evaluation, the environmental auditing program could also benefit from an occasional third-party evaluation This could include asking a qualified third-party to observe an actual audit, or review audit reports for substance and format

857

G AUDIT COVERAGE

When conducting an environmental audit a variety of environmental issues may be addressed Following is a suggested checklist of records to review, physical features to inspect or observe, and people to interview as part of an environmental audit In addition, typical environmental compliance problems are identified for several areas which may be part of an environmental and safety audit

Air Emissions

Typical Compliance Problems

- Air emission points not completely identified including stacks, ventilators, wall fans, exhaust ports, incinerators, fume hoods
- Air emission inventory not available or incomplete
- Air emission sources not permitted or exemption letters not available
- Performance testing records not available
- Monitoring equipment not maintained properly
- Vapor control systems not installed on required sources
- Submerged fill pipes not installed on gasoline fuel tanks
- Modifications to air sources not reported to regulators
- Air pollution alert plans or emergency plans not available or incomplete
- Sulfur content of fuel oil not in conformance with regulatory limitations for fuel burners
- Fugitive dust impacting neighborhood areas
- Asbestos abatement or demolition activities not reported to regulatory agencies prior to the event
- Incinerator operations not maintained at correct temperature requirements and charging rates

Records To Review

- Air pollution control regulations
- Emissions inventory
- Air pollution source permits
- Plans and procedures applicable to air pollution control
- Emission monitoring records
- Opacity records
- Notifications of violations from regulatory authorities
- Instrument calibration and maintenance records
- Reports and complaints concerning air quality
- Air emergency plans
- Regulatory inspection reports
- Documentation of preventative measure or action
- Results of air sampling and monitoring
- Plans for future activities

Physical Features to Inspect or Observe at the Facility

- All air pollution sources (fuel burners, incinerators, VOC sources, etc)
- Air pollution monitoring and control devices
- Air emission stacks
- Air intake vents

Physical Features to Inspect or Observe at Solvent Cleaning Stations

- Observe that the cover is always closed when not in use
- Provisions for draining parts must be internal to degreaser
- Cleaned parts should be allowed to drain for at least 15 seconds or until dripping stops
- Observe that operating instructions are posted near the cleaner
- Observe that solvent stream does not cause splashing above freeboard level
- Observe any thermostat or safety switches operation

People to Interview

- Environmental Compliance Manager
- Safety Office personnel
- Operators of emission sources
- Project Resource Manager
- Facility Managers
- Laboratory Manager
- Monitoring and sampling personnel
- Maintenance personnel
- Individuals responsible for maintaining records and complying with permit conditions

Wastewater Discharges

Typical Compliance Problems

- Permits out of date or re-application not properly submitted
- Proper sampling procedures not followed
- Discharge monitoring reports not submitted on time
- Excursions not reported immediately to agencies
- Changes in plant operations or discharges not reflected in permit revisions or renewal application
- Inoperative or poorly maintained monitoring equipment
- Unpermitted process wastewaters in shop areas discharging to sewer lines, septic tanks, or streams
- Discharges to sewer lines contain materials which are fire or explosion hazards, corrosive hazards, or flow obstructions
- QA/QC procedures not followed by analytical laboratory

Records to Review

- Permits and renewal applications
- Discharge monitoring reports for the past year
- Laboratory records, procedures, and QA/QC results
- Monthly operating reports for wastewater treatment facilities
- Flow monitoring calibration, certification, and supporting records
- Spill prevention plans
- Agency notices of noncompliance or violation
- Sewage treatment plant operator certification
- Old spill reports
- Sewer and storm drain layout
- Repair and maintenance records for the wastewater treatment system

Physical Features to Inspect or Observe

- Discharge outfall pipes
- Wastewater treatment facilities
- Streams, rivers, and open waterways
- Floor & sink drains (especially in industrial areas)
- Observe general housekeeping, plant conditions, and presence of odors
- Observe operation of treatment equipment
- Provisions for standby power and adequate alarm systems for equipment failures
- Spare parts inventory for critical equipment
- Inspect the O&M manual for consistency with actual plant operations
- Review operating logs (check for neatness and clarity)
- Observe sampling procedures at sampling points
- Observe effluent bypass points and discuss instances of hydraulic overloading
- Observe posting of safety or occupational hazards and contingency measures

People to Interview

- Operations personnel
- Facility Manager
- Wastewater treatment plant supervisor and other personnel

861

Stormwater Discharges

Typical Compliance Problems

- Runoff from hazardous waste materials storage areas discharging to sewer lines or streams
- Unpermitted contaminated stormwater discharges to storm sewers or streams
- Hazardous materials stored outside in manner allowing for stormwater contamination
- Stormwater falling on petroleum or chemical unloading areas not segregated and treated prior to discharge
- Soil erosion and sedimentation controls not used or properly maintained during construction
- Secondary containment drainage valves left open
- Stormwater collected in secondary containment areas not inspected prior to discharge
- Machinery or vehicles which are leaking oil parked in areas which drain directly to storm sewers

Records to review

- Permits and renewal applications
- Spill prevention plans
- Agency notices of noncompliance or violation
- Old spill reports
- Sewer and storm drain layout

Physical Features to Inspect or Observe

- Discharge outfall pipes (look for obvious signs of contamination such as, odors, discoloration, oil sheen, etc)
- Stormwater collection points
- Oil storage tanks
- Observe any on-site sludge disposal areas Look for evidence of disease vectors, surface runoff control, seeding, or other cover measures
- Identify the location of possible sources of contamination
- If monitoring is required in a permit, observe location of sampling points and proper operation of sampling devices
- Inspect oil/water separators for proper operation and maintenance

People to Interview

- Operations personnel
- Facility Manager

862

Solid Wastes

Typical Solid Waste Compliance Problems

- Solid waste disposed/buried on-site without permit or approval from regulatory agency
- Use of off-site disposal facilities not properly permitted for solid waste stream
- No knowledge of identity of off-site solid waste facilities used by haulers
- Solid waste containing asbestos, not sealed in leak proof containers and not disposed of at approved disposal facilities
- Solid waste receptacles not meeting design and operational specifications
- No procedures to insure that only nonhazardous waste materials are placed in solid waste receptacles
- Ash residues or sludges not tested for hazardous constituents before disposed as solid waste
- Used oils contaminated with hazardous constituents disposed of as nonhazardous waste
- Effective recycling/reclamation procedures not in place for solid waste streams

Records to Review

- Record of current non-hazardous solid waste management activities
- Inspection reports
- Environmental monitoring and procedures plans
- records of resource recovery practices, including the sale of materials for the purpose of recycling
- Solid waste removal contracts and inspection records

Physical Features to Inspect or Observe

- Resource recovery facilities
- Incineration and land disposal facilities (active and inactive)
- Areas where non-hazardous waste is disposed
- Construction debris areas
- Waste receptacles
- Solid waste vehicle storage and washing areas

People to Interview

- Environmental Compliance Manager
- Safety Office personnel
- Project Resource Manager
- Facility Manager
- Laboratory Manager

Hazardous Wastes

Typical Hazardous Waste Compliance Problems

- Inadequate waste analysis plan resulting in hazardous waste being handled as nonhazardous waste
- Satellite accumulation drums not properly labeled and kept in closed condition except when used
- Hazardous waste manifest file incomplete
- Hazardous waste containers stored longer than regulatory limits
- Accumulation start dates and other required information missing or incomplete on hazardous waste containers
- Open top funnels and bungs missing on highly flammable hazardous waste drums in storage
- Accumulation point not maintained with proper segregation of incompatible wastes, three feet of aisle space, and safe stacking height
- Accumulation point manager not specifically designated in writing and not properly trained
- Inspection records not available, incomplete, or missing
- Emergency response equipment and material not available or inadequate at the collection point
- Contingency and Emergency Response Plan not available and maintained

Records to Review

- Hazardous waste manifests and exception reports
- Employee training documentation
- Storage and accumulation records
- Spill and contingency plans

Physical Features to Inspect or Observe

- Disposal sites
- Accumulation points and storage facilities (including drums)
- Inspect drums and other containers for leaks, corrosion, and bulges
- Inspect labels on drums for consistency with waste
- Review additional information contained on drum
- Observe that containers are tightly sealed Open funnels are not permitted Bungs should be closed
- Highly flammable waste should be electrically grounded
- Inspect accumulation points for presence of
  --telephone --fire extinguisher
  --spill cleanup equipment --warning signs
- Drums should be on pallets and adequate aisle space maintained
- Containers holding ignitable or reactive waste should be located 50 feet from the property line

People to Interview

- Environmental Compliance Manager
- Safety Office personnel
- Facility Manager
- Laboratory Manager

864

PCBs

Typical Compliance Problems

- PCBs in hydraulic systems or heat transfer systems not known
- PCB transformers not inspected routinely and inspection records incomplete
- Combustible materials stored next to PCB transformers
- PCB storage area not designed properly, including no secondary containment, presence of drains and cracked floors, and lack of spill cleanup materials
- Liquid PCBs not stored in approved containers
- PCB records are not available or are incomplete

Records to Review

- Inspection, storage, maintenance, and disposal records for PCBs/PCB items
- PCB equipment inventory and sampling results
- Correspondence with regulatory agencies concerning PCBs/PCB items
- Facility reports

Physical Features to Inspect or Observe

- PCB storage areas
- Equipment, fluids and other items used or stored at the facility containing PCBs
- Compare PCB inventory with PCB equipment on the facility for consistency
- Inspect PCB transformer locations, look for proper labeling
- Look for drains adjacent to PCB transformers and evidence of leaks from equipment
- Inspect any PCB transformer locations which pose a potential exposure risk to food and feed
- Inspect logs to ensure all PCB transformers are inspected quarterly for leaks
- For PCB transformers found to be leaking, ensure cleanup is initiated within 48 hours
- Inspect PCB storage area for the following
  --Roof/walls to exclude rain
  --Six-inch curb or containment
  --No drains, valves, joints, or openings
  --Floors/curbing continuous and impervious
  --Doors are locked and access controlled
- Verify that the PCB storage area is inspected every 30 days
- Observe presence of cleanup/absorbent materials in storage facility
- Observe all PCB equipment in storage facility is properly marked

People to Interview

- Environmental Compliance Manager
- Safety Office personnel
- Engineering personnel
- Operations personnel
- Facility managers
- Laboratory Manager

865

Hazardous Materials

Typical Compliance Problems

- Inside bulk storage of flammable materials not in compliance with design standards (containment, ventilation, self-closing doors, explosion proof lighting)
- Flammable/combustible bulk storage inside buildings not meeting stack heights, aisle space, and quality restrictions
- Flammable/combustible materials stored outside not graded or contained to keep spills away from buildings
- Approved metal cabinets not used for incidental storage of flammable materials around shop and work areas
- Flammable materials not put in approved safety cans when in use around shop areas
- Dispensing areas for flammable materials missing drip pans under containers
- Grounding clips missing on highly flammable materials containers
- Compressed gas cylinders not tied down and stored in segregated area in one-story building
- Material safety data sheets not available

Records to Review

- Hazardous substance spill and contingency plan
- Spill records
- Emergency plan documents
- Material safety data sheets
- Inventory records
- Shipping papers
- Training records
- Signage and labeling of hazardous materials

Physical Features to Inspect or Observe

- Hazardous materials storage and dispensing areas
- Shop activities
- Shipping and receiving area

People to Interview

- Environmental Compliance Manager
- Safety Office personnel
- Engineering personnel
- Operations personnel
- Facility managers
- Laboratory Manager

866

Petroleum and Oil Storage and Handling

Typical Compliance Problems

- Spill Prevention and Response Plan not, prepared, available, or not consistent with oil storage facilities at the plant
- No evidence of spill response training
- Lack of adequate spill control equipment and materials
- Lack of specific procedures on handling of used oil
- Appropriate containment measures (dikes, berms, etc) not installed around oil storage facilities
- Secondary containment structures cracked, drains present, or underdesigned for volume of oil present
- Oil/water separators not installed or not maintained and cleaned periodically for efficient operation
- Tank inspection and monitoring not conducted
- Inventory control and tank leak testing not conducted
- New tanks not installed with proper corrosion protection
- New tanks not constructed with proper spill/overfill protection
- New and existing pressurized piping not outfitted with automatic flow restrictor, automatic shut off device, continuous alarm system, or no annual line testing or monthly monitoring

Records to Review

- Records of all spills, leaks, an associated site assessment/cleanup activities
- Official correspondence with regulatory agency
- Spill Prevention and Response Plan
- Records of spill response training programs

Physical Features to Inspect or Observe

- Refueling facilities, including
  --above- and below-ground storage tanks and dikes
  --vents --fill pipe --gauges
- Vehicle maintenance areas
- Oil separators
- Inspect oil storage facilities to ensure that all facilities are included in the Spill Prevention and Response Plan
- Inspect the condition of secondary containments (berms, dikes, etc)
- Observe that appropriate cleanup equipment is available on the facility
  --absorbent materials --oil retention booms
  --sand bags --fuel recovery pumps
  --protective gear (boots, gloves, etc)

People to Interview

- Environmental Compliance Manager
- Safety Office personnel
- Engineering personnel
- Operations personnel
- Facility managers
- Laboratory Manager

867

Pesticide Management

Typical Compliance Problems

- Pesticide applicators not properly trained
- Health monitoring of pesticide handling personnel not conducted or monitored
- Pesticide application records not maintained at the facility
- Pesticide storage facilities not segregated from other nonregulated spaces
- Concentrated pesticides improperly released to sanitary wastewater or stormwater drains
- Use of banned pesticides
- Pesticide storage not in a dry, well ventilated area designed for two air changes per hour
- Personal protective clothing and equipment not available (respirators, masks, gloves, coveralls)
- Failure to follow restrictions on "restricted use" pesticides

Records to Review

- Records of pesticides purchased by the facility
- Pesticide application records
- Description of the facility's pest control program
- Training records and/or certification status of pesticide applicators
- Pesticide disposal records

Physical Features to Inspect or Observe

- Personal protective equipment
- Pesticide application equipment
- Pesticide storage areas, including storage containers
- Observe that the storage, mixing, and preparation areas are separate from laundry, office, showers, and locker rooms
- Observe that the storage facility is dry and well-ventilated with no drains or cracks in the floor
- Observe that curbing or other containment is provided for mixing areas or decontamination areas
- Observe that all rinse or washwaters are contained and do not connect to sanitary or stormwater lines
- Inspect mixing area ventilation for six air changes per hour
- Inspect storage area ventilation for two air changes per hour
- Observe that personnel protective clothing and equipment is provided
  --respirators
  --masks
  --gloves
  --safety clothes
- Observe that no smoking, food consumption, or drinking is allowed in the pesticide storage areas
- Observe that pesticide containers are kept closed when not in use, stored upright above the facility floor with all labels plainly visible
- observe that signs which read "DANGER--POISON, PESTICIDE STORAGE" are posted near entries to storage facilities

868

People to Interview

- Pesticide Coordinator
- Environmental Compliance Manager
- Safety Office personnel
- Engineering personnel
- Operations personnel
- Facility managers
- Laboratory Manager

Drinking Water

Typical Compliance Problems

- Water treatment plant operators not properly trained and certified or no documentation available
- Drinking water not monitored for all required parameters (e g , nitrates, fluoride, turbidity, bacteriological, radiological, etc)
- Drinking water systems not checked for corrosivity
- Monitoring records not available

Records to Review

- Bacterial and chemical analyses of drinking water, including sampling dates and locations, dates of analyses, analytical methods used, and results of analyses
- Monthly operating reports
- Action taken by the facility to correct violations of primary drinking water regulations
- Records of well monitoring and testing

Physical Features to Inspect or Observe

- Drinking water collection, treatment, and distribution facilities
- Laboratory analysis facilities
- Wells
- Swimming pools

People to Interview

- Environmental Compliance Manager
- Safety Office personnel
- Engineering personnel
- Operations personnel
- Facility managers
- Laboratory Manager

870

Worker Health and Safety

Typical Compliance Problems

- No documentation available for employee noise exposures
- Periodic noise level measurements not routinely taken
- Written respiratory protection program not documented
- Emergency breathing equipment not properly maintained, tested or stored properly
- Hazard warning labels missing on chemical containers in shop areas
- Material identification labels missing on chemical containers in shop areas
- MSDSs not complete for chemicals in the workplace and MSDS file not maintained in an accessible area for employees
- Hazard material training for employees not adequately conducted or documented
- Records of personnel trained in first aid and CPR not available for inspection
- Ventilation systems do not have routine maintenance programs, regular air flow rate tests, and regular filter changes
- Machine guard not properly installed or removed by employees
- Overhead cranes and lifting equipment not labeled with tonnage rating
- No safety manual or guidelines
- Firefighting piping and hoses not hydrostatically tested or physically inspected on an annual basis
- Fire extinguisher training for employees not conducted or documented
- All exits not marked with illuminated signs and exit paths not clearly marked
- hard hat and safety glasses procedures not uniformly monitored and enforced by plant management
- Work related injuries and illnesses records not maintained

811

H AUDIT PROCEDURES

The approach to and the procedures for performing an environmental audit as described in the following section are the most comprehensive and exhaustive methods that can be implemented It constitutes the "Cadillac" version of an environmental audit Do not feel that because you do not have the time or the financial capability to perform an audit of this magnitude that it is not worth doing the job The scope of any environmental audit must be scaled to the size of the facility to be audited, activities that occur on that facility, available resources, and the goals and objectives of the audit program

For example, if you are the sole environmental coordinator with the responsibility for a single facility, many of the pre-audit activities (e g , notifying the facility, compiling and reviewing background information, etc) described in this chapter would not be necessary If the facility to be audited is relatively small, an audit "team" may not be necessary, and one person with a sufficiently broad background could conduct the audit

The one area in which the utmost caution must be exercised when scaling back the audit is making assumptions concerning the applicability of specific regulations For example, due to a limitation of available resources, or particular corporate goals or directives, a conscious decision to audit solely for hazardous waste compliance in a given year may be made As long as that restriction is recognized as a limitation of the audit it is satisfactory However, the assumption should not be made prior to the audit, that certain regulations (such as air emission requirements) do not apply to a facility without conducting an initial audit to assess regulatory applicability

There are four basic steps in performing any environmental audit Pre-audit activities, On-site activities, Post-audit activities, and the Audit Report Each of these will be described in this Section

PRE-AUDIT ACTIVITIES

An environmental audit is initiated by commencing pre-audit activities Depending on the scale of the audit, pre-audit activities may involve the six tasks listed below

- Audit planning
- Notifying the facility and applicable staff and management personnel
- Compiling and reviewing background information
- Reviewing relevant regulations
- Defining audit scope and team responsibilities
- Reviewing audit protocols

812

Audit Planning
Pre-audit planning activities help to ensure that the audit is properly focused and that it will be conducted smoothly and efficiently During this process, documents, forms, equipment, and other audit materials should be collected or prepared For larger facilities, or audit programs developed for multiple facilities, a comprehensive plan should be prepared which describes the audit objectives, tasks for fulfilling the objectives, methods and procedures to be followed, safes, considerations, personnel and equipment resources needed, and the schedule for initiating and completing each task

Notifying the Facility
Notification for routine audits is usually given by phone with a follow-up notification letter The letter should specify the authority for and purpose of the audit, and outline the areas to be examined during the site visit and subsequent audit report

The notification letter should also contain a request for whatever general information is available on the facility background, previous audits and other relevant records, pollutant and waste generation control, treatment, and disposal systems, and on requirements, regulations, and limitations These are presented in detail below

For on-site personnel, obviously this step may not be necessary However, it is strongly recommended that on-site environmental staff establish a specific date and perform a formal environmental audit through the implementation of these procedures

Compiling and Reviewing Background Information
The review of facility information requested in the facility notification letter is the next stage in the audit process Reviewing facility background information will enable the audit team to be sufficiently aware of facility environmental activities and clarify technical issues so that relevant regulations and requirements can be obtained and reviewed Examples of these information items are listed below

<u>Facility Background</u>

- Maps of site with building/shop locations designated and environmental and geographic features noted (discharge pipes, waste disposal sites, etc)
- Description of geology/hydrogeology of the area
- Environmental setting (e g , air quality, climate conditions, land use, flood plain, wetlands, historical sites, and sensitive receptors at and near the facility)
- Names and phone numbers of facility officials
- Records of changes in facility conditions since previous audits

873

Audit Reports and Other Relevant Records

- Federal and state compliance reports
- Correspondence between the facility and local, state, and federal agencies on environmental matters
- Citizens' complaints, follow-up studies, and findings
- Audit records, reports, and correspondence on past incidents or violations
- Inventory of waste generation sources, emission sources, and pollutant discharges
- Self-monitoring data and reports
- Regulatory agency and consultant studies and reports
- Reports and permit records
- Records of hazardous substance spills
- Representative copies of hazardous waste manifests

Pollutant and Waste Generation, Control, Storage, Transportation, Treatment, and Disposal

- Description and design data for pollution control systems and process operations
- Sources and characterization of wastewater discharges, hazardous wastes, emissions, types of treatment and disposal
- Waste storage, treatment, and disposal areas
- Waste/spill contingency plans
- Bypasses, diversions, and spill containment facilities

Requirements, Regulations, and Limitations

- Permit applications, draft, or existing permits, registrations, approvals, and applicable federal, state, and local regulations and requirements
- Draft permits or information on draft permit terms which are different from current conditions
- Conditioned or unconditioned exemptions and waivers

874

- Receiving stream water quality standards, ambient air standards, State Implementation Plans, protected uses

- Pesticide labels

Reviewing Relevant Regulations
Once the response to the notification letter has been received, the relevant regulations potentially affecting the facility should be reviewed Major regulations to be reviewed prior to conducting an audit should include those on air pollution, wastewater discharges drinking water, toxic substances (including PCBs), pesticides, hazardous materials, underground storage tanks, and hazardous and solid wastes

One method to obtain the regulations that are not on hand is to request copies directly from the federal or state regulatory agency responsible for implementing a particular program This is particularly useful for local regulations, such as Publicly Owned Treatment Work (POTW) ordinances, municipal effluent limitations, air emission regulations from air quality control regions or agencies, and flammable/combustible storage and handling regulations from state/local health departments or the local fire department

Defining Audit Scope and Team Responsibilities
The scope of an environmental compliance audit should be defined Within the resources available and time constraints, the audit should be broad enough to cover adequately the most important compliance categories or areas for a particular facility

Team members should be assigned as auditors for specific compliance areas so that they can prepare themselves fully beforehand to audit the designated categories or areas For more complex areas, it may be appropriate to assign more than one member from the team

When selecting the audit team, care should be given to balance the skills of team members to include knowledge of

- the audit process,

- applicable environmental laws and regulations,

- company and organizational policies, and

- the particular facility being audited

Team members should understand the rules, regulations, and other provisions, including permits, registrations, authorizations, limitations, and monitoring requirements as they pertain to a specific facility The auditors should have, as appropriate, knowledge of applicable pollution control technologies, and the nature of pollution problems and possible viable solutions, including available treatment and controls

875

Individual team members may have more specific specialized knowledge than other team members of a process, monitoring system, control equipment, environmental media, or set of regulations The team as a whole, however, should have sufficient collective knowledge and background to efficiently and effectively conduct all aspects of a facility audit They should also understand the techniques for evidence gathering, and possess skill in collecting information and in interviewing all types of personnel Cooperation and good working relations with facility personnel should be established and maintained

Reviewing Audit Protocols and Checklists

As a final pre-audit step, both the auditors and host facility engineer/coordinator should familiarize themselves thoroughly with all of the protocols and checklists for the major categories of each medium at a facility On site, experienced auditors may use these aids as reference documents, reviewing them mornings and evenings to ensure that all categories or areas of potential noncompliance are covered Less-experienced auditors may refer to their protocols and checklists more often to avoid overlooking any essential items

An example of audit protocols and checklists for hazardous materials and hazardous waste storage and handling at an industrial facility located in California, U S A are provided at the end of this Section

ON-SITE ACTIVITIES

One of the purposes of an audit is to assist the facility personnel in identifying regulations that may be applicable to their facility, recognizing deficiencies, and making necessary improvements and modification to achieve compliance The audit team should be prepared to immediately answer questions concerning the application of specific laws and regulations to the facility, and provide recommendations to achieve compliance No one, for example, is expected to be able to cite, from memory, the hazardous waste number for beryllium (P015) However, the auditors should have familiarized themselves with the facility enough to know that they produce beryllium as a commercial chemical product, and that it is a listed waste

The auditors <u>must document</u> everything that they observe on-site This requirement cannot be emphasized strongly enough The use of a camera to record observations of operations and facilities is encouraged Detailed notes are absolutely essential Do not, for example, note that "some drums behind one of the buildings were rusted " Instead, make a sketch and note "five drums next to the north wall of building A-15, none were labeled, all were closed, and three had rusting tops None showed any signs of leakage July 19, 1994, 2 PM " No checklist can substitute for a keen eye and detailed set of notes when it comes time to write the audit report

The on-site activities of the environmental compliance audit include the four tasks listed below The key to the success of any environmental audit, and hence its acceptance by the facility personnel, is based on the on-site performance of the audit team If the team is unprepared or disorganized, it will leave an impression with the facility personnel that will be difficult to overcome

1 Arrival and opening conference

2 Records/documents review

3 Staff interviews and physical inspections of facilities

4 On-site post-audit debriefing

Arrival and Opening Conference
The audit team should arrive at the facility during normal working hours and should identify themselves to the appropriate facility official(s) Auditor(s) should fully comply with the facility rules and policies governing security, information confidentiality, traffic, and entry/exit (sign-in and sign-out) procedures

At the opening conference with facility officials, the audit team leader should present his or her credentials, provide names of the other team members, specify the purpose of the audit, and outline procedures and the proposed schedule to be followed A cooperative working relationship should be maintained between the auditors and all facility personnel both during the opening conference and throughout all other on-site audit activities

Topics to be discussed at the opening conference should include audit objectives, processes and areas to be inspected, anticipated audit schedules within particular areas of the facility, basic types of records to be reviewed, health and safety requirements, the handling of confidential data (which should be obtained only if absolutely necessary), the manner of handling questions during the audit, and the post-audit debriefing If team members desire to take photographs or make copies of records during the audit, this matter should also be discussed during the conference and approval should be obtained from the appropriate plant management personnel prior to any on-site audit activities

Records/Document Review (Paper Audit)
The review of background information that was performed during the pre-audit phase will have furnished the auditors with leads as to which records, files, and reports should be requested for review during the actual audit Normally, records and documents should be reviewed just before conducting staff interviews and inspecting facilities But for smaller facilities, it might be expedient to do all or portions of the reviewing simultaneously with an interview or inspection The records, files, and reports should be organized for reviewing based on the typical compliance areas and operations found at the company's facilities

Many compliance requirements will not be found in the pages of the Code of Federal Regulations but may be contained within the review materials For example, an NPDES permit may contain conditions on Best Management Practices (BMPs) listed within the permit Auditors then need to verify if these practices are being performed

827

Auditors should obtain copies of documents uncovered during the audit that can aid them in evaluating the compliance status of the facility, and in writing the audit report and developing the compliance management plan To minimize handling of confidential information, only those materials that the team determines are absolutely necessary to complete a thorough evaluation of the facility's compliance status should be copied

Staff Interviews

The first step before journeying out of the office should be to obtain a map or sketch of the facility, and label the buildings with the same designations known to facility personnel These designations should be used in notes and throughout the report for consistency, and to ensure understanding of any findings and recommendations by the facility personnel It is often useful to make a "let your fingers do the walking" tour of the facility using this map Have someone point out the various structures on the facility and explain the processes that occur in each while you make general notes on the structures and items you wish to see in each

Proper interviewing is perhaps the single most important aspect of an environmental audit The U S EPA lists the following interviewing skills and techniques which, if followed, can enhance the outcome of the audit

Schedule interviews ahead of time

Interrupting busy personnel is a sure way to cause ill feelings During the opening conference is a good time to set up tentative schedules for visiting the various operations For example, the shop foremen or other managers may be present at this time and a preliminary schedule can be established ("we will do the paint shop after lunch on the second day") Before lunch on the second day, call the paint shop and confirm that this timing is still convenient

Conduct interviews in work spaces

Conducting interviews in the work space of the interviewee allows him or her to be more relaxed Often key records or files are kept in the work space Also, the auditor is able to observe first hand actual work place conditions

Be sensitive to the interviewee's nervousness and defensiveness

A normal negative reaction is associated with audits regardless of the auditor's plea that "I'm only here to help you " The auditor must continue to reassure the interviewee that the audit is only intended to help facility personnel in uncovering the areas that need more attention, resources, staff training, etc , in order to comply with regulations and that the audit may help them in justifying their requests for these resources

Avoid questions soliciting straight yes or no responses

Questions asked during the audit should be focused on getting the interviewees to open up and discuss compliance issues Rather than asking, "Do you sample your wastewater discharge every 30 days?" which would likely elicit a yes or no answer and no other information, phrase your question in a more open-ended manner, for example, "How do you monitor your wastewater discharge?" Recognize that the initial response to a question for many interviewees will be to tell you what they think you want to hear

Physical Inspections of Facilities

Physical inspections of facilities involves observing and evaluating facility operations, required compliance activities, and environmental control equipment and monitoring devices The most important objective is to ensure that all operations of the facility have been inspected so that all applicable environmental standards and requirements are identified For example, the inspection should identify all pipes, vents, stacks, or physical evidence of discharges from the facility so that the auditor can determine if the facility has all of the required permits The physical inspection should also confirm consistency of the facility records with the physical evidence observed in the inspection For example, ensure that amounts and types of all of the hazardous wastes generated in the various parts of the facility are consistent with the amounts and types of hazardous wastes that are found on the facility paperwork, such as manifests and annual/biennial reports

Secondly, the physical inspection should evaluate the compliance of the facility with the various environmental regulations that apply to those operations For example, ensure that all of the facility satellite and central accumulations points for hazardous wastes are operated in accordance with applicable regulations

Finally, the physical inspection should evaluate the operation and maintenance of any environmental control equipment utilized on the facility for compliance with environmental requirements This would include, for example, waste incinerators, stormwater discharges, wastewater treatment facilities, hazardous waste storage, treatment, or disposal activities, spill prevention and containment facilities, and air pollution control systems

On-Site Post-Audit Debriefing

Before the on-site post-audit debriefing, the auditors should make a final review of their protocols, checklists, and field audit notes, and summarize preliminary audit findings or observations

Besides the audit team, participants in the post-audit debriefing may include facility managers and supervisors, environmental coordinators, public works personnel, and other key personnel who should be made immediately cognizant of the preliminary findings of the audit

879

Important matters to cover during the debriefing are

- actual or imminent problems such as leaks, spills, or other health and safety hazards,
- actual or potential noncompliance areas,
- information gaps that still need to be filled by the audit team or by facility personnel, and
- unclear findings that need to be clarified

POST-AUDIT ACTIVITIES

Post-audit activities include the management of audit data, other information collected during the site visit, and any follow up required to confirm the on-site findings or fill in any missing data

Data and Information Management

Portions of the auditing process are devoted to verifying whether those who are being audited are properly managing the data and information necessary to comply with environmental laws and regulations In turn, it is also imperative that the auditors themselves keep careful records of their own data and information pertaining to each audit This recordkeeping applies both to

- on-site records - the protocols, checklists, field notes, photographs, and other materials associated with the actual audit, and
- off site records - those collected for review before, during, or after the audit and those prepared during the pre- and post-audit phases, such as correspondence, the audit reports, and compliance management plans

Good data and information management also calls for the sorting and chronological organizing of all hard copy records into audit files Items in these files would include

- copies of facility records obtained for review,
- correspondence with facility and regulatory authorities,
- notebooks,
- protocols and checklists,
- photographs, and
- sampling records, where appropriate

Audit notebooks should contain a legible and coherent documentation of all relevant audit activities and observations Entries should be objective, factual, and impersonal They should be made in bound notebooks

Protocols and checklists, which augment the observations in the audit notebooks, also contribute to the performance of comprehensive audits Copies of the checklists may be left at audited facilities to inform facility personnel of the preliminary audit results

If photographs are made a part of the documentation of the audit, a note should be made on the date, time, exact location at the facility, the names of the photographer, the purpose and subject matter of the photograph, and any other appropriate details

If it is determined that samples should be analyzed at certain facilities, they should be properly collected, packaged, labeled, and shipped to an approved laboratory within sample holding time, in strict compliance with DOT and EPA regulations and quality assurance guidelines (Sampling at this level of audit would not normally be required If it is necessary, only qualified personnel trained in the proper procedures and using proper equipment and health/safety precautions should be used)

Follow Up Data Collection

Although one objective of the onsite activities should be the collection of all pertinent data necessary to evaluate the facility and complete the audit report, there will be times when this objective is not accomplished This situation could occur, for example, if facility personnel could not locate some information while the audit team was on-site, when some reports or data may be stored at headquarters or another facility that provides support services to the audited facility (which is more common in smaller facilities that are part of a larger organization), or when it is necessary to collect additional guidance from a regulatory agency that is applicable to a situation observed on the facility

The most important point in relation to follow-up data collection is that it should be accomplished immediately after the on-site activities and/or when it becomes obvious that additional data is needed Delaying the submission of the audit report while waiting for additional data to arrive is a sure method for alienating the facility staff and undermining the results of the audit

THE AUDIT REPORT

The final step in multi-media environmental compliance auditing is the preparation of the Audit Reports and Compliance Management Plan There are more types of reports or report outlines than there are reasons for performing an environmental audit This variety is due to the fact that reports can be structured based on the types of facilities that were audited, the regulations that were covered, legal aspects of the audit, and the response and follow-up of the facility Some of the factors to be considered in developing an audit report format are discussed below

881

Basic Requirements

At a minimum, all audit reports should include the following information

- An executive summary The part of the report, which is placed at the front of the document, briefly summarizes all points described in the report

- The location at which the audit was conducted This includes the facility name, location, and the operations that were audited For example, if the facility has responsibility for noncontiguous parcels of land, or if different parts of the facility report to different pieces of a corporate hierarchy, these additional or separate responsibilities should be so noted in the audit report

- The dates over which the audit was conducted Although audit findings should be representative of the facility, there may be circumstances that are unique because of the time of the audit Certain operations may be down for maintenance, or the facility may be performing other one time functions

- The names of the individuals who conducted the audit List the name of each member of the audit team (in the event that they need to be contacted later), and the points of contact at the facility that assisted the audit team

- The reasons for conducting the audit The report should define the scope and purpose of the audit For example, describe if the audit was only for legal purposes or if it was intended to support an acquisition, and identify the scope of the audit, i e , does it cover all operations on the facility or only a limited number? Are all environmental regulations considered or only air emissions?

- A map of the facility that identifies basic structures and operations referenced in the audit report

- A list of acronyms and abbreviations

Level of Background Information

Depending upon the purpose of the audit and the intended audience for the report, the detail of background information pertaining to the facility will vary For example, if the environmental audit was conducted to support an acquisition, the readers of the report may not be fully familiar with the activities that occur on the site Therefore, the report may include more detail on the layout of the facility and the operations and procedures (e g , waste management, reporting, and record keeping) than would otherwise be included Conversely, if the report is intended for personnel at the corporate office of a company that operates multiple plants - all of which perform essentially similar functions - detailed descriptions of the activities at the plant may not be necessary

As another example, if one of the purposes of the audit is to determine the regulatory requirements that are applicable to a facility, and the intended audience is facility managers and shop foremen, the report may include more background and detail particular environmental laws and how their implementing regulations apply to the facility than if the report was intended for the legal or corporate environmental staff (who, hopefully, are already aware of the background and focus of all applicable environmental laws)

Level of Compliance Reporting

When deciding how to prepare an audit report, an auditor must first decide how he or she will address findings of satisfactory compliance Some auditors view an environmental audit report as an "exception report" and therefore include only areas of non-compliance in the statement of findings Others feel that the report should recognize all areas of compliance as well as note program deficiencies Under this "comprehensive" approach, exemplary actions are always noted

In addition, each environmental audit report must address is the severity of each non-compliance instance For example, the storing of incompatible wastes in the same area or a leaking tank of a hazardous material are obviously more severe than a manifest that did not include the correct generator's identification number, although each is a violation

One method for responding to this issue is to classify each noncompliance issue according to the following system First, define each point of non-compliance as either a regulatory or procedural deficiency For each regulatory and procedural deficiency, determine whether the problem is significant, major, or minor This terminology is explained below

Regulatory Deficiency

A regulatory deficiency is one involving non-compliance with regulations external to the facility or corporation (i e , those imposed by federal, state, and local agencies)

Procedural Deficiency

A procedural deficiency is one involving non-compliance with facility or corporate policy (if, however, a company policy implements an external law or regulations, a point of noncompliance should be classified as a regulatory deficiency)

Significant Deficiency

A problem categorized as significant requires immediate action It poses, or has a high likelihood to pose, a direct and immediate threat to human health, safety, the environment, or the facility operations For example, failure to ensure that hazardous waste is destined for a permitted facility, failure to report a release when required, and failure to meet a compliance schedule mandated by a Notice of Violation are all significant deficiencies

Major Deficiency

A problem categorized as major requires action, but not necessarily immediately This category of deficiency usually result in a Notice of Violation from a regulatory agency Major deficiencies may pose a threat to human health, safety, or the environment However, if they are immediate threats they must be classified as significant Examples of this category includes failure to apply for an air permit for a new emissions source (such as a point booth or boiler), or failure to conduct an inspection each day during the previous year of a hazardous waste storage tank

Minor Deficiency

Minor deficiencies are mostly administrative in nature They may also involve temporary or occasional instances of noncompliance Examples of minor deficiencies include using the improper abbreviation for the quantity of a shipment on a hazardous waste manifest, or submitting the renewal of a permit several days after the previous permit expired

Legal Review

A legal review of an environmental audit report or the participation of legal counsel may occur during the preparation and/or submission of the audit report in order to protect the confidentiality of the results The inclusion of legal counsel during the audit process will accomplish this objective in most cases, although these details are beyond the scope of this manual Facilities interested in utilizing legal review to provide added confidentiality should consult with their counsel

Requirements for Follow-up

To be purposeful and effective, all environmental audits must include a follow-up site visit to ensure that appropriate actions have taken to remedy the areas of non-compliance This objective can be included in the reporting process in two ways

First, where the audit is part of an on-going program, the report should include an analysis of the facility's response to non-compliance areas identified in previous reports

Secondly, as the final section of the environmental audit report, the facility can append an action plan that describes what responses the facility will implement in relation to each of the deficiencies noted in the audit report In many organizations, the preparation of this action plan and regular evaluation of the implementation of the plan are a part of not just the environmental audit program but also the facility and personnel evaluations

Example Audit Protocol: Hazardous Materials

SECTION A IDENTIFYING, STORING, AND HANDLING

If your facility uses and stores hazardous materials, complete this module If not, go to Module 6 (See Note A)

1 Business Plan

If your facility stores greater than reportable quantities of hazardous materials or waste, complete this subsection If not, go to Subsection 2 (See Note B)

Review business plan for your facility

		Yes	No	N/A
1 1	Is a copy of the business plan maintained at the facility it pertains to?	[ ]	[ ]	[ ]
1 2	Are facility personnel with emergency response responsibility aware of the location and contents of the Business Plan?	[ ]	[ ]	[ ]
1 3	Does the emergency response section accurately and completely describe emergency response procedures such as			
a	Prevention Plans	[ ]	[ ]	[ ]
b	Notification requirements	[ ]	[ ]	[ ]
c	Mitigation procedures	[ ]	[ ]	[ ]
d	Evacuation plans	[ ]	[ ]	[ ]
e	Abatement plans	[ ]	[ ]	[ ]
f	Personnel responsible for above actions	[ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req'd
	[ ]	[ ]
	[ ]	[ ]
	[ ]	[ ]
	[ ]	[ ]

NOTE. For each checklist item found to be out of compliance document the following
1) Question number 2) Description of exception 3) Corrective action planned or taken 4) Completion date

886

SECTION A IDENTIFYING, STORING, AND HANDLING

		Yes	No	N/A
1 4	Does the site plan accurately identify the storage locations of			
	a Hazardous materials	[ ]	[ ]	[ ]
	b Hazardous waste	[ ]	[ ]	[ ]
	c Spill response equipment	[ ]	[ ]	[ ]
1 5	Have you updated the Business Plan annually? (See Note C)	[ ]	[ ]	[ ]
1 6	Did you update the plan whenever changes occurred at your facility that affected the plan?	[ ]	[ ]	[ ]
1 7	Compare the Business Plan chemical inventory with your most recently issued Report K08210-01, Monthly Listing of Reportable Quantities Are all hazardous materials listed in the report included in the Business Plan chemical inventory? (See FCD 104 0145 C)	[ ]	[ ]	[ ]
1 8	Did you update the Business Plan chemical inventory whenever a reportable quantity of a chemical was added to or deleted from storage?	[ ]	[ ]	[ ]
1 9	Did you submit an annual Business Plan chemical inventory update reflecting the information generated on Report K08215-01, Annual Listing of Reportable Quantities?	[ ]	[ ]	[ ]
1 10	Inspect the Business Plan file Do you keep copies of the Business Plan and Business Plan chemical inventory on file for three years?	[ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req d
	[ ]	[ ]
	[ ]	[ ]
	[ ]	[ ]
	[ ]	[ ]

Use reverse side for additional comments [ ]

NOTE. For each checklist item found to be out of compliance document the following

1) Question number 2) Description of exception 3) Corrective action planned or taken 4) Completion date

887

2 Chemical Inventory

If your facility handles or stores reportable quantities of hazardous materials, complete the following two subsections If not, go to Subsection 4

2 1 Compare the hazardous materials stored reportable quantities or those materials that have the potential to meet or exceed reportable quantities, with report K08210-01,"Monthly listing of reportable quantities"

		Yes	No	N/A
a	Does the report accurately list the hazardous materials (meeting or exceeding reportable quantities) in storage at your facility?	[ ]	[ ]	[ ]
b	Do all stored hazardous materials and wastes (meeting or exceeding reportable quantities) appear on the report?	[ ]	[ ]	[ ]
c	Are the Chemical Inventory forms (Form No 6411) completed for each reportable quantity hazardous material addition, deletion, or change?	[ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req'd
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Use reverse side for additional comments [ ]

NOTE. For each checklist item found to be out of compliance document the following

1) Question number 2) Description of exception 3) Corrective action planned or taken 4) Completion date

3 Material Safety Data Sheets (MSDS)

3 1 Compare 10% of the hazardous materials stored at your facility with the those listed on report K08135-01 "MSDS List by Location Code" and verify that these MSDSs are located in the MSDS binder

		Yes	No	N/A
a	Are the sampled materials listed on report K08135-01?	[ ]	[ ]	[ ]
b	Are MSDSs for the sampled materials located within the MSDS binder?	[ ]	[ ]	[ ]
c	Are MSDSs acquired for direct-purchase items and those ordered through the Company warehouse before the material is used or stored at the facility?	[ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req'd
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539

4 Storage

If you store hazardous materials, complete this subsection If not, go to Subsection 5 (See FCD 104 0601, B 1 and I)

Inspect the hazardous material storage area

		Yes	No	N/A
4 1	Do all storage areas housing containers of flammables, poisons corrosives, or irritants have adequate ventilation?	[ ]	[ ]	[ ]
4 2	Are oxidizing agents separated in storage from flammable or combustible materials and sources of sparks?	[ ]	[ ]	[ ]
4 3	Are acids with a pH less than 2 stored separately from other hazardous materials?	[ ]	[ ]	[ ]
4 4	Are drums stored on pallets?	[ ]	[ ]	[ ]
4 5	Are drums of hazardous material surrounded by a curb or is spill response equipment in an easily accessible area?	[ ]	[ ]	[ ]
4 6	Are "No Smoking" signs posted in all areas used to store flammables?	[ ]	[ ]	[ ]
4 7	Are all hazardous materials containers, including those containing hazardous materials transferred from their original containers clearly labeled with			
	a Physical hazard	[ ]	[ ]	[ ]
	b Name of substance	[ ]	[ ]	[ ]
	c Health hazard warning	[ ]	[ ]	[ ]
4 8	Do you ensure that hazardous materials (or any materials) are not stored with hazardous waste?	[ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req'd
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5 Shipping Papers

If you receive hazardous materials from the Company warehouse, complete this subsection If not, go to Subsection 6

		Yes	No	N/A
5 1	Review your hazardous materials records Have you retained all Bills of Lading for one year? (See FCD 104 0040 J 12)	[ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req'd
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6 Vehicles

If your department operates vehicles that transport hazardous materials, complete this subsection If not, go to Section B (See Note E)

Inspect drivers licenses for drivers who transport hazardous materials

		Yes	No	N/A
6 1	Do all drivers that operate a vehicle that transports hazardous materials have a Hazardous Material/Waste Certificate?	[ ]	[ ]	[ ]
6 2	Do all drivers that operate a tank combination vehicle for the transport of hazardous materials have the Tank Combination/Bulk Liquid Load Certificate?	[ ]	[ ]	[ ]
6 3	Do vehicles that transport 1000 pounds or more of hazardous material at one time have the annual license for "Hazardous Material Transportation"?	[ ]	[ ]	[ ]
6 4	Are all hazardous materials drivers at least 21 years old?	[ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req'd
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898

NOTES

A. (1) FCD 104 0040 Appendix A is a list of hazardous materials, coded and stocked by the Company, and is used by shippers to determine what material is considered hazardous

(2) FCD 104 0040 Appendix B is a list of direct charge materials that have been identified as "Hazardous Materials "

B Reportable quantities triggering business plan requirements, which are set by the state, are as follows However, your local administering agency may set lower levels

Solids 500 lbs
Liquids 55 gal
Compound Gases 200 cu ft.

C The local administering agency may specify more frequent update See FCD 104 0145 B

E All drivers and vehicles must be licensed and registered to transport hazardous materials and wastes (Refer to FCD 104 0040 K. TRANSPORTING HAZARDOUS MATERIALS)

SECTION B TRAINING

If you supervise employees who handle hazardous materials, hazardous waste or polychlorinated biphenyls (PCBs), complete this section If not, go to Section C

1 Initial and Annual Refresher Training

		Yes	No	N/A
1 1	Review training records Did all employees in your department who handle hazardous materials, hazardous waste and PCBs receive initial training in all required modules? (See FCD 104 0001)	[ ]	[ ]	[ ]
1 2	Have all employees received the required annual refresher training?	[ ]	[ ]	[ ]
1 3	Review training records for all employees who are new or reassigned to jobs requiring handling hazardous materials or waste since the last self-audit. Did they receive all required training within six months of beginning their assignments?	[ ]	[ ]	[ ]
1 4	Have supervisors trained employees who may work with hazardous materials on hazards associated with these materials, proper work practices and use of protective equipment? (See FCD 104 0007 D)	[ ]	[ ]	[ ]

2. Recordkeeping

2 1	Compare the Employee Training Record (Form 5300) completed since the last self-audit with your most recent quarterly Employee Training Report (WO8142) Does the computerized report correctly list all training modules completed by all employees?	[ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req'd
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894

SECTION C HAZARDOUS MATERIALS ACTIVITIES

Complete this section if you are observing shipment of hazardous material If not go to Subsection 2

1 Shipping

Complete this subsection while a shipment is being prepared

	Yes	No	N/A
1 1 Inspect the hazardous material package that are to be shipped Does each package used for shipping hazardous material meet the applicable US Department of Transportation (DOT) packaging requirements? (See Note A)	[ ]	[ ]	[ ]
Inspect the packages' marking (See Note B)			
1 2 Is the container marked with			
a. The proper shipping name	[ ]	[ ]	[ ]
b "UN" or "NA" identification number?	[ ]	[ ]	[ ]
c Name and address of your facility or the destination?	[ ]	[ ]	[ ]
d Appropriate hazard warning label(s)?	[ ]	[ ]	[ ]
1 3 Are markings displayed			
a On a background of sharply contrasting color?	[ ]	[ ]	[ ]
b Unobscured by labels or attachments?	[ ]	[ ]	[ ]
c Away from other markings that could reduce their effectiveness?	[ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req'd
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895

		Yes	No	N/A
1 4	Are the abbreviations used in conjunction with the proper shipping name limited to			
	a "N O S " for Not Otherwise Specified?	[ ]	[ ]	[ ]
	b "RQ" for Reportable Quantity?	[ ]	[ ]	[ ]
	c "LTD Qty" for Limited Quantity?	[ ]	[ ]	[ ]
	d "ORM" for Other Regulated Material?	[ ]	[ ]	[ ]
1 5	If you are shipping a mixture or a solution of a hazardous substance, is the container labeled with the names of each substance making it a hazardous substance?	[ ]	[ ]	[ ]
1 6	Are all packages that contain an inside package of liquid hazardous material marked with "THIS SIDE UP" or "THIS END UP" and arrows indications the upward direction?	[ ]	[ ]	[ ]
1 7	Did you check to ensure that small quantities of hazardous materials designated as limited quantities are exempt from labeling requirements (except when being shipped by air)? (See Note C)	[ ]	[ ]	[ ]
Inspect shipping papers used to ship hazardous materials				
1 8	Do you ensure that shipping papers are filled out for all materials requiring them? (See Note D)	[ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req'd
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Use reverse side for additional comments [ ]

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896

		Yes	No	N/A
1 9	Do shipping papers include			
a	The type of packaging?	[ ]	[ ]	[ ]
b	"LTD" for limited quantities?	[ ]	[ ]	[ ]
c	"RQ" for reportable quantities?	[ ]	[ ]	[ ]
d	Information in parentheses in the "Description and Classification" following the proper shipping name and hazard class?	[ ]	[ ]	[ ]
e	Hazard class of the material?	[ ]	[ ]	[ ]
f	The "UN" or "NA" number?	[ ]	[ ]	[ ]
g	Total quantity of material by either weight or volume?	[ ]	[ ]	[ ]
h	Are all descriptions legible and in English?	[ ]	[ ]	[ ]
	(See Note E)			
1 10	Did the driver check the hazardous materials listed on the shipping papers prior to loading the vehicle?	[ ]	[ ]	[ ]
1 11	Did you offer the correct placards to common carriers prior to loading the vehicle with the hazardous materials? (See Note F)	[ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req'd
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1 12 *Observe loading or unloading of hazardous material* Did you observe that

		Yes	No	N/A
a	The vehicle hand brake is set prior to loading or unloading?	[ ]	[ ]	[ ]
b	No smoking is allowed within 25 feet when handling a flammable, or oxidizing, materials?	[ ]	[ ]	[ ]
c	Any portable containers of flammable liquids, compressed gas corrosives, or poisons are secured against movement in the vehicle?	[ ]	[ ]	[ ]
d	Valve protection caps are in place on cylinders of compressed gases?	[ ]	[ ]	[ ]
e	Cylinders are secured against any movement during transport?	[ ]	[ ]	[ ]
f	Bungs and rings are in place when drums are shipped?	[ ]	[ ]	[ ]
g	No container or packages is damaged or leaking?	[ ]	[ ]	[ ]
h	Only compatible hazardous materials are placed in the same vehicle?	[ ]	[ ]	[ ]
i	No hazardous material is transported in the cab of a truck? (See Note G)	[ ]	[ ]	[ ]
j	Vehicle is placarded on each side and at the rear as required?	[ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req'd
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898

SECTION C HAZARDOUS MATERIALS ACTIVITIES

	Yes	No	N/A
1 13 *Inspect the cab of a Company vehicle used to transport hazardous material* Are the shipping papers carried inside the pouch in the inside door on the driver's side, or in a separate plastic envelope for hazardous material and on top of any other documents of envelopes?	[ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req'd
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899

SECTION C HAZARDOUS MATERIALS ACTIVITIES

Complete this subsection when you are servicing or disposing of mercury-containing devices

2. Mercury-Containing Devices

		Yes	No	N/A
2 1	For all vacuum gauges and manometers removed from service, did you contact Environment Services to arrange for disposal? (See Note H)	[ ]	[ ]	[ ]

Comments/Corrective Actions

	Status: Complete	Status: Not Req'd
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900

NOTES

A. (1) Refer to FCD 104 0040 D Each package must be designed and constructed and the contents limited so that under normal transportation

- There is no significant release of hazardous material to the atmosphere
- The effectiveness of the package is not substantially reduced
- There is no mixture of gases or vapors in the package which could significantly reduce the effectiveness of the package

B Refer to FCD 104 0035, Hazardous Materials Storage

(1) The proper shipping name and identification number preceded by "UN" or "NA" is to be printed on or affixed to the package

(2) Packages that have been previously marked as required for the material it contains need not be remarked

(3) All marking must be clearly visible and unobscured

(4) Only those abbreviations listed must be used in conjunction with the proper shipping name

(5) Package are to marked on the end or side with the proper designation ORM-D markings may be placed on an attached tag if unable to place on package surface The ORM marking are certification by the person offering the package for shipment that the material is properly described, classed, packaged marked, and labeled

(6) Labels must be affixed next to the proper shipping name See FCD 104 0040 Appendix A and B for labeling requirements

(7) Refer to FCD 104 0040 H Packages containing only "ORM-D" materials are exempted from labeling requirements if the gross weight of each package is less than 65 pounds, and if the material is suitable for sale to consumers The proper shipping name is then "Consumer Commodity" Appendix A of FCD 104 0040 lists the material commonly used by the Company that are considered to be ORM-D

C Limited quantities of various specified materials are to be packaged according to the requirements to qualify for the exemption to labelling Refer to FCD 104 0040, Section G

D Refer to FCD 104 0040 J 3, J 4, and J 5

(1) Shipping papers are not required when Company vehicles driven by Company drivers carry less than 500 pounds of hazardous materials

(2) ORM-D materials and combustible liquids in packages of 110 gallons or less do not require shipping papers and are not included in the 500 pound limit, unless the ORM is a hazardous substance or hazardous waste

NOTES
(continued)

(3) Compressed gas cylinders must be cleaned and completely purged to be exempt from shipping paper requirements

(4) Hazardous materials that are transported by air require shipping papers

E Refer to FCD 104 0040 J 1 and J 2

(1) Divisions use Form 5024, Straight Bill of Lading Material Operations uses Form 5024 as the shipping paper

(2) Hazardous material exempted from labeling requirements, will still require shipping paper

(3) A technical or chemical name in parentheses used with the shipping name is placed between the proper shipping name and the hazard class

F Refer to FCD 104 0040 M

(1) All vehicles that transport hazardous materials are placarded if the weight or volume of the material exceeds 1000 pounds

(2) The person shipping a hazardous material must provide all necessary placards to the driver

(3) FCD 104 0040 M 5 is a list of placards that commonly required by the Company

G Refer to FCD 104 0040 L If there are any questions regarding the dangers of a hazardous material or the compatibilities of hazardous materials, contact Material Services Staff or the Shipping Supervisor

H Field personnel are not to remove mercury from vacuum gauges and manometers Contact Environmental Services for handling or disposal procedures. However, if you are properly trained to handle or service mercury contained equipment and have necessary protective gears you may service the equipment (such as vacuum flow gauges)

I The needed forms and their uses are

(1) Form 1684, Miscellaneous Delivery Receipt, for manometers to be returned after decontamination

(2) Form 36, Reclaimed Material, for recorders and manometers which are not to be returned

(3) Form 186, Capital Tool Transfer for vacuum gauges ("Not Needed" is indicated on the form when vacuum gauges are not to be returned, two forms are completed if they are to be returned)

(4) Form 5024, Straight Bill of Lading, for total number of manometers, vacuum gauges, and recorders and thermometers

(5) Form 4177, Material Requisition for thermometers. Refer to Bulletin No 1 104 0040 B 7, C 4, D 1 and D 2 for details on each form required

Example Audit Protocol: Hazardous Waste

1 General

If your facility generates, stores, or ships hazardous waste, complete this module If not, go to Module 7

Note Audit questions pertaining to Hazardous Waste Training requirements are in Module 5, Hazardous Materials, Section B, Training

		Yes	No	N/A
1 1	Does your facility have a US Environmental Protection Agency (USEPA) ID number? (See Note A1)	[ ]	[ ]	[ ]

If your operations routinely produces hazardous waste in excess of 12,000 kilograms (26,400 pounds) or 12 kilograms (26 4 pounds) of extremely hazardous waste in a reporting year, the facility is considered a large quantity generator Large quantity generators may be subject to additional reporting requirements such as a Biennial Report and a Hazardous Waste Source Reduction and Management Review Report

1 2	Are copies of the two most recent Biennial Reports on file at the facility? (See Note A2)	[ ]	[ ]	[ ]
1 3	Has a Hazardous Waste Source Reduction and Management Review Report been prepared for the facility? (See Note A3)	[ ]	[ ]	[ ]
	• Is the plan maintained on-site?	[ ]	[ ]	[ ]
	• Has the plan been updated every four years?	[ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req d
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2 Contingency Plan

If your facility has a hazardous waste storage area, complete Subsections 2 through 6 If not, go to Section B, Hazardous Waste Shipping

2 1 Are all hazardous wastes stored in designated Hazardous Waste Storage areas?	[ ]	[ ]	[ ]

2 Contingency Plan (continued)

	Yes	No	N/A
2 2 a) Review your Hazardous Waste Contingency Plan is your facility's Hazardous Waste Contingency Plan complete and up-to-date? (See Note B)	[ ]	[ ]	[ ]
b) Review Spill Response Equipment Inspection Log, Form 6391 Were inspections conducted quarterly?	[ ]	[ ]	[ ]
c) Are logs retained in file for one year?	[ ]	[ ]	[ ]
2 3 Have you submitted the Contingency Plan to the appropriate local agencies?	[ ]	[ ]	[ ]
2 4 Verify that all on-call supervisors are familiar with the Contingency Plan and know where it is kept Are all appropriate personnel at your facility			
a) Familiar with the Contingency Plan?	[ ]	[ ]	[ ]
b) Knowledgeable about where it is kept?	[ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req'd
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3 Inventory and Inspections

Review the containers in storage and the current inventory log, Form 6362 (See Note C1)

		Yes	No	N/A
3 1	Do you have a separate log for each drum of hazardous waste in storage?	[ ]	[ ]	[ ]
3 2	Does each inventory log agree with the hazardous wastes as shown on the drum?	[ ]	[ ]	[ ]
3 3	Does the accumulation start date on the inventory log match the start date on Hazardous Waste Accumulation drum label?	[ ]	[ ]	[ ]
3 4	Does the accumulation start date indicate that the waste has been on site for			
	a) less than 90 days for waste generated on-site?	[ ]	[ ]	[ ]
	b) **less than 6 days, 144 hours, for field generated waste?** (see Note C2)	[ ]	[ ]	[ ]
3 5	Review inventory log Form 6362 Do you have the inventory logs for the last three years on file?	[ ]	[ ]	[ ]

Review inspection logs, Form 6365, completed since the last self-audit

3 6	**Did you inspect all hazardous waste storage areas, including drum storage and roll off bin areas, weekly and log the inspections? (See Note C3)**	[ ]	[ ]	[ ]
3 7	*Review inventory logs, Form 6365 on file* Are inspection logs retained for three years?	[ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req'd
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4 Drum Labeling/Marking

Inspect all drums in all hazardous waste storage areas, including waste oil process drums, to answer Questions 4 1 through 4 5 If no drums are in storage, go to Subsection 5

		Yes	No	N/A
4 1	Are all drums that contain hazardous wastes, other than waste oil, labeled/marked with the following (See Note D)			
a	The common waste name?	[ ]	[ ]	[ ]
b	Base name?	[ ]	[ ]	[ ]
c	Drum number?	[ ]	[ ]	[ ]
d	Hazardous waste accumulation record? (Form 5280)	[ ]	[ ]	[ ]
e	Hazardous waste label (Form WM-6)?	[ ]	[ ]	[ ]
f	An appropriate Hazardous Class label (e g , Flammable Liquid, Corrosive, etc)?	[ ]	[ ]	[ ]
4 2	Are all drums that contain waste oil labeled/marked with the following (See Note D)			
a	Waste Oil Process Drum Label?	[ ]	[ ]	[ ]
b	Hazardous Waste Accumulation Record Label? (Form 5280)	[ ]	[ ]	[ ]
c	Base Name?	[ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req'd
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4 Drum Labeling/Marking (continued)

		Yes	No	N/A
d	Drum Number?	[ ]	[ ]	[ ]
e	Hazardous Waste Label (Form WM-6) if waste oil is picked up by Material Operations - Shipping?	[ ]	[ ]	[ ]
4 3	Have all labels with the exception of the Waste Oil Process Drum label been removed or painted over, and an "EMPTY" label placed on all empty waste oil storage drums?	[ ]	[ ]	[ ]
4 4	Since the last self-audit, did you reuse all waste oil process drums that were in good conditions?	[ ]	[ ]	[ ]

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NOTE For each checklist item found to be out of compliance document the following

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5 Storage Area Requirements

Inspect the hazardous waste storage area to verify the following

		Yes	No	N/A
5 1	If your hazardous waste storage area is paved, is the pavement in good condition?	[ ]	[ ]	[ ]
5 2	If the area is not paved, is a metal or plastic tray or plastic sheeting in good condition used to cover the ground surface?	[ ]	[ ]	[ ]
5 3	Is spill response equipment maintained in a close, easily accessible location? (See Note E)	[ ]	[ ]	[ ]
5 4	Is the hazardous waste storage area posted with a sign that reads, "CAUTION! HAZARDOUS WASTE STORAGE AREA HANDLE WITH CARE"?	[ ]	[ ]	[ ]
5 5	Do you take measures to prevent the accumulation of rainwater on or in drums?	[ ]	[ ]	[ ]
5 6	Do you store drums on pallets so that they will not contact any surface water?	[ ]	[ ]	[ ]
5 7	Do you keep all bungs and lids in place and tight? (See Note F)	[ ]	[ ]	[ ]
5 8	Do you store incompatible wastes in separate containers? (See Note G)	[ ]	[ ]	[ ]
5 9	Do you segregate incompatible wastes in the storage area?	[ ]	[ ]	[ ]
5 10	Are the containers used to store hazardous wastes approved for the types and quantities of waste they contain? (See Note H)	[ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req'd
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6 Ignitables and Reactives

If you store ignitables or reactives in the area, complete this subsection (See Note I) If not, go to Subsection 7

		Yes	No	N/A
6 1	Is the storage area at least 50 feet away from the facility property line?	[ ]	[ ]	[ ]
6 2	Is the storage area away from all ignition sources and posted with a "NO SMOKING" sign?	[ ]	[ ]	[ ]
6 3	Are provisions for grounding and bonding present at the storage area? (See Note J)	[ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req'd
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7 Battery Storage

If you store spent automotive lead acid batteries at your facility, complete this section (See Note K) If not, go to Subsection 8

Inspect your spent battery storage area

		Yes	No	N/A
7 1	Do you have less than 11 intact spent batteries at the facility?	[ ]	[ ]	[ ]
7 2	Do you manage groups of more than 10 intact spent batteries as a hazardous waste?	[ ]	[ ]	[ ]
7 3	Do you store all intact spent batteries in a safe manner, including			
	a Off the ground?	[ ]	[ ]	[ ]
	b Vented indoor or a covered exterior area?	[ ]	[ ]	[ ]
	c Away from car wash sump racks or other drains?	[ ]	[ ]	[ ]
	d Away from ignition sources?	[ ]	[ ]	[ ]
	e Tightly capped?	[ ]	[ ]	[ ]
7 4	Do you containerize damaged, cracked, or leaking batteries in a DOT 17C or 17H drum with a polyethylene liner and manage them as hazardous waste?	[ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req'd
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8 Waste Oil Filters

If your facility generates used oil filters, complete questions 8 1 thru 8 8 (See Note L) If not, go to Subsection 9

		Yes	No	N/A
8 1	Are all used automotive oil filters drained into the waste oil drum for at least 24 hours until no free-flowing oil remained inside?	[ ]	[ ]	[ ]
8 2	Once drained, are the filters placed in a 17C/17H, 55 gallon drum?	[ ]	[ ]	[ ]
8 3	Are only the used automotive oil filters placed in the drum (i e , no absorbent, plastic bags or other containers such as empty oil cans)?	[ ]	[ ]	[ ]
8 4	Are the drums marked "Drained Used Oil Filters" along with the date that the first filter was placed in the drum?	[ ]	[ ]	[ ]
8 5	**Are accumulation dates all within 1 year?**	[ ]	[ ]	[ ]
8 6	Are drums used to store used automotive oil filters stored away from the hazardous waste storage area?	[ ]	[ ]	[ ]
8 7	Is the amount of used automotive oil filters presently at the facility less than 1 ton (4 drums)?	[ ]	[ ]	[ ]
8 8	Are your trash bins or dumpsters free of discarded oil filters?	[ ]	[ ]	[ ]
8 9	If your facility generates or stores used large oil filters from compressor station engines, are they handled as hazardous waste? (See Note M)	[ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req'd
	[ ]	[ ]
	[ ]	[ ]
	[ ]	[ ]
	[ ]	[ ]

Use reverse side for additional comments [ ]

NOTE For each checklist item found to be out of compliance document the following

1) Question number 2) Description of exception 3) Corrective action planned or taken 4) Completion date

9 Disposal of Small Containers

If your facility uses small containers (5 gallons or less) of hazardous materials, including spray cans, complete this section (See Note N) If not, go to Subsection 10

Check trash cans in your department for small (5 gallons or less) empty containers of hazardous materials

		Yes	No	N/A
9 1	Do all containers disposed of in the trash contain no free-flowing liquids/materials?	[ ]	[ ]	[ ]
9 2	Are the container top, bottom, and sidewalls clean or coated with only a thin uniform layer of material?	[ ]	[ ]	[ ]
9 3	Are all spray cans emptied of contents and propellant prior to discarding?	[ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req'd
	[ ]	[ ]
	[ ]	[ ]
	[ ]	[ ]
	[ ]	[ ]

Use reverse side for additional comments [ ]

NOTE For each checklist item found to be out of compliance document the following
1) Question number 2) Description of exception 3) Corrective action planned or taken 4) Completion date

10 Solvents

If your facility generates or stores solvent wastes, complete this Subsection If not, go to Subsection 11

		Yes	No	N/A
10 1	Since the last self-audit, did you segregate all solvent waste by chlorinated or non-chlorinated categories? (See Note O)	[ ]	[ ]	[ ]
10 2	Since the last self-audit, did you recycle all solvents that can be recycled?	[ ]	[ ]	[ ]
10 3	**As documentation of recycling, are copies of each "Service/Sales Acknowledgment" retained in file for three years ?**	[ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req'd
_____	[ ]	[ ]
_____	[ ]	[ ]
_____	[ ]	[ ]
_____	[ ]	[ ]

Use reverse side for additional comments [ ]

NOTE For each checklist item found to be out of compliance document the following

1) Question number 2) Description of exception 3) Corrective action planned or taken 4) Completion date

11 Aboveground Tanks

If your facility stores any hazardous wastes in aboveground tanks with a capacity greater than 110 gallons, complete this Subsection (See Note P) If not, go to Subsection 12

		Yes	No	N/A
11 1	Does the tank have a secondary containment, (i e , a vault, double walled, paved bermed area)?	[ ]	[ ]	[ ]
11 2	Is the secondary containment system equipped with a leak detection system, **(e g , daily visual inspections, or electronic leak detection equipment)** that is designed to detect the presence of any release of hazardous waste or accumulated liquids?	[ ]	[ ]	[ ]

If your tank was installed on or before July 14, 1986 and does not have secondary containment as described in questions 11 1 and 11 2, answer questions 11 3 and 11 4

11 3	Has a written assessment of the tank ensuring that the tank is not leaking and is fit for use been prepared and certified by a professional engineer?	[ ]	[ ]	[ ]
11 4	Is a copy of the report on file at the facility?	[ ]	[ ]	[ ]

Inspect the tanks and surrounding area to answer questions 11 3 through 11 10

11 5	Is a current Hazardous Waste Accumulation Record Form 5280, affixed to the tank?	[ ]	[ ]	[ ]
11 6	Does the accumulation start date indicate that the waste has been in storage less than 90 days?	[ ]	[ ]	[ ]
11 7	Is there a sign posted at the tanks that reads, "CAUTION! HAZARDOUS WASTE STORAGE AREA HANDLE WITH CARE"?	[ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req'd
	[ ]	[ ]
	[ ]	[ ]
	[ ]	[ ]
	[ ]	[

Use reverse side for additional comments [ ]

NOTE For each checklist item found to be out of compliance document the following

1) Question number 2) Description of exception 3) Corrective action planned or taken 4) Completion date

11 Aboveground Tanks (continued)

	Yes	No	N/A
11 8 Do you limit the maximum amount of waste in these tanks to 5,000 gallons or 45,000 pounds (whichever is greater)?	[ ]	[ ]	[ ]
11 9 If hazardous waste is continuously fed into a tank at your facility, is the tank equipped with an automatic waste feed cutoff or bypass?	[ ]	[ ]	[ ]
11 10 If ignitables or reactives are stored, are they protected from sources of ignition or reaction?	[ ]	[ ]	[ ]
11 11 Are liquid levels in open top tanks maintained at least 2 feet below the top of the tank?	[ ]	[ ]	[ ]
11 12 Do you empty all intermediate hazardous waste holding tanks into the storage tank(s) before the storage tank is emptied for shipment? (See Note Q)	[ ]	[ ]	[ ]

Review the Hazardous Waste Aboveground Tank Inspection Logs, Form 6363, completed since the last self audit (See Note R)

11 13 Have daily inspections been conducted on the following

a) overfill/spill control equipment, e g , waste-feed cutoff systems, bypass systems,and drainage systems to ensure that it is in good working order;	[ ]	[ ]	[ ]
b) aboveground portion of the system to detect corrosion of releases of wastes,	[ ]	[ ]	[ ]
c) area immediately surrounding the tank to detect erosion or signs of release	[ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req'd
	[ ]	[ ]
	[ ]	[ ]
	[ ]	[ ]
	[ ]	[ ]

Use reverse side for additional comments [ ]

NOTE For each checklist item found to be out of compliance document the following

1) Question number 2) Description of exception 3) Corrective action planned or taken 4) Completion date

11 Aboveground Tanks (continued)

		Yes	No	N/A
d) data from monitoring equipment and leak-detection equipment to ensure that the tank is being operated according to design,	[ ]	[ ]	[ ]	
e) uncovered tanks for compliance with liquid levels		[ ]	[ ]	[ ]
In addition, have the following been inspected and documented?				
f) cathodic protection within 6 months of installation and annually thereafter,		[ ]	[ ]	[ ]
g) bimonthly inspection/testing of all sources of impressed current		[ ]	[ ]	[ ]
11 14 Review the file for Form 6363 Does the file include the completed inspection logs for the past three years?		[ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req'd
	[ ]	[ ]
	[ ]	[ ]
	[ ]	[ ]
	[ ]	[ ]

Use reverse side for additional comments [ ]

NOTE For each checklist item found to be out of compliance document the following

1) Question number 2) Description of exception 3) Corrective action planned or taken 4) Completion date

12 Non-Hazardous Waste

In order to ensure that hazardous waste is not placed in non-hazardous waste containers, complete the following questions (See Note S)

	Yes	No	N/A
12 1 Inspect drums used to store non-hazardous waste Are all drums used to store non-hazardous waste labeled with non-hazardous waste label?	[ ]	[ ]	[ ]
12 2 Do you store all containers of non-hazardous wastes, including trash cans and roll-off bins, in a separate area away from the hazardous waste area?	[ ]	[ ]	[ ]

Go to Section B

Comments/Corrective Actions	Status: Complete	Status: Not Req'd
	[ ]	[ ]
	[ ]	[ ]
	[ ]	[ ]
	[ ]	[ ]

Use reverse side for additional comments [ ]

NOTE For each checklist item found to be out of compliance document the following

1) Question number 2) Description of exception 3) Corrective action planned or taken 4) Completion date

NOTES

A (1) Facilities that are authorized to store hazardous waste for up to 90 days are required to have an EPA ID number See S I 104 0030 Appendix C for a list of facilities authorized to store hazardous wastes If you have any questions, contact Environment & Safety

(2) Environmental Services prepares a Biennial Report by March 1 of each even numbered year for every facility that generate 1 1 ton or more of hazardous waste in a single month The report, which summaries hazardous waste activity during the previous two years, is based on the uniform Hazardous Waste Manifests generated by the facility The report is sent to the EPA and copies are sent to the facilities for retention Facilities should maintain the two most current reports on file and have them available for inspection

(3) The requirements of Hazardous Waste Source Reduction and Management Review are covered in California regulations Title 22 Section 67100 1 The Hazardous Waste Source Reduction and Management Review is not a turn-in or submission program Facilities that routinely generate through on-going processes and operations, more than 12 000 kilograms of hazardous waste in a reporting year or more than 12 kilograms of extremely hazardous waste in a calendar year may be subject to these requirements Certain hazardous waste streams are not included in calculating the volume The following waste streams are not considered

1 Wastes generated in association with the operation of motor vehicles, e g , transmission oil, antifreeze

2 Waste from site cleanup and mitigation activities including remedial investigations

3 Asbestos

4 PCBs

The Hazardous Waste Source Reduction and Management Review are required to be maintained on site and must be updated every four years The plan must be reviewed by a registered professional engineer Preparation of the plan is the responsibility of Environmental Services

B (1) Refer to S I 104 0025 Company long-term and temporary hazardous waste storage facilities are required to have a Hazardous Waste Contingency Plan The Plan must include

(a) Actions facility personnel must take in an emergency

(b) Arrangements agreed to by local police and fire departments, hospitals, contractors and State and local emergency response teams

(c) Lists of all persons (and phone numbers) who are qualified to act as coordinator

(d) A list of all emergency equipment located at the facility

(e) An evacuation plan for the facility in the event of an emergency

NOTES
(continued)

(2) The Contingency Plan must be immediately amended whenever

(a) The plan fails in an emergency

(b) Emergency response personnel change

(c) Emergency equipment changes

(d) Operations at the facility change in a way that increases the potential of explosion, fire, or release from the facility

(3) Emergency equipment is inspected quarterly by facility personnel and documented on Form 6391, Spill Response Equipment Inspection Log Completed logs are reviewed by the Emergency Coordinator and retained in file for one year

NOTES
(continued)

C (1) Refer to S I 104 0020 A current inventory of each drum of hazardous waste is kept on Form 6362, Hazardous Waste Inventory Log The logs are used to track types, amounts and time drummed wastes are stored The logs are kept on file at the facility for three years, then destroyed

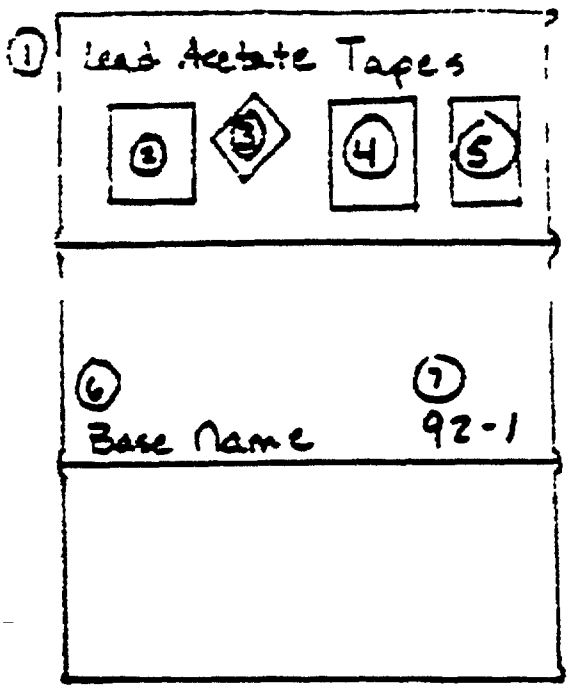
C (2) The Company has a variance letter issued by the DTSC which allows for the transportation of less than 100 kilograms of field generated hazardous waste to a Company temporary storage facility without preparing Effective July 6, 1993, the current variance letter requires that the waste be shipped from the temporary storage facility within 144 hours or 6 days Environmental Services is seeking a modification of the variance letter from the DTSC, however, until the modification is approved the maximum 6 days storage requirement must be complied with

C (3) Refer to S I 104 0020 All designated hazardous waste storage areas, drum storage areas and roll off bin areas, must be inspected on a weekly basis The results are recorded on Form 6365, Hazardous Waste Drum Storage Area Weekly Inspection Log The inspection logs are kept on file at the storage facility for three years, then destroyed

NOTES
(continued)

D All drums of hazardous waste must be properly labeled/marked while in storage S I 104 0020, outlines these requirement and provides a sample of a commonly generated waste in Appendix A For ease of reference, a sample of required marking for a drum of spent lead Acetate tape is provided on pages A-20 & A-21 and a sample for waste oil is provided on page A-22

MARKING AND LABELING
LEAD ACETATE TAPES



1 WASTE NAME, enter as shown in Company S I. 104 0030 Appendix A, Column 1 Mark with a white marking stick in letters at least 1/2" high.

2 HAZARDOUS WASTE ACCUMULATION RECORD, Form 5280 See form instruction for Form 5280

3 WARNING LABEL, affix the appropriate label as identified in S.I. 104 0030 Appendix A, Column 7 For lead acetate tapes an ORM-E label is required.

4 HAZARDOUS WASTE LABEL, Form WM-6 see next page for a sample label for lead acetate tapes.

5 EMPTY LABEL, affix to all empty drums that previously contained hazardous material or waste

6 BASE NAME Mark with a white marking stick in letters at least 1/2" high.

7 DRUM NUMBER, consecutively number drums by year For example the first drum in 1992 is marked 92-1 and the fifth drum in 1992 is marked 92-5 Numbers are not repeated ad as a result each drum has a unique number Mark with a white marking stick in letter at least 1/2" high.

Note: The order in which labels 2 through 5 appear may vary

SAMPLE OF HAZARDOUS WASTE LABEL
SAMPLE IS FOR WASTE PROFILE 020

HAZARDOUS WASTE

FEDERAL LAW PROHIBITS IMPROPER DISPOSAL

IF FOUND, CONTACT THE NEAREST POLICE, OR PUBLIC SAFETY AUTHORITY, OR THE U S ENVIRONMENTAL PROTECTION AGENCY

GENERATOR INFORMATION.

NAME _____

ADDRESS _____ PHONE _____

CITY _____ STATE CA ZIP _____

EPA ID NO / MANIFEST DOCUMENT NO. _____ / 87904390

ACCUMULATION START DATE 8-1-92 EPA WASTE NO D008

Hazardous Waste Solid, N.O.S., ORM-E, NA9189 (Lead Acetate Tapes)

D.O.T. PROPER SHIPPING NAME AND UN OR NA NO. WITH PREFIX

HANDLE WITH CARE!

STYLE 1005

Printed by LABELMASTER, Div. of AMERICAN LABELMARK CO., CHICAGO, IL 60646 (800) 621-5808

Reference Company System Instruction 104.0030 (AS-A, AS-M, ASMS, DI
EP, TRAN).

1) Obtain from Appendix C

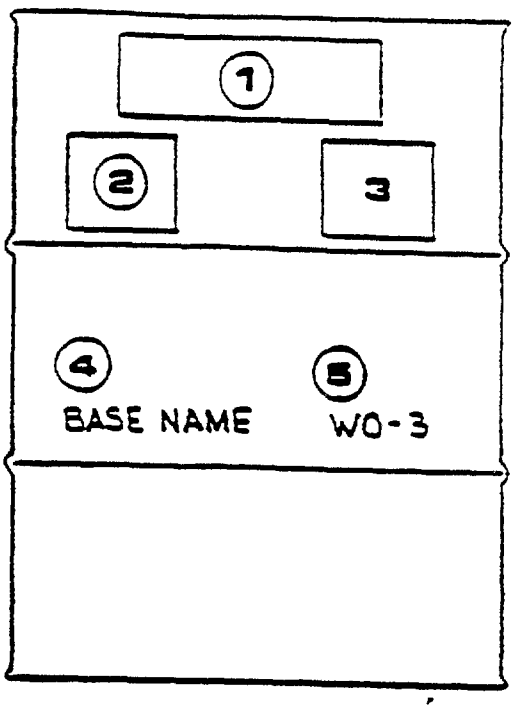
2) Document number of Manifest used to ship waste.

3) Date waste was first entered into storage.

4) Obtain from Appendix A, Column 4

5) Obtain from Appendix A, Column 3

MARKING AND LABELING
WASTE OIL PROCESS DRUMS



1) Affix a Waste Oil Process Drum Label. The label is availab from Environmental Services.

2) Form 5280, Hazardous Waste Accumulation Record, is affixed the drum when oil is first placed in the drum. The label i removed or painted over when the drum is emptied. See form instruction 5280.

3) Complete and affix Hazardous Waste Label. Refer to the pri page for a sample. This label is only required on waste oi drums that are picked up by Material Operations - Shipping transported to for recycling.

* 4) Enter base name.

* 5) Consecutively number the drums preceded by "WO". For examp if a base has three waste oil process drums, they are numb WO-1, WO-2 and WO-3.

* Mark with white marking stick in letters at least 1/2" high

NOTES
(continued)

E Refer to S I 104 0020 Spill equipment is required whether or not a curb or moat exists Spill equipment includes absorbents, shovels, brooms, sand, spare approved containers, etc

F Refer to S I 104 020 Dunng a work shift, bungs and lids must be in place but can be loose At the
end of a shift or at the end of the day bungs and lids are securely tightened

G Refer to S I 104 0020

(1) If the storage area is used to store incompatible wastes, the area must provide for segregation of incompatibles with a berm or wall or a minimum of 20 feet of separation

(2) Incompatible wastes are not placed in the same container Generally strong acids and bases (caustics) are not compatible with each other or with water and liquid hydrocarbon, and cyanides/sulfides/solvents are not compatible with acids Contact Environmental Services if you have questions about incompatibles

H Refer to S I 104 0020 The only drums approved for the storage of hazardous wastes by the Company are

(1) New or reconditioned US Department of Transportation (DOT) specifications (Spec) drums DOT Spec 17C and 17H, drums are used for solids, and DOT Spec 17E drums and 17E 5 gallon containers are used for liquids Steel DOT Spec drums are Company Material and Supply (M&S) coded items

(2) Empty drums that formerly contained a hazardous chemical, provided the drum is in good condition and the waste that is put in the drum is derived from the material that was originally in the drum For example, waste chloroethene can be stored in an empty drum which originally contained new chloroethene

NOTES
(continued)

I Refer to S I 104 0020 If the storage area is used for storage of ignitable wastes (flashpoint less than 140° F) or reactives (e g , concentrated sulfides and cyanide, explosives or strong oxidizers), the area must be at least 50 feet inside the facility's property line, away from all ignition sources, and posted with a "NO SMOKING "

J Refer to S I 166 0020 When transferring Class 1 liquids, metal containers are to be bonded to one another or to a common ground Containers may be grounded to a metal water pipe or a grounding stake driven into the ground

NOTES
(continued)

K S I 104 0020 addresses handling of spent lead-acid batteries Regulations exempt 10 or fewer spent lead-acid automotive batteries, and size from hazardous waste regulations If the batteries are recycled or reclaimed recycler The transfer must be documented on a Bill of Lading The Bill of Lading must be retained on-site for three years If however, 11 or more batteries are accumulated, all must be managed as hazardous waste Additionally, damaged, cracked or leaking batteries must be managed as hazardous waste

NOTES
(continued)

L Used oil filters must not be discarded in the trash As an alternative to disposal as a hazardous waste, used automotive oil filters transferred to a metal reclamation facility Hazardous Waste Storage, S I 104 0020 is pending revision

M Refer to S I 104 0020 The large oil filters from compressor stations are managed as hazardous waste These filters are drained of free flowing oil and accumulated in roll-off bins

NOTES
(continued)

N Hazardous Waste Storage, S I 104 0020 is being revised to include recent regulatory changes regarding the disposal of small containers which previously held hazardous substances, materials and waste Per the new regulations, California Code of Regulations Title 22 66261 7, **empty containers of five gallons or less in capacity**, may be disposed of in the trash if the following conditions are met

(1) No material can be poured or drained from the container

(2) The top, bottom or sidewalls of the container do not have a crust of material resulting from the build up of successive layers of materials A thin uniform layer of dried material is acceptable

Spray cans must be emptied of contents and propellant to the maximum extent possible prior to being discarded

Otherwise the containers must be disposed of as hazardous waste

NOTES
(continued)

O For recycling, chlorinated and non-chlorinated solvents must be segregated Below is a list of solvents commonly found at the Company, and S I 104 0020 has more information on segregation

(1) Commonly Used Non-Chlorinated Solvents

Abbot 145 Solvent
Acetone
Aqua Sol
Cal Sol #373 Cleaning Solvent
Chevron Kerosene
Chevron 51L Solvent
Remover
Chevron Thinner #325
Chevron Thinner #350B
Chevron Thinner #350H
Chevron Thinner #410B
Chevron Thinner #450B
DuPont Acrylic Enamel Reducer
DuPont 3924S Gun & Equipment
DuPont Y3832 Enamel Reducer
Engard 31VR Thinner
Engine Degreaser
Epoxy Thinner TA-72
Gasoline
Instant Starting Fluid
Kreiger Kleaning Compound
Lacquer Thinner (30-9455)
Mark V Super Solvent
Mineral Spirits 145EC
Paint Thinner
Pemsolv 140 EC Solvent
Poly PL-37 Parts Cleaning Fluid
RM Pre-Keano Wax and Silicone
Shell Cleaning Solvent
Shell Solvent 145 EC
Sinclair Lacquer Thinner
Sinclair Paint Thinner
Sinclair Synthetic Reducer
Sinclair #199 Synthetic Reducer
Sinclair #350 Thinner
Sol 360 EC-Pemaco
Solvent Heavy Duty Cleaner
Thinner (30-9478)
Trophy Acrylic Lacquer Thinner
Union 76 Solvent
Union Cleaning Solvent
Union Solvent #365
United Lab #392 Parts Cleaner

(2) Commonly Used Chlorinated Solvents

Abbot MPT 100
Action Carburetor Cleaner
Carburetor Cleaner
Chloroethene Cleaner
EMC-13
Lyme Carburetor Cleaner
Mac's Carburetor Cleaner
Malco Parts Dip
McKay's Parts Dip & Carburetor Cleaner
NAPA Brake-Motor Thinner
Pemsolv 555 Solvent
Saf-Sol Solvent Degreaser
Saf-Sol 20-20
Sta-Lube Carburetor Dip
Tomahawk Carburetor Cleaner
Trichloroethane
Tyme Carburetor Cleaner
Wedco Chloroethene Cleaner
Poly Tech PL-36
Soapman Carburetor Cleaner

NOTES
(continued)

P Current state regulations require that hazardous waste storage tanks be equipped with secondary containment and leak detection systems Compliance dates are phased-in depending on the type of waste stored and the age of the tank Inspections of the tank must be conducted **daily** and recorded in the operating record of the facility Environmental Services is currently assessing the impact of these requirements on Company operations and procedures (Reference Title 22, Sections 66265 193 and 66265 195)

NOTES
(continued)

Q Hazardous waste can be accumulated on-site for no more than 90 days To be sure that waste accumulated in transfer or intermediate holding tanks does not exceed this time limit, these tanks must be emptied into the storage tank before waste is picked up by the transporter

R Company functional guidance regarding the inspection of hazardous waste aboveground tanks is not current The inspection guidelines outlined in this manual, question 11 13, reflect the current regulatory inspection requirements which must be met to ensure compliance Environmental Services is in the process of revising S I 104 0020, Hazardous Waste Storage and the Hazardous Waste Aboveground Tank Inspection Log, Form 6363

NOTES
(concluded)

S Refer to S I 104 0020 Drums that have contained hazardous waste cannot be used for non-hazardous waste without first decontaminating the drum

(1) Storage time is limited to 90 days

(2) The contents of the tank and its accumulation start date must be shown on the tank

(3) The amount of waste in the tank must not exceed 5000 gallons or 45,000 pounds (whichever is greater) unless the facility has a hazardous waste facility permit from the Department of Toxic Substance Control (DTSC)

(4) If so equipped, Tanks equipped with waste feed cut-off and by-pass equipment, or other monitoring equipment (e g , pressure/temperature guages) must be inspected daily to ensure that it is in good operating order and operating according to its design specifications Daily inspections are also required to ensure that liquid levels in open top tanks are maintained at least 2 feet below the top of the tank

(5) Inspections for any evidence of leakage must be conducted daily Inspections are documented on Form 6363, Hazardous Waste Aboveground Tank Inspection Log Logs are retained on site for 3 years then destroyed

1 Shipment of Wastes from Field or Job Site Locations

If your facility transports any hazardous waste from field or job site locations to a Company temporary storage facility or to a contract treatment, storage, or disposal facility (TSDF), complete this subsection If not, go to Section C, Environmental Inspections

Inspect your department's vehicle(s) used to transport small quantities of hazardous wastes from field or job site locations to a company storage facility (See Note A)

		Yes	No	N/A
1 1	Inspect all drums that are ready for shipment Are all such shipments containerized in DOT-approved containers?	[ ]	[ ]	[ ]
1 2	Do all these vehicles carry a Transportation Variance Letter?	[ ]	[ ]	[ ]
1 3	Do you limit all such shipments to small quantities (i e , 220 pounds or 28 gallons or less)?	[ ]	[ ]	[ ]

When you generate large quantities (more than 220 pounds or 28 gallons) of hazardous waste at field job sites

1 4	Are the waste shipments properly manifested and shipped directly to either the long term storage at or to an approved TSDF (See Note B)	[ ]	[ ]	[ ]
1 5	Do you obtain a temporary USEPA ID number from Environmental Services for all such shipments? (See Note C)	[ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req'd
	[ ]	[ ]
	[ ]	[ ]
	[ ]	[ ]
	[ ]	[ ]

Use reverse side for additional comments [ ]

NOTE For each checklist item found to be out of compliance document the following

1) Question number 2) Description of exception 3) Corrective action planned or taken 4) Completion date

1 Shipment of Wastes from Field or Job Site Locations (continued)

1 6 Inspect labels and markings on all drums ready for shipment
Are the drums labeled and marked with the following (See Note D)

		Yes	No	N/A
a	The common waste name?	[ ]	[ ]	[ ]
b	The base name or generation location?	[ ]	[ ]	[ ]
c	Drum number?	[ ]	[ ]	[ ]
d	Form 5280, Hazardous Waste Accumulation Record?	[ ]	[ ]	[ ]
e	Form WM-6, Hazardous Waste Label?	[ ]	[ ]	[ ]
f	An appropriate Hazardous Class warning label?	[ ]	[ ]	[ ]
1 7	Are all labels filled out correctly?	[ ]	[ ]	[ ]
1 8	Do you use only Company or contract registered haulers to transport such shipments? (See S I 104 0030 Appendix I)	[ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req d
	[ ]	[ ]
	[ ]	[ ]
	[ ]	[ ]
	[ ]	[ ]

Use reverse side for additional comments [ ]

NOTE For each checklist item found to be out of compliance document the following
1) Question number 2) Description of exception 3) Corrective action planned or taken 4) Completion date

2 Shipments from a Company Temporary Storage Facility

If you ship hazardous waste from a Company temporary storage facility to the long term storage facility at or to an approved TSDF, review a shipment of waste that is ready for shipment and answer this section If not, go to Subsection 3

		Yes	No	N/A
2 1	Do you use only DOT approved containers to transport hazardous waste?	[ ]	[ ]	[ ]
2 2	Do you check to ensure that drums are tightly sealed (bungs tight, rings and bolts in place) prior to shipment?	[ ]	[ ]	[ ]
2 3	Check labels and markings on all drums Are they all labeled and marked with the following (See Note D)			
	a The common waste name?	[ ]	[ ]	[ ]
	b The base name or generation location?	[ ]	[ ]	[ ]
	c Drum number?	[ ]	[ ]	[ ]
	d Form 5280, Hazardous Waste Accumulation Record?	[ ]	[ ]	[ ]
	e Form WM-6, Hazardous Waste Label?	[ ]	[ ]	[ ]
	f An appropriate Hazardous Class warning label?	[ ]	[ ]	[ ]
2 4	Are all labels filled out completely and correctly?	[ ]	[ ]	[ ]
2 5	Is the State Manifest document number entered on the hazardous waste label (Form WM-6) prior to shipment? (See Note E)	[ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req'd
	[ ]	[ ]
	[ ]	[ ]
	[ ]	[ ]
	[ ]	[ ]

Use reverse side for additional comments [ ]

NOTE For each checklist item found to be out of compliance document the following

1) Question number 2) Description of exception 3) Corrective action planned or taken 4) Completion date

2 Shipments from a Company Temporary Storage Facility (continued)

2 6 For hazardous waste shipped directly to a TSDF, other than Long Term Storage Facility are (See Note F)

	Yes	No	N/A
a) Disposal Notification and Certification forms prepared for all Land Ban waste listed Appendix A, column 9 of S I 104 0030, Hazardous Waste Shipping?	[ ]	[ ]	[ ]
b) Is a copy of the form attached to the manifest and given to the driver?	[ ]	[ ]	[ ]
c) Is a copy of the form sent which with the manifest copy designated "GENERATOR SENDS THIS COPY TO THE DTSC WITHIN 30 DAYS" to Environmental Services?	[ ]	[ ]	[ ]
d) Is a copy retained in file at the facility for 5 (five) years?	[ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req'd
	[ ]	[ ]
	[ ]	[ ]
	[ ]	[ ]
	[ ]	[ ]

Use reverse side for additional comments [ ]

NOTE For each checklist item found to be out of compliance document the following

1) Question number 2) Description of exception 3) Corrective action planned or taken 4) Completion date

3 Lead Acid Automotive Batteries

If you ship spent automotive lead acetate batteries off-site, complete this subsection If not, go to Subsection 4

		Yes	No	N/A
3 1	Inspect documentation for shipments of spent automotive batteries Since the last self-audit, did you ship spent, intact, leak-free, lead-acid batteries off-site prior to accumulating 11 batteries? (See Note H)	[ ]	[ ]	[ ]
3 2	Did you use a Straight Bill of Lading for all shipments of less than 11 intact batteries?	[ ]	[ ]	[ ]
3 3	Did you retain all Straight Bill of Ladings on-site for three years?	[ ]	[ ]	[ ]
3 4	If more than 10 batteries or leaking batteries are accumulated, are they containerized, labeled and marked as hazardous waste and manifested to long-term storage at	[ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req'd
	[ ]	[ ]
	[ ]	[ ]
	[ ]	[ ]
	[ ]	[ ]

Use reverse side for additional comments [ ]

NOTE For each checklist item found to be out of compliance document the following
1) Question number 2) Description of exception 3) Corrective action planned or taken 4) Completion date

4 Waste Oil and Carwash Sump Wastes Shipment

This subsection applies to oil and carwash sump wastes from all company facilities that are handled by an outside contractor If you are located at one of these facilities, complete this subsection If you are not, go to Subsection 5

		Yes	No	N/A
4 1	Are you using only Company approved designated haulers to ship waste oil and carwash sump waste?	[ ]	[ ]	[ ]
4 2	Were all shipments of waste oil picked up as scheduled? (See Note I)	[ ]	[ ]	[ ]
4 3	Were all shipments of carwash sump waste picked up as scheduled? (See Note I)	[ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req'd
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	[ ]	[ ]

Use reverse side for additional comments [ ]

NOTE For each checklist item found to be out of compliance document the following

1) Question number 2) Description of exception 3) Corrective action planned or taken 4) Completion date

5 Shipment of Oil from Remote Locations

This section applies only to waste oil shipments from locations that are handled by Material Operations- Shipping If you are located at one of these facilities, complete this subsection If not, go to Subsection 6

		Yes	No	N/A
5 1	Do you ship all waste oil to via company trucks as part of regular pick-up and delivery by Material Operations-Shipping? (See Note J)	[ ]	[ ]	[ ]
5 2	Inspect labels and markings on all drums ready for shipment Are the drums labeled and marked with the following (See Note D)			
a	Waste Oil Process Drum Label?	[ ]	[ ]	[ ]
b	Form 5280, Hazardous Waste Accumulation Record?	[ ]	[ ]	[ ]
c	Form WM-6, Hazardous Waste Label?	[ ]	[ ]	[ ]
d	Name of Base?	[ ]	[ ]	[ ]
e	Drum number?	[ ]	[ ]	[ ]
5 3	Are all labels filled out completely and correctly?	[ ]	[ ]	[ ]
5 4	Are the "EMPTY" waste oil process drums returned from Material Operations			
a	Without free liquids?	[ ]	[ ]	[ ]
b	With an "EMPTY" label?	[ ]	[ ]	[ ]
c	With Hazardous Waste and Hazardous Waste Accumulation labels removed or painted over?	[ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req'd
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	[ ]	[ ]
	[ ]	[ ]
	[ ]	[ ]

Use reverse side for additional comments [ ]

NOTE For each checklist item found to be out of compliance document the following

1) Question number 2) Description of exception 3) Corrective action planned or taken 4) Completion date

941

6 Empty Drums

If you dispose of empty drums that previously contained hazardous materials or waste, complete this subsection If not, go to Subsection 7 (See Note K)

		Yes	No	N/A
6 1	Are empty vendor drums, those with a deposit, returned to the vendor?	[ ]	[ ]	[ ]
6 2	a) **Are all empty drums that will be sent to marked with the date emptied?**	[ ]	[ ]	[ ]
	b) **Are all drums shipped within 1 year from the date emptied?**	[ ]	[ ]	[ ]
	c) Are empty drum that previously contained hazardous materials or waste, excluding acutely hazardous materials or wastes segregated based on the hazard of class of the material that they previously contained?	[ ]	[ ]	[ ]
	d) Are the drums shipped to with a Straight Bill of Lading, Form 5024?	[ ]	[ ]	[ ]
6 3	a) Are empty drums that formally contained acutely hazardous materials or waste, eg mercury, poison etc , segregated based on the hazard class of the materials or waste that they once contained?	[ ]	[ ]	[ ]
	b) Are the drums shipped to with a uniform hazardous waste manifest?	[ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req'd
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	[ ]	[ ]
	[ ]	[ ]
	[ ]	[ ]

Use reverse side for additional comments [ ]

NOTE For each checklist item found to be out of compliance document the following

1) Question number 2) Description of exception 3) Corrective action planned or taken 4) Completion date

947

7 Used Automotive Oil Filters

If you dispose of used automotive oil filters, complete this Subsection (See Note L) If not, go to Subsection 8

		Yes	No	N/A
7 1	Are used automotive oil filters being picked up directly by the vendor or shipped to within one year from the start of accumulation?	[ ]	[ ]	[ ]
7 2	Are shipments documented on a Bill of Lading?	[ ]	[ ]	[ ]
7 3	Are the Bill of Ladings retained in file for 3 years?	[ ] [ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req'd
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	[ ]	[ ]
	[ ]	[ ]
	[ ]	[ ]

Use reverse side for additional comments [ ]

NOTE For each checklist item found to be out of compliance document the following

1) Question number 2) Description of exception 3) Corrective action planned or taken 4) Completion date

8 Extremely Hazardous Waste

If you generated Extremely Hazardous Waste since the last self audit complete this subsection
If not, go to Subsection 9 (See Note M)

	Yes	No	N/A
8 1 Prior to shipping the waste, did you contact Environmental Services to obtain an Extremely Hazardous Waste Disposal Permit? (See Note N)	[ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req'd
	[ ]	[ ]
	[ ]	[ ]
	[ ]	[ ]
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Use reverse side for additional comments [ ]

NOTE For each checklist item found to be out of compliance document the following
1) Question number 2) Description of exception 3) Corrective action planned or taken 4) Completion date

9 Hazardous Waste Manifest

If you prepare hazardous waste manifests, complete this subsection If not, go to Subsection 10

9 1 *Review manifest(s) for the current shipment and/or manifests completed since the last self-audit (See Note O)*

	Yes	No	N/A
a For each manifest, has the hauler			
(1) printed their name?	[ ]	[ ]	[ ]
(2) signed their name?	[ ]	[ ]	[ ]
(3) printed date?	[ ]	[ ]	[ ]
(4) for night pickup by Material Operations - Shipping, has the driver entered the State Transporter I D Number?	[ ]	[ ]	[ ]
b Did you send the copy "Generator Sends This Copy To DTSC Within 30 Days" to Environmental Services the same day the waste is picked up?	[ ]	[ ]	[ ]
c Did you keep the "Generator Retains" copy until you received the "TSDF Sends This Copy To Generator within 30 Days"?	[ ]	[ ]	[ ]
d When you received the manifest copy designated "TSDF Sends This Copy To Generator Within 30 Days," did you make sure it had been signed by the TSDF facility representative?(See Note P)	[ ]	[ ]	[ ]
9 2 Review manifest files Have you retained copies of all manifests for three years?	[ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req'd
_____	[ ]	[ ]
_____	[ ]	[ ]
_____	[ ]	[ ]
_____	[ ]	[ ]

Use reverse side for additional comments [ ]

NOTE For each checklist item found to be out of compliance document the following

1) Question number 2) Description of exception 3) Corrective action planned or taken 4) Completion date

10 Hazardous Waste Hauling Vehicles

If your department operates vehicles that haul hazardous waste, including any hauls from field generation sites to a temporary storage facility, complete this subsection If not, go to Section C

Check the vehicles operated by your facility

		Yes	No	N/A
10 1	Were all of your vehicles inspected by the California Highway Patrol (CHP) within the last year? (See Note Q)	[ ]	[ ]	[ ]
10 2	Inspect vehicles and associated trailers to verify the following			
a	Is the registration current?	[ ]	[ ]	[ ]
b	Is the current certificate of compliance affixed to the right front of the vehicle and trailers?(See Note R)	[ ]	[ ]	[ ]
c	Is the Emergency Response guidebook carried in the vehicle?	[ ]	[ ]	[ ]
10 3	Verify the following for all drivers who haul hazardous waste			
a	Does each driver have the appropriate endorsement to operate vehicles that transport hazardous wastes and materials that require placarding?	[ ]	[ ]	[ ]
b	Are all drivers over 21 years of age? (See Note S)	[ ]	[ ]	[ ]

Go to Section C

Comments/Corrective Actions	Status: Complete	Status: Not Req'd
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Use reverse side for additional comments [ ]

NOTE For each checklist item found to be out of compliance document the following

1) Question number 2) Description of exception 3) Corrective action planned or taken 4) Completion date

NOTES

A Refer to S I 104 0030 Small quantities (220 lbs or 28 gallons or less) of hazardous waste may be transported from field or job site locations to a Company temporary storage facility on a Company vehicle, no documentation needs to accompany this type of shipment However, the vehicle must carry a current copy of the Transportation Variance Letter from the Department of Toxic Substance Control (DTSC)

B Refer to S I 104 0030

(1) Large quantities (more than 220 lbs or 28 gallons) of hazardous waste that are generated at a field or job site must be properly containerized, labeled, manifested and shipped directly to long-term storage at , or to an approved TSDF via an approved registered hazardous waste hauler A temporary US EPA ID number must be obtained from Environmental Services for all such shipments

(2) If unable to ship directly to or a TSDF, the waste may be taken to the closest company hazardous waste temporary storage facility that is in the county where the waste is generated and held for up to 144 hours

(3) Approved TSDF are listed in S I 104 0030

C When requesting a temporary EPA ID number for a planned job, allow Environmental Services a minimum of two weeks advance notice

NOTES
(continued)

D Drums of waste must be containerized, labeled and marked for shipment to long-term storage at or to an approved TSDF Refer to S I 104 0020 and 104 0030

E The State Manifest document number is found in field "A" on the Uniform Hazardous Waste Manifest

NOTES
(continued)

F In some circumstances, hazardous waste may be shipped directly from a generating location to a TSDF other than Long Term Storage Facility Asbestos, hydrocarbon contaminated soil and solids, and large transmission oil filters and oily rags are sometimes managed in this manner In these circumstances, the generator is responsible for preparing the Disposal Notification and Certification forms for all "land ban waste " Land ban waste are identified in Appendix A, column 9 of S I 104 0030, Hazardous Waste Shipping Forms vary depending on the TSDF Copies should be obtained directly from the TSDF or contact Environmental Services for assistance

G (Reserved)

NOTES
(continued)

H Shipping instructions for Spent, intact lead-acid batteries are covered in S I 104 0030

(1) Spent, intact lead-acid batteries are not regulated as hazardous waste as long as there are no more than 10 on site These batteries are shipped off-site to a vendor on Form 5024, Straight Bill of Lading as "Battery, Wet, Filled with Acid, Corrosive Material, UN 2794 " The Straight Bill of Lading must be retained on site for three years Under these circumstances, the Company is not require to use a manifest The three year retention of the Bill of Lading is specified in 22 CCR §66266 81 The Company S I is pending revision to include this information

(2) Leaking lead-acid batteries or more than 10 intact batteries are considered hazardous waste and are to be treated as such

NOTES
(continued)

I Refer to S I 104 0030 Appendix D lists the Contract hauler waste oil pick-up schedule If you are not contacted by the transporter 24 hours before the pick-up, you should contact them to ensure that the pick-up will take place as scheduled A schedule of carwash sump waste pick-up is available from Automotive Staff

NOTES
(continued)

J Refer to S I 104 0030 Waste oil from several outlying locations are manifested and shipped to the long-term storage at via Material Operations-Shipping

952

NOTES
(continued)

K Empty drums, except those that formally contained acutely hazardous materials or wastes, are recycled The drums are shipped to ' with a Straight Bill of Lading S I 104 0030 will be revised to reflect the recent change in the state regulations, California Code of Regulations Title 22 S 66261 7 Contaminated Containers

Empty vendor drums are to be returned to the original vendor If they refuse to accept the drum, the drums is to be handled as any other waste drum

Drums are to be identified and segregated based upon the hazard class of the material or waste that was once in the drum **California regulations exempt drums from management as hazardous waste if specific requirements are met 1) Each drum must be labeled with the date emptied 2) Drums must be shipped to for recycling within one year of being emptied** Environmental Services is revising Company procedure to address these requirements in procedures

Empty drums that formally contained acutely hazardous materials or waste are not recycled and must be handled as hazardous waste The drums are segregated based on the hazard class of the materials or waste they formally contained and shipped to with a uniform hazardous waste manifest

SEGREGATION OF DRUMS

Corrosives		Combustible/Flammable	Other
ACIDS (pH<2)	ALKALIES(a) pH>12 5 SULFIDES CYANIDES	SOLVENTS ORGANICS FLAMMABLE OILS	OXIDIZERS PESTICIDES

* CAUTION Acids or Alkalies are segregated Drums that contained sulfides or cyanides are not to be mixed with drums that contained acids

NOTES
(continued)

L Automotive Staff has issued a blanket service agreement with a vendor for the recycling of the used automotive oil filters The vendor picks up and exchanges the waste oil filter drums directly from most garages Shipments are documented on a Bill of Lading which is retained for three (3) years Outlying location prepare a Bill of Lading and ship their waste oil filters directly to for pick up by the vendor

NOTES
(continued)

M Refer to Hazardous Waste Shipping, S I 104 0030, Appendix A, for a list of extremely hazardous waste common to Company Operations

N The Department of Toxic Substance Control (DTSC) issues the Extremely Hazardous Waste Disposal permits The application for permit must be requested at least 15 days prior to the intended date of shipping and/or disposal

NOTES
(continued)

O Refer to S I 104 0030 F

(1) Division personnel are responsible for preparing the Uniform Hazardous Waste Manifest The hauler does not prepare the manifest Manifests are prepared prior to the arrival of the hauler See S I 104 0030 Appendix B, for examples

(2) The hauler signs all six copies One is kept at the generating facility, one is sent to Environmental Services prior to being sent to the DTSC, and four copies are kept by the hauler

P Refer to S I 104 0030 The generator location receives the copy of the manifest designated "TSDF SENDS THIS COPY TO GENERATOR WITHIN 30 DAYS", signed by the TSDF within 35 days of the date of waste was accepted by the hauler This copy is filed and retained for three (3) years unless advised by Environmental Services to retain for a longer period of time The "GENERATOR RETAINS" copy is discarded

If the appropriate signed copy is not received within 35 days, the generator contacts the transporter and/or TSDF to determine the status of the hazardous waste Contact should also be made with Environmental Services

If the appropriate signed copy is not received within 45 days, the generator prepares and transmits to Policy - , an Exception Report for submittal to the DTSC

NOTES
(continued)

Q Refer to S I 104 0030

(1) The inspection is scheduled by the CHP and include vehicle maintenance and drivers hours of service

(2) Certificates of Compliance are issued annually after inspection

(3) Contact Environmental Services if you have not been contacted by the CHP by July 15 of each year for an inspection

R Refer to S I 104 0030

(1) The vehicle and trailer must be registered with the DTSC as a waste hauler and each must have a current certificate of Compliance decal affixed to the right front of the vehicle and trailer

S Refer to S I 104 0030 Effective January 1, 1989, state law established two new categories of special drivers certificates

(1) A Hazardous Material/Waste Endorsement is required for any person who operates a vehicle transporting hazardous wastes/materials that require placarding

(2) A Tank Combination/Bulk Liquid Load Endorsement is required for any person who operates a tank combination vehicle transporting hazardous materials or wastes

(3) Endorsements are obtained through Department of Motor Vehicles The examination can be taken at the same time the operator renews his or her driver's license

(4) No person under 21 years of age may operate a vehicle transporting hazardous waste

If your facility is subject to inspection by any environmental agencies, complete this section If not go to Module 7

1 Handling Inspections By Environmental Agencies

		Yes	No	N/A
1 1	Are personnel that might be asked to accompany an agency representative during an inspection of your facility knowledgeable of			
a	How the inspection should be handled? (See Note A)	[ ]	[ ]	[ ]
b	Where the records which the inspector might want to review are located? (See Note B)	[ ]	[ ]	[ ]
1 2	Have all inspections which have occurred since your last self audit been reported on Form 6510?	[ ]	[ ]	[ ]
1 3	Have all corrective actions required by the inspector been completed in a timely manner?	[ ]	[ ]	[ ]
1 4	Have all resulting fines been paid and reported to the Manager of Environmental '	[ ]	[ ]	[ ]

Comments/Corrective Actions	Status: Complete	Status: Not Req'd
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	[ ]	[ ]
	[ ]	[ ]

Use reverse side for additional comments [ ]

NOTE For each checklist item found to be out of compliance document the following
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NOTES

A Guidelines for handling inspections by environmental agencies are provided in S I 151 0010, Environmental Agency Inquires and Inspections

B Personnel who might be asked to accompany an agency representative during an inspection of a Company Facility should know where records that the inspector might want to review are located Examples include permits, equipment maintenance records, inspection records, training records, Business Plans, manifests, Biennial Reports, Contingency Plans, MSDS, etc

Protecting Audit Results

I LEGAL PROTECTION AND CONFIDENTIALITY FOR ENVIRONMENTAL AUDITS

Protecting the Environmental Audit Report

Because an effective audit process must inherently be as comprehensive as possible, it is likely that the audit will disclose the existence of environmental violations and/or a number of possible compliance issues requiring further evaluation Clearly, the audit can be useful in identifying and correcting areas of potential noncompliance However, there is a very real possibility that the audit may disclose compliance issues that would probably not have been discovered without the audit itself, or that the company will later conclude, based on additional research, that the issues are not really problems

If the audit results are not privileged, a company contemplating the establishment of an extensive audit process faces the possibility that it is simply establishing a detailed list of evidence which could be used against it by an environmental regulatory agency or citizen Given the number of environmental laws which typically allow for large fines based on a per day violation, it is not surprising that many companies are reluctant to conduct environmental audits

Although confidentiality of audit results can never be fully guaranteed, there are steps a company can take to preserve the confidentiality of audit reports

Attorney-Client Privilege

The attorney-client privilege, which protects communications between a lawyer and client, can play an important role in protecting the confidentiality of environmental audit results Three elements are necessary to establish and maintain the privilege

- Applies only to communications between the attorney and the client
- The communication must be for the purpose of obtaining legal advice
- The communication must be maintained as confidential

Company Maintained Confidentiality

Perhaps the best means of maintaining the confidentiality of environmental audit results is to establish and enforce the following guidelines for conducting an environmental audit

- All audit team members should sign a confidentiality agreement
- All documents should be marked "Privileged and Confidential" and "Do Not Duplicate "
- All audit questionnaires should be retained by the audit coordinator and kept in a locked file cabinet separately dedicated to the project
- Questionnaire responses should be handwritten and returned to the audit coordinator Individuals who filled out the questionnaires should only be allowed to see their own questionnaires and not be allowed to review questionnaires filled out by others
- Notebooks, checklists and working papers of the field auditors should be destroyed upon completion of the audit
- Upon completion of the environmental audit, the auditor may conduct a closing meeting with the facility manager The meeting should be prefaced with a confidentiality warning and should be a verbal debriefing in which the facility manager is not allowed to take notes

461

- Distribution of any audit reports should be on a need-to-know basis
- Draft copies of the audit report should be numbered and distributed to a limited number of company staff members No photocopies of the draft report should be made Upon completion and issuance of the final report, the draft reports should be returned to the audit coordinator and destroyed The destruction of the draft reports should be confirmed in writing
- Upon completing their review of the final report, company staff members should return them to the audit coordinator for storage in the locked file cabinet separately dedicated to the project

Summary

With the aid of legal counsel and sound confidentiality guidelines, an environmental audit can be planned, staffed, and implemented in a way that maximizes confidentiality and minimizes liability to a point at which a company should be able to feel secure that they are not taking an unreasonable risk

962

J TRAINING AUDITORS

Auditor training is an essential element of any audit program Discharging poorly trained staff to conduct audits at operating facilities can create technical, legal, and organizational problems, particularly in cases where companies or institutions are attempting to establish the credibility of a corporate or headquarters audit program

Fortunately with a modest level of effort invested up front, one can feel comfortable in knowing that audit staff are at least trained in the fundamentals of manufacturing operations, regulatory requirements, interviewing and inspection techniques, and perhaps most importantly, dealing effectively with plant management

Choosing the best training approach is a decision that must be made by management for the organization There is no one solution that fits each and every case Yet, the environmental manager can go through an analytical process that can help define the training needs of the organization These steps include[1]

- Diagnosing the situation

  --What is the status quo?

  --What discrepancy exists between the current behavior of the trainees and what is desired?

  --What are the realistic goals of training?

  --What methods are needed to achieve the instructional objectives?

- Developing the instructional plan

  --Title?
  --Trainers?
  --Sponsoring organization?
  --Participants?
  --Dates and times?
  --Places?
  --Overall training objectives?
  --Training plan?
  - -time period
  - -goal
  - -method
  - -materials needed

  --Evaluation procedure?

---

[1]Taken from Friedman, P G , and E A Yarbrough, ***Training Strategies from Start to Finish,*** Prentice-Hall, Inc , Englewood Cliffs, N J , 1985

93

- Implementing and monitoring

  --Frequency and monitoring?
  --Updating?
  --Annual evaluations?

Selecting the Trainers
There are three basic choices involved in selecting the trainers for an audit program

- Use experienced in-house auditors to train junior staff

- Send inexperienced staff to publicly available courses on environmental auditing

- Have consultants come in and train staff in groups

Selecting the Trainees
Obviously, those staff who will be conducting the audits should be trained prior to their first audit In addition, refresher training for all auditors should be provided One should also consider exposing those to be audited (e g , plant managers, environmental managers, etc) to the training programs so that they are made aware of the objectives of the environmental audit program

Selecting the Training Techniques
A variety of teaching techniques are available, which could be used in structuring an environmental audit training program Those that are most appropriate are outlined below

- **Lecture** -- Probably the most commonly used technique, the lecture, can be useful in explaining the fundamentals of environmental auditing Lectures can be supported by visual aids to make them more interesting, especially photographs and slides

- **Problem Solving** -- As a general rule, problem solving is a very useful tool in helping one to understand the subject at hand The use of problem solving in better understanding environmental auditing is no exception to this rule

- **Role Playing** -- Role playing can be a valuable and enjoyable supporting technique in any training program It allows program participants to more directly experience situations that occur during audits

Attached at the end of this section are copies of several examples of problem solving and role playing exercises as provided in the following environmental auditing handbook

> Lawrence B Cahill, and Raymond W Kane, ***Environmental Audits,*** Government Institutes, Inc , Rockville, MD, 1991

964

Keys to Successful Training

Developing and implementing a successful training program can be made easier if some of the following guidelines are followed

- **Be Prepared** -- Adequate preparation is essential in advance, one needs to decide on the objectives, develop the agenda, select the trainers and audience, select the methods, and develop the training tools Practice sessions are very useful In addition, attention to details such as, making sure that the audio-visual equipment is available and working correctly, is very important

- **Make it Fun** -- Do not rely to heavily on lectures Use interactive techniques such as in-class problem solving, role playing, and field exercises

- **Evaluate the Program** -- Always prepare an evaluation sheet to assess the program training programs should not be static improvements should be made constantly Feedback is essential

- **Leave the Trainees With a "To Do" List** -- in many training programs, the trainee is hit with a barrage of materials and can easily become over whelmed by the volume and complexity of the issues It is important to sum up the training by relaying the 5 to 10 most important things a trainee should take from the training Examples could include

  --Develop a checklist for your self or what you need to accomplish during the pre-audit phase

  --Develop a list of the materials you need to take with you on any audit

  --Spend at least 4 hours a week reviewing the environmental literature so as to keep up on regulatory trends

465

SAMPLE TRAINING TOOLS

H

SAMPLE TRAINING TOOLS

AUDITING TECHIQUES

WASTEWATER DISCHARGES
AIR EMISSIONS
OIL SPILL CONTROL
PCB'S
DEALING WITH REGULATORY AGENCIES
HANDLING SENSITIVE SITUATIONS
A FIELD EXERCISE

DEBRIEFING EXERCISE
ROLE PLAYING EXERCISE

AUDITING TECHNIQUES

WASTEWATER DISCHARGES

BACKGROUND

The facility you are about to audit has a permitted wastewater treatment plant with one major outfall (001) and four unpermitted stormwater outfalls (002-005) Outfall 001 requires daily sampling The NPDES permit expires six months from now Permitted effluent parameters include flow BOD TSS, TOC, pH, and several priority pollutants The treatment plant includes primary clarifiers, activated sludge tanks, unlined settling lagoons, and a sludge lagoon Your job is to audit the wastewater treatment plant system and wastewater discharge compliance in general

ASSIGNMENT

1 What is the logical sequence of tasks you would undertake to evaluate discharge compliance of outfall 001?

___ Observe technician taking a sample for proper technique

___ Determine if lab is certified

___ Inspect outfall 001

___ Inspect treatment plant/interview operator

___ Inspect discharge monitoring reports

___ Review NPDES Permit

2 You notice in doing the above that the flow and pH exceeded the limits specified in the permit an average of 4 times/month for the last 12 months How would you react to this? What would you ask or tell the facility contact?

3 What are some of the key questions you would ask the treatment plant operator/superintendent?

4 How would you begin your survey of the stormwater facilities?

5 You notice outfall 002 has a strong odor and outfall 004 an oily discharge What would you then do ask or say?

AUDITING TECHNIQUES
AIR EMISSIONS

BACKGROUND

In the course of preparing to audit air emissions compliance you discover that the facility has several sourcea which are regulated by the state for opacity (fuel burners incinerators) It also has about 20 stacks and vents on the roofs of three buildings, some of which may be exempted from permitting by the state The actual audit is scheduled for the next day and you are working by yourself

ASSIGNMENT

1 How would you schedule activities for the next day to perform the audit efficiently and accurately?

2 Would you physically go up on the roofs and record ALL the stacks and attempt to match them with equipment/ operations inside the buildings?

3 How would you best determine what stacks or vents were exempted from any licenses or permits?

4 How would you determine if all sources of VOC emissions are identified at the facility? What would you do to verify compliance with VOC emissions?

5 Later in the day you observe asbestos is being removed from a boiler and piping system by an outside contractor You had not anticipated this because your escort forgot to tell you it was happening What would you do? What would some of your key questions be? Who would you address them to?

AUDITING TECHNIQUES
OIL SPILL CONTROL

BACKGROUND

As part of a multimedia comprehensive environmental audit scheduled to last five days, you will be examining the facility's Spill Prevention Control and Countermeasures (SPCC) Plan After reviewing the entire facility layout and SPCC Plan, you will note that according to the SPCC Plan there are 20 oil storage tanks of various capacities that have a system of diking installed You decided to look at five of the 20 oil storage tanks to verify that containment is in accordance with the plan

You look at the first tank and discover that, contrary to the SPCC, there is no diking You confirm that you are at the right tank and that you are accurately reading the SPCC Plan

You continue on to the second oil storage tank Here you find a somewhat different situation While there is diking installed your calculation indicates that it is about half the capacity indicated in the SPCC Plan which calls for secondary containment of 150 percent of tank volume Additionally you note that the dike walls are made of concrete and the base (inside the diked area) is the natural ground Your escort tells you that he has repeatedly put in work requests to management to get the base of the dike paved but nothing seems to happen

ASSIGNMENT

1 Would you at this point modify your original audit plan? How? Have you seen enough? Would you decide to look at more than the original 5 tanks?

2 What would be your reactions relative to the first tank?

3 How would you react to the problems at the second tank? What specifically would you look for do or ask at this tank?

4 How and when would you discuss this with the Facility Manager?

AUDITING TECHNIQUES

PCBs

BACKGROUND

As part of your environmental audit of a large facility you have been asked to review the facility s compliance with PCB regulations After reviewing the entire facility layout and the PCB Inventory you note that according to the inventory there are 65 individual transformers or capacitors that are known to contain PCBs These transformers and capacitors are spread out over a large area of the facility The first part of your review is to inspect for proper labeling containment of the in-service equipment

ASSIGNMENT

1 How will you select your sample (assuming you do not intend to inspect all of them)?

2 If three of the first five transformers you inspect are not labeled (and should be) would you change your sampling scheme? How?

3 If later in the audit you find a transformer leaking what would you do?

4 You uncover a transformer in the basement of a building listed on the inventory as a PCB transformer with no label The supervisor says that it was disconnected a month ago and is not used so he took the label off and, according to the regulations he no longer has to inspect it How would you react to this what would you say?

AUDITING TECHNIQUES

DEALING WITH REGULATORY AGENCIES

BACKGROUND

You have completed an environmental review of a major process unit On this unit you have discovered a small incinerator burning H_2S off-gas You later determine that H_2S is a listed hazardous waste (U135) This incinerator is presently covered under the facility's air permit but does not have a RCRA hazardous waste permit To determine the need for a RCRA permit you make a "blind" phone call to the State They tell you, in no uncertain terms, that the incinerator must have a permit and it is your legal and ethical duty to report the noncompliance instance immediately to them for possible enforcement You are now beginning to understand the true meaning of the phrase "What did he know and when did he know it?"

ASSIGNMENT

1 How would you end your phone call with the State Representative?

2 What should your next steps be?

3 How would you determine your personal liability? How will this affect your actions?

AUDITING TECHNIQUES

A FIELD EXERCISE

You are about to undertake an audit -- "Should you decide to accept this mission"

You are directed to the Plant Hazardous Waste Collection Point This is an area in the plant where wastes and chemicals are stored The wastes are awaiting pickup by a vendor All wastes are to be removed in less than 90 days in order to eliminate the need for a permit You will be given some recent manifests for the area

Your team's job is to review the paperwork and the facility and to report back in the morning As a guide, keep in mind the following

1 Paperwork

- Accuracy
- Signature/dates
- Waste minimization certification
- Return manifests
- Alternative disposal point
- Type of disposal

2 Facility

- Labels (dates, legibility, presence)
- Close drums
- Leaks
- Compatible storage (MSDS's)
- Pallets
- Flammable waste grounding
- Aisle space
- Inspection log
- Spill equipment
- Fire extinguishers
- Containment

GOOD LUCK!

AUDITING TECHNIQUES

HANDLING SENSITIVE SITUATIONS

BACKGROUND

You are in the midst of your hazardous waste audit at a large chemical plant It has one major accumulation point, which during the last audit of a year ago was observed not to have sufficient (any) secondary containment, as required by law It was agreed then by site management that a dike would be constructed in three months The accumulation point manager has simply not gotten around to fixing the problem because his other plant responsibilities, such as running Process Unit No 3, have taken up all his time He is aware of his oversight but can only shrug his shoulders and promise he will fix it as soon as he can He also mentions in passing that he is two years from retirement and has recently been reprimanded for a safety violation He seems like a nice enough person unable to keep up with added responsibilities due to staff cutbacks

ASSIGNMENT

1 How would you write this incident up in you audit report?

2 If the accumulation point was otherwise in compliance and was kept neat would that affect your language?

3 Are there ways to "soften the blow" in the write-up to make the A P Manager and site staff look better? Can this be done without compromising the accuracy of the report?

DEBRIEFING EXERCISE

You as the audit team leader are going to give the facility manager and other senior staff a debriefing on your findings You have just completed an audit of the facility and have discovered several discrepancies Your audit team has provided you with the following facts Prepare a 5-7 minute debriefing and deliver it on hazardous waste management compliance

FINDING 25 out of 50 hazardous waste manifests reviewed were filled out correctly The others had missing or incomplete data illegible signatures and several had no Part 3 copy from the TSD facility The person in charge said that he was so busy he had to delegate preparation of manifests to some of his staff

FINDING HW accumulation points were inspected Three were perfectly maintained and completely in accordance with the regulations These were run by a staff person who was highly motivated (John Jones) and who worked in the Bravo Department

FINDING Two other accumulation points in the Delta Department were not well maintained A few labels were missing, accumulation start dates showed storage in excess of 90 days on 2 drums Records of inspections were available but incomplete These facilities were run by Bill Smith and Mary Brown who were open, honest and apparently good workers, but who claimed they had other job responsibilities that were critical to the DOE facility and that hazardous waste management was only a collateral duty for them They had never had a spill or discharge at their accumulation point and given their heavy work schedule, felt they were doing o k

FINDING The hazardous waste Contingency Plan and Emergency Response plans were available and generally had the information required Interviews with some facility staff indicated that they were unaware of its contents or that they were unaware that they were responsible for doing anything if there was an emergency except call the Safety Department They had been trained however within 6 months of joining the staff on hazardous waste management responsibilities at a formal course given by an outside commercial training firm

A - AUDITOR
PE - PLANT ENGINEER

A Good morning Mr _____ my name is _____ and I am here to conduct an environmental audit of the hazardous waste storage facility here at your plant The purpose of this audit is to uncover poor practices and negligent operation and report them to officials responsible so that corrective actions can be taken Those actions might be to fund needed maintenance and repair or arrange for personnel action to remove or replace incompetent staff Do you understand this or have any questions?

PE Well no EXCEPT that all this RCRA stuff is pretty recent and I am doing the best I can with what I got Mr _____ he's my supervisor, said you were coming over but I figured this was more of an EPA-type inspection We had one of those last month and we did real good, except for three items which I am working on right now The EPA said we should have more specific training and I've arranged with a company to come in and help with

A That is all very interesting Mr _____ but I have my own inspection protocol which I have to follow and I'm sure some of it will cover all of the same areas that the EPA touched on

PE Okay It was kind of interesting, what we did and all but whatever you want to do is okay with me

A Well, can you tell me how your storage facility complies with the RCRA General Facility Standards Specifically how do you comply with the security requirements?

PE Well the place is secure, you know It s inside the plant and it has a fence and we keep people out, so its secure

A How about signs?

PE We have signs and we keep people out of the storage area

A What do the signs say?

PE They say to keep out I don't remember the exact wording It's whatever the RCRA regulations require I remember having to get the exact wording from the regulations to give to the sign shop They made up the signs with the wording from the regulations

A How big are the signs and the lettering?

PE Oh, they re about like this (uses hand) I don t know

A How far away can the signs be read?

PE I guess that depends on how good your eyes are (acting annoyed)

A Mr _____ I'm trying to conduct a serious effort here and your present attitude is not helping at all

PE Well Mr _____, your questions are not exactly to the point You seem to be playing some sort of game here If you could be more specific in your questions I could probably give you better answers

A All right Mr _____, how about this Are the signs you erected legible from a distance of 25 feet?

PE Yes Sure I guess I don t know How about we just go out and look at the signs and you can see for yourself

A I have to finish this check-off list first and then I want to review all your permits plans and manifests Another auditor will look at the physical layout

PE Well, I would judge that the average person could read the signs at 25 feet but

A Lets move on With regard to inspections Do you inspect the facility at least weekly?

PE Oh sure

A Do you have a written inspection plan?

PE You bet

A Can I see the plan?

PE Well, let me see Here it is (PROP)

A This shows that you inspect the facility daily why do you do that? You just said that you inspected weekly

PE Well <u>you</u> said weekly and I figured that was what I was supposed to do

A Okay Mr _____, let s go over this again You actually inspect the storage area daily?

PE That s right Something wrong with that

A Well, you only have to do it weekly Where, you record the results of the inspections?

PL We only write-up problems observed on this here form and send it over to plant maintenance for them to repair We keep copies here in this folder

A So you only note exceptions on the inspection report?

PE Yes, I guess you could say that

A Mr _____, you should be aware that 40 CFR 264 15(d) requires you to keep a log of inspections which includes, at a minimum, a separate entry for each inspection including the date and time of each inspection, the name - not simply the initials as you have done here - of the inspector, a notation of observations made - both positive and negative - and the date and nature of any repairs Mr _____ the inspection recording procedures you have here are totally inadequate and are in violation of federal regulations

PE Hey' wait a minute I'm doing my best We know what the problems are and we fix anything we find If you d go out and see the yard you'd see that we got all the leakers in overpacks, we got our spill clean-up gear in place the yard is dry and everything is okay So I ain t got some darn log What are you concerned with anyway, the paper or how we manage the waste?

A Mr the RCRA program is a heavily paper intensive effort and if you can t deal with these requirements, I don t see how this facility can ever be brought into compliance

PE What else do you want to see?

A Well, we re way behind schedule here but I would like to discuss personnel training Has everyone who works here completed a program of training to teach them to perform their duties?

PE Yes

A The person who directs the training must also be trained in hazardous waste management Who directs the training?

PE I do

A Are you yourself trained Mr _____?

PE I am

A Where did you get trained?

PE I took a course with _____

A Do you feel that such a course qualifies you to train people?

PE I do Why do you have some kind of problem with that?

A No No, Mr _____ One last question and then I really must leave do any newly hired people people who have not completed training do any of these people work alone or unsupervised?

PE No We closely supervise all our new employees

A Good What about that young fellow over there Is he a new employee?

PE Yes

A Is anyone supervising him?

PE Well he s only eating his lunch I think he can do that by himself

A Well Mr _____, thank you for your time My associate Mr _____ will be coming along later to discuss container storage standards This has been most interesting

PF Okay Watch your step on the way out I wouldn t want anything unpleasant to happen to you

A Well hello Mr _____' ___ ___ _____ said he had finished his portion of the interview and that you were ready to talk about container standards

PE Oh Okay I guess I can spare some time How long will this take

A I know you're a busy man and I really won't take any more of your time than necessary Probably no more than one hour

PE Okay

A Let s see You know there is so much involved in these regulations, I can hardly keep up and I deal with this every day How do you keep track of all of these regulations

PE Well the Division Staff sends us notices on changes and _____, the environmental coordinator, and I tall about changes every few weeks I have a copy of the Code of Federal Regulations and I refer to that And I keep a notebook of the relevant state regulations

A Oh, do you keep copies of all that around here

PE Yes I have to in order to conduct my inspections and everything But its a big job to keep up

A Yes it really is Well, I want to see how you store containers so I guess the best thing to do is to go out and see the drum storage area

PE Ok You re the boss, Mr _____

A Well, is there anything else you think we should do first? This is your facility and you know it best so I guess I'm asking you if that would be a good place to start

PE You re right We should probably see the yard first

A What do you store here, mostly?

PE Mostly waste solvents paint stripper, and paint sludge

A Is that all flammable?

PE Yes We had some of the stuff tested and it is flammable All the solvents are F001 and F002 wastes, of course

A Anything special about some of the waste?

PE Nope

A What do you figure is in this drum labeled 'solvent and sludge?"

PE Oh, those guys over at the metal shop have a small plating line and they often times drop the sludge into a solvent drum and mix the whole mess together Now looks like they've done it again

A Will you have to do anything special with this waste?

PE Yeh Probably have to pay the hauler extra, since he can t reclaim the solvent with all the metal hydroxides in it now Those guys have no idea what problems they cause

A Sure makes your job tough Those drums over there that are all dented, are they full of hazardous waste?

PE Yes thats one of our designated accumulation points

A Can we look at them?

PE Sure I inspected it just the other day

A I notice you have a funnel on the top of the drums Thats good to prevent spillage Do you keep the funnels in all the time?

PE Yes, you never know when these guys are going to put something in them and half the time they are always rushing and would probably spill the waste if it wasn t for the funnel

A Yes I know what you mean That's a good idea I think it would be wise to use the funnel that has the spring loaded top instead of the open top one you are using here That would keep the drum closed and prevent emissions of any volatiles and also would prevent any discharge to the ground if the drum was knocked over

PE Yea you're right I never realized that We've being doing it like this for years But Ill change the funnel

A I see you have put the accumulation start date on all the drums

PE Oh yea we are careful to always do that

A Why do you think those 2 drums over there have been stored for greater than 90 days

PE Where? Oh those drums Those are just old labels from last time we used them The new labels are on this side of the drum See, they show April 18 that is less than 90 days

A Ok I think you understand the requirement, but that could be confusing I think you should make sure only the correct start dates are on the drum

PE Right will do

A Also these other drums are pretty banged up A few are dented and some corrosion is starting to work its way through Probably a good idea to change these as soon as you can

PE Yea, looks like I m failing this test

A Don't look at this audit as a test We re trying to focus your attention on some things that could cause problems if not managed properly These little problems I m finding are typical at other plants too They may seem trivial but they are important These are potential risks to the company This area is highly dependent on groundwater and with these sandy soils, contamination from leaking drums could put us all in a bad position A lot of companies are paying out big bucks for major problems that all started out as small items like these

PE Yea, I think we all need a little refeasher training on some of these procedures

A Yes I think so too Ok that completes this part of the audit Thanks for your time Is there anything you want to tell me before I go

PE No, I don t think so

A Ok I ll be summarizing my findings at the out brief on Friday for the plant manager If you want to talk to me about anything else before then let me know Also I think you might find it useful to come to the briefing

PE There is one thing though

A What s that

PE The guy who audited me earlier this morning does he work for you?

A Yes, he does

PE Well no offense intended but I think he could use a little refresher training too

A Really in what area?

PE In the proper way to conduct these audits

ENVIRONMENTAL AUDITING

Auditing for Industrial Property Purchases

Environmental Auditing for Industrial Property Purchases

- ASTM Standards
  - Goals
    - Reduce existing risk
    - Categorize and standardize protocols
    - Define limit and extent of appropriate inquiry
  - Records Review
  - Site Reconnaissance
  - Interview with Current Owners
  - Report and Evaluation

VI ENVIRONMENTAL AUDITING FOR INDUSTRIAL PROPERTY PURCHASES

The ASTM Standard Practices for Environmental Assessments[1]

Evolution of the ASTM Standards
During the past two decades, a plethora of environmental laws have been promulgated in the United States, resulting in extensive liabilities and costs for those involved in contaminated properties Thus, assessing the environmental risk associated with particular property has become increasingly important to owners, operators, sellers, purchasers, and lenders involved with commercial real estate transactions Accordingly, the Phase I environmental site assessment has become the standard tool for evaluating the environmental condition of a property prior to a purchase

As a result of a three-year effort, the American Society of Testing and Materials (ASTM) Subcommittee on Environmental Assessments for Commercial Real Estate Transactions developed the following standards (Note, a copy of these standards is provided at the end of this Section)

1 Standard Practice for Environmental Assessments Phase I Environmental Site Assessment Process

2 Standard Practice for Environmental Assessments Transaction Screen Process

At the outset the Subcommittee's goals were to

- Reduce existing risk and uncertainty associated with environmental due diligence
- Categorize and standardize existing environmental due diligence protocol now followed by competent environmental consultants
- Define the limit and extent of appropriate inquiry as articulated by the phrase "good commercial or customary practice" for use in the innocent landowner defense

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[1]Excerpts taken from The Journal of Environmental Law & Practice, "the ASTM Standard Practices for Environmental Assessments "

Components of the Phase I Site Assessment Process
As developed by the ASTM Subcommittee, the Phase I Site Assessment Standards are divided into four basic components

- Records Review
- Site Reconnaissance
- Interview with Current Owners and Operators
- Evaluation and Report Preparation

Following is a summary of the primary elements of each component

Records Review -- The records review process requires a mandatory review of certain information sources which are deemed standard sources Generally, the environmental professional performs an investigation of property usage from the present back until 1940 by using standard historical sources such as
--aerial photographs
--fire insurance maps
--property tax files
--environmental agency records

Site Reconnaissance -- The second component of a Phase I Site Assessment is a site reconnaissance This requires that the environmental professional visit the site to perform a visual physical inspection of the property, including a review of the interior and exterior of all structures on the property The barriers or limits to a thorough site visit must be identified in the report For example, if part of a building is inaccessible, an appropriate notation should be included in the report The site visit also enables the environmental professional to gather information as to the present use of the adjoining properties

Interview with Current Owners -- The third component of a Phase I Site Assessment, is the performance of interviews with the current owners and operators of the property Typically, such interviews are conducted during the site visit but may be conducted separately The report should identify the individual with the most information about the environmental condition of the property A reasonable effort should be made to interview as many of the property occupants as possible The requirement to perform interviews also includes consultations with local government officials such as fire and health officials

Report and Evaluation -- The final component of the Phase I Site Assessment consists of an evaluation of the data collected and the preparation of a report The report is critical to insure that a reasonably informed reader of the site assessment report could essentially confirm the validity of the site assessment from the information provided in the report Therefore, all critical documentation developed by the environmental professional must be attached to the report

In the report, the environmental professional must identify all limiting conditions to the assessment and all points at which he departed from the requirements of the Standard Practices The environmental professional is required to provide an overall opinion about the data developed in the course of the assessment but is not required, and, indeed, is directed not to include any recommendations about the property in the report

Finally, in order to facilitate reader understanding of the report, the environmental professional is required to provide a standard form of conclusion There are just two choices The environmental professional must conclude that the inquiry did not reveal evidence of the presence or the likely presence of "recognized environmental conditions" at the site or that the inquiry did not reveal such conditions except for those enumerated in the conclusion section of the report The report should also be signed by the environmental professional that performed the Phase I Site Assessment

ASTM Standard and Due Diligence Practices

Designation E 1527 - 93

AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process[1]

This standard is issued under the fixed designation E 1527 the number immediately following the designation indicates the year of original adoption or in the case of revision the year of last revision A number in parentheses indicates the year of last reapproval A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval

1 Scope

1 1 *Purpose*—The purpose of this practice, as well as Practice E 1528, is to define good commercial and customary practice in the United States of America for conducting an *environmental site assessment*[2] of a parcel of *commercial real estate* with respect to the range of contaminants within the scope of Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and *petroleum products* As such, this practice is intended to permit a *user* to satisfy one of the requirements to qualify for the *innocent landowner defense* to CERCLA liability that is the practices that constitute "all appropriate inquiry into the previous ownership and uses of the property consistent with good commercial or customary practice" as defined in 42 USC § 9601(35)(B) (See Appendix X1 for an outline of CERCLA's liability and defense provisions)

1 1 1 *Recognized Environmental Conditions*—In defining a standard of good commercial and customary practice for conducting an *environmental site assessment* of a parcel of *property*, the goal of the processes established by this practice is to identify *recognized environmental conditions* The term *recognized environmental conditions* means the presence or likely presence of any *hazardous substances* or *petroleum products* on a *property* under conditions that indicate an existing release, a past release, or a material threat of a release of any *hazardous substances* or *petroleum products* into structures on the *property* or into the ground, groundwater, or surface water of the *property* The term includes *hazardous substances* or *petroleum products* even under conditions in compliance with laws The term is not intended to include *de minimis* conditions that generally do not present a material risk of harm to public health or the environment and that generally would not be the subject of an enforcement action if brought to the attention of appropriate governmental agencies

1 1 2 *Two Related Practices*—This practice is closely related to Practice E 1528 Both are *environmental site assessments* for *commercial real estate* See 4 3

1 1 3 *Petroleum Products*—*Petroleum products* are included within the scope of both practices because they are of concern with respect to many parcels of *commercial real estate* and current custom and usage is to include an inquiry into the presence of *petroleum products* when doing an *environmental site assessment* of *commercial real estate* Inclusion of *petroleum products* within the scope of this practice and Practice E 1528 is not based upon the applicability, if any, of CERCLA to *petroleum products* (See Appendix X1 for discussion of *petroleum exclusion* to CERCLA liability)

1 1 4 *CERCLA Requirements Other Than Appropriate Inquiry*—This practice does not address whether requirements in addition to *appropriate inquiry* have been met in order to qualify for CERCLA's *innocent landowner defense* (for example, the duties specified in 42 USC § 9607(b)(3)(a) and (b) and cited in Appendix X1)

1 1 5 *Other Federal State and Local Environmental Laws*—This practice does not address requirements of any state or local laws or of any federal laws other than the appropriate inquiry provisions of CERCLA's *innocent landowner defense* *Users* are cautioned that federal, state, and local laws may impose environmental assessment obligations that are beyond the scope of this practice *Users* should also be aware that there are likely to be other legal obligations with regard to *hazardous substances* or *petroleum products* discovered on *property* that are not addressed in this practice and that may pose risks of civil and/or criminal sanctions for non-compliance

1 2 *Objectives*—Objectives guiding the development of this practice and Practice E 1528 are (1) to synthesize and put in writing good commercial and customary practice for *environmental site assessments* for *commercial real estate*, (2) to facilitate high quality, standardized *environmental site assessments*, (3) to ensure that the standard of *appropriate inquiry* is practical and reasonable, and (4) to clarify an industry standard for *appropriate inquiry* in an effort to guide legal interpretation of CERCLA's *innocent landowner defense*

1 3 *Considerations Beyond Scope*—The use of this practice is strictly limited to the scope set forth in this section. Section 12 of this practice, identifies, for informational purposes, certain environmental conditions (not an all-inclusive list) that may exist on a *property* that are beyond the scope of this practice but may warrant consideration by parties to a *commercial real estate* transaction

1 4 *Organization of This Practice*—This practice has several parts and two appendixes Section 1 is the Scope Section 2 is Referenced Documents Section 3, Terminology, has definitions of terms not unique to this practice and descriptions of terms unique to this practice and acronyms. Section 4 is Significance and Use of this practice Section 5 describes User's Responsibilities Sections 6 through 11 are the main body of the Phase I Environmental Site Assessment, in-

[1] This practice is under the jurisdiction of ASTM Committee E 50 on Environmental Assessment and is the direct responsibility of Subcommittee E50 02 on Commercial Real Estate Transactions.

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All definitions, descriptions of terms, and acronyms are defined in Section 3 Whenever terms defined in 3 2 or described in 3 3 are used in this practice, they are in *italics*

934

cluding evaluation and report preparation Section 12 provides additional information regarding non-scope considerations (see 1 3) The appendixes are included for information and are not part of the procedures prescribed in either this practice or Practice E 1528 Appendix X1 explains the liability and defense provisions of CERCLA that will assist the user in understanding the user's responsibilities under CERCLA, it also contains other important information regarding CERCLA and this practice Appendix X2 provides a recommended table of contents and report format for a Phase I Environmental Site Assessment Report

1 5 *This standard does not purport to address all of the safety problems if any associated with its use It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use*

2 Referenced Document

2 1 *ASTM Standard*

E 1528 Practice for Environmental Site Assessments Transaction Screen Process[3]

3 Terminology

3 1 This section provides definitions descriptions of terms, and a list of acronyms for many of the words used in this practice and Practice E 1528 The terms are an integral part of both practices and are critical to an understanding of the practices and their use

3 2 *Definitions*

3 2 1 *asbestos*—six naturally occurring fibrous minerals found in certain types of rock formations Of the six, the minerals chrysotile, amosite, and crocidolite have been most commonly used in building products When mined and processed, asbestos is typically separated into very thin fibers Because asbestos is strong, incombustible, and corrosion-resistant, asbestos was used in many commercial products beginning early in this century and peaking in the period from World War II into the 1970s When inhaled in sufficient quantities, asbestos fibers can cause serious health problems[4,5]

3 2 2 *asbestos containing material (ACM)*—any material or product that contains more than 1 % asbestos[4]

3 2 3 *Comprehensive Environmental Response Compensation and Liability Information System (CERCLIS)*—the list of sites compiled by EPA that EPA has investigated or is currently investigating for potential hazardous substance contamination for possible inclusion on the National Priorities List

3 2 4 *construction debris*—concrete brick, asphalt, and other such building materials discarded in the construction of a building or other improvement to property

3 2 5 *contaminated public wells*—public wells used for drinking water that have been designated by a government entity as contaminated by toxic substances (e g , chlorinated solvents), or as having water unsafe to drink without treatment

3 2 6 *demolition debris*—concrete, brick, asphalt, and other such building materials discarded in the demolition of a building or other improvement to property

3 2 7 *drum*—a container (typically, but not necessarily, holding 55 gal (208 L) of liquid) that may be used to store *hazardous substances* or *petroleum products*

3 2 8 *dry wells*—underground areas where soil has been removed and replaced with pea gravel, coarse sand, or large rocks Dry wells are used for drainage, to control storm runoff, for the collection of spilled liquids (intentional and non-intentional) and wastewater disposal (often illegal)

3 2 9 *dwelling*—structure or portion thereof used for residential habitation

3 2 10 *environmental lien*—a charge, security, or encumbrance upon title to a *property* to secure the payment of a cost, damage, debt, obligation, or duty arising out of response actions, cleanup, or other remediation of *hazardous substances* or *petroleum products* upon a *property*, including (but not limited to) liens imposed pursuant to CERCLA 42 USC § 9607(1) and similar state or local laws

3 2 11 *ERNS list*—EPA's emergency response notification system list of reported CERCLA hazardous substance releases or spills in quantities greater than the reportable quantity, as maintained at the National Response Center Notification requirements for such releases or spills are codified in 40 CFR Parts 302 and 355

3 2 12 *Federal Register (FR)*—publication of the United States government published daily (except for federal holidays and weekends) containing all proposed and final regulations and some other activities of the federal government When regulations become final, they are included in the Code of Federal Regulations (CFR), as well as published in the Federal Register

3 2 13 *fire insurance maps*—maps produced for private fire insurance map companies that indicate uses of properties at specified dates and that encompass the property These maps are often available at local libraries, historical societies, private resellers, or from the map companies who produced them See Question 23 of the transaction screen process in Practice E 1528 and 7 3 4 2 of this practice

3 2 14 *hazardous substance*—A substance defined as a hazardous substance pursuant to CERCLA 42 USC § 9601(14), as interpreted by EPA regulations and the courts "(A) any substance designated pursuant to section 1321(b)(2)(A) of Title 33, (B) any element, compound, mixture, solution, or substance designated pursuant to section 9602 of this title, (C) any hazardous waste having the characteristics identified under or listed pursuant to section 3001 of the Solid Waste Disposal Act (42 USC § 6921) (but not including any waste the regulation of which under the Solid Waste Disposal Act (42 USC § 6901 *et seq*) has been suspended by Act of Congress), (D) any toxic pollutant listed under section 1317(a) of Title 33, (E) any hazardous air pollutant listed under section 112 of the Clean Air Act (42 USC § 7412), and (F) any imminently hazardous chemical substance or mixture with respect to which the Administrator (of EPA) has taken action pursuant to section 2606 Title 15 The term does not include petroleum, including crude oil or any fraction thereof which is not otherwise

[3] *Annual Book of ASTM Standards*, Vol 11 04

[4] See EPA, *Managing Asbestos in Place A Building Owner s Guide to Operations and Maintenance Programs for Asbestos-Containing Materials* July 1990 p 2

[5] See also for an additional definition of Asbestos, ASTM STP 834 ASTM

985

specifically listed or designated as a hazardous substance under subparagraphs (A) through (F) of this paragraph and the term does not include natural gas natural gas liquids liquefied natural gas, or synthetic gas usable for fuel (or mixtures of natural gas and such synthetic gas)" (See Appendix X1)

3 2 15 *hazardous waste*—any hazardous waste having the characteristics identified under or listed pursuant to section 3001 of the Solid Waste Disposal Act (42 USC § 6921) (but not including any waste the regulation of which under the Solid Waste Disposal Act (42 USC § 6901 *et seq*) has been suspended by Act of Congress) The Solid Waste Disposal Act of 1980 amended RCRA RCRA defines a hazardous waste in 42 USC § 6903, as "a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may—(A) cause, or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness, or (B) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed"

3 2 16 *landfill*—a place, location, tract of land area, or premises used for the disposal of solid wastes as defined by state solid waste regulations The term is synonymous with the term *solid waste disposal site* and is also known as a garbage dump, trash dump, or similar term

3 2 17 *local street directories*—directories published by private (or sometimes government) sources that show ownership, occupancy, and/or use of sites by reference to street addresses Often local street directories are available at libraries of local governments, colleges or universities, or historical societies See 7 3 4 6 of this practice

3 2 18 *material safety data sheet (MSDS)*—written or printed material concerning a hazardous substance which is prepared by chemical manufacturers, importers, and employers for hazardous chemicals pursuant to OSHA's Hazard Communication Standard. 29 CFR 1910 1200

3 2 19 *National Contingency Plan (NCP)*—the National Oil and Hazardous Substances Pollution Contingency Plan found at 40 CFR § 300, that is the EPA's blueprint on how hazardous substances are to be cleaned up pursuant to CERCLA

3 2 20 *National Priorities List (NPL)*—list compiled by EPA pursuant to CERCLA 42 USC § 9605(a)(8)(B) of properties with the highest priority for cleanup pursuant to EPA s Hazard Ranking System See 40 CFR Part 300

3 2.21 *occupants*—those tenants, subtenants, or other persons or entities using the *property* or a portion of the *property*

3 2 22 *owner*—generally the fee owner of record of the *property*

3 2 23 *petroleum exclusion*—The exclusion from CERCLA liability provided in 42 USC § 9601(14), as interpreted by the courts and EPA "The term (hazardous substance) does not include petroleum including crude oil or any fraction thereof which is not otherwise specifically listed or designated as a hazardous substance under subparagraphs (A) through (F) of this paragraph, and the term does not include natural gas, natural gas liquids, liquefied natural gas, or synthetic gas usable for fuel (or mixtures of natural gas and such synthetic gas)"

3 2 24 *petroleum products*—those substances included within the meaning of the *petroleum exclusion* to CERCLA, 42 USC § 9601(14), as interpreted by the courts and EPA, that is petroleum including crude oil or any fraction thereof which is not otherwise specifically listed or designated as a hazardous substance under Subparagraphs (A) through (F) of 42 USC § 9601(14), natural gas, natural gas liquids, liquefied natural gas, and synthetic gas usable for fuel (or mixtures of natural gas and such synthetic gas) (The word fraction refers to certain distillates of crude oil, including gasoline, kerosene, diesel oil, jet fuels, and fuel oil, pursuant to *Standard Definitions of Petroleum Statistics* [6]

3 2 25 *Phase I Environmental Site Assessment*—the process described in this practice

3 2 26 *pits ponds or lagoons*—man-made or natural depressions in a ground surface that are likely to hold liquids or sludge containing *hazardous substances* or *petroleum products* The likelihood of such liquids or sludge being present is determined by evidence of factors associated with the pit, pond, or lagoon, including, but not limited to, discolored water, distressed vegetation, or the presence of an obvious wastewater discharge

3 2 27 *property*—the real property that is the subject of the *environmental site assessment* described in this practice Real property includes buildings and other fixtures and improvements located on the property and affixed to the land

3 2 28 *property tax files*—the files kept for property tax purposes by the local jurisdiction where the property is located and includes records of past ownership, appraisals, maps, sketches, photos, or other information that is reasonably ascertainable and pertaining to the property See 7 3 4 3

3 2 29 *RCRA generators*—those persons or entities that generate hazardous wastes, as defined and regulated by RCRA

3 2 30 *RCRA generators list*—list kept by EPA of those persons or entities that generate hazardous wastes as defined and regulated by RCRA

3 2 31 *RCRA TSD facilities*—those facilities on which treatment, storage, and/or disposal of hazardous wastes takes place, as defined and regulated by RCRA

3 2 32 *RCRA TSD facilities list*—list kept by EPA of those facilities on which treatment, storage, and/or disposal of hazardous wastes takes place, as defined and regulated by RCRA

3 2 33 *recorded land title records*—records of fee ownership, leases, land contracts, easements, liens, and other encumbrances on or of the property recorded in the place where land title records are, by law or custom, recorded for the local jurisdiction in which the *property* is located. (Often such records are kept by a municipal or county recorder or clerk) Such records may be obtained from title companies or directly from the local government agency Information about the title to the property that is recorded in a U S district court or any place other than where land title records are, by law or custom, recorded for the local jurisdiction in

[6] *Standard Definitions of Petroleum Statistics* American Petroleum Institute, Fourth Edition, 1988

986

which the property is located, are not considered part of recorded land title records See 7 3 4 4

3 2 34 *records of emergency release notifications (SARA § 304)*—Section 304 of EPCRA or Title III of SARA requires operators of facilities to notify their local emergency planning committee (as defined in EPCRA) and state emergency response commission (as defined in EPCRA) of any release beyond the facility's boundary of any reportable quantity of any extremely hazardous substance Often the local fire department is the local emergency planning committee Records of such notifications are "Records of Emergency Release Notifications" (SARA § 304)

3 2 35 *report*—the written record of a transaction screen process as required by Practice E 1528 or the written report prepared by the environmental professional and constituting part of a "Phase I Environmental Site Assessment," as required by this practice

3 2 36 *solid waste disposal site*—a place location, tract of land, area, or premises used for the disposal of solid wastes as defined by state solid waste regulations The term is synonymous with the term *landfill* and is also known as a garbage dump, trash dump, or similar term

3 2 37 *solvent*—a chemical compound that is capable of dissolving another substance and is itself a *hazardous substance*, used in a number of manufacturing/industrial processes including but not limited to the manufacture of paints and coatings for industrial and household purposes, equipment clean-up and surface degreasing in metal fabricating industries

3 2 38 *state registered USTs*—state lists of underground storage tanks required to be registered under Subtitle I, Section 9002 of RCRA

3 2 39 *sump*—a pit, cistern, cesspool, or similar receptacle where liquids drain, collect, or are stored.

3 2 40 *TSD facility*—treatment, storage, or disposal facility (see *RCRA TSD facilities*)

3 2 41 *underground storage tank (UST)*—any tank, including underground piping connected to the tank that is or has been used to contain *hazardous substances* or *petroleum products* and the volume of which is 10 % or more beneath the surface of the ground

3 2 42 *USGS 7 5 Minute Topographic Map*—the map (if any) available from or produced by the United States Geological Survey, entitled "USGS 7 5 Minute Topographic Map," and showing the property See 7 3 4 5

3 2 43 *wastewater*—water that (1) is or has been used in an industrial or manufacturing process, (2) conveys or has conveyed sewage, or (3) is directly related to manufacturing, processing, or raw materials storage areas at an industrial plant Wastewater does not include water originating on or passing through or adjacent to a site, such as stormwater flows, that has not been used in industrial or manufacturing processes, has not been combined with sewage, or is not directly related to manufacturing, processing, or raw materials storage areas at an industrial plant.

3 2 44 *zoning/land use records*—those records of the local government in which the *property* is located indicating the uses permitted by the local government in particular zones within its jurisdiction The records may consist of maps and/or written records They are often located in the planning department of a municipality or county See 7 3 4 8

3 3 *Descriptions of Terms Specific to This Standard*

3 3 1 *actual knowledge*—the knowledge actually possessed by an individual who is a real person, rather than an entity Actual knowledge is to be distinguished from constructive knowledge that is knowledge imputed to an individual or entity

3 3 2 *adjoining properties*—any real property or properties the border of which is contiguous or partially contiguous with that of the property, or that would be contiguous or partially contiguous with that of the property but for a street, road, or other public thoroughfare separating them

3 3 3 *aerial photographs*—photographs taken from an airplane or helicopter (from a low enough altitude to allow identification of development and activities) of areas encompassing the property Aerial photographs are often available from government agencies or private collections unique to a local area. See 7 3 4 1 of this practice

3 3 4 *appropriate inquiry*—that inquiry constituting "all appropriate inquiry into the previous ownership and uses of the property consistent with good commercial or customary practice" as defined in CERCLA, 42 USC § 9601(35)(B), that will give a party to a *commercial real estate* transaction the *innocent landowner defense* to CERCLA liability (42 USC § 9601(A) and (B) and § 9607(b)(3)), assuming compliance with other elements of the defense See Appendix X1

3 3 5 *approximate minimum search distance*—the area for which records must be obtained and reviewed pursuant to Section 7 subject to the limitations provided in this section This may include areas outside the *property* and shall be measured from the nearest *property* boundary This term is used in lieu of radius to include irregularly shaped properties

3 3 6 *building department records*—those records of the local government in which the property is located indicating permission of the local government to construct, alter, or demolish improvements on the property Often building department records are located in the building department of a municipality or county See 7 3 4 7

3 3 7 *commercial real estate*—any real property except a dwelling or property with no more than four dwelling units exclusively for residential use (except that a dwelling or property with no more than four dwelling units exclusively for residential use is included in this term when it has a commercial function, as in the building of such dwellings for profit) This term includes but is not limited to undeveloped real property and real property used for industrial, retail, office, agricultural, other commercial, medical, or educational purposes, property used for residential purposes that has more than four residential dwelling units, and property with no more than four dwelling units for residential use when it has a commercial function, as in the building of such dwellings for profit.

3 3 8 *commercial real estate transaction*—a transfer of title to or possession of real property or receipt of a security interest in real property, except that it does not include transfer of title to or possession of real property or the receipt of a security interest in real property with respect to individual dwelling or building containing fewer than five dwelling units, nor does it include the purchase of a lot or

987

lots to construct a dwelling for occupancy by a purchaser but a commercial real estate transaction does include real property purchased or leased by persons or entities in the business of building or developing dwelling units

3 3 9 *due diligence*—the process of inquiring into the environmental characteristics of a parcel of *commercial real estate* or other conditions, usually in connection with a commercial real estate transaction The degree and kind of due diligence vary for different properties and differing purposes See Appendix X1

3 3 10 *environmental audit*—the investigative process to determine if the operations of an existing facility are in compliance with applicable environmental laws and regulations This term should not be used to describe Practice E 1528 or this practice, although an environmental audit may include an *environmental site assessment* or if prior audits are available, may be part of an environmental site assessment See Appendix X1

3 3 11 *environmental professional*—a person possessing sufficient training and experience necessary to conduct a *site reconnaissance*, *interviews*, and other activities in accordance with this practice, and from the information generated by such activities, having the ability to develop conclusions regarding *recognized environmental conditions* in connection with the *property* in question An individual's status as an environmental professional may be limited to the type of assessment to be performed or to specific segments of the assessment for which the professional is responsible The person may be an independent contractor or an employee of the *user*

3 3 12 *environmental site assessment (ESA)*—the process by which a person or entity seeks to determine if a particular parcel of real *property* (including improvements) is subject to *recognized environmental conditions* At the option of the user, an environmental site assessment may include more inquiry than that constituting *appropriate inquiry* or, if the user is not concerned about qualifying for the *innocent landowner defense*, less inquiry than that constituting *appropriate inquiry* See Appendix X1 An environmental site assessment is both different from and less rigorous than an *environmental audit*

3 3 13 *fill dirt*—dirt, soil, sand, or other earth, that is obtained off-site, that is used to fill holes or depressions, create mounds, or otherwise artificially change the grade or elevation of real property It does not include material that is used in limited quantities for normal landscaping activities

3 3 14 *hazardous waste/contaminated sites*—sites on which a release has occurred or is suspected to have occurred of any *hazardous substance*, *hazardous waste*, or *petroleum products*, and that release or suspected release has been reported to a government entity

3 3 15 *innocent landowner defense*—that defense to CERCLA liability provided in 42 USC § 9601(35) and § 9607(b)(3) One of the requirements to qualify for this defense is that the party make "all appropriate inquiry into the previous ownership and uses of the property consistent with good commercial or customary practice " There are additional requirements to qualify for this defense See Appendix X1

3 3 16 *interviews*—those portions of this practice that are contained in Section 9 and 10 thereof and address questions to be asked of *owners* and *occupants* of the *property* and questions to be asked of local government officials

3 3 17 *key site manager*—the person identified by the *owner* of a *property* as having good knowledge of the uses and physical characteristics of the property See 9 5 1

3 3 18 *local government agencies*—those agencies of municipal or county government having jurisdiction over the *property* Municipal and county government agencies include but are not limited to cities, parishes, townships, and similar entities

3 3 19 *LUST sites*—state lists of leaking underground storage tank sites Section 9003 (h) of Subtitle I of RCRA gives EPA and states under cooperative agreements with EPA, authority to clean up releases from UST systems or require owners and operators to do so

3 3 20 *major occupants*—those tenants, subtenants, or other persons or entities each of which uses at least 40 % of the leasable area of the *property* or any anchor tenant when the *property* is a shopping center

3 3 21 *obvious*—that which is plain or evident, a condition or fact that could not be ignored or overlooked by a reasonable observer while *visually or physically observing the property*

3 3 22 *other historical sources*—any source or sources other than those designated in 7 3 4 1 through 7 3 4 8 that are credible to a reasonable person and that identify past uses or occupancies of the property The term includes records in the files and/or personal knowledge of the *property owner* and/or *occupants* See 7 3 4 9

3 3 23 *physical setting sources*—sources that provide information about the geologic, hydrogeologic, hydrologic, or topographic characteristics of a *property* See 7 2 3

3 3 24 *practically reviewable*—information that is practically reviewable means that the information is provided by the source in a manner and in a form that, upon examination, yields information relevant to the *property* without the need for extraordinary analysis of irrelevant data. The form of the information shall be such that the user can review the records for a limited geographic area. Records that cannot be feasibly retrieved by reference to the location of the *property* or a geographic area in which the *property* is located are not generally *practically reviewable* Most databases of public records are *practically reviewable* if they can be obtained from the source agency by the county, city, zip code, or other geographic area of the facilities listed in the record system Records that are sorted, filed, organized, or maintained by the source agency only chronologically are not generally practically reviewable For large databases with numerous facility records (such as RCRA hazardous waste generators and registered underground storage tanks), the records are not *practically reviewable* unless they can be obtained from the source agency in the smaller geographic area of zip codes Even when information is provided by zip code for some large databases, it is common for an unmanageable number of sites to be identified within a given zip code In these cases, it is not necessary to review the impact of all of the sites that are likely to be listed in any given zip code because that information would not be *practically reviewable* In other words, when so much data is generated that it cannot be feasibly reviewed for its impact on the *property*, it is not *practically reviewable*

487

3 3 25 *preparer*—the person preparing the *transaction screen questionnaire* pursuant to Practice E 1528 who may be either the user or the person to whom the user has delegated the preparation of the *transaction screen questionnaire*

3 3 26 *publicly available*—information that is publicly available means that the source of the information allows access to the information by anyone upon request

3 3 27 *reasonably ascertainable*—for purposes of both this practice and Practice E 1528, information that is (1) *publicly available*, (2) obtainable from its source within reasonable time and cost constraints, and (3) *practically reviewable*

3 3 28 *recognized environmental conditions*—the presence or likely presence of any *hazardous substances* or *petroleum products* on a *property* under conditions that indicate an existing release, a past release, or a material threat of a release of any *hazardous substances* or *petroleum products* into structures on the *property* or into the ground, groundwater, or surface water of the *property* The term includes *hazardous substances* or *petroleum products* even under conditions in compliance with laws The term is not intended to include *de minimis* conditions that generally do not present a material risk of harm to public health or the environment and that generally would not be the subject of an enforcement action if brought to the attention of appropriate governmental agencies

3 3 29 *records review*—that part that is contained in Section 7 of this practice addresses which records shall or may be reviewed

3 3 30 *site reconnaissance*—that part that is contained in Section 8 of this practice and addresses what should be done in connection with the *site visit* The site reconnaissance includes, but is not limited to, the *site visit* done in connection with such a Phase I Environmental Site Assessment

3 3 31 *site visit*—the visit to the property during which observations are made constituting the *site reconnaissance* section of this practice and the *site visit* requirement of Practice E 1528

3 3 32 *standard environmental record sources*—those records specified in 7 2 1 1

3 3 33 *standard historical sources*—those sources of information about the history of uses of property specified in 7 3 4

3 3 34 *standard physical setting source*—a current USGS 7 5 minute topographic map (if any) showing the area on which the property is located See 7 2 3

3 3 35 *standard practice(s)*—the activities set forth in either and both this practice and Practice E 1528

3 3 36 *standard sources*—sources of environmental, physical setting, or historical records specified in Section 7 of this practice

3 3 37 *transaction screen process*—the process described in Practice E 1528

3 3 38 *transaction screen questionnaire*—the questionnaire provided in Section 6 of Practice E 1528

3 3 39 *user*—the party seeking to use Practice E 1528 to perform an *environmental site assessment* of the *property* A user may include, without limitation, a purchaser of *property*, a potential tenant of property, an *owner* of *property*, a lender or a property manager

3 3 40 *visually and/or physically observed*—during a *site visit* pursuant to Practice E 1528, or pursuant to this practice this term means observations made by vision while walking through a *property* and the structures located on it and observations made by the sense of smell, particularly observations of noxious or foul odors The term "walking through" is not meant to imply that disabled persons who cannot physically walk may not conduct a *site visit*; they may do so by the means at their disposal for moving through the *property* and the structures located on it

3 4 *Acronyms*

3 4 1 *ASTM*—American Society for Testing and Materials

3 4 2 *CERCLA*—Comprehensive Environmental Response, Compensation and Liability Act of 1980 (as amended 42 USC § 9601 *et seq*)

3 4 3 *CERCLIS*—Comprehensive Environmental Response, Compensation and Liability Information System (maintained by EPA)

3 4 4 *CFR*—Code of Federal Regulations

3 4 5 *EPA*—United States Environmental Protection Agency

3 4 6 *EPCRA*—Emergency Planning and Community Right to Know Act ((also known as SARA Title III), 42 USC § 11001 *et seq*)

3 4 7 *ERNS*—emergency response notification system

3 4 8 *ESA*—environmental site assessment (different than an *environmental audit*; see 3 3 12)

3 4 9 *FOIA*—U S Freedom of Information Act (5 USC 552 *et seq*)

3 4 10 *FR*—Federal Register

3 4 11 *LUST*—leaking underground storage tank.

3 4 12 *MSDS*—material safety data sheet

3 4 13 *NCP*—National Contingency Plan

3 4 14 *NPDES*—national pollution discharge elimination system

3 4 15 *NPL*—national priorities list

3 4 16 *PCBs*—polychlorinated biphenyls

3 4 17 *PRP*—potentially responsible party (pursuant to CERCLA 42 USC § 9607(a))

3 4 18 *RCRA*—Resource Conservation and Recovery Act (as amended 42 USC § 6901 *et seq*)

3 4 19 *SARA*—Superfund Amendments and Reauthorization Act of 1986 (amendment to CERCLA)

3 4 20 *USC*—United States Code

3 4 21 *USGS*—United States Geological Survey

3 4 22 *UST*—underground storage tank

4 Significance and Use

4 1 *Uses*—This practice is intended for use on a voluntary basis by parties who wish to assess the environmental condition of *commercial real estate* While use of this practice is intended to constitute *appropriate inquiry* for purposes of CERCLA's *innocent landowner defense*, it is not intended that its use be limited to that purpose This practice is intended primarily as an approach to conducting an inquiry designed to identify *recognized environmental conditions* in connection with a *property*, and *environmental site assessments* that are both more and less comprehensive than this practice (including, in some instances, no *environmental*

987

site assessment) may be appropriate in some circumstances Further, no implication is intended that a person must use this practice in order to be deemed to have conducted inquiry in a commercially prudent or reasonable manner in any particular transaction Nevertheless this practice is intended to reflect a commercially prudent and reasonable inquiry

4 2 *Clarifications on Use*

4 2 1 *Use Not Limited to CERCLA*—This practice and Practice E 1528 are designed to assist the *user* in developing information about the environmental condition of a *property* and as such has utility for a wide range of persons, including those who may have no actual or potential CERCLA liability and/or may not be seeking the *innocent landowner defense*

4 2 2 *Residential Tenants/Purchasers and Others*—No implication is intended that it is currently customary practice for residential tenants of multifamily residential buildings, tenants of single-family homes or other residential real estate or purchasers of dwellings for one's own residential use, to conduct an *environmental site assessment* in connection with these transactions Thus, these transactions are not included in the term commercial real estate transactions and it is not intended to imply that such persons are obligated to conduct an *environmental site assessment* in connection with these transactions for purposes of *appropriate inquiry* or for any other purpose In addition, no implication is intended that it is currently customary practice for *environmental site assessments* to be conducted in other unenumerated instances (including but not limited to many commercial leasing transactions, many acquisitions of easements, and many loan transactions in which the lender has multiple remedies) On the other hand, anyone who elects to do an *environmental site assessment* of any *property* or portion of a property may, in such person's judgment, use either this practice or Practice E 1528

4 2 3 *Site-Specific*—This practice is site-specific in that it relates to assessment of environmental conditions on a specific parcel of *commercial real estate* Consequently, this practice does not address many additional issues raised in transactions such as purchases of business entities, or interests therein, or of their assets, that may well involve environmental liabilities pertaining to properties previously owned or operated or other off-site environmental liabilities

4 3 *Two Related Practices*—This practice sets forth one procedure for an *environmental site assessment* known as a "Phase I Environmental Site Assessment" or a "Phase I ESA" or simply a "Phase I " This practice is a companion to Practice E 1528 These practices are each intended to meet the standard of *appropriate inquiry* necessary to qualify for the *innocent landowner defense* It is essential to consider that these practices taken together provide for two alternative practices of *appropriate inquiry*

4 3 1 *Election to Commence with Either Practice*—The *user* may commence inquiry to identify *recognized environmental conditions* in connection with a *property* by performing either the *transaction screen process*, or the Phase I Environmental Site Assessment given in this practice

4 3 2 *Who May Conduct*—The *transaction screen process* may be conducted either by the *user* (including an agent or employee of the user) or wholly or partially by an *environmental professional* The *transaction screen process* does not require the judgment of an *environmental professional* Whenever a Phase I Environmental Site Assessment is conducted it must be performed by an *environmental professional* to the extent specified in 6 5 1 Further, at the Phase I Environmental Site Assessment level, no practical standard can be designed to eliminate the role of judgment and the value and need for experience in the party performing the inquiry The professional judgment of an *environmental professional* is, consequently, vital to the performance of appropriate inquiry at the Phase I Environmental Site Assessment level

4 4 *Additional Services*—As set forth in 11 9, additional services may be contracted for between the *user* and the *environmental professional*

4 5 *Principles*—The following principles are an integral part of both practices and are intended to be referred to in resolving any ambiguity or exercising such discretion as is accorded the *user* or *environmental professional* in performing an *environmental site assessment* or in judging whether a *user* or *environmental professional* has conducted *appropriate inquiry* or has otherwise conducted an adequate *environmental site assessment*

4 5 1 *Uncertainty Not Eliminated*—No *environmental site assessment* can wholly eliminate uncertainty regarding the potential for *recognized environmental conditions* in connection with a *property* Performance of this practice or E 1528 is intended to reduce, but not eliminate, uncertainty regarding the potential for *recognized environmental conditions* in connection with a property, and both practices recognize reasonable limits of time and cost.

4 5 2 *Not Exhaustive—Appropriate inquiry* does not mean an exhaustive assessment of a clean *property* There is a point at which the cost of information obtained or the time required to gather it outweighs the usefulness of the information and in fact, may be a material detriment to the orderly completion of transactions One of the purposes of this practice is to identify a balance between the competing goals of limiting the costs and time demands inherent in performing an *environmental site assessment* and the reduction of uncertainty about unknown conditions resulting from additional information

4 5 3 *Level of Inquiry Is Variable*—Not every *property* will warrant the same level of assessment. Consistent with good commercial or customary practice, the appropriate level of *environmental site assessment* will be guided by the type of *property* subject to assessment, the expertise and risk tolerance of the *user*, and the information developed in the course of the inquiry

4 5 4 *Comparison With Subsequent Inquiry*—It should not be concluded or assumed that an inquiry was not *appropriate inquiry* merely because the inquiry did not identify *recognized environmental conditions* in connection with a *property Environmental site assessments* must be evaluated based on the reasonableness of judgments made at the time and under the circumstances in which they were made Subsequent *environmental site assessments* should not be considered valid standards to judge the appropriateness of any prior assessment based on hindsight, new information, use of developing technology or analytical techniques, or other factors

4 6 *Continued Viability of Environmental Site Assess-*

990

ment—An *environmental site assessment* meeting or exceeding either Practice E 1528 or this practice and completed less than 180 days previously is presumed to be valid An *environmental site assessment* meeting or exceeding either practice and completed more than 180 days previously may be used to the extent allowed by 4 7 through 4 7 5

4 7 *Prior Assessment Usage*—Both Practice E 1528 and this practice recognize that *environmental site assessments* performed in accordance with these practices will include information that subsequent *users* may want to use to avoid undertaking duplicative assessment procedures Therefore, the practices describe procedures to be followed to assist users in determining the appropriateness of using information in *environmental site assessments* performed previously The system of prior assessment usage is based on the following principles that should be adhered to in addition to the specific procedures set forth elsewhere in these practices

4 7 1 *Use of Prior Information*—Subject to 4 7 4, *users* and *environmental professionals* may use information in prior *environmental site assessments* provided such information was generated as a result of procedures that meet or exceed the requirements of this practice or Practice E 1528 and then only provided that the specific procedures set forth in the appropriate practice are met

4 7 2 *Prior Assessment Meets or Exceeds*—Subject to 4 7 4, a prior *environmental site assessment* may be used in its entirety, without regard to the specific procedures set forth in these practices, if, in the reasonable judgment of the *user* the prior *environmental site assessment* meets or exceeds the requirements of Practice E 1528 or this practice and the conditions at the *property* likely to affect *recognized environmental conditions* in connection with the *property* are not likely to have changed materially since the prior *environmental site assessment* was conducted In making this judgment, the *user* should consider the type of *property* assessed and the conditions in the area surrounding the *property*

4 7 3 *Current Investigation*—Except as provided in 4 7 2 and 4 7 2 of Practice E 1528 prior *environmental site assessments* should not be used without current investigation of conditions likely to affect *recognized environmental conditions* in connection with the *property* that may have changed materially since the prior *environmental site assessment* was conducted At a minimum, for a Phase I Environmental Site Assessment consistent with this practice, a new *site reconnaissance*, interviews, and an update of the *records review* should be performed.

4 7 4 *Actual Knowledge Exception*—If the *user* or *environmental professional(s)* conducting an *environmental site assessment* has *actual knowledge* that the information being used from a prior *environmental site assessment* is not accurate or if it is *obvious*, based on other information obtained by means of the *environmental site assessment* or known to the person conducting the *environmental site assessment*, that the information being used is not accurate, such information from a prior *environmental site assessment* may not be used

4 7 5 *Contractual Issues Regarding Prior Assessment Usage*—The contractual and legal obligations between prior and subsequent *users* of *environmental site assessments* or between *environmental professionals* who conducted prior *environmental site assessments* and those who would like to use such prior *environmental site assessments* are beyond the scope of this practice

4 8 *Rules of Engagement*—The contractual and legal obligations between an *environmental professional* and a *user* (and other parties, if any) are outside the scope of this practice No specific legal relationship between the *environmental professional* and the user is necessary for the *user* to meet the requirements of this practice

5 User's Responsibilities

5 1 *Scope*—The purpose of this section is to describe tasks that will help identify the possibility of *recognized environmental conditions* in connection with the *property* These tasks do not require the technical expertise of an *environmental professional* and are generally not performed by *environmental professionals* performing a Phase I Environmental Site Assessment. They may be performed by the *user*

5 2 *Checking Title Records for Environmental Liens*—*Reasonably ascertainable recorded land title records* (see 7 3 4 4) should be checked to identify *environmental liens* if any, that are currently recorded against the *property* Any *environmental liens* so identified shall be reported to the *environmental professional* conducting a Phase I Environmental Site Assessment This practice does not impose on the *environmental professional* the responsibility to check for recorded *environmental liens* Rather the *user* should check or engage a title company or title professional to check *reasonably ascertainable recorded land title records* for *environmental liens* currently recorded against the *property*

5 2 1 *Reasonably Ascertainable*—Environmental liens that are unrecorded or are recorded any place other than *recorded land title records* are not considered to be in *recorded land title records* that are *reasonably ascertainable* *Recorded land title records* need not be checked if they otherwise do not meet the definition of the term *reasonably ascertainable*

5 3 *Specialized Knowledge or Experience of the User*—If the *user* is aware of any specialized knowledge or experience that is material to *recognized environmental conditions* in connection with the *property*, it is the user's responsibility to communicate any information based on such specialized knowledge or experience to the *environmental professional* The *user* should do so before the *environmental professional* does the *site reconnaissance*

5 4 *Reason for Significantly Lower Purchase Price*—In a transaction involving the purchase of a parcel of *commercial real estate*, if a user has *actual knowledge* that the purchase price of the *property* is significantly less than the purchase price of comparable properties, the *user* should try to identify an explanation for the lower price and to make a written record of such explanation Among the factors to consider will be the information that becomes known to the *user* pursuant to the Phase I Environmental Site Assessment.

6 Phase I Environmental Site Assessment

6 1 *Objective*—The purpose of this Phase I Environmental Site Assessment is to identify, to the extent feasible pursuant to the processes prescribed herein, recognized environmental conditions in connection with the property (See 1 1 1)

6 2 *Four Components*—A Phase I Environmental Site Assessment shall have four components as described as follows

6 2 1 *Records Review*—Review of records, see Section 7,

6 2 2 *Site Reconnaissance*—A visit to the property, see Section 8,

6 2 3 *Interviews*

6 2 3 1 Interviews with current *owners* and *occupants* of the property, see Section 9, and

6 2 3 2 Interviews with local government officials, see Section 10, and

6 2 4 *Report*—Evaluation and report, see Section 11

6 3 *Coordination of Parts*

6 3 1 *Parts Used in Concert*—The *records review*, *site reconnaissance*, and *interviews* are intended to be used in concert with each other If information from one source indicates the need for more information, other sources may be available to provide information For example, if a previous use of the *property* as a gasoline station is identified through the *records review*, but the present *owner* and *occupants* interviewed report no knowledge of an underground storage tank, the person conducting the *site reconnaissance* should be alert for signs of the presence of an underground storage tank.

6 3 2 *User Obligations*—The *environmental professional* shall note in the report whether or not the *user* has reported to the *environmental professional* any *environmental liens* encumbering the *property* or any specialized knowledge or experience of the *user* that would provide important information about previous ownership or uses of the *property* that may be material to identifying *recognized environmental conditions*

6 4 *No Sampling*—This practice does not include any testing or sampling of materials (e g., soil, water, air, building materials)

6 5 *Who May Conduct a Phase I*

6 5 1 *Environmental Professional s Duties*—The *interviews* and *site reconnaissance*, as well as review and interpretation of information upon which the report is based and overseeing the writing of the report, are all portions of a Phase I Environmental Site Assessment that shall be performed by an *environmental professional* or *environmental professionals* If more than one environmental professional is involved in these tasks, they shall coordinate their efforts

6 5 2 *Environmental Professional Supervision*—Information for the *records review* needed for completion of a Phase I Environmental Site Assessment may be provided by a number of parties including government agencies, third-party vendors, the *user*, and present and past *owners* and *occupants* of the *property*, provided that the information is obtained by or under the supervision of an *environmental professional* or is obtained by a third-party vendor specializing in retrieval of the information specified in Section 7 Prior assessments may also contain information that will be appropriate for usage in a current *environmental site assessment* provided the prior usage procedures set forth in Sections 7, 8, and 9 are followed The *environmental professional(s)* participating in the *site reconnaissance* and responsible for the report shall review all of the information provided

6 5 2 1 *Reliance*—An environmental professional is not required to verify independently the information provided but may rely on information provided unless he or she has *actual knowledge* that certain information is incorrect or unless it is *obvious* that certain information is incorrect based on other information obtained in the Phase I Environmental Site Assessment or otherwise actually known to the *environmental professional*

7 Records Review

7 1 *Introduction*

7 1 1 *Objective*—The purpose of the *records review* is to obtain and review records that will help identify *recognized environmental conditions* in connection with the *property*

7 1 2 *Approximate Minimum Search Distance*—Some records to be reviewed pertain not just to the *property* but also pertain to properties within an additional *approximate minimum search distance* in order to help assess the likelihood of problems from migrating *hazardous substances* or *petroleum products* When the term *approximate minimum search distance* includes areas outside the *property*, it shall be measured from the nearest *property* boundary The term *approximate minimum search distance* is used in lieu of radius in order to include irregularly shaped properties.

7 1 2 1 *Reduction of Approximate Minimum Search Distance*—When allowed by 7 2 1 1, the *approximate minimum search distance* for a particular record may be reduced in the discretion of the environmental professional. Factors to consider in reducing the *approximate minimum search distance* include (1) the density (e g., urban, rural, or suburban) of the setting in which the *property* is located, (2) the distance that the *hazardous substances* or *petroleum products* are likely to migrate based on local geologic or hydrogeologic conditions, and (3) other reasonable factors The justification for each reduction and the *approximate minimum search distance* actually used for any particular record shall be explained in the report. If the *approximate minimum search distance* is specified as "property only," then the search shall be limited to the *property* and may not be reduced unless the particular record is not *reasonably ascertainable*

7 1 3 *Accuracy and Completeness*—Accuracy and completeness of record information varies among information sources, including governmental sources Record information is often inaccurate or incomplete The *user* or *environmental professional* is not obligated to identify mistakes or insufficiencies in information provided However, the *environmental professional* reviewing records shall make a reasonable effort to compensate for mistakes or insufficiencies in the information reviewed that are *obvious* in light of other information of which the *environmental professional* has *actual knowledge*

7 1 4 *Reasonably Ascertainable/Standard Sources*—Availability of record information varies from information source to information source, including governmental jurisdictions The *user* or *environmental professional* is not obligated to identify, obtain, or review every possible record that might exist with respect to a *property* Instead, this practice identifies record information that shall be reviewed from standard sources, and the *user* or *environmental professional* is required to review only record information that is reasonably ascertainable from those standard sources

992

Record information that is *reasonably ascertainable* means (1) information that is publicly available, (2) information that is obtainable from its source within reasonable time and cost constraints, and (3) information that is *practically reviewable*

7 1 4 1 *Publicly Available*—Information that is *publicly available* means that the source of the information allows access to the information by anyone upon request

7 1 4 2 *Reasonable Time and Cost*—Information that is obtainable within reasonable time and cost constraints means that the information will be provided by the source within 20 days of receiving a written, telephone, or in-person request at no more than a nominal cost intended to cover the source's cost of retrieving and duplicating the information Information that can only be reviewed by a visit to the source is *reasonably ascertainable* if the visit is permitted by the source within 20 days of request

7 1 4 3 *Practically Reviewable*—Information that is *practically reviewable* means that the information is provided by the source in a manner and in a form that, upon examination, yields information relevant to the *property* without the need for extraordinary analysis of irrelevant data The form of the information shall be such that the *user* can review the records for a limited geographic area Records that cannot be feasibly retrieved by reference to the location of the *property* or a geographic area in which the *property* is located are not generally *practically reviewable* Most databases of public records are practically reviewable if they can be obtained from the source agency by the county, city, zip code or other geographic area of the facilities listed in the record system Records that are sorted, filed, organized, or maintained by the source agency only chronologically are not generally *practically reviewable* For large databases with numerous facility records (such as RCRA generators and registered USTs), the records are not *practically reviewable* unless they can be obtained from the source agency in the smaller geographic area of zip codes Even when information is provided by zip code for some large databases it is common for an unmanageable number of sites to be identified within a given zip code In these cases, it is not necessary to review the impact of all of the sites that are likely to be listed in any given zip code because that information would not be *practically reviewable* In other words, when so much data is generated that it cannot be feasibly reviewed for its impact on the *property*, it is not required to be reviewed.

7 1 5 *Alternatives to Standard Sources*—Alternative sources may be used in lieu of standard sources if they are of similar or better reliability and detail, or if a *standard source* is not *reasonably ascertainable*

7 1 6 *Coordination*—If records are not *reasonably ascertainable* from *standard sources* or alternative sources, the *environmental professional* shall attempt to obtain the requested information by other means specified in this practice such as questions posed to the current *owner* or *occupant(s)* of the *property* or appropriate persons available at the source at the time of the request

7 1 7 *Sources of Standard Source Information*—*Standard source* information or other record information from government agencies may be obtained directly from appropriate government agencies or from commercial services Government information obtained from nongovernmental sources may be considered current if the source updates the information at least every 90 days or, for information that is updated less frequently than quarterly by the government agency, within 90 days of the date the government agency makes the information available to the public

7 1 8 *Documentation of Sources Checked*—The report shall document each source that was used, even if a source revealed no findings Sources shall be sufficiently documented, including name, date request for information was filled, date information provided was last updated by source, date information was last updated by original source (if provided other than by original source, see 7 1 7) so as to facilitate reconstruction of the research at a later date

7 1 9 *Significance*—If a standard *environmental record source* (or other sources in the course of conducting the *Phase I Environmental Site Assessment*) identifies the *property* or another site within the *approximate minimum search distance*, the report shall include the *environmental professional s* judgment about the significance of the listing to the analysis of *recognized environmental conditions* in connection with the *property* (based on the data retrieved pursuant to 7 2, additional information from the government source, or other sources of information) In doing so, the *environmental professional* may make statements applicable to multiple sites (for example, a statement to the effect that none of the sites listed is likely to have a negative impact on the property except)

7 2 *Environmental Information*

7 2 1 *Standard Environmental Sources*—The following *standard environmental record sources* shall be reviewed, subject to the conditions of 7 1 1 through 7 1 7

7 2 1 1 *Standard Environmental Record Sources Federal and State*—The *approximate minimum search distance* may be reduced, pursuant to 7 1 2 1, for any of these *standard environmental record sources* except the Federal NPL site list and Federal RCRA TSD list

	Approximate Minimum Search Distance, miles (kilometres)
Federal NPL site list	1 0 (1 6)
Federal CERCLIS list	0 5 (0 8)
Federal RCRA TSD facilities list	1 0 (1 6)
Federal RCRA generators list	property and adjoining properties
Federal ERNS list	property only
State lists of hazardous waste sites Identified for investigation or remediation (NPL and CERCLIS equivalents)	1 0 (1 6)
State landfill and/or solid waste disposal site lists	0 5 (0 8)
State leaking UST lists	0 5 (0 8)
State registered UST lists	property and adjoining properties

7 2 2 *Additional Environmental Record Sources State or Local*—One or more additional state sources or local sources of environmental records may be checked in the discretion of the *environmental professional*, to enhance and supplement federal and state sources identified above Factors to consider in determining which local or additional state records, if any, should be checked include (1) whether they are *reasonably ascertainable*, (2) whether they are sufficiently useful, accurate, and complete in light of the objective of the *records review* (see 7 1 1), and (3) whether they are generally obtained, pursuant to local good commercial or customary practice, in initial *environmental site assessments* in the type

993

of *commercial real estate* transaction involved To the extent additional state sources or local sources are used to supplement the same record types listed above, *approximate minimum search distances* should not be less than those specified above (adjusted as provided in 7 2 1 1 and 7 1 2 1) Some types of records and sources that may be useful include

Types of Local Records

Lists of Landfill/Solid Waste Disposal Sites
Lists of Hazardous Waste/Contaminated Sites
Lists of Registered Underground Storage Tanks
Records of Emergency Release Reports (SARA § 304)
Records of Contaminated Public Wells

Local Sources

Department of Health/Environmental Division
Fire Department
Planning Department
Building Permit/Inspection Department
Local/Regional Pollution Control Agency
Local/Regional Water Quality Agency
Local Electric Utility Companies (for records relating to PCBs)

7 2 3 *Physical Setting Sources*—A current USGS 7 5 Minute Topographic Map showing the area on which the *property* is located shall be reviewed provided it is *reasonably ascertainable* It is the only *standard physical setting source* and the only *physical setting source* that is required to be obtained (and only if it is *reasonably ascertainable*) One or more additional *physical setting sources* may be obtained in the discretion of the *environmental professional* Because such sources provide information about the geologic, hydrogeologic, hydrologic, or topographic characteristics of a site, discretionary *physical setting sources* shall be sought when (1) conditions have been identified in which *hazardous substances* or *petroleum products* are likely to migrate to the *property* or from or within the *property* into the groundwater or soil and (2) more information than is provided in the current USGS 7 5 Minute Topographic Map is generally obtained, pursuant to local good commercial or customary practice in initial *environmental site assessments* in the type of *commercial real estate transaction* involved, in order to assess the impact of such migration on *recognized environmental conditions* in connection with the *property*

Mandatory Standard Physical Setting Source

USGS—Current 7 5 Minute Topographic Map

Discretionary and Non-Standard Physical Setting Sources

USGS and/or State Geological Survey—Groundwater Maps
USGS and/or State Geological Survey—Bedrock Geology Maps
USGS and/or State Geological Survey—Surficial Geology Maps
Soil Conservation Service—Soil Maps
Other Physical Setting Sources that are reasonably credible (as well as reasonably ascertainable)

7 3 *Historical Use Information*

7 3 1 *Objective*—The objective of consulting historical sources is to develop a history of the previous uses or occupancies of the *property* and surrounding area in order to identify those uses or occupancies that are likely to have led to *recognized environmental conditions* in connection with the *property*

7 3 2 *Uses of the Property*—Identifying prior uses of the *property* is a two-tiered process (1) uses of the *property* shall be identified from the present back until 1940 using *standard historical sources*; and (2) for uses prior to 1940 (until a time when the *property* was not yet developed (development including the placement of fill upon the *property*) using at least one of the *standard historical sources* listed in 7 3 4 In developing a protocol for identifying prior use, the *environmental professional* will choose search intervals which he or she determines will adequately establish a site history, taking into account the extent applicable records are *reasonably ascertainable* The report shall explain why the uses are identified back to the earliest date identified in the report (e g, records showed no apparent development of the *property* prior to the specific date) and articulate the chosen search intervals

7 3 2 1 *General Type of Use*—In identifying previous uses or occupancies, more specific information about uses or occupancies is more helpful than less specific information, but it is sufficient, for purposes of 7 3 2 to identify the general type of use (for example industrial, manufacturing, airport, railroad, retail, other commercial, school, residential, agricultural) unless it is *obvious* from the standard historical source(s) consulted that the use may be more specifically identified

7 3.2 2 *Data Failure*—If all of the *reasonably ascertainable standard historical sources* in 7 3 4 1 through 7 3.4 8 are checked and do not identify the uses of the *property* back until 1940, compliance with the provisions of 7 3 shall not thereby be deemed incomplete Whatever history of previous uses of the *property* is derived from checking all *reasonably ascertainable standard historical sources* specified in 7 3 4 1 through 7 3 4 8 shall be deemed sufficient historical use information to comply with this practice

7 3 3 *Uses of Properties in Surrounding Area*—Additionally, a history and/or general uses of properties in the area surrounding the property may be researched at a search distance and time period determined in the discretion of the *environmental professional* Factors to consider in making this determination include the extent to which information is *reasonably ascertainable*; the extent to which information is useful, accurate, and complete in light of the purpose of the records review (see 7 1 1), hydrogeologic/geologic conditions of the property that may indicate a high probability of *hazardous substances* or *petroleum products* migration to the property, how recently local development has taken place, information obtained from *interviews*; and the extent to which history and/or uses of properties in the area surrounding the *property* are generally researched, pursuant to local good commercial or customary practice, in initial *environmental site assessments* in the type of *commercial real estate transaction* involved.

7 3 4 *Standard Historical Sources*—In order to meet the requirements of 7 3 2, at least one of the following standard historical sources must be consulted, subject to the conditions of 7 1 1 through 7 1 5 If the standard historical source initially consulted is not *reasonably ascertainable* or does not show the subject site for that *standard historical source* or

494

does not date back to before 1940, another *reasonably ascertainable standard historical source* must be consulted

7 3 4 1 *Aerial Photographs*—The term 'aerial photographs" means photographs taken from an airplane or helicopter (from a low enough altitude to allow identification of development and activities) of areas encompassing the *property* Aerial photographs are often available from government agencies or private collections unique to a local area

7 3 4 2 *Fire Insurance Maps*—The term *fire insurance maps* means maps produced by private fire insurance map companies that indicate uses of properties at specified dates and that encompass the *property* These maps are often available at local libraries, historical societies, private resellers, or from the map companies who produced them

7 3 4 3 *Property Tax Files*—The term *property tax files* means the files kept for property tax purposes by the local jurisdiction where the *property* is located and includes records of past ownership, appraisals, maps, sketches, photos, or other information that is *reasonably ascertainable* and pertaining to the *property*

7 3 4 4 *Recorded Land Title Records*—The term *recorded land title records* means records of fee ownership, leases, land contracts, easements, liens, and other encumbrances on or of the *property* recorded in the place where land title records are, by law or custom, recorded for the local jurisdiction in which the *property* is located (Often such records are kept by a municipal or county recorder or clerk) Such records may be obtained from title companies or directly from the local government agency Information about the title to the *property* that is recorded in a U S district court or any place other than where land title records are, by law or custom, recorded for the local jurisdiction in which the *property* is located, are not considered part of recorded land title records, because often this source will provide only names of previous owners, lessees, easement holders, etc and little or no information about uses or occupancies of the *property*, but when employed in combination with another source recorded land title records may provide helpful information about uses of the *property This source cannot be the sole historical source consulted If this source is consulted at least one additional standard historical source must also be consulted*

7 3 4 5 *USGS 7 5 Minute Topographic Maps*—The term *USGS 7 5 Minute Topographic Maps* means the map (if any) available from or produced by the United States Geological Survey, entitled "USGS 7 5 minute topographic map," and showing the property

7 3 4 6 *Local Street Directories*—The term *local street directories* means directories published by private (or sometimes government) sources and showing ownership and/or use of sites by reference to street addresses Often local street directories are available at libraries of local governments, colleges or universities, or historical societies

7 3 4 7 *Building Department Records*—The term *building department records* means those records of the local government in which the property is located indicating permission of the local government to construct, alter, or demolish improvements on the property Often building department records are located in the *building department* of a municipality or county

7 3 4 8 *Zoning/Land Use Records*—The term *zoning/land use records* means those records of the local government in which the property is located indicating the uses permitted by the local government in particular zones within its jurisdiction The records may consist of maps and/or written records They are often located in the *planning department* of a municipality or county

7 3 4 9 *Other Historical Sources*—The term *other historical sources* means any source or sources other than those designated in 7 3 4 that are credible to a reasonable person and that identify past uses or occupancies of the *property* However, if such source or sources do not show uses or occupancies prior to 1940, at least one other of the standard historical sources specified in 7 3 4 must be consulted in an attempt to determine uses or occupancies of the *property* before 1940 Included in this category are records in the files and/or personal knowledge of the property *owner* and/or *occupants*

7 4 *Prior Assessment Usage—Standard historical sources* reviewed as part of a prior *environmental site assessment* do not need to be searched for or reviewed again but uses of the *property* since the prior *environmental site assessment* should be identified either through *standard historical sources* (as specified in 7 3) or by alternatives to *standard historical sources*, to the extent such information is reasonably ascertainable (See 4 7)

8 Site Reconnaissance

8 1 *Objective*—The objective of the *site reconnaissance* is to obtain information indicating the likelihood of identifying *recognized environmental* conditions in connection with the property

8 2 *Observation*—On a visit to the *property* (the *site visit*), the *environmental professional* shall *visually and physically* observe the *property* and any structure(s) located on the *property* to the extent not obstructed by bodies of water, adjacent buildings, or other obstacles

8 2 1 *Exterior*—The periphery of the *property* shall be *visually and physically observed*, as well as the periphery of all structures on the property, and the *property* should be viewed from all adjacent public thoroughfares If roads or paths with no apparent outlet are observed on the *property*, the use of the road or path should be identified to determine whether it was likely to have been used as an avenue for disposal of *hazardous substances* or *petroleum products*

8 2 2 *Interior*—On the interior of structures on the *property*, accessible common areas expected to be used by *occupants* or the public (such as lobbies, hallways, utility rooms, recreation areas, etc), maintenance and repair areas, including boiler rooms, and a representative sample of *occupant* spaces, should be *visually and physically observed* It is not necessary to look under floors, above ceilings, or behind walls

8 2 3 *Methodology*—The *environmental professional* shall document, in the report, the method used (e g , grid patterns or other systematic approaches used for large properties, which spaces for *owner* or *occupants* were observed) to observe the *property*

8 2 4 *Limitations*—The *environmental professional* shall document, in the report, general limitations and bases of review, including limitations imposed by physical obstructions such as adjacent buildings, bodies of water, asphalt, or

995

other paved areas and limiting conditions (e g , snow rain)

8 2 5 *Frequency*—It is not expected that more than one visit to the *property* shall be made by the *environmental professional* in connection with a *Phase I Environmental Site Assessment* The one visit constituting part of the *Phase I Environmental Site Assessment* may be referred to as the *site visit*

8 3 *Prior Assessment Usage*—The information supplied in connection with the *site reconnaissance* portion of a prior *environmental site assessment* may be used for guidance but shall not be relied upon without determining through a new *site reconnaissance* whether any conditions that are material to *recognized environmental conditions* in connection with the *property* have changed since the prior *environmental site assessment*

8 4 *Uses and Conditions*—The *environmental professional(s)* conducting the *site reconnaissance* should note the uses and conditions specified in 8 4 1 through 8 4 4 8 to the extent *visually or physically observed* during the *site visit* The uses and conditions specified in 8 4 1 through 8 4 4 8 should also be the subject of questions asked as part of *interviews* of *owners* and *occupants* (see Section 9) Uses and conditions to be noted shall be recorded in field notes of the *environmental professional(s)* conducting the *site reconnaissance* but are only required to be described in the report to the extent specified in 8 4 1 through 8 4 4 8 The *environmental professional(s)* performing the *Phase I Environmental Site Assessment* are obligated to identify uses and conditions only to the extent that they may be *visually and physically observed* on a *site visit*, as described in this practice, or to the extent that they are identified by the *interviews* (see Sections 9 and 10) or *record review* (see Section 7) processes described in this practice

8 4 1 *General Site Setting*

8 4 1 1 *Current Use(s) of the Property*—The current use(s) of the *property* shall be identified in the report Any current uses likely to involve the use, treatment, storage, disposal, or generation of *hazardous substances* or *petroleum products* shall be identified in the report Unoccupied occupant spaces should be noted In identifying current uses of the *property*, more specific information is more helpful than less specific information (For example, it is more useful to identify uses such as a hardware store, a grocery store, or a bakery rather than simply retail use)

8 4 1 2 *Past Use(s) of the Property*—To the extent that indications of past uses of the *property* are *visually or physically observed* on the *site visit*, or are identified in the *interviews* or *record review*, they shall be identified in the report, and past uses so identified shall be described in the report if they are likely to have involved the use, treatment, storage, disposal, or generation of *hazardous substances* or *petroleum products* (For example, there may be signs indicating a past use or a structure indicating a past use)

8 4 1 3 *Current Uses of Adjoining Properties*—To the extent that current uses of *adjoining properties* are *visually or physically observed* on the *site visit*, or are identified in the *interviews* or *records review*, they shall be identified in the report, and current uses so identified shall be described in the report if they are likely to indicate *recognized environmental conditions* in connection with the *adjoining properties* or the *property*

8 4 1 4 *Past Uses of Adjoining Properties*—To the extent that indications of past uses of *adjoining properties* are *visually or physically observed* on the *site visit*, or are identified in the *interviews* or *record review*, they shall be noted by the *environmental professional*, and past uses so identified shall be described in the report if they are likely to indicate *recognized environmental conditions* in connection with the *adjoining properties* or the *property*

8 4 1 5 *Current or Past Uses in the Surrounding Area*—To the extent that the general type of current or past uses (e g , residential, commercial, industrial) of properties surrounding the *property* are *visually or physically observed* on the *site visit* or going to or from the *property* for the *site visit*, or are identified in the *interviews* or *record review*, they shall be noted by the *environmental professional*, and uses so identified shall be described in the report if they are likely to indicate *recognized environmental conditions* in connection with the *property*

8 4 1 6 *Geologic Hydrogeologic Hydrologic and Topographic Conditions*—The topographic conditions of the *property* shall be noted to the extent *visually or physically observed* or determined from *interviews*, as well as the general topography of the area surrounding the *property* that is *visually or physically observed* from the periphery of the *property* If any information obtained shows there are likely to be *hazardous substances* or *petroleum products* on the property or on nearby properties and those *hazardous substances* or *petroleum products* are of a type that may migrate, topographic observations shall be analyzed in connection with geologic, hydrogeologic, hydrologic, and topographic information obtained pursuant to *records review* (see 7 2 3) and *interviews* to evaluate whether *hazardous substances* or *petroleum products* are likely to migrate to the *property*, or within or from the *property*, into groundwater or soil

8 4 1 7 *General Description of Structures*—The report shall generally describe the structures or other improvements on the *property*, for example number of buildings, number of stories each, approximate age of buildings, ancillary structures (if any), etc

8 4 1 8 *Roads*—Public thoroughfares adjoining the *property* shall be identified in the report and any roads, streets, and parking facilities on the *property* shall be described in the report

8 4 1 9 *Potable Water Supply*—The source of potable water for the *property* shall be identified in the report.

8 4 1 10 *Sewage Disposal System*—The sewage disposal system for the *property* shall be identified in the report Inquiry shall be made as to the age of the system as part of the process under Sections 7, 9, or 10

8 4 2 *Interior and Exterior Observations*

8 4 2 1 *Current Use(s) of the Property*—The current use(s) of the *property* shall be identified in the report Any current uses likely to involve the use, treatment, storage, disposal, or generation of *hazardous substances* or *petroleum products* shall be identified in the report Unoccupied *occupant* spaces should be noted In identifying current uses of the *property*, more specific information is more helpful than less specific information (For example, it is more useful to identify uses such as a hardware store, a grocery store, or a bakery rather than simply retail use)

996

8 4 2 2 *Past Use(s) of the Property*—To the extent that indications of past uses of the *property* are *visually or physically observed* on the *site visit*, or are identified in the *interviews* or *records review*, they shall be identified in the report and past uses so identified shall be described in the report if they are likely to have involved the use, treatment storage, disposal, or generation of *hazardous substances* or *petroleum products* (For example, there may be signs indicating a past use or a structure indicating a past use)

8 4 2 3 *Hazardous Substances and Petroleum Products in Connection with Identified Uses*—To the extent that present uses are identified that use, treat, store, dispose of, or generate *hazardous substances* and *petroleum products* on the *property* (1) the *hazardous substances* and *petroleum products* shall be identified or indicated as unidentified in the report, and (2) the approximate quantities involved, types of containers (if any) and storage conditions shall be described in the report To the extent that past uses are identified that used, treated, stored, disposed of, or generated *hazardous substances* and *petroleum products* on the *property*, the information shall be identified to the extent it is *visually or physically observed* during the *site visit* or identified from the *interviews* or the *records review*

8 4 2 4 *Storage Tanks*—Above ground storage tanks, or underground storage tanks or vent pipes, fill pipes or access ways indicating underground storage tanks shall be identified (e g , content, capacity, and age) to the extent *visually or physically observed* during the *site visit* or identified from the *interviews* or *records review*

8 4 2 5 *Odors*—Strong, pungent, or noxious odors shall be described in the report and their sources shall be identified in the report to the extent *visually or physically observed* or identified from the *interviews* or *records review*

8 4 2 6 *Pools of Liquid*—Standing surface water shall be noted Pools or *sumps* containing liquids likely to be *hazardous substances* or *petroleum products* shall be described in the report to the extent *visually or physically observed* or identified from the *interviews* or *records review*

8 4 2 7 *Drums*—To the extent *visually or physically observed* or identified from the *interviews* or *records review*, *drums* shall be described in the report, whether or not they are leaking, unless it is known that their contents are not *hazardous substances* or *petroleum products* (in that case the contents should be described in the report) *Drums* often hold 55 gal (208 L) of liquid, but containers as small as 5 gal (19 L) should also be described

8 4 2 8 *Hazardous Substance and Petroleum Products Containers (Not Necessarily in Connection With Identified Uses)*—When containers identified as containing *hazardous substances* or *petroleum products* are *visually or physically observed* on the *property* and are or might be a *recognized environmental condition* the *hazardous substances* or *petroleum products* shall be identified or indicated as unidentified in the report, and the approximate quantities involved, types of containers, and storage conditions shall be described in the report

8 4 2 9 *Unidentified Substance Containers*—When open or damaged containers containing unidentified substances suspected of being *hazardous substances* or *petroleum products* are *visually or physically observed* on the *property*, the approximate quantities involved, types of containers and storage conditions shall be described in the report

8 4 2 10 *PCBs*—Electrical or hydraulic equipment known to contain PCBs or likely to contain PCBs shall be described in the report to the extent *visually or physically observed* or identified from the *interviews* or *records review* Fluorescent light ballast likely to contain PCBs does not need to be noted.

8 4 3 *Interior Observations*

8 4 3 1 *Heating/Cooling*—The means of heating and cooling the buildings on the property, including the fuel source for heating and cooling, shall be identified in the report (for example, heating oil, gas, electric, radiators from steam boiler fueled by gas)

8 4 3 2 *Stains or Corrosion*—To the extent *visually or physically observed* or identified from the *interviews*, stains or corrosion on floors, walls, or ceilings shall be described in the report, except for staining from water

8 4 3 3 *Drains and Sumps*—To the extent *visually or physically observed* or identified from the *interviews*, floor drains and *sumps* shall be described in the report.

8 4 4 *Exterior Observations*

8 4 4 1 *Pits Ponds or Lagoons*—To the extent *visually or physically observed* or identified from the *interviews* or *records review*, *pits*, *ponds*, *or lagoons* on the *property* shall be described in the report, particularly if they have been used in connection with waste disposal or waste treatment. *Pits*, *ponds*, *or lagoons* on *properties* adjoining the *property* shall be described in the report to the extent they are *visually or physically observed* from the *property* or identified in the *interviews* or *records review*

8 4 4 2 *Stained Soil or Pavement*—To the extent *visually or physically observed* or identified from the *interviews*, areas of stained soil or pavement shall be described in the report

8 4 4 3 *Stressed Vegetation*—To the extent *visually or physically observed* or identified from the *interviews*, areas of stressed vegetation (from something other than insufficient water) shall be described in the report

8 4 4 4 *Solid Waste*—To the extent *visually or physically observed* or identified from the *interviews* or *records review*, areas that are apparently filled or graded by non-natural causes (or filled by fill of unknown origin) suggesting trash or other solid waste disposal, or mounds or depressions suggesting trash or other solid waste disposal, shall be described in the report

8 4 4 5 *Waste Water*—To the extent *visually or physically observed* or identified from the *interviews* or *records review*, waste water or other liquid (including storm water) or any discharge into a drain, ditch, or stream on or adjacent to the *property* shall be described in the report

8 4 4 6 *Wells*—To the extent *visually or physically observed* or identified from the *interviews* or *records review*, all wells (including dry wells, irrigation wells, injection wells, abandoned wells, or other wells) shall be described in the report

8 4 4 7 *Septic Systems*—To the extent *visually or physically observed* or identified from the *interviews* or *records review*, indications of on-site septic systems or cesspools should be described in the report

9 Interviews With Owners and Occupants

9 1 *Objective*—The objective of *interviews* is to obtain information indicating *recognized environmental conditions*

991

in connection with the *property*

9 2 *Content*—Interviews with *owners* and *occupants* consist of questions to be asked in the manner and of persons as described in this section The content of questions to be asked shall attempt to obtain information about uses and conditions as described in Section 8 as well as information described in 9 8 and 9 9

9 3 *Medium*—Questions to be asked pursuant to this section may be asked in person, by telephone or in writing, in the discretion of the *environmental professional*

9 4 *Timing*—Except as specified in 9 8 and 9 9, it is in the discretion of the *environmental professional* whether to ask questions before during, or after the *site visit* described in Section 8, or in some combination thereof

9 5 *Who Should be Interviewed*

9 5 1 *Key Site Manager*—Prior to the *site visit*, the *owner* should be asked to identify a person with good knowledge of the uses and physical characteristics of the *property* (the *key site manager*) Often the *key site manager* will be the property manager, the chief physical plant supervisor or head maintenance person (If the *user* is the current *property* owner, the user has an obligation to identify a *key site manager*, even if it is the *user* himself or herself) If a *key site manager* is identified, the person conducting the *site visit* shall make at least one reasonable attempt (in writing or by telephone) to arrange a mutually convenient appointment for the *site visit* when the *key site manager* agrees to be there If the attempt is successful, the *key site manager* shall be interviewed in conjunction with the *site visit* If such an attempt is unsuccessful, when conducting the *site visit*, the *environmental professional* shall inquire whether an identified *key site manager* (if any) or if a person with good knowledge of the uses and physical characteristics of the *property* is available to be interviewed at that time, if so, that person shall be interviewed In any case, it is within the discretion of the *environmental professional* to decide which questions to ask before, during, or after the *site visit* or in some combination thereof

9 5 2 *Occupants*—A reasonable attempt shall be made to interview a reasonable number of *occupants* of the *property*

9 5 2 1 *Multi-Family Properties*—For multi-family residential properties, residential *occupants* do not need to be interviewed, but if the *property* has nonresidential uses, interviews should be held with the nonresidential *occupants* based on criteria specified in 9 5 2 2

9 5.2 2 *Major Occupants*—Except as specified in 9 5 2 1, if the *property* has five or fewer current *occupants*, a reasonable attempt shall be made to interview a representative of each one of them If there are more than five current *occupants*, a reasonable attempt shall be made to interview the *major occupant(s)* and those other *occupants* whose operations are likely to indicate *recognized environmental conditions* in connection with the *property*

9 5.2 3 *Reasonable Attempts to Interview*—Examples of reasonable attempts to interview those *occupants* specified in 9 5 2 2 include (but are not limited to) an attempt to interview such *occupants* when making the *site visit* or calling such *occupants* by telephone In any case, when there are several *occupants* to interview, it is not expected that the *site visit* must be scheduled at a time when they will all be available to be interviewed

9 5 2 4 *Occupant Identification*—The report shall identify the occupants interviewed and the duration of their occupancy

9 5 3 *Prior Assessment Usage*—Persons interviewed as part of a prior *Phase I Environmental Site Assessment* consistent with this practice do not need to be questioned again about the content of answers they provided at that time However, they should be questioned about any new information learned since that time, or others should be questioned about conditions since the prior *Phase I Environmental Site Assessment* consistent with this practice

9 6 *Quality of Answers*—The person(s) interviewed should be asked to be as specific as reasonably feasible in answering questions The person(s) interviewed should be asked to answer in good faith and to the extent of their knowledge

9 7 *Incomplete Answers*—While the person conducting the interview(s) has an obligation to ask questions, in many instances the persons to whom the questions are addressed will have no obligation to answer them

9 7 1 *User*—If the person to be interviewed is the user (the person on whose behalf the *Phase I Environmental Site Assessment* is being conducted), the *user* has an obligation to answer all questions posed by the person conducting the interview in good faith, to the extent of his or her *actual knowledge* or to designate a *key site manager* to do so If answers to questions are unknown or partially unknown to the *user* or such *key site manager*, this *interview* section of the *Phase I Environmental Site Assessment* shall not thereby be deemed incomplete

9 7 2 *Non-user*—If the person conducting the interview(s) asks questions of a person other than a user but does not receive answers or receives partial answers, this section of the *Phase I Environmental Site Assessment* shall not thereby be deemed incomplete, provided that (1) the questions have been asked (or attempted to be asked) in person or by telephone and written records have been kept of the person to whom the questions were addressed and the responses, or (2) the questions have been asked in writing sent by first class mail or by private, commercial carrier and no answer or incomplete answers have been obtained and at least one reasonable follow up (telephone call or written request) was made again asking for responses

9 8 *Questions About Helpful Documents*—Prior to the *site visit*, the *property owner*, *key site manager* (if any is identified), and *user* (if different from the *property owner*) shall be asked if they know whether any of the documents listed in 9 8 1 exists and, if so, whether copies can and will be provided to the *environmental professional* within reasonable time and cost constraints. Even partial information provided may be useful If so, the *environmental professional* conducting the *site visit* shall review the available documents prior to or at the beginning of the *site visit*

9 8 1 *Helpful Documents*

9 8 1 1 Environment site assessment reports,

9 8 1 2 Environment audit reports,

9 8 1 3 Environmental permits (for example, solid waste disposal permits, hazardous waste disposal permits, wastewater permits, NPDES permits),

9 8 1 4 Registrations for underground and above-ground storage tanks,

993

9 8 1 5 Material safety data sheets,

9 8 1 6 Community right-to-know plan,

9 8 1 7 Safety plans, preparedness and prevention plans, spill prevention, countermeasure, and control plans, etc ,

9 8 1 8 Reports regarding hydrogeologic conditions on the property or surrounding area,

9 8 1 9 Notices or other correspondence from any government agency relating to past or current violations of environmental laws with respect to the property or relating to environmental liens encumbering the property,

9 8 1 10 Hazardous waste generator notices or reports, and

9 8 1 11 Geotechnical studies

9 9 *Proceedings Involving the Property*—Prior to the *site visit*, the *property owner*, *key site manager* (if any is identified), and *user* (if different from the *property owner*) shall be asked whether they know of (1) any pending, threatened, or past litigation relevant to *hazardous substances* or *petroleum products* in, on, or from the *property*; (2) any pending, threatened, or past administrative proceedings relevant to *hazardous substances* or *petroleum products* in, on or from the *property*; and (3) any notices from any governmental entity regarding any possible violation of environmental laws or possible liability relating to *hazardous substances* or *petroleum products*

10 Interviews With Local Government Officials

10 1 *Objective*—The objective of *interviews* with *local government officials* is to obtain information indicating *recognized environmental conditions* in connection with the *property*

10 2 *Content*—Interviews with *local government officials* consist of questions to be asked in the manner and of persons as described in this section The content of questions to be asked shall be decided in the discretion of the *environmental professional(s)* conducting the *Phase I Environmental Site Assessment*, provided that the questions shall generally be directed towards identifying *recognized environmental conditions* in connection with the *property*

10 3 *Medium*—Questions to be asked may be asked in person or by telephone, in the discretion of the *environmental professional*

10 4 *Timing*—It is in the discretion of the *environmental professional* whether to ask questions before or after the *site visit* described in Section 8, or in some combination thereof

10 5 *Who Should Be Interviewed*

10 5 1 *Local Agency Officials*—A reasonable attempt shall be made to interview at least one staff member of any one of the following types of local government agencies

10 5 1 1 Local fire department that serves the *property*,

10 5 1 2 Local health agency or local/regional office of state health agency serving the area in which the *property* is located, or

10 5 1 3 Local agency or local/regional office of state agency having jurisdiction over hazardous waste disposal or other environmental matters in the area in which the *property* is located.

10 6 *Prior Assessment Usage*—Persons interviewed as part of a prior *Phase I Environmental Site Assessment* consistent with this practice do not need to be questioned again about the content of answers they provided at that time However, they should be questioned about any new information learned since that time, or others should be questioned about conditions since the prior *Phase I Environmental Site Assessment* consistent with this practice

10 7 *Quality of Answers*—The person(s) interviewed should be asked to be as specific as reasonably feasible in answering questions The person(s) interviewed should be asked to answer in good faith and to the extent of their knowledge

10 8 *Incomplete Answers*—While the person conducting the *interview(s)* has an obligation to ask questions, in many instances the persons to whom the questions are addressed will have no obligation to answer them If the person conducting the *interview(s)* asks questions but does not receive answers or receives partial answers, this section shall not thereby be deemed incomplete, provided that questions have been asked (or attempted to be asked) in person or by telephone and written records have been kept of the person to whom the questions were addressed and their responses

11 Evaluation and Report Preparation

11 1 *Report Format*—The report of findings for the *Phase I Environmental Site Assessment* should generally follow the recommended report format attached as Appendix X2 unless otherwise required by the user

11 2 *Documentation*—The report should include documentation (for example, references, key exhibits) to support the analysis, opinions, and conclusions found in the report. All sources, including those that revealed no findings, should be sufficiently documented to facilitate reconstruction of the research at a later date

11 3 *Contents of Report*—The report shall include those matters required to be included in the report pursuant to various provisions of this practice In addition, the report shall state whether the *user* reported to the *environmental professional* any information pursuant to the user's responsibilities described in Section 5 of this practice (for example, an *environmental lien* encumbering the *property* or any relevant specialized knowledge or experience of the user)

11 4 *Credentials*—The report shall name the *environmental professional(s)* involved in conducting the *Phase I Environmental Site Assessment* One of two options shall be available to address qualifications of those persons involved in conducting the *Phase I Environmental Site Assessment* (1) the report shall include a qualifications statement of the *environmental professional(s)* responsible for the *Phase I Environmental Site Assessment* and preparation of the report, and the qualifications statement shall include relevant individual and corporate qualifications, or (2) a written qualifications statement of the *environmental professional(s)* responsible for the *Phase I Environmental Site Assessment* and preparation of the report, including relevant individual and corporate qualifications, shall be delivered to the *user*

11 5 *Opinion*—All evidence of recognized environmental conditions shall be described in full. The report shall include the *environmental professional's* opinion of the impact of *recognized environmental conditions* in connection with the *property*

11 6 *Findings and Conclusions*—The report shall have a findings and conclusions section that states one of the following.

993

11 6 1 'We have performed a *Phase I Environmental Site Assessment* in conformance with the scope and limitations of ASTM Practice E 1527 of [insert address or legal description], the *property* Any exceptions to or deletions from this practice are described in Section [ ] of this report This assessment has revealed no evidence of recognized environmental conditions in connection with the property," or

11 6 2 "We have performed a *Phase I Environmental Site Assessment* in conformance with the scope and limitations of ASTM Practice E 1527 of [insert address or legal description], the property Any exceptions to, or deletions from, this practice are described in Section [ ] of this report This assessment has revealed no evidence of recognized environmental conditions in connection with the *property* except for the following (list) "

11 7 *Deviations*—All deletions and deviations from this practice (if any) shall be listed individually and in detail and all additions should be listed

11 8 *Signature*—The environmental professional(s) responsible for the *Phase I Environmental Site Assessment* shall sign the report

11 9 *Additional Services*—Any additional services contracted for between the user and the environmental professional(s), including a broader scope of assessment, more detailed conclusions, liability/risk evaluations, recommendation for Phase II testing, remediation techniques, etc , are beyond the scope of this practice, and should only be included in the report if so specified in the terms of engagement between the user and the *environmental professional*

12 Non-Scope Considerations

12 1 *General*

12 1 1 *Additional Issues*—There may be environmental issues or conditions at a property that parties may wish to assess in connection with *commercial real estate* that are outside the scope of this practice (the non-scope considerations) As noted by the legal analysis in Appendix X1 of this practice, some substances may be present on a property in quantities and under conditions that may lead to contamination of the property or of nearby properties but are not included in CERCLA's definition of hazardous substances (42 USC § 9601(14)) or do not otherwise present potential CERCLA liability In any case, they are beyond the scope of this practice

12 1 2 *Outside Standard Practices*—Whether or not a *user* elects to inquire into non-scope considerations in connection with this practice or any other environmental site assessment, no assessment of such non-scope considerations is required for appropriate inquiry as defined by this practice

12 1 3 *Other Standards*—There may be standards or protocols for assessment of potential hazards and conditions associated with non-scope conditions developed by governmental entities, professional organizations, or other private entities

12 1 4 *List of Additional Issues*—Following are several non-scope considerations that persons may want to assess in connection with commercial real estate No implication is intended as to the relative importance of inquiry into such non-scope considerations, and this list of non-scope considerations is not intended to be all-inclusive

12 1 4 1 Asbestos-Containing Materials,
12 1 4 2 Radon,
12 1 4 3 Lead-Based Paint,
12 1 4 4 Lead in Drinking Water, and
12 1 4 5 Wetlands

APPENDIXES

(Nonmandatory Information)

X1 LEGAL BACKGROUND TO FEDERAL LAW AND THE PRACTICES ON ENVIRONMENTAL ASSESSMENTS IN COMMERCIAL REAL ESTATE TRANSACTIONS

INTRODUCTION

The legal section of Subcommittee E50 02 on Environmental Assessments In Commercial Real Estate Transactions provides the following background to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended including amended by the Superfund Amendments and Reauthorization Act (SARA), 42 USC § 9601 *et seq* The background to CERCLA, commonly known as the Superfund law, outlines the potential liability for the cleanup of hazardous substances available defenses to such liability, appropriate inquiry under Superfund, statutory definition of hazardous substances, petroleum products and petroleum exclusion to CERCLA, and reasons why certain environmental-hazards are excluded from the scope of Superfund and this practice and Practice E 1528

There are several elements of Superfund liability and the commonly termed "innocent purchaser" defense, that arises out of the statutory third-party defense, that may impact on the development and understanding of this practice and Practice E 1528

X1 1 *Superfund Liability*

X1 1 1 All of the following elements of liability under Superfund must be established by a plaintiff before a defendant will be held liable under superfund for a *government s* response costs [7]

X1 1 1 1 The site is a facility, as defined at § 9601(9),

X1 1 1 2 A release or threatened release of a hazardous substance from the site occurred (release is defined at § 9601(22) as *any* amount of any hazardous substance, hazardous substance" is defined at § 9601(14) (see statutory definition of "hazardous substance"),

X1 1 1 3 A release or threatened release caused the plaintiff to incur response costs Response costs are defined at § 9601(25) to mean costs related to both removal actions (§ 9601(23)) and remedial actions (§ 9601(24)), and

X1 1 1 4 Defendants fall within at least one of the four classes of responsible parties [8]

X1 1 2 In order to recover response costs, a government plaintiff must prove that the costs were not inconsistent with the National Oil and Hazardous Substances Pollution Contingency Plan (commonly referred to as the National Contingency Plan or NCP), 40 CFR § 300 [9] A private plaintiff must prove its costs were necessary costs of response and that the response action was consistent with the NCP 42 USC § 9607 (a) [10]

X1 1 3 If there is a release or threatened release of hazardous substances on a site, private parties, even if they are not PRPs, may decide to incur response costs and seek recovery from other private parties, and PRPs may seek contribution from other PRPs

X1 1 4 There is an important difference between government's burden to show that its response costs are "not inconsistent with the NCP" and the burden a private party bears to show that its response costs are "consistent with the NCP" See § 9607 (a)(4)(A) and (B) Courts have interpreted this statutory difference to give the government a rebuttable presumption that its response costs are consistent with the NCP, whereas a private party who undertakes response costs and seeks recovery from responsible parties bears the burden of proving its response was consistent with the NCP [11] The EPA takes the position that a private party who undertakes a response action must be only in "substantial compliance", rather than strict technical compliance, with the NCP, as long as a CERCLA-quality cleanup is achieved The NCP requirements for a private party response-action are set forth at 40 CFR § 300 700

X1 2 *Defenses to Liability*

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42 USC §9607(a) (All statutory references are to Title 42 of the United States Code unless otherwise specified.) See *United States versus Aceto Agricultural Chemicals Corp* 872 F 2d 1373 (8th Cir 1989) Private plaintiffs, as well as the government, may seek response costs under Superfund from defendants. While many users of these ASTM practices or other private parties may think in terms of how to defend against Superfund liability they should recognize that they may decide to conduct cleanup actions and seek response costs from other parties

[8] The four classes of potentially responsible parties (PRPs) are listed as § 9607(a) as follows

(*1*) Owner and operator of a facility (See § 9601 (20)(A) the term owner or operator" does not include a person who without participating in the management of a facility holds indicia of ownership primarily to protect his security interest in the facility In *re Bergsoe Metal Corporation* 910 F 2d 668 (9th Cir Aug. 9 1990) *Guidice versus BFG Electroplating and Manufacturing Co* 732 F Supp 556 (W D Pa 1989) *United States v Mirabile* 23 ERC 1511 (E D Pa. 1985) But see *United States versus Fleet Factors Corp* 901 F 2d 1550 (11th Cir 1990) *United States versus Maryland Bank and Trust Co* 632 F Supp 573 (D Md. 1986) For clarification of the security interest exclusion see EPA s rule on lender liability under CERCLA 57 Federal Register 18344 (April 29 1992)

(*2*) Any person who at the time of disposal of any hazardous substance owned or operated any facility at which such hazardous substances were disposed of

(*3*) Any person who by contract, agreement, or otherwise arranged for disposal or treatment or transport of hazardous substances, and

(*4*) Any person who accepts hazardous substances for transport to a facility selected by such person

[9] The National Contingency Plan is the federal government s blueprint on how hazardous substances are to be cleaned up pursuant to CERCLA

[10] See *Dedham Water Co versus Cumberland Farms Dairy Inc* 889 F 2d 1146 (1st Cir 1989) other cases cited at ABA, *Natural Resources Energy and Environmental Law 1989 The Year In Review* p 215 Note 155

[11] *Amland Properties Corp versus Aluminum Co of America*, 711 F Supp 78[illegible] 794 (D N.J 1989) *Artesian Water Co versus New Castle County* 659 F Sup[illegible] 1269 1291 (D Del 1987) *United States versus Northeastern Pharmaceutical and Chemical Co* 579 F Supp 823 (W D Mo 1984) *aff'd in part rev d on other grounds* 810 F 2d 726 (8th Cir 1986)

10 D1

X1 2 1 Assuming all the elements of liability exist, a party may avoid liability only by meeting one of the defenses listed in § 9607(b) These listed defenses are exclusive of all others [12] Section 9607(b) states (*emphasis added*)

> There shall be no liability under subsection (a) for a person otherwise liable who can establish by a preponderance of the evidence [the lowest evidentiary standard available meaning more probable than not] that the release or threat of release of a hazardous substance and the damages resulting therefrom were *caused solely by*—
> 1) an act of God
> 2) an act of war;
> 3) *an act or omission of a third party other* than an employee or agent of the defendant, or *than one whose act or omission occurs in connection with a contractual relationship* [see the definition of contractual relationship" in X1 2 2], existing directly or indirectly, with the defendant , if the defendant establishes by a preponderance of the evidence that (a) he exercised due care with respect to the hazardous substance concerned and (b) he took precautions against foreseeable acts or omissions of any such third party and the consequences that could foreseeably result from such actions or omissions "

X1 2 2 Under § 9601(35)(A), a contractual relationship "includes, but is not limited to, land contracts, deeds, or other instruments transferring title or possession " These contractual relationships with third parties eliminate the defense to liability unless the defendant is an innocent purchaser Or as stated by the statute at § 9601(35)(A)(emphasis added), a contractual relationship with the third party defeats the defense

> ' unless the real property on which the facility is located was acquired by the defendant after disposal or placement of the hazardous substance and one or more of the following circumstances is also established by the defendant by a preponderance of the evidence
> (i) At the time the defendant acquired the facility the defendant *did not know and had no reason to know* that any hazardous substance which is the subject of the release or threatened release was disposed of on in or at the facility
> (ii) The defendant is the government
> (iii) The defendant acquired the facility by inheritance or bequest."

X1 2 3 Therefore, the so-called innocent purchaser defense arises out of the third-party defense of § 9607(b)(3) Restated, this defense to Superfund liability is available only if the defendant shows the following.

X1 2 3 1 The release or threat of release was caused solely by a third party,

X1 2 3 2 The third party is not an employee or agent of the defendant,

X1 2 3 3 The acts or omissions of the third party did not occur in connection with a direct or indirect contractual relationship to the defendant, or if there was a contractual relationship, the defendant acquired the property after disposal or placement of the hazardous substance, and at the time the defendant acquired the facility the defendant *did not know and had no reason to know* that any hazardous substance that is the subject of the release or threatened release was disposed of on, in, or at the facility, and

X1 2 3 4 The defendant exercised due care with respect to the hazardous substances and took precautions against foreseeable acts or omissions of the third party

X1 2 4 The statute then states at § 9601(35)(B) (*emphasis added*)

> To establish that the defendant had no reason to know, as provided [above], *the defendant must have undertaken at the time of acquisition all appropriate inquiry into the previous ownership and uses of the property consistent with good commercial or customary practice* in an effort to minimize liability [T]he court shall take into account any specialized knowledge or experience on the part of the defendant, the relationship of the purchase price to the value of the property if uncontaminated, commonly known or reasonably ascertainable information about the property, the obviousness of the presence or likely presence of contamination at the property, and the ability to detect such contamination by appropriate inspection "

X1 3 *Appropriate Inquiry in Commercial Real Estate Transactions*

X1 3 1 One of the major questions that parties to commercial real estate transactions face when considering their potential Superfund liability is, "What level of inquiry into the previous ownership and uses of the property is appropriate to establish the innocent purchaser defense to Superfund liability?" These practices are structured to articulate the level of inquiry under Superfund that is appropriate for different situations.

X1 3 2 *The Appropriate Level of Inquiry*

X1 3 2 1 The level of environmental inquiry that is appropriate under Superfund cannot be the same for every property or every party to a real estate transaction The level of inquiry, in fact, will change depending on the particular property or party involved in a transaction The statutory language, Congressional history, and common sense support this conclusion

X1 3 2 2 First, it must be noted that little case law exists to serve as guidance about the minimum level of inquiry that will be deemed appropriate for the innocent purchaser defense See, for example, *United States versus Serafini*, 706 F Supp 346 (M D Pa 1988), and 1990 U S Dist. LEXIS 18466 (M D Pa 1990) (By entertaining disputed facts as to the custom and practice of viewing land prior to purchase, the court implied that appropriate inquiry necessarily varies on a site-by-site basis), *United States versus Pacific Hide and Fur Depot Inc*, 716 F Supp 1341 (D Idaho 1989) (No inquiry was required by those who received an ownership interest in property via corporate stock transfer and warranty deed under the facts of this case), *International Clinical Laboratories Inc versus Stevens*, 30 ERC 2066, 20 ELR 20,560 (E D N Y 1990) (Despite a long history of toxic wastewater disposal and presence of the site on the state's hazardous waste disposal site list, the purchaser established the innocent purchaser defense since there were no visible environmental problems at the site, the defendant had no knowledge of environmental problems at the site and the purchase price did not reflect a reduction on account of the problem)

X1 3 2 3 While the statute does not specifically distin-

[12] *United States versus Aceto Agricultural Chemicals Corp* 872 F 2d 1373 (8th Cir 1989) But see *United States versus Marisol Inc* 725 F Supp 833 (M D Pa. 1989) (equitable defenses under CERCLA may be available after the development of a factual record)

1002

guish certain types of properties and uses from others, or certain types of parties from others, it does list certain factors courts should consider in determining whether one's inquiry under the circumstances is appropriate The statute as explained in X1 2, requires a court to consider a party's specialized knowledge or experience The statute further mandates a court to consider what is '*reasonably* ascertainable information about the property", what contamination is *obviously* present, and the *party s* "ability to detect such contamination" The very use of terms such as "appropriate" and "reasonably", and the use of "specialized knowledge and experience" and "ability" in conjunction with the specific person attempting to utilize the defense signifies that Congress did not intend the appropriateness of the inquiry be judged by a bright line standard If it so intended, Congress would have stated, but did not, that the same inquiry should be made in every case

X1 3 2 4 What is reasonable and obvious to one party may not be so to other parties, and ability, by necessity, varies among all parties The statute, therefore, recognizes that different properties and parties must be treated differently That is, different parties may conduct different levels of inquiry appropriate to their circumstances

X1 3 2 5 The statutory standard of "appropriate inquiry" suggests the level of inquiry will depend on the circumstances and the underlying facts Since the facts are almost always different, the level of inquiry must change with them The legislative history on this particular issue demonstrates that Congress intended that the level of inquiry changes with the type of property and party[13]

> The duty to inquire under this provision shall be judged as of the time of acquisition Defendants shall be held to a higher standard as public awareness of the hazards associated with hazardous releases has grown, as reflected by this Act, the 1980 Act [CERCLA] and other Federal and State statutes
> Moreover good commercial or customary practice with respect to inquiry in an effort to minimize liability shall mean that a reasonable inquiry must have been made in all circumstances, in light of best business and land transfer principles
> Those engaged in commercial transactions should, however, be held to a higher standard than those who are engaged in private residential transactions.

X1 3 2 6 Because few cases address the standard of inquiry in the innocent purchaser defense and the legislative history describing Congressional intent is sparse, common sense is a useful guide in interpreting statutory language If CERCLA mandated that the level of inquiry be the same for every property or potential defendant, then a lay consumer (renter or buyer) of a home, a purchaser of a small environmentally benign business, and a multinational corporate buyer of an industrial complex would have to conduct the same environmental site assessment (ESA) of the different properties in question Additionally, the statute makes no mention of a Phase I ESA or any other specific type of inquiry one is to conduct in order for the inquiry to be deemed appropriate If all inquires had to be at the same level to be "appropriate", it would be illogical to stop at a Phase I ESA since some commercial or industrial properties routinely undergo, in the exercise of good commercial and customary practices, intrusive sampling (typically a Phase II ESA activity) Therefore, since routinely some properties undergo sampling, an inflexible standard would require sampling of all properties, no matter what its use This could not have been the intended result of SARA

X1 3 3 *The Minimum Inquiries to Satisfy All Appropriate Inquiry*

X1 3 3 1 Recognizing that inquiry changes with the underlying circumstances, the next question concerns that level of inquiry, if any, that Superfund requires to utilize the innocent landowner defense

X1 3 3 2 As noted above, in some real estate transactions a Phase II ESA is routinely conducted A Phase I ESA is conducted in these transactions only as a necessary prerequisite to outline the scope of the Phase II ESA A Phase II ESA typically involves taking soil, water, and air samples to determine their contaminant content or verify that no contaminants are present or likely present. Note, however, that this simplistic outline of the Phase II ESA is misleading since the party can always dig down one foot deeper, take one more sample, or conduct one more test. The problem of how much inquiry is conducted, or at what level a party should begin, involves proving a negative, i e, that no contamination is present[14] Since, according to the statute, inquiries should be judged by the circumstances existing at the time of acquisition, then there could be some properties and parties to real estate transactions where it may be appropriate to begin the inquiry with an intrusive Phase II ESA in order to invoke the innocent purchaser defense to liability

X1 3 3 3 At the other extreme, the minimum level of inquiry that a party would be expected to conduct is found by looking at the least environmentally obtrusive class of property and party from a CERCLA perspective This transaction likely involves the lay buyer of a home or the renter of an apartment. Assuming these parties meet the other prerequisites for the innocent purchaser defense, what level of environmental inquiry must they conduct to avoid Superfund liability? While there are no recorded court cases on this issue, the answer is probably none, unless a particular residential purchaser or renter has some specialized knowledge about or experience with the property in question that would lead a court to conclude that some questions should have been asked Beyond these rare situations, it is highly unlikely that Congress intended to saddle housing consumers with the burden of investigating or cleaning up contaminated

[13] H R. Rep. No 962, 99th Cong. 2d Sess. 187 (1986) *reprinted at* 1986 U S Code Cong. and Admin News 3276 3280

[14] The inability to prove a negative creates a dilemma for the potential defendant. If the party s inquiry discovers contamination then under the statute the party will not be able to avail itself of the innocent purchaser defense If the inquiry does not discover contamination. EPA or another private party can argue in a response action that the inquiry was not "appropriate" and, therefore, the defendant can have no defense. This dilemma is explicitly recognized by the Subcommittee E50 02 as beyond any reasonable interpretation of Congressional intent. The scope of the E50 02 Standard Practices resolves the party s dilemma in the only reasonable way by stating: "It should not be concluded or assumed that the inquiry was not appropriate inquiry merely because the inquiry did not identify existing recognized environmental conditions in connection with a property Environmental site assessments must be evaluated based on the reasonableness of the judgments made at the time and under the circumstances in which they were made." See 4 5 4

1003

sites In fact, EPA has issued a statement of enforcement policy to the effect that it will not generally pursue owners of single family residences pursuant to CERCLA [15] Therefore, for some properties and parties to real estate transactions, it is appropriate to conduct no environmental inquiry in order to meet one's innocent purchaser defense to liability

X1 3 3 4 The minimum level of appropriate inquiry under Superfund, therefore, ranges from no specialized inquiry to conducting an intrusive Phase II ESA In order to satisfy these practices, to do no specialized inquiry, such as the Transaction Screen or Phase I ESA, is not enough for commercial real estate transactions Under current commercial and customary practice and in light of best business and land transfer principles, however, no environmental site assessments are conducted in many real estate transactions particularly those involving smaller properties, vacant land, or transactions of low monetary value This practice and Practice E 1528 and the minimum level of inquiry under these practices, actually raises the average level of inquiry that should be performed where the parties want to come within the protection of the innocent landowner defense

X1 3 3 5 The burden of proof is on the defendant to sustain by a preponderance of the evidence, the innocent purchaser defense This is the least onerous burden of proof available to a party in litigation The defendant must show only that the evidence offered to support the level of inquiry that was taken at the time of acquisition is of greater weight or more convincing than the evidence offered in opposition to it In other words, the evidence on the inquiry issue taken as a whole shows that the fact sought to be proved is more probable than not. There may be technical or business judgments on whether the inquiry conducted or any other fact in a particular case is sufficient to meet the needs or concerns of a party to the real estate transaction The bottom line, however, is that the judgment on whether the specific facts of a case, in light of statutory language, are sufficient to produce liability or a viable defense to liability is a legal one and such judgments constitute the practice of law

X1 3 3 6 Practice E 1528 is designed as the minimum level of inquiry to satisfy the practice from which a party to a commercial real estate transaction should proceed, recognizing that some parties to some commercial real estate transactions may wish to proceed by beginning with a Phase I or a Phase II ESA

X1 4 *Statutory Definition of Hazardous Substance*

X1 4 1 The statute at 42 USC § 9601(14)(A – F) defines hazardous substance by referring to five other statutes as well as to Superfund's own § 9602 The following is a description of the relevant portions of the other statutes and § 9602 of Superfund.

42 USC § 9601(14)(A) [A]ny substance designated pursuant to section 1321(b)(2)(A) of Title 33 " Title 33 USC § 1321 lies within the Clean Water Act and refers to among other things hazardous substance liability 33 USC § 1321(b)(2)(A) states that the EPA shall develop as may be appropriate regulations designating as hazardous substances, other than oil as defined in this section such elements and compounds which when discharged in any quantity into" the navigable waters of the United States present an imminent and substantial danger to the public health or welfare, including, but not limited to fish shellfish, wildlife, shorelines and beaches."

42 USC § 9601(14)(B) "[A]ny element, compound, mixture, solution or substance designated pursuant to section 9602 of this title " Section 9602 gives EPA the authority to designate as a hazardous substance such elements, compounds, mixtures, solutions and substances which, when released into the environment may present substantial danger to the public health or welfare or the environment. "

42 USC § 9601(14)(C) "[A]ny hazardous waste having the characteristics identified under or listed pursuant to section 3001 of the Solid Waste Disposal Act [42 USCA § 6921] (but not including any waste the regulation of which under the Solid Waste Disposal Act [42 USCA § 6901 *et seq*] has been suspended by Act of Congress) " The Solid Waste Disposal Act of 1980 amended the Resource Conservation and Recovery Act (RCRA) 42 USCA § 6921 of RCRA provides authority to the EPA to develop criteria for identifying characteristics of hazardous waste and for listing particular hazardous wastes within the meaning of 42 USCA § 6903(5) of RCRA RCRA, § 6903(5) defines hazardous waste to mean

'a solid waste, or combination of solid wastes, which because of its quantity, concentration or physical, chemical, or infectious characteristics may—

(A) cause, or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness or

(B) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed."

For the identification and listing of hazardous wastes under RCRA, see 40 CFR §§ 261 1 *et seq*

42 USC § 9601(14)(D) [A]ny toxic pollutant listed under Section 1317(a) of Title 33 " Section 1317(a) of Title 33 refers to toxic and pretreatment effluent standards under the Clean Water Act. The EPA is charged in this section with publishing and revising from time to time a list of toxic pollutants, taking ' into account toxicity of the pollutant, its persistence, degradability, the usual or potential presence of the affected organisms in any waters, the importance of the affected organisms, and the nature and extent of the effect of the toxic pollutant on such organisms " Each toxic pollutant listed according to this section shall be subject to effluent limitations. For toxic pollutant effluent standards, see 40 CFR §§ 129 1 *et seq*

42 USC § 9601(14)(E) ' [A]ny hazardous air pollutant listed under Section 112 of the Clean Air Act [42 USCA § 7412] " Section 7412 of Title 42 deals with national emission standards for hazardous air pollutants The EPA is charged here with publishing and revising from time to time 'a list which includes each hazardous air pollutant for which [it] intends to establish an emission standard under this section " The term "hazardous air pollutant" means an air pollutant that in EPA's judgment causes, or contributes to air pollution which may reasonably be anticipated to result in an increase in mortality or an increase in serious irreversible or incapacitating reversible illness." For emission standards for hazardous pollutants, see 40 CFR § 61 01 *et seq*

42 USC § 9601(14)(F) [A]ny imminently hazardous chemical substance or mixture with respect to which the [EPA] has taken action pursuant to Section 2606 of Title 15 " Section 2606 of Title 15 deals with imminent hazards under the Toxic Substances Control Act (TSCA) The EPA is authorized under 15 USC § 2606 to seize an imminently hazardous chemical substance or mixture or seek other relief such as requiring notice to users of the chemical substance or public notice of the risk

[15] EPA *Policy Towards Owners of Residential Property at Superfund Sites* OSWER Directive No 9834 6 July 3 1991

1004

associated with the substance or mixture The term im minently hazardous chemical substance or mixture means a chemical substance or mixture which presents an imminent and unreasonable risk of serious or widespread injury to health or the environment

X1 4 2 After Subsections A–F, outlined above the Superfund definition of "hazardous substance" in § 9601(14) then goes on to state

The term does not include petroleum including crude oil or any fraction thereof which is not otherwise specifically listed or designated as a hazardous substance under Subparagraphs (A) through (F) of this paragraph, and the term does not include natural gas, natural gas liquids, liquefied natural gas, or synthetic gas usable for fuel (or mixtures of natural gas and such synthetic gas) "

X1 4 3 The EPA has collected a list of "those substances in the statutes referred to in Section 101(14) of the Act [42 USC § 9601(14)]" 40 CFR § 302 1 (1989) ("List of Hazardous Substances And Reportable Quantities," 40 CFR Part 302) This list changes with notices in the Federal Register Also, any time a new hazardous waste is listed, the waste automatically becomes a hazardous substance

X1 5 *Petroleum Products*

X1 5 1 Under the petroleum exclusion of CERCLA (42 USC § 9601(14)), petroleum and crude oil have been explicitly excluded from the definition of hazardous substances under CERCLA Nevertheless, petroleum products are included within the scope of both practices because they are of concern in many commercial real estate transactions and current custom and usage is to include an inquiry into the presence of petroleum products in an environmental site assessment Inclusion of petroleum products within the scope of the practices is not based upon the applicability, if any, of CERCLA to petroleum products

X1 5 2 One reason to include petroleum products within the scope of the practices is because to do so reflects custom and usage when environmental assessments are conducted in connection with commercial real estate transactions, they customarily include an assessment of the presence or likely presence of petroleum products under conditions that may lead to contamination For example, environmental assessments ordinarily seek to assess whether there may be underground or above-ground storage tanks that may be leaking, whether those tanks contain petroleum products or some other product

X1 5 3 In addition, although CERCLA may exclude petroleum products, other laws require cleanup of releases or spills of petroleum products For example, petroleum products sometimes (for example, when they cannot be reclaimed from soil) become hazardous wastes subject to RCRA Subtitle C (42 USC § 6921 *et seq*), must be cleaned up if released from underground storage tanks pursuant to RCRA Subtitle I (42 USC § 6991 *et seq*), must be cleaned up pursuant to the Oil Pollution Act of 1990 (33 USC § 1321 *et seq*), and must be cleaned up if released into the navigable waters of the United States pursuant to the Clean Water Act (33 USC § 1251 *et seq*)

X1 5 4 Moreover, case law and EPA interpretations of the petroleum exclusion require an analysis of the facts of each case to determine whether a particular petroleum product is included in CERCLA's petroleum exclusion The exclusion has been broadly interpreted to exclude gasoline and leaded gasoline from CERCLA's definition of hazardous substances regardless of the fact that gasoline and leaded gasoline contain certain indigenous components and additives which have themselves been designated as hazardous pursuant to CERCLA See *Wilshire Westwood Associates versus Atlantic Richfield Corporation*, 881 F 2d 801 (9th Cir 1989) The interpretation was narrowed when a judicial distinction was made between petroleum fractions produced by distillation processes and waste products resulting from contaminated tank scale See *United States versus Western Processing Co*, 761 F Supp 713 (W D Wash 1991) Another decision narrowly interpreted CERCLA's petroleum exclusion to be inapplicable to oil-related wastes containing hazardous substances because the primary purpose of the exclusion is to remove "spills or other releases strictly of oil" from the scope of CERCLA response and liability (not releases of hazardous substances mixed with oil) See *City of New York versus Exxon Corporation*, 744 F Supp 474 (S D N Y 1990) For additional discussion, see EPA Memorandum entitled, "The Petroleum Exclusion Under the Comprehensive Environmental Response Compensation and Liability Act," issued by EPA's General Counsel, Francis S Blake, July 31, 1987

X1 6 *Exclusion of Certain Hazards From Superfund*

X1 6 1 The information that follows is provided to explain why these potential environmental hazards are not covered by Superfund's appropriate inquiry responsibilities.

X1 6 2 As a preliminary matter, it should be noted that an environmental site assessment that does not address substances excluded from CERCLA (whether those substances are excluded because they are petroleum products or by virtue of other characteristics) but that otherwise constitutes "all appropriate inquiry into the previous ownership and uses of the property consistent with good commercial or customary practice" should nevertheless entitle the user to the innocent purchaser defense, assuming that other requirements of the defense are met.

X1 6 3 *Radon*

X1 6 3 1 A case discussing Superfund and radon is *Amoco Oil Company versus Borden Inc*, 889 F 2d 664 (5th Cir 1989) This case dealt with a private cost recovery action by the buyer of a site against the seller for response costs relating to radiation from phosphogypsum wastes left on the site Radon emanated from these radioactive wastes The case points out that the "EPA has designated radionuclides as hazardous substances under § 9602(a) of CERCLA Additionally, the EPA under § 112 of the Clean Air Act list radionuclides as a hazardous air pollutant Radon and its daughter products are considered radionuclides, which are defined as 'any nuclide that emits radiation' " Therefore, radon is a CERCLA hazardous substance Also, when discussing what constitutes a release of a hazardous substance under the statute, the statute is plain that there is no quantitative requirement and that a release, broadly defined at 42 USC § 9601(22), of *any* amount constitutes a CERCLA release

X1 6 3 2 Liability under Superfund depends on several factors, as noted in X1 1 Only one of four factors is the release or threatened release of a hazardous substance The other three factors are (*1*) the site is a facility, (*2*) the

1005

defendant falls within at least one of four classes of potentially responsible parties (PRPs), and (*3*) the release or threatened release *caused* the plaintiff (that can be the government or another private party) to incur response costs Further, response costs must not be inconsistent with the National Contingency Plan (NCP), *and must not be limited by § 9604(a)(3)* And, of course, there is no need to raise the innocent purchaser defense and its appropriate inquiry requirements unless the elements of liability will be met

X1 6 3 3 Where radon from any source occurs in a building, three of the liability elements under CERCLA are met There is a release of a hazardous substance, the building is a facility, and we can assume the defendant is a PRP However, under 42 USC § 9604(a)(3)(A), "[r]emedial actions taken in response to hazardous substances as they occur naturally are specifically excluded from the NCP and are therefore not recoverable" *Amoco Oil Company versus Borden Inc*, 889 F 2d at 570 The statute is plain [16]

> (3) Limitations on response
>
> The President shall not provide for a removal or remedial action under this section in response to a release or threat of release—
>
> (A) *of a naturally occurring substance in its unaltered form or altered solely through naturally occurring processes or phenomena from a location where it is naturally found*
>
> (B) from products which are part of the structure of and result in exposure within, residential buildings or business or community structures,[17] or
>
> (C) into public or private drinking water supplies due to deterioration of the system through ordinary use [18]
>
> (4) Exception to limitations
>
> Notwithstanding paragraph (3) of this subsection, to the extent authorized by this section the President may respond to any release or threat of release if in the President's discretion, it constitutes a public health or environmental emergency and no other person with the authority and capability to respond to the emergency will do so in a timely manner"

X1 6 3 4 Therefore, no liability under CERCLA attaches for naturally occurring radon If a party to a real estate transaction wants to look for radon within a building, no amount of radon investigation will have any bearing on one's innocent purchaser defense under Superfund. Investigation of naturally occurring radon would be included, if at all, in the portion of the practice that deals with non-scope issues

X1 6 4 *Asbestos*

X1 6 4 1 The analysis of asbestos is similar to that involving radon Before considering appropriate inquiry responsibilities, the four elements of CERCLA liability must be satisfied Once again, as with radon, they are not met.

X1 6 4 2 Section 9604(a)(3)(B) of CERCLA prohibits response actions involving a release or threat of release "from products which are part of the structure of, and result in exposure within, residential buildings or business or community structures" There are a number of cases dealing with asbestos that interpret this statutory language One such case is *First United Methodist Church of Hyattsville versus United States Gypsum Co* that cites to other relevant cases

X1 6 4 3 In *First United* the church brought a private cost recovery action against the manufacturer of asbestos-containing acoustical plaster In holding that the action was barred by a state statute of repose (a certain time allowed by statute for bringing litigation) and that CERCLA did not preempt the state statute of repose, the court stated that § 9604(a)(3)(B) of CERCLA "represents much more than a procedural limitation on the President's authority; it is a substantive limitation of the breadth of CERCLA itself"[19] Therefore, the limitations of § 9604(a)(3) apply to private parties as well

X1 6 4 4 Citing to the legislative history, the *First United* court concluded, "[i]n view of this clear expression of Congressional intent, we will[l] not expand CERCLA to encompass asbestos-removal actions" The court further explained [20]

> "In closing, we note that this interpretation of CERCLA fully comports with the most fundamental guide to statutory construction—common sense To extend CERCLA's strict liability scheme to all past and present owners of buildings containing asbestos as well as to all persons who manufactured, transported, and installed asbestos products into buildings, would be to shift literally billions of dollars of removal cost liability based on nothing more than an improvident interpretation of a statute that Congress never intended to apply in this context [FN12] Certainly, if Congress had intended for CERCLA to address the monumental asbestos problem, it would have said so more directly when it passed SARA
>
> *FN12*—It is for this reason, that Congress simply did not intend for CERCLA to remedy the asbestos-removal problem, that we decline to follow the reasoning of *Prudential Knox and Covalt* in rejecting First United's preemption argument Instead of recognizing the fact that CERCLA is out of context in this situation, these courts rejected similar attempts to invoke the statute by construing CERCLA's key terms in a way to exclude asbestos-removal actions *Covalt*, 860 F 2d [1434] at 1438-39 (defining "environment" to exclude the interior of a workplace), *Knox*, 690 F Supp at 756-57 (defining "release" in terms of "spills" or "disposal"), *Prudential*, [711 F Supp 1244] at 1254-55 (defining "disposal" to exclude the sale of a product for consumer use) We find this analysis unsatisfactory because it runs the risk of unnecessarily restricting the scope of CERCLA merely to dispose of claims that the statute was never intended to encompass in the first place It is far better to simply acknowledge the inapplicability of CERCLA to asbestos-removal claims than to restrict its operative terms"

X1 6 4 5 Since asbestos that is a part of the structure of, and results in exposure within, residential buildings or business or community structures is excluded from

[16] 42 USC § 9604(a)(3) and (4) (*emphasis added*)

[17] This provision has implications for asbestos and lead based paint. See X1 6 4 and X1 6 5

[18] This provision has implications for lead from lead pipes and solder See X1 6 5

[19] One such case is *First United Methodist Church of Hyattsville versus United States Gypsum Co* 882 F.2d 862 (4th Cir 1989) that cites to other relevant cases.

[20] The same at 869 See also *3550 Stevens Creek Associates versus Barclays Bank of California*, 915 F 2d 1355 (9th Cir 1990)

1006

CERCLA liability, it should not be investigated pursuant to a party's innocent purchaser appropriate inquiry requirements Like naturally occurring radon, investigation of asbestos-containing materials that are part of the structure of buildings should be included, if at all, in the portion of this practice that deals with non-scope issues Note, however if asbestos is disposed of on a site and, therefore, is no longer part of the structure of a building, the cleanup of the disposed asbestos is subject to Superfund response actions Likewise, if a building is sold with the knowledge that it will be demolished, one court ruled that the sale constitutes a disposal falling under CERCLA s liability provisions [21]

X1 6 5 *Lead in Drinking Water and Lead-Based Paint*—These hazards can be evaluated in terms of the exclusions of 42 USC § 9604(a)(3)(B) and (C), in an analysis similar to the analysis applied above to radon and asbestos While there is no reported case law on these environmental issues as they relate to Superfund, the statutory language seems clear that these environmental hazards are not encompassed by Superfund's appropriate inquiry responsibilities Note, however, like asbestos, where there is a disposal of these substances on the site or in a facility, CERCLA liability may arise

[21] *CP Holdings Inc versus Goldberg Zoino & Associates Inc* 769 F Supp 432 (D N H 1991)

X2 RECOMMENDED TABLE OF CONTENTS AND REPORT FORMAT

X2 1 Summary
X2 2 Introduction
X2 2 1 Purpose
X2 2 2 Special Terms and Conditions
X2 2 3 Limitations and Exceptions of Assessment
X2 2 4 Limiting Conditions and Methodology Used
X2.3 Site Description
X2 3 1 Location and Legal Description
X2 3 2 Site and Vicinity Characteristics
X2 3 3 Descriptions of Structures, Roads, Other Improvements on the Site (including heating/cooling system, sewage disposal, source of potable water)
X2 3 4 Information (if any) Reported by User Regarding Environmental Liens or Specialized Knowledge or Experience (pursuant to Section 5)
X2 3 5 Current Uses of the Property
X2 3 6 Past Uses of the Property (to the extent identified)
X2 3 7 Current and Past Uses of Adjoining Properties (to the extent identified)
X2 3 8 Site Rendering, Map, or Site Plan
X2 4 Records Review
X2 4 1 Standard Environmental Record Sources, Federal and State
X2 4 2 Physical Setting Source(s)
X2 4 3 Historical Use Information
X2 4 4 Additional Record Sources (if any)
X2.5 Information from Site Reconnaissance and Interviews
X2 5 1 Hazardous Substances in Connection with Identified Uses (including storage, handling, disposal)
X2 5 2 Hazardous Substance Containers and Unidentified Substance Containers (including storage, handling, disposal)
X2 5 3 Storage Tanks (including contents and assessment of leakage or potential for leakage)
X2 5 4 Indications of PCBs (including how contained and assessment of leakage or potential for leakage)
X2 5 5 Indications of Solid Waste Disposal
X2 5 6 Physical Setting Analysis, if migrating Hazardous Substances are an issue
X2 5 7 Any Other Conditions of Concern
X2 5 8 Site Plan (if available)
X2 6 Findings and Conclusions
X2 7 Signatures of Environmental Professionals
X2.8 Qualifications of Environmental Professionals Participating in Phase I Environmental Site Assessment
X2.9 Optional Appendices (for example)
X2 9 1 Other Maps, Figures, and Photographs
X2 9 2 Ownership/Historical Documentation
X2 9 3 Regulatory Documentation
X2 9 4 Interview Documentation
X2 9 5 Contract between User and Environmental Professional

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1007

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Standard Practice for Environmental Site Assessments: Transaction Screen Process[1]

This standard is issued under the fixed designation E 1528 the number immediately following the designation indicates the year of original adoption or in the case of revision the year of last revision A number in parentheses indicates the year of last reapproval A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval

1 Scope

1 1 *Purpose*—The purpose of this practice, as well as Practice E 1527, is to define good commercial and customary practice in the United States of America for conducting an *environmental site assessment*[2] of a parcel of *commercial real estate* with respect to the range of contaminants within the scope of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) and *petroleum products* As such, this practice is intended to permit a user to satisfy one of the requirements to qualify for the *innocent landowner defense* to CERCLA liability that is, the practices that constitute "all appropriate inquiry into the previous ownership and uses of the property consistent with good commercial or customary practice" as defined in 42 USC § 9601(35)(B) (See Appendix X1 for an outline of CERCLA's liability and defense provisions)

1 1 1 *Recognized Environmental Conditions*—In defining a standard of good commercial and customary practice for conducting an *environmental site assessment* of a parcel of *property*, the goal of the processes established by this practice is to identify *recognized environmental conditions* The term *recognized environmental conditions* means the presence or likely presence of any *hazardous substances* or *petroleum products* on a *property* under conditions that indicate an existing release, a past release, or a material threat of a release of any *hazardous substances* or *petroleum products* into structures on the *property* or into the ground, groundwater, or surface water of the *property* The term includes *hazardous substances* or *petroleum products* even under conditions in compliance with laws The term is not intended to include *de minimis* conditions that generally do not present a material risk of harm to public health or the environment and that generally would not be the subject of an enforcement action if brought to the attention of appropriate governmental agencies

1 1 2 *Two Related Practices*—This practice is closely related to Practice E 1527, a *Phase I Environmental Site Assessment* Both are *environmental site assessments* for *commercial real estate* See 4 3

1 1 3 *Petroleum Products*—*Petroleum products* are included within the scope of both practices because they are of concern on many parcels of *commercial real estate* and current custom and usage is to include an inquiry into the presence of *petroleum products* when doing an *environmental site assessment* of *commercial real estate* Inclusion of *petroleum products* within the scope of this practice is not based upon the applicability, if any, of CERCLA to *petroleum products*

1 1 4 *CERCLA Requirements Other Than Appropriate Inquiry*—This practice does not address whether requirements in addition to *appropriate inquiry* have been met in order to qualify for CERCLA's *innocent landowner defense* (for example, the duties specified in 42 USC § 9607(b)(3)(a) and (b) and cited in Appendix X1)

1 1 5 *Other Federal State and Local Environmental Laws*—This practice does not address requirements of any state or local laws or of any federal laws other than the appropriate inquiry provisions of CERCLA's *innocent landowner defense* Users are cautioned that federal, state, and local laws may impose environmental assessment obligations that are beyond the scope of this practice *Users* should also be aware that there are likely to be other legal obligations with regard to *hazardous substances* or *petroleum products* discovered on *property* that are not addressed in this practice and may pose risks of civil and/or criminal sanctions for non-compliance

1 2 *Objectives*—Objectives guiding the development of this practice and Practice E 1527 are (1) to synthesize and put in writing good commercial and customary practice for *environmental site assessments* for *commercial real estate*, (2) to facilitate high- quality, standardized *environmental site assessments*, (3) to ensure that the standard of *appropriate inquiry* is practical and reasonable, and (4) to clarify an industry standard for *appropriate inquiry* in an effort to guide legal interpretation of CERCLA's *innocent landowner defense*

1 3 *Considerations Beyond the Scope*—The use of this practice is strictly limited to the scope set forth in this section Section 11 of this practice identifies, for informational purposes, certain environmental conditions (not an all-inclusive list) that may exist on a *property* that are beyond the scope of this practice but may warrant consideration by parties to a *commercial real estate* transaction

1 4 *Organization of This Practice*—This practice has several parts and two appendixes Section 1 is the Scope Section 2 refers to other ASTM standards in the Referenced Documents Section 3, Terminology, has definitions of terms not unique to this practice, descriptions of terms unique to this practice and acronyms Section 4 is Significance and Use of this practice Section 5 is the Introduction to the Transaction Screen Questionnaire Section 6 sets forth the Transaction Screen Questionnaire itself Sections 7 through 10 contain

[1] This practice is under the jurisdiction of ASTM Committee E 50 on Environmental Assessment and is the direct responsibility of Subcommittee E50 02 on Commercial Real Estate Transactions

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[2] All definitions, descriptions of terms, and acronyms are defined in Section 3 of Practice E 1527 Whenever terms defined in 3 2 or described in 3 3 are used in this practice, they are in *italics*

1008

the Guide to the Transaction Screen Questionnaire and its various parts Section 11 provides additional information regarding non-scope considerations (see 1 3) The appendixes are included for information and are not part of the procedures prescribed in either Practice E 1527 or this practice Appendix X1 and Practice E 1527 explain the liability and defense provisions of CERCLA that will assist the user in understanding the user's responsibilities under CERCLA, it also contains other important information regarding CERCLA and this practice Appendix X2 provides information referred to in the guide to the transaction screen questionnaire

1 5 *This standard does not purport to address all of the safety problems if any associated with its use It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use*

2 Referenced Document

2 1 *ASTM Standard*

E 1527 Practice for Environmental Site Assessment Phase I Environmental Sites Assessment Process[3]

3 Terminology

3 1 *Scope*—This section provides definitions, descriptions of terms, and a list of acronyms for many of the words used in this practice and Practice E 1527 The terms are an integral part of both practices and are critical to an understanding of the written practices and their use

3 2 *Definitions*

3 2 1 *asbestos*—six naturally occurring fibrous minerals found in certain types of rock formations Of the six, the minerals chrysotile, amosite, and crocidolite have been most commonly used in building products When mined and processed, asbestos is typically separated into very thin fibers Because asbestos is strong, incombustible, and corrosion-resistant, asbestos was used in many commercial products beginning early in this century and peaking in the period from World War II into the 1970s When inhaled in sufficient quantities, asbestos fibers can cause serious health problems [4] (See also, for an additional definition of asbestos, ASTM STP 834 [5])

3 2 2 *asbestos-containing material (ACM)*—any material or product that contains more than one percent asbestos [4]

3 2 3 *Comprehensive Environmental Response Compensation and Liability Information System (CERCLIS)*—the list of sites compiled by EPA that EPA has investigated or is currently investigating for potential hazardous substance contamination for possible inclusion on the National Priorities list

3 2 4 *construction debris*—concrete, brick, asphalt, and other such building materials discarded in the construction of a building or other improvement to property

3 2 5 *contaminated public wells*—public wells used for drinking water that have been designated by a government entity as contaminated by toxic substances, (e g , chlorinated solvents), or as having water unsafe to drink without treatment

3 2 6 *demolition debris*—concrete, brick, asphalt, and other such building materials discarded in the demolition of a building or other improvement to property

3 2 7 *drum*—a container (typically, but not necessarily, holding 55 gal (208 L) of liquid) that may be used to store *hazardous substances* or *petroleum products*

3 2 8 *dry wells*—underground areas where soil has been removed and replaced with pea gravel, coarse sand, or large rocks Dry wells are used for drainage, to control storm runoff, for the collection of spilled liquids (intentional and non-intentional) and wastewater disposal (often illegal)

3 2 9 *dwelling*—structure or portion thereof used for residential habitation

3 2 10 *environmental lien*—a charge, security, or encumbrance upon title to a *property* to secure the payment of a cost, damage, debt, obligation, or duty arising out of response actions, cleanup, or other remediation of *hazardous substances* or *petroleum products* upon a *property*, including (but not limited to) liens imposed pursuant to CERCLA 42 USC § 9607(1) and similar state or local laws

3 2 11 *ERNS list*—EPA's Emergency Response Notification System list of reported CERCLA hazardous substance releases or spills in quantities greater than the reportable quantity, as maintained at the National Response Center Notification requirements for such releases or spills are codified in 40 CFR Parts 302 and 355

3 2 12 *Federal Register (FR)*—publication of the United States government published daily (except for federal holidays and weekends) containing all proposed and final regulations and some other activities of the federal government When regulations become final, they are included in the Code of Federal Regulations (CFR), as well as published in the Federal Register

3 2 13 *fire insurance maps*—maps produced for private fire insurance map companies that indicate uses of properties at specified dates and that encompass the property These maps are often available at local libraries, historical societies, private resellers, or from the map companies who produced them See Question 23 of the transaction screen process in this practice and 7 3 4 2 of Practice E 1527

3 2 14 *hazardous substance*—a substance defined as a hazardous substance pursuant to CERCLA 42 USC § 9601(14), as interpreted by EPA regulations and the courts "(A) any substance designated pursuant to Section 1321(b)(2)(A) of Title 33, (B) any element, compound, mixture, solution, or substance designated pursuant to Section 9602 of this title, (C) any hazardous waste having the characteristics identified under or listed pursuant to Section 3001 of the Solid Waste Disposal Act (42 USC § 6921) (but not including any waste the regulation of which under the Solid Waste Disposal Act (42 USC § 6901 *et seq*) has been suspended by Act of Congress), (D) any toxic pollutant listed under Section 1317(a) of Title 33, (E) any hazardous air pollutant listed under Section 112 of the Clean Air Act (42 USC § 7412), and (F) any imminently hazardous chemical substance or mixture with respect to which the administrator (of EPA) has taken action pursuant to Section 2606 of Title 15 The term does not include petroleum, including crude oil

[3] *Annual Book of ASTM Standards* Vol 11 04

[4] See EPA *Managing Asbestos in Place A Building Owner s Guide to Operations and Maintenance Programs for Asbestos Containing Materials* EPA, July 1990 p 2

[5] See also for an additional definition of asbestos, *ASTM STP 834* ASTM

1009

or any fraction thereof which is not otherwise specifically listed or designated as a hazardous substance under Subparagraphs (A) through (F) of this paragraph, and the term does not include natural gas natural gas liquids, liquefied natural gas, or synthetic gas usable for fuel (or mixtures of natural gas and such synthetic gas)," (See Appendix X1)

3 2 15 *hazardous waste*—any hazardous waste having the characteristics identified under or listed pursuant to Section 3001 of the Solid Waste Disposal Act (42 USC § 6921) (but not including any waste the regulation of which under the Solid Waste Disposal Act (42 USC § 6901 *et seq*) has been suspended by Act of Congress) The Solid Waste Disposal Act of 1980 amended RCRA The RCRA defines a hazardous waste, in 42 USC § 6903, as

"a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may—(A) cause, or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness or (B) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed "

3 2 16 *landfill*—a place, location, tract of land, area, or premises used for the disposal of solid wastes as defined by state solid waste regulations The term is synonymous with the term *solid waste disposal site* and is also known as a garbage dump, trash dump, or similar term

3 2 17 *local street directories*—directories published by private (or sometimes government) sources that show ownership, occupancy, use of sites and/or by reference to street addresses Often local street directories are available at libraries of local governments, colleges or universities, or historical societies See 7 3 4 6 of the Records Review Section of Practice E 1527

3 2 18 *material safety data sheet (MSDS)*—written or printed material concerning a *hazardous substance* which is prepared by chemical manufacturers, importers, and employers for hazardous chemicals pursuant to OSHA's Hazard Communication Standard, 29 CFR 1910 1200(g)

3 2 19 *National Contingency Plan (NCP)*—the National Oil and Hazardous Substances Pollution Contingency Plan, found at 40 CFR § 300, that is the EPA's blueprint on how hazardous substances are to be cleaned up pursuant to CERCLA

3 2 20 *National Priorities List (NPL)*—list compiled by EPA pursuant to CERCLA 42 USC § 9605(a)(8)(B) of properties with the highest priority for cleanup pursuant to EPA's hazard ranking system See 40 CFR Part 300

3 2 21 *occupants*—those tenants, subtenants, or other persons or entities using the *property* or a portion of the *property*

3 2 22 *owner*—generally the fee owner of record of the *property*

3 2 23 *petroleum exclusion*—the exclusion from CERCLA liability provided in 42 USC § 9601(14), as interpreted by the courts and EPA "The term (hazardous substance) does not include petroleum, including crude oil or any fraction thereof which is not otherwise specifically listed or designated as a hazardous substance under Subparagraphs (A) through (F) of this paragraph, and the term does not include natural gas, natural gas liquids, liquefied natural gas, or synthetic gas usable for fuel (or mixtures of natural gas and such synthetic gas) "

3 2 24 *petroleum products*—those substances included within the meaning of the terms within the *petroleum exclusion* to CERCLA, 42 USC § 9601(14), as interpreted by the courts and EPA, that is petroleum, including crude oil or any fraction thereof that is not otherwise specifically listed or designated as a *hazardous substance* under Subparagraphs (A) through (F) of 42 USC § 9601(14), natural gas, natural gas liquids, liquefied natural gas, and synthetic gas usable for fuel (or mixtures of natural gas and such synthetic gas) (The word fraction refers to certain distillates of crude oil, including gasoline, kerosene, diesel oil, jet fuels, and fuel oil, pursuant to *Standard Definitions of Petroleum Statistics* [6]

3 2 25 *Phase I Environmental Site Assessment*—the process described in Practice E 1527

3 2 26 *pits ponds or lagoons*—man-made or natural depressions in a ground surface that are likely to hold liquids or sludge containing *hazardous substances* or *petroleum products* The likelihood of such liquids or sludge being present is determined by evidence of factors associated with the pit, pond, or lagoon, including, but not limited to, discolored water, distressed vegetation, or the presence of an obvious wastewater discharge

3 2 27 *property*—the real property that is the subject of the environmental site assessment described in this practice Real property includes buildings and other fixtures and improvements located on the property and affixed to the land

3 2 28 *property tax files*—the files kept for property tax purposes by the local jurisdiction where the property is located and includes records of past ownership, appraisals, maps, sketches, photos, or other information that is reasonably ascertainable and pertaining to the property See 7 3 4 3 of the Records Review Section of Practice E 1527

3 2 29 *RCRA generators*—those persons or entities which generate *hazardous wastes*, as defined and regulated by RCRA

3 2 30 *RCRA generators list*—list kept by EPA of those persons or entities that generate *hazardous wastes* as defined and regulated by RCRA

3 2 31 *RCRA TSD facilities*—those facilities on which treatment, storage, and/or disposal of *hazardous wastes* takes place, as defined and regulated by RCRA

3 2 32 *RCRA TSD facilities list*—list kept by EPA of those facilities on which treatment, storage, and/or disposal of *hazardous wastes* takes place, as defined and regulated by RCRA

3 2 33 *recorded land title records*—records of fee ownership, leases land contracts, easements, liens and other encumbrances on or of the *property* recorded in the place where land title records are, by law or custom, recorded for the local jurisdiction in which the property is located (Often such records are kept by a municipal or county recorder or clerk) Such records may be obtained from title companies or directly from the local government agency Information

[6] *Standard Definitions of Petroleum Statistics* American Petroleum Institute Fourth Edition 1988

1010

about the title to the *property* that is recorded in a U S district court or any place other than where land title records are, by law or custom, recorded for the local jurisdiction in which the property is located, are not considered part of recorded land title records See 7 3 4 4 of the Records Review Section of Practice E 1527

3 2 34 *records of emergency release notifications* (SARA §304)—Section 304 of EPCRA or Title III of SARA requires operators of facilities to notify their local emergency planning committee (as defined in EPCRA) and State Emergency Response Commission (as defined in EPCRA) of any release beyond the facility's boundary of any reportable quantity of any extremely *hazardous substance* Often the local fire department is the local emergency planning committee Records of such notifications are "Records of Emergency Release Notifications" (SARA §304)

3 2 35 *report*—the written record of a transaction screen process as required by Practice E 1527 or the written report prepared by the environmental professional and constituting part of a *Phase I Environmental Site Assessment*, as required by Practice E 1527

3 2 36 *solid waste disposal site*—a place, location, tract of land, area, or premises used for the landfill disposal of solid wastes as defined by state solid waste regulations The term is synonymous with the term *landfill* and is also known as a garbage dump, trash dump, or similar term

3 2 37 *solvent*—a chemical compound that is capable of dissolving another substance and is itself a *hazardous substance* used in a number of manufacturing/industrial processes including, but not limited to, the manufacture of paints and coatings for industrial and household purposes, equipment clean-up, and surface degreasing in metal fabricating industries

3 2 38 *state registered USTs*—state lists of underground storage tanks required to be registered under Subtitle I, Section 9002 of RCRA

3 2 39 *sump*—a pit, cistern, cesspool, or similar receptacle where liquids drain, collect, or are stored

3 2 40 *TSD Facility*—treatment, storage, or disposal facility (see definition of *RCRA TSD facilities*)

3 2 41 *underground storage tank (UST)*—any tank, including underground piping connected to the tank, that is or has been used to contain *hazardous substances* or *petroleum products* and the volume of which is 10 % or more beneath the surface of the ground

3 2 42 *USGS 7 5 Minute Topographic Map*—the map (if any) available from or produced by the United States Geological Survey, entitled "USGS 7 5 Minute Topographic Map," and showing the *property* See 7 3 4 5 of Practice E 1527

3 2 43 *wastewater*—water that is or has been used in an industrial or manufacturing process, conveys or has conveyed sewage, or is directly related to manufacturing, processing, or raw materials storage areas at an industrial plant Wastewater does not include water originating on or passing through or adjacent to a site, such as stormwater flows, that has not been used in industrial or manufacturing processes, has not been combined with sewage, or is not directly related to manufacturing, processing, or raw materials storage areas at an industrial plant.

3 2 44 *zoning/land use records*—those records of the local government in which the *property* is located indicating the uses permitted by the local government in particular zones within its jurisdiction The records may consist of maps and/or written records They are often located in the planning department of a municipality or county See 7 3 4 8 of the Records Review Section of Practice E 1527

3 3 *Descriptions of Terms Specific to This Standard*

3 3 1 *actual knowledge*—the knowledge actually possessed by an individual who is a real person, rather than an entity Actual knowledge is to be distinguished from constructive knowledge, that is, knowledge imputed to an individual or entity (See 5 5 3)

3 3 2 *adjoining properties*—any real property or properties the border of which is contiguous or partially contiguous with that of the property, or that would be contiguous or partially contiguous with that of the property but for a street, road, or other public thoroughfare separating them

3 3 3 *aerial photographs*—photographs taken from an airplane or helicopter of areas encompassing the property Aerial photographs are often available from government agencies or private collections unique to a local area See 7 3 4 1 of Practice E 1527

3 3 4 *appropriate inquiry*—that inquiry constituting "all appropriate inquiry into the previous ownership and uses of the property consistent with good commercial or customary practice" as defined in CERCLA, 42 USC § 9601(35)(B), that will give a party to a *commercial real estate* transaction the *innocent landowner defense* to CERCLA liability (42 USC § 9601(A) and (B) and 9607(b)(3)), assuming compliance with other elements of the defense See Appendix X1 and Practice E 1527

3 3 5 *approximate minimum search distance*—the area for which records must be obtained and reviewed pursuant to the Records Review Section of Practice E 1527, subject to the limitations provided in that section The term *approximate minimum search distance* may include areas outside the *property* and shall be measured from the nearest *property* boundary The term *approximate minimum search distance* is used in lieu of radius to include irregularly shaped properties

3 3 6 *building department records*—those records of the local government in which the property is located indicating permission of the local government to construct, alter, or demolish improvements on the property Often building department records are located in the building department of a municipality or county See 7 3 4 7 of Practice E 1527

3 3 7 *commercial real estate*—any real property except a dwelling or property with no more than four dwelling units exclusively for residential use (except that a dwelling or property with no more than four dwelling units exclusively for residential use is included in the term commercial real estate when it has a commercial function, as in the building of such dwellings for profit) The term *commercial real estate* includes but is not limited to undeveloped real property and real property used for industrial, retail, office, agricultural, other commercial, medical, or educational purposes, *property* used for residential purposes that has more than four residential dwelling units, and *property* with no more than four dwelling units for residential use when it has a commercial function, as in the building of such dwellings for profit

3 3 8 *commercial real estate transaction*—a transfer of

title to or possession of real property or receipt of a security interest in real property, except that it does not include transfer of title to or possession of real property or the receipt of a security interest in real property with respect to an individual dwelling or building containing fewer than five dwelling units, nor does it include the purchase of a lot or lots to construct a dwelling for occupancy by a purchaser, but a commercial real estate transaction does include real property purchased or leased by persons or entities in the business of building or developing dwelling units

3 3 9 *due diligence*—the process of inquiring into the environmental characteristics of a parcel of *commercial real estate* or other conditions, usually in connection with a commercial real estate transaction The degree and kind of due diligence vary for different properties and differing purposes See Appendix X1 and Practice E 1527

3 3 10 *environmental audit*—the investigative process to determine if the operations of an existing facility are in compliance with applicable environmental laws and regulations The term *environmental audit* should not be used to describe this practice or Practice E 1527 although an environmental audit may include an *environmental site assessment* or, if prior audits are available, may be part of an environmental site assessment See Appendix X1 and Practice E 1527

3 3 11 *environmental professional*—a person possessing sufficient training and experience necessary to conduct a *site reconnaissance interviews*, and other activities in accordance with Practice E 1527, and from the information generated by such activities, having the ability to develop conclusions regarding *recognized environmental conditions* in connection with the *property* in question An individual's status as an environmental professional may be limited to the type of assessment to be performed or to specific segments of the assessment for which the professional is responsible The person may be an independent contractor or an employee of the *user*

3 3 12 *environmental site assessment (ESA)*—the process by which a person or entity seeks to determine if a particular parcel of real *property* (including improvements) is subject to *recognized environmental conditions* At the option of the user, an environmental site assessment may include more inquiry than that constituting *appropriate inquiry* or, if the user is not concerned about qualifying for the *innocent landowner defense*, less inquiry than that constituting *appropriate inquiry* See Appendix X1 and Practice E 1527 An environmental site assessment is both different from and less rigorous than an *environmental audit*

3 3 13 *fill dirt*—dirt, soil, sand, or other earth, that is obtained off-site, that is used to fill holes or depressions, create mounds, or otherwise artificially change the grade or elevation of real property It does not include material that is used in limited quantities for normal landscaping activities

3 3 14 *hazardous waste/contaminated sites*—sites on which a release has occurred, or is suspected to have occurred, of any *hazardous substance hazardous waste*, or *petroleum products*, and on which release or suspected release has been reported to a government entity

3 3 15 *innocent landowner defense*—that defense to CERCLA liability provided in 42 USC § 9601(35) and § 9607(b)(3) One of the requirements to qualify for this defense is that the party make "all appropriate inquiry into the previous ownership and uses of the property consistent with good commercial or customary practice " There are additional requirements to qualify for this defense See discussion in Appendix X1 and Practice E 1527

3 3 16 *interviews*—those portions of the *Phase I Environmental Site Assessment* in Practice E 1527 that are contained in Sections 9 and 10 thereof and addresses questions to be asked of *owners* and *occupants* of the *property* and questions to be asked of local government officials

3 3 17 *key site manager*—the *key site manager* is the person identified by the *owner* of a *property* as having good knowledge of the uses and physical characteristics of the property See 9 5 1 of Practice E 1527

3 3 18 *local government agencies*—those agencies of municipal or county government having jurisdiction over the *property* Municipal and county government agencies include but are not limited to cities, parishes, townships, and similar entities

3 3 19 *LUST sites*—state lists of leaking underground storage tank sites Section 9003 (h) of Subtitle I of RCRA gives EPA and states, under cooperative agreements with EPA, authority to clean up releases from UST systems or require owners and operators to do so

3 3 20 *major occupants*—those tenants, subtenants, or other persons or entities each of which uses at least 40 % of the leasable area of the *property* or any anchor tenant when the *property* is a shopping center

3 3 21 *obvious*—that which is plain or evident, a condition or fact which could not be ignored or overlooked by a reasonable observer while *visually or physically observing* the *property*

3 3 22 *other historical sources*—any source or sources other than those designated in 7 3 4 1 through 7 3 4 8 of Practice E 1527 that are credible to a reasonable person and that identify past uses or occupancies of the *property* The term includes records in the files, and/or personal knowledge of the *property owner* and/or *occupants* See 7 3 4 9 of the Records Review Section of Practice E 1527

3 3 23 *physical setting sources*—sources that provide information about the geologic, hydrogeologic, hydrologic, or topographic characteristics of a *property* See 7 2 3 of Practice E 1527

3 3 24 *practically reviewable*—information that is practically reviewable means that the information is provided by the source in a manner and in a form that, upon examination, yields information relevant to the *property* without the need for extraordinary analysis of irrelevant data. The form of the information shall be such that the user can review the records for a limited geographic area Records that cannot be feasibly retrieved by reference to the location of the *property* or a geographic area in which the *property* is located are not generally *practically reviewable* Most databases of public records are *practically reviewable* if they can be obtained from the source agency by the county, city, zip code, or other geographic area of the facilities listed in the record system Records that are sorted, filed, organized, or maintained by the source agency only chronologically are not generally practically reviewable For large databases with numerous facility records (such as RCRA hazardous waste generators and registered underground storage tanks), the records are

1012

not *practically reviewable* unless they can be obtained from the source agency in the smaller geographic area of zip codes Even when information is provided by zip code for some large databases, it is common for an unmanageable number of sites to be identified within a given zip code In these cases, it is not necessary to review the impact of all of the sites that are likely to be listed in any given zip code because that information would not be practically reviewable In other words, when so much data is generated that it cannot be feasibly reviewed for its impact on the property, it is not *practically reviewable*

3 3 25 *preparer*—the person preparing the *transaction screen questionnaire* pursuant to this practice, who may be either the *user* or the person to whom the *user* has delegated the preparation

3 3 26 *publicly available*—information that is publicly available means that the source of the information allows access to the information by anyone upon request

3 3 27 *reasonably ascertainable*—for purposes of both this practice and Practice E 1527 information that is *publicly available*, obtainable from its source within reasonable time and cost constraints, and *practically reviewable*

3 3 28 *recognized environmental conditions*—the presence or likely presence of any *hazardous substances* or *petroleum products* on a *property* under conditions that indicate an existing release, a past release, or a material threat of a release of any *hazardous substances* or *petroleum products* into structures on the *property* or into the ground, groundwater, or surface water of the *property* The term includes *hazardous substances* or *petroleum products* even under conditions in compliance with laws The term is not intended to include *de minimis* conditions that generally do not present a material risk of harm to public health or the environment and that generally would not be the subject of an enforcement action if brought to the attention of appropriate governmental agencies

3 3 29 *records review*—that part of the *Phase I Environmental Site Assessment* in Practice E 1527 that is contained in Section 7 thereof and addresses which records shall or may be reviewed

3 3 30 *site reconnaissance*—that part of the *Phase I Environmental Site Assessment* in Practice E 1527 that is contained in Section 8 thereof and addresses what should be done in connection with the *site visit* The site reconnaissance includes, but is not limited to, the *site visit* done in connection with such as *Phase I Environmental Site Assessment*

3 3 31 *site visit*—the visit to the property during which observations are made constituting the *site reconnaissance* section the *Phase I Environmental Site Assessment* in Practice E 1527 and the *site visit* requirement of the transaction screen process in this practice

3 3 32 *standard environmental record sources*—those records specified in 7 2 1 1 of the Records Review Section of the *Phase I Environmental Site Assessment* of Practice E 1527

3 3 33 *standard historical sources*—those sources of information about the history of uses of property specified in 7 3 4 of the Records Review Section of the *Phase I Environmental Site Assessment* of Practice E 1527

3 3 34 *standard physical setting source*—a current USGS 7 5 minute topographic map (if any) showing the area on which the property is located See 7 2 3 of Practice E 1527

3 3 35 *standard practice(s)*—the activities set forth in either this practice or Practice E 1527, or both, for the conduct of environmental site assessments

3 3 36 *standard sources*—sources of environmental, physical setting, or historical records specified in the Records Review Section (Section 7) of the *Phase I Environmental Site Assessment* of Practice E 1527

3 3 37 *transaction screen questionnaire*—the questionnaire provided in Section 6 of Practice E 1527

3 3 38 *transaction screen process*—the process described in Practice E 1527

3 3 39 *user*—the party seeking to use the transaction screen process of this practice or the *Phase I Environmental Site Assessment* of Practice E 1527 to perform an *environmental assessment* of the *property* A *user* may include, without limitation, a purchaser of *property* a potential tenant of *property*, an *owner* of *property*, a lender, or a property manager

3 3 40 *visually and/or physically observed*—during a *site visit* pursuant to the *transaction screen process* of this practice or pursuant to a *Phase I Environmental Site Assessment* of Practice E 1527 the term *visually and physically observed* means observations made by vision upon walking through a *property* and the structures located on it and observations made by the sense of smell, particularly observations of noxious or foul odors The term *walking through* is not meant to imply that disabled persons who cannot physically walk may not conduct a *site visit*; they may do so by the means at their disposal for moving through the *property* and the structures located on it

3 4 *Acronyms*

3 4 1 *ASTM*—American Society for Testing and Materials

3 4 2 *CERCLA*—Comprehensive Environmental Response, Compensation and Liability of 1980 Act (as amended, 42 USC § 9601 *et seq*)

3 4 3 *CERCLIS*—Comprehensive Environmental Response, Compensation and Liability Information System maintained by EPA

3 4 4 *CFR*—Code of Federal Regulations

3 4 5 *EPA*—United States Environmental Protection Agency

3 4 6 *EPCRA*—Emergency Planning and Community Right to Know Act (also known as SARA Title III), (42 USC § 11001 *et seq*)

3 4 7 *ERNS*—Emergency Response Notification System

3 4 8 *ESA*—environmental site assessment (different than an environmental audit, see 3 3 12)

3 4 9 *FOIA*—U S Freedom of Information Act (5 USC § 552 *et seq*)

3 4 10 *FR*—Federal Register

3 4 11 *LUST*—leaking underground storage tank.

3 4 12 *MSDS*—material safety data sheet

3 4 13 *NCP*—National Contingency Plan

3 4 14 *NPDES*—National Pollution Discharge Elimination System

3 4 15 *NPL*—National Priorities List.

3 4 16 *PCBs*—polychlorinated biphenyls

3 4 17 *PRP*—potentially responsible party (pursuant to CERCLA 42 USC § 9607(a)

3 4 18 *RCRA*—Resource Conservation and Recovery Act (as amended, 42 USC § 6901 *et seq*)

3 4 19 *SARA*—Superfund Amendments and Reauthorization Act of 1986 (amendment to CERCLA)

3 4 20 *USC*—United States Code

3 4 21 *USGS*—United States Geological Survey

3 4 22 *UST*—underground storage tank

4 Significance and Use

4 1 *Uses*—This practice is intended for use on a voluntary basis by parties who wish to assess the environmental condition of *commercial real estate* While use of this practice is intended to constitute *appropriate inquiry* for purposes of CERCLA's *innocent landowner defense*, it is not intended that its use be limited to that purpose This practice is intended primarily as an approach to conducting an inquiry designed to identify *recognized environmental conditions* in connection with a *property*, and *environmental site assessments* that are both more and less comprehensive than this practice (including, in some instances no *environmental site assessment*) may be appropriate in some circumstances Further, no implication is intended that a person must use this practice in order to be deemed to have conducted inquiry in a commercially prudent or reasonable manner in any particular transaction Nevertheless, this practice is intended to reflect a commercially prudent and reasonable inquiry

4 2 *Clarifications on Use*

4 2 1 *Use Not Limited to CERCLA*—This practice and Practice E 1527 are designed to assist the *user* in developing information about the environmental condition of a *property* and as such has utility for a wide range of persons, including those who may have no actual or potential CERCLA liability and/or may not be seeking the *innocent landowner defense*

4 2 2 *Residential Tenants/Purchasers and Others*—No implication is intended that it is currently customary practice for residential tenants of multifamily residential buildings, tenants of single-family homes or other residential real estate, or purchasers of dwellings for residential use to conduct an *environmental site assessment* in connection with these transactions Thus, these transactions are not included in the term commercial real estate transactions, and it is not intended to imply that such persons are obligated to conduct an *environmental site assessment* in connection with these transactions for purposes of *appropriate inquiry* or for any other purpose In addition no implication is intended that it is currently customary practice for *environmental site assessments* to be conducted in other unenumerated instances (including but not limited to many commercial leasing transactions, many acquisitions of easements, and many loan transactions in which the lender has multiple remedies) On the other hand, anyone who elects to do an *environmental site assessment* of any *property* or portion of a property may, in such person's judgment, use either this practice or Practice E 1527

4 2 3 *Site-Specific*—This practice is site-specific in that it relates to assessment of environmental conditions on a specific parcel of *commercial real estate* Consequently, this practice does not address many additional issues raised in transactions such as purchases of business entities, or interests therein, or of their assets, that may well involve environmental liabilities pertaining to properties previously owned or operated or other off-site environmental liabilities

4 3 *Two Related Practices*—This practice sets forth one procedure for an environmental site assessment for purposes of appropriate inquiry necessary to qualify for CERCLA's *innocent landowner defense* known as a "transaction screen process" or a transaction screen " This practice is a companion to Practice E 1527 that is called the "Phase I Environmental Site Assessment Process" or a "Phase I ESA" or simply a 'Phase I " These practices are each intended to meet the standard of *appropriate inquiry* necessary to qualify for the *innocent landowner defense* of CERCLA It is essential to consider that these two practices, taken together, provide for two alternative practices of appropriate inquiry the *transaction screen process* described in this practice and the *Phase I Environmental Site Assessment* described in Practice E 1527

4 3 1 *Election to Commence With Either Practice*—The *user* may commence inquiry to identify recognized *environmental conditions* in connection with a *property* by performing either the *transaction screen process* or the *Phase I Environmental Site Assessment*

4 3 2 *Who May Conduct*—The *transaction screen process* may be conducted either by the *user* (including an agent, independent contractor or employee of the *user*) or wholly or partially by an *environmental professional* The *transaction screen process* does not require the judgment of an *environmental professional* Whenever a *Phase I Environmental Site Assessment* is conducted, it must be performed by an *environmental professional* to the extent specified in 6 5 1 through 6 5 2 1 of Practice E 1527 Further, at the *Phase I Environmental Site Assessment* level, no practical standard should be designed to eliminate the role of judgment and the value and need for experience in the party performing the inquiry The professional judgment of an *environmental professional* is, consequently, vital to the performance of appropriate inquiry at the *Phase I Environmental Site Assessment* level

4 3 3 *Completion of Transaction Screen Process*—Performance of the *transaction screen process* may allow the *user* to conclude that no further inquiry is needed to assess the potential for identifying any *recognized environmental condition* at the property and hence that performance of the *transaction screen process* constitutes *appropriate inquiry* without undertaking the *Phase I Environmental Site Assessment* Upon completion of the *transaction screen process*, the *user* should conclude either (1) no further inquiry into recognized environmental conditions at the property is needed for purposes of *appropriate inquiry*, or (2) further inquiry is needed to assess *recognized environmental conditions* appropriately for purposes of *appropriate inquiry* If no further inquiry is needed, the *user* has completed his or her *appropriate inquiry* of the *property*

4 3 4 *Inquiry Beyond the Transaction Screen Process*—If further inquiry is needed after performance of the *transaction screen process* (as described in 4 3 3), the *user* must determine, in the exercise of the *user's* reasonable business judgment, whether further inquiry may be limited to those specific issues identified as of concern or should proceed to a full *Phase I Environmental Site Assessment*

1014

4 4 *Additional Services*—As set forth in 11 9 of Practice E 1527, additional services may be contracted for between the *user* and the *environmental professional(s)*

4 5 *Principles*—The following principles are an integral part of this practice and are intended to be referred to in resolving any ambiguity or exercising such discretion as is accorded the *user* or *environmental professional* in performing an *environmental site assessment* or in judging whether a *user* or *environmental professional* has conducted *appropriate inquiry* or has otherwise conducted an adequate *environmental site assessment*

4 5 1 No *environmental site assessment* can wholly eliminate uncertainty regarding the potential for *recognized environmental conditions* in connection with a *property* Performance of either this practice or Practice E 1527 is intended to reduce but not eliminate uncertainty regarding the existence of *recognized environmental conditions* in connection with a property, and both practices recognize reasonable limits of time and cost

4 5 2 *Appropriate inquiry* does not mean an exhaustive assessment of a clean *property* There is a point at which the cost of information obtained or the time required to gather it outweighs the usefulness of the information and, in fact, may be a material detriment to the orderly completion of transactions One of the purposes of this practice is to identify a balance between the competing goals of limiting the costs and time demands inherent in performing an *environmental site assessment* and the reduction of uncertainty about unknown conditions resulting from additional information

4 5 3 Not every *property* will warrant the same level of assessment Consistent with good commercial or customary practice, the appropriate level of *environmental site assessment* will be guided by the type of property subject to assessment, the expertise and risk tolerance of the *user*, and the information developed in the course of the inquiry

4 5 4 It should not be concluded or assumed that an inquiry was not *appropriate inquiry* merely because the inquiry did not identify *recognized environmental conditions* in connection with a *property* *Environmental site assessments* must be evaluated based on the reasonableness of judgments made at the time and under the circumstances in which they were made Subsequent *environmental site assessments* should not be considered valid standards to judge the appropriateness of any prior assessment based on hindsight, new information, use of developing technology or analytical techniques, or other factors

4 6 *Continued Viability of Environmental Site Assessment*—An *environmental site assessment* meeting or exceeding either this practice or Practice E 1527 and completed less than 180 days previously is presumed to be valid An *environmental site assessment* meeting or exceeding either practice and completed more than 180 days previously may be used to the extent allowed by 4 7 through 4 7 5

4 7 *Prior Assessment Usage*—Both this practice and Practice E 1527 recognize that *environmental site assessments* performed in accordance with these practices will include information which *users* or subsequent users may want to use to avoid undertaking duplicative assessment procedures Therefore, the practices describe procedures to be followed to assist users in determining the appropriateness of using information in *environmental site assessments* performed previously The system of prior assessment usage is based on the following principles that should be adhered to in addition to the specific procedures set forth elsewhere in these practices

4 7 1 Subject to 4 7 4, *users* and *environmental professionals* may use information in prior *environmental site assessments* provided such information was generated as a result of procedures that meet or exceed the requirements of this practice or Practice E 1527 and then only provided that the specific procedures set forth in each practice are met

4 7 2 Subject to 4 7 4, a prior *environmental site assessment* may be used in its entirety, without regard to the specific procedures set forth in these practices, if, in the reasonable judgment of the *user* the prior *environmental site assessment* meets or exceeds the requirements of this practice or Practice E 1527, and the conditions at the *property* likely to affect *recognized environmental conditions* in connection with the *property* are not likely to have changed materially since the prior *environmental site assessment* was conducted In making this judgment, the *user* should consider the type of *property* assessed and the conditions in the area surrounding the *property*

4 7 3 Except as provided in 4 7 2 and 4 7 2 of Practice E 1527, prior *environmental site assessments* should not be used without current investigation of conditions likely to affect *recognized environmental conditions* in connection with the *property* that may have changed materially since the prior *environmental site assessment* was conducted At a minimum, for a *transaction screen process* consistent with this practice, a new *site visit* should be performed

4 7 4 If the *user* or *environmental professional(s)* conducting an *environmental site assessment* has *actual knowledge* that the information being used from a prior *environmental site assessment* is not accurate or if it is *obvious*, based on other information obtained by means of the *environmental site assessment* or known to the person conducting the *environmental site assessment*, that the information being used is not accurate, such information from a prior *environmental site assessment* may not be used

4 7 5 The contractual and legal obligations between prior and subsequent *users* of *environmental site assessments* or between *environmental professionals* who conducted prior *environmental site assessments* and those who would like to use such prior *environmental site assessments* are beyond the scope of this practice

4 8 The contractual and legal obligations between an *environmental professional* and a *user* (and other parties, if any) are beyond the scope of this practice No specific legal relationship between the *environmental professional* and the *user* is necessary for the *user* to meet the requirements of this practice

4 9 If the *user* is aware of any specialized knowledge or experience that is material to *recognized environmental conditions* in connection with the *property*, and the *preparer* is not the *user*, it is the *user*'s responsibility to communicate any information based on such specialized knowledge or experience to the *preparer* The *user* should do so before the preparer makes the site visit.

4 10 In a transaction involving the purchase of a parcel of *commercial real estate*, if a *user* has *actual knowledge* that

1015

the purchase price of the property is significantly less than the purchase price of comparable properties the *user* should try to identify an explanation for the lower price and to make a written record of such explanation Among the factors to consider will be the information that becomes known to the *user* pursuant to the *transaction screen environmental site assessment*

5 Introduction to Transaction Screen Questionnaire

5 1 *Process*—The *transaction screen process* consists of asking questions contained within the *transaction screen questionnaire* of *owners* and *occupants* of the *property*, observing site conditions at the *property* with direction provided by the *transaction screen questionnaire*, and, to the extent *reasonably ascertainable*, conducting limited research regarding certain *government records* and certain *standard historical sources* The questions asked of *owners* when conducting *site visits* are the same questions as those asked of *occupants*

5 2 *Guide*—The *transaction screen questionnaire* is followed by a guide designed to assist the person completing the *transaction screen questionnaire* The guide to the *transaction screen questionnaire* is set out in Sections 7 through 10 of this practice The guide is divided into three sections Guide for Owner/Occupant Inquiry, Guide to Site Visit, and Guide to Government Records/Historical Sources Inquiry

5 2 1 To assist the *user*, its employee or agent, or the *environmental professional* in preparing a report, the guide repeats each of the questions set out in the *transaction screen questionnaire* in both the guide for *owner/occupant inquiry* and the guide to *site visit* The questions regarding *government records/historical sources inquiry* are also repeated in the guide to that section

5 2 2 The guide also describes the procedures to be followed to determine if reliance upon the information in a prior *environmental site assessment* is appropriate under this practice

5 2 3 A *user*, his employee or agent, or *environmental professional* conducting the *transaction screen process* should not use the *transaction screen questionnaire* without reference to, or familiarity from prior usage with, the guide

5 3 *User and Preparer*—The *user* conducting the *transaction screen process* is the party seeking to perform *appropriate inquiry* with respect to the *property* The *user* may delegate the preparation of the *transaction screen questionnaire* to an employee or agent of the *user* or may contract with a third party to prepare the questionnaire on behalf of the *user* The person preparing the questionnaire is the *preparer*, who may be either the *user* or the person to whom the *user* has delegated the preparation of the *transaction screen questionnaire*

5 4 *Exercise of Care*—The *preparer* conducting the transaction screen process should use good faith efforts in determining answers to the questions set forth in the transaction screen questionnaire The *user* should take time and care to check whatever records are in the user s possession The *preparer* should ask all persons to whom questions are directed to give answers to the best of the respondent's knowledge As required by Section 9601(35)(B) of CERCLA, the *user* or *preparer* should discuss with a responsible person in authority in the user's organization (if any) any specialized knowledge or experience relating to *hazardous substances* on the *property* and the *preparer* should understand such information

5 5 *Knowledge*—The owner or occupant of the *property* to which portions of the transaction screen questionnaire are directed should have sufficient knowledge and experience with respect to the property or in the owner's or occupant's particular business to understand the purpose and use of the transaction screen questionnaire All answers should be given to the best of the owner's or occupant's actual knowledge

5 5 1 While the person conducting the *transaction screen process* has an obligation to ask the questions set forth in the *transaction screen questionnaire*, in many instances the parties to whom the questions are addressed will have no obligation to answer them The *user* is only required to obtain information to the extent it is *reasonably ascertainable*

5 5 2 If the preparer asks the questions set forth in the *transaction screen questionnaire*, but does not receive any response or receives partial responses, the questions will be deemed to have been answered provided the questions have been asked, or were attempted to be asked, in person or by telephone and written records have been kept of the person to whom the questions were addressed and their responses, or the questions have been asked in writing sent by certified or registered mail, return receipt requested, postage prepaid, or by private, commercial overnight carrier and no responses have been obtained after at least two follow-up telephone calls were made or written request was sent again asking for responses

5 5 3 The *transaction screen questionnaire* and the *transaction screen guide* sometimes include the phrase "to the best of your knowledge " Use of this phrase shall not be interpreted as imposing a constructive knowledge standard when it is not included or as imposing anything other than an *actual knowledge* standard for the person answering the questions regardless of whether it is used It is sometimes included as an assurance to the person being questioned that he or she is not obligated to search out information he or she does not currently have in order to answer the particular question

5 6 *Conclusions Regarding Affirmative or Unknown Answers*—If any of the questions set forth in the transaction screen questionnaire are answered in the affirmative, the user must document the reason for the affirmative answer If any of the questions are not answered or the answer is unknown, the user should document such nonresponse or answer of unknown and evaluate it in light of the other information obtained in the transaction screen process, including, in particular, the *site visit* and the government records/historical sources inquiry If the *user* decides no further inquiry is warranted after receiving no response, an answer of unknown or an affirmative answer, the *user* must document the reasons for any such conclusion

5 6 1 Upon obtaining an affirmative answer, an answer of unknown or no response, the *user* should first refer to the guide The guide may provide sufficient explanation to allow a *user* to conclude that no further inquiry is appropriate with respect to the particular question

5 6 2 If the guide to a particular question does not, in

itself, permit a *user* to conclude that no further inquiry is appropriate, then the *user* should consider other information obtained from the *transaction screen process* relating to this question For example, while on the site performing a *site visit*, a person may find a storage tank on the *property* and therefore answer Question 10 of the *transaction screen questionnaire* in the affirmative However, during or subsequent to the *owner/occupant inquiry*, the *owner* may produce evidence that substances now or historically contained in the tank (e g , water) are not likely to cause contamination

5 6 3 If either the guide to the question or other information obtained during the *transaction screen process* does not permit a *user* to conclude no further inquiry is appropriate with respect to such question, then the user must determine, in the exercise of the *user s* reasonable business judgment, based upon the totality of unresolved affirmative answers or answers of unknown received during the *transaction screen process*, whether further inquiry may be limited to those specific issues identified as of concern or should proceed with a full *Phase I Environmental Site Assessment*

5 7 *Presumption*—A presumption exists that further inquiry is necessary if an affirmative answer is given to a question because the answer was unknown or no response was given In rebutting this presumption, the *user* should evaluate information obtained from each component of the transaction screen process and consider whether sufficient information has been obtained to conclude that no further inquiry is necessary The user must determine, in the exercise of the user's reasonable business judgment, the scope of such further inquiry whether to proceed with a *Phase I Environmental Site Assessment* prepared in accordance with Practice E 1527 or a lesser inquiry directed at specific issues raised by the questionnaire

5 8 *Further Inquiry Under Practice E 1527*—Upon completing the *transaction screen questionnaire*, if the *user* concludes that a *Phase I Environmental Site Assessment* is needed, the *user* should proceed with such inquiry with the advice and guidance of an *environmental professional* Such further inquiry should be undertaken in accordance with Practice E 1527

5 9 *Signature*—The *user* and the *preparer* of the *transaction screen questionnaire* must complete and sign the questionnaire as provided at the end of the questionnaire

6 Transaction Screen Questionnaire

6 1 *Persons to be Questioned*—The following questions should be asked of (*1*) the current *owner* of the *property*, (*2*) any major *occupant* of the *property* or, if the *property* does not have any major *occupants*, at least 10 % of the *occupants* of the *property*, and (*3*) in addition to the current *owner* and the *occupants* identified in (*2*), any *occupant* likely to be using, treating, generating, storing or disposing of *hazardous substances* or *petroleum products* on or from the *property* A major *occupant* is any *occupant* using at least 40 % of the leasable area of the property or any anchor tenant when the *property* is a shopping center In a multifamily property containing both residential and commercial uses, the *preparer* does not need to ask questions of the residential *occupants* The preparer should ask each person to answer all questions to the best of the respondent's *actual knowledge* and in good faith When completing the *site visit* column, the *preparer* should be sure to observe the *property* and any buildings and other structures on the *property* The guide provides further details on the appropriate use of this questionnaire

Description of Site Address

Question	Owner[7]			Occupants (if applicable)			Observed During Site Visit		
1 Is the *property* or any *adjoining property* used for an industrial use?	Yes	No	Unk	Yes	No	Unk	Yes	No	Unk
2 To the best of your knowledge, has the *property* or any *adjoining property* been used for an industrial use in the past?	Yes	No	Unk	Yes	No	Unk	Yes	No	Unk
3 Is the *property* or any *adjoining property* used as a gasoline station motor repair facility commercial printing facility dry cleaners, photo developing laboratory junkyard or landfill, or as a waste treatment, storage disposal, processing, or recycling facility?	Yes	No	Unk	Yes	No	Unk	Yes	No	Unk
4 To the best of your knowledge has the *property* or any *adjoining property* been used as a gasoline station motor repair facility commercial printing facility dry cleaners photo developing laboratory junkyard or landfill or as a waste treatment, storage, disposal processing, or recycling facility?	Yes	No	Unk	Yes	No	Unk	Yes	No	Unk

[7] Unk = "unknown" or "no response "

1017

Question	Owner[7]			Occupants (if applicable)			Observed During Site Visit		
5 Are there currently or to the best of your knowledge have there been previously any damaged or discarded automotive or industrial batteries or pesticides paints, or other chemicals in individual containers of greater than 5 gal (19 L) in volume or 50 gal (190 L) in the aggregate stored on or used at the *property* or at the facility?	Yes	No	Unk	Yes	No	Unk	Yes	No	Unk
6 Are there currently or to the best of your knowledge have there been previously any industrial *drums* (typically 55 gal (208 L)) or sacks of chemicals located on the property or at the facility?	Yes	No	Unk	Yes	No	Unk	Yes	No	Unk
7 Has *fill dirt* been brought onto the property that originated from a contaminated site or that is of an unknown origin?	Yes	No	Unk	Yes	No	Unk	Yes	No	Unk
8 Are there currently or to the best of your knowledge have there been previously any *pits ponds or lagoons* located on the *property* in connection with waste treatment or waste disposal?	Yes	No	Unk	Yes	No	Unk	Yes	No	Unk
9 Is there currently or to the best of your knowledge has there been previously any stained soil on the *property*?	Yes	No	Unk	Yes	No	Unk	Yes	No	Unk
10 Are there currently or to the best of your knowledge have there been previously any registered or unregistered storage tanks (above or underground) located on the *property*?	Yes	No	Unk	Yes	No	Unk	Yes	No	Unk
11 Are there currently or to the best of your knowledge have there been previously any vent pipes, fill pipes, or access ways indicating a fill pipe protruding from the ground on the *property* or adjacent to any structure located on the *property*?	Yes	No	Unk	Yes	No	Unk	Yes	No	Unk
12 Are there currently or to the best of your knowledge have there been previously any flooring, drains, or walls located within the facility that are stained by substances other than water or are emitting foul odors?	Yes	No	Unk	Yes	No	Unk	Yes	No	Unk
13 If the *property* is served by a private well or non public water system have contaminants been identified in the well or system that exceed guidelines applicable to the water system or has the well been designated as contaminated by any government environmental/health agency?	Yes	No	Unk	Yes	No	Unk	Yes	No	Unk
14 Does the *owner* or *occupant* of the *property* have any knowledge of *environmental liens* or governmental notification relating to past or recurrent violations of environmental laws with respect to the *property* or any facility located on the *property*?	Yes	No	Unk	Yes	No	Unk	Yes	No	Unk
15 Has the *owner* or *occupant* of the *property* been informed of the past or current existence of *hazardous substances* or *petroleum products* or environmental violations with respect to the *property* or any facility located on the *property*?	Yes	No	Unk	Yes	No	Unk	Yes	No	Unk
16 Does the *owner* or *occupant* of the *property* have any knowledge of any *environmental site assessment* of the *property* or facility that indicated the presence of *hazardous substances* or *petroleum products* on or contamination of the *property* or recommended further assessment of the *property*?	Yes	No	Unk	Yes	No	Unk	Yes	No	Unk

1018

Question	Owner[7]			Occupants (if applicable)			Observed During Site Visit		
17 Does the *owner* or *occupant* of the *property* know of any past, threatened or pending lawsuits or administrative proceedings concerning a release or threatened release of any *hazardous substance* or *petroleum products* involving the *property* by any owner or occupant of the *property*?	Yes	No	Unk	Yes	No	Unk	Yes	No	Unk
18 Does the *property* discharge waste water on or adjacent to the *property* other than storm water into a sanitary sewer system?	Yes	No	Unk	Yes	No	Unk	Yes	No	Unk
19 To the best of your knowledge, have any *hazardous substances* or *petroleum products* unidentified waste materials tires automotive or industrial batteries or any other waste materials been dumped above grade buried and/or burned on the *property*?	Yes	No	Unk	Yes	No	Unk	Yes	No	Unk
20 Is there a transformer capacitor or any hydraulic equipment for which there are any records indicating the presence of PCBs?	Yes	No	Unk	Yes	No	Unk	Yes	No	Unk

Government Records/Historical Sources Inquiry

(See guide Section 10)

21 Do any of the following Federal government record systems list the property or any property within the circumference of the area noted below

National Priorities List—within 1 0 mile (1 6 Km)?	Yes	No
CERCLIS List—within 0 5 mile (0 8 Km)?	Yes	No
RCRA TSD Facilities—within 1 0 mile (1 6 Km)?	Yes	No

22 Do any of the following state record systems list the property or any property within the circumference of the area noted below

List maintained by state environmental agency of hazardous waste sites identified for investigation or remediation that is the state agency equivalent to NPL—within approximately 1 0 mile (1 6 Km)?	Yes	No
List maintained by state environmental agency of sites identified for investigation or remediation that is the state equivalent to CERCLIS—within 0 5 mile (0 8 Km)?	Yes	No
Leaking Underground Storage Tank (LUST) List—within 0 5 mile (0 8 Km)?	Yes	No
Solid Waste/Landfill Facilities—within 0 5 mile (0 8 Km)?	Yes	No

23 Based upon a review of *fire insurance maps* or consultation with the local fire department serving the *property* all as specified in the guide are any buildings or other improvements on the *property* or on an *adjoining property* identified as having been used for an industrial use or uses likely to lead to contamination of the *property*? Yes No N/A

The *preparer* of the *transaction screen questionnaire* must complete and sign the following statement. (For definition of preparer" and user " see 5 3 or 3 3 25)

This questionnaire was completed by
Name _____
Title _____
Firm _____
Address _____
_____
_____
Phone number _____
Date _____

If the preparer is different than the user complete the following.
Name of user _____
User s address _____
_____
User's phone number _____
Preparer's relationship to site _____
Preparer s relationship to user (for example, principal, employee agent, consultant)

Copies of the completed questionnaire have been filed at.
_____
_____
_____

Copies of the completed questionnaire have been mailed or delivered to
_____
_____
_____

Preparer represents that to the best of the preparer s knowledge the above statements and facts are true and correct and to the best of the preparer s actual knowledge no material facts have been suppressed or misstated.

Signature _____ Date _____

Signature _____ Date _____

Signature _____ Date _____

1019

7 Guide to Transaction Screen Questionnaire

7 1 The following sets forth the guide to the *transaction screen questionnaire* The guide accompanies the *transaction screen questionnaire* to assist the *preparer* in completing the questionnaire Questions found in the *transaction screen questionnaire* are repeated in the guide

7 2 If the *preparer* completing the *transaction screen questionnaire* is familiar with the guide from prior usage, the questionnaire may be completed without reference to the guide

7 3 The *site visit* portion of the guide considers the same questions set forth in the guide to *owner/occupant inquiry* because the *transaction screen process* requires both questions of *owners* and *occupants* of the *property* and observations of the *property* by the *preparer*

7 4 Prior *environmental site assessment* usage procedures are contained in the guide to *owner/occupant inquiry* and the guide to *government records/historical sources inquiry* The information supplied in connection with the *site visit* portion of a prior *environmental site assessment* may be used for guidance but may not be relied upon without determining through a new *site visit* whether any conditions that are material to recognized environmental conditions in connection with the *property* have changed since the prior *environmental site assessment* Therefore, the guide to the *site visit* does not contain any prior assessment procedures

7 5 In performing the *site visit* portion of the *transaction screen process*, the *preparer* should *visually and physically observe* the *property* and any structure located on the *property* to the extent not obstructed by bodies of water, cliffs, adjacent buildings, or other impassable obstacles

7 5 1 The periphery of the *property* should be *visually and physically observed*, as well as the periphery of all structures on the *property*, and the *property* should be viewed from all adjacent public thoroughfares Any overgrown areas should be inspected, including roads or paths with no apparent outlet that should be *visually and physically* observed to their ends

7 5 2 On the interior of structures on the *property*, accessible common areas expected to be used by building *occupants* or the public (such as lobbies, hallways, utility rooms, and recreation areas), a representative sample of *owner* and *occupant* spaces, and maintenance and repair areas, including boiler rooms, should be *visually and physically* observed It is not necessary to look under floors, above ceilings, or behind walls

7 5 3 After completing the *site visit* the *preparer* of the *transaction screen questionnaire* may obtain yes answers that require the *preparer* once again to ask questions of the *owner* of the *property* or *occupants* of the *property* to satisfy the *user* that no further inquiry is necessary

7 6 In addition to asking questions of the *owner* of the *property* and *occupants* of the *property* (Section 8) and *visually and physically* observing the *property* (Section 9), the *user* completing the *transaction screen process* should determine, either from governmental agencies or through commercial services providing government environmental records, whether certain known or suspected contaminated sites or activities involving the release of *hazardous substances or petroleum products* occur on or near the *property* See Section 10

7 6 1 These records may be obtained either directly from the government agencies or from commercial services that provide the records for a fee Because of the numerous sources that must be searched and the response time of government agencies, commercial services are available that provide a single source for federal and state records These services may provide a quicker response than the government agencies but fees will be charged for the information

7 6 2 If government information is obtained from a commercial service, the firm should provide assurances that its records stay current with the government agency record sources Government information obtained from non-government sources may be considered current if the source updates the information at least every 90 days, or, for information that is updated less frequently than quarterly by the government agency, within 90 days of the date the government agency makes the updated information available to the public

7 6 3 The identity of firms providing this type of government information may be obtained through local telephone directories or through an inquiry of environmental professionals in the area of the preparer completing the transaction screen questionnaire

8 Guide for Owner/Occupant Inquiry

8 1 Is the *property* or any *adjoining property* used for an industrial use?

_____Yes _____No _____Unknown

	Land Use
Property	_____
Adjoining properties north	_____
Adjoining properties south.	_____
Adjoining properties east.	_____
Adjoining properties west	_____

8 1 1 *Guide*

8 1 1 1 It is recommended that the *preparer* describe the use of the *property* and *adjoining properties*

8 1 1 2 Certain industrial uses on the *property* may raise concerns regarding the possibility of contamination affecting the *property* For purposes of the *transaction screen questionnaire*, an industrial use is an activity requiring the application of labor and capital for the production or distribution of a product or article, including, without limitation, manufacturing, processing, extraction, refining, warehousing, transportation and utilities Manufacturing is defined as a process or operation of producing by hand, machinery, or other means a finished product or article from raw material Industrial uses may be categorized as light or heavy industrial uses, depending upon the scale of the operations and the impact upon surrounding property in terms of smoke, fumes, and noise Regardless of such categorization, the concern for purposes of the transaction screen process is whether the use involves the processing, storage, manufacture, or transportation of *hazardous substances* or *petroleum products* For example, further inquiry would be necessary if the industrial use concerned the manufacture of paints, oils, solvents, and other chemical products but not if the use

concerned the storage of inert goods in containers

8 1 1 3 The term *adjoining properties* means any real property or properties the border of which is contiguous or partially contiguous with that of the property, or that would be contiguous or partially contiguous with that of the property but for a street, road, or other public thoroughfare separating them *Adjoining properties* means the *property* and include *properties* across the street or any right of way from the property

8 1 1 4 To use the information supplied in response to this question in a prior *environmental site assessment*, the *preparer* must determine if there were changes in the use of the *property* or any *adjoining property* since the prior *environmental site assessment* that are material to *recognized environmental conditions* in connection with the *property* If not, using information in the prior *environmental site assessment* is appropriate If so, the information requested must be supplied for each *property* for which the use has so changed

8 2 To the best of your knowledge, has the *property* or any *adjoining property* been used for an industrial use in the past?

_____Yes _____No _____Unknown

8 2 1 *Guide*—See guide for question 8 1

	Owner	Use	Dates
Previous use of property			
Previous use of properties to north			
Previous use of properties to south			
Previous use of properties to east			
Previous use of properties to west			

8 3 Is the *property* or any *adjoining property* used as a gasoline station, motor repair facility, commercial printing facility, dry cleaners, photo developing laboratory, junkyard, or landfill, or as a waste treatment, storage, disposal, processing, or recycling facility?

_____Yes _____No _____Unknown

	Land Use
Property	
Adjoining properties north	
Adjoining properties south	
Adjoining properties east.	
Adjoining properties west.	

8 3 1 *Guide*

8 3 1 1 It is recommended that the *preparer* describe the uses of the *property* and *adjoining properties*

8 3 1 2 Gasoline stations, motor vehicle repair facilities (with or without supplying gas for the motor vehicles), dry cleaners, photo developing laboratories, commercial printing facilities, junkyards or land-fills, and waste treatment, storage, disposal, processing, or recycling facilities all involve the use of *hazardous substances* or *petroleum products* and therefore require further inquiry concerning the possible release of such substances

8 3 1 3 The term *adjoining properties* means any real property or properties the border of which is contiguous or partially contiguous with that of the *property*, or that would be contiguous or partially contiguous with that of the *property* but for a street, road, or other public thoroughfare separating them

8 3 1 4 To rely on the information supplied in response to this question in a prior *environmental site assessment*, the *preparer* must determine if there were changes in the use of the property or any *adjoining property* since the prior *environmental site assessment* that are material to *recognized environmental conditions* in connection with the *property* If not, then use of information in the prior *environmental site assessment* is appropriate If so, the information requested must be supplied for each *property* for which the use has so changed

8 4 To the best of your knowledge, has the *property* or any *adjoining property* been used in the past as a gasoline station, motor repair facility, commercial printing facility, dry cleaners, photo developing laboratory, junkyard or landfill, or as a waste treatment, storage, disposal, processing, or recycling facility?

_____Yes _____No _____Unknown

8 4 1 *Guide*—See guide for question 8 3

	Owner	Use	Dates
Previous use of property			
Previous use of properties to north			
Previous use of properties to south			
Previous use of properties to east			
Previous use of properties to west			

LAND ISSUES

8 5 Are there currently, or to the best of your knowledge, have there been previously, any damaged or discarded automotive or industrial batteries, or pesticides, paints, or other chemicals in individual containers of greater than 5 gal (19 L) in volume or 50 gal (190 L) in the aggregate, stored on or used at the property or at the facility?

_____Yes _____No _____Unknown

8 5 1 *Guide*

8 5 1 1 Are there any containers on the site that may contain any of these items? Is there any reason to suspect that chemicals or *hazardous substances* in such quantities may be stored on the site? Sheltered areas, cartons, sacks, storage bins, large canisters, sheds, or cellars of existing improvements are examples of containers and areas where chemicals or *hazardous substances* may be stored If the answer to this question is "yes," list the items and the location(s) where they are stored If unfamiliar with the contents of any container located on the site, the question must be answered "yes" until the materials are identified

8 5 1 2 *Hazardous substances* may often be unmarked The *preparer* should never open any containers that are unmarked because they may contain explosive materials or acids

8 5 1 3 Consumer products in undamaged containers

1021

used for routine office maintenance or business, such as copy toner, should not create a need for further inquiry unless the quantity of such products is in excess of what would be customary for such use The Environmental Protection Agency has published a guidance document that identifies hazardous substances that must be reported under Sections 311 and 312 of the Emergency Planning and Community Right to Know Act ("EPCRA")[8] This document lists in tabular form the CERCLA Section 103 chemicals If a preparer has a question regarding whether the substance is a hazardous substance under CERCLA, the preparer may refer to the list of lists or 40 CFR Part 302 In addition, the Environmental Protection Agency has also published a guidance document[9] This document sets forth the *hazardous substances* found in many common consumer products listed by trade name

8 5 1 4 A *preparer* should not rely exclusively upon a prior *environmental site assessment* in supplying this information

8 6 Are there currently, or to the best of your knowledge have there been previously, any industrial drums (typically, 55 gal (208 L)) or sacks of chemicals located on the property or at the facility?

_____Yes _____No _____Unknown

8 6 1 *Guide*

8 6 1 1 Chemicals are frequently stored in large 55-gal (208-L) drums and dry chemicals are often stored in 20 lb (9 kg) sacks See Appendix X2 for examples of 55-gal (208-L) drums and for surface staining resulting from improper drum storage

8 6 1 2 A *preparer* should not rely exclusively upon a prior *environmental site assessment* in supplying this information

8 7 Has *fill dirt* been brought onto the property that originated from a contaminated site or that is of an unknown origin?

_____Yes _____No _____Unknown

8 7 1 *Guide*

8 7 1 1 The origin of *fill dirt* brought onto the *property* should be investigated to determine whether such dirt originated from a contaminated site The term *fill dirt* is defined in the definitions and the *preparer* should refer to the definitions if the *preparer* has any question concerning the meaning of the term

8 7 1 2 If any structures have been demolished on the property, the *preparer* should investigate whether the structures were demolished in place and *fill dirt* compacted over them because such demolition debris may contain asbestos or *hazardous substances*

8 7 1 3 To use the information supplied in response to this question in a prior *environmental site assessment*, the *preparer* must determine if there has been any filling at the site since the prior *environmental site assessment* If not, then using information in the prior *environmental site assessment* is appropriate If so, the information requested must be supplied for any *fill dirt* brought on the property since the prior *environmental site assessment*

8 8 Are there currently, or to the best of your knowledge have there been previously, any *pits ponds or lagoons* located on the *property* in connection with waste treatment or waste disposal?

_____Yes _____No _____Unknown

8 8 1 *Guide*

8 8 1 1 The presence of *pits ponds or lagoons*, together with waste treatment or waste disposal may indicate contaminated property See the definitions with respect to the definition of *pits ponds or lagoons* in 3 2 26

8 8 1 2 A *preparer* should not rely exclusively upon a prior *environmental site assessment* in supplying this information

8 9 Is there currently, or to the best of your knowledge has there been previously, any stained soil on the *property*?

_____Yes _____No _____Unknown

8 9 1 *Guide*

8 9 1 1 Stained soils are frequently associated with contamination and often are an indication of either current or previous leakage associated with piping and liquid storage containers Soils that are stained show a marked discoloration as compared to other soils in the immediate vicinity

8 9 1 2 A *preparer* should not rely exclusively upon a prior *environmental site assessment* in supplying this information

8 10 Are there currently, or to the best of your knowledge have there been previously, any registered or unregistered storage tanks (above or underground) located on the *property*?

_____Yes _____No _____Unknown

8 10 1 *Guide*

8 10 1 1 Tanks are often used to store heating fuels, chemicals, and petroleum products, while tanks may be associated with the storage of chemicals, they are most often associated with liquid fuel heating systems (e g , oil furnaces)

8 10 1 2 To use the information supplied in response to this question in a prior *environmental site assessment*, the *user* must determine if there were storage tanks installed on the site since the prior *environmental site assessment* If not, then using information in the prior *environmental site assessment* is appropriate If so, the information requested must be supplied on all storage tanks installed on the site since the prior *environmental site assessment*

8 11 Are there currently or to the best of your knowledge have there been previously any vent pipes, fill pipes, or access ways indicating a fill pipe protruding from the ground on the *property* or adjacent to any structure located on the *property*?

_____Yes _____No _____Unknown

8 11 1 *Guide*

8 11 1 1 Vent or fill pipes often signal the current or previous existence of underground storage tanks

8 11 1 2 Additionally, in answering this question the owner and occupant should consider any asphalt or concrete

[8] Title III List of Lists, Consolidated List of Chemicals Subject to Reporting Under Title III of the Superfund Amendments and Reauthorization Act (SARA) of 1986 " U S EPA Office of Toxic Substances, January 1989

[9] "Common Synonyms for Chemicals Listed Under Section 313 of the Emergency Planning and Community Right to Know Act" Office of Toxic Substances, U S EPA, January 1988

1027

patching that would indicate the possibility of previous underground storage tank removal Examples of vent and fill pipes are illustrated in Appendix X2

8 11 1 3 A *preparer* should not rely exclusively upon a prior *environmental site assessment* in supplying this information

STRUCTURE ISSUES

8 12 Are there currently, or to the best of your knowledge have there been previously, any flooring, drains, or walls located within the facility that are stained by substances other than water or are emitting foul odors?

_____Yes _____No _____Unknown

8 12 1 *Guide*

8 12 1 1 Stains (other than water stains) or foul odors may indicate leaks of hazardous substances of contaminants Floor drains located within a building adjacent to hazardous substance storage areas or connected to an on-site disposal system (e g, septic system) present a potential source of subsurface discharge of contaminants

8 12 1 2 A *preparer* should not rely exclusively upon a prior *environmental site assessment* in supplying this information

OTHER ISSUES

8 13 If the *property* is served by a private well or non-public water system, have contaminants been identified in the well or system that exceed guidelines applicable to the water system or has the well been designated as contaminated by any government environmental/health agency?

_____Yes _____No _____Unknown

8 13 1 *Guide*

8 13 1 1 Private wells and non-public water systems are not monitored daily for water quality as municipal systems are monitored If the system is private, it probably has been tested for contamination or evidence that it is free from contamination and the results of any such tests should be produced by the *owner* or *occupant* of the well The *preparer* is not required to test the water system to conduct the *transaction screen*

8 13 1 2 A *preparer* should not rely exclusively upon a prior *environmental site assessment* in supplying this information

8 14 Does the owner or occupant of the property have any knowledge of *environmental liens* or governmental notification relating to past or current violations of environmental laws with respect to the *property* or any facility located on the property?

_____Yes _____No _____Unknown

8 14 1 *Guide*

8 14 1 1 In most cases, the federal or state government will notify the property owner prior to filing a lien on the *property* Sections 302, 311, 312, and 313 of The Emergency Planning and Community Right-to-Know Act and other provisions of federal and state environmental laws establish reporting requirements with respect to businesses storing or using *hazardous substances* in excess of certain quantities These businesses should be making periodic reports to a federal, state, or local environmental department, agency or bureau The government may periodically inspect such facilities to ensure compliance with environmental laws In the event of a release of a reportable quantity within a 24-h period (as defined in CERCLA and the regulations promulgated pursuant to CERCLA), the person in charge of the facility is obligated to notify the U S EPA of the release Any notification or response by any governmental entity will be in writing

8 14 1 2 The information supplied in response to this question in a prior *environmental site assessment* may be used provided it is updated to the present time

8 15 Has the *owner* or *occupant* of the *property* been informed of the past or current existence of *hazardous substances* or *petroleum products* or environmental violations with respect to the *property* or any facility located on the *property*?

_____Yes _____No _____Unknown

8 15 1 *Guide*

8 15 1 1 Consider whether any *environmental professionals* familiar with *hazardous substances* or *petroleum products* have observed or determined that contamination existed on the property *Hazardous substances* or *petroleum products* from the *property* may have affected soils, air quality, water quality, or otherwise affected structures located on the *property*

8 15 1 2 The information supplied in response to this question in a prior *environmental site assessment* may be used provided it is updated to the present time

8 16 Does the *owner* or *occupant* of the *property* have any knowledge of any *environmental site assessment* of the *property* or facility that indicated the presence of *hazardous substances* or *petroleum products* on, or contamination of, the *property* or recommended further assessment of the *property*?

_____Yes _____No _____Unknown

8 16 1 *Guide*

8 16 1 1 Copies of *reasonably ascertainable* prior *environmental site assessments* of the *property* or any portion thereof should be obtained and examined to determine whether further action or inquiry is necessary in connection with any environmental problems raised by a prior *environmental site assessment*

8 16 1 2 The information supplied in response to this question in a prior *environmental site assessment* may be used provided it is updated to the present time

8 17 Does the *owner* or *occupant* of the *property* know of any past, threatened, or pending lawsuits or administrative proceedings concerning a release or threatened release of any *hazardous substance* or *petroleum products* involving the *property* by any owner or occupant of the *property*?

_____Yes _____No _____Unknown

8 17 1 *Guide*

8 17 1 1 The *user* is not required to make an independent investigation or search of records on file with a court or public agency in answering this question, this question is to be answered by the *owner* or *occupant* based upon their respective *actual knowledge* and review of *reasonably ascertainable* records in their possession

8 17 1 2 The information supplied in response to this

1023

question in a prior *environmental site assessment* may be used provided it is updated to the present time

8 18 Does the *property* discharge waste water, on or adjacent to the *property* other than storm water into a sanitary sewer system?

_____Yes _____No _____Unknown

8 18 1 *Guide*

8 18 1 1 The *owner* and each *occupant* should be asked where drain traps lead and the purpose of drainage pipes at the facility Domestic sewage is not a CERCLA issue and the reference to *wastewater* does not include domestic sewage

8 18 1 2 To use the information supplied in response to this question in a prior *environmental site assessment*, the *preparer* must determine if there was any change in discharge practices at the facility since the prior *environmental site assessment* If not, using information in the prior *environmental site assessment* is appropriate If so, the information requested must be supplied for all new or changed discharge practices

8 18 1 3 Some jurisdictions require facilities with large roof or paved areas and construction sites to collect and divert runoff through a treatment process prior to discharging the stormwater runoff to municipal, separate storm sewer systems, or the waters of the United States Such units are often called stormwater treatment systems Oil-water separators are most often found outside a building under a manhole and require routine servicing to remove oil Oil-water separators are usually in restaurants, repair garages, and service stations An example of an oil-water separator is shown in Appendix X2 If any such oil-water separators or treatment systems have been installed at the *property* since a prior *environmental site assessment*, the requested information must be supplied for each new installation

8 19 To the best of your knowledge, have any *hazardous substances* or *petroleum products*, unidentified waste materials, tires, automotive or industrial batteries or any other waste materials been dumped above grade, buried and/or burned on the *property*?

_____Yes _____No _____Unknown

8 19 1 *Guide*

8 19 1 1 Past waste disposal practices should be examined because these may have resulted in *hazardous substances* or *petroleum products* being released on the *property* Does the *property* evidence any mounds or depressions that suggest a disposal site?

8 19 1 2 To use the information supplied in response to this question in a prior *environmental site assessment*, the *preparer* must determine if there was any dumping, burying, or burning of such materials at the site since the prior *environmental site assessment* If not, then using information in the prior *environmental site assessment* is appropriate If so, the information requested must be supplied for all such events since the prior *environmental site assessment*

8 20 Is there a transformer, capacitor, or any hydraulic equipment for which there are any records indicating the presence of PCBs?

_____Yes _____No _____Unknown

8 20 1 *Guide*

8 20 1 1 PCBs are regulated by the Toxic Substances Control Act 15 USC Section 2601 *et seq* and, in the absence of a release, are not regulated by CERCLA The provisions of CERCLA do apply if there is a release of PCBs Accordingly, if an affirmative answer is obtained to this question, the further focus should be on whether there have been any instances of insulating oil leakage and, if so, whether these are suspected of being PCB or PCB-contaminated

8 20 1 2 Transformers containing PCBs may have many different sizes and shapes Some of the more commonly used transformers are set forth in Appendix X2 Transformers are to be registered pursuant to 40 CFR § 761 30

8 20 1 3 Elevators and auto lifts are often run by hydraulically controlled systems containing PCBs If inspection or maintenance records for the elevator, capacitor, or other hydraulic equipment indicate no release has occurred or that regular, scheduled maintenance has taken place and the machinery does not appear to be damaged or leaking, no further inquiry is required

8 20 1 4 To use the information supplied in response to this question in a prior *environmental site assessment*, the *preparer* must determine if there were any transformers installed at the site since the prior *environmental site assessment* that are not owned by a utility, cooperative, or association If not, then using information in the prior *environmental site assessment* is appropriate, except that for any transformer identified in the prior *environmental site assessment*, the PCB status should be updated If new transformers have been installed, their PCB status should also be verified

9 Guide to Site Visit

9 1 Is the *property* or any *adjoining property* used for an industrial use?

_____Yes _____No _____Unknown

	Land Use
Property	_____
Adjoining properties north	_____
Adjoining properties south	_____
Adjoining properties east.	_____
Adjoining properties west.	_____

9 1 1 *Guide*

9 1 1 1 It is recommended that the *preparer* describe the uses of the *property* and *adjoining properties*

9 1 1 2 Certain industrial uses on the *property* may raise concerns regarding the possibility of contamination affecting the *property* For purposes of the *transaction screen questionnaire*, an industrial use is an activity requiring the application of labor and capital for the production or distribution of a product or article, including, without limitation, manufacturing, processing, extraction, refining, warehousing, transportation, and utilities Manufacturing is defined as a process or operation of producing by hand, machinery, or other means a finished product or article from raw material Industrial uses may be categorized as light or heavy industrial uses, depending upon the scale of the operations and the impact upon surrounding property in terms of smoke, fumes, and noise Regardless of such categorization, the

1324

concern for purposes of the transaction screen process is whether the use involves the processing, storage, manufacture, or transportation of *hazardous substances* or *petroleum products* For example, further inquiry would be necessary if the industrial use concerned the manufacture of paints oils, solvents, and other chemical products but not if the use concerned the storage of inert goods in containers

9 1 1 3 The term *adjoining properties* means any real property or properties the border of which is contiguous or partially contiguous with that of the *property*, or that would be contiguous or partially contiguous with that of the *property* but for a street, road, or other public thoroughfare separating them

9 2 To the best of your knowledge, has the property or any adjoining property been used for an industrial use in the past?

_____Yes _____No _____Unknown

9 2 1 *Guide*

9 2 1 1 The *user* should inspect for any indications present on the *property* that would cause the *user* to suspect an industrial facility may once have existed on the site Old buildings, pipes, containers, or other debris are indicators of previous industrial use of the site

9 2 1 2 See guide for 9 1

	Owner	Use	Dates
Previous use of property			
Previous use of properties to north			
Previous use of properties to south			
Previous use of properties to east			
Previous use of properties to west			

9 3 Is the property or any adjoining property used as a gasoline station, motor repair facility, commercial printing facility, dry cleaners, photo developing laboratory, junkyard or landfill, or as a waste treatment, storage, disposal, processing, or recycling facility?

_____Yes _____No _____Unknown

	Land Use
Property	
Adjoining properties north	
Adjoining properties south	
Adjoining properties east	
Adjoining properties west.	

9 3 1 *Guide*

9 3 1 1 It is recommended that the *preparer* describe the uses of the *property* and *adjoining properties*

9 3 1 2 Gasoline stations, motor vehicle repair facilities (with or without supplying gas for the motor vehicles), dry cleaners, photo developing laboratories, commercial printing facilities, junkyards or landfills, and waste treatment, storage, disposal, processing, or recycling facilities all involve the use of *hazardous substances* or *petroleum products* and therefore require further inquiry concerning the possible release of such substances

9 3 1 3 The term *adjoining properties* means any real property or properties the border of which is contiguous or partially contiguous with that of the *property*, or that would be contiguous or partially contiguous with that of the *property* but for a street, road, or other public thoroughfare separating them Adjoining properties include those that border the property and include properties across the street or any right of way from the property

9 4 To the best of your knowledge, has the *property* or any *adjoining property* been used in the past as a gasoline station, motor repair facility, commercial printing facility, dry cleaners, photo developing laboratory, junkyard or landfill, or as a waste treatment, storage, disposal, processing, or recycling facility?

_____Yes _____No _____Unknown

9 4 1 *Guide*—See guide for 9 2 and 9 3

	Owner	Use	Dates
Previous use of property			
Previous use of properties to north			
Previous use of properties to south			
Previous use of properties to east			
Previous use of properties to west			

LAND ISSUES

9 5 Are there currently or to the best of your knowledge have there been previously, any damaged or discarded automotive or industrial batteries, or pesticides, paints, or other chemicals in individual containers of greater than 5 gal (19 L) in volume or 50 gal (190 L) in the aggregate, stored on or used at the *property* or at the facility?

_____Yes _____No _____Unknown

9 5 1 *Guide*

9 5 1 1 Are there any containers on the site that may contain any one of these items? Is there any reason to suspect that chemicals or *hazardous substances* or *petroleum products* in such quantities may be stored on the site? Sheltered areas, cartons, sacks, storage bins, large canisters, sheds, or cellars of existing improvements should be investigated because these are areas where chemicals or *hazardous substances* or *petroleum products* may be stored If the answer to this question is "yes," list the items and the location(s) where they are stored If you are unfamiliar with the contents of any container located on the site, the question must be answered "yes" until the materials are identified The existence of any damaged or opened containers identified as containing *hazardous substances* or *petroleum products* requires further investigation

9 5 1 2 *Hazardous substances* or *petroleum products* may often be unmarked The *preparer* should never open any unmarked containers at the facility because they may contain explosive materials or acids

9 5 1 3 Consumer products in undamaged containers used for routine office maintenance or business, such as copy toner, should not create a need for further inquiry unless the quantity of such products is in excess of what would be customary for such use The Environmental Protection

1025

Agency has published a guidance document that identifies hazardous substances or petroleum products that must be reported under Section 311 and 312 of EPCRA[8] This document lists in tabular form the CERCLA Section 103 chemicals If a preparer has a question regarding whether the substance is a hazardous substance under CERCLA, the preparer may refer to the list of lists or 40 CFR Part 302 In addition, the Environmental Protection Agency has also published a guidance document[9] This document sets forth the hazardous substances or petroleum products found in many common consumer products listed by trade name

9 6 Are there currently, or to the best of your knowledge have there been previously, any industrial *drums* (typically, 55 gal (208 L)) or sacks of chemicals located on the *property* or at the facility?

_____Yes _____No _____Unknown

9 6 1 *Guide*—If found, they will require further examination with respect to any *hazardous substance* associated with them

9 7 Has *fill dirt* been brought onto the *property* that originated from a contaminated site or that is of an unknown origin?

_____Yes _____No _____Unknown

9 7 1 *Guide*—*Fill dirt* brought onto the *property* may appear as mounds or depressions that do not appear to be naturally occurring *Fill dirt* may be added in construction of a facility The term *fill dirt* is defined in the definitions and the *preparer* should refer to the definitions if the *preparer* has any question concerning the meaning of the term

9 8 Are there currently, or to the best of your knowledge have there been previously, any *pits ponds or lagoons* located on the *property* in connection with waste treatment or waste disposal?

_____Yes _____No _____Unknown

9 8 1 *Guide*—The presence of *pits ponds or lagoons*, together with waste treatment or waste disposal may indicate contaminated property See the definitions with respect to the definition of *pits ponds or lagoons* in 3 2 26

9 9 Is there currently, or to the best of your knowledge has there been previously, any stained soil on the *property*?

_____Yes _____No _____Unknown

9 9 1 *Guide*—Stained soils are frequently associated with contamination and often are an indication of either current or previous leakage associated with piping and liquid storage containers Soils that are stained show a marked discoloration as compared to other soils in the immediate vicinity

9 10 Are there currently, or to the best of your knowledge have there been previously, any evidence of any registered or unregistered storage tanks (above or underground) located on the *property*?

_____Yes _____No _____Unknown

9 10 1 *Guide*—Tanks are often used to store heating fuels, chemicals, and *petroleum products*; while tanks may be associated with storage of chemicals, they are most often associated with liquid fuel heating systems (that is, oil furnaces) Examples of tanks are illustrated in Appendix X2

9 11 Are there currently, or to the best of your knowledge have there been previously, any vent pipes, fill pipes, or access ways indicating a fill pipe protruding from the ground on the property or adjacent to any structure located on the property?

_____Yes _____No _____Unknown

9 11 1 *Guide*—Vent or fill pipes often signal the current or previous existence of underground storage tanks Additionally, observations should be made regarding any asphalt or concrete patching that would indicate the possibility of previous underground storage tank removal Examples of vent and fill pipes are illustrated in Appendix X2

STRUCTURE ISSUES

9 12 Are there currently, to the best of your knowledge or have there been previously, any flooring, drains, or walls located within the facility that are stained by substances other than water or are emitting foul odors?

_____Yes _____No _____Unknown

9 12 1 *Guide*—Stains (other than water stains) or foul odors may indicate leaks of *hazardous substances* or *petroleum products* or contaminants Floor drains located within a building adjacent to *hazardous substance* storage areas or connected to an on-site disposal system (e g , septic system) present a potential source of subsurface discharge of contaminants

OTHER ISSUES

9 13 If the *property* is served by a private well or non-public water system, have contaminants been identified in the well or system that exceed guidelines applicable to the water system or has the well been designated as contaminated by any government environmental/health agency?

_____Yes _____No _____Unknown

9 13 1 *Guide*—Evidence of well water generally consists of a 4– to 12-in (102– to 305–mm) diameter low level pipe protruding from the ground that is capped, as illustrated in Appendix X2

9 14 Does the *owner* or *occupant* of the *property* have any knowledge of *environmental liens* or governmental notification relating to past or recurrent violations of environmental laws with respect to the property or any facility located on the property?

_____Yes _____No _____Unknown

9 14 1 *Guide*—In most cases, the federal or state government will notify the property owner prior to filing a lien on the property Sections 302, 311, 312, and 313 of The Emergency Planning and Community Right-to-Know Act and other provisions of federal and state environmental laws establish reporting requirements with respect to businesses storing or using *hazardous substances* or *petroleum products* in excess of certain quantities These businesses should be making periodic reports to a federal, state, or local environmental department, agency, or bureau The government may periodically inspect such facilities to ensure compliance with environmental laws In the event of a release, the owner or occupant is obligated to notify the U S EPA of the release Any notification or response by any governmental entity will be in writing.

1026

9 15 Has the *owner* or *occupant* of the *property* been informed of the past or current existence of *hazardous substances* or *petroleum products* or environmental violations with respect to the *property* or any facility located on the *property*?

_____Yes _____No _____Unknown

9 16 Does the *owner* or *occupant* of the *property* have any knowledge of any *environmental site assessment* of the *property* or facility that indicated the presence of *hazardous substances* or *petroleum products* on, or contamination of, the *property* or recommended further assessment of the *property*?

_____Yes _____No _____Unknown

9 17 Does the *owner* or *occupant* of the *property* know of any past, threatened, or pending lawsuits or administrative proceedings concerning a release or threatened release of any *hazardous substance* involving the property by any owner or occupant of the *property*?

_____Yes _____No _____Unknown

9 18 Does the property discharge *wastewater*, on or adjacent to the property other than storm water or into a sanitary sewer system?

_____Yes _____No _____Unknown

9 18 1 *Guide*

9 18 1 1 All drain traps and pipes should be examined and their end points should be determined Any ditches or streams on or adjacent to the site should be *visually and physically observed* for *wastewater* flow

9 18 1 2 Some jurisdictions require facilities with large roof or paved areas and construction sites to collect and divert such runoff through a treatment process prior to discharging the stormwater runoff to municipal, separate storm sewer systems, or the waters of the United States Such units are often called stormwater treatment systems Oil-water separators are most often found outside a building under a manhole and require routine servicing to remove oil Oil-water separators are usually in restaurants, repair garages, and service stations An example of an oil-water separator is shown in Appendix X2

9 19 To the best of your knowledge, have any *hazardous substances* or *petroleum products*, unidentified waste materials, tires, automotive, or industrial batteries or any other waste materials been dumped above grade, buried and/or burned, on the site?

_____Yes _____No _____Unknown

9 19 1 *Guide*—Past waste disposal practices should be examined because these may have resulted in *hazardous substances* being released on the *property* Does the site evidence any mounds or depressions that suggest a disposal site?

9 20 Is there a transformer, capacitor, or any hydraulic equipment for which there are any records indicating the presence of PCBs?

_____Yes _____No _____Unknown

9 20 1 *Guide*

9 20 1 1 PCBs are regulated by the Toxic Substances Control Act 15 USC Section 2601 *et seq* and, in the absence of a release, are not regulated by CERCLA The provisions of CERCLA do apply if there is a release of PCBs Accordingly, if an affirmative answer is obtained to this question, the further focus should be on whether there have been any instances of insulating oil leakage and, if so, whether these are suspected of being PCB or PCB-contaminated

9 20 1 2 Elevators and auto lifts are often operated by hydraulically controlled systems containing PCBs If inspection or maintenance records for the elevator, capacitor, or other hydraulic equipment indicate no release has occurred and the machinery does not appear to be damaged or leaking, no further inquiry is required

9 20 1 3 Transformers containing PCBs may have many different sizes and shapes Some of the more commonly used transformers are set forth on Appendix X2 Transformers are to be registered pursuant to 40 CFR § 761 30

10 Guide to Government Records/Historical Sources Inquiry

10 1 Do any of the following federal government record systems list the property or any property within the circumference of the area noted below

National Priorities List—within 1 0 mile (1 6 Km)? _____Yes _____No
CERCLIS List—within 0 5 mile (0 8 Km)? _____Yes _____No
RCRA TSD Facilities—within 1 0 mile (1 6 Km)? _____Yes _____No

10 1 1 *Guide*

10 1 1 1 The NPL or National Priorities List is a list compiled by EPA pursuant to CERCLA 42 USC § 9605(a)(8)(B) of properties with the highest priority for cleanup pursuant to EPA's Hazard Ranking System See 40 CFR Part 300

10 1 1 2 The Comprehensive Environmental Response Compensation and Liability Information System (CERCLIS) is the list of sites compiled by EPA that EPA has investigated or is currently investigating for potential hazardous substance contamination for possible inclusion on the national Priorities List

10 1 1 3 RCRA TSD Facilities are those facilities on which treatment, storage and/or disposal of hazardous wastes takes place, as defined and regulated by RCRA The RCRA TSD Facilities List is a list kept by EPA of those facilities on which treatment, storage, and/or disposal of hazardous wastes takes place, as defined and regulated by RCRA

10 1 1 4 If the preparer elects to obtain the records directly from government agencies, those records typically must be obtained through a formal written request to the office within each agency that is responsible for maintaining the records or for responding to public requests for records At the federal level, these requests are governed by the Freedom of Information Act (FOIA) FOIA requires a written request and the request should identify the records the preparer requires and should identify the site and geographic area for which the preparer needs the records (e g , the address of the site and the appropriate city, county, or zip code to be searched) The request should be directed to the FOIA officer for the regional EPA office responsible for the region in which the site is located A list of the FOIA offices for each of the EPA regions may be obtained from the federal government or local library From the federal EPA offices, the *preparer* should anticipate a response no sooner than four to eight weeks.

1027

10 1 1 5 If government information is obtained from a commercial service, the firm should provide ensurances that its records stay current with the government agency record sources Government information obtained from commercial sources may be considered current if the source updates the information at least every 90 days, or for information that is updated less frequently than quarterly by the government agency, within 90 days of the date the government agency makes the updated information available to the public

10 1 1 6 The information supplied in response to this question in a prior *environmental site assessment* may be used provided it is updated to the present time

10 2 Do any of the following state record systems list the *property* or any *property* within the circumference of the area noted below

List maintained by state environmental agency of hazardous waste sites identified for investigation or remediation that is the state agency equivalent to NPL—within 1 0 mile (1 6 Km)?

_____Yes _____No

List maintained by state environmental agency of sites identified for investigation or remediation that is the state equivalent to CERCLIS—within 0 5 mile (0 8 Km)?

_____Yes _____No

Leaking Underground Storage Tank (LUST) List—within 0 5 mile (0 8 Km)?

_____Yes _____No

Solid Waste/Landfill Facilities—within 0 5 mile (0 8 Km)?

_____Yes _____No

10 2 1 *Guide*

10 2 1 1 The LUST list is a list of sites containing one or more underground storage tanks that have been identified as having leaked or are potentially leaking their contents into the ground or groundwater; these sites may be involved in a state cleanup program

10 2 1 2 The solid waste/landfill facilities list is a list of sites that currently accept, or have accepted in the past, waste of any kind for disposal on site Solid waste/landfill facilities lists typically are obtained through a state office of solid waste management that is often a division of the primary state environmental agency

10 2 1 3 Although many states do not have specific Freedom of Information laws, if the preparer elects to obtain the records directly from government agencies, a similar written request for state records should be made to the primary state agency responsible for environmental regulation in that state Typically, the office responsible for maintaining the records and for responding to requests for records are the same Once again, the written request should identify the specific records requested and identify the site and geographic area for which the preparer needs the records The state agency response will vary from state to state and agency to agency, but the *preparer* should anticipate a minimum of four weeks for a response

10 2 1 4 In some cases, the request should be directed to a specific state office For example, leaking underground storage tank requests should be made through either the state agency's groundwater management division, the state Fire Marshall's office, or the state Emergency Planning and Management Agency

10 2 1 5 The identity of the state office to which the request should be made can be obtained by contacting the primary state environmental agency Also, there are publications listing agency sources for each state The local public library may contain these publications

10 3 Based upon a review of *fire insurance maps* or consultation with the local fire department serving the property all as specified in the guide, are any buildings or other improvements on the property or on an adjoining property identified as having been used for an industrial use or uses likely to lead to contamination of the property

_____Yes _____No _____Not Applicable

10 3 1 *Guide*

10 3 1 1 The focus of this research is to determine whether any past use of the *property* would suggest the presence of contamination associated with the *property* If *reasonably ascertainable*, one of two sources of data should be examined in the following order of preference *fire insurance maps* showing the *property* or the local fire department serving the property However, if the user has first-hand knowledge of the use of the *property* from the present back to 1940 or if the *preparer* interviewed disinterested people with such knowledge, then the *preparer* may eliminate this research and answer "not applicable" to the questions above In addition, the preparer may eliminate this research and answer "not applicable" to the question if the *preparer* is unable to find appropriate sources of *fire insurance maps* or individuals at the local fire department for the property with knowledge of the property's past use, after making a reasonable effort in good faith to locate such information or if the information is otherwise not *reasonably ascertainable*

10 3 1 2 Subject to the previous paragraph, the *preparer* should obtain *fire insurance maps* from the period(s) not covered by the first-hand knowledge of the *user* or of those interviewed, beginning with when the maps are first available for the area or when the area was first thought to be developed At least two maps should be ordered at points in time separated by at least ten years

10 3 1 3 *Fire insurance maps* are defined in 3 2 13 To obtain a *fire insurance map* for the *property*, write to the address given in Footnote 10 and request the Map Information Source The Map Information Source will list sources of fire insurance map companies and the areas served by such companies In addition to these companies, *fire insurance maps* may also be available for review from public libraries, colleges, and local historical societies

10 3 1 4 In examining a *fire insurance map*, the *user* is only required to review those areas shown in the given source For example, if the *property* is at the edge of a map sheet, the user need not order the adjoining sheet. If a source covers a large area the *user* need only review the area within approximately ⅛ mile (200 m) of the *property*

10 3 1 5 *Fire insurance maps* reviewed as part of a prior *environmental site assessment* do not need to be searched for

[10] USGS—ESIC 507 National Center Reston Virginia 22092 (1-800-872 6277)

1028

or reviewed again, but the *preparer* should make a reasonable effort to determine the uses of the *property* since the last use identified in a prior *environmental site assessment*

11 Non-Scope Considerations

11 1 *General*

11 1 1 There may be environmental issues or conditions at a *property* that parties may wish to assess in connection with *commercial real estate* that are outside the scope of this practice (the non-scope considerations) As noted by the legal analysis in Appendix X1 of this practice, some substances may be present on a property in quantities and under conditions that may lead to contamination of the property or of nearby properties but are not included in CERCLA's definition of *hazardous substances* (42 USC 9601(14)) or do not otherwise present potential CERCLA liability In any case, they are beyond the scope of this practice

11 1 2 Whether or not a *user* elects to inquire into non-scope considerations in connection with this practice or any other *environmental site assessment*, no assessment of such non-scope considerations is required for appropriate inquiry as defined by this practice

11 1 3 There may be standards or protocols for assessment of potential hazards and conditions associated with non-scope conditions developed by governmental entities, professional organizations, or other private entities

11 1 4 Following are several non-scope considerations that persons may want to assess in connection with commercial real estate No implication is intended as the relative importance of inquiry into such non-scope considerations, and this list of non-scope considerations is not intended to be all-inclusive

11 1 4 1 Asbestos-containing materials,

11 1 4 2 Radon,

11 1 4 3 Lead-based paint,

11 1 4 4 Lead in drinking water, and

11 1 4 5 Wetlands

APPENDIXES

(Nonmandatory Information)

X1 LEGAL BACKGROUND TO FEDERAL LAW AND THE PRACTICES ON ENVIRONMENTAL ASSESSMENTS IN COMMERCIAL REAL ESTATE TRANSACTIONS

INTRODUCTION

The legal section of Subcommittee E 50 02 on Environmental Assessments in Commercial Real Estate Transactions provides the following background to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended including amended by the Superfund Amendments and Reauthorization Act (SARA), 42 USC §§ 9601 *et seq* The background to CERCLA, commonly known as the Superfund Law, outlines the potential liability for the cleanup of hazardous substances, available defenses to such liability, appropriate inquiry under Superfund, statutory definition of hazardous substances, petroleum products and petroleum exclusion to CERCLA, and reasons why certain environmental hazards are excluded from the scope of Superfund and this practice and Practice E 1527

There are several elements of Superfund liability and the commonly termed "innocent purchaser" defense, that arises out of the statutory third-party defense, that may impact on the development and understanding of this practice and Practice E 1527

X1 1 *Superfund Liability*

X1 1 1 All of the following elements of liability under Superfund must be established by a plaintiff before a defendant will be held liable under Superfund for a *government s* response costs [11]

X1 1 1 1 The site is a facility, as defined as § 9601(9),

X1 1 1 2 A release or threatened release of a hazardous substance from the site occurred (release is defined at § 9601(22) as *any* amount of any hazardous substance, "hazardous substance" is defined at § 9601(14) (see statutory definition of hazardous substance below),

X1 1 1 3 A release or threatened release caused the plaintiff to incur response costs Response costs are defined at § 9601(25) to mean costs related to both removal actions (§ 9601(23)) and remedial actions (§ 9601(24)), and

X1 1 1 4 Defendants fall within at least one of the four classes of responsible parties [12]

[11] USC § 9607(a) (All statutory references are to Title 42 of the United States Code unless otherwise specified.) See *United States versus Aceto Agricultural Chemicals Corp* 872 F 2d 1373 (8th Cir 1989) Private plaintiffs, as well as the government, may seek response costs under Superfund from defendants. While many users of these practices or other private parties may think in terms of how to defend against Superfund liability they should recognize that they may decide to conduct cleanup actions and seek response costs from other parties.

[12] The four classes of potentially responsible parties (PRPs) are listed at § 9607(a) as follows.

1029

X1 1 2 In order to recover response costs, a government plaintiff must prove that the costs were not inconsistent with the National Oil and Hazardous Substances Pollution Contingency Plan (commonly referred to as the National Contingency Plan or NCP), 40 CFR § 300 [13] A private plaintiff must prove its costs were necessary costs of response and that the response action was consistent with the NCP 42 USC § 9607 (a) [14]

X1 1 3 If there is a release or threatened release of hazardous substances on a site, private parties, even if they are not PRPs, may decide to incur response costs and seek recovery from other private parties The PRPs may seek contribution from other PRPs

X1 1 4 There is an important difference between the government's burden to show that its response costs are "not inconsistent with the NCP" and the burden a private party bears to show that its response costs are "consistent with the NCP " See § 9607 (a)(4)(A) and (B) Courts have interpreted this statutory difference to give the government a rebuttable presumption that its response costs are consistent with the NCP, whereas a private party who undertakes response costs and seeks recovery from responsible parties bears the burden of proving its response was consistent with the NCP [15] The EPA takes the position that a private party who undertakes a response action must be only in "substantial compliance," rather than strict technical compliance, with the NCP, as long as a CERCLA-quality cleanup is achieved The NCP requirements for a private party response-action are set forth at 40 CFR § 300 700

X1 2 *Defenses to Liability*

X1 2 1 Assuming all the elements of liability exist, a party may avoid liability only by meeting one of the defenses listed in § 9607(b) These listed defenses are exclusive of all others [16] Section 9607(b) states (*emphasis added*)

There shall be no liability under subsection (a) for a person otherwise liable who can establish by a preponderance of the evidence (the lowest evidentiary standard available meaning more probable than not) that the release or threat of release of a hazardous substance and the damages resulting therefrom were *caused solely by*—

1) an act of God,

2) an act of war

3) *an act or omission of a third party other* than an employee or agent of the defendant, or *than one whose act or omission occurs in connection with a contractual relationship* (see the definition of contractual relationship" below) existing directly or indirectly, with the defendant

if the defendant establishes by a preponderance of the evidence that (a) he exercised due care with respect to the hazardous substance concerned and (b) he took precautions against foreseeable acts or omissions of any such third party and the consequences that could foreseeably result from such actions or omissions "

X1 2 2 Under § 9601(35)(A), a contractual relationship "includes, but is not limited to, land contracts, deeds, or other instruments transferring title or possession " These contractual relationships with third parties eliminate the defense to liability unless the defendant is an innocent purchaser Or as stated by the status of § 9601(35)(A) (*emphasis added*), a contractual relationship with the third party defeats the defense

unless the real property on which the facility is located was acquired by the defendant after disposal or placement of the hazardous substance and one or more of the following circumstances is also established by the defendant by a preponderance of the evidence

(i) At the time the defendant acquired the facility the defendant did not know and had no reason to know that any hazardous substance which is the subject of the release or threatened release was disposed of on, in, or at the facility

(ii) The defendant is the government

(iii) The defendant acquired the facility by inheritance or bequest "

X1 2 3 Therefore, the so-called innocent purchaser defense arises out of the third party defense of § 9607(b)(3) Restated, this defense to Superfund liability is available only if the defendant shows the following

X1 2 3 1 The release or threat of release was caused solely by a third party,

X1 2 3 2 The third part is not an employee or agent of the defendant,

X1 2 3 3 The acts or omissions of the third party did not occur in connection with a direct or indirect contractual relationship to the defendant, or if there was a contractual relationship, the defendant acquired the property after disposal or placement of the hazardous substance, and at the time the defendant acquired the facility the defendant *did not know and had no reason to know* that any hazardous substance which is the subject of the release or threatened release was disposed of on, in, or at the facility, and

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(1) Owner and operator of a facility (see § 9601 (20)(A) the term owner or operator" does not include a person who without participating in the management of a facility holds indicia of ownership primarily to protect his security interest in the facility In *re Bergsoe Metal Corporation*, 910 F 2d 668 (9th Cir Aug. 9 1990) *Guidice versus BFG Electroplating and Manufacturing Co* 732 F Supp 556 (W D Pa. 1989) *United States versus Mirabile* 23 ERC 1511 (E D Pa. 1985) But see *United States versus Fleet Factors Corp* 901 F 2d 1550 (11th Cir 1990) *United States versus Maryland Bank and Trust Co* 632 F Supp 573 (D Md 1986) For clarification of the security interest exclusion see EPA s rule on lender liability under CERCLA, 57 Federal Register 18344 (April 29 1992)

(2) Any person who at the time of disposal of any hazardous substance owned or operated any facility at which such hazardous substances were disposed of

(3) Any person who by contract, agreement, or otherwise arranged for disposal or treatment or transport of hazardous substances and

(4) Any person who accepts hazardous substances for transport to a facility selected by such person.

[13] The National Contingency Plan is the federal government s blueprint on how hazardous substances are to be cleaned up pursuant to CERCLA

[14] See *Dedham Water Co versus Cumberland Farms Dairy Inc* 889 F.2d 1146 (1st Cir 1989) other cases cited at ABA, *National Resources Energy and Environmental Law 1989 The Year In Review* p 215 Note 155

[15] *Amland Properties Corp versus Aluminum Co of America*, 711 F Supp 784 794 (D N.J 1989) *Artesian Water Co versus New Castle County* 659 F Supp 1269 1291 (D Del 1987) *United States versus Northeastern Pharmaceutical Chemical Co* 579 F Supp 823 (W D Mo 1984) *aff'd in part rev d on other grounds* 810 F.2d 726 (8th Cir 1986)

[16] *United States versus Aceto Agricultural Chemicals Corp* 872 F 2d 1373 (8th Cir 1989) But see *United States versus Marisol Inc* 725 F Supp 833 (M D Pa. 1989) (equitable defenses under CERCLA may be available after the development of a factual record)

1530

X1 2 3 4 The defendant exercised due care with respect to the hazardous substances and took precautions against foreseeable acts or omissions of the third party

X1 2 4 The statute then states at § 9601(35)(B)(*emphasis added*)

To establish that the defendant had no reason to know as provided (above) *the defendant must have undertaken at the time of acquisition all appropriate inquiry into the previous ownership and uses of the property consistent with good commercial or customary practice* in an effort to minimize liability [T]he court shall take into account any specialized knowledge or experience on the part of the defendant the relationship of the purchase price to the value of the property if uncontaminated, commonly known or reasonably ascertainable information about the property the obviousness of the presence or likely presence of contamination at the property, and the ability to detect such contamination by appropriate inspection "

X1 3 *Appropriate Inquiry in Commercial Real Estate Transactions*

X1 3 1 One of the major questions that parties to commercial real estate transactions face when considering their potential Superfund liability is, "What level of inquiry into the previous ownership and uses of the property is appropriate to establish the innocent purchaser defense to Superfund liability?" These practices are structured to articulate the level of inquiry under Superfund that is appropriate for different situations

X1 3 2 *The Appropriate Level of Inquiry*

X1 3 2 1 The level of environmental inquiry that is appropriate under Superfund cannot be the same for every property or every party to a real estate transaction The level of inquiry, in fact, will change depending on the particular property or party involved in a transaction The statutory language, Congressional history, and common sense support this conclusion

X1 3 2 2 First, it must be noted that little case law exists to serve as guidance about the minimum level of inquiry that will be deemed appropriate for the innocent purchaser defense See, for example, *United States versus Serafini*, 706 F Supp 346 (M D Pa 1988), and 1990 U S Dist LEXIS 18466 (M D Pa 1990) (By entertaining disputed facts as to the custom and practice of viewing land prior to purchase, the court implied that appropriate inquiry necessarily varies on a site-by-site basis), *United States versus Pacific Hide and Fur Depot Inc*, 716 F Supp 1341 (D Idaho 1989) (No inquiry was required by those who received an ownership interest in property via corporate stock transfer and warranty deed under the facts of this case), *International Clinical Laboratories Inc versus Stevens*, 30 ERC 2066, 20 ELR 20,560 (E D N Y 1990) (Despite a long history of toxic wastewater disposal and presence of the site on the state's hazardous waste disposal site list, the purchaser established the innocent purchaser defense since there were no visible environmental problems at the site, the defendant had no knowledge of environmental problems at the site, and the purchase price did not reflect a reduction on account of the problem)

X1 3 2 3 While the statute does not specifically distinguish certain types of properties and uses from others, or certain types of parties from others, it does list certain factors courts should consider in determining whether one's inquiry under the circumstances is appropriate The statute, as explained above in X1 2 requires a court to consider a party's specialized knowledge or experience The statute further mandates a court to consider what is "*reasonably* ascertainable information about the property," what contamination is *obviously* present, and the *party s ability* to detect such contamination" The very use of terms such as "appropriate" and "reasonably", and the use of "specialized knowledge and experience" and "ability" in conjunction with the specific person attempting to utilize the defense signifies that Congress did not intend the appropriateness of the inquiry be judged by a bright line standard If it is so intended, Congress would have stated, but did not, that the same inquiry should be made in every case

X1 3 2 4 What is reasonable and obvious to one party may not be so to other parties, and ability, by necessity, varies among all parties The statute, therefore, recognizes that different properties and parties must be treated differently That is, different parties may conduct different levels of inquiry appropriate to their circumstances

X1 3 2 5 The statutory standard of "appropriate inquiry" suggests the level of inquiry will depend on the circumstances and the underlying facts Since the facts are almost always different, the level of inquiry must change with them The legislative history on this particular issue demonstrates that Congress intended that the level of inquiry changes with the type of property and party [17]

The duty to inquire under this provision shall be judged as of the time of acquisition Defendants shall be held to a higher standard as public awareness of the hazards associated with hazardous releases has grown, as reflected by this Act, the 1980 Act [CERCLA] and other Federal and State statutes

Moreover good commercial or customary practice with respect to inquiry in an effort to minimize liability shall mean that a reasonable inquiry must have been made in all circumstances, in light of best business and land transfer principles

Those engaged in commercial transactions should, however be held to a higher standard than those who are engaged in private residential transactions

X1 3 2 6 Because few cases address the standard of inquiry in the innocent purchaser defense and the legislative history describing Congressional intent is sparse, common sense is a useful guide in interpreting statutory language If CERCLA mandated that the level of inquiry be the same for every property or potential defendant, then a lay consumer (renter or buyer) of a home, a purchaser of a small environmentally benign business, and a multinational corporate buyer of an industrial complex would have to conduct the same environmental site assessment (ESA) of the different properties in question Additionally, the statute makes no mention of a Phase I ESA or any other specific type of inquiry one is to conduct in order for the inquiry to be deemed appropriate If all inquiries had to be at the same level to be "appropriate," it would be illogical to stop at a Phase I ESA since some commercial or industrial properties routinely undergo, in the exercise of good commercial and customary practices, intrusive sampling (typically a Phase II ESA activity) Therefore, since routinely some properties

[17] H R Rep No 962, 99th Cong. 2d Sess. 187 (1986) *reprint at* 1986 U.S Code Cong. and Admin. News 3276 3280

1031

undergo sampling, an inflexible standard would require sampling of all properties no matter what its use This could not have been the intended result of SARA

X1 3 3 *The Minimum Inquiries to Satisfy All Appropriate Inquiry*

X1 3 3 1 Recognizing that inquiry changes with the underlying circumstances, the next question concerns that level of inquiry, if any, that Superfund requires to utilize the innocent landowner defense

X1 3 3 2 As noted above, in some real estate transactions a Phase II ESA is routinely conducted A Phase I ESA is conducted in these transactions only as a necessary prerequisite to outline the scope of the Phase II ESA A Phase II ESA typically involves taking soil, water, and air samples to determine their contaminant content or verify that no contaminants are present or likely present Note, however, that this simplistic outline of the Phase II ESA is misleading since the party can always dig down one foot deeper, take one more sample, or conduct one more test The problem of how much inquiry is conducted, or at what level a party should begin, involves proving a negative—that is, that no contamination is present [18] Since, according to the statute, inquiries should be judged by the circumstances existing at the time of acquisition, then there could be some properties and parties to real estate transactions where it may be appropriate to begin the inquiry with an intrusive Phase II ESA in order to invoke the innocent purchaser defense to liability

X1 3 3 3 At the other extreme, the minimum level of inquiry that a party would be expected to conduct is found by looking at the least environmentally obtrusive class of property and party from a CERCLA perspective This transaction likely involves the lay buyer of a home or the renter of an apartment Assuming these parties meet the other prerequisites for the innocent purchaser defense, what level of environmental inquiry must they conduct to avoid Superfund liability? While there are no recorded court cases on this issue, the answer is probably none, unless a particular residential purchaser or renter has some specialized knowledge about or experience with the property in question that would lead a court to conclude that some questions should have been asked Beyond these rare situations, it is highly unlikely that Congress intended to saddle housing consumers with the burden of investigating or cleaning up contaminated sites In fact, EPA has issued a statement of enforcement policy to the effect that it will not generally pursue owners of single family residences pursuant to CERCLA [19] Therefore for some properties and parties to real estate transactions, it is appropriate to conduct no environmental inquiry in order to meet the innocent purchaser defense to liability

X1 3 3 4 The minimum level of appropriate inquiry under Superfund, therefore, ranges from no specialized inquiry to conducting an intrusive Phase II ESA In order to satisfy the practices, to do no specialized inquiry, such as the transaction screen or Phase I ESA, is not enough for commercial real estate transactions Under current commercial and customary practice and in light of best business and land transfer principles, however, no environmental site assessments are conducted in many real estate transactions, particularly those involving smaller properties, vacant land, or transactions of low monetary value This practice and Practice E 1527 and the minimum level of inquiry under these practices, actually raises the average level of inquiry that should be performed where the parties want to come within the protection of the innocent landowner defense

X1 3 3 5 The burden of proof is on the defendant to sustain by a preponderance of the evidence, the innocent purchaser defense This is the least onerous burden of proof available to a party in litigation The defendant must show only that the evidence offered to support the level of inquiry that was taken at the time of acquisition is of greater weight or more convincing than the evidence offered in opposition to it In other words, the evidence on the inquiry issue taken as a whole shows that the fact sought to be proved is more probable than not There may be technical or business judgments on whether the inquiry conducted or any other fact in a particular case is sufficient to meet the needs or concerns of a party to the real estate transaction The bottom line, however, is that the judgment on whether the specific facts of a case, in light of statutory language, are sufficient to produce liability or a viable defense to liability is a legal one and such judgments constitute the practice of law

X1 3 3 6 This practice is designed as the minimum level of inquiry to satisfy the practice from which a party to a commercial real estate transaction should proceed, recognizing that some parties to some commercial real estate transactions may wish to proceed by beginning with a Phase I or a Phase II ESA

X1 4 *Statutory Definition of Hazardous Substance*

X1 4 1 The statute at 42 USC § 9601(14)(A–F) defines hazardous substance by referring to five other statutes as well as to Superfund's own § 9602 The following is a description of the relevant portions of the other statutes and § 9602 of Superfund.

42 U.S C § 9601(14)(A) [A]ny substance designated pursuant to section 1321(b)(2)(A) of Title 33 " Title 33 USC § 1321 lies within the Clean Water Act and refers to among other things, hazardous substance liability 33 USC § 1321(b)(2)(A) states that the EPA shall develop as may be appropriate regulations designating as hazardous substances, other than oil as defined in this section such elements and compounds which when discharged in any quantity into" the navigable waters of the United States present an imminent and substantial danger to the public health or welfare, including, but not limited to fish, shellfish, wildlife, shorelines, and beaches "

42 U.S C § 9601(14)(B) [A]ny element, compound, mixture solution or substance designated pursuant to section 9602 of this title " Section 9602 gives EPA the authority to designate as a hazardous substance such elements, compounds, mixtures, solutions, and sub-

[18] The inability to prove a negative creates a dilemma for the potential defendant. If the party s inquiry discovers contamination then under the statute the party will not be able to avail itself of the innocent purchaser defense. If the inquiry does not discover contamination EPA or another private party can argue in a response action that the inquiry was not appropriate" and, therefore the defendant can have no defense The dilemma is explicitly recognized by Subcommittee E50 02 as beyond any reasonable interpretation of Congressional intent. The scope of these practices resolves the party s dilemma in the only reasonable way by stating. It should not be concluded or assumed that the inquiry was not appropriate inquiry merely because the inquiry did not identify existing recognized environmental conditions in connection with a property Environmental site assessments must be evaluated based on the reasonableness of the judgments made at the time and under the circumstances in which they were made" See 4 5 4

[19] EPA *Policy Towards Owners of Residential Property at Superfund Sites* OSWER Directive No 9834 6 July 3 1991

stances which when released into the environment may present substantial danger to the public health or welfare or the environment "

42 U.S C § 9601(14)(C) [A]ny hazardous waste having the characteristics identified under or listed pursuant to section 3001 of the Solid Waste Disposal Act [42 USCA § 6921](but not including any waste the regulation of which under the Solid Waste Disposal Act [42 USCA § 6901 et seq] has been suspended by Act of Congress) " The Solid Waste Disposal Act of 1980 amended the Resource Conservation and Recovery Act (RCRA) 42 USCA § 6921 of RCRA provides authority to the EPA to develop criteria for identifying characteristics of hazardous waste and for listing particular hazardous wastes within the meaning of 42 USCA § 6903(5) of RCRA RCRA, § 6903(5), defines hazardous waste to mean

'a solid waste or combination of solid wastes, which because of its quantity concentration or physical chemical, or infectious characteristics may—

(A) cause or significantly contribute to an increase in mortality or an increase in serious irreversible or incapacitating reversible illness or

(B) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of or otherwise managed "

For the identification and listing of hazardous wastes under RCRA see 40 C F R §§ 261 1 *et seq*

42 USC § 9601(14)(D) [A]ny toxic pollutant listed under section 1317(a) of Title 33 " Section 1317(a) of Title 33 refers to toxic and pretreatment effluent standards under the Clean Water Act The EPA is charged in this section with publishing and revising from time to time a list of toxic pollutants, taking "into account toxicity of the pollutant, its persistence, degradability, the usual or potential presence of the affected organisms in any waters, the importance of the affected organisms and the nature and extent of the effect of the toxic pollutant on such organisms " Each toxic pollutant listed according to this section shall be subject to effluent limitations For toxic pollutant effluent standards, see 40 CFR §§ 129 1 *et seq*

42 USC § 9601(14)(E) "[A]ny hazardous air pollutant listed under section 112 of the Clean Air Act [42 USCA § 7412] " Section 7412 of the Title 42 deals with national emission standards for hazardous air pollutants The EPA is charged here with publishing and revising from time to time ' a list which includes each hazardous air pollutant for which [it] intends to establish an emission standard under this section " The term ' hazardous air pollutant" means an air pollutant that in EPA s judgment causes, or contributes to, air pollution which may reasonably be anticipated to result in an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness " For emission standards for hazardous pollutants, see 40 CFR § 61 01 *et seq*

42 USC § 9601(14)(F) [A]ny imminently hazardous chemical substance or mixture with respect to which the [EPA] has taken action pursuant to section 2606 of Title 15 " Section 2606 of Title 15 deals with imminent hazards under the Toxic Substances Control Act (TSCA) The EPA is authorized under 15 USC § 2606 to seize an imminently hazardous chemical substance or mixture or seek other relief such as requiring notice to users of the chemical substance or public notice of the risk associated with the substance or mixture The term ' 'imminently hazardous chemical substance or mixture means a chemical substance or mixture which presents an imminent and unreasonable risk of serious or widespread injury to health or the environment."

X1 4 2 After Subsections A through F, the Superfund definition of "hazardous substance" in § 9601(14) then goes on to state

The term does not include petroleum including crude oil or any fraction thereof which is not otherwise specifically listed or designated as a hazardous substance under Subparagraphs (A) through (F) of this paragraph and the term does not include natural gas natural gas liquids liquefied natural gas or synthetic gas usable for fuel (or mixtures of natural gas and such synthetic gas) "

X1 4 3 The EPA has collected a list of "those substances in the statutes referred to in section 101(14) of the Act [42 USC § 9601(14)] " 40 CFR § 302 1 (1989) ("List of Hazardous Substances and Reportable Quantities," 40 CFR Part 302) This list changes with notices in the Federal Register Also, any time a new hazardous waste is listed, the waste automatically becomes a hazardous substance

X1 5 *Petroleum Products*

X1 5 1 Under the petroleum exclusion of CERCLA (42 USC § 9601(14)), petroleum and crude oil have been explicitly excluded from the definition of hazardous substances under CERCLA Nevertheless, petroleum products are included within the scope of both practices because such they are of concern in many commercial real estate transactions and current custom and usage is to include an inquiry into the presence of petroleum products in an environmental site assessment Inclusion of petroleum products within the scope of the practices is not based upon the applicability, if any, of CERCLA to petroleum products

X1 5 2 One reason to include petroleum products within the scope of the practice is because to do so reflects custom and usage when environmental assessments are conducted in connection with commercial real estate transactions, they customarily include an assessment of the presence or likely presence of petroleum products under conditions that may lead to contamination For example, environmental assessments ordinarily seek to assess whether there may be underground or above-ground storage tanks that may be leaking, whether those tanks contain petroleum products or some other product

X1 5 3 In addition, although CERCLA may exclude petroleum products, other laws require cleanup of releases or spills of petroleum products For example, petroleum products sometimes (for example, when they cannot be reclaimed from soil) become hazardous wastes subject to RCRA Subtitle C (42 USC § 6921 *et seq*), must be cleaned up if released from underground storage tanks pursuant to RCRA Subtitle I (42 USC § 6991 *et seq*), must be cleaned up pursuant to the Oil Pollution Act of 1990 (33 USC § 1321 *et seq*), and must be cleaned up if released into the navigable waters of the United States pursuant to the Clean Water Act (33 USC § 1251 *et seq*)

X1 5 4 Moreover, case law and EPA interpretations of the petroleum exclusion require an analysis of the facts of each case to determine whether a particular petroleum product is included in CERCLA's petroleum exclusion The exclusion has been broadly interpreted to exclude gasoline and leaded gasoline from CERCLA's definition of hazardous substances regardless of the fact that gasoline and leaded gasoline contain certain indigenous components and additives which have themselves been designated as hazardous pursuant to CERCLA See *Wilshire Westwood Associates versus Atlantic Richfield Corporation*, 881 F 2d 801 (9th Cir 1989) The interpretation was narrowed when a judicial distinction was made between petroleum fractions produced by distillation

1033

processes and waste products resulting from contaminated tank scale *United States versus Western Processing Co*, 761 F Supp 713 (W D Wash 1991) Another decision narrowly interpreted CERCLA's petroleum exclusion to be inapplicable to oil-related wastes containing hazardous substances because the primary purpose of the exclusion is to remove "spills or other releases strictly of oil" from the scope of CERCLA response and liability (not releases of hazardous substances mixed with oil) See *City of New York versus Exxon Corporation*, 744 F Supp 474 (S D N Y 1990) For additional discussion, see EPA memorandum entitled "The Petroleum Exclusion under the Comprehensive Environmental Response Compensation and Liability Act," issued by EPA's General Counsel, July 31, 1987

X1 6 *Exclusion of Certain Hazards from Superfund*

X1 6 1 The information that follows is provided to explain why these potential environmental hazards are not covered by Superfund's appropriate inquiry responsibilities

X1 6 2 As a preliminary matter, it should be noted that an environmental site assessment that does not address substances excluded from CERCLA (whether those substance are excluded because they are petroleum products or by virtue of other characteristics) but that otherwise constitutes "all appropriate inquiry into the previous ownership and uses of the property consistent with good commercial or customary practice" should nevertheless entitle the user to the innocent purchaser defense, assuming that other requirements of the defense are met

X1 6 3 *Radon*

X1 6 3 1 A case discussing Superfund and radon is *Amoco Oil Company versus Borden Inc* This case dealt with a private cost recovery action by the buyer of a site against the seller for response costs relating to radiation from phosphogypsum wastes left on the site Radon emanated from these radioactive wastes The case points out that the "EPA has designated radionuclides as hazardous substances under § 9602(a) of CERCLA Additionally, the EPA under § 112 of the Clean Air Act list radionuclides as a hazardous air pollutant " "Radon and its daughter products are considered radionuclides, which are defined as 'any nuclide that emits radiation '" Therefore, radon is a CERCLA hazardous substance Also, when discussing what constitutes a release of a hazardous substance under the statute, the statute is plain that there is no quantitative requirement and that a release, broadly defined at 42 USC § 9601(22), of *any* amount constitutes a CERCLA release

X1 6 3 2 Liability under Superfund depends on several factors, as noted in X1 1 Only one of four factors is the release or threatened release of a hazardous substance The other three factors are the site is a facility, the defendant falls within at least one of four classes of potentially responsible parties (PRPs), and the release or threatened release *caused* the plaintiff (which can be the government or another private party) to incur response costs Further, response costs must not be inconsistent with the National Contingency Plan (NCP), *and must not be limited by § 9604(a)(3)* And, of course, there is no need to raise the innocent purchaser defense and its appropriate inquiry requirements unless the elements of liability will be met.

X1 6 3 3 Where radon from any source occurs in a building, three of the liability elements under CERCLA are met There is a release of a hazardous substance, the building is a facility, and we can assume the defendant is a PRP However, under 42 USC § 9604(a)(3)(A), "[r]emedial actions taken in response to hazardous substances as they occur naturally are specifically excluded from the NCP and are therefore not recoverable " A case discussing superfund and radon is *Amoco Oil Company versus Borden Inc*, 889 F 2d 664 (5th Cir 1989) The statute is plain (42 USC § 9604(a)(3) and (4)(*emphasis added*)

(3) Limitations on response

The President shall not provide for a removal or remedial action under this section in response to a release or threat of release—

(A) *of a naturally occurring substance in its unaltered form or altered solely through naturally occurring processes or phenomena from a location where it is naturally found*

(B) from products which are part of the structure of and result in exposure within, residential buildings or business or community structures[20] or

(C) into public or private drinking water supplies due to deterioration of the system through ordinary use [21]

(4) Exception to limitations

Notwithstanding Paragraph (3) of this subsection, to the extent authorized by this section, the President may respond to any release or threat of release if in the President's direction, it constitutes a public health or environmental emergency and no other person with the authority and capability to respond to the emergency will do so in a timely manner "

X1 6 3 4 Therefore, no liability under CERCLA attaches for naturally occurring radon If a party to a real estate transaction wants to look for radon within a building, no amount of radon investigation will have any bearing on one's innocent purchaser defense under Superfund Investigation of naturally occurring radon would be included, if at all, in the portion of the practice that deals with non-scope issues

X1 6 4 *Asbestos*

X1 6 4 1 The analysis of asbestos is similar to that involving radon Before considering appropriate inquiry responsibilities, the four elements of CERCLA liability must be satisfied Once again, as with radon, they are not met

X1 6 4 2 Section 9604(a)(3)(B) of CERCLA prohibits response actions involving a release or threat of release "from products which are part of the structure of, and result in exposure within, residential buildings or business or community structures " There are a number of cases dealing with asbestos that interpret this statutory language One such case is *First United Methodist Church of Hyattsville versus United States Gypsum Co*,[22] that cites to other relevant cases

X1 6 4 3 In *First United* the church brought a private cost recovery action against the manufacturer of asbestos-containing acoustical plaster In holding that the action was barred by a state statute of repose (a certain time allowed by statute for bringing litigation) and that CERCLA did not preempt the state statute of repose, the court stated that § 9604(a)(3)(B) of CERCLA "represents much more than a

[20] This provision has implications for asbestos and lead based paint. See X1 6 4

[21] This provision has implications for lead from lead pipes and solder See X1 6 5

[22] One such case is *First United Methodist Church of Hyattsville versus United States Gypsum Co* 882 F 2d 862 (4th Cir 1989) that cites to other relevant cases.

procedural limitation on the President's authority, it is a substantive limitation of the breadth of CERCLA itself[23] Therefore, the limitations of § 9604(a)(3) apply to private parties as well

X1 6 4 4 Citing to the legislative history, the *First United* court concluded, "[i]n view of this clear expression of Congressional intent, we will not expand CERCLA to encompass asbestos-removal actions " The court further explained[23]

' In closing, we note that this interpretation of CERCLA fully comports with the most fundamental guide to statutory construction—common sense To extend CERCLA s strict liability scheme to all past and present owners of buildings containing asbestos as well as to all persons who manufactured transported, and installed asbestos products into buildings, would be to shift literally billions of dollars of removal cost liability based on nothing more than an improvident interpretation of a statute that Congress never intended to apply in this context. [FN12] Certainly, if Congress had intended for CERCLA to address the monumental asbestos problem it would have said so more directly when it passed SARA

FN12—It is for this reason that Congress simply did not intend for CERCLA to remedy the asbestos-removal problem that we decline to follow the reasoning of *Prudential Knox* and *Covalt* in rejecting First United s preemption argument Instead of recognizing the fact that CERCLA is out of context in this situation these courts rejected similar attempts to invoke the statute by construing CERCLA s key terms in a way to exclude asbestos-removal actions *Covalt* 860 F 2d [1434] at 1438 39 (defining environment" to exclude the interior of a work place), *Knox*, 690 F Supp at 756-57 (defining release" in terms of spills" or disposal") *Prudential* [711 F Supp 1244] at 1254-55 (defining disposal" to exclude the sale of a product for consumer use) We find this analysis unsatisfactory because it runs the risk of unnecessarily restricting the scope of CERCLA merely to dispose of claims that the statute was never intended to encompass in the first place It is far better to simply acknowledge the inapplicability of CERCLA to asbestos-removal claims than to restrict its operative terms "

X1 6 4 5 Since asbestos that is a part of the structure of, and results in exposure within, residential buildings or business or community structures is excluded from CERCLA liability, it should not be investigated pursuant to a party's innocent purchaser appropriate inquiry requirements Like naturally occurring radon, investigation of asbestos-containing materials that are part of the structure of buildings should be included, if at all, in the portion of the practice that deals with non-scope issues Note, however, if asbestos is disposed of on a site and, therefore, is no longer part of the structure of a building, the cleanup of the disposed asbestos is subject to Superfund response actions Likewise, if a building is sold with the knowledge that it will be demolished, one court ruled that the sale constitutes a disposal falling under CERCLA's liability provisions[24]

X1 6 5 *Lead in Drinking Water and Lead-Based Paint*—These hazards can be evaluated in terms of the exclusions of 42 USC § 9604(a)(3)(B) and (C), in an analysis similar to the analysis applied above to radon and asbestos While there is no reported case law on these environmental issues as they relate to Superfund, the statutory language seems clear that these environmental hazards are not encompassed by Superfund's appropriate inquiry responsibilities Note, however, like asbestos, where there is a disposal of these substances on the site or in a facility, CERCLA liability may arise

[23] See also *3550 Stevens Creek Associates versus Barclays Bank of California* 915 F 2d 1355 (9th Cir 1990)

[24] *CP Holdings Inc versus Goldberg Zoino and Associates Inc* 769 F Supp 432 (D N H 1991)

1035

X2 SUPPLEMENTAL INFORMATION FOR USE IN CONNECTION WITH THE GUIDE ON ENVIRONMENTAL SITE ASSESSMENTS OF COMMERCIAL REAL ESTATE

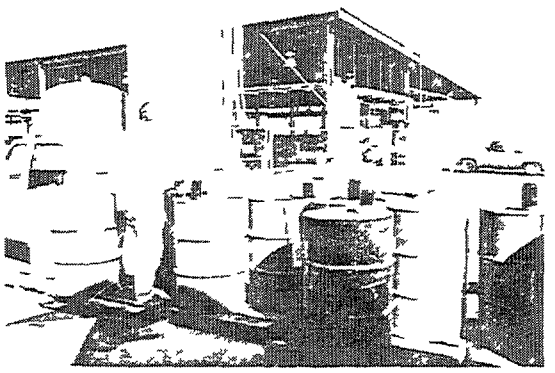


FIG X2 1 Chemical Storage in 55 gal (208 L) Steel Drums

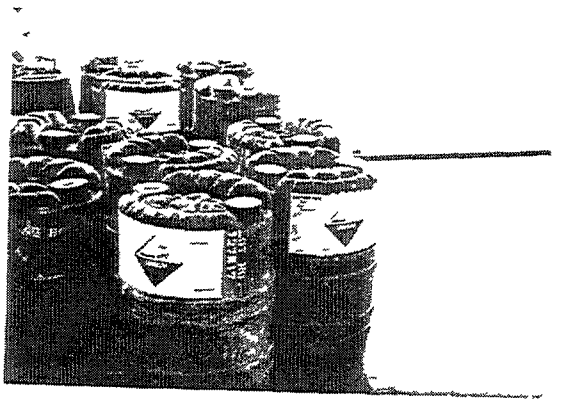


FIG X2 2 Chemical Storage in 55 gal (208-L) Plastic Drums

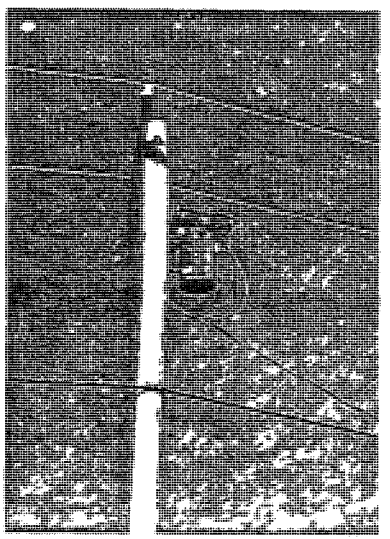
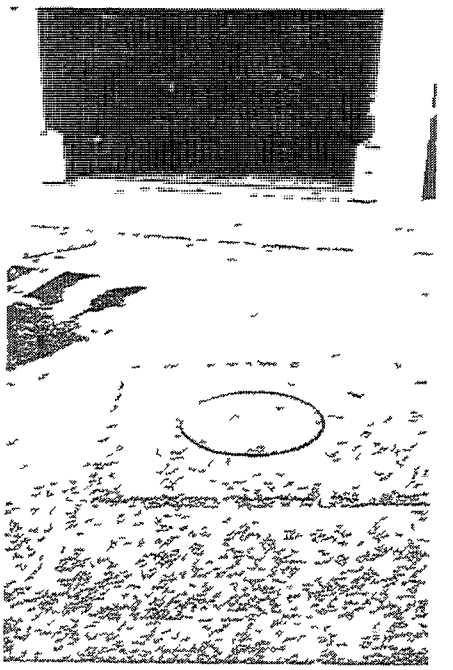
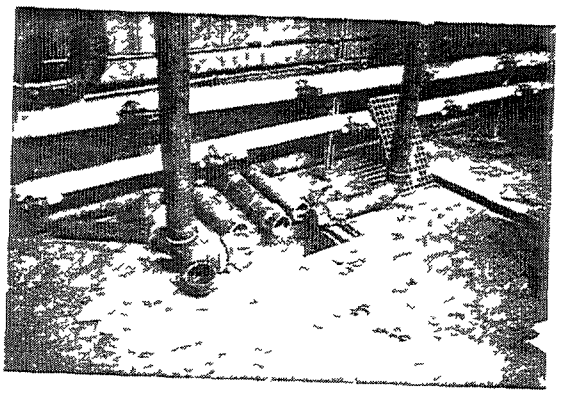


FIG X2.3 Typical Pole-Mounted Transformer



NOTE—Oil water separators are often located under manholes outside repair garages or a any location where it is necessary to separate oil from water prior to discharge

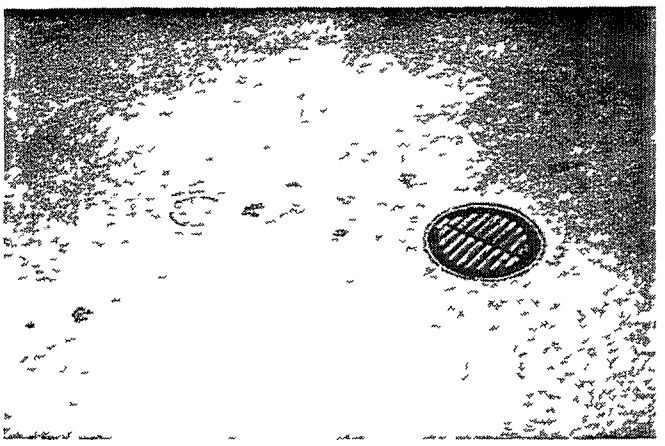
FIG X2 4 Manhole Cover Outside Repair Garage



NOTE—Floor drains come in various shapes and sizes Shown here is one type of floor drain It is important to know the point of discharge of any floor drain

FIG X2 5 Example of Floor Drain

1036



NOTE—Floor drains come in various shapes and sizes. Shown here is one type of floor drain. It is important to know the point of discharge of any floor drain.

FIG. X2.6 Example of Floor Drain

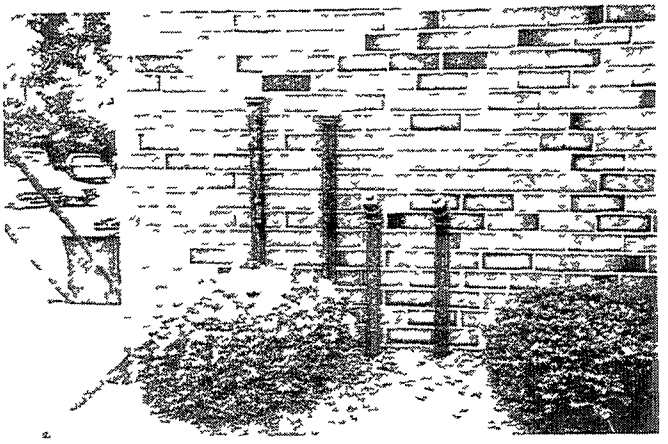


FIG. X2.7 Two Fill and Vent Pipes Leading to Two Underground Storage Tanks

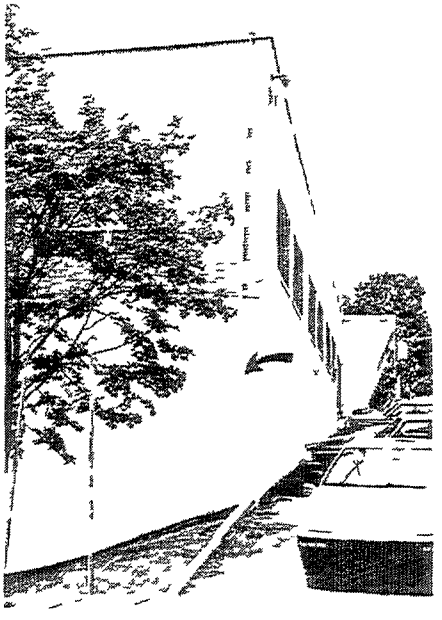
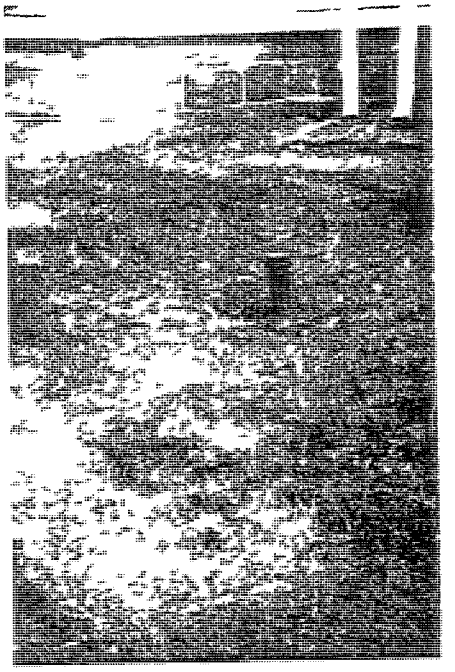
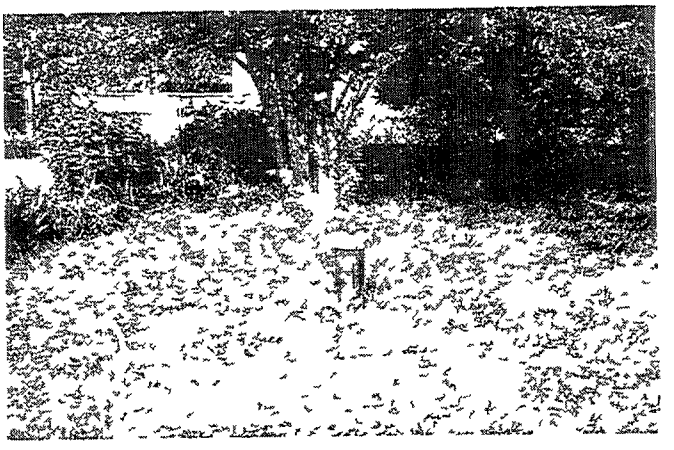


FIG. X2.8 Single Tall Vent Pipe (Arrow) for Underground Storage Tank on Side of Building



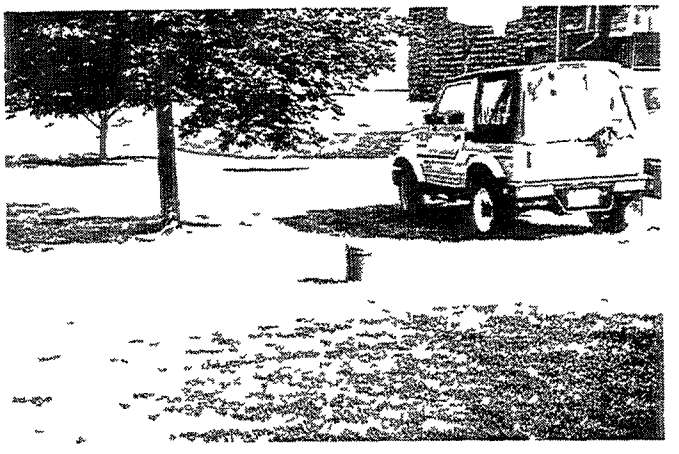
NOTE—Approximately 2½-in. (64 mm) diameter with screw cap.

FIG. X2.9 Fill Pipe for Residential Underground Fuel Oil Storage Tank



NOTE—Approximately 8-in. (203-mm) diameter.

FIG. X2.10 Water Supply Well for Residential Property



NOTE—Approximately 8-in. (203 mm) diameter.

FIG. X2.11 Water Supply Well for Residential Property

1031

FIG X2 12 Surface Staining from Improper Drum Storage

The American Society for Testing and Materials takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

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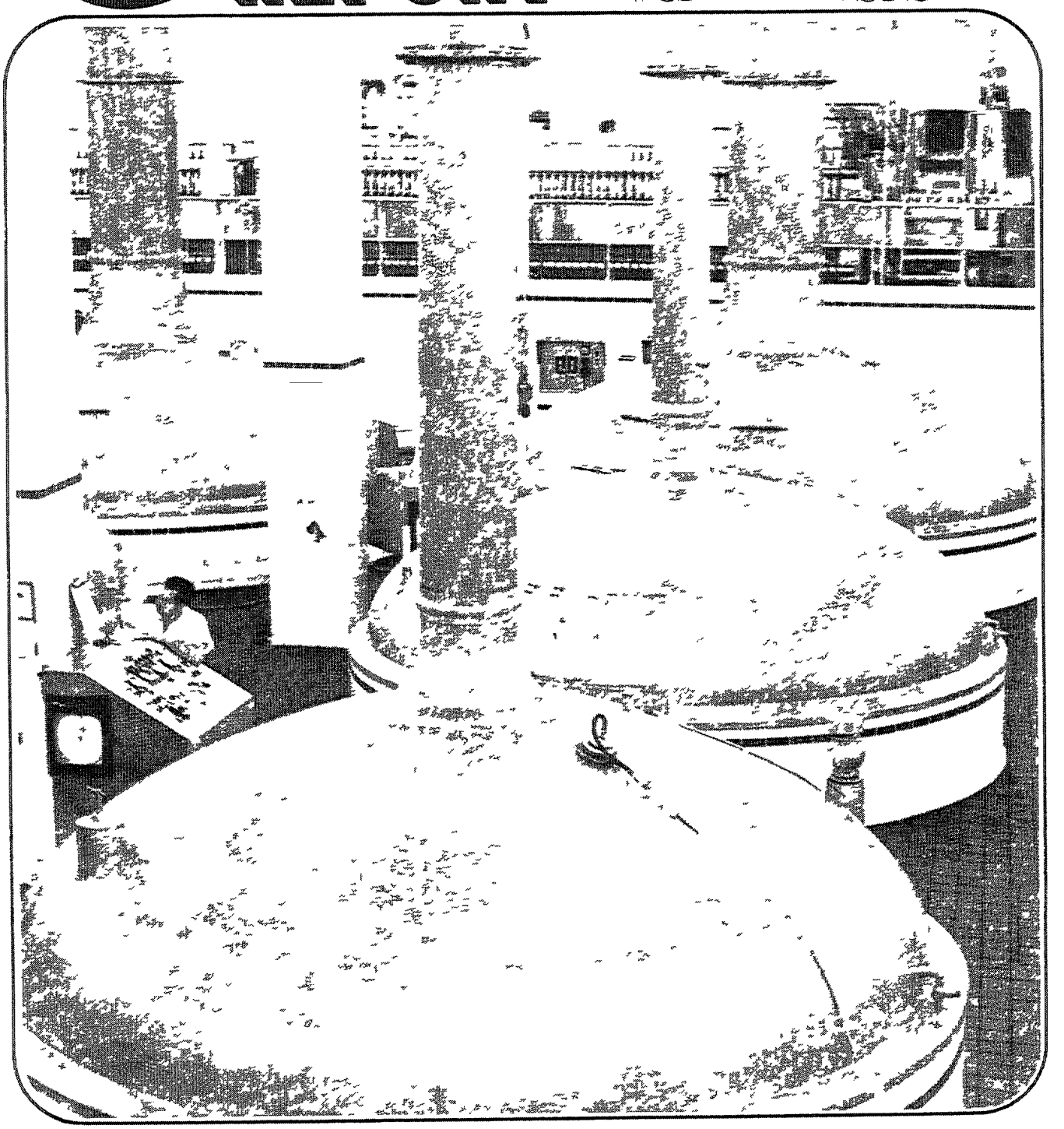
6 EPA TECHNOLOGY TRANSFER CAPSULE REPORT

POLLUTION ABATEMENT IN A BREWING FACILITY

PREPARED BY U.S. ENVIRONMENTAL PROTECTION AGENCY



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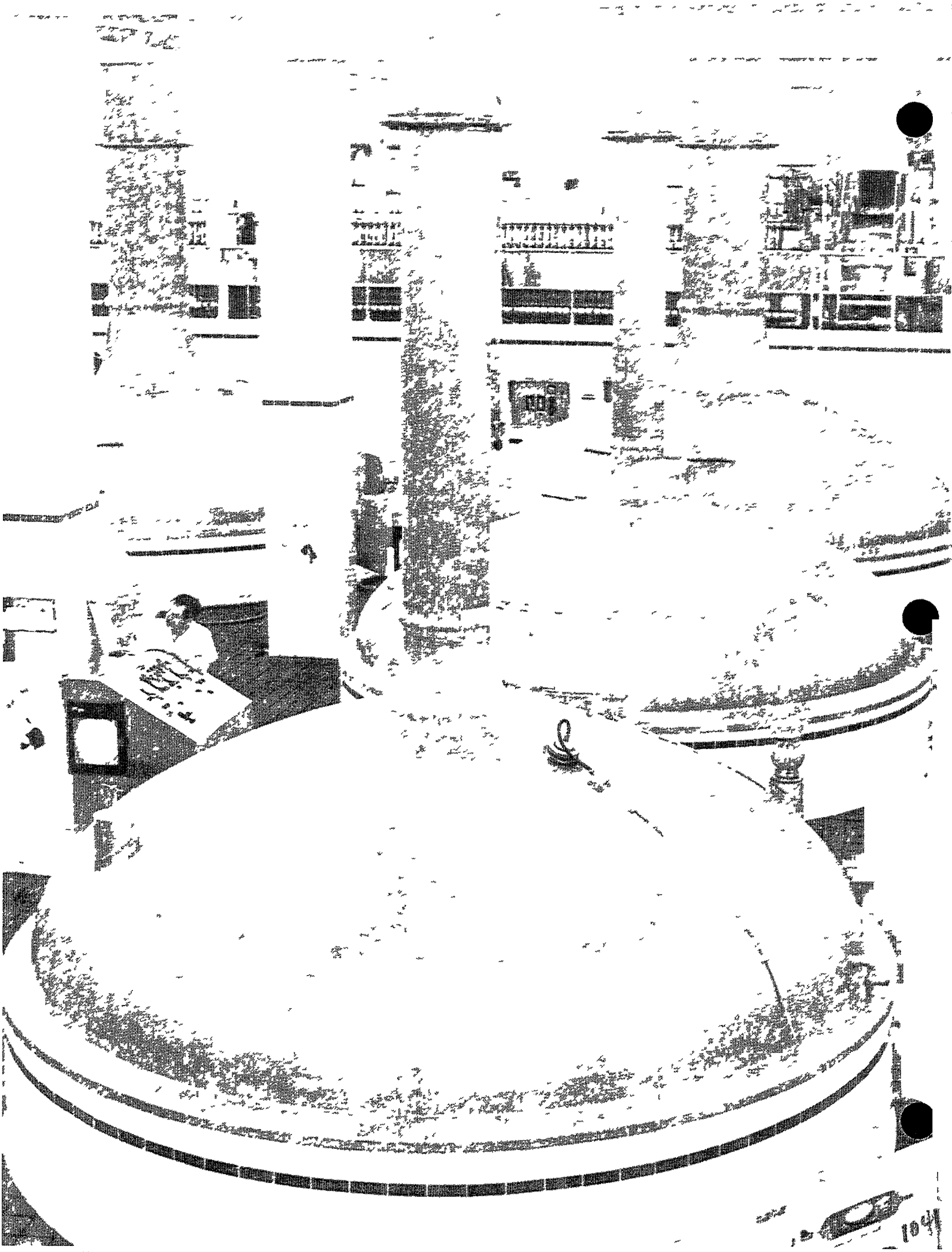
EPA TECHNOLOGY TRANSFER

6 CAPSULE REPORT

POLLUTION ABATEMENT IN A BREWING FACILITY

PREPARED BY U.S. ENVIRONMENTAL PROTECTION AGENCY

1040



THE SIGNIFICANCE

The brewing industry in the United States is comprised of 185 facilities producing malt beverages including beer, ale, and "malt liquor" Half of these are large facilities with individual water consumption rates exceeding 20 million gallons each per year and a combined water usage rate of more than 140 billion gallons per year About 60 billion gallons of the water used annually in these major facilities are discharged as wastewater The mean raw waste loading levels for the large brewing facilities are 3 05 lb/bbl beer (1622 mg/l) Biochemical Oxygen Demand (BOD) and 1 24 lb/bbl beer (772 mg/l) suspended solids These concentrations of oxygen-demanding organic materials and suspended solids in the wastewater, at the quantities discharged, are sufficiently high to potentially cause oxygen depletion and sedimentation buildup in streams unless adequate treatment is provided Therefore, treatment must be provided at either the brewery facility or at a municipal waste treatment plant prior to discharge to a stream

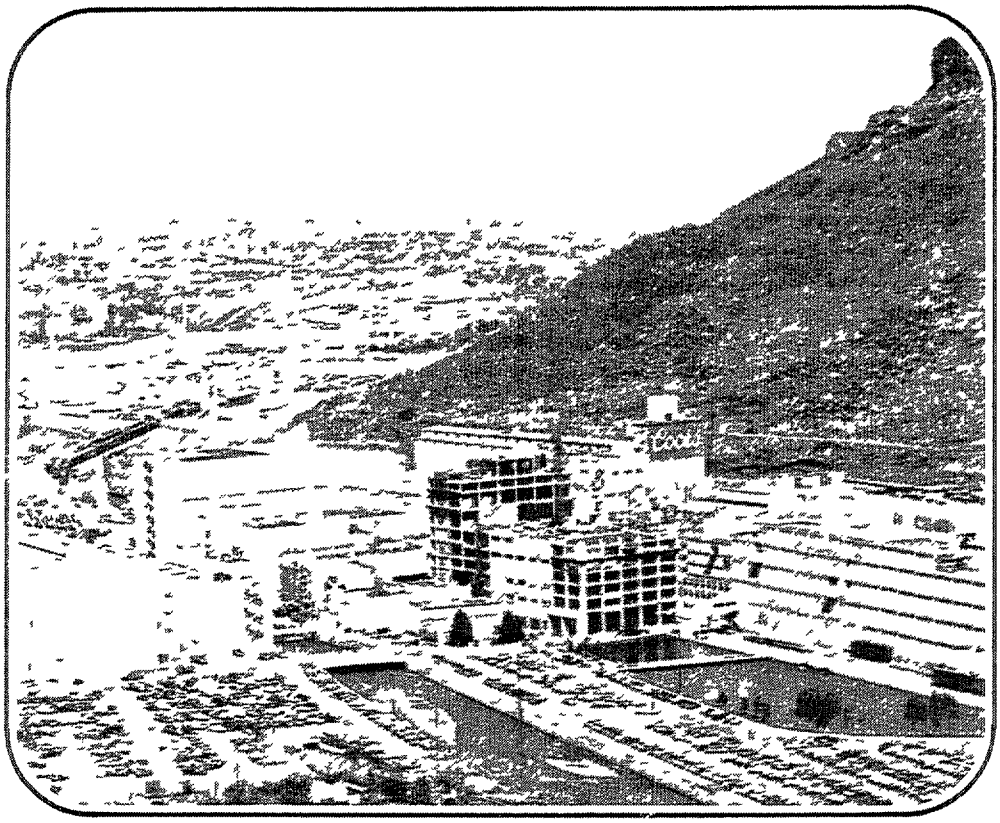
The Adolph Coors Company, now the fourth largest brewer in the United States, produces all of its malt beverages in one facility located at Golden, Colorado The Golden facility is the largest single brewery in the world, presently producing in excess of 10 5 million barrels of beer per year

Coors began its pollution control efforts in 1951 with the construction of a waste treatment facility and the initiation of a conservation program to reduce in-plant water usage and waste discharges This success is due, in part, to the top priority given to the waste reduction and treatment effort by Coors management. During the past 22 years Coors has been successful in reducing the raw waste loading to less than half of the brewing industry mean raw waste levels through engineering design improvements and changes in operating practice The raw waste from the plant is treated in the Coors waste treatment facility which provides both primary and secondary treatment. The effluent containing about 30 mg/l BOD and suspended solids is discharged from the waste treatment facility into Clear Creek, a tributary of the South Platte River, which passes through the plant site Through these and other efforts, Coors has earned the U S Environmental Protection Agency's Region Eight environmental achievement award for its total environmental program which included aluminum and glass recycling, waste treatment, air and sound pollution control and environmental planning

This report was written to show the degree of effluent reduction and savings in waste treatment facility capital and operating costs that can be achieved through a well planned and well executed environmental control program

Coors Copper Brewing Kettles

2. THE PROCESS



Adolph Coors Company Brewery Golden Colorado

The Coors plant at Golden is both a brewing and malting facility The barley malt used in brewing is produced at the facility The process flow diagram for the production of beer at the plant is shown in Figure 1

Throughout the process care is taken to minimize water usage, prevent beer or by-products from entering the waste stream, and recover as much of the protein-rich by-product material as possible for marketing as animal feed or feed supplements The recovery systems are economically feasible in addition to providing for a significant reduction in the waste load In designing new facilities or modifying existing equipment considerable attention is given to conserving water and reducing waste loads

The production of beer begins with the malting operation where barley is soaked in water in steeping tanks and transferred to germinating compartments for approximately one week to convert the starch in the barley into malt sugar The germinated barley is transferred to the malt drying kiln where the heat stops the barley's growth and partly caramalizes the malt to produce the desired beer color and flavor The malt, or dried sprouted barley is then finely ground for use in the brewing operation The malt sprouts and screenings are added to the dried waste solids and subsequently ground pelletized and marketed as animal feed

In the brewing operation finely ground malt and brewers rice are added to water in the copper mash kettle or mash tun where the mixture is heated to complete the conversion of starch to malt sugar

The mash is then filtered through a plate and frame filter and the extract is sent to the brew kettle The spent grain filter cake drops from the filter into a hopper and is pumped away with no additional sluicing water required Coors installed the plate and frame filter rather than the commonly used Lauter tub because the extract can be separated from the spent grain in the plate and frame filter with minimal water usage The Lauter tub has the

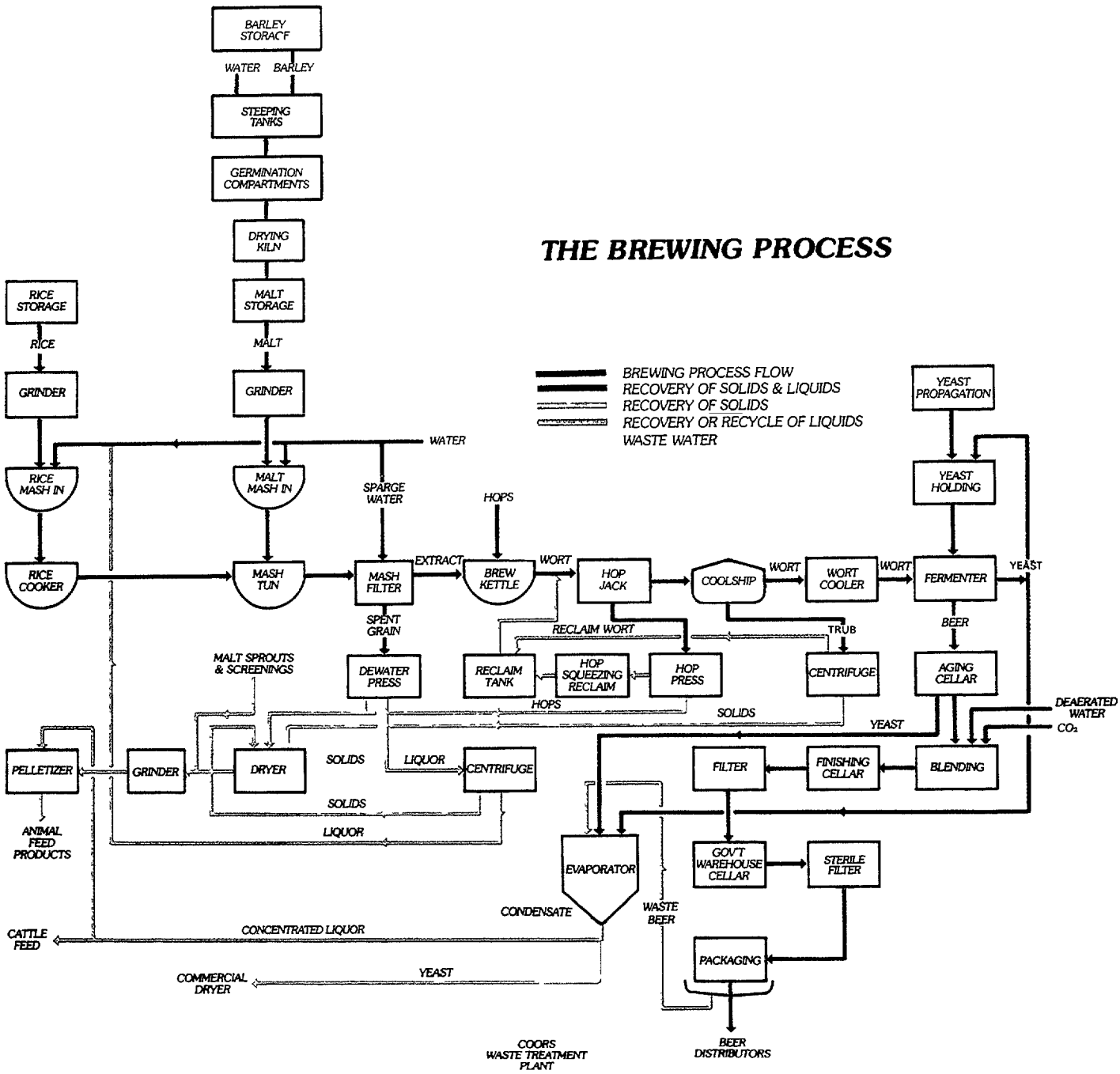


FIGURE I

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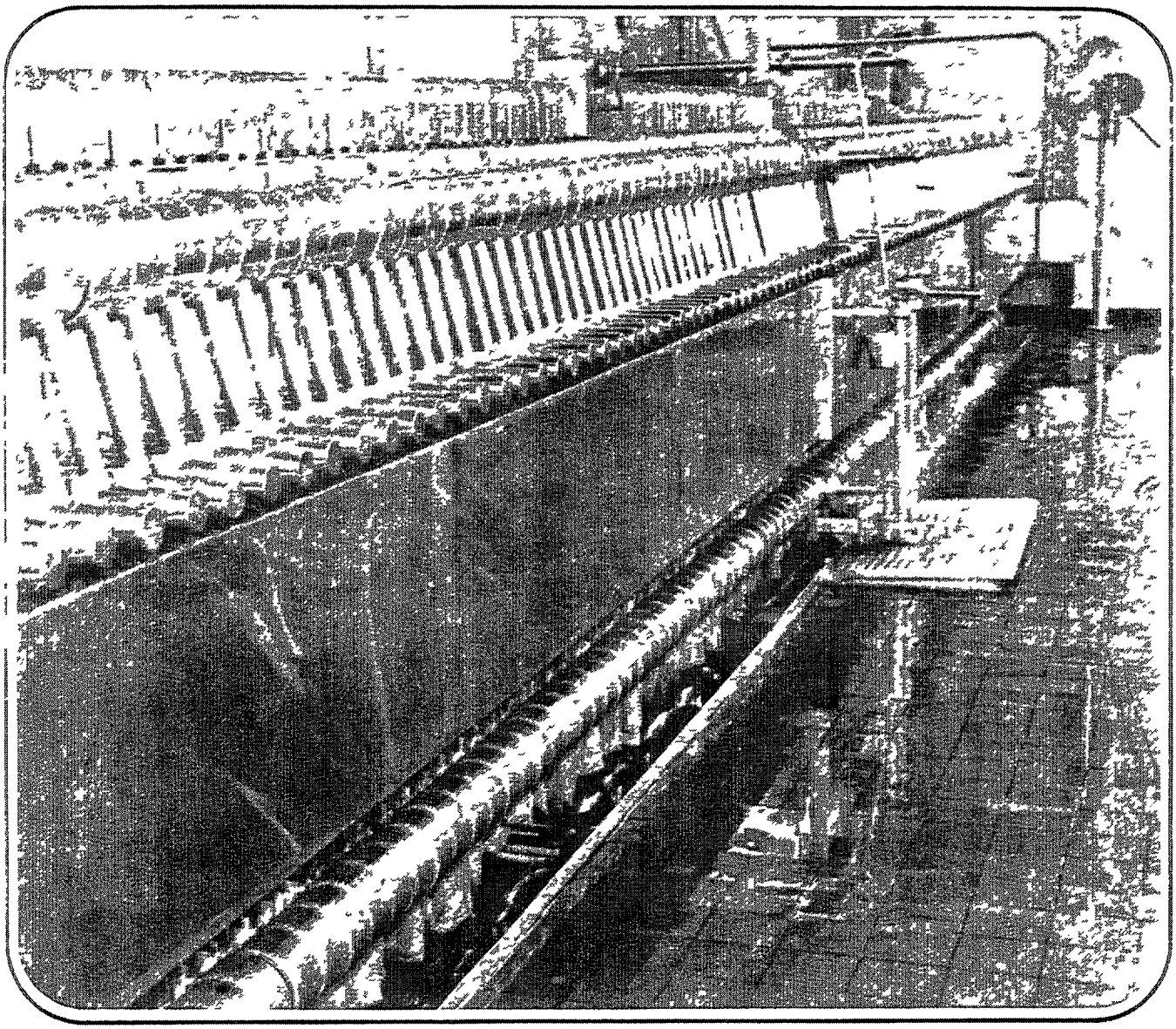
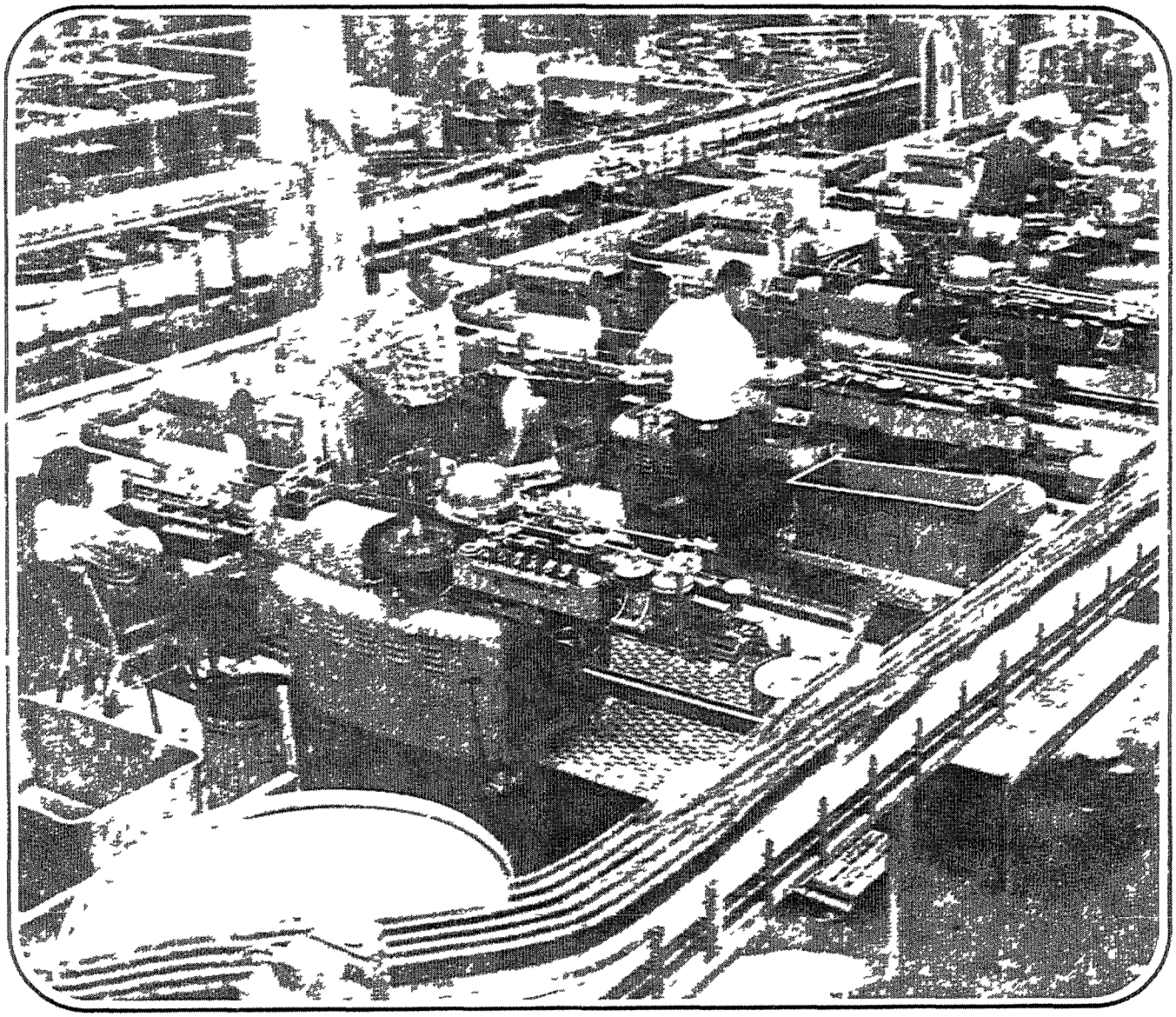


Plate and Frame Filter

disadvantage of requiring a considerable amount of water to sluice out the spent grain

The spent grain is then dewatered in a screw press and dried in a steam drier The spent grain liquor from the screw press is centrifuged to remove the solids These solids are added to the spent grain which is marketed as cattle feed The centrifuged liquor is then returned as make-up to the rice mash-in operation

In the brew kettle the malt extract is boiled vigorously with hops to add flavor and aroma The hot malt extract, called wort, is then pumped to a large circular coolship (clarifier) where insoluble proteins coagulate and are settled out. This wet coagulate called trube is then sent to a centrifuge to separate the solids from the wort. The recovered liquid wort is recycled into the process and the trube solids are added to the spent grain The wort flows from the coolship to a cooler where



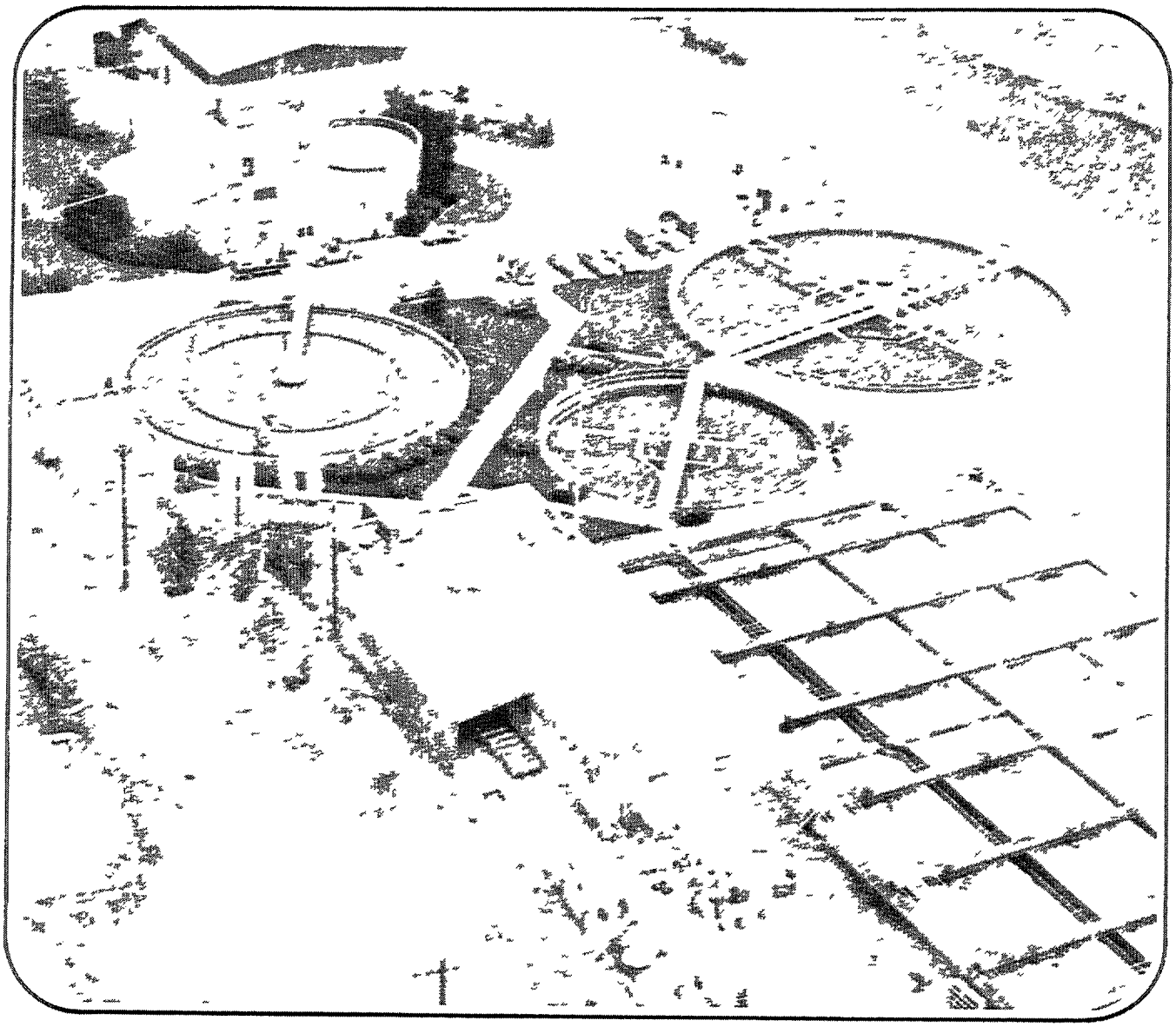
Coors Bottle Filling Room

it is cooled to achieve fermentation temperature

Specially prepared yeast cultures grown at the plant are added to the cooled wort in the fermentation tanks In the carefully controlled primary fermentation step the yeast converts the malt sugar in the wort into alcohol and CO_2 gas The fermented beer is then transferred to glass lined aging tanks for its secondary fermentation and aging period Aging under pressure permits beer to build up its own natural carbonation

After aging, the beer is chilled and pumped through batteries of filters for clarification The spent filter pads are removed and processed for reuse The beer flows from the filters to sterile filling rooms for packaging

3. THE RAW WASTE



Waste Treatment Facility

Wastes generated from the Coors combined brewing and malting operations amount to 3 3 million gallons per day at a BOD level of 825 mg/l This is less than half the waste load produced by the average large brewery without malting facilities

Table 1 shows the low rate of waste discharge achieved at Coors by a continuing program of water conservation, in-plant waste reduction and recovery of waste materials as by-products The quantities of wastewater from in-plant sources contributing to the overall raw waste load are shown in Table 2 This table shows the significant reductions in raw waste volume that Coors has achieved relative to the brewing industry mean raw waste loads from in-plant sources including cooling water, cleaning filtration, fermentation brewing and

OVERALL PLANT RAW WASTE CHARACTERISTICS

Parameter	Coors Raw Waste Loads [1]	Brewing Industry Mean Raw Waste Loads [2]
Raw Waste Volume	108 5 gal/bbl [3] beer	257 gal/bbl beer
Raw Waste BOD	0 75lb/bbl beer (825 mg/1)	3 05 lb/bbl beer (1622 mg/l)
Raw Waste Suspended Solids	0.26 lb/bbl beer (280 mg/l)	1.24 lb/bbl beer (772 mg/l)

[1] *Based on average at Coors for month of June 1973*

[2] *Industrial Waste Survey of the Malt Liquor Industry SIC No 2082 prepared for the Environmental Protection Agency August 1971 by Associated Water and Air Resources Engineers, Inc*

[3] *One barrel contains 31 gallons*

Table 1

RAW WASTE CONTRIBUTIONS FROM IN-PLANT SOURCES

Source of Raw Waste	Coors Raw Waste Loads [1] (gal/bbl beer)	Brewery Industry Mean Raw Waste Loads [2] (gal/bbl beer)
Cooling Water	3 1	43 5
House Cleaning	15 5	21.8
Aging	24 8	12 4
Filtration	6 2	21 8
Fermentation	6.2	9 3
Brewing	9 3	37.3
Malting	40.3	—
Other	3.1	111 6
TOTAL	108 5	257 7

[1] *Based on average at Coors for month of June 1973*

[2] *Industrial Waste Survey of the Malt Liquor Industry SIC No 2082 prepared for the Environmental Protection Agency August 1971 by Associated Water and Air Resources Engineers, Inc.*

Table 2

1048

COMPARISON OF RAW WASTES

Parameter	Raw Waste Characteristics at Coors Plant[1]	Raw Waste Characteristics at Equivalent Sized Plant Discharging at the Brewing Industry Mean Raw Waste Levels[2]	Ratio of Mean to Coors Raw Waste
Flow	3 3 MGD[3]	7 8 MGD[3]	2.36
BOD	22,700 lb/day	90,550 lb/day	3 99
Suspended Solids	7,710 lb/day	36,180 lb/day	4 69
Sludge Produced	13 tons/day	50 tons/day	3 85

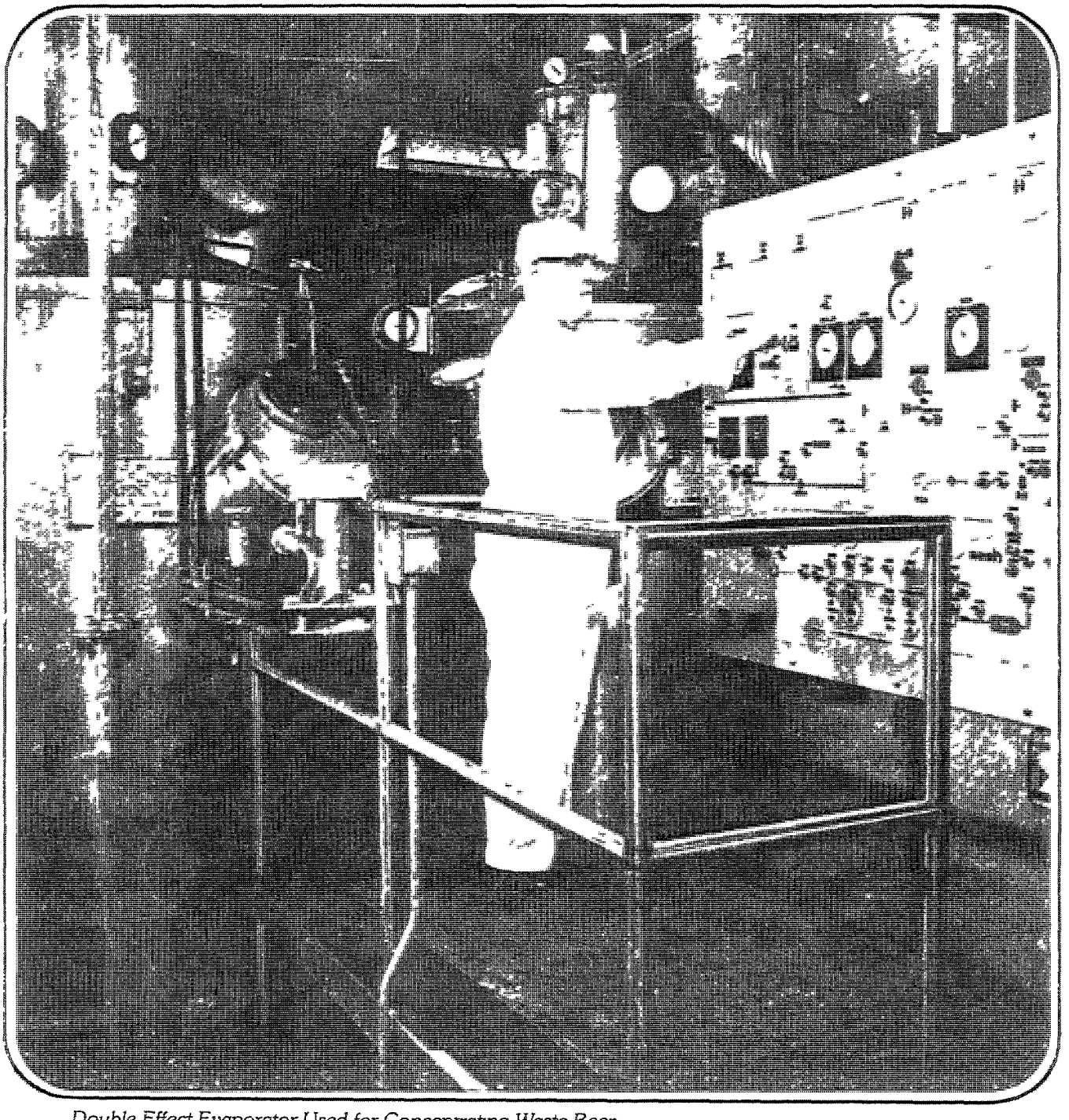
[1] *Based on average at Coors for month of June 1973*

[2] *Hypothetical plant raw waste levels calculated at brewing industry mean raw waste discharge rate for a plant producing approximately 10 5 million barrels of beer per year*

[3] *Million gallons per day*

Table 3

other sources Table 3 compares the present Coors raw waste quantities with the discharge that would be produced at the facility if the raw waste discharge per barrel of beer produced were equal to the mean levels for the brewery industry



Double Effect Evaporator Used for Concentrating Waste Beer and Spent Grain Liquor into Cattle Feed Syrup

4. THE WASTE TREATMENT SYSTEM

The Coors waste treatment facility shown in Figure 2, provides primary treatment through neutralization and solids removal, and secondary treatment through a high rate activated sludge system using a modification of the Hatfield Process

The raw waste first flows through a bar screen and a grit chamber to remove coarse solids The raw waste is continuously monitored and adjusted to a pH of 7 by an automatic control system The effluent then flows into a 550,000 gallon surge chamber which is used to equalize the flow in the waste treatment plant. The batch processes used in producing beer make flow equalization and pH control necessary in order to provide for optimum performance of the treatment system The waste is pumped out of the surge tank and into the primary clarifier at a constant rate

Effluent from the primary clarifier then enters the activated sludge portion of the plant and is mixed in the aeration basins with return sludge from the secondary clarifier Mixed liquor contact time in the aeration basins is about ten hours Twenty-four surface aerators rated at 20 horsepower each are used to maintain the dissolved oxygen level at about 2 mg/1

Mixed liquor then flows from the aeration basins to the secondary clarifiers Clarified effluent is chlorinated and returned to Clear Creek.

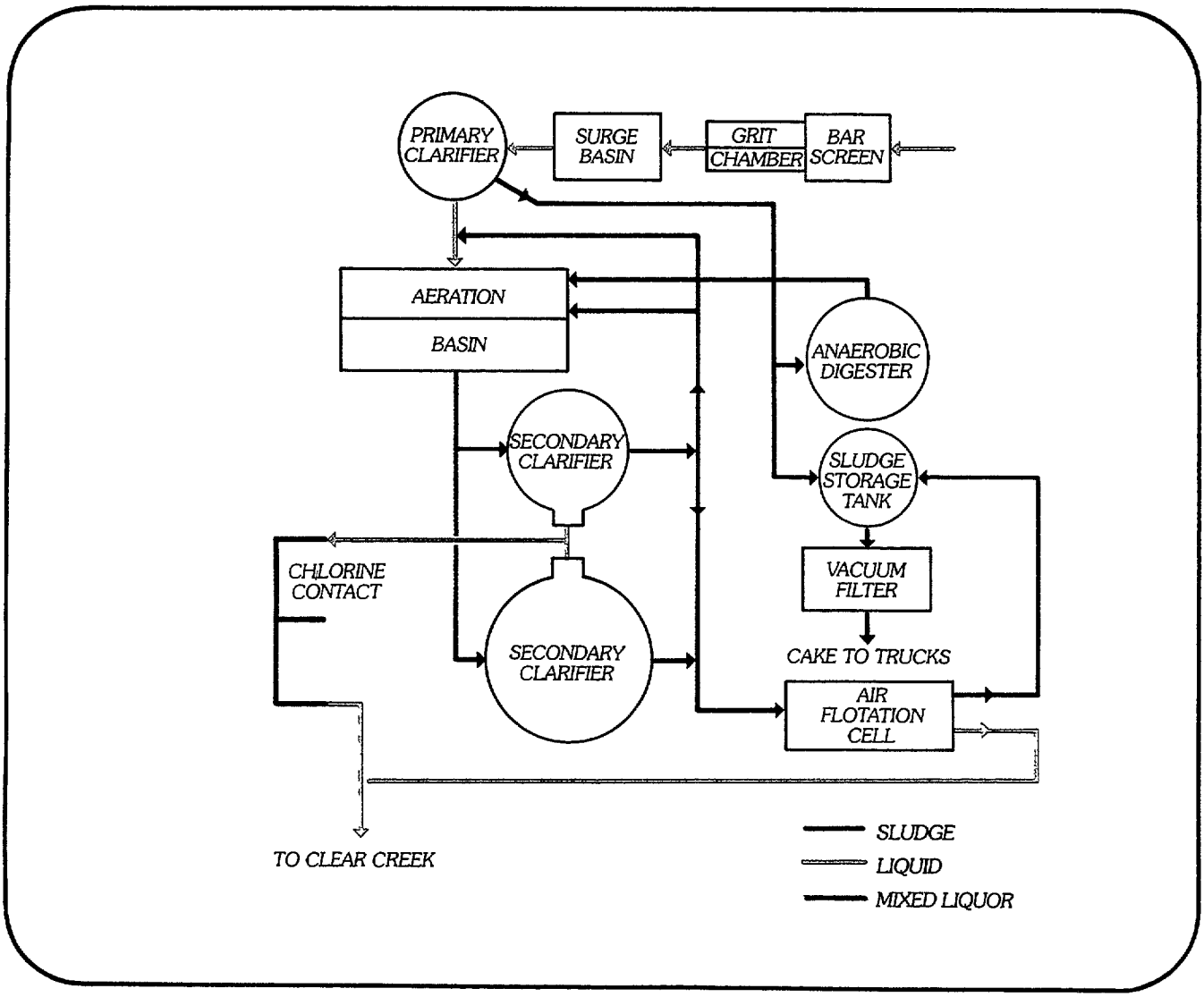


FIGURE 2 WASTE TREATMENT FACILITY

***COORS RAW WASTE AND EFFLUENT PARAMETERS*[1]**

	Raw Waste	Treated Effluent
Flow	3 3 MGD	–
BOD	825 mg/l	34 mg/l
Suspended Solids	280 mg/l	29 mg/l
% Removal BOD	–	96
% Removal Suspended Solids	–	90

[1] *Based on average at Coors for month of June 1973*

Table 4

The quality of the treated effluent and the percent removal of BOD and suspended solids is shown on Table 4

Sludge is pumped from the bottom of the secondary clarifiers to the aeration basin at a rate of 30% of the total flow The sludge is aerated for 19 hours with surface aerators A small amount of digested anaerobic sludge is added to the aeration basin as a means of controlling filamentous organisms in the predominantly carbohydrate brewery waste

Waste sludge is produced at the rate of about 13 tons/day The waste activated sludge is concentrated in dissolved air flotation cells to 4% solids by weight The concentrated waste activated sludge is mixed with primary sludge and dewatered on vacuum filters after being coagulated with lime and ferric chloride

The filtered sludge containing 16% solids is presently disposed of on land owned by Coors Because of high sludge handling costs and the difficulty in finding suitable disposal sites, Coors has decided to install a sludge drying system This system will dry the sludge in a multiple effect evaporator using vegetable oil as a carrier liquid The carrier oil will then be removed from the sludge by centrifuging and pressing and recycled within the system When the sludge drying evaporator is in operation organic polymers will be used in place of ferric chloride and lime for coagulation of sludge so that the sludge can be used as animal feed

Preliminary feeding tests show that the dried sludge can be used successfully as a high protein animal feed supplement The nutritional value of the sludge is further increased by its high vitamin content Colorado State University scientists have found that the brewery waste is usable as a replacement for soybean meal and fish meal in poultry feeds

1052

5. THE SAVINGS IN TREATMENT COSTS

Coors has realized sizable savings in the capital and operating costs for its waste treatment facility by significantly reducing the raw wastes from the plant Tables 5 and 6 compare the Coors waste treatment facility with the treatment facility that would be required for a brewery of equal size discharging at the brewing industry mean rate These tables highlight the capital and operating cost savings being realized by Coors through their reduction of raw waste loads to their treatment plant

It should also be noted that part of the Coors waste treatment facility was designed for the high loads and flows experienced before all the in-plant reductions were accomplished Thus there is now excess capacity in the flotation cells and clarifiers The BOD load on the waste treatment facility was formerly about 60,000 lb/day compared to the present load of about 22,700 lb/day In spite of this excess installed capacity Coors is realizing a $1,575,000 savings in capital costs and $1,457,500 savings in annual operation costs relative to the costs they would have incurred if they were discharging raw wastes at the brewing industry mean levels

CAPITAL COSTS SAVINGS

Item	Present Capacity and Loading Rate at Coors Facility	Additional Requirements Needed for Plant Discharging at the Brewing Industry Mean Rate	Savings in Capital Cost Realized by Coors
Primary Clarifier	one 90 ft diameter 500 gal/day-ft^2	one 80 ft diameter	$ 150,000
Aeration Tanks	2 5 million gal capacity at 71 lb/day-100 ft^3	6 7 million gal	$1,200,000
Secondary Clarifiers	14,800 ft^2 200 gal/day-ft^2	—	—
Vacuum Filters	one 509 ft^2 one 430 ft^2 used alternate weeks 16 hrs/day at 4 5 lb/hr-ft^2	2,000 ft^2 filter plus piping and building	$ 100,000
Air Flotation Cells	one 700 ft^2 32 lb/day-ft^2 one 1150 ft^2 19 lb/day-ft^2 (used alternately)	700 ft^2	$ 125,000
Total Savings in Capital Costs			$1,575,000

Table 5

1053

OPERATING COST SAVINGS

Item	Present Requirements at Coors Facility	Additional Requirements Needed for Plant Discharging at the Brewing Industry Mean Rate	Savings in Operating Cost Realized by Coors
Aeration Horsepower	480 hp	1,340 hp	$ 134,000/yr
Chlorine	84 tons/yr	134 tons/yr ($131 /ton)	17,500/yr
Lime	1,000 tons/yr	2,850 tons/yr ($34 /ton)	97,000/yr
Ferric Chloride	900 tons/yr	2,500 tons/yr ($72 /ton)	181,000/yr
Polymer	125,000 lb/yr	351,000 lb/yr ($ 31/lb)	108,000/yr
H_2SO_4	120 tons/yr	190 tons/yr ($33 /ton)	6,200/yr
Ammonia	35 tons/yr	98 tons/yr ($174/ton)	17,000/yr
Defoamer	12,000 gal	33,700 gal/yr ($2 /gal)	67,000/yr
Deodorant	700 gal	2,000 gal/yr ($3 40/gal)	6,800/yr
Labor	2 men/shift	1 man/shift [1]	48,000/yr
Sludge Disposal	13 tons/day	37 tons/day [2]	675,000/yr
Maintenance	$50,000/yr	$100,000 (6% of Capital)	100,000/yr
Savings in Operating Costs			$1,457,500/yr

[1] *One man/shift plus one relief man at $12 000/man yr*

[2] *37 tons/day at a cost of $50/ton for vacuum filtration, power hauling landfill costs and overhead.*

Table 6

1054

6. AREAS OF APPLICATION

The techniques used by Coors to significantly reduce water usage and raw wastes, and recover by-products is directly applicable to the other malt liquor production facilities as well as other food processing industries The reductions in the cost of waste treatment through reduction in raw waste loading can be realized whether the waste is treated in privately owned treatment plants or in municipal waste treatment plants Savings in the cost of privately owned facilities can be realized as lower capital and operating costs, while saving in the cost of municipal waste treatment can be realized by the brewery as reduced user charges and reduced municipal waste treatment plant capital costs

For Further Information Write·

Technology Transfer
Environmental
Protection Agency
Washington, D C
20460

1055

Foote, Kyle E

From owner environews
To environews
Subject E Link IPO announced for World's 1st sustainable brewery
Date Thursday, July 18 1996 8 50AM

IPO Announced for
New Eco Brewery in Ann Arbor Michigan

The Ann Arbor Brewing Company working together with the United Nations, the Chinese Academy of Science the University of Michigan, and the Dean of Architecture from the University of Virginia, is buildingwhat it believes is the world s first environmentally sustainable brewery, slated to open in the summer of 1997 in Ann Arbor, Michigan Following in the footsteps of their great grand uncle,Aldo Leopold, brothers Scott and Todd Leopold founded the brewery in 1995 to demonstrate that, with proper design and forethought industry could balance profitability with environmental concern Fellow author Stephen Cox said of Aldo Leopold s book, A Sand County Almanac, 'The core of American thinking about conservation runs from Thoreau to Muir to Leopold "

In what co founder and CEO Scott Leopold describes as smart manufacturing," the design of the brewery eliminates many polluting processes, uses more environmentally friendly chemicals, minimizes packaging requirements and optimizes the use of energy and other resources What were typically viewed as "waste products" from the brewing process and discharged to local sewers are reused within the brewery or are sold to others for use in another application Examples include using solid wastes to cultivate mushrooms which will be served in an adjacent restaurant, and recycling washwaters and reusing them within the brewery Formerly with the largest wastewater and water engineering consulting firm in the world Scott Leopold helped several Fortune 500 companies profitably accomplish similar pollution prevention" measures

Balancing profit with the environment came naturally for Scott Leopold who obtained his undergraduate degrees in Industrial Engineering/Management Science and Economics from Northwestern University and his master s degree in Environmental Engineering from Stanford University Noting that Michigan ranks 47th in the nation in the number of microbreweries per capita and that the Ann Arbor area is home to over 250 000 people most of whom fit the ideal profile for a microbrewery enthusiast Scott Leopold believed Ann Arbor would embrace the concept

Thus he developed the company with his brother Todd a graduate of the Siebel Institute of Technology where most of America s brewmasters receive their formal education Together the two developed 5 different beers plus some seasonal offerings including 1 organic beer which Ann Arbor Brewing Company will produce and bottle for retail distribution in Michigan under the brand name "Leopold Bros "

The United Nations University and the Department of Systems Ecology of the Chinese Academy of Science will contribute to the project as part of their Zero Emissions Research Initiative (ZERI) The ZERI program is searching for systems and technologies which can convert industrial processes into zero emissions activities The applications of such systems and technologies will

1056

result in the creation of new industries, and in the clustering of industries where waste outputs from one industry become raw materials to others

Beer breweries are of particular interest to the United Nations because of the implications in developing countries such as China where beer production has increased by 600% in the last 10 years while only reaching a per capita consumption rate of 0 58 gallons/year (compared to e g 22 0 gallons/year in Michigan) If China increases its beer consumption by five times it will mean that China will require about 8 5 billion gallons of fresh water, and produce approximately 170 billion gallons of wastewater, most of which is currently released untreated into various bodies of water It is therefore necessary for the Ann Arbor Brewing Co to generate a healthy profit while maintaining its waste free ecosystem, so that a new paradigm is created which brewers in developing countries can emulate

The profit minded focus on the environment also extends into the design of the brewery's building itself which will use energy efficient lighting systems non ozone depleting ventilation and refrigeration systems, low toxicity building materials and lumber from sustainably managed forests To accomplish this, the company plans to team with University of Virginia s Dean of Architecture William McDonough to finalize the design of a 14 000 ft2 brewery and a 6,000 ft2 restaurant adjacent to the brewery McDonough s architectural firm recently completed similar environmental designs for furniture manufacturer Herman Miller and a major U S clothing manufacturer McDonough also received the Presidential Award for Sustainable Development and served as the lead designer for the "Greening of the White House" project Retired University of Michigan Professor of Urban Planning, and former chair of the Ann Arbor Planning Commision, Allan Feldt, will also be assisting in the design of the facility

The 6,000 ft2 restaurant the Leopolds have planned adjacent to the brewery will boast a traditional German beer garden and will be called the Ann Arbor Beer Gardens For its design the Leopolds will team with their father Harvard University Loeb Fellow and former Chief Landscape Architect for the Department of the Interior Robert Leopold The Beer Gardens will serve as part of the pollution prevention program, as the various plants will absorb part of the large amounts of carbon dioxide which are generated during the beer's fermentation processes There will also be a small greenhouse adjacent to the gardens, where vegetables, mushrooms and flowers will be grown year round Excess heat generated by the various brewing processes will be used to help to warm areas of the entire facility The Company has a web site at <http //members gnn com/sleopold/aabrew htm> that will post articles regarding the design of the facility and give investment information as well

Ann Arbor Brewing Company estimates the total cost for the land and building at $2 3 million and an additional $1 5 million for the brewing bottling energy recovery, and restaurant equipment To pay for the brewing and bottling equipment and provide a start up cash reserve Michigan Microbrewing Industries L L C and its two subsidiaries Ann Arbor Brewing Company L L C and Ann Arbor Beer Gardens, L L C recently announced an initial public offering of its equity interests In it the company s managers have put their money where their mouth is by not accepting a salary while working full time for the companies for the next 10 years Instead the management team will maintain only an equity stake in the profits

1059

of the company and not dilute the capital contributed by outside investors The building will be financed separately

30

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1058

1995 Category Descriptions

PART IV

Category Descriptions

There are 24 categories of lager ale or mixed style beers three categories of mead one category of cider and one category of meads to be judged All have subcategories using small letter designations If a beer is entered for example as 9b Brown Porter it will be judged as a Brown Porter against the others in the Porter category Judges do not see your recipe information but they do use the guidelines when evaluating your entry

The following section gives more detailed information about each category and subcategory Please note that when a style characteristic is designated OK this means it does not have to be apparent but it is permissible in amounts indicated When the term noble type hops is used it refers to European continental type hops such as Saaz Hallertauer Tettnanger and Spalt to name a few

Categories are designated by numbers Subcategories are designated by letters Please note the Style Guidelines Chart on page 10

ALE

Ales are distinguished by the use of top fermenting Saccharomyces cerevisiae yeast strains These strains perform at warmer temperatures the ferments are faster and fermentation byproducts are generally more evident Ales tend to have a very pronounced palate where esters and fruity qualities are part of the character

1 Barley Wine

Category award sponsored by Edme Ltd Mistley Manningtree England

(a) Barley Wine — Copper to medium brown Malty sweetness Fruity/estery Low to high bitterness Medium to full body Low to high hop aroma and flavor Alcoholic taste Low to medium diacetyl OK

2. Belgian and French Ale

Category award sponsored by Manneken Brussel Imports Inc Austin Texas

(a) Flanders Brown — Slight vinegarlike or lactic sourness and spiciness Light to medium bodied Deep copper to brown Fruity/estery No hop flavor or aroma Low to medium bitterness No diacetyl Low roasted malt character OK

(b) Dubbel — Dark amber to brown Sweet malty nutty chocolate roast malt aroma OK Medium to full body Low bitterness very low diacetyl OK Low levels of fruity-esters (especially banana) OK

(c) Tripel — Light/pale color Light malty and hoppy aroma Neutral hop/malt balance Finish may be sweet Medium to full body Alcoholic but best examples do not taste strongly of alcohol Spicy phenolic-clove banana flavors esters OK

(d) Belgian Ale — Golden to deep amber A Belgian pale ale Hop character subdued Light to medium body Low malt aroma Slight acidity OK No diacetyl Low fruity esters in aroma and flavors Low caramel or toasted malt flavor OK

(e) Belgian Strong Ale — Pale to dark brown Alcoholic Can be vinous Darker beers are colored with candi sugar and not so much dark malt Medium body Low to high bitterness Low hop flavor and aroma

(f) White — Unmalted wheat and malted barley Oats OK Often spiced with coriander seed and dried bitter orange peel Hop flavor and aroma noble type desired Low to medium bitterness Low to medium body Dry Low diacetyl OK Low to medium fruity esters

(g) Bière de Garde — Deep golden to deep copper/light brown Medium to high malt flavor Light to medium body Medium hop bitterness Light to medium hop flavor and aroma May have light to medium fruitiness esterness Lager yeast may be used Earthy cellar like musty aromas OK Traditionally a French style beer that improves with some aging

3 Belgian-style Lambic

Category award sponsored by L D Carlson Co Kent, Ohio

Intensely and cleanly sour No hop bitterness flavor or aroma Effervescent Fruity/estery and uniquely aromatic Malted barley and unmalted wheat Stale old hops used Cloudiness OK

(a) Faro — Lambic with sugar and sometimes caramel added Pale to light amber

(b) Gueuze — Unflavored blend of old and young lambics secondarily fermented Very dry or mildly sweet Intensely sour and acidic flavor Fruity-estery Pale Light body Use unmalted wheat malted barley and stale aged hops Very low hop bitterness

(c) Fruit (Framboise Kriek Pêche) — Lambic fermented with fruits such as raspberry cherry peach etc Fruit flavor aroma and color are intense Sourness predominates Often very dry

4 Brown Ale

Category award sponsored by Premier Malt Products, Grosse Pointe Mich

(a) English Brown — Deep copper to brown Sweet and malty Low bitterness Hop flavor and aroma low Some fruitiness and esters Medium body Low diacetyl OK

(b) English Mild — Low alcohol Light amber to very dark brown Low hop bitterness flavor and aroma Mild maltiness Light body Low esters

(c) American Brown — Medium to dark brown High hop bitterness flavor and aroma Medium maltiness and body Low diacetyl OK

5 English-style Pale Ale

Category award sponsored by Wynkoop Brewing Co Denver Colo

(a) Classic English Pale Ale Golden to deep amber/copper Low to medium maltiness High hop bitterness flavor and aroma Use of English hops such as Goldings Fuggles etc Fruity/estery Low diacetyl OK Medium body Low caramel character OK

(b) India Pale Ale — Golden to deep amber/copper Medium body Medium maltiness High hop bitterness Hop flavor and aroma medium to high Fruity/estery Alcoholic strength evident Low diacetyl OK

6 American-style Ale

Category award sponsored by Northwestern Extract Co Brookfield Wis

(a) American Pale Ale — Pale to deep amber/red/copper Low to medium maltiness High hop bitterness Medium hop flavor and aroma Use of American hops such as Cascade Willamette Centennial (CFJ 90) etc Fruity/estery Low diacetyl OK Medium body Low caramel character OK

(b) American Wheat — Golden to light amber Light to medium body Low to medium bitterness Malt and hop flavor and aroma OK Low to medium fruitiness and esters Low diacetyl OK Lager or ale yeast used No phenolic character

7 English Bitter

Category award sponsored by Alternative Beverage Charlotte N C

Gold to copper Low carbonation Medium to high bitterness May or may not have hop flavor or aroma Low to medium maltiness Light to medium body Low diacetyl OK Fruitiness/esters OK

(a) English Ordinary — Mildest form of bitter Low diacetyl and fruity esters

(b) English Special — Moderate strength Maltiness more evident along with increased hop character

(c) English Extra Special — Strong bitter Maltiness evident Hop bitterness flavor and aroma medium to high Full body

8. Scottish Ale

Category award sponsored by Something's Brewing Burlington Vt.

(a) Scottish Light — Gold to amber Low carbonation Very low bitterness No hop flavor and aroma Medium maltiness Light body Low to medium diacetyl OK Fruitiness/esters OK Faint smoky character OK

American Homebrewers Association 1995 National Homebrew Competition

1995 Category Descriptions

(b) Scottish Heavy — Gold to amber to dark brown Low carbonation Low bitterness May or may not have hop flavor and aroma Medium to high maltiness Medium body Low to medium diacetyl OK Low fruitiness/esters OK Faint smoky character OK

(c) Scottish Export — Gold to amber to dark brown Low carbonation Low to medium bitterness May or may not have hop flavor and aroma High maltiness Medium body Low to medium diacetyl OK Fruitiness/esters OK Faint smoky character OK

9 Porter

Category award sponsored by The Cellar Seattle Wash

(a) Robust Porter — Black No roast barley character Sharp bitterness of black malt without high burnt/charcoallike flavor Medium to full bodied Malty sweet Hop bitterness medium to high Hop flavor and aroma none to medium Fruitiness/esters OK Low diacetyl OK

(b) Brown Porter — Medium to dark brown No roast barley or strong burnt malt character Light to medium body Low to medium malt sweetness Medium hop bitterness Hop flavor and aroma none to medium Fruitiness/esters OK Low diacetyl OK

10 English and Scottish Strong Ale

Category award sponsored by Wine & Hop Shop Denver Colo

(a) English Old Ale/Strong Ale — Light amber to deep amber/copper Medium to full body Malty Hop bitterness apparent but not aggressive flavor and aroma can be assertive Fruitiness/esters high Alcoholic strength recognizable Low diacetyl OK

(b) Strong Scotch Ale — Similar to English Old/Strong Ale Overwhelmingly malty Deep copper to very black Hop bitterness low Diacetyl medium to high Hop flavor and aroma very low or absent Full bodied Faint smoky character OK Malt character balanced by clean alcohol flavors

11 Stout

Category award sponsored by Alternative Garden Supply Streamwood Ill

(a) Classic Dry Stout — Black opaque Medium body Medium to high hop bitterness Roasted barley character is required but can be at low levels Slight malt sweetness or caramel malt character OK No hop flavor or aroma Slight acidity/sourness OK Very low diacetyl OK

(b) Foreign Style — Black/opaque Medium to full body No hop aroma and flavor Slight acidity/sourness OK Slight malt sweetness or caramel malt character OK Very low diacetyl OK Low fruity esters OK

(c) Sweet Stout/Cream Stout — Overall character sweet Black opaque Medium to full body Hop bitterness low Roasted barley (coffeelike) character mild No hop flavor or aroma Sweet maltiness and caramel flavors evident Low diacetyl OK

(d) Imperial Stout — Dark copper to very black Hop bitterness flavor and aroma medium to high Alcohol strength evident Rich maltiness High fruitiness/esters Full-bodied Very low diacetyl OK

LAGER

Lagers are produced with bottom fermenting Saccharomyces uvarum (a k a carlsbergensis) strains of yeast at colder fermentation temperatures than ales This cooler environment inhibits the natural production of esters and other fermentation byproducts creating a cleaner tasting product

12. Bock

Category award sponsored by Washington Hop Commission Yakima Wash

(a) Traditional German Bock — Deep copper to dark brown Medium to full body Malty sweet character predominates in aroma and flavor with some toasted chocolate malt character Low bitterness Low hop flavor noble type OK No hop aroma No fruitiness or esters Low diacetyl OK

(b) Helles (light) Bock — Pale to amber Medium body Malty sweet character predominates in aroma and flavor No toasted chocolate malt character Low bitterness Low hop flavor noble type OK No hop aroma No fruitiness or esters Low diacetyl OK

(c) Doppelbock — Light to very dark amber to dark brown Very full body Malty sweetness evident in aroma and flavor can be intense High alcoholic flavor Slight fruitiness and esters OK but not very desirable Low bitterness Low hop flavor noble-type OK No hop aroma Low diacetyl OK

(d) Eisbock — A stronger version of Doppelbock Deep copper to black Very alcoholic Typically brewed by freezing a doppelbock and removing resulting ice to increase alcohol content

13. Bavarian Dark

Category award sponsored by Crosby & Baker Westport Mass

(a) Munich Dunkel — Copper to dark brown Medium body Nutty toasted chocolatelike malty sweetness in aroma and flavor Medium bitterness Low noble type hop flavor and aroma No fruitiness or esters Low diacetyl OK

(b) Schwarzbier — Dark brown to black Medium body Roasted malt evident Low sweetness in aroma and flavor Low to medium bitterness Low bitterness from roast malt Hop flavor and aroma noble type OK No fruitiness esters Low diacetyl OK

14 German Light Lager

Category award sponsored by Briess Malting Co Chilton Wis

(a) Dortmund/Export — Pale to golden Medium body Medium malty sweetness Medium bitterness Very low noble type hop flavor and aroma No fruitiness esters or diacetyl Alcoholic warmth evident

(b) Munich Helles — Pale to golden Medium body Medium malty sweetness Low bitterness Noble type hop flavor and aroma OK No fruitiness esters No diacetyl

15. Classic Pilsener

Category award sponsored by California Concentrates Acampo Calif

(a) German — Pale to golden Light to medium body High hop bitterness Medium hop noble type flavor and aroma Low maltiness in aroma and flavor No fruitiness esters Very low diacetyl OK

(b) Bohemian — Pale to golden Light to medium body Medium to high bitterness Low to medium hop noble-type flavor and aroma Low to medium maltiness in aroma and flavor No fruitiness esters Low diacetyl OK

16. American Lager

Category award sponsored by Pabst Brewing Co Milwaukee Wis

(a) Diet/Lite — Very pale Light body Very low bitterness No malt aroma or flavor No hop aroma or flavor Effervescent No fruitiness esters or diacetyl

(b) American Standard — Very pale Light body Very low bitterness Low malt aroma and flavor Low hop aroma and flavor OK Effervescent No fruitiness esters or diacetyl

(c) American Premium — Very pale to golden Light body Low to medium bitterness Low malt aroma and flavor OK Low hop flavor or aroma OK Effervescent No fruitiness esters or diacetyl

(d) Dry — Pale to golden Light body Low to medium bitterness Low malt aroma or flavor Low hop aroma and flavor Effervescent No fruitiness esters or diacetyl No lingering aftertaste or bitterness

(e) Cream Ale/Lager — Very pale Effervescent Light body Low to medium bitterness Low hop flavor or aroma OK Low fruitiness/ester OK Can use ale or lager yeasts or combination

(f) American Dark — Deep copper to dark brown Light to medium body Low bitterness Low malt aroma or flavor OK Low hop flavor or aroma OK Effervescent No fruitiness esters Very low diacetyl OK

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1995 Category Descriptions

17 Vienna/Oktoberfest/Märzen

Category award sponsored by F H Steinbart Portland Ore

(a) Vienna — Amber to deep copper/light brown Toasted malt aroma and flavor Low malt sweetness Light to medium body Hop bitterness noble-type low to medium Low hop flavor and aroma *noble-type OK No fruitiness esters Low diacetyl OK.

(b) Oktoberfest/Märzen — Amber to deep copper/orange Malty sweetness toasted malt aroma and flavor dominant Medium body Low to medium bitterness Low hop flavor and aroma noble-type OK. No fruitiness esters or diacetyl

MIXED STYLE (LAGER-ALE)

The following beers are fermented or aged with mixed traditions and could be brewed as an ale or lager

18. German-Style Ale

Category award sponsored by BRISTOL BREWHOUSE Milwaukee Wis

(a) Dusseldorf style Altbier — Copper to dark brown Medium to high maltiness Medium to high bitterness Very low hop flavor No hop aroma Light to medium body Low fruitiness and esters Traditionally fermented warm but aged at cold temperatures No diacetyl

(b) Kölsch — Pale gold Low hop flavor and aroma Medium bitterness Light to medium body Slightly dry winy palate Malted wheat OK Lager or ale yeast or combination of yeasts OK No fruitiness esters or diacetyl

19. Fruit Beer

Category award sponsored by The Purple Foot Milwaukee Wis

(a) Fruit Beer — Any ale or lager made with fruit Character of fruit should be evident in color aroma and flavor Body color hop character and strength can vary greatly

(b) Classic style Fruit Beer — Any classic style of ale or lager to which fruit has been added Brewer to specify style

20. Herb Beer

Category award sponsored by Mann Brewing Co Larkspur Calif

(a) Herb Beer — Any ale or lager with herbs Character of herb or spice should be evident in aroma and flavor Body color hop character and strength can vary greatly

(b) Classic style Herb Beer — Any classic style of ale or lager to which herbs have been added Brewer to specify style

21 Specialty Beer

Category award sponsored by Homebrew Headquarters Dallas Texas

Any ale or lager brewed using unusual techniques and/or ingredients other than (or in addition to) malted barley as a unique contribution to the overall character of the beer Examples of specialty beers include (but are not limited to) beers brewed with honey maple sap or syrup worts heated with white hot stones (Steinbier) and low or non-alcoholic beers Examples do not include the use of fruit or herbs although they can be used to add to the character of other ingredients

(a) Specialty Beer — Any non-classic style fitting the above description

(b) Classic style Specialty Beer — Any classic ale or lager to which special ingredients have been added or a special process has been used e g honey Pilsener maple porter sorghum stout pumpkin pale ale Brewer to specify style

22. Smoked Beer

Category award sponsored by Jim s Homebrew Supply Spokane Wash

(a) Bamberg-style Rauchbier — Oktoberfest style (see Oktoberfest) with a sweet smoky aroma and flavor Dark amber to dark brown Intensity of smoke medium to high Low diacetyl OK

(b) Classic style Smoked Beer — Any beer that is based on a classic style beer to which smoked characteristics have been added Brewer to specify style

(c) Other (brewer to specify style) — All other beers with smoked characteristics

23 California Common Beer

Category award sponsored by Anchor Brewing Co San Francisco Calif

(a) California Common Beer — Light amber to copper Medium body Toasted or caramelike maltiness in aroma and flavor Medium to high hop bitterness. Hop flavor medium to high Aroma medium Fruitiness and esters low Low diacetyl OK. Lager yeast, fermented warm but aged cold

24 Wheat Beer

Category award sponsored by the Tabernash Brewing Co Denver Colo

(a) Berliner Weisse — Pale Light body Dry Sharp lactic sourness Fruity/estery Between 60 and 70 percent malted wheat. Very low bitterness No hop flavor or aroma Effervescent. No diacetyl

(b) German style Weizen/Weissbier — Pale to golden Light to medium body About 50 percent wheat malt Clove and slight banana character Fruity/estery Clove vanilla, nutmeg smoke and cinnamonlike phenolics permissible Mild sourness OK. Highly effervescent Cloudiness OK Low bitterness Low hop flavor and aroma OK No diacetyl

(c) German style Dunkelweizen — Deep copper to brown Dark version of Weizen Roasted malt and chocolatelike flavors evident Banana and cloves and other phenolics may still be evident but to a lesser degree Stronger than Weizen Medium body No diacetyl Low hop flavor and aroma OK

(d) German-style Weizenbock — Usually deep copper to dark brown, but light versions can be amber to copper Medium to full body Alcoholic strength evident Maltiness high Low bitterness Hop flavor and aroma absent Banana and clove character apparent No diacetyl Dark versions have a mild roast malt flavor and aroma

MEAD

Meads are produced by the fermentation of honey water yeast and optional ingredients such as fruit, herbs and/or spices Their final gravity roughly determines whether they are Dry — 0 996 to 1 009 Medium — 1 010 to 1 019 Sweet — 1.020 to 1 029 or Very Sweet — 1 030 and higher Wine Champagne sherry mead ale or lager yeasts may be used

25. Traditional Mead and Braggot

Category award sponsored by BEERCRAFTERS INC Turnersville N J

(a) Sparkling Traditional Mead — Effervescent Dry medium or sweet (designate on entry form) Light to medium body No flavors other than honey Honey character in aroma and flavor Low to medium fruity acidity Color depends on honey type Absence of harsh and/or stale character

(b) Still Traditional Mead — Not effervescent Dry medium sweet or very sweet (designate on entry form) Light to full body Honey character in aroma and flavor Low to medium fruity acidity Color depends on honey type Absence of harsh and/or stale character

(c) Sparkling Braggot — Effervescent Made with malt Dry medium or sweet (designate on entry form) Light to medium body Honey flavors predominate

(d) Still Braggot — Not effervescent Made with malt Dry medium or sweet (designate on entry form) Light to medium body Honey flavors predominate

26 Fruit Mead

Category award sponsored by The National Honey Board Longmont Colo

Melomel is made with any fruit Cyser is made with apples and/or apple juice Pyment is made with grapes Ingredients should be expressed in aroma and flavor Color should represent ingredients Honey character apparent in aroma and flavor Absence of harsh and/or stale character

(a) Sparkling Melomel — Effervescent Light to medium body Dry medium or sweet (designate on entry form)

1995 Category Descriptions

(b) Still Melomel — Not effervescent Light to full body Dry medium sweet or very sweet (designate on entry form)

(c) Sparkling Cyser — Effervescent Light to medium body Dry medium or sweet (designate on entry form).

(d) Still Cyser — Not effervescent Light to full body Dry medium sweet or very sweet (designate on entry form)

(e) Sparkling Pyment — Effervescent Light to medium body Dry medium or sweet (designate on entry form)

(f) Still Pyment — Not effervescent Light to full body Dry medium sweet or very sweet (designate on entry form)

27 Herb Mead

Category award sponsored by Madhava's Mountain Gold Honey Lyons Colo

Metheglin is made with any herbs or spices Hippocras is made with spices and grapes (spiced Pyment) Ingredients should be expressed in aroma and flavor Color should represent ingredients Honey character must be apparent in aroma and flavor Absence of harsh and/or stale character

(a) Sparkling Metheglin — Effervescent Light to medium body Dry medium or sweet (designate on entry form)

(b) Still Metheglin — Not effervescent Light to full body Dry medium sweet or very sweet (designate on entry form)

(c) Sparkling Hippocras — Effervescent Light to medium body Dry medium or sweet (designate on entry form).

(d) Still Hippocras — Not effervescent. Light to full body Dry medium sweet or very sweet (designate on entry form)

CIDER

Ciders are produced by the fermentation of apple juices and optional ingredients such as fruits and spices Wine Champagne ale lager or wild yeasts may be used

28. Cider

Category award sponsored by Lyon s Brewery of Dublin, Dublin, Calif

NOTE Cider made with honey as an adjunct (Cyser) should be entered into category 26 for Melomel Cyser and Pyment

(a) Still — Not effervescent. Less than 5.5 percent alcohol by weight (7 percent by volume) Can be dry or sweet Pale yellow color must be clear or brilliant Apple aroma Light-bodied and crisp apple flavor Sugar adjuncts may be used

(b) Sparkling — Effervescent but not foamy May be force-carbonated No head Less than 6.3 percent alcohol by weight (8 percent by volume) Dry or sweet Pale yellow color must be clear and brilliant Light to medium body crisp apple taste Sugar adjuncts may be used

(c) New England-style — Still or sparkling dry cider Carbonation must be natural Between 6 3 and 11 percent alcohol by weight (8 and 14 percent by volume) Pale to medium yellow color Pronounced apple aroma Medium to full body Balanced by drying tannins, but never hot due to excess alcohol Adjuncts include white and brown sugars molasses or raisins Wild or wine yeasts only

(d) Specialty Cider — Any and all adjuncts and yeasts may be used Alcohol content must be below 11 percent alcohol by weight (14 percent by volume) At least 75 percent apple juice must be used in the must

SAKÉ

Saké is a traditional Asian fermented drink made from rice The rice is washed steamed and fermented with a yeastlike fungus (Aspergillus orgyzae) which acts both as a saccharifier and fermenter

29 Saké

Category award sponsored by Kohnan Inc Napa Calif

(a) Saké (Japanese rice beer) — 9 4 to 15 7 percent alcohol by weight (Twelve to 20 percent by volume) Can be semidry to dry to very dry No carbonation Pale yellow color to almost water clarity Must be made with rice koji rice and yeast only Designate type of saké on entry form

Genshu saké — full strength 14 1 to 15 7 percent alcohol by weight (18 to 20 percent by volume).

Ordinary saké — 12 6 to 13.3 percent alcohol by weight (16 to 17 percent by volume)

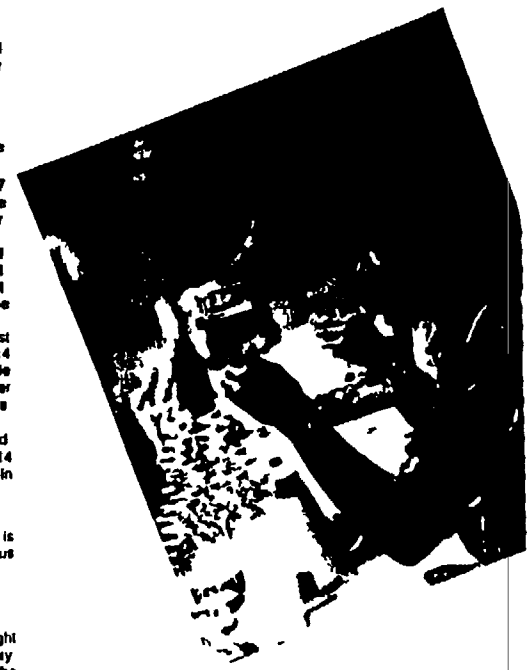
Nigori saké (unfiltered/unpasteurized) saké — will often be cloudy and have sediment in suspension

Ginjo saké — made from highly polished rice crystal clear and almost colorless

Brown rice (Genmai) saké — ginjo saké made from unpolished rice and rice koji

(b) Sparkling Saké — this is regular saké refermented in the bottle (like Champagne) to produce carbonation It is about 9 6 percent alcohol by weight (12 5 percent by volume) and the bottle priming is rice syrup and yeast Can be made from fruit or herb saké

(c) Other Oriental Rice Beers (jus) — any indigenous brews and Asian homebrew such as Chinese amber rice beer (Chiu) Korean saké types (Takjoo and other Jus) Japanese (Doburoku) saké variations from other grains (corn barley millet etc) Mirin (cooking) saké and rice wine fruit or herb saké Designate type of rice beer on entry form



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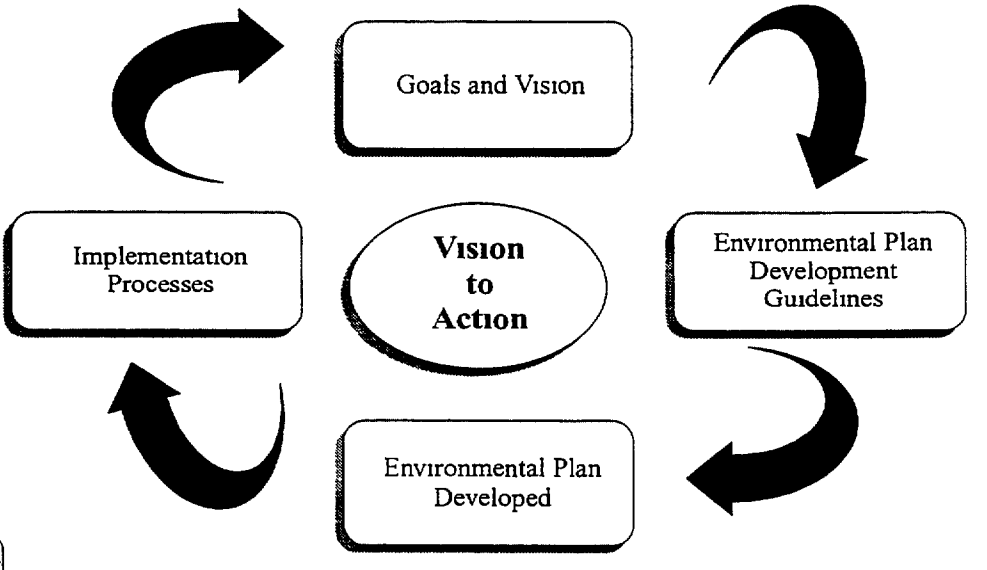
Creating Environmental Vision

Setting Corporate Environmental Policy

BLACK & VEATCH

Environmental Planning Cycle



1061

Value of Using Corporate Environmental Policy and Plan

- Creates a Common Vision
- Promotes Competitive Advantage While Achieving Environmental Commitments
- Utilizes All Resources

Environmental Strategic Planning Definition

"The Planned Management of Change of Your Environmental Efforts Over An Extended Timeframe"

1062

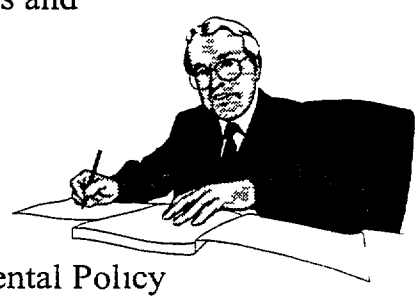
Environmental Strategic Planning

Four Step Approach

- Know Where You Are Today in Your Environmental Effort
- Describe Where You Want to Be at Some Point in Time and Why Want to Be There
- Analyze Those Factors Influencing Movement From the Present to the Future
- Develop Strategies a Realistic Roadmap and Specific Plans

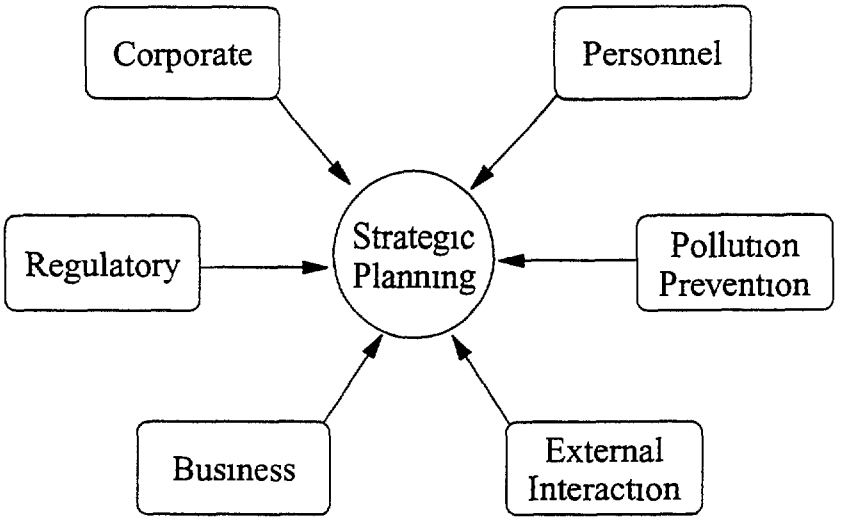
Environmental Vision Purpose

A Planning Tool to Integrate Business and Environmental Thinking Throughout



- Predict Resource Needs
  - Ensure Compliance With Additional Regulatory Requirements
  - Implement Corporate Environmental Policy
  - Meet Environmental Goals
- Measure and Predict Progress Toward Environmental Goals
- Collect Information to Help Develop Strategies for Future Pollution Prevention Programs

Corporate Environmental Policy Strategic Planning Considerations

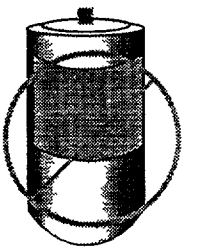


Strategic Planning Considerations

Corporate

- Identify Existing and New Environmental Goals and Expectations
- Identify Timeframe for Achieving Goals
- Describe Separate Goals for Individual Operations on Businesses

SC Johnson Wax Company



Goal Cease Use of Aerosol Products Worldwide

Timeframe 1998

- Individual Operations
  - Management Committment - Tape in 23 Languages
  - Research and Development
  - Eco Efficiency
    - Packaging
    - Recycling - Gas, Cans, Plastics
    - Innovative Technology for Eliminating VOCs
    - Partnerships - Goodwill, Wood

Strategic Planning Considerations

Regulatory

- Identify Existing Regulatory Requirements
- Analyze the Potential Future Regulatory Impact on Your Sites
- Identify Non-Compliance Issues
- Describe Existing and Desired Relationship With Regulatory Agencies

1065

Strategic Planning Considerations

Business

- Understand Each Operation's Environmental Impact
- What New Operations Are Planned and What Will Be the Change in Environmental Impact?
- What Expansions or Capacity Increases Will Take Place?
- What Are Your Competitors Doing to Protect the Environment, Health, and Safety?

Strategic Planning Considerations

Pollution Prevention

- Make an Inventory of All Waste Streams and Emissions and Have Them Fully Characterized
- Identify the Priority for Targeted Reduction
- Implement Conservation Efforts for Energy, Water, Materials

Strategic Planning Considerations

Personnel

- Identify Training and Development Needs
- Match Resources With Task Level
- Integrate Environmental Responsibility Into the Line Organization

Strategic Planning Considerations

External Interaction

- Evaluate Current Community Relations
- Identify Required Improvements
- Work With Other Similar Industries
- Build Partnerships With Others in Academic and Conservation Groups

Key Elements of Environmentally Sound Companies

- Policy
- Commitment
- Support
- Resources
- Processes and Systems
- Input / Partnering
- Communications

Key Elements of Environmentally Sound Companies

Policy

- Clearly Written Proactive Policy, Well Communicated
- Mission and Value Statements
- Short and Long Range EHS Goals
- Universal Standards

Commitment

- Line Management Responsibility
- Compensation Tied to EHS Performance
- Reward and Recognition for EHS Excellence
- TQM Approach and Continuous Improvement Mindset

Key Elements of Environmentally Sound Companies

Support

- Demonstrated Top Management Commitment
- Officer Level EHS Leader
- Board Level EHS Committee With External Members(s) With Credible Environmental Credentials
- Senior Executive Level EHS Policy Committee

Key Elements of Environmentally Sound Companies

Resources

- Sufficient, Skilled Staff
- Ongoing Training
- Succession Planning
- Career Development Program for EHS Professionals and Managers
- Younger Staff Spend Time in EHS Assignments

Key Elements of Environmentally Sound Companies

Processes and Systems

- Strategic EHS Planning Process and Business Integration
- Layered Quality Assurance Program (Audits at Plants, Business, Corporate Level)
- Training at All Levels
- Strong Pollution Prevention Effort Throughout the Product Life Cycle

US Independent Power Producer

- Environmental Emphasis in Siting and Design
- Computer Databases Identify Hazardous Chemicals
- Water Re-Use
- Wetlands for Water Treatment
- State-of-the-Art Water Treatment - Minimize C1 or P04
- Low Sulfur Oil for Backup Fuel
- Gas Primary Fuel

Key Elements of Environmentally Sound Companies

Processes and Systems

- Design Criteria for Pollution Prevention
- Product Stewardship System
- Life Cycle Analysis
- Effective System for Regulatory Tracking and Influencing Outcomes
- Effective Emergency Response

Key Elements of Environmentally Sound Companies

Input / Partnering

- Community Advisory Panels Sponsored by Sites
- Partnerships With Conservation Organizations (Land Management, Wildlife Habitat Enhancement, Philanthropy)
- Partnership With University EHS Research
- Participation in External Dialogue

Key Elements of Environmental Sound Companies

Communications

- Annual External Reporting of EHS Performance and Activities
- EHS Newsletters to Keep Employees Informed
- Serious Environmental Incidents and Lost Workday Injuries Reported Promptly to Senior Management

Characteristics of Successful Companies

- Know Where They Are Going (Vision, Goals, Policy, Milestones) and Competitively Execute (Processes and Systems)
- Practice Stewardship All Along the Value Chain (Cradle to Cradle)
- Know the Ultimate Fate and Disposal of Everything They Make
- Work on the Leading Edge of Technology to Produce Low Waste Processes and Sustainable Products

Characteristics of Successful Companies

- Continually Reduce Environmental Liabilities
- View Environmentalist as an Economic Opportunity, Building Assets in the Area vs Liabilities
- Listen and Learn From Customers, Stockholders, Society and Employees
- Are Strong Participants in the Public Policy Arena to Shape Outcomes Favorable to Their Customers, Stockholders, Employees and Society

Characteristics of Successful Companies

- Invest, Innovate, and Collaborate With Others In Industry, Government, and Universities
- Develop and Maintain Economically Healthy and Sustainable Businesses

Environmental Strategic Plan
An Integrated Approach

Company Vision Drives

Environmental Mission — Focusing Attention On

Key Objectives — Made Tangible By

Specific Goals — Keyed to

Strategies — Made Operational via

Action Plans

Environmental Policy - Setting Process

Phase 1 Leadership Challenge
- Corporate Environmentalism Introduced
- Organization Committed to Comprehensive "Stretch" Goals
- Marketing to Corporate Leadership

Phase 2 Corporate Environmentalism Defined
- Development of Environmental Policy Statement
- Internal and External Opinion Leaders Utilized
- Vision and Positioning for the Future Defined

Phase 3 Economic and Environmental Integration
- Clarifying Environmental Expectations and Accountabilities in Business Terms
- Promoting Competitive Execution in Achieving Environmental Commitments

Phase I
Leadership Challenge

Creating Commitment

- Gain / Sustain Top Management Commitment
- Identify Existing Good Environmental Practices
- Make Environmental Compliance / Accountability Required for Advancement
- Convert Environmental Benefits Into Financial Cost Savings

Green Wall

Marketing Environmental Compliance to Management

↑ Cost to Business
Detriment to Performance

VS

Opportunity to Maximize
Efficiency Create
Competitive Advantage

1075

Phase I
Leadership Challenge

Creating Commitment

- Set Goals / Identify Procedures for Correcting Environmental Problems
- Reward Creative Solutions to Environmental Problems
- Use Technical Experts to Advise Top Management If Necessary
- Respect Your Critics, Address Their Concerns

Phase 2
Developing an Environmental Policy Statement

- United Nations Publications
- Environmental Management in Transnational Corporations
- Benchmark Corporate Environmental Survey

Phase 2
Developing an Environmental Policy Statement

Trends

Old

Prevention of Accidents and Pollution

New

Proactive Strategic Environmental Management

Cost of Environmental Health / Safety Is Long Term Investment Central to Successful Business Ventures

Phase 2
Developing an Environmental Policy Statement

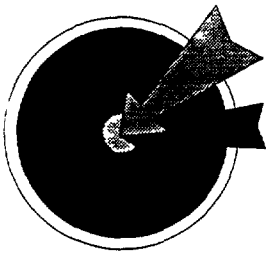
Types of Statements	Focus
Leadership	Goal to Become Environmental Leader
Preventive Management	Pollution Prevention
Stakeholder Orientation	Outreach to Customers Suppliers Public Trust
Compliance / Safety	Worker Safety / Regulatory Compliance
Integrated	Environmental Leadership as Good Business

Phase 2
Advanced Corporate Environmental Policy Statements

- Corporate Commitment to Sustainable Development
- Pledge Environmentally Friendly Products
- Minimize Adverse Environmental Impacts of Production Processes
- Fulfill Social Responsibilities

Phase 3
Economic and Environmental Integration

Clarify Environmental Expectations and Accountabilities in Business Terms



- Set Specific EH&S Targets
  - Reduce Water Consumption by 20%
  - Increase Energy Efficiency by 30%
  - Eliminate Use of CFC's by 1996
- Identify Cost Savings in Achieving Goals
- Tie Goal Achievement to Promotion and Compensation

Being EH&S Proactive

Doing What's Prudent From an EH&S Standpoint

to Support Your *Long-Term* Business Strategy

Regardless of Whether These Activities Are *Currently*

Required by the Regulatory Agencies

Proactivity Is More Complex

- Activities Are More Discretionary
- Judgment Is Critical
- The Focus Is Long-Term
- Technical / Regulatory / Business Issues Must Be Fully Considered
- It Takes Perseverance
- It Takes *Strategic Planning*

Evolution of Environmental Programs

	Level 1	Level 2	Level 3	Level 4
General Thrust	No Program	Problem Solving	Environmental Management	Environmental Leadership
Primary Purpose	Fire Fighting	Defining Basic Goals Dealing With Immediate Problems	Building Management Systems Achieve Goals Coordinating Compliance / Solutions to Common Problems Across Organizational Boundaries	Systems in Place for On Going Environmental Risk Management

Evolution of Environmental Programs

	Level 1	Level 2	Level 3	Level 4
Organization	No Full Time Personnel Staff With Collateral Duties	Specialists Working at Plant Level on Problems and Issues	Coordinators Committees or Small Groups	Formalized Groups at Corporate and Plant Levels with Integrated Functions
Primary Motivation	Keep Regulators Off the Front Step	Cost Avoidance	Resource Management to Comply With Regulations	Protect Internal Resources and Prevent Environmental Damage
Vulnerabilities	Civil and Criminal Penalties	Constant Substantive Problems and No Mechanisms to Address Them	Focused on Compliance With Existing Regulations Only	Continued Investment in Environmental Programs Without Immediate Payback

Environmental Policy Statement Group Discussions

- 25 Minutes
- 5 Minute Reports
- Take Up Papers / Roll
- Thursday - Draft Policy Statement

- Groups of 6
- Scribe
- Reporter
- Pens / Pads / Easels

Developing an Environmental Policy Statement

Common Terms

- Obligation
- Commitment
- Stewardship
- Environmental Excellence
- Compliance
- Responsible
- Citizenship

Developing An Environmental Policy Statements

Common Components of Policy Statements

- Sustainable Development
- Best Environmental Practice
- Environmentally Friendly
- Health and Safety Protection
- Minimize Adverse Environmental Consequences
- Environmental Management Practices
- Public Information
- Customer Relations
- Technically Feasible, Financially Possible Ecologically Justifiable

What to Expect in the Next Five Years

- More Regulation, Increasingly Complex and Intrusive
- More Citizen Suits by Those Who Feel Wronged by Industrial Pollution
- A Broadening of the Environmental Justice Movement
- Expanded "Green Consumerism"
- A Move to Closer Cooperation Among Government, Industry and Mainstream Environmental Groups

What to Expect in the Next Five Years

- Some Breakthroughs in Pollution Prevention Technology
- Strong Internal Focus on Cost Effectiveness (Value) of All Activities
- Re-Engineering (or Do More With Less)
- Aggressive Risk Management

1083

SETTING CORPORATE ENVIRONMENTAL POLICY

CREATING ENVIRONMENTAL VISION

Prepared by

A. F. Harris

Establishing environmental goals and identifying key objectives to address environmental concerns are critical steps in developing and implementing an environmental strategic plan. The establishment of an environmental policy applicable to all aspects of business operations creates a common vision throughout a company and promotes a competitive advantage while achieving environmental commitments and utilizing all appropriate resources

Environmental strategic planning is typically defined as "the planned management of change in environmental efforts over an extended timeframe." Implementing a plan involves evaluating your company's current environmental status, identifying goals, analyzing factors influencing attainment of those goals, and developing strategies for meeting objectives. The environmental policy statement and vision promote the integration of environmental thinking throughout the organization. Further, they facilitate predicting resource requirements to maximize compliance with regulatory requirements and identifying information required to help develop strategies for future pollution prevention programs.

Strategic planning considerations in developing a corporate environmental policy include the management structure of the organization, regulatory requirements, business considerations, personnel (both existing and required), pollution prevention options, and interactions with other entities and organizations Management will play a key role in identifying environmental goals and expectations and timeframes for achieving goals. In many companies, it may be appropriate to identify separate goals for separate operating units. Identifying applicable regulatory requirements should include an evaluation of both existing and potential compliance requirements, an identification of existing non-compliance issues through a self audit procedure, and establishing and maintaining good working relationships with regulatory agencies and funding institutions.

1084

Business considerations include identifying the environmental impact of each existing operation and planned expansions or capacity increases. Communications with competitors regarding policies and/or processes routinely implemented to protect the environment, health, and safety may also provide valuable ideas which may be applicable to your facility or business. The environmental impacts of plant or company operations should be quantified to fully evaluate the cost implications of management decisions.

Developing an inventory of all waste streams and emissions is a preliminary step in pollution prevention. Once the inventory has been developed, processes for targeted reductions and conservation initiatives for water, fuel, energy, and other materials can be defined. Personnel training and development requirements must also be identified. Once adequate staffing is in place, task assignments relating to implementing the corporate environmental policy and the integration of environmental responsibility into individual company operations can be identified. Interactions with external entities can also play a critical role in strategic planning. Evaluating and responding to community concerns to identify required improvements, working with representatives from similar industries, and forming partnerships with academic institutions and conservation groups will provide valuable ideas for inclusion in environmental management plans.

Several recent studies have evaluated companies with sound environmental compliance records to identify common elements which might be utilized by other entitites seeking to develop or enhance their own operations. Characteristics shared by these successful companies include the following.

- Clearly written environmental policy statement and goals.

- Commitment by management illustrated by reward, recognition, and compensation for environmental excellence.

- Support of environmental excellence by policy committees and board members with scientific credentials.

- Sufficient resources, including skilled staff with ongoing training, session planning, and career development.

1085

- Processes and systems which foster environmental awareness and compliance, including pollution prevention efforts, systems for regulatory tracking, and effective emergency response.

- Input from and partnering with the community, conservation organizations, and universities.

- Both internal and external communications to keep employees, the community, and regulatory agencies informed

Successful companies also place a high value on producing low waste processes and sustainable products, continually seek to reduce environmental liabilities, and participate in legislative initiatives and the development of public policy.

The environmental policy setting process involves evaluating and potentially challenging the existing leadership structure and priorities, defining corporate environmentalism in the context of that company's products and/or services, and integrating economics with environmental protection to clarify environmental expectations and accountabilities in business terms. Setting specific environmental, health and safety standards, identifying cost savings in achieving goals, and associating goal achievement with promotion and compensation facilitate the integration of environmental concerns into business plans.

A major objective of environmentally sound companies is being proactive with respect to environmental, health, and safety issues. Many outstanding companies have a policy of doing what is prudent to support long term business strategies regardless of whether these activities are currently required by regulatory agencies or other governing bodies. Although it is a more complex approach, and requires perseverance and strategic planning, the cost savings can be considerable, especially if measures such as recycling or process changes result in waste reduction or pollution prevention.

Companies evaluated in the United Nations Benchmark Survey demonstrated one of four levels of environmental management programs. Companies with Level 1 programs were those which basically had no well defined program. No full time personnel were assigned to environmental management, and company actions were directed primarily toward responding to crises and keeping

1086

regulators at bay. Key vulnerabilities included civil and criminal penalties. Level 2 companies emphasized problem solving rather than prevention, defined goals to deal with immediate problems, and were motivated primarily by cost avoidance. Although there were specialists working at the plant level on problems and issues, there were constant substantive problems with no mechanisms to address them.

Companies designated as Level 3 were those which had initiated an environmental management program within the organization and were building management systems to achieve environmental goals. They also were attempting to coordinate compliance efforts and solutions to common problems across organizational boundaries Plant staff members tended to be organized into committees or small groups whose primary motivation was resource management and complying with existing regulations The companies with the most sophisticated environmental programs demonstrated significant environmental leadership with systems in place for on going environmental risk management. Most have established formal groups at the corporate and plant level with integrated functions. The primary focus of environmental management in these companies is to protect internal resources and prevent environmental damage.

1087

Environmental Management Course

Developing A Corporate Environmental Policy Statement

Terms and Phrases Commonly Used in Environmental Policy Statements

Obligation	Best contemporary practice
No significant risk	Environmentally responsible manner
Right to expect	A high degree
Corporate commitment	Reduce adverse effects to a practicable minimum
Positive environmental stewardship	Without unacceptable effects on the environment
Environmental excellence	Minimize environmental consequences
Environmental commitment and achievement	Ensure activities continue on a sound basis environmentally
Sound environmental management and practices	Technically feasible financially possible and ecologically justifiable
Responsible	Highest practically achievable standards
Environmental record	Have the least possible long-term impact on the environment
Compliance with existing regulations and laws	Ecologically motivated, technically possible, and economically reasonable
Highest standard	Be a good citizen within the local community in which it operates

Typical Components of Environmental Policy Statements

Will operate in an environmentally friendly manner	Control of environmental information
Will pursue best environmental practice	Responsibility of employees
Definition of environmental protection (preventive integrative international validity)	Environmental management practices
Importance of research and development	Environmental protection measures
Emphasis on process and product safety	Emergency action plans
Health protection	Information to the public
Production technology	Relations with customers
Environmental protection technology	

1039

Table I 1 Corporate policy priorities
Corporate activities on EH&S and sustainable development

Higher-priority areas	Percentage of respondents
Energy-related activities	
R&D for energy efficient production	70 7
Policies for securing energy supplies	67 7
Polices for conserving non-renewable resources	54 4
Energy conservation	54 0
Health and safety activities	
Worker health and safety	67 5
Accident prevention	60 3
Emergency preparedness	58 0
Hazard assessment procedures	56 9
Traditional environment activities	
Water quality/pollution	48 1
Air quality/pollution	47 2
Noise pollution	41 1
Soil quality/pollution	31 2
Waste/disposal-related activities	
Recycling	84 5
Waste-handling procedures	56 3
Waste-disposal policies	51 6
Waste-reduction technologies	48 7

Lower-priority areas	Percentage of respondents
Genuine sustainable development activities	
Afforestation programmes	40 4
R&D for greenhouse gas generation reduction	39 0
Renewable energy sources	22 0
Preservation of endangered species	15 8
Conservation of biodiversity	10 1
Policies for protection of wetlands/rainforests in LDCs	9 2

Source TCMD/DESD Benchmark Survey, 1990-1991, (see annex table D 1)

Commitment to Environmental Excellence

Con Edison's policy is to demonstrate leadership and excellence in environmental protection. Our commitment to environmental excellence must be evident in all Company operations. It should be known and understood by the Company's employees, customers and shareholders, and continuously reinforced by our actions within and outside the Company.

Every Con Edison employee has a personal obligation to meet the fundamental workplace requirements established by law and by regulation, and to reach beyond these basic requirements to realize a higher level of achievement.

To achieve these goals and to encourage employees to care for the environment and appreciate its importance, Con Edison will:

- Maintain in each Company organization an accountability for environmental health and safety;
- Provide training to prepare employees to meet environmental challenges;
- Integrate sound environmental practices in all aspects of our business;
- Support research to develop new technologies to improve environmental performance;
- Strive for continuous improvement in waste reduction and recycling, pollution prevention and risk reduction;
- Maintain open communications on environmental issues with regulatory agencies, environmental groups, customers and employees;
- Work with our customers to pursue and promote energy efficiency; and
- Periodically and objectively audit and evaluate our compliance with applicable laws and regulations, and address opportunities for improvement in a prompt and effective manner.

Con Edison

Con Ed Corporate Environmental Policy
Figure 1.3-1

1680

CORPORATE POLICY STATEMENT

RISK CONTROL POLICY

Policy No [redacted]
Effective Date 01-01-90

I STATEMENT OF POLICY

It is the goal of [redacted] to conduct its business in compliance with all applicable laws and regulations and all reasonable standards of care relating to employee safety and protection of our assets and the environment This goal extends to (1) the selection of the materials and methods used in the design, construction and operations of [redacted] facilities, (2) the design, manufacture and distribution of [redacted] products, and (3) the disposal of all waste by-products which occur as part of [redacted] business

To meet this goal, the corporation will

1 Take all appropriate measures to provide a safe work environment for all employees giving full regard to evolving industry practices, regulatory requirements and societal standards of care;

2. Assign responsible, qualified personnel to the management and control of environmental, health (industrial hygiene) and safety matters,

3 Reduce to the lowest practicable levels any adverse effects on personnel, assets and the environment resulting from its products, services, facilities and operations,

4 Contribute to the development of appropriate standards, laws and regulations for the protection of personnel, assets and the environment,

5 Comply with all applicable laws and regulations relating to environmental protection, health and safety, and

6 Establish voluntary standards where it is believed laws and regulations may not exist for our operations or are less stringent than would be required by [redacted] beliefs and values

CORPORATE POLICY STATEMENT

II GUIDELINES

A Risk Management Services shall be responsible for directing programs intended to inform, instruct, train and influence all levels of management on the regulatory requirements of Federal, State, and Local governmental agencies regarding the areas of employee health and safety, and protection of our assets and the environment

In so doing, Risk Management Services will

1 Provide and administer corporate policies and standards,

2 Issue appropriate bulletins, guidelines and procedures,

3 Provide leadership to company professionals involved with employee safety, industrial hygiene, environmental protection, property protection and hazardous materials transportation,

4 Assist all locations in the development of their own procedures,

5 Provide advice and counsel to operating divisions and subsidiaries on safety, industrial hygiene, property protection and environmental protection matters concerning company facilities, products and services,

6 Assure that appraisals of safety, environmental and property protection programs are undertaken, and that appropriate recommendations are made to Senior Management, and

7 Ensure that all such programs are consistent with and in support of our corporate beliefs and values

B Management of all facilities, operating units, departments and subsidiaries (foreign and domestic) shall be responsible for ensuring that their operations and facilities comply with all applicable laws and regulations and meet the intent of the policy outlined above Managers shall be guided in this effort by the principle that applicable laws and regulations are the "minimum accepted standard practice", and that in some cases it may be necessary to go "beyond compliance" to provide for the safety of personnel, assets, and the environment.

In so doing, management will

1. Consider and address protection of personnel, assets and the environment in

- the design and construction of new facilities and operations, processes, equipment and product,
- the selection, substitution and use of raw materials, and
- the acquisition, lease and disposal of property, equipment or materials,

2 Establish and maintain procedures for handling safety and/or environmental incidents, property damage losses and other emergencies,

3 Train employees in proper safety, environmental and asset protection procedures,

CORPORATE POLICY STATEMENT

4 Conduct routine self-assessments and correct all identified safety, environmental and property protection deficiencies,

5 Seek to reduce adverse environmental impacts by minimizing releases of hazardous and toxic substances to the air, water or land,

6 Avoid removing contaminants from one media only to contaminate another (e g air-to-water),

7 Minimize the generation of solid and hazardous wastes,

8. Adopt company procedures that minimize environmental, personnel and property risk where laws are nonexistent or less stringent than corporate standards, and

9 Keep corporate risk control personnel and management appraised of current programs and compliance status through candid periodic reports and reviews

III REPORTS AND REVIEWS

At least annually, the senior person in charge of every division and subsidiary will evaluate with their direct reports the Personnel Safety, Environmental Protection, and Asset Protection conditions within their facilities They will report their appraisal of those conditions to the President and Chief Executive Officer

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WRITTEN BY

APPROVED BY

CORPORATE POLICY & PROCEDURE

[redacted]

Document Name [redacted]
Effective 12-01-91
Last Revision 01/93

Environmental Communications/Reporting

PURPOSE

This procedure establishes the methodology for formal communication and reporting of environmental data and information, and facilitates the exchange of information between the various operating units and Risk Management Services on current programs and regulatory compliance This procedure is designed to achieve the following objectives

- Provides for a high level of environmental awareness to facility and other managers,
- Provides a format and a schedule to promote consistency of reporting throughout the Corporation
- Provides input to a data base that will be used for determining the status of environmental issues and for anticipating future compliance issues applicable to the Corporation,
- Provides a mechanism for carrying out [redacted] Policy that facility-level management including specified operating units, departments, and subsidiaries will "keep Corporate Risk Control personnel and management appraised of current programs and compliance status through candid periodic reports and reviews "

SCOPE

This procedure applies to selected [redacted] facilities, operating units, departments, and subsidiaries as listed in Appendix A. It covers both the internal reporting of environmental data and information (i e , within the Corporation) and external reporting and communication (i.e., to regulatory agencies, to the public, and to the media) Although this procedure is not written for U S application only, it does refer to certain U S regulations for standard definitions It will be necessary for non-U S facilities to adapt these definitions, where necessary to conform with local definitions of the technical terms used

1094

CORPORATE POLICY & PROCEDURE

TABLE OF CONTENTS

SCOPE 1
DEFINITIONS 2
RESPONSIBILITIES 3
METHODOLOGY 3
Reporting to Reporting Unit Management 3
Annual Corporate Environmental Reporting 4
Reports to Regulatory Agencies 4
External Communication to the Media and the Public 4
APPENDIX A - Reporting Units 6
ATTACHMENTS A and B - Environmental Reporting Forms 8

DEFINITIONS

The definitions of technical terms provided below are taken from or are consistent with those published in United States Code of Federal Regulations For additional definitions of technical terms not provided below, please refer to 40 CFR 260 10, 40 CFR 302 3, and 49 CFR 171.8 or contact the Corporate Environmental Protection Administrator

The Corporation - All [redacted] facilities, operating units, departments, or subsidiaries, either individually or collectively

Nonhazardous Waste - For the purposes of this procedure, nonhazardous waste is considered to be all waste which is not subject to hazardous waste regulations.

Reportable Event - A circumstance, incident, or occurrence that involves the release or discharge of a hazardous material that requires action other than routine housekeeping, any regulatory agency interaction except those carried out for the purpose of general information gathering or to establish good relations, any improper disposal of a hazardous waste or material, any exceedence of a permit limitation, regulatory requirement, or applicable standard discovered or determined by monitoring, inspection, or formal audit, and any environmental initiatives whose benefits need to be highlighted to management.

Reporting Period - Period of time (e.g , calendar year 1992) which the subject report covers

Reporting Unit - A discrete segment of the Corporation upon which activities are reported. Appendix A lists the Reporting Units

Senior Management Official - The official (e g , a plant manager) with management responsibility for the technical person(s) that provides for compliance with environmental procedures and requirements and who certifies environmental reports to government agencies as required by government regulatory requirements

RESPONSIBILITIES

Corporate Environmental Protection Administrator shall

1 Receive environmental reports and coordinate the compilation and analysis of the data

2. Provide information and support at the request of Reporting Units during or after the occurrence of a Reportable Event

3 Prepare and provide to management and others an annual environmental report as well as other ad hoc reports and issue papers regarding environmental issues related to the compiled data

Senior Management Official shall.

1 Allocate the necessary resources to collect and compile the environmental data and information required to prepare the prescribed environmental reports

2. Review and approve environmental reports for each Reporting Unit.

3. Submit approved environmental reports in the prescribed medium [i.e , Environmental Reporting Form and Environmental Database Management System (EDMS)] to the Environmental Protection Administrator by February 14th of each year for the preceding year

4. Upon discovery of a Reportable Event or significant compliance issue, ensure that the Corporate Environmental Protection Administrator is promptly notified and kept fully apprised of the situation until resolution is achieved

Environmental Administrator/Coordinator shall.

1. At the direction of the Senior Management Official, collect and compile the necessary environmental data and information, and prepare the prescribed environmental report(s)

2. Maintain records of raw data, calculations, and analyses used to prepare the prescribed environmental reports(s) such that the sources, methods and accuracy of the information reported can be verified via an audit

3. Upon discovery or determination of a Reportable Event or significant compliance issue, ensure that the Senior Management Official is promptly notified and kept fully apprised of the situation until resolution is achieved

METHODOLOGY

A Reporting to Reporting Unit Management

A methodology for the collection of environmental data and

information and reporting to Reporting Unit management should be designed to achieve the following objectives

- o to keep the Senior Management Official informed and aware of the Reporting Unit's routine environmental activities and compliance status,
- o to keep the Senior Management Official fully apprised of significant compliance issues as soon as possible after discovery until resolution is achieved
- o to meet the responsibilities established in this procedure for preparing environmental reports,
- o to ensure prompt internal notification of environmental emergencies and Reportable Events,

B Annual Corporate Environmental Reporting

Every Reporting Unit listed in Appendix A is required to report the information requested in the Environmental Reporting Form (Attachment A for U S. facilities, Attachment B for non-U S. facilities) It is crucial that this data be accurate and complete (to the extent possible) in order to ensure that the analytical results, trends, Corporate roll-ups, and conclusions drawn form a sound basis for future decision-making

C. Reports to Regulatory Agencies

Reporting to regulatory agencies by a Reporting Unit shall be carried out in accordance with procedures prescribed by the respective agency Copies of all such reports are to be kept on file by the submitting Reporting Unit for a period of three (3) years or longer where it is required by agency regulations Files shall be kept in a manner that promotes easy identification and retrieval of specific documents and facilitates inspection by a Corporate or regulatory agency auditor Paper copies of all final reports to government regulatory agencies are to be submitted to the Corporate Environmental Protection Administrator for information purposes. However, Reporting Units are encouraged to obtain a Corporate-level review and comment of their draft reports during preparation prior to being submitted to the regulatory agency

D. External Communication to the Media and the Public

Unless otherwise directed by the Senior Management Official, all media inquiries regarding environmental issues or data shall be directed to and addressed by the Corporate Media Relations Department in accordance with Corporate Procedure No 960 or a comparable inhouse staff in the case of subsidiaries and non-U S operations that maintain this capability Inquiries by the public should be directed to Consumer Affairs Division or a comparable inhouse staff in the case of subsidiaries and non-U S operations

Implementing a Comprehensive Environmental Management Plan

BLACK & VEATCH

Key Objectives

- Establish Acceptable Goals
- Ensure Regulatory Compliance
- Control Costs
- Planning vs Crisis Management
- System-Wide Approach

1098

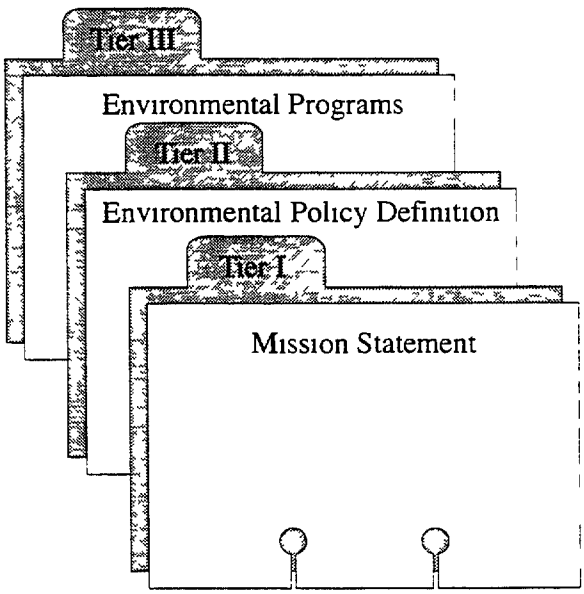
Why Implement Comprehensive Environmental Management

- ↑ Maximize Compliance
- ↓ Minimize Potential Environmental Liabilities
- ↓ Costs
- ↑ Corporate Image

Value - Protect Environment for Present and Future Generations

1099

Environmental Management



Tier II Environmental Policies

Energy-Related

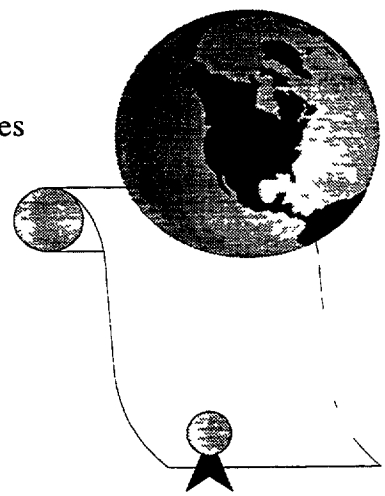
- Research / Development
- Energy Supplies
- Conservation Non-Renewable Resources
- Energy Conservation

Health / Safety

- Worker Health / Safety
- Accident Prevention
- Emergency Preparedness
- Hazard Assessment

Traditional

- Air, Water Noise, Waste Disposal



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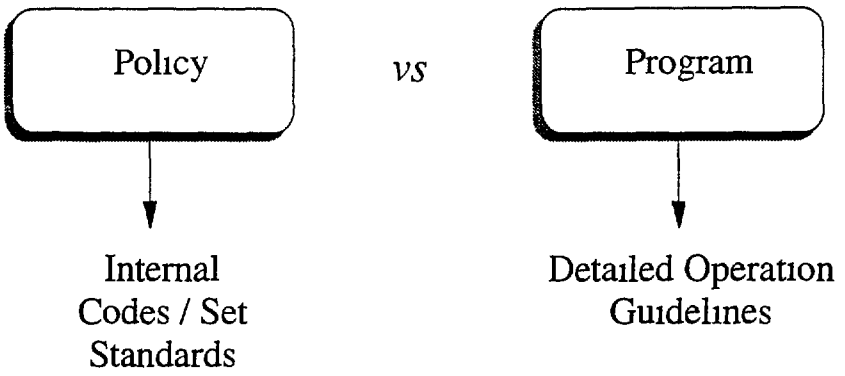
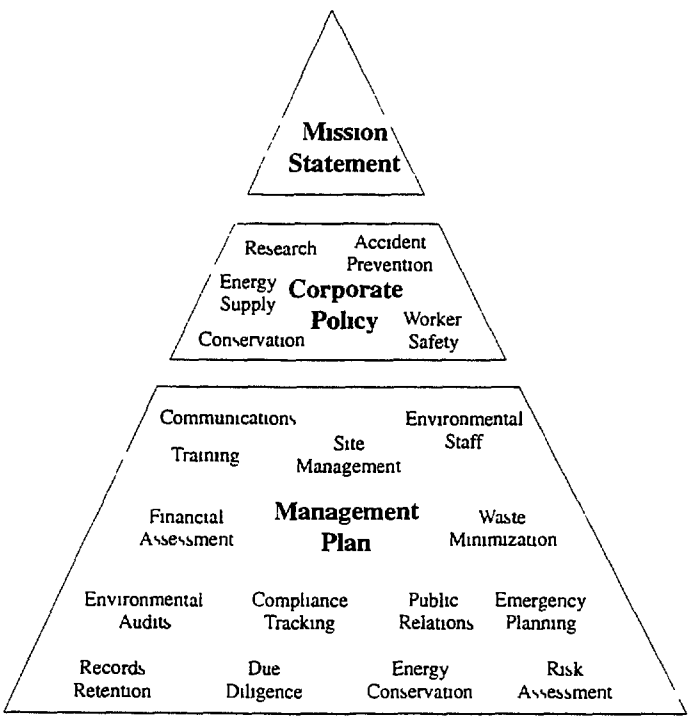

Policy
vs
Program
Internal Codes / Set Standards
Detailed Operation Guidelines

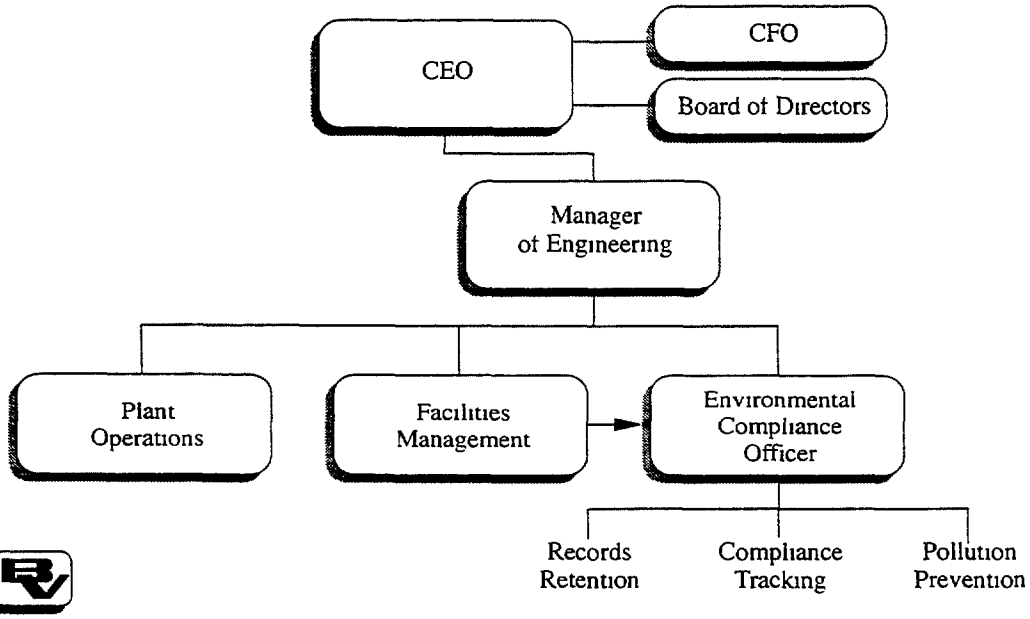

Mission Statement
Research
Accident Prevention
Energy Supply
Corporate Policy
Worker Safety
Conservation
Communications
Environmental Staff
Training
Site Management
Financial Assessment
Management Plan
Waste Minimization
Environmental Audits
Compliance Tracking
Public Relations
Emergency Planning
Records Retention
Due Diligence
Energy Conservation
Risk Assessment

1101

Environmental Organization

- Design to Meet Environmental Goals
- Communication Access to Senior Management
- Reflect Corporate Environmental Staff Responsibilities

Environmental Organization



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Environmental Staffing

- Water Quality
- Air Pollution Control
- Regulatory Specialist
- Computer Tracking
- Training Director

Environmental Compliance Tracking

Regulatory Requirements

- Laws
- Regulation
- Bank Requirements
- Guidelines
- Permit Requirements

Compliance Requirements

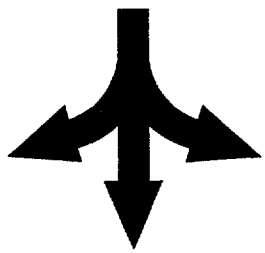
- Air
- Wastewater Discharge / Stormwater
- Noise
- Solid Waste
- Worker Safety
- Hazardous Waste

Reporting

Training

Pollution Prevention Program

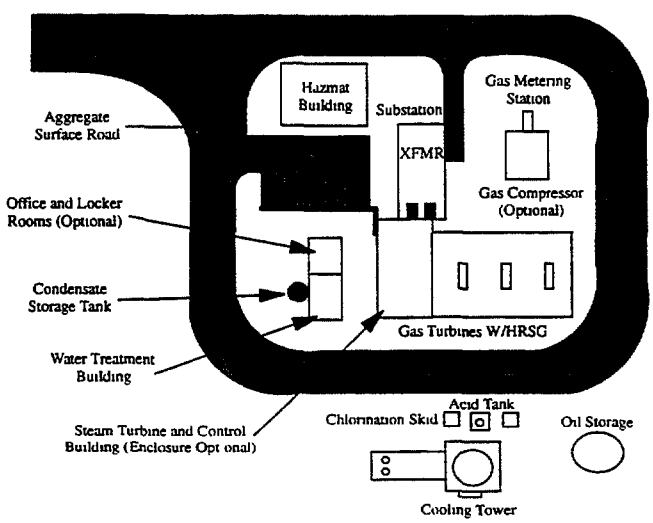
Toxic Materials
List of Toxics
Screen Products
Storage Requirements
Process Changes



Off-Site
Waste Disposal
Site Identification
Treatment Assessment

Waste Minimization
New Raw Materials
Reuse
Recycle

Site Management



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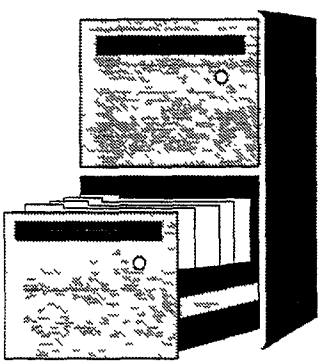
Employee Training

- Mission Statement
- Corporate Policies
- Regulatory Requirement
- Written Manuals
- Training Exercises
- Emergency Response

Varies With Level of Employee

Records Retention

- Laws / Regulations
- Permits
- Training Records
- Monitoring Reports
- Modeling Runs
- Emission Records
- Meteorological Data



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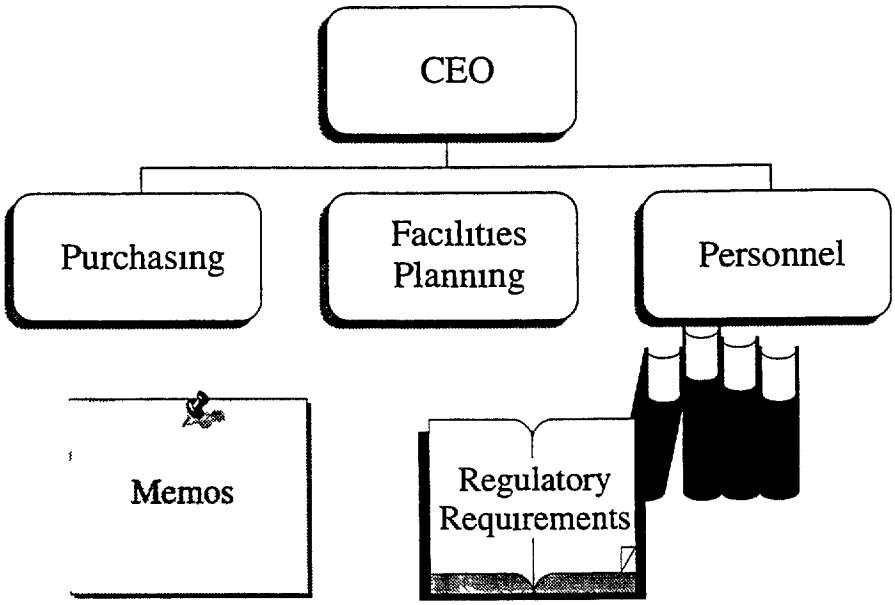
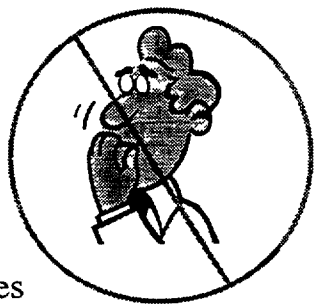
Communications

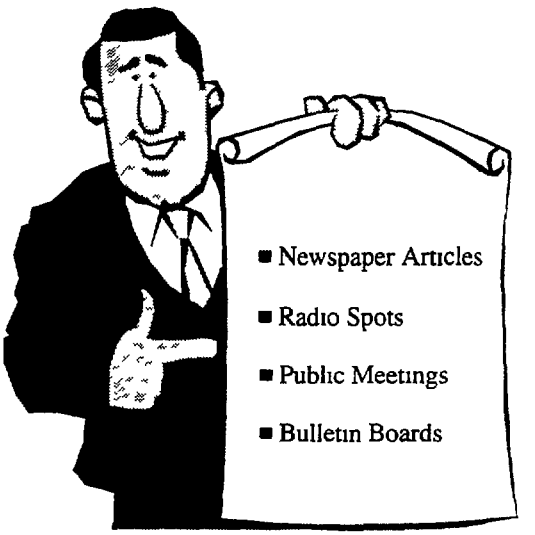


Emergency Response

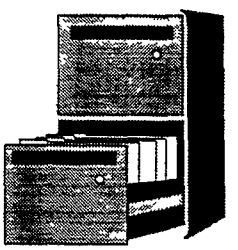


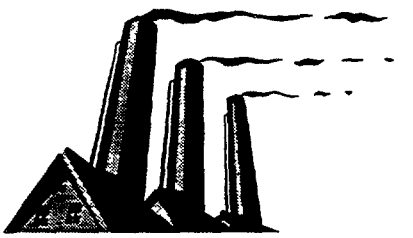
- Training / Drills
- Responsible Parties
- Response Procedures
- Communications
- Outside Contractors

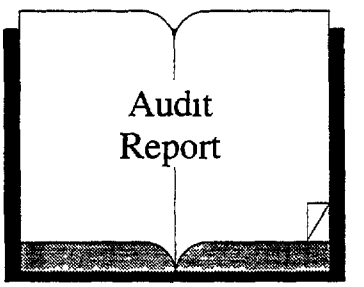
Public Relations



Environmental Auditing







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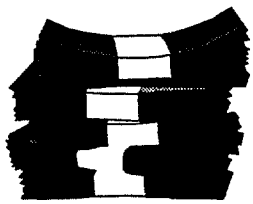
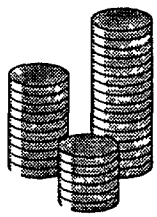
Financial Assessment

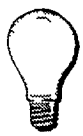
- O&M Costs
- Audit Results
- Potential Fines
- Insurance Costs
- Permit Fees





Energy Conservation

- Energy Audit
- Minimize Energy Use



- Alternative Energy Sources
  - Solar
  - Cogeneration
- Fuel Switching

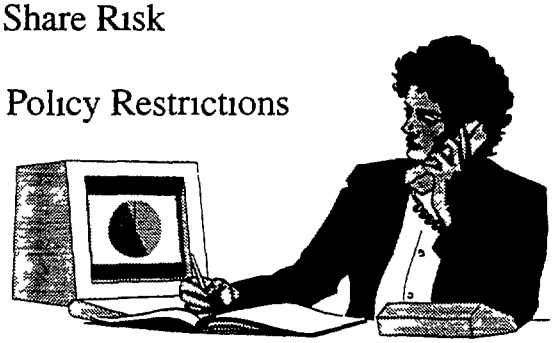
Due Diligence Program

- Applies to Acquisitions / Divestitures
- Audit Requirements
- Environmental Costs / Liabilities
- Compliance Status

Be Aware of What Is Being Exchanged

Risk Financing / Insurance

- Evaluate Existing Insurance Policies
- Insurance Companies Share Risk
- Train Staff Regarding Policy Restrictions

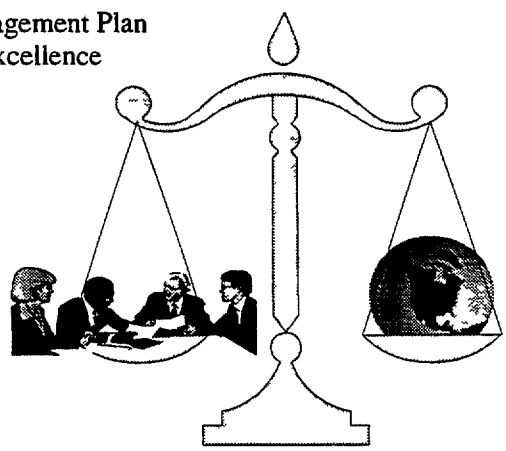


Human Resource Requirements

- Management Activities
  - Facilitates Employee Involvement
  - Prioritizes Environmental Management
- Training
  - Creates Awareness
  - Improves Knowledge Base

Specific Management Activities

- Employee Accountability
  - Environmental Protection Part of Job Description
  - Environmental Performance / Safety Part of Performance Evaluations
  - Employee Participation in Management Plan
  - Incentives for Environmental Excellence
- Standardization
  - Material Data Safety Sheets
  - Company-Wide Emergency Response Training
  - Standardized Safety Training



1110

Comprehensive Environmental Management Plan

Organizing, Establishing and Implementing a Comprehensive Environmental Management Program

Environmental management programs can provide a framework for operating a facility in compliance with corporate environmental policies and applicable regulatory requirements This summary provides guidelines for establishing an environmental management program It identifies objectives and practical reasons for implementing a program, environmental policy priorities that should be considered, and key components of a comprehensive environmental management program which have been identified and established by numerous companies It also provides a brief discussion of human resource requirements which are essential to the effective implementation of an environmental management program

1 0 Initial Objectives

Initial objectives which should be considered in establishing and implementing a comprehensive Environmental Management Program (Program) are identified below

- Identify and establish attainable goals that are acceptable company wide and integrate them into daily operations
- Ensure that the Program at a minimum achieves regulatory compliance
- Create a mechanism or system designed to control costs of the Program
- Emphasize long range planning versus crisis response
- Integrate a systems approach which allows for measurement of Program success

1112

2.0 Practical Reasons For Implementing a Comprehensive Environmental Management Program

Although a particular company, government agency, or business may have established a corporate policy prioritizing environmental compliance, there are numerous practical reasons for implementing a comprehensive environmental management program Some of the key advantages are described below

2.1 Maximizing Compliance with Environmental Regulatory Requirements

The regulatory requirements applicable to many facilities are generally so complex that an organized system for tracking new regulations, auditing compliance with existing regulations, and training management and staff is required Penalties for non-compliance are expected in the future to be very substantial, including fines and criminal sanctions

2 2 Minimizing Environmental Liabilities

Environmental risks are often unrelated to achieving compliance with regulations Typically there are no legal requirements for completion of environmental site assessments for properties, assets, or businesses being considered for acquisitions Yet potentially significant environmental liability can be accrued for unknowing purchasers Also, offsite disposal of wastes can lead to potential liability, even through applicable wastes disposal practices were in compliance with existing law or regulations at the time of disposal As a result, management programs must address issues not specifically required by laws, such as due diligence evaluations for all property acquisitions and auditing offsite disposal facilities

2.2 Reduction of Operating Costs

Implementing a comprehensive environmental management program often results in reduced environmental costs, as well as reduced non-environmental costs Environmental activities cost much less when completed in a planned and organized manner, versus being implemented on a crisis by crisis basis Non-environmental operating costs are often reduced as a result of the implementation of the environmental program The substitution of less toxic materials, the reduction of pollutant emissions, and the implementation of waste minimization programs often lead to process or operational costs savings These savings often translate to reduced raw material requirements, process energy requirements, etc

2.3 Enhanced Corporate/Organizational Image

Implementing an environmental management plan may lead to an enhanced corporate/organizational image with the public, clients, vendors, subcontractors, employees, regulators, and investors Such an enhanced image can lead to tangible benefits such as an increase in market share over competitors facing public or regulatory opposition due to environmental and health hazards

1113

3.0 Environmental Management Policies and Programs

Creating a comprehensive environmental management plan requires the development of organizational objectives and internal environmental policies These environmental policies function as internal codes of conduct setting standards for environmental protection within the organization on specific issues such as water, energy, safety, and waste Development of these policies is the first step in launching programs and management activities to address specific issues Programs, on the other hand, are more detailed operational guidelines on how the corporation can implement the objectives in its corporate policies

Tier 1· Environmental Mission Statement
Tier 2. Environmental Policies
Tier 3· Environmental Programs

A list of specific policy priorities which should be considered and applied throughout the organization is presented below

<u>Energy related activities</u>
- Research and development for energy efficient production
- Policies for securing energy supplies
- Policies for conserving non-renewable resources
- Energy conservation

<u>Health and safety activities</u>
- Worker health and safety
- Accident prevention
- Emergency preparedness
- Hazard assessment procedures

<u>Traditional environmental activities</u>
- Water quality/pollution
- Air quality/pollution
- Noise pollution
- Soil quality/pollution
- Waste/disposal-related activities
  - Recycling
  - Waste handling procedures
  - Waste reduction technologies

114

4.0 Components of a Comprehensive Environmental Management Plan

A Comprehensive Environmental Management Plan might consist of all or several of the following components

- Environmental Policy Statement
- Permanent System of Environmental Organization, Responsibility, and Communication
- Adequate Environmental Staffing
- Environmental Compliance Tracking Program
- Site Management Program
- Pollution Prevention Program
  - Toxic Materials Minimization
  - Waste Minimization
  - Offsite Waste Disposal Management
- Employee Training Program
- Records Retention
- Communications Program
- Emergency and Contingency Planning

Other components which have been successfully implemented to reduce environmental liability include the following

- Environmental Public Relations Program
- Continuous Environmental Auditing Program
- Environmental Financial Assessment Program
- Energy Conservation Program
- Due Diligence Program
- Risk Financing and Insurance

More detailed discussions of these potential environmental management program elements are provided below

4.1 Environmental Policy Statement

The Policy Statement should be sufficiently comprehensive to cover all of the activities of the organization, such as purchasing, manufacturing, storage, product distribution, product use, pollution, control, waste disposal, etc The Policy Statement should cover all business units of the organization, and should clearly indicate what relationship the Policy Statement has to other corporate policies, programs or directives

1115

4 2 Environmental Organization

The environmental functions of the firm must be organized in a manner conducive to meeting the firm's environmental goals Environmental issues must be actively addressed by senior management, potentially including the chief executive officer, the chief financial officer, and the board of directors All environmental operating functions must ultimately report to one senior official who has the responsibility for assuring that all of the environmental goals are met The Plan's organization should allow for the senior environmental official to have sufficient access to senior management The environmental organization should also reflect the responsibilities of the corporate environmental staff and the responsibilities of the plant level environmental staff

4.3 Environmental Staffing

The organization must have an adequate number of knowledgeable and experienced staff to achieve its environmental goals There should be sufficient environmental staff at the corporate management level, with training and experience consistent with their assigned responsibilities It is also important to have sufficient environmental staff at the business unit level and at the planT level to manage anticipated workloads All staff with environmental responsibilities must be held accountable for their performance in meeting the corporation's environmental goals

4 4 Environmental Compliance Tracking

Identifying and tracking applicable regulations, standards and requirements is essential to a comprehensive environmental management program A facility or business may be subject to in-country laws and regulations such as emission limits, reporting requirements, and training requirements In addition, there may be requirements imposed on the project by a financing institution or government administrative agency Individual approvals or permits also define specific requirements A group or an individual within the organization should be assigned responsibility for identifying and tracking compliance with these requirements and advising management of duties, problems, and specific needs Individual programs for tracking compliance issues related to air emissions, wastewater, solid and hazardous wastes, storage tanks, PCBs, asbestos, worker safety, lead, storm water runoff, toxic substances, and unplanned releases may be appropriate

4 5 Site Management

If possible, each facility should have staff responsible for management of key compliance areas, such as air, water, oil delivery/storage, waste disposal These individuals should be responsible for ensuring that the facility is in compliance with all regulatory requirements applicable to this aspect of facility operation They should also be encouraged to identify and, when resources allow, implement pollution prevention or minimization programs applicable to these resources

1116

4 6 Pollution Prevention Program

A specific program should be considered to minimize the release of pollutants to air, surface-water, soils and groundwater The pollution prevention program should focus on modifying existing storage procedures, manufacturing procedures, and product distribution procedures The program should also focus on the feasibility of capturing and recycling pollutant releases Like all environmental management plan sub programs, the pollution prevention program should be designed with a management review component to ensure that the program is adequate and effective Specific pollution prevention programs are described briefly below

4 6 1 Toxic Materials Minimization Program

A specific program addressing the need for minimizing the use of potentially hazardous or toxic materials should be considered Such a program might be integrated with the audit program and could contain procedures requiring the substitution of less toxic or hazardous materials and the modification of operations in which toxic or hazardous materials are used A data management system should also be utilized to document any reduction in the use of toxic or hazardous materials Corporate management should also be involved in the review of the adequacy of the minimization program

4 6 2 Waste Minimization Program

A specific program should be considered to address minimizing the generation and disposal of wastes, covering all organizational activities The program should focus on minimizing the generation of wastes by substituting raw materials that are more completely utilized This program should also address the feasibility of minimizing the need for treatment or disposal of waste via re-use or recycling of waste streams

4 6 3 Off-Site Waste Disposal Management Program

The liabilities associated with the off-site disposal of all wastes must be evaluated periodically Ideally, a program should be created to review past and present off-site waste treatment and disposal procedures, covering all waste streams A vital component of such a plan would include obtaining or completing detailed assessments of all potential off-site treatment and disposal facilities As part of the program, all disposal contracts used would be systematically evaluated to ensure that they are cost effective and protective of the company's interests

4.7 Employee Training

The organization must have some form of a formal training program for all staff charged with specific environmental responsibilities, commensurate with the individual employee's level of environmental responsibility It is also suggested that other non-environmental staff have some periodic environmental training All training must be documented Ideally both in-house and external resources should be utilized to provide training At a minimum, written training manuals must be made available Following training exercises, employees should be tested in order to demonstrate environmental

1117

competence Training should also be augmented by the distribution of commercially produced magazines, internal newsletters, etc

4 8 Records Retention

Each facility should have well organized files which contain copies of regulatory requirements (e g applicable laws, regulations, guidelines), permits, and approvals In addition, copies of reports, emission records, on-site data (meteorological data, monitoring data), should be available in this file, along with copies of submittal letters and other documents verifying compliance with reporting requirements Retention periods should be consistent with standards identified by corporate management and/or regulatory requirements

4 9 Communications

There should be a system for clear communications between environmental staff and other facility organizations, including management, purchasing, facilities planning, and personnel Adverse environmental performance can result when planning, hiring, purchasing, and acquisitions are made without consideration of environmental requirements

4 10 Emergency Response and Contingency Planning

It is imperative that any comprehensive environmental management plan contain adequate spill response and contingency or emergency response planning to address potential environmental emergencies Such a contingency plan must be developed and tailored for each operating location It should identify all potential contingencies, enumerate appropriate response procedures, and identify responsible persons located both on and offsite All such plans should also identify appropriate communications channels, staff training requirements, and periodic emergency response drills Plans must be periodically reviewed and evaluated in order to confirm their adequacy Plans may also require periodic modification to account for changes in facility operations and staff

4 11 Environmental Public Relations Program

An environmental public relations strategy or program should be considered a useful component of the overall management plan Such a program should be designed to include proactive procedures for disseminating both positive and negative environmental news The program must be supported by advertising and marketing and requires input from public relations professionals with substantial experience The program also ought to include some mechanism for responding to environmental emergencies

1118

4 12 Environmental Auditing Program

A formal environmental auditing program should be established, covering all of the activities of the organization The auditing program should mandate environmental audits on a periodic basis sufficient to track existing problems and to identify emerging environmental liabilities The auditing program should, at a minimum, focus on regulatory compliance and on management liability The audit program should be implemented by a combination of in-house staff and outside experts, and should require corporate review of all completed audits The audit should also require implementation of periodic quality control checks

4 13 Environmental Financial Assessment Program

A systematic program to financially quantify potential environmental liabilities should be considered Such an environment financial assessment program should be implemented in concert with the auditing program and should identify all potential compliance issues and other environmental liabilities which might lead to significant fiscal exposures The financial assessment should also assess the potential timing of each identified fiscal exposure, as well as provide a range of costs associated with each identified exposure The financial assessment must be actively considered in the organizations budgeting process

4.14 Energy Conservation

A program should be considered to minimize energy use Such a program can be financially lucrative, depending upon its overall success Such a program should include a comprehensive energy audit, procedures for minimizing energy use for lighting, heating, ventilation, and energy use Such a program should also consider potential energy reductions that may be available through alternative forms of energy such as cogeneration, waste-to-energy, solar power, wind power, etc Such a program should also include procedures for substituting potentially cleaner sources of energy

4 15 Due Diligence Program

A successful comprehensive environmental management plan should contain a due diligence program component, which is designed to be utilized whenever assets or businesses are acquired or divested The program should identify potential environmental liabilities in the context of divestiture or acquisition, and should aim to resolve environmental problems prior to the organization entering into sales agreements Similarly, the due diligence program should contain a procedure requiring the performance of comprehensive audits of all assets or businesses being considered for acquisition The audits should focus on the potential for environmental liabilities and on compliance problems

119

4.16 Risk Financing and Insurance

From a cost benefit viewpoint, each management plan ought to contain procedures designed to evaluate the possibility of transferring some of the potential fiscal risks associated with environmental outside parties such as insurance carriers Note that such coverage may be required by certain environmental laws and regulations As part of developing a risk financing and insurance strategy, it will be necessary to evaluate current and old insurance policies Potentially applicable insurance agencies and policies should be evaluated periodically for price and coverage Procedural mechanisms should also be established to identify and report claims Guidance and training should also be provided to various levels of management and staff to assure compliance with any relevant policy restrictions or requirements

1120

5 0 Human Resource Requirements

Employee awareness of environmental problems and pollution control measures is crucial for the successful implementation of the environmental management plan Training is required to create awareness and expertise and to improve the knowledge base as technology changes

5 1 Human Resource Management Activities

The following activities should be considered as options for incorporation in the organization's human resource policy to further successful implementation of the environmental management plan

- Make environmental protection responsibilities a part of an employee's job description
- Educate staff on the environmental impact of the firm's operations
- Make environmental performance and safety records a part of staff's performance evaluations
- Encourage/allow worker's participation in developing environmental management plan standards
- Establish standardized company-wide worker safety/emergency response training programs
- Establish standardized material safety data sheets for hazardous materials
- Create a standardized management safety training program
- Adopt incentive schemes at plant level to induce staff to contribute to the firm's comprehensive environmental management plan's objectives

5 2 Training

Labor communications and training are crucial to implementing and executing the environmental management plan Standardized employee training practice should include the entire corporation's staff in order to make all employees aware of the corporation's environmental objectives and policy goals, to ensure that environmental management proceeds smoothly To achieve that end, the following training devices and activities should be considered to be implemented

- Prepare a corporate environment education curriculum graded by stratum within the organization (new employee, mainstay employee, administrative or supervisory personnel
- Create a policy encouraging personnel to become qualified (certified) in environmental matters
- Hold hypothetical accident training exercises
- Hold special events, such as Environmental Improvements Week
- Publish informational and educational bulletin's on environmental matters
- Institute management structures placing additional responsibility on supervisors and senior officials

1121