ENVIRONMENTAL IMPACT ASSESSMENT & Management

1. INTRODUCTION

Impact of development projects under Civil Engineering on environment - Environmental Impact Assessment (EIA) - Environmental Impact Statement (EIS) – EIA capability and limitations – Legal provisions on EIA.

2. METHODOLOGIES

Methods of EIA –Check lists – Matrices – Networks – Cost-benefit analysis – Analysis of alternatives –Case studies.

3. PREDICTION AND ASSESSMENT

Assessment of Impact on land, water and air, noise, social, cultural flora and fauna; Mathematical models; public participation – Rapid EIA.

4. ENVIRONMENTAL MANAGEMENT PLAN

Plan for mitigation of adverse impact on environment – options for mitigation of impact on water, air and land, flora and fauna; Addressing the issues related to the Project Affected People – ISO 14000

5. CASE STUDIES

EIA for infrastructure projects – Bridges – Stadium – Highways – Dams – Multi-storey Buildings – Water Supply and Drainage Projects

TOTAL : 45

TEXT BOOKS

1. Canter, R.L., “Environmental Impact Assessment”, McGraw-Hill Inc., New Delhi, 1996.
2. Shukla, S.K. and Srivastava, P.R., “Concepts in Environmental Impact Analysis”, Common Wealth Publishers, New Delhi, 1992.

REFERENCES

1. John G. Rau and David C Hooten (Ed)., “Environmental Impact Analysis Handbook”, McGraw-Hill Book Company, 1990.
2. “Environmental Assessment Source book”, Vol. I, II & III. The World Bank, Washington, D.C., 1991.
3. Judith Petts, “Handbook of Environmental Impact Assessment Vol. I & II”, Blackwell Science, 1999.

Environmental impact assessment on Civil Engineering Projects

UNIT-I

Description of the technique

Environmental Impact Assessment (EIA) is a process by which the likely significant effects of a project or development on the environment are identified, assessed and then taken into account by the competent authority in the decision-making process. It is a systematic process that examines in advance the environmental impacts of proposed development actions and therefore can contribute to better projects from an environmental perspective.

Definition for EIA (Environmental Impact Assessment):
A formal process for identifying likely effects of activities or projects on the ENVIRONMENT, and on human health and welfare and also the means and measures to mitigate & monitor these impacts.

The purpose of the technique

Early work on an EIA initiative in Europe began in 1975 with the European Commission stating that an EIA procedure should be drawn up and adopted under the second action programme. Since those days EIA has moved away from being only a defensive tool to protect the environment to a tool that contributes to environmental sustainability in a more holistic manner with feedback loops to and from Strategic Environmental Assessments (SEA). SEA evaluates the environmental impacts of policies, plans and programmes on a higher tier of the decision-making hierarchy. EIA also provides the framework to consider location, design and environmental issues in parallel, potentially leading to improved relationship between the developer, the planning authority and the local community.

The statutory requirements of the EIA process, such as the EU's EIA Directive, are generally designed in such away that they can be adapted to different situations and circumstances. Consequently the EIA is a tool that constantly develops within countries' institutional structures and the decisions made reflect their prevailing environmental politics.

Circumstances in which it is applied

The EIA Directive serves as a good example of the circumstances in which an EIA is required. This Directive has categorised projects that are likely to have a significant effect on the environment, and requiring an EIA, by distinguishing projects (Annex I, see Box 1 *Annex I of project classes that always require an EIA*) where the EIA is mandatory from projects (Annex II, see Box 2 *Annex II lists classes of project under 13 headings*) where the EIA is discretionary. For the discretionary Annex II projects Member States must decide on a case by case examination, and/or by reference to thresholds or criteria, whether a project should be subject to an assessment or not. Annex III of the Directive sets out the selection criteria that Member States must consider when screening Annex II projects. These screening selection criteria are:

- Characteristics of Projects (size of the project, cumulative impacts, use of natural resources, the production of waste, pollution and nuisance and the risk of accidents)
- Location of Projects (environmental sensitivity of geographical areas affected by projects, having regard to existing land use, the nature of the natural resources and absorption capacity of the environment)
- Characteristics of the potential impact (the extent of the impact, the transfrontier nature of the impact, the magnitude and complexity of the impact, the probability of the impact, the duration, frequency and reversibility of the impact

In some cases Member States have set the thresholds for Annex II projects so high that in practice a large number of projects with a considerable environmental impact do not require an EIA. For example the European Court of Justice found Ireland's thresholds for reforestation, land reclamation and peat extraction to be too high (Commission of the European Communities, 2002).

In some cases an EIA is required, not only based on the type of project, but on the environmentally sensitive location of the project. For example the EIA Directive requires an EIA for all projects that are likely to have a significant effect on Natura 2000 sites.

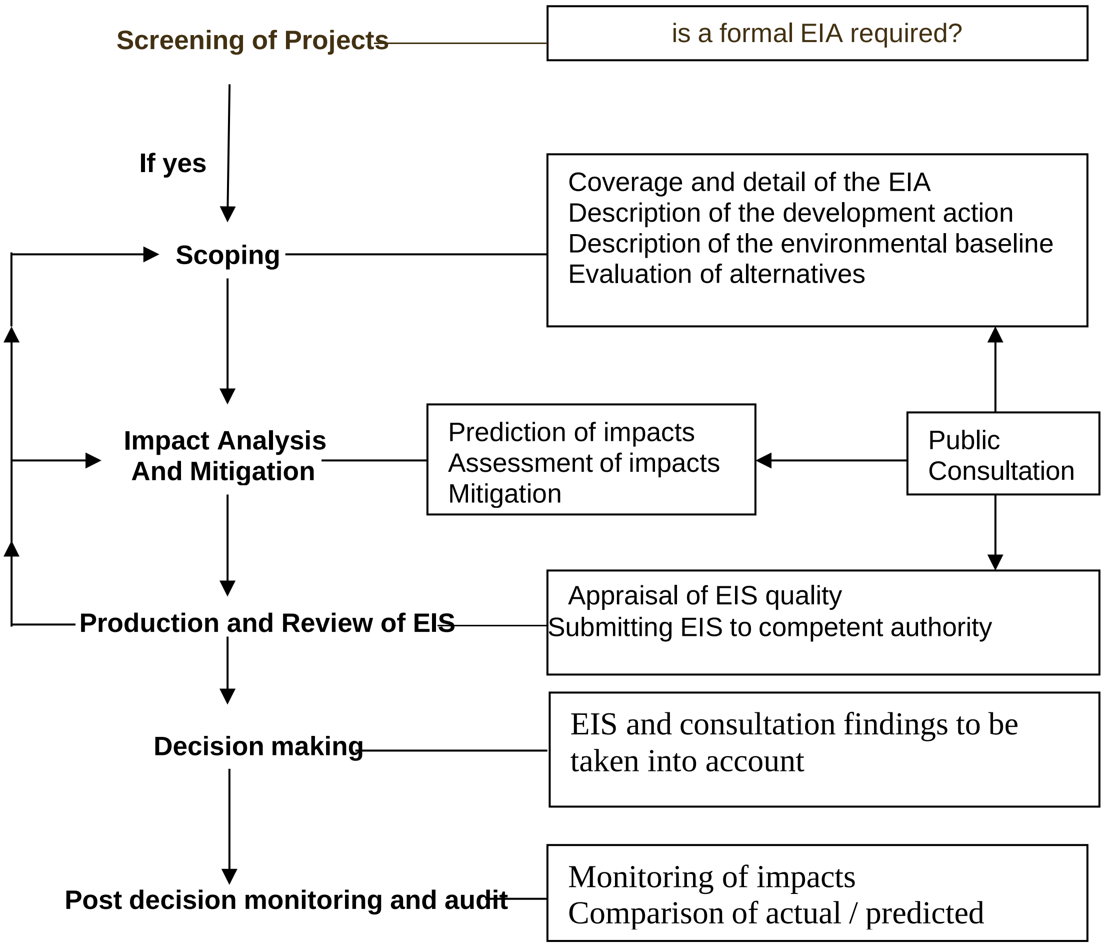
Annex I of project classes that always require an EIA

- **Oil refineries; large thermal power stations and nuclear power stations and reactors; installations for storage or disposal of radioactive waste; iron and steel works; installations for extracting and processing asbestos; integrated chemical installations; construction of motorways, express roads, railway lines and airports;**
- **trading ports and inland waterways; installations for incineration, treatment or landfil of hazardous waste. incineration or chemical treatment of non hazardous waste; groundwater abstraction exceeding 10 million cu. metres per annum;**
- **works for transferring water between river basins; waste water treatment plants;**
- **extraction of oil and gas;dams;pipelines for gas, oil and chemicals;**
- **installations for intensive rearing of poultry or pigs; pulp and paper plants;**
- **quarries; overhead power lines; and storage of petroleum and chemicals.**

Source: The classes are described in more detail in the Directive (Official Journal, 1997).

Main steps in the EIA process shows the main steps in the EIA process. It is important to note that the EIA is a cyclical process with feed-back loops between stages as well as links to other evaluation tools, such as SEA. As a consequence the orders of the stages are not set in stone.

Box 3. Main steps in the EIA Process



Step 1. Screening of Projects

During the screening process the developer has to evaluate whether a formal EIA is required for the project. It is the responsibility of the competent authority to decide whether an EIA is required and then make the decision public. The developer can also decide to voluntarily undertake an EIA without the formal screening decision from the competent authority. Volunteering to undertake an EIA can save time and costs later in the process.

Step 2. Scoping

The scoping stage sets the coverage and detail of the EIA process. Scoping evaluates which impacts and issues to consider and ensures that the impact evaluation provides all the relevant information. Generally scoping takes place between the developer and the competent authority. During the scoping stage those to be consulted, such as communities, local authorities and statutory agencies, are identified. The scoping ought to specify the project in such detail that potential direct, indirect and cumulative impacts can be identified at a later stage.

Description of the project/development action includes information about the purpose and rationale of the project and an understanding of its various characteristics, such as development location and processes.

Description of the environmental baseline should include present and the possible future state of the environment, assuming that the project is not undertaken. The time span should be the same as for the project. Baseline data project description and mitigation measures should be developed with monitoring implications in mind.

Evaluation of alternatives brings into consideration alternative means of carrying out the project, including technical and technological alternatives. Most of the possible alternatives that arise will be rejected by the developer on economic, technical or regulatory grounds. In the case of unforeseen difficulties during construction or operation of a project re-examination of these alternatives may help to produce rapid and cost-effective solutions.

Step 3. Impact Analysis and Mitigation

During this stage issues identified through scoping are analysed and the impacts are defined.

The prediction of impacts aims to identify the magnitude and other dimensions of identified change in the environment with or without the project, based on the baseline information gathered during the scoping stage. The significance of impacts could also cast new light on the scoping exercise. Box 4 *Types of impacts to be considered during the prediction of impacts* shows the types of impacts that ought to be taken into consideration.

Box 4: Types of impacts to be considered during the prediction of impacts

- **Physical and socio-economic**
- **Direct, indirect and cumulative**
- **Short and long run Local and strategic**
- **Adverse and beneficial Reversible and irreversible**
- **Quantitative and qualitative**
- **Distribution by group and/or area**
- **Actual and perceived Relative to other developments**

Assessment of impacts assigns relative significance to predicted impacts associated with the project, and to determine the order in which impacts are to be avoided, mitigated or compensated.

Mitigation consists of measures to avoid, reduce and if possible to remedy significant environmental effects. At one extreme, prediction and evaluation of impacts can lead to such adverse effects that the only sensible mitigation measure is to abandon the project. Like many elements in the EIA process, mitigation is not limited to one point of assessment.

Step 4. Production and Review of EIS

The environmental information acquired during the assessment is submitted to the Competent Authority by the developer together with the application for development consent. The environmental information is presented in the form of an Environmental Impact Statement (EIS). The EIS is made available to environmental authorities and the public for their information and to obtain their comments. For the qualities of a good EIS see the European Commission's guidance document The review involves a systematic appraisal of the quality of the EIS. In some Member States there is a formal requirement for independent review of the adequacy of the environmental information before it is considered by the Competent Authority.

Step 5. Decision-making

The competent authority takes all relevant information (including the EIS and the consultation findings) into account in reaching a decision on the proposed project.

Step 6. Post-decision Monitoring and Audit

Monitoring should include both baseline monitoring (before the project) and impact monitoring (after the project). Post-auditing again involves comparing the impacts predicted in the EIS with those actually occurring after implementation based on the monitoring. This enables an assessment of the quality of predictions and of the effectiveness of mitigation measures. The main purpose of post-auditing is to provide feedback to the EIA process and apply the lessons learned to be implemented in future EIAs.

Strengths and limitations of the approach

The EIA process results in greater environmental awareness among the stakeholders and ideally the decisions ought to reflect this. However, EIA is only an aid to the decision-making process, making it more transparent and informed, but it is not a decision making tool in itself and does not guarantee environmentally sustainable outcomes. The EIA process can only lead to a decision beneficial for the environment if the required environmental policy and criteria are in place elsewhere.

Decision-making remains an inherently political process and no techniques of rational assessment can balance away conflicts, which arise from the incompatible objectives of different interest groups. Rather the transparency and public openness enabled by EIA makes decision-making more political, not less. (Rees 1985, Sheate 1994)

EIA is intended for the less strategic project level of the decision-making hierarchy. Consequently EIAs impact on Structural Funds Programmes, higher on the decision-making hierarchy, can only be indirect, relying on feedback loops from the project-specific level to the programme level of SEA. This is especially important in terms of achieving better monitoring and review of Structural Funds Programmes.

The strengths of the EIA are closely linked to the quality of the assessment as well as to the developer's attitude towards the process. For example potential cost savings could go unnoticed if the EIS is perceived by the developer as a meaningless statutory add on. An example of EIAs potential as a cost saving exercise is shown in Box 5 *Example: The EIA of Billund Airport (Denmark)* and the strengths and limitations of EIA are highlighted in Box 6 *Strengths & limitations of EIA.*

Strengths & limitations of EIA

Strengths

- **Improved public participation and co-operation**
- **Decision-making becomes more transparent**
- **Universal applicability (many positive outcomes in developing countries)**
- **Tool for innovations and cost-saving alterations Increases environmental awareness**
- **Tool for sustainability**
- **Extends into SEA as an integrated part of decision making**
- **Introduces a cyclical learning process into a linear planning process**
- **Takes into account transboundary impacts**

Limitations

- **Ignores politics and models of decision making**
- **Uncertainty an intrinsic factor**
- **The inadequate understanding of the behaviour of the environment**
- **To a great extent a commitment dependent tool**
- **Susceptible to bias and personal interests (developer as well as pressure groups)**
- **Quality of data (out of date or the level of detail may be insufficient)**

Environmental Impact Statement

- An Environmental Impact Statement (EIS) is a document prepared to describe the effects for proposed activities on the environment. "Environment," in this case, is defined as the natural and physical environment and the relationship of people with that environment. This means that the "environment" considered in an EIS includes land, water, air, structures, living organisms, environmental values at the site, and the social, cultural, and economic aspects. An "impact" is a change in consequence that results from an activity. Impacts can be positive or negative or both. An EIS describes impacts, as well as ways to "mitigate" impacts. To "mitigate" means to lessen or remove negative impacts.

- Therefore, an Environmental Impact Statement, or EIS, is a document that describes the impacts on the environment as a result of a proposed action. It also describes impacts of alternatives as well as plans to mitigate the impacts.

- EIS document generally consist on three parts, introduction, description of proposed project and alternatives and description of the environment affected by the proposed actions.

- The introduction part of the document will state overview of the project, the purpose, alternative actions, summary of important environmental aspects and the methods of assessment being used. The description of proposed actions and alternative will describe the actions, lists of stage conducted for the project. In this part, alternatives are also mentioned, including a “no-action” alternatives as well. Statement also includes the projected actions if the project is not done.

- The core of the EIS document is actually located on this part. The name of this part is description of the environment affected by the proposed action or project. Suppose there is one proposed action with another alternative, each of these actions will contain the lists of environment will likely to get affected by particular action and alternatives. The measurement of the effect is defined by EIU, Environmental Impact Unit. The formula of EIU is as follows:

- EIU = PIU x EQI

- PIU = Parameter Impact Unit
  EQI = Environmental Quality Index

- The description of the environment affected by the proposed project contains lists of environmental parameters such as ecology, aesthetics and environmental pollution and human health. This list is grouped according their characteristics. For example, ecology may comprise of species or microorganisms live in the location of the proposed project, ecosystems etc. Several examples are shown below.

- Ecology:
  - Species and populations
  - habitat
  - wetlands and
  -ecosystems

- Aesthetics:
  - land
  - air
  - biota (biology)
  - water
  - object of historical or cultural significance

- Environmental pollution and human health
  - water
  - air
  - land
  - noise

- Economics:
  - jobs created or lost
  - property values

- If you heed on lists above, they are still in general. Therefore, we usually have to make more detail lists or specific subtopics. For example in environmental pollution and human health, there is water item, we identify the quality of water such as BOD (Biological Oxygen Demands) or DO (Dissolved Oxygen). If we focus on air, it may have specific subtopics such as sound or odor.

- Each of these items will be assigned a numerical rating to each of them, which is called EIU. You already know the formula to obtain EIU, we have to obtain PIU and EQI. Environmental Quality Index (EQI) is a ratio between the present value and the predicted value after the project. For example DO in surface water where the project is located and may interrupt the quality of the surface water, at present after laboratory test DO is, say 8 mg/L, the predicted DO after the project is 2 mg/L, thus the ration is 2/8, equals 0.25. Each listings has to be assigned this EQI. If you are dealing with quantitative items such as odor or aquatic life, you may assigned the scale from 0 to 1. To assign the EQI for items that have natural qualitative characteristics you may want to convert them into quantitative one. For example, cost spent for population around project location with current odor or sound qualitative condition and with the predicted condition. The EQI will then be tabulated for each items.

- Next step is to assign weights for each item, usually by distributing 1000 PIU. The distribution of PIU is usually chosen by the decision maker. The number of 1000 PIU is subjective depends on the committee of decision maker, this it is possible as well to assign 10 or 100 PIU.

- I want to make a very simple example, suppose the proposes project is to build shopping malls on an empty spot in the center of city near the river. Next step is to list the areas of environmental impact. They are:

- - water appearance
  - DO
  - odor
  - turbidity
  - suspended solid
  - aquatic life

- We have to determine the condition before project and prediction after project and then calculate the ratio. The list below follows the order: items, condition before project (unitless;mg/L), condition after project, EQI.

- - Water appearance, 10, 4, 0.4
  - DO, 8 mg/L, 2 mg/L, 0.25
  - odor, 10, 5, 0.5
  - turbidity, 15 NTU, 30 NTU, 0.5 (as higher NTU means more turbidity, thus the ratio is 15/30)

- suspended solid, 20 mg/L, 2000 mg/L, 0.01
- aquatic life 10, 4, 0.4

- The qualitative items such water appearance, odor and aquatic life are assigned value from 10 to 1 in which lower value means degradation of environment. The EQI is weighted by 10 PIU in this example and the EIU is calculated. We assign PIU for each item as follows:

- - water appearance, 1 PIU
  - DO, 2 PIU
  - odor, 1 PIU
  - turbidity, 2 PIU
  - suspended solid, 2 PIU
  - aquatic life, 2 PIU

- Total is 10 PIU.

- Now we calculate the EIU based on the following order: item, PIU, EQI, EIU.

- - water appearance, 1 PIU, 0.4 EQI, 0.4 EIU
  - DO, 2 PIU, 0.25 EQI, 0.5 EIU
  - odor, 1 PIU, 0.5 EQI, 0.5 EIU
  - turbidity, 2 PIU, 0.5 EQI, 1 EIU
  - suspended solid, 2 PIU, 0.01 EQI, 0.02 EIU
  - aquatic life, 2 PIU, 0.4 EQI, 0.8 EIU

- Total EIU is (0.4 + 0.5 + 0.5 + 1 + 0.02 + 0.8) 3.22 EIU. So we have obtained total EIU of a proposed action, now analogue with this method, we calculate the total EIU for other alternatives. Total EIU for each action is then compared to each other. Better action is indicated by higher EIU.

Legal provisions on Environmental Policy/Legislation

Environment clearance of development projects including mining is done by the Government, with the following objectives:_ optimal utilisation of finite natural resources through use of better technologies and management packages, and _ increasing suitable remedial measures at the project formulation stage.

The Policy Statement of Pollution issued by the Ministry of Environment and Forests Govt. of India in 1992, provides instruments in the form of legislation and regulation, fiscal incentives, voluntary agreements, educational programmes and information campaigns in order to prevent, control and reduce environmental pollution. The establishment and functioning of any industry including mining will be governed by the following environmental acts/regulations besides the local zoning and land use laws of the States and Union Territories:

i) The Water (Prevention and Control of Pollution) Act, 1974 as amended from time to time (Water Act)

ii) The Water (Prevention and Control of Pollution) Cess Act, 1977, as amended (Water Cess Act)

iii) The Air (Prevention and Control of Pollution) Act, 1981 as amended (Air Act).

iv) The Environment (Protection) Act, 1986 (EPA)

v) The Wildlife (Protection) Act, 1972 as amended

vi) The Forest (Conservation) Act, 1980 as amended

vii) The Public Liability Insurance Act, 1991

viii) The Mines and Minerals (Regulation and Development) Act, 1957, as amended (MMRD Act)

ix) Circulars issued by the Director-General Mines Safety (DGMS).

Environmental Impact Assessment on Civil Engineering Projects

Unit-2

EIA Methods

Introduction

EIA methods are usually taken to include the means of gathering and analyzing data, the sequence of steps in preparing a report, and the procedure (who does what and when). The essential ingredients of the EIA process, such as scoping, IEE, and detailed EIA, are universally agreed upon, but EIA techniques vary widely.

Considering the complexity of the interacting systems that constitute the environment, and the infinite variety of possible impacting actions, it seems unlikely that a single method would be able to meet all the above criteria. The general applicability of all methods also has to be balanced against the administrative and economic constraints within which they are employed.

There is no single approved method for an EIA study. Therefore, what is important is the ability to think in a systematic way:

- to understand the interactions of the environment and technological change;
- to meet, in a practical way, the needs of the development manager; and
- to follow the fundamental process of preparing an EIA.

A distinction between EIA methods and tools must be carefully noted. The four fundamental methods which are commonly used as methods for conducting an EIA are

- Checklists,
- Matrices,
- Networks, and
- Overlays.

Tools for EIA support the application of the above basic methods. Some of the commonly used tools are prediction models, geographical information systems, and expert systems. These tools can be used for purposes other than EIA.

Generally, more than one method and tool are used, depending on the tier of the EIA process, to accomplish the best results. Recommendations for the use of methods and tools are made in the form of a comprehensive flow chart.

Checklists

Checklists serve as reminder of all possible relationships and impacts, out of which a set tailored for the specific assignment may be chosen.

Checklists are designed to establish whether a proposed project is likely to have negative impacts on the environment. For such projects, all possible negative impacts must be assessed in detail in relation to the project's positive impacts. This is accomplished in the next steps of the EIA.

The checklists help people in key positions to become more aware of what they should be looking for when assessing a proposed project. They may also help to develop a higher degree of awareness of the environmental aspects of a project.

Checklists can be classified into **descriptive and weight-scaling categories.**

The purpose of a descriptive checklist is to provide a list of important issues for the purpose of identification and scoping. One of the simplest forms of the checklists is the one with project-specific questions. A common, simple and inexpensive method is the checklist. These can be of different types.
Below are the most common listed:

Simple checklists list the components or aspects, usually of the environment that might be considered by the assessor but no other assistance is provided to guide the impact identification process.
Descriptive checklists provide additional assistance by indicating, for example, the specific variables to be measured to characterize each component.
Scaling checklists go a step further and include simple devices for assessing importance or significance of suspected impacts. This might be through the use of letter or numeric scales, assigned after comparison with criteria supplied in the checklist, to indicate the importance of an impact. Another approach is to use threshold values, based on statutory criteria (e.g. for water quality standards) or on derived measures (e.g. visitor carrying-capacity for a given locality). The suspected impact can be estimated in broad terms and given a value to represent its significance. On that basis, a start can be made on comparing and ranking alternative project options.
Questionnaire checklist, is a form of scaling checklist but uses a series of carefully directed questions to elicit information about possible impacts and their likely importance.Checklists help to organise the work and identify important issues. The risk of using checklists is that important issues not included in the checklist may exist.
Checklist of impact categories for land development projects (summarised from Schaenam 1976).
1 Local economy
Public fiscal balance
Employment
Wealth
2 Natural environment
Air quality
Water quality
Noise
Wildlife and vegetation
Natural disasters
3 Aesthetics and cultural values
Attractiveness
View opportunities
Landmarks
4 Public and private services
Drinking water

Hospital care
Crime control
Feeling of security
Fire protection
Recreation - public facilities
Recreation — informal settings
Education
Transportation - mass transit
Transportation - pedestrian
Transportation — private vehicles
Shopping
Energy services
Housing
5 Other social impacts
People displacement
Special hazards
Sociability/friendliness
Privacy

Checklists can be also developed based on issues. The issues can be later graded to identify those of significance based on the project and environment features, i.e., relevance. Issues of high significance can be later decomposed into responsible "activities" and "components of concern" to develop mitigation, protection, and monitoring measures in the succeeding levels of an EIA. Box 4.2 shows an illustration of an issue-based checklist developed for projects on power development. The issue-based checklists thus assist in the exercise of scoping and IEE.

Environmental impacts often tend to appear in the form of chains of cause and effect. If the first link in the chain is revealed, the subsequent impacts will also be uncovered. In order to reduce the number of questions in each checklist, the questions are most often related to the first link in the chain

Advantages of the checklist method

- Checklists provide all possible relationships and impacts, out of which a set tailored for the specific assignment may be chosen.
- Checklists help people in responsible positions to become more aware of what they should be looking for when assessing a proposed project.
- Checklists may also help to produce a higher degree of awareness of the environmental aspects of a project.
- Quantification of impacts is possible using the weighted-scale method.

Limitations of the checklist method

- Descriptive checklists may be exhaustive, including the impacts during the various stages of the project. However, no quantitative information is provided regarding magnitude and degree of impact.
- Another important drawback of this method is the way it attempts to compartmentalize the environment. Environmental systems comprise a complex web of interrelated parts, often incorporating feedback loops. This fact is not included in the weighted checklists. This method should be therefore used with some caution. Its quantitative features may be used to distinguish between alternatives and so should be used only when a comparision needs a quantitative resolution.
- The main drawback of the checklist method is the inability to relate individual activities to environmental components affected by these activities.

Matrices

A more detailed approach is given in matrices, where project activities are cross-tabulated with environmental components. Also matrices can be made quite simple or be developed into a stage with a large amount of information. The strength of the matrix approach is the usefulness in designing further studies, the inexpensive nature (also true for checklists) and their comprehensiveness. Limitations may be an inability to handle indirect impacts and temporal aspects, a potential rigidity of categories, an a difficulty to get an overview when many variable are included. In many cases numbers of magnitude and severity of impact are included on a very poor basis ("this feels larger than the other"). Thus many matrices used give much less and lower quality information than thought on first impression.

Matrices relate activities to environmental components so that the box at each intersection can be used to indicate a possible impact. The term "matrix" does not have any mathematical implication, but is merely a style of presentation.

Environmental and socio-economic factors	Issues arising from the development							
	Traffic	Waste	Workforce	Site vehicles	Site machinery	Raw materials	Landscaping	Temporary buildings or cabins
Flora								
Fauna								
Water								
Microclimate								
Aesthetic appeal								
Noise								
Air quality								
Local residents								
Local businesses								
Local landowners								

Develop a scoring system, for example:

0 = no impact
1 = low impact
2 = moderate impact
3 = high impact

Spilt values can be assigned, and some more important factors could be weighted (e.g. score doubled) to increase validity.

Totals can then be calculated for each factor.

matrix can be used to identify impacts by systematically checking each development activity against each environmental component. If it was thought that a particular development activity was to affect an environmental component, a mark is placed in the cell at the intersection of the activity and the environmental component. A matrix analysis can systematically identify potentially important effects demanding more careful attention or analysis or focus attention on important possible effects that might otherwise be overlooked. Matrix is thus an extension of the basic checklist.

There are three types of commonly used matrices:

- descriptive matrices;
- symbolic and presentation matrices;
- scaled/weighted or numeric matrices.

Example of plus/minus matrix on the theme "Why does the proposed activity improve the soil condition?"

Environmental Component	Existing situation	Proposed activity	Process alternative	Environmentally most friendly
Air	0			0
Soil	0	+	+	+
Surface water	0		0	0
Waste	0	+	+	+
Noise	0	-	-	-
Safety	0	(-)	(-)	(-)
Nature	0	0	0	0
Energy	0	-	0	+
Costs	0	-	-	-

Legend: - deterioration compared to the existing situation; + improvement; 0 no difference; (-) insignificant deterioration.

Advantages of the matrix approach

- A matrix presentation has a better structure framework than the checklist approach. In fact, it makes a summarized analytical presentation of the project and environment-related checklists.
- Matrix structure allows for speculation of impact characteristics, albeit in a subjective way. This provides a gradation in the impacts, thereby providing a focus for further studies, verification, or discussions. It also helps in making priorities on some mitigation measures which are estimated to alleviate the impacts speculated.
- It presents an easily understood summary of a large number of primary impacts.
- It is a generalized but well defined approach, forcing a comprehensive consideration of environmental components and primary impacts.
- It is an easily performed process which can specify the overall character of a project early in the design phase.
- In an extended form, the method can include information about many impact attributes, and clarify the assumptions supporting the assessments.
- Matrices have low resource requirements.

Limitations of the matrix approach

- Unless weight-scaled impact scores are used, the comparison of many project alternatives is difficult.
- Scaling the multitude of scores contained in a matrix is also not a tractable proposition, as the ability to independently replicate the method is undermined by a dependence on highly subjective judgments.
- The impact characterization step of the matrix involves subjective prediction as well as assessment.
- There is little opportunity for quantification. However, it is possible to accommodate further detailing in the matrix presentation if prediction/evaluation techniques are separately used.

- While developing matrix structure, it becomes apparent that higher order impacts are not accounted for using this approach.

Network diagrams

Network diagrams may be used to illustrate linkages and higher order effects in the system. This shows how secondary and higher order effects may be evaluated in cause effect chains. A problem with this kind of diagrams is that i very easily tends to become large and complex. There are no quantitative measures on impact magnitude or significance as is often found in the matrices. This may be an advantage since the aim of the impact identification is not to quantify and the quantitative data is often poor at this stage in the study.

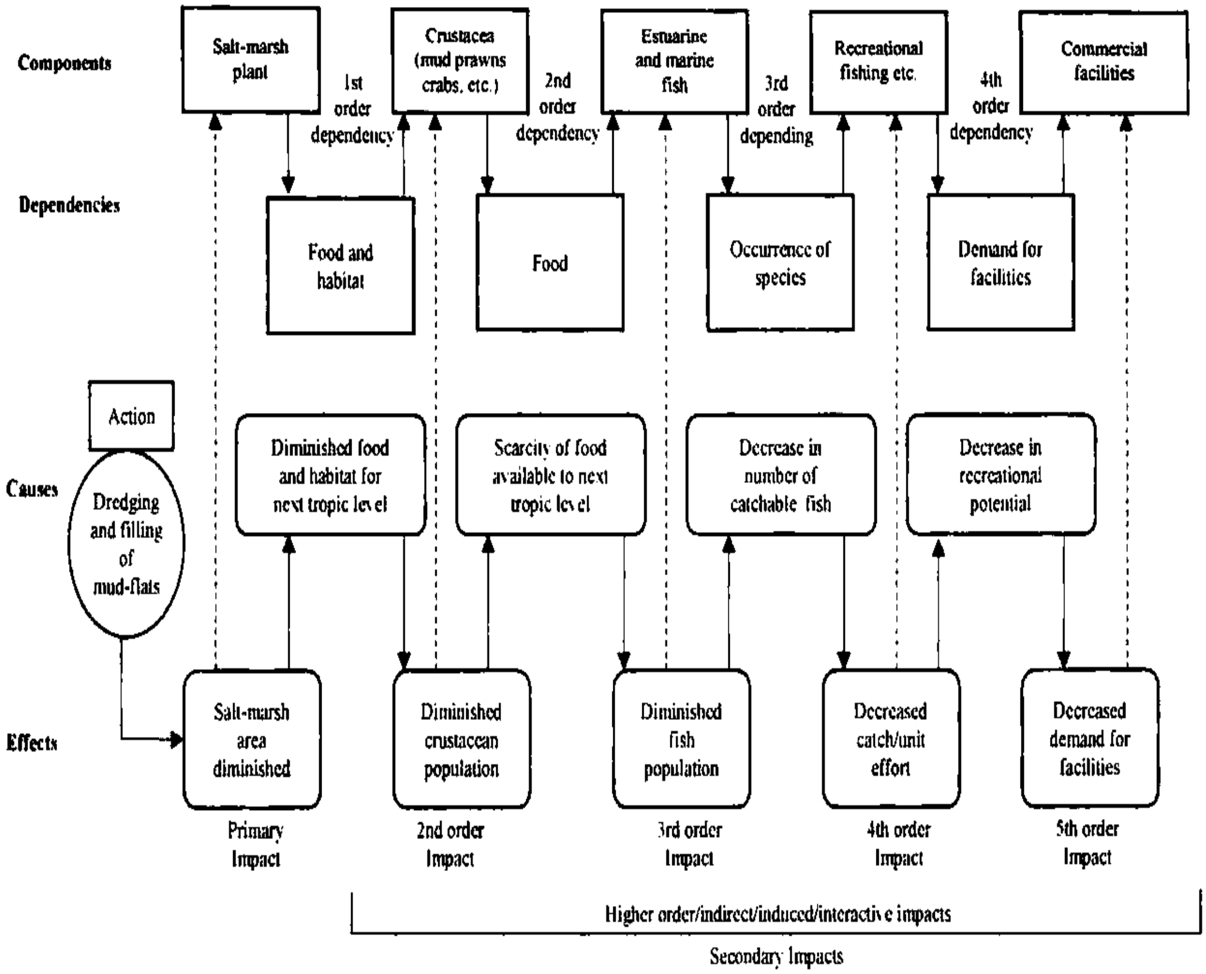
Investigation of higher order linkages in two dimensions can be carried out by using directional diagrams called **networks.** Networks, although widely discussed in the EIA literature, have not been used as extensively as matrices and simple checklists. Networks were essentially developed to explicitly consider the secondary, tertiary, and higher order impacts that can arise from an initial impact. Here, any effect on the biophysical and socio-economic environments that arises from a cause directly related to the project activities is termed a first-order or primary impact. The secondary impacts are those affecting the biophysical and socio-economic environments which arise from an action, but which are not initiated directly by that action. Presentation matrices can only clearly show the primary or first-order impacts within any particular activity-component framework. The network technique developed by Sorensen is probably the best-known approach for investigating higher order impacts. The objective of the network approach is to display, in an easily understood format, the intermediate links between a project and its ultimate impacts. This type of network includes the identification of probable importance of temporal effects as well as a list of data requirements. Complexity increases as higher order impacts are considered, and, as a result, the Sorensen network is restricted to third and lower order impacts.

Advantages of the network method

- Presentation matrices can only clearly show the primary or first-order impacts within any particular activity-component framework. It is possible, however, to investigate higher order linkages in two dimensions by using networks.
- It is possible to translate networks into mathematical models for a more quantitative judgement. The network method structures the relationships implied in qualitative simulations.

Limitations of the network method

- One of the main limitations of the network method is that since impacts are not scored in any quantitative way, the comparison of project alternatives is not readily achieved.
- Spatial representation of impacts is not possible.



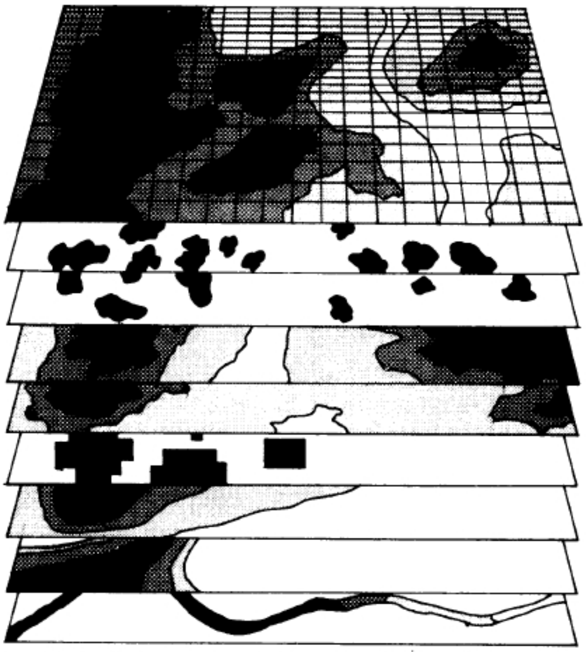
Overlays

The overlay approach to impact assessment involves the use of a series of transparencies to identify, predict, assign relative significance to, and communicate impacts in a geographical reference frame larger in scale than a localized action would require. The approach has been employed for selecting highway corridors, for evaluating development options in coastal areas, and in numerous other applications.

The McHarg overlay is based on a set of transparent maps, each of which represents the spatial variation of an environmental parameter (e.g., susceptibility to erosion or recreational value). The maps are shaded to show three degrees of parameter compatibility with the proposed project. A composite picture of the overall social cost of affecting any particular area is approximated by superimposing all the transparent maps. Any number of project alternatives can be located on the final map to investigate the degree of associated impacts. The validity of the analysis is related to the type and number of parameters chosen. For a readable composite map, the number of parameters in a transparency overlay is limited to about 10 (Munn, 1979). Parameter maps present data in a summarized and easily interpreted form, but are unable to reflect the possibility of secondary impacts. They also rely heavily on cartographic skills and their effectiveness depends to a large degree on cartographic execution.

This method is easily adaptable for use with a computer programmed to perform the tasks of aggregating the predicted impacts for each geographical subdivision and of searching for the areas least affected. Automated procedures are also available for selecting sequences of unit areas for routing highways, pipelines, and other corridors. The computer method is more flexible, and has an advantage whenever the reviewer suggests that the system of weights be changed.

The overlay approach can accommodate both qualitative and quantitative data. The weakness of the overlay approach is that it is only moderately comprehensive, because there is no mechanism that requires consideration of all potential impacts. When using overlays, the burden of ensuring comprehensiveness is largely on the analyst. Also, the approach is selective because there is a limit to the number of transparencies that can be viewed together. Finally, extreme impacts with small probabilities of occurrence are not considered. However, a skilled assessor may make indications in a footnote or on a supplementary map.



The use of overlays to show environmental impacts.

Cost benefit Analysis (CBA) is a tool used either to rank projects or to choose the most appropriate option. The ranking or decision is based on expected economic costs and benefits. The rule is that a project should be undertaken if lifetime expected benefits exceeds all expected costs. The art of the analysis process comes in the measurement of these impacts, their adjustment for market failure, and for the effects of time, income distribution, incomplete information and potentially irreversible consequences. A principle of western economics since Adam Smith is that 'the market knows best. In a perfect world, the market would ensure that land, labour and capital were allocated in a way that would maximize both profits, and the welfare of society. Ours is an imperfect world, but CBA is a tool that allows the analyst to mimic the welfare optimizing behaviour of the market. Although complexities arise when costs and benefits are being measured and corrected, CBA is a simple tool with numerous uses and applications, especially in the environmental assessment sphere. Its use increases accountability and consistency in decision-making.

This document has been written for a wide audience. Its objective is to serve as an initial reference text. The aim is to provide an introductory information source to government authorities, environmental practitioners, nongovernmental organizations (NGOs), industry, project proponents, academics, students and other interested and affected parties (I&APs). This document provides an overview of the theory and methods of CBA. The process on how to perform CBA is provided. The advantages and disadvantages of CBA is explained. Key issues that complicate the application of CBA are highlighted. This document is not prescriptive but rather provides an overview of the key criteria to consider when applying CBA.

APPLICATIONS OF COST BENEFIT ANALYSIS

CBA is used at two basic levels. In the private sector financial CBA is used to justify equipment and technology investments; measure life cycle costs; meet regulations cost-effectively; and quantify hidden costs and intangible benefits. It is also a useful tool to show how outsourcing and leasing can result in cost savings, and how quality improvements can affect returns. Social CBA is used to appraise the social merit of projects or policies. The projects may be public or private, and the analysis is typically used to inform public decision makers. This type of CBA is the form typically used in EIAs.

1. *Evaluate or rank the feasibility of projects*- CBA is used by decision makers to determine whether a single activity or project should be undertaken, or
to rank competing projects or policies.

2. *Analyse the effect of regulation*- A typical purpose of new public regulations is to reduce or eliminate specified risks to environmental quality. While scientific and engineering estimates can indicate how and by what amount the proposed regulations will reduce the risk, the ‘optimal’ level of intervention still has to be established. CBA can help inform this process; it can also indicate whether the risk would be more effectively addressed through private action, newregulation, or stronger enforcement of existing statutes.

3. *Justify equipment and technology investment*- CBA can be used to determine whether a new investment in equipment or technology for governmentis an efficient use of the taxpayers’ money.

4. *Determine the most effective way to cut costs, especially in capital planning.*CBA provides a simple method to implement costeffective capital planning.

5. *Determine the relative benefits of outsourcing and leasing.* A traditional function of the state is the provision of
public goods. These are goods (such as lighthouses or public immunization schemes) that are not depleted by use and from whose benefits the public are not excluded if they refuse to pay. However, many of the goods and services provided by the state have a ‘private goods’ component. Where this is the case, outsourcing part of a project may reduce costs and improve quality. CBA can be used to identify such opportunities.

6. *Quantify hidden costs and intangible benefits.* A common justification for the EIA process is that it may reveal possibilities that the internal planning process missed. While this is expected in the scientific studies of an EIA, it can also occur on the economic side. In the process of performing financial CBA, unanticipated costs and benefits may be uncovered. More importantly, the valuation of all costs and benefits reveals the full consequences of a project or policy decision. This is especially important in the public health and environmental spheres, where the relative magnitudes of impacts are central.

7. *Ensure accountability by public sector decision-makers*- CBA presents its results after a sensitivity analysis. The output should be clear and its interpretation simple. Where it is part of an EIA, CBA provides information for the public, NGOs and the press, and in doing so increases the accountability of public decision-makers.

ANALYSIS OF ALTERNATIVES

Rationale

The consideration of alternatives to a proposed project is a requirement of EIAs in many jurisdictions and is a core element of the EIA process and methodology. The Trinidad and Tobago environmental management regime is no exception: Applicants must identify and appropriately evaluate project alternatives as part of the process. The process for analysing alternatives is designed to incorporate environmental considerations into all stages of project and development planning. Ideally, this approach begins with strategic environmental assessment to analyse broad alternatives within a sector or geographic region. When such a framework is absent, as is the case in Trinidad and Tobago, the key alternatives are examined as part of a project-specific EIA as addressed in this chapter.

In many cases, certain alternatives will have been foreclosed by the overall project approach undertaken and earlier stages of decision-making. Retroactive analysis of alternatives is not considered good practice unless the circumstances deem it necessary, for example, when a proposal is well advanced but has a potentially significant impact on the environment or involves the relocation of large numbers of people. The relative impact of each alternative is compared against the baseline environment (with and without the project) to select a preferred alternative, including taking no action. Election of the no action alternative does not necessarily correspond to the maintaining of baseline conditions, however, because changes may result from other actions.

Range of Alternatives Considered

Types and ranges of alternatives considered include:

• **Demand alternatives** – using cogeneration to improve the energy safety and efficiency of the plant.

• **Input or supply alternatives** – with the completion of Project Stages 2, 3, and 4, introduce a waste brine stream from DESALCOTT to minimise the need to obtain water required for the chlor-alkali operation from WASA's potable supply resources. Several suppliers were canvassed to locate the purest limestone to reduce the quantity of reaction mud produced by the process.

• **Project activity alternatives** – several alternatives were investigated for the piling activity that would occur during plant construction. The soil conditions and limited availability of piling equipment, contractors, tools, and techniques on the island restrict the options available for this activity.

• **Location alternatives** – For the entire proposal as well as for various project components, several potential locations were evaluated before selecting Trinidad and the proposed Project site in Point Lisas. Trinidad was chosen because of its strategic location relative to the potential customer base and the attractive energy pricing. Alternative configurations of major plant components were studied with regard to protecting public health and the environment while simultaneously optimizing operations (e.g., moving cooling towers, the entire chlor-alkali facility,, and the ponds to areas of the site where they would be farthest from nearby residences.

• **Process alternatives** – Mechanical vapour recompression, among the most efficient use of energy for evaporation, is the technology that would be used for concentrating waste brine. Mechanical vapour recompression was proposed as a design alternative to multiple-effect evaporation for the brine concentrator. This technology, along with the cell membrane process, would substantially improve the plant's energy efficiency.

• **Start up approach** – The Project would be phased to minimize the risk of an environmental or health and safety incident during startup and to provide an opportunity to prove the brine purification process, and test and quantify waste solids products, one step at a time. The Project design calls for the dryer off-gas filtration system to be replaced so that particulate emissions are reduced and all water streams are recycled to achieve a "zero" process waste water discharge.

• **Use of best available technologies** – The proposed chlor-alkali plant would incorporate state-of-the-art cell membrane—not diaphragm or mercury membrane—technology. The industry has largely phased out the use of mercury membrane technology in the United States and Europe. The cell membrane would be nameplate rated and would use CONVE equipment. The Project would also use high efficiency scrubbers to minimize air emissions from the plant. The Containment Pit would be either an earth-bermed structure with a geomembrane liner or an engineered concrete structure to minimize the risk of groundwater contamination from process water. If the concrete option is chosen, the structure would be designed with leak stops and an underdrain to detect any leakage, and would be designed to meet the appropriate seismic requirements.

• **Scheduling alternatives** – The Project would be phased, in part, to allow time for the introduction of greener alternatives, which require large upfront capital investments, including the ability to use the waste brine stream from DESALCOTT and to develop the cogeneration plant. Cogeneration has a higher overall efficiency than conventional utility systems, typically 85 percent versus 58 percent. This efficient use of fuel would reduce the forecast emissions of greenhouse gases by approximately 30 percent. Stakeholder input (through meetings with stakeholders, community outreach efforts, and focus groups) was actively sought to inform the generation and analysis of viable alternatives.

Unit-III

Assessment of Impact on land, water and air, noise, social, cultural flora and fauna

The impacts due to development works construction will be first minimized by adequate planning and taking construction activities as per PERT and CPM Chart. The specific measures that shall be put to practice to minimize the impact on the environment are discussed below:

Air Environment

- Provision shall be made for sprinkling of water on loose soil to avoid dust generation.
- The debris and unutilized construction material and earth from the construction site shall be removed immediately to recycle within the project so that no nuisance dust is generated due to wind.
- The vehicles employed by the developers shall be checked for vehicular emissions. The developers shall also impress upon the service agencies to get vehicles regularly checked for vehicular emissions.
- Construction Activities shall not be allowed at Night.
- The mitigation measures shall include regular maintenance of machinery and provision of personnel protective equipments to workers where needed.
- The steps shall be taken to reduce the impact of noise by taking to plantations from the very beginning.
- A Hot Mix Bitumen Plant with air pollution control system shall be used to provide Bitumen Macadam Roads and entire operation shall be mechanized to complete the work in shortest duration and in one go.
- The permission of the Himachal Pradesh State Environment Protection & Pollution Control Board shall be taken as relevant.
- A Sewage Treatment Plant with tertiary level of treatment is being provided as per details in **Annexure-4.1** to avoid any odour pollution from the sewage generated from the colony.
- Extensive plantation is planned as discussed in Section-4.6 to mitigate the impact of noise and to improve the ambient air in general.
- The standby generator shall be installed with enclosures as per guidelines of Central pollution Control Board and after taking consent from Himachal Pradesh.
- Environment Protection & Pollution Control Board under Air (Prevention and Control of Pollution) Act, 1981. The details are given in **Annexure-4.2**
- No individual shall, however, be allowed to install generators on roadsides, in corridors or in such a manner to act as a public nuisance, by way of making this a part of agreement, while allotting the flats.

Water Environment

- The run-off during development shall be controlled by removing construction related solid waste as malba, loose soil etc.
- Further land clearing activity shall be kept to the absolute minimum by working at the specific sites one by one where construction is to take place.
- A septic tank shall be provided with toilet facilities to meet the daily needs of labour during working hours. Workers shall be discouraged from toilet in open.

- Both roof top rainwater harvesting and storm water run off shall be tapped for recharging the aquifers and storage. The developers shall undertake Rain Water Harvesting in Parks and Public Places.
- The provision of the same shall be made compulsory for those who shall purchase plots and construct it. The Environment Management Cell of the Developers shall further carry out awareness campaigns on the same for the owners of the individual plots.
- A Roof Top Area of 40000 Sq.m with annual Roof Top Rain Water Harvesting Potential of 32000 m3 is available. The details of rain water harvesting are given in **Annexure-4.4.** The Strom Water plan is attached at **Annexure-4.5**
- A Sewage Treatment Plant of 900 m3/day capacity is planned to treat the sewage to BOD <5 mg/l. and recycle the same.
- The details are given in Annexure-4.1.
- About 1800 Kg/day of solid waste shall be generated from the proposed housing colony.
- The Developer plan to introduce a paid house-to-house garbage collection work for which cycle carts shall be provided. A designated sites for provision of Safai Kendra to segregate the solid wastes and undertaking solid waste management through vermiculture biotechnology.
- The Environment Management Cell by developer in consultation with HIMUDA and HPSEP&PCB shall take all steps to see the compliance of the Municipal Solid Wastes (Management and Handling) Rules, 2000. The details of vermiculture technology are given in Annexure-4.3.The environmental monitoring programme is discussed in Section-4.5.

Land Environment

- To avoid erosion of the top soil the development is planned in the shortest possible time and landclearing activity shall be kept to the absolute minimum by working at the specific sites one by one where construction is to take place so as to increase detention and infiltration.
- The activities that result in soil being laid bare shall be scheduled in such a way that some type of vegetative cover appropriate to the site shall be established prior to onset of monsoons.
- Natural waterways/drainage pattern shall be maintained by providing culverts where needed. The solid waste generated from the construction activities shall be effectively recycled within the project.
- The requirements of sand and aggregates for the construction works are met from in and around Baddi, where, these are taken out from seasonal rivulets that get replenished annually.
- The development works shall prefer use of concrete blocks and concrete and use of bricks shall be to minimum. The fly ash based cement shall be used for the purpose.
- For the development works the use of wood shall not be allowed (Timber Free Construction) and is replaced by Mild Steel, Aluminium, Glass and Plastic.
- The project involves development of a residential colony over an area of 8.79 Ha (21.71 Acres). The residential area is divided into 5 Blocks with a total of 1712 Flats (Block-A 336 Flats, Block-B 368 Flats, Block-C 432 Flats, Block- D464 Flats and Block-E 112 Flats.

- Permissible Ground Floor Coverage is 50% and Permissible FAR is 1.5. The Blocks A & B are G.F + 4 Floors whereas Blocks C, D & E are G.F + 3 Floors. A total population of 9000 is expected with an average of 5 persons per flat.
- Area under housing is only 36% of the total area and remaining area is under common services as parks, roads, footpaths, schools and health center.
- A 5 m green bet is placed all along the colony. The land use is thus so planned that there is minimum adverse impact.
- The solid waste is being managed through vermiculture technology as discussed in Annexure-4.3 to minimize any impact on land environment.

Energy Management

- The orientation of the plots to maximum extent is planned to make use of natural light and direction of sun.
- The land use is thus so planned that there is minimum adverse impact and maximum use of principles of eco design.
- A fundamental principle of solar design is to maximize the solar gain in the winter and minimize it in the summer and is used to the extent possible practically.
- The Environment Management Cell for the colony shall also hold awareness programmes for the individual plot owners in this regard to maximize the benefits of working with the sun.

Environment Monitoring Programme

Regular monitoring of all significant environmental parameters is essential to check the compliance status vis-à-vis the environmental laws and regulation. The objectives of the monitoring will be as follows:

• To verify the results of the impact assessment study with respect to the proposed projects.
• To study the trend of concentrated values of the parameters, which have been identified as critical and then planning the mitigating measures.
• To check and assess the efficacy of pollution control equipment.
• To ensure that any additional parameters, other than those identified in the impact, do not turn critical after the commissioning of proposed project.To implement the EMP, a structured Environment Management Cell (EMC) interwoven with the existing management system will be created. EMC will undertake regular monitoring of the environment and conduct yearly audit of the environmental performance during the construction of the project. It will also check that the stipulated measures are being satisfactorily implemented and operated. It shall also co-ordinate with local authorities to see that all environmental measures are well coordinated. A comprehensive environmental monitoring program that has been prepared for the purpose of implementation in the proposed residential colony by the EMC is described below:

- The Ambient Air quality shall be monitored at project Site and two upward and downstream locations once every quarter for RSPM, SPM, NOx & SO2, and CO levels during the Construction Phase and Operational Phase. The Ambient Noise Levels shall also be monitored once every six months.
- The Vehicles shall be checked for PUC once every quarter during the development period and records shall be maintained.
- Groundwater quality of the Tube wells in site area will be regularly monitored preferably once in a quarter during the development period.

- Sewage Treatment Plant shall be provided with a small Laboratory and weekly monitoring of the parameters shall be undertaken. In addition monitoring shall be got done from an independent agency as laid down by Himachal Pradesh State Environment Protection & Pollution Control Board. All the above observations will be complied and documented by the EMC to serve the following purposes.
- Identification of any environmental problems that are occurring in the area.
- Initiating or providing solution to those problems through designed channels and verification of the implementation status.
- Controlling activities inside the project, until the environmental problem has been corrected.
- Suitably responding to emergency situations.

The environmental parameters likely to be affected by mining are related to many factors, i.e., physical social, economic, agriculture and aesthetic. Opencast mining involves extraction of underneath minerals, it's dumping and dumping of waste along with other operations, viz, traffic network, and other vehicular movements. All the operations can disturb environment of the area in various ways, such as removal of mass, change of landscape, displacement of human settlement, flora and fauna of the area, surface drainage, change in air, water and soil quality. While for the purpose of and economic upliftment of people, there is a need for establishment of industrial project, but these have to be environmentally friendly. Therefore it is essential to assess the impacts of mining on different environmental parameters, before starting the mining operations, so that abatement measures could be planned in advance for eco-friendly mining in the area. The increasing awareness among the people about ecological imbalance and environmental degradation has raised many apprehensions which should be clarified. The impacts on different environmental parameters due to this mining project are discussed below:

IMPACT ON SOIL AND LAND USE PATTERN

Impact of Mining on Soil Environment

There may be some impact on soil of the study area located beyond the working area of the mining project due to pollution to air & water, which are the distant carriers of solid, liquid & gaseous matters. Soil samples will be collected and tested regularly for the study area, which will show us if there is any effect. By proper mitigation measures, the impact on the soil environment of the study area due to the mining activities can be controlled / minimized.

Impact on Land use Pattern

Absence of scientific approach for waste recycling through land application may result in degradation of surrounding land. However, controlled recycling through land application, as suggested in environmental management plan, will result in improved land use pattern, vegetation and aesthetic quality of surrounding landscape. There may not be any adverse impact on existing vegetation due to the project activity, when proper mitigating measures and or proper reclamation measures are adopted.

Impact on Topography

Due to mining activity, the topography does change. By proper planning of excavation, road, dumps, & green belt development, plantation, the aesthetic beauty of area can be enhanced. This if not attended properly, the derelicted shape will lead to ugly topography.

Impact on Vegetation

Following impacts are inevitable:

a) Deforestation required for the development of the mine.

b) Deforestation required for the development of infrastructure such as approach roads etc.

c) Impact due to rolling down of the boulders.
d) Dispersion in characteristics of original soil due to waste dumps.
The impact can be nullified or even better landscape and greenery can be developed by better efforts on re-vegetation of area after mining is over in that part of land.

IMPACT OF MINING ACTIVITIES ON AGRICULTURAL PRACTICE OF THE AREA

The crops grown in the area are primarily wheat in Rabi crop and paddy and maize during Kharif. Besides small areas are also cropped with vegetables including onion, ginger and potato. There is no commercial orchard in the area. The crop yield may be affected either due to change in soil characteristics or reduction in agricultural area. Unless soil remain unaffected by less or no pollution effect or mined out area is converted back to agricultural land by backfilling & soil capping over it.

Impact of Mining Activity on Floral and Faunal Environment of the Area

The mining activities have some effect on flora and fauna of the area and its surroundings to a reasonable distance. Impact on flora/fauna is due to:
(a) Deforestation
(b) Blasting operations & other sounds
(c) Interference due to human population
(d) Electrification
The impact on flora and fauna is un-avoidable during operation phase unless efforts are made to divert them away, by creating suitable environment in extension areas, & restoring the disturbed area back to original.

IMPACT ON WATER REGIME

It is apprehended that mining activity causes lowering of water table in the area. touched. The clean mining will have nil to marginal impact. There could be a long term impact on water resources of the region due to removal of limestone which may be serving as water retention body. This, though correct in theory, is not going to be significant in case of Manal

Limestone Mine due to the following: -
i.) The total plan area of limestone body does not exceed 1.5 Sq. kms.
ii.) If the entire area retains 50% of 2000 mm annual rainfall, the quantity of storage water will be very less,
iii.) If this quantity of water is released over 150 days, the average rate of release will be 10,000 m3/day or less than 0.1 cusecs. This will be very small quantity to affect the water balance of the area,

IMPACT ON AIR QUALITY

Air Pollution due to Mining

(i) Gaseous Pollution

The gaseous pollutants (SO_2, NO_x and CO) are anticipated by HEMM like, excavator, dumpers, dozer, compressor and other transport vehicles. By proper mitigation measures viz better maintenance and efficient operation & utilization will keep pollution under control.

(ii) *Suspended Particulate Matter*

The generation of dust is anticipated from various mining activities i.e. dozing, drilling, blasting, loading, haulage and other transport activities related to mining. These will increase SPM/RPM in the area if no mitigative measures are taken. Dust suppressive, green belt & efficient operation will keep it in under control.

IMPACT OF NOISE

Noise and Vibration Problems

The ground and noise vibrations are produced during following operations:-
i) Drilling and blasting.
ii) Movement of mining equipments like shovels, dumpers, drills, dozers, rippers etc.
iii) Workshop and garage where maintenance of heavy earthmoving equipments and Light vehicles is done,
iv) Noise vibrations produced by crushing plant.

The noise generating sources are grouped under two heads:
(a) Noise due to blasting operations.
(b) Noise from mining and allied equipments.
By proper mitigation measures, these are to be kept under control.

Noise and vibrations due to blasting

Noise and vibrations produced due to blasting operations is not a continuous phenomenon, though repetitive, hence less hazardous to the nearby areas. The blasting was normally performed once in six days controlled blasting gives less noise and vibration.

Noise and vibration due to movement of mining and allied equipment

Operation of mining equipments is a continuous source of noise pollution and directly proportional to the equipments concentration at a point. These equipments generally create noise levels of about 75 db. at a distance of about 15m. This however, is localized within the vicinity of the equipments. The operator's cabin if equipped with sound-proof system and use of ear plugs to operation will keep them safe from bad effect of noise.

SOCIO-ECONOMIC IMPACT

Social Demographic Profile

The mines activity generates a lot of socio-economic benefits to the people of the area. In mines numbers of skilled and unskilled local workers are employed. The mines generate direct and indirect employment to persons. Additional facilities such as medical, educational and transportation are made available to the local population. The impacts on different components viz. employment, housing, education, medical and transporting facilities, fuel availability, economic status, health and agriculture are increased to the best level. While assessing the socioeconomic and sociological impact, it has been noticed that economic status of the people, level of literacy, general health standards, life style, quality of residential houses, etc definitely improves in surrounding areas.The living standards also improve generally.

Occupational Health and Safety

There will be some health and safety hazards, which may affect the persons employed in the mine. The people may suffer from occupational diseases or may get injured while working in the mine. Therefore, proper measures are required to protect the persons from these hazards.

Historical Monuments

No public place/building or monument of historical and archeological value exists in the study area. The nearest place of cultural and archeological or tourist importance in the area is Paonta Sahib, 22 km in SE direction and Renuka 32 km in NW direction of Manal limestone mine area by road.

Mathematical models

Many problems arise in the evaluation of environmental impacts due to new projects; for instance: the determination of the pertinent variables, the choice of methodology to follow, the need to inform the project proponent and regulatory agencies at every step of the evaluation process, and to present the best assessments possible for a variety of alternatives, the necessity to provide understandable information to the public. These problems are emphasized by the presence of many specialists of different disciplines who have to find a common language to integrate their experiences towards the same aim: the prediction of the impacts of a new project. Mathematical modeling presents a unified way to meet these requirements. The study was divided into two parts: abiotic and biotic models. Abiotic models include water quality and water management modelling. Biotic models take into account the biological aspects which have been used for impact assessments. The work is based primarily on visits to groups that are active in using modelling (or creating models) and simulation for impact assessment and on literature surveys

All decision making involves an implicit (if not explicit) use of models, since the decision maker invariably has a causal relationship in mind when he mskes a decision. Mathematical modelling can therefore be regarded as a formalization of decision-making processes.

Usually environmental management encompasses the following steps: perception of needs, problem definition and monitoring program, problem analysis and modelling, simulation to test alternative strategies, - Evaluation of alternatives, Selection by decision makers, Implementation and monitoring program.

Modelling plays an important role in the decision-making process. However, the results are uncertain because: the conceptual analysis (summation of “mental” evaluations and physical concepts) is incomplete, the mathematical relations used are representative of present knowledge, some uncontrollable or unpredictable even (e.g., natural catastrophe) can occur.

Advantages and Disadvantages of Simulation Modelling:

Disadvantages	Advantages
Requires computer facilities (*) Requires expertise and a fair amount of time Results may be too easily believed by decision makers Results are usually complex (if there are many variables) and are therefore difficult to communicate to decision makers Relations between variables usually assumed constant through time	Promotes communication between disciplines User forced to clarify assumptions anc causal mechanisms Any form of relationship can be handled — linear or nonlinear Helps to identify key variables or relationships that need to be investigated or are sensitive Can include uncertainties of various types Can easily compare alternative management schemes Can use detailed information concerning processes in the natural system Graphics output a good way of communicating impact Can utilize information about known processes that have not been investigated for the particular system of study but that have some generality (e.g., predation, population growth)

FROM BLACK BOX TO WHITE BOX

Mathematical models are based on the fundamental concepts of physical systems. A physical system is described by a few measurable variables and well-defined boundaries. Modelling the environment requires finding analytical relationships between variables knowing some responses of the system under various stimuli. This is known as an inverse problem (Karplus 1983) because it can be solved by a variety of mathematical relations. A simple algebraic mode, known as a black box, can represent the response of a system for very specific applications. If the model is to be used in a wide spectrum of different situations, it has to rely as much as possible on principles of physical systems (conservation principles of mass, energy and momentum). Most of the time (Taft 1965) due to numerous factors (computatiorial limits, unknown parameters, complexity of the formulation,...), mathematical models are simplified, taking into account only some of the fundamental equations. So, in air pollution, even in the case of wind field modelling, the principle of mas$ conservation alone is taken into account. In water modelling, equations of mass and momentum are c&rentfj Used, simplifying assumptions being made either on spatial "fepresentation (e.g., omitting one or two dimensions) or on the transient nature of the system. With this perspective, it appears that the robustness of a model will depend updn'the assumptions which have been made. Figure I, taken from Karplus (1983) presents this situation, It appears, that air pollution and ecological modelling are still at the boundaries between clean mechanistic models (white box models) and models with incompletely known factors (black box models). This uncertainty in the models As stated by Karpius (1983): Imust be considered carefully.

it is important to_ recognize, in evaluating and in using mathematical models, that each shade of gray in the
spectrum carries with it a built-in "validity factor". The ultimate use of a model must conform to the expected validity o the mode/.

SCOPE, VERIFICATION, CALIBRATION AND VALIDATION OF MODELS

The precision required of a mathematical model depends upon the output expected from that model. The studies conducted in EIA can be schematized in two parts. The first is evaluation of different strategies: In such situations, we wish to rank several scenarios which have been previously established. This is the case when several options are in balance. In response to the question, "Is it better to develop coal or nuclear plants?", the decision maker does not ask for an evaluation of his energy policy. He is looking for the optimum way to apply his policy. In that perspective, models do not need to precisely predict future impacts. Rather, they have to rank the different strategies that the proponent is looking at. The model has to be as simple as possible with some comparison or sensitivity analysis to establish its credibility. The second is prediction of non-compliance with standards: Legislation has established certain environmental standards, necessitating assessment of new projects or proposed
As the mathematical models are intended to help the decision maker, it is of paramount importance to analyse their limits.Modifications of existing plants. In these cases, the models are used to evaluate impacts considering technical data given by the proponents. Modelling can directly affect equipment design (stack height, water treatment unit, etc.), therefore precise prediction is expected by the proponent. Unfortunately, the nature of systems under study and state of the art in modelling usually preclude accurate predictions.
Introductionof a high security factor (e.g., as is usually the case in structure design) can make a project unfeasible. Usually, establishing prediction as precise and reliable as By **calibration, we** mean that the parameters of the model are possible necessitates the utilization of models of

growing chosen. The range of these parameters may be found in the complexity, yielding successively less conservative evaluations. - literature. Calibration is done when the parameters of the If at any level of complexity the project respects the model, while respecting some defined ranges, are adjusted to standards, then the modeling effort is endedTo establish credibility of models, we need some concept to measure model accuracy. As seen previously, the model might be more reliable if it rests upon physical laws, rather then transfer functions for which the parameters have been found in a very specific situation. The degree of confidence will depend also upon its verification, calibration, and validation (McLeod 1982; Park 1982).

PROBLEM Investigate if a given project will result **in an environmental problem**

By verification, we mean that the fundamental equations with the implied basic assumptions and the computer code have been checked, and are error-free. It is difficult to get error-free codes, and techniques of good programming (structured programming with independently checked procedures) might be used. The verification of fundamental equations and basic assumptions might involve the proponent and, ideally, independent experts. The robustness of the model can be checked with a sensitivity analysis of its parameters and some modifications may follow.

By **validation, we** mean that the model with its previously defined parameters is applied in a new situation and its results are compared with field or laboratory experiments. This validation step gives to some extent the degree of confidence of the model. This confidence is limited to similar applications. If the natural system is to be perturbed far from its present state, the model may only yield at best the general trends of the perturbed system.

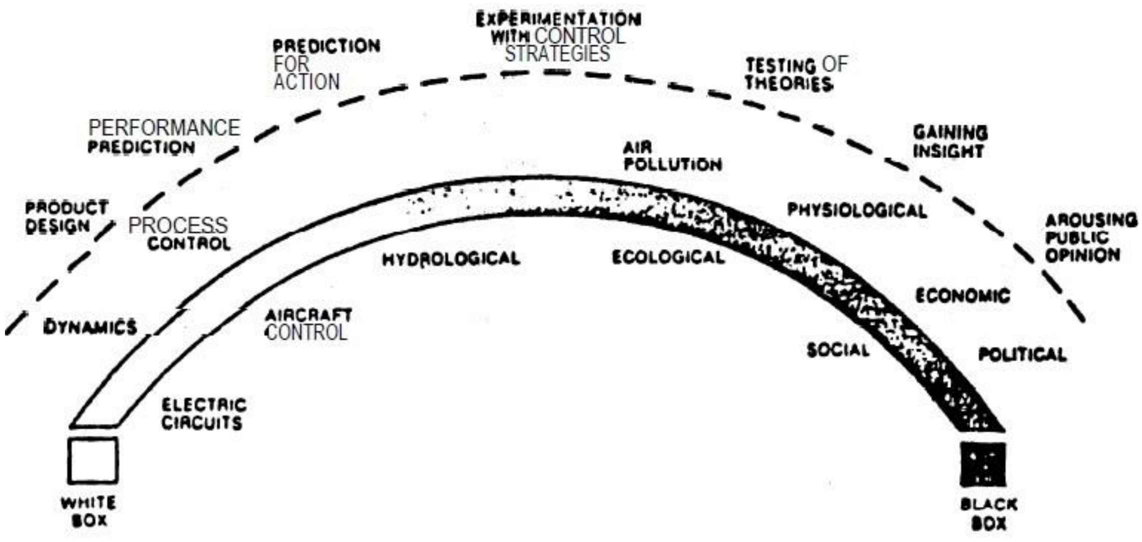


Figure 1. Spectrum of Mathematical Models

Air dispersion modelling is, by far, the main mathematical tool used by consulting firms in the environmental area. This is understandable because air is, with water, one of the chief dilution and transport media. This is also due to the fact that several mathematical models are available (mainly from U.S. EPA), and are easy to use. Many companies or government agencies in have developed their own models, and information about these models ranges from excellent to very poor. Some calibration and validation have been done, but the results are not always easy to interpret. Table gives a classification of the models currently used

Different Types of Air Dispersion Models

Different Types of Air Dispersion Models
Short- to Medium-Range: — Gaussian distribution Steady state, continuous release, puff model, instantaneous release, variable wind field — Statistical Non-uniform distribution Monte-Carlo simulation (Lagrangian) — Box model — Eulerian model (diffusion-advection equation)
Long-range: — Lagrangian — Gaussian — Box model — Eulerian

Short-range (up to about 10 km) to medium-range (up to about 30 km) models are applied close to the source. Long: range models examine the fate of pollutants which travel hundreds or thousands of kilometers, and must generally consider the physical processes of dry and wet pollutant deposition and chemical change. Short-range models are used mainly for hazard determination during emergencies, or for assessing impacts of new sources and their compliance with air quality standards. Long-range models are used for assessing the impacts of distant sources, often in other countries. The impact at any given instant is usually weak, while the cumulative effects may be severe.

SHORT- AND MEDIUM-RANGE MODELS

Gaussian Models

Air dispersion modelling is largely dominated by the Gaussian model established some twenty years ago (Pasquill-Gifford equations). This model assumes normal distributions of the direction of wind. It permits assessments of continuous or instantaneous release of pollutants, with or without a linear reaction rate or decay. Further developments have consisted of the inclusion of special features which were not part of the original model: pollutant reflection at the ground and at the inversion lid, introduction of a variety of different sources (point sources, line sources, area sources, volumic sources, fugitive sources), linear reaction or decay rate, washout by rain, settling of particles, uptake by vegetation or water, topographic effects, lake or sea breeze, temporal and spatial variation of meteorological conditions. GEMIGEMGAR is a standard Gaussian model developed in the United States.

Statistical Models

Gaussian models cannot constitute the only answer in air modelling. It was shown by Misra (1982 a,b) and Venkatram (1982) that Gaussian assumptions of normal distributions are not sufficient to represent a convective boundary layer. In that situation, downdraft and updraft plumes are composed of statistically independent distributions which present distinct behaviors. A normal distribution is kept to model horizontal spreading perpendicular to the wind direction. The product of the distribution functions gives an expression for the

concentration which is similar to the Gaussian formulation. Validations of this kind of model have been conducted on two different locations (Nanticoke generating station (Misra 1982b) and the lnco stack (Venkatram 1982) in Sudbury. On a completely different basis, it is possible to build statistical models from Monte Carlo particle trajectories. Reid (1979b) from AES applied this technique to estimate vertical dispersion from a ground-level source. Marsan built a model to evaluate the dispersion and impingement on foliage of insecticide droplets sprayed from a plane, based on work done at the University of New Brunswick by Picot. The results of this shortrange
Lagrangian model were compared with site measurements.

Box Models
This kind of model assumes constant concentration in a control volume, and has been used to predict average concentrations in cities where the heat-island effect is nonnegligible (summers 1967). A box model has been used in a different context by ESL to simulate release of radon gas in an open pit mine. This model is built with several adjacent boxes and yields average concentrations with time. It has been tested and validated by comparison with a wind tunnel model.

Eulerian Models
These models are based upon the conservation equation, using a co-ordinate system fixed in space. First-order closure models treat turbulence as diffusion term, and are known as gradient transport or K models (higher-order closure is not yet used in impact assessment studies). The use of gradient transport models is still rare, but they provide some extra possibilities as compared with Gaussian models. Wind field may vary with space, diffusion parameters may vary with height, and pollutant kinetics can be as complex as necessary. This method also presents several disadvantages. Diffusion parameters are not well known, wind field must be computed or partially observed at the site, and computations are complex and lead to numerical problems. IMPACT is the best-known code (Fabrick et *a/.* 1977) associated with gradient transport models. It contains a submodel (named WEST) which computes the wind field to be non-divergent, with some perturbations to take into account atmospheric stability, while requiring a limited number of meteorological stations to measure wind (typically one or two).

LONG-RANGE MODELS

Lagrangian Models
These are based on computation of trajectories between sources and receptors. These models are useful to evaluate different strategies of reduction of long-term and long-range pollution (e.g., acid rain). Turbulent diffusion is considered uniform along the vertical. It is also a statistical model because it uses time average rather than meteorological data, except for wind field. This model takes into account four different forms of sulphur (dry and wet Son, dry and wet Sod).
Pollutants undergo chemical reactions and are submitted to wet and dry deposition as well as vertical diffusion. Wind field is updated every six hours and the numerical integration is performed with a time-step of three hours. Precipitation is simulated by way of a Markov chain. The cumulative effects of deposition are computed over a season or a year.
Gaussian Model
The only model found in this field is MEP model (MEPTRANS code). It follows the same concepts as described for short- to medium-range modelling (MUST code). It is a segmented Gaussian model (Gaussian dispersion around a trajectory with four atmospheric layers and mixing depth variations with seasons. It takes into account Son, SO, wet and dry chemistry

and NO,. Wind field is generated by three-hour surface pressure, and pollutants are tracked for five days. Some validation was made for 1978.

Box Model

This approach has been used by McMahon et a/. (1976) in association with Acres. Assumptions of uniform concentration are made along the vertical and along a circular arc drawn from the source over an angle representing the angular variation of the plume trajectory. Concentration is lowered with distance as the plume disperses within the widening box. Time-step is one day and meteorogical data are averaged over that time period. Output can be on a monthly, seasonal, or

annual basis. The pollutant trajectory is assumed bounded by the sides of the wedge-shaped box. Wind data are taken at the station nearest to the receptor considered. (wet and dry), NO, and No, for the Nova Scotia Power.

Eulerian Models

MOE is contracting MEP and ERT to build a gradient transport model for long-range studies. MEP is designing the meteorological model including a detailed profile of the boundary layer. ERT is developing the gradient transport model. The chemistry taken into account is complex and non-linear. At the beginning, the model was looking at 114 different chemical reactions. The number of chemical reactions has been reduced to 35 after some sensitivity analyses. The model requires twenty-four hours of computer time on a Cray computer for a ten-day simulation, and is still in development.

VALIDATION STUDIES

Verification is relatively easy. It can be done comparing output of different models used in the same relatively simple situation.For instance, an Eulerian model can be checked against a Gaussian model. Calibration is usually not done. Plume rise and vertical or horizontal standard deviations are computed making a choice between well-known available formulae. However, it is interesting to note that this choice is not always well adapted to Canadian conditions (Reid 1979a). Moreover, measurements conducted on different sites by MOE or Hydro-Quebec have shown that the “BRIGGS 1975” plume rise formula leads to over-prediction of plume heights. Thus at the Nanticoke generating station (Misra 1982b), factor “1.6” had to be changed to “I”, reducing plume rise by 37 percent. l3C Hydro found large discrepancies between plume rise generated by Briggs’s formula and measurements made by helicopter. As cited in the text It is difficult to draw general conclusions from these studies for several reasons.

HYDROLOGY AND HYDRODYNAMICS

A good knowledge of water flow field is a prerequisite to any water quality modelling. Direct measurement is seldom sufficient to provide good insight into water motion. Many factors influence the behavior of a body of water: seasonal conditions, rain, snow or ice melting, topography of the bottom, characteristics of the bottom surface, thermal motion, wind at the surface, tidal effects, Coriolis forces, etc. A mathematical or a physical model must be used to obtain the flow conditions.

HYDROLOGICAL MODELLING

Many mathematical models are available to calculate flow rates in rivers over time, requiring only a few meteorological factors. CEQUEAU model from INRS-Eau is a good example of such a model. This model was first used to find the dimensions of the structures of the La Grande River reservoirs (instead of stochastic models which were common at this time). Presently, this model is the basis for water quality studies (Ste-Anne River) and water quality management (Yamaska River). The basin is divided into square parcels of equal surface.

Certain physiographic characteristics are obtained for each parcel: a representative elevation and the percentages of forest, lakes and marches. Each parcel is subdivided along the line of drainage, and the direction of water flux is indicated. The only meteorological data used are liquid or solid precipit and minimum and maximum. temperatures on a daily basis. The model is calibrated to take into account:

- snow build-up and melting,
- evaporation and evapotranspiration,
- underground accumulation and flow,
- propagation of water from one parcel to the other.

WATER QUALITY MODELLING

As stated previously, water quality modelling is closely related to flow field. One equation is used to express conservation of mass and, if necessary, another one to express conservation of energy. The structures of these equations are quite similar. In rivers, the equations are integrated along the direction of flow (one-dimensional) assuming constant properties in a cross-section. In lakes and reservoirs, concentration of a pollutant is frequently considered as constant along the depth, leading to two-dimensional models, and temperature is considered constant along a horizontal plane, leading to one dimensional models. In several situations, the flow field is ignored, assuming a uniform state in the body of water. This is often the case when a quick evaluation is needed.

ONE-DIMENSIONAL MODELS

Along the Vertical

In a lake or a reservoir, it is frequently assumed that temperature is uniform along a horizontal plane and varying with depth. This assumption is well corroborated in many lakes and reservoirs. Most of the models used are derived from the work of Ryan and Harleman in 1971. This approach is based on an energy budget between air and water including short-wave and long-wave radiation, precipitation, evaporation and convection. Water entering the lake or reservoir is introduced at the depth corresponding to the same temperature level. The work of Ryan and Harleman is currently extended to include ice cover with time and the height of a varying mixed zone due to wind shear stress. These models have given good approximations when tested in several lakes and reservoirs. The prediction of dissolved oxygen in lakes and reservoirs is a direct consequence of a temperature profile. The equation is quite similar to the temperature equation. It is necessary to include a re-aeration rate at the surface. The difficulty is to define the oxygen uptake by sediments, and this factor is frequently ignored.

Along the Flow

Different models assume homogeneity of parameters over a cross-section perpendicular to the flow. These models include several factors. Beak applied this kind of model for pulp and paper industries in New Brunswick, Ontario and Quebec. It resulted in the development of waste treatment alternatives and operational policies. In another field, winter oxygen depletion in a river in Alberta due to decay of algae and macrophytes was computed;the effects of a series of weirs was carried out to evaluate their re-aeration rate. CENTREAU modelled the change of salinity profile following the flow rate reduction in the Eastmain (Dupuis and Ouellet 198 1) and Koksoak (Ouellet and Ropars 1979, 1980) rivers as In long lakes or reservoirs, the model LARM assumes variation of temperature vertically and along the flow. MacLaren used it for thermal pluming in the Battle River Reservoir, and for evaporation studies in the Rafferty Reservoir. CCIW combined a two-dimensional model along a vertical plane for temperature and dissolved oxygen with a two dimensional model along a horizontal plane in Lake Erie (Lam et *a/.* 1983). Lam et *al.* (1981) conducted research to evaluate the turbulent diffusion parameters from observations.

Along a Horizontal Plane

These models are used frequently for large bodies of water (lakes, reservoirs, estuaries, etc.). They assume homogeneous concentrations on the vertical axis for active or passive contaminants. Transport is the result of flow convection and turbulent diffusion

THREE-DIMENSIONAL MODELS

The three-dimensional convection-diffusion model can be solved analytically in simple situations where flow field can be considered uniform. The treatment of boundary conditions, using the image method, is tedious. This model can provide rough estimates of concentration with time and position.(Marsan has used it at Kitimat Arm.).

WELL-MIXED MODELS several circumstances, a well-mixed model gives very quick estimates of variation of concentration in a body of water with time. This method is useful to look at mean content of chemical species. Very often, the body of water can be split into several boxes, with some kind of information about fluxes between boxes

GROUNDWATER QUALITY MODELS

Infiltration of liquid pollutants into the ground is becoming a main concern in environmental studies. Pollutants can be soluble in water and partially adsorbed and reacted. Liquid (usually contaminated water) percolates through porous materials and flows along fractured rock to reach the water table. Acres developed two two-dimensional finite element models to simulate groundwater transport through porous materials and fractured rock. One model is integrated in a vertical plane to represent vertical flow and lateral diffusion. The other model is horizontal to simulate transport into the water table. These models have been applied to leaching from radioactive and chemical waste disposal areas.

EROSION AND SEDIMENTATION IN RIVERS

The cross-section geometry of a river may be altered if its hydrograph or sediment supply is modified by changes in land use or by river developments such as dams.

OIL SLICK MODELLING

As stated by Huang (1983) the fate and behaviour of spilled oil is affected by several mechanisms: advection, spreading, evaporation, dissolution, emulsification, dispersion, autooxidation, biodegradation and sedimentation. Many models currently used treat the first mechanism, while neglecting the other aspects which are important to assess the impact on the system under study. These different mechanisms are largely influenced by physico-chemical properties of the spilled oil, and MacKay et al. (1980) developed some equations to represent these properties. Mackay (1984) distinguishes four kinds of mathematical models in that field: “real-time trajectory” models for emergency situations. “environmental assessment” models to evaluate the impact of eventual accidents. “war-games” models to train people in charge of emergency situations. “regional ecosystem impact” models to assess long-term oil development impacts on fisheries, for example.

AES developed two kinds of models. The first (Venkatesh et *al.* 1981) is used for an emergency situation and is implemented on mini-computers available in six regional centres in Canada. The response-time is of the order of a few minutes, and wind forecast for the next fourty-eight hours is available at any time. This model takes into account the advection of the oil slick by wind-driven and other residual water currents, plus the spreading of the slick according to the Fay algorithm. The model has been tested for actual spills. The second model (Hirt et al. 1982) developed in collaboration with MEP, takes into account the same mechanisms plus weathering effects such as evaporation, emulsification and dissolution in a more elaborate analysis. For instance, the slick is composed of several parcels to represent break-up from with a more realistic point of view. .An interactive data base gives wind field. Surface currents are derived from Madsen’s formulae. Operational tests gave good predictions on the location of the spill after twenty-four hours.

RISK AND PATHWAYS ANALYSIS
PATHWAYS MODELS
Pathways modelling is used to examine the distribution or accumulation of persistent contaminants in the environment, usually with accumulation in humans as the desired outcome.
The accumulation within an organism may then be compared with dose-effect data to evaluate the health risk to an individual. Critical pathways models examine dosages to the most exposed members of the population. Most frequently, pathways models are applied to radionuclides, but they are also applied to heavy metals and toxic organic compounds. The pathways for the transmission of the contaminant through the environment are identified, and uptake coefficients are used to quantify transfers from each stage of a pathway to the next. The underlying system (e.g., food chain) is usuallyconsidered as being in steady state.

By itself, pathways analysis is a very simple technique to apply since it is essentially linear algebra. One consultant uses a spreadsheet program to make these calculations on a microcomputer.

EPIDEMIOLOGICAL RISK ANALYSIS
Epidemiological risk analysis is essentially based on actuarial calculations. Changes in life expectancy as the result of exposure to some sort of environmental change are usually examined. For example, if one wishes to know the increased risk to the population of the proposed installation of a certain type of industry, one could examine differences in life expectancy around similar plants already existing elsewhere, as compared with the life expectancy of the population as a whole. Such studies have been applied to plant workers and uranium miners in the United States and Canada, but we did not encounter any publicized studies for impact assessment.
ACCIDENT RISK ANALYSIS
Accident risk analysis is also based on actuarial calculations.. Using directly applicable historical data, or extrapolated from indirectly applicable historical data, probabilities of certain occurrences are calculated. These probabilities are then multiplied and/or summed, to arrive at an overall probabilitythat a certain series of events will occur.
BIOTIC MODELS
Far and away the vast majority of biotic models have been used for research purposes only, and their use in impact assessment has been rare. This is because: many models cannot be applied generally, some models have prohibitive input requirements, we lack adequate quantitative knowledge to model reliably certain processes, especially fluxes of material or energy between trophic levels,many models are tautological in nature, there is a lack of confidence in biological models, most biological models have not been validated, there is a lack of personnel with expertise in both biology and modelling, and quantitative impact predictions for biological components are not always required by regulating agencies . Even in the academic community there is controversy about the usefulness of biological models. Confronted with these factors, few consultants are willing to devote the time and expense necessary for the development and/or implementation of a model. In pre-project impact assessments reviewed, the only explicit dynamic biological models found were for the spruce budworm in terrestrial systems or for bacteria in aquatic systems. Implicit modelling is more frequent. For instance, when a water quality model examines BOD5, there is implicit model of the organisms consuming the oxygen. Carbon and phosphorus. cycling are other examples of implicit biological modelling. Implicit modelling was used for almost all processes in SEBJ’s model of water quality changes as a result of decomposition of vegetation and soil in the LG-2 reservoir. Somewhat farther removed are models that consider habitat “accounting”, where changes in the amount of available habitat are calculated based on man-induced

changes such as water level or land use? Pathways models can also be seen as implicit biological models, since biota are parts (or the endpoints) of the pathways but they themselves are not necessarily modelled. Since these types of models have been covered elsewhere, this discussion is limited to explicit models. Explicit models of biota are usually compartmental and treat the various components under examination in terms of biomass, energy, or numbers of individuals. Biomass and energy are in fact equivalent, since biomass can be seen as representing stored potential energy, respiration and natural mortality as entropy, predation and grazing as energy transfers, etc. For these two approaches, populations are considered homogeneous. An example of a biomass model is SEBJ's phytoplankton model for the LG-2 reservoir. When numbers of individuals are used, there is usually also an age structure in the population (e.g., immature VS. mature). In addition to population size, age distribution is also followed over time. An example of this type is spruce budworm modelling as done for New Brunswick (Task Force 1976) and, by Marsan, for Quebec.

MODELLING APPROACHES

Biotic models can be grouped roughly into two categories according to their output: quantitative and quasi-quantitative. Quantitative models are intended to give precise predictions. Quasi-quantitative models are instead intended to give relative predictions, and sometimes the predictions are not the actual purpose of such models. The dividing line between the two types is not clear-cut, because some quasi-quantitative models can give fairly precise results.

Quantitative Models

The use of quantitative models has been far less frequent for biological impact prediction than for other aspects of the environment. The work that has been done has for the most part examined aquatic systems, linked with or part of water quality models. Typical biotic state variables are bacteria (usually coiiforms), primary productivity or chlorophyll-a or phytoplankton, zooplankton, and fish. Most of these models have been research-oriented, but they have been applied by CCIW, SEBJ and Beak.

Quasi-Quantitative Models

These models have been applied to a certain extent in impact assessment, particularly by Environmental and Social Systems Analysts Ltd. (ESSA) and associates at the University of British Columbia in what is called adaptive environmental assessment. Examples of use of these models include management of the British Columbia salmon fisheries, prestudy planning for the Mackenzie Delta (Liard River deveiopment), and spruce budworm management in New Brunswick. Marsan has applied the latter model to Quebec. These modelsare used to give relative evaluations of the impacts of policy alternatives, or in some cases, the applications are heuristic to suggest possible types of impacts and focus subsequent research directions. The philosophy of such models is that the information and detail required to make precise predictions are frequently either unobtainable or impractical to obtain, but that by using available quantitative, functional, and empirical information, part of the general behaviour of the system can be mimicked. If and when additional information and data become available, they are incorporated into the model, and sensitivity analyses can direct the efforts of information collection.

COMMUNITY TYPES

Aquatic Models

A large number of aquatic food-chain models have been developed at research institutes and universities, but rarely have they been applied to impact assessment in Canada. Applications of such models have been done for the Great Lakes (CCIW) and the LG-2 reservoir (SEBJ). Norecol has used the MINI-CLEANER model. Such models are usually linked with water quality and transport models, or at least require flow rates and water quality parameters (e.g., temperature, oxygen, phosphorus, nitrogen, etc.) as inputs. All such models are similar in structure, and a general examination of these can be found in Jorgensen (1980) and Platt et *al.* (1981).Dynamic fish models have been used to compare different scenarios for management and exploitation of pelagic stocks, especially in British Columbia (Holling 1978). These models are usually based on numbers of individuals, with an explicit age structure in the population. Degree of exploitation and hatchery management is the major perturbations compared, and factors external to the questions of prime interest are considered to be constant. Fish models differ in spatial representations from other aquatic models, due to the high degree of non-passive mobility of fish.

Terrestrial Models

These models may examine from one to several species, and infrequently group various species together into a smaller number of compartments. The model of the spruce budworm (Holling 1978; Marsan and Coupal 1981) is an example of a terrestrial model. Budworm population dynamics and forest growth are modelled together, including cross effects. Forest management and insecticide-spraying scenarios are superimposed to evaluate changes in the system. Other examples are ESSA's model for evaluating exploitation rates for fur-bearers and ungulates. A model written by the U.S. Fish and Game service evaluates the effects on summer pest bird densities in the northern United States and Canada resulting from control measures carried out at the wintering grounds in the southern United States.

DATA PROBLEMS

Data problems have plagued quantitative modelling of aquatic systems. Plankton tend to have patchy distributions, reducing the reliability of density estimates. Patchiness is taken to the extreme in benthic communities, and even research models have tended to ignore them. Above-sediment macrophyte production is relatively easy to sample, but root biomass is more difficult. Bacteria, frequently representing negligible biomass but the largest gross turnover of material, are usually neglected, except, for example, in Beak's studies evaluating wastewater treatment. Commercially important fish **species** are the best-known elements of aquatic systems, due to large data-collection efforts for management purposes. Terrestrial models have had greater data problems than aquatic models. A major reason for this is that aquatic (freshwater) systems have fixed boundaries, and immigration emigration across these boundaries is limited and quantificiable (e.g. plankton densities in water entering a lake). In contrast, terrestrial study areas seldom have rigid boundaries. Terrestrial animals, especially birds, have a high degree of mobility across these boundaries, and such movement can be difficult to quantify. (The same is of course true of ocean movements of pelagic fish). As spatial scale increases, this difficulty is reduced but accurate population estimation can become more difficult. Naturally such problems do not exist for forest models.

MODEL VALIDATION

General validation of biological models has been weak to date. Many models simply cannot be validated in the strictest sense because the output is in too general a form to be compared with specific data. Quite often these models are not meant to be validated anyway. Some other models operate over such a long time-scale that validation may not be possible until a decade or more after the simulation predictions have been made. Even in some studies where validation has been attempted, the results have been inconclusive. A case in point is a study using a variant of the model CLEANER (Collins 1980). In this study, a very complicated model of plankton dynamics was calibrated to data collected over a one-year period at a lake,and was subsequently applied (again over a one-year period) at another lake. Since the model predictions did not diverge much from observations in the second lake, the model and associated parameters were considered to be validated. However, there are two problems with this procedure. One year of data collection may not be adequate to find good parameter estimates (Simons and Lam 1980). In addition, even where parameters have been estimated using a relatively long time-series of data, application of the same model and data to another location for only a one-year period may not show divergence from observations, while over a longer period divergence becomes significant (Morrison et *al.* 1985). Even if a model has undergone rigorous validation, there may still be problems. A model that is valid for a system undergoing limited or no perturbations may not be suitable for a system undergoing radical modifications. The validation problem is serious, because confidence in model results is directly related to model validity. There are only a few projects where post project monitoring has had the time scale necessary for model validation. This situation may **not** improve until project proponents are required to undertake long-scale post-project monitoring. The monitoring problem is not unique to biological models.

Unit -4

Environmental Management Plan

ENVIRONMENTAL IMPACTS AND THEIR MITIGATION

Introduction

In this section environmental impacts related to construction and the operational phase of the Project are discussed and remedial measures proposed. Options for impact mitigation during detailed design are also indicated. Distinction will be made between significant positive and negative impacts, direct and indirect impacts, temporary and long-term impacts. Where possible, expected impacts will be described quantitatively and indications made on their geographical extent, the size of the affected population, the magnitude and complexity, probability, duration, frequency and reversibility of the impact.

Impacts on Ambient Air Quality and their Mitigation

Impacts on ambient air quality will occur during the construction and the operational phase of the Project: *During construction* dust development will occur as an immediate result of clearance operations, site preparation, and the movement of heavy construction equipment. The operation of heavy machinery will adversely affect air quality through the emission of air pollutants. This impact would affect the workforce, the personnel attached to the DWC Store adjacent to the site, and the Mandir. The effect of construction-related dust development and air pollution will be short time and local. As regards human settlements the level and thus significance of such impact can most effectively be reduced by generally avoiding haulage of materials through narrow village roads. Where this cannot be totally avoided another effective mitigation measure would be to require contractors to regularly water haul routes in sensitive sections during dry periods. The potential impact of air and dust pollution on both the workforce and local residents can best be minimized at source by proper maintenance and handling of construction equipment and by providing appropriate protective working gear (masks, goggles etc.) as required. During the "*Operation" Phase*, impacts on air quality will be due to human activities of a domestic nature and to movement of private vehicles – in particular cars – within the Housing Estate. Given the size of the development, such impacts are estimated to be insignificant.

Impacts on Soils and their Mitigation

The most significant impact on soils will be the permanent and irreversible loss of land due to the construction of the Housing Estate. Additional areas will be impaired through compaction due to the movement of heavy vehicles and equipment- which areas will eventually be constructed upon to provide for accesses within the property. In the context of the Project the net loss of soils cannot be avoided, but the scale of the overall impact will be minimized as follows: The topsoil will be removed from the working EIA NHDC Project Cap Malheureux Feb 2011 VI – 2 area during the early stages of site preparation and be temporarily stockpiled at suitable locations. Later on the top soil will be reused in landscaping works. The cost for this measure will be made a separately priced item in the BoQ to secure implementation. The Supervising Engineer shall ensure that the Contractor complies strictly with the requirements of the works contract concerning this issue.

Impacts on Geomorphology and their Mitigation

The impact of the Project on the natural relief will be permanent and irreversible but restricted to the project site. The scale of the physical and visual impact can be effectively mitigated through appropriate landscaping measures within the property. It may also be noted that the degree of the visual impact(s) is memory and time related. Viewed from this angle, it may also be said that such visual impacts are, in fact, temporal.

Impacts on Water Resources and their Mitigation

As already mentioned earlier, there are no natural watercourses either crossing the project site or in the nearby vicinity. Consequently, the project will not have any significant impact on the quality of any surface waters. Further, since all wastewaters will be treated through a STP and treated to the tertiary level for use as irrigation water for lawns and other landscaping works, the quality of groundwater will not be impacted upon.

Impacts on Terrestrial Flora and Fauna and their Mitigation

It can safely be concluded that the project is not going to have any negative impact on the biological environment On the contrary, since the built up area will cover only 19% of the area of the site, the project will provide good opportunities to planting native plants and to enhancing habitats for birds and reptiles.

Noise Impacts and Their Mitigation

Construction noise is often explained as sound that is unwanted by the listener. Sound, pressure and noise are measured in units of decibel (dB) using a logarithmic scale. If a sound is increased by 10 dB, it is perceived as a doubling in loudness. Changes in a sound by 3 dB(A)2 is barely perceptible to the human ear. Noise is said to cause more off-site complaints than any other topic. Construction activities causing the greatest noise problems are: piling, use of pneumatic tools, demolition, earthmoving; scabbling (roughening of concrete surfaces); concrete pours; blasting and maintenance works. 2 The unit dBA means that the measured level is in decibels and that it has been passed through a filter so that it represents a level of noise that is very close to what can be perceived by the human ear EIA NHDC Project Cap Malheureux Feb 2011 VI - 3 Excessive noise levels on site represent a major hazard to site workers. If people need to shout to make themselves heard over background noise from a site, background noise is likely to be about 75 – 80 dBA. Continued exposure to noise levels of 90 dBA can permanently damage hearing. Sudden or continuous noise early in the morning or late at night, on rest days or holidays etc. is a frequent reason for complaints by local residents. Construction noise problems on site may be most effectively minimized by reducing the level of noise generated at source, e.g. proper site management and construction methods, plant used and screening. Where sensitive receptors like residential areas exist in the vicinity of the site, construction may be limited to the daytime period where less restrictive noise standards apply (i.e. 60 dBA from 07:00 to 18:00 hours).

Impacts on Landscape and Their Mitigation

The impact of the Project on the landscape will be permanent and irreversible, but restricted to the project site. The scale of the physical and visual impact can be effectively mitigated through appropriate landscaping measures within the property. Further, as already mentioned under paragraph 7.4 above, the degree of the visual impact(s) is memory and time related. Viewed from this angle, it may also be said that such visual impacts are, in fact, temporal.

Impacts on Road Safety and Their Mitigation

During construction road safety may be impaired through the temporary movement of heavy machinery, bad visibility, muddy, slippery roads etc. Such potential impacts would only be temporary, but may have significant adverse effects at the local level. In general, such risks can be effectively mitigated through appropriate traffic management, which would include the construction site and all temporary haul routes in- and outside the built-up areas. To this regard the specifications should require the contractor to provide a method statement on how he intends to achieve and effectively maintain road safety throughout the construction process. These proposed measures will need to be approved by the Project Manager and will be monitored by the Supervising Engineer (SE). It may be noted that the site borders the Vingt Pieds Road (B45) to Cap Malheureux. In this neighbourhood, the traffic density is quite low. *After the commissioning of the project*, road safety can be maintained and improved by strictly monitoring compliance with traffic rules and speed limits. However, the scale of the development is such that road safety will not be unduly affected by the proposed development.

Beneficial Impacts
As already mentioned under Section 3 above, the implementation of the proposed project is in line with Government Policy to provide a roof for everyone. The "Do Nothing" Scenario would be against such policy, and, obviously, to the detriment of the country. Since the middle-income group is targeted, the project will result in job creation. Possible jobs will concern housemaids, gardeners, and other artisans. People in the neighbouring village of Cap Malheureux, including fishermen, will certainly benefit from the project.

The **Rapid Environmental Impact Assessment in Disaster** (REA) is a tool to identify, define, and prioritize potential environmental impacts in disaster situations. A simple, consensus-based qualitative assessment process, involving narratives and rating tables, is used to identify and rank environmental issues and follow-up actions during a disaster. The REA is built around conducting simple analysis of information in the following areas:
• The general context of the disaster.
• Disaster related factors which may have an immediate impact on the environment.
• Possible immediate environmental impacts of disaster agents.
• Unmet basic needs of disaster survivors that could lead to adverse impact on the environment.
• Potential negative environmental consequences of relief operations

The REA is designed for natural, technological or political disasters, and as a best practice tool for effective disaster assessment and management. The REA does not replace an EIA, but fills a gap until an EIA is appropriate. A REA can be use from shortly before a disaster up to 120 days after a disaster begins, or for any major stage-change in an extended crisis. The REA does not provide answers as to how to resolve environmental problems. It does provide sufficient information to allow those responding to a disaster to formulate common sense solutions to most issues identified. Where solutions are not evident, the REA provides sufficient information to request technical assistance or to advocate action by a third party. The REA contributes to activity and environmental M&E, but does not replace a formal M&E system. The REA does not require expert knowledge. Primary REA users are people directly involved in disaster response operations, with a basic knowledge of the disaster management process but no background in environmental issues. The REA process can be used by disaster survivors with appropriate support. The best results are expected to come when the REA is completed with structured input from survivors and organizations providing relief assistance. Sections of the REA can also be used for needs assessment and environmental impact screening during relief project design and review.
The Rapid Environmental Impact Assessment in Disasters (REA) process involves completing four modules according to the specific tasks indicated below, preferably though a group-based process. The REA process should begin with a review of the material contained in the ***Introduction to the REA*** *section of the Guidelines, and proceed through the four modules summarized below.*
MODULE ONE: ORGANIZATION LEVEL ASSESSMENT
1. Collect background information and identify assessment participants.
2. Draft three paragraphs describing the disaster for Section One.
3. Complete Section One: The **Context Statement.**
4. Complete Section Two covering **Factors Influencing Environmental Impacts.**
5. Complete Section Three covering **Environmental Threats of Disasters.**
6. Complete Section Four covering **Unmet Basic Needs.**
7. Complete Section Five covering **Negative Environmental Consequences of Relief Activities.**

8. Rank issues by importance within each section as indicated in the *Guidelines*.
Note that Sections Two to Five can be completed in break-out sessions.

MODULE TWO: COMMUNITY LEVEL ASSESSMENT

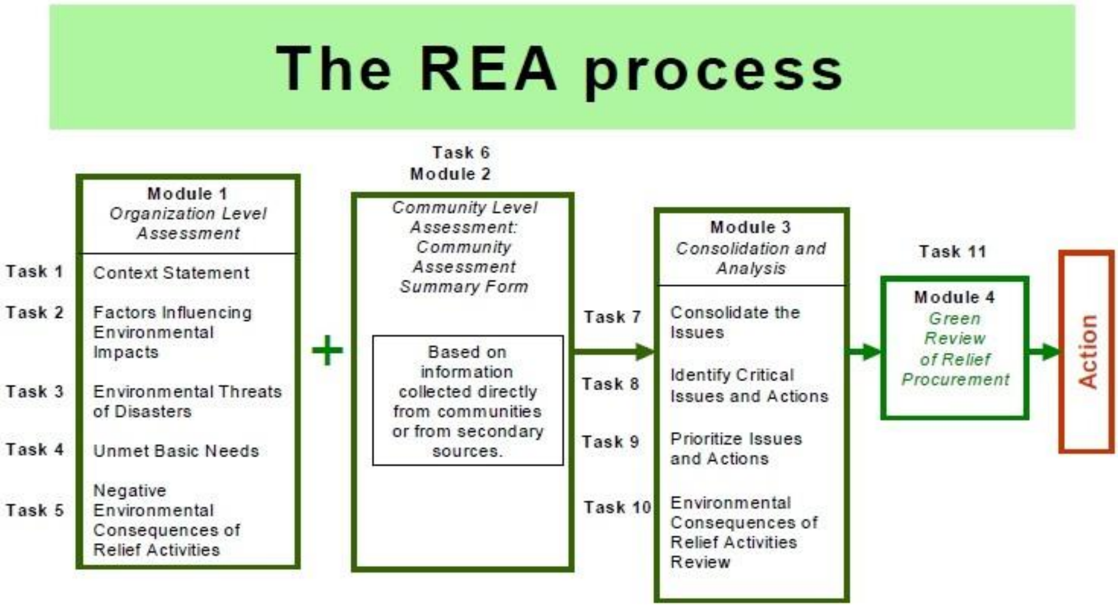
1. Decide on how information on community perceptions of the environment will be collected.
2. If a questionnaire or focused discussion method is used, plan, test and administer the method in communities.
3. Compile the results of the community level assessment into usable form (a report or completed questionnaire) for each community.
4. If data from other assessments are used, ensure that all the information needed for this module is collected or extracted from existing assessment reports.
5. Complete the Community Assessment Summary Form based on the information collected or drawn from other assessments.
6. Rank the issues by relative importance within each section of the form.

MODULE THREE: CONSOLIDATION AND ANALYSIS

1. Include three to five issues from each section of the Organization and Community Level Assessments on the Issues Consolidation Table and consolidate the issues into a single list.
2. Place the single list of issues on the Issues and Actions Table and identify initial actions and issues and actions.
3. Prioritize these issues and actions according to the impact on life, welfare and environment hierarchy.
4. Review the potential environmental impact of the actions and make changes are appropriate.

MODULE FOUR: GREEN REVIEW OF RELIEF PROCUREMENT

1. Review the guidance provided in Green Review of Relief Procurement module.
2. Complete the procurement screening table provided in the module.
3. Make changes to procurement plans as appropriate.



These guidelines for a **Rapid Environmental Impact Assessment** (REA) fill a gap in the range of tools available to assess environmental impacts during disasters. The REA is designed to provide input on environmental conditions in disaster situations in a way which is convenient for the fast moving, time compressed operational environment faced in responding to a disaster2. The REA is one of several initiatives to improve the linkages between sustainable environmental management and disaster response.

Concepts and Outcomes

The REA is based on the concept that identifying and incorporating environmental issues into the early stages of a disaster response will make relief activities more effective and lay a foundation for a more comprehensive and speedy rehabilitation and recovery. The process and structure of the REA recognize that those who respond to disasters have little time for in depth research and are not likely to be environmental specialists. A completed REA identifies critical environmental issues. Some issues arise from conditions existing before the disaster. Others are new to the location or population experiencing the disaster. The nature and impact of environmental issues will change during and after the disaster and new issues may arise. For these reasons, the output from an REA is not a static assessment but one to be reviewed and revised throughout the post-disaster period. The REA **does not provide answers as to how to resolve the critical issues** identified in the assessment. A completed REA **does provide sufficient information to allow those involved in responding to a disaster to formulate common sense solutions** using information otherwise available to address, mitigate or avoid the issues raised in the assessment.

Where common sense solutions are not evident or issues are complicated or unclear, a REA **provides sufficient information to request appropriate technical assistance or advocate appropriate action** by a third party.

Approach

The REA uses a simple, guided, consensus-based qualitative assessment process incorporating narratives, rating tables and action lists to develop an overall assessment of critical environmental issues and follow-up actions during a disaster. The REA does not call for any quantitative data collection, recognizing that this is both time consuming and operationally difficult in most disasters. However, quantitative data should be collected and used whenever possible if data collection and use will not slow the overall relief effort. In addition, a clear documentation of the REA process and collection of environmental data during a disaster will make an EIA for post-disaster recovery planning easier and more accurate.

REA Process

The REA process is designed to:

1. Collect information needed to assess environmental impacts,
2. Provide simple steps for analyzing this information to identify important issues and
3. Review procurement decisions to reduce the potential negative environmental impacts of emergency assistance.

The REA process focuses on the perceptions and concerns about environmental issues and disaster-environment linkages at two levels. The first level is that of organizations involved in responding to a disaster. This level includes government, non-government and private organizations that provide external assistance and support in response to a disaster. The second level is that of communities and groups within communities which are affected by a disaster. Experience shows that those providing disaster relief and those affected directly by a disaster often have different perceptions of the impact of a disaster and corresponding relief needs. Identifying organization and community perceptions separately and then consolidating these environmental concerns into one set of issues and actions will improve the efficiency of relief efforts by diminishing the gap in understanding between relief providers and survivors.

Assessment Modules

A complete REA is accomplished through four modules. The first two modules, anOrganization **Level Assessment** and a **Community Level Assessment**, are designed to collect the basic information necessary to identify critical environmental issues. These modules focus on five areas:

1. The general context in which the disaster is taking place,
2. The identification of disaster related factors which may have an immediate impact on the environment,
3. The identification of possible immediate environmental impacts of disaster agents,
4. The identification of unmet basic needs of disaster survivors that could lead to an adverse impact on the environment, and,
5. The identification of negative environmental consequences of relief operations.

The information collection process differs between the two modules. The **Organization Level Assessment** uses a combination of narrative and rating tables which correspond closely to the five topical areas summarized above. The **Community Level Assessment** can use one of several sources, including a specifically designed questionnaire, focused discussions, or information collected during other types of assessments (e.g., a food security assessment). The tasks to complete these two assessments are described in more detail in the respective modules below. It is possible to complete a rapid environmental impact assessment using only the **Organization** or the **Community** level assessment module. Using only the **Organization Level Assessment** is conceivable when there is no opportunity to collect information from communities, as is likely in rapid onset disasters. Given this possibility, the **Organization** level module also provides basic guidance on how to link assessment outcomes to immediate relief actions. It is **strongly recommended** that if only an **Organization Level Assessment** is initially done, a **Community Level Assessment** should be completed as soon as possible to avoid any gaps between organization and community level perceptions of environmental issues. and how these issues should be addressed. On the other hand, sometimes only a **Community Level Assessment** can be completed and analyzed. However, limiting the REA to only community level input presumes those organizations (and their personnel) responding to a disaster do not have their own perceptions of environmental issues and will completely accept the community perceptions. The reality is that organizations (and especially their funding sources) usually hold strong views on the nature and modalities of relief assistance. Conducting both **Organization** and **Community Level Assessments** ensures that assistance providers and survivors are, at the least, not working at cross purposes. The consolidation and analysis of issues identified in the assessment occurs in the two assessment modules and through a separate **Consolidation and Analysis** module. In the
Organization Level Assessment, a preliminary ranking of issues occurs as the result of the issue rating process. In the **Community Level Assessment,** a preliminary ranking of issues occurs through the process of extracting information from a questionnaire, reports on focused discussions or from other assessment reports.

The **Consolidation and Analysis** module moves the analysis process further by providing simple procedures to help consolidate and prioritize the issues identified in the assessments.

The consolidation and analysis process does not identify specific solutions to the issues identified, but does provide a simple approach to initiate the process of addressing the issues identified. The final module, on **Green Review of Relief Procurement**, aids relief organizations in identifying whether the services and material assistance they are providing in response to a disaster have the least negative environmental impact possible. This module lays out the background to green (sustainable) procurement and provides a simple evaluation tool for use in emergency procurement. A number of sources of information can be used to support the completion of the rapid environmental impact assessment. Annexes to this

Guidelines include sources of information on environmental and disaster issues (**Annex A**), general guidance on managing group meetings (**Annex C**) and on participatory rapid appraisal (**Annexes F** and **G**).It is important that users fully complete the assessment process before taking any significant action to address identified environmental or disaster-related problems. The REA is an incremental process designed to draw together many diverse aspects of disaster environment linkages. The most significant issues requiring highest priority action will not be fully evident until all the assessment results are consolidated and analyzed.

Good Practice and Standards

The REA has been developed as a good practice for rapid environmental impact assessment in disasters. The REA is expected to evolve to take into account changes in the way disasters are managed and new information sources and procedures. The REA process has also been linked, where appropriate, to the minimum humanitarian assistance standards described in the Sphere Project Manual (see http://www.sphereproject.org/). However, completing the REA is not dependent on the Sphere standards, and the REA can easily be used in conjunction with alternates to the Sphere standard.

Applicability

The REA is designed for use in all types of disaster situations, including natural, technological and political events.3 The REA supplements specific technical assessments and actions initiated following a technological disaster. In political disasters, such as a civil war, there may be considerable periods when the affected populations are in disaster-like conditions. The REA is most useful when there is a significant rapid change in these conditions, such as a change in the mode of conflict, livelihoods or mechanisms of assistance. For instance, the REA process would be extremely useful in developing a rapid response to assist returning populations following a peace agreement ending a civil war. However, an assessment of rapid changes in a long-term situation needs to take into consideration that there are likely to be overlapping short-and long-term environmental issues. Some of these issues can be addressed through immediate relief efforts, but others need more substantial long-term solutions. These longer term solutions need to be based on a more detail environmental impact assessment than that provided in a REA. The REA can be used in multiple or concurrent disasters. In these situations there is a need to differentiate between the impacts of the different disasters, and corresponding different relief options and operations. For instance, the human and environmental impacts of an earthquake and a drought are different. Addressing environmental issues arising from each disaster will occur in different time frames and require different types of assistance. These differences need to be taken into account in the assessment process, and in the process of linking actions to issues identified during the assessment. The REA can be used to provide input into a Monitoring and Evaluation (M&E) system (discussed below). It also has uses as the basis for an environmental impact check list in relief project design and as a basis for reviewing plans and operations. This process is best done in collaboration with the persons designing or running the relief operation. The REA can be modified to reflect the typical disasters and relief and recovery modalities of a specific region or country. Such modification should focus on changing terminology to reflect local approaches to disaster management, eliminating unneeded items from various rating tables, focusing the community assessment process on local conditions and established assessment procedures and integrating the REA process and analysis into other routinely done disaster assessment procedures or protocols. Significantly changing the REA process or eliminating modules is not recommended.

When to Do an REA

The REA is designed for use during the critical disaster response period, from when a warning of a disaster is first received until conditions have stabilized, normally within 120

days after a trigger event. This 120-day period provides time to begin an EIA as part of the recovery and rehabilitation process. The REA, besides identifying immediate environmental factors relevant to the relief operations, provides data and insight that can be incorporated into the EIA.The REA should be started as soon as practicable after a warning or start of a disaster. The initial (baseline) assessment should be followed by periodic updates to ensure the REA updates depends on the nature of the disaster. They should be more frequent in large, quickly evolving events than smaller, more stable disasters. The immediacy of disaster impact and urgency of relief should be taken into account in deciding on whether to use a REA or a formal environmental impact assessment process. For instance, the REA can provide a quick identification of critical environmental issues following a major earthquake leading to considerable damage and relief needs over a large area. On the other hand, a REA may not be as urgent, or even appropriate, for a drought which develops over several years, where impacts are seasonal and time is available to
develop a formal EIA. The REA can be used before a disaster to anticipate environmental issues and impacts. However, if there is any significant early warning (e.g., in excess of 60 days), it is more useful to initiate an EIA as part of the pre-disaster planning and mitigation efforts.

The REA provides a "snap-shot" of environmental conditions at the time it is completed. By setting out prioritized critical issues the REA allows for some anticipation of environmental impacts. These impacts, and the impact of REA-identified actions, can be assessed through revisions of the initial REA. Because the REA is based on perceptions and (often) incomplete data, it should not be used to make hard-and-fast predictions of environmental impacts. The REA results, like much in the relief phase of a disaster, are subject to uncertainty and unanticipated changes.

Steps can be taken to prepare for a REA as part of disaster preparedness efforts. Pre disaster tasks can include:

1. Training staff in the use of the REA,
2. Collection of background information (particularly for **Section One: Context Statement**),
3. Reviewing potential hazards and their impacts on potential disaster areas and survivors (**Section Three: Environmental Threats of Disasters)**,
4. Screening possible relief interventions for negative environmental impacts (**Section Five:Negative Environmental Consequences of Relief Activities**), and,
5. Developing skills and systems to quickly collect information from communities for the **Community Level Assessment** module.

Taking these steps will considerably shorten the time needed to conduct the REA during a disaster.

Link to Formal Environmental Impact Assessments

A REA does not replace a formal EIA. Rather, it fills the gap between the start of a disaster and when the formal EIA process can be initiated. This gap is expected to correspond closely to the120 day relief operations period, with the EIA process coming to play with the design and planning of recovery programs. Data collected and data collection systems established through a REA can provide important inputs into an EIA. A well-documented REA will aid considerably in defining the scope and coverage of an eventual EIA and data collected as part of the REA or subsequent M&E efforts may have use in completing a normal EIA.

Users

The REA is intended to be used by persons with no specific background in environmental issues and relatively little background in disaster management. The primary REA users are expected to be government, NGO or IO staff conducting field assessments or directly managing relief operations. The REA can be used by communities experiencing a disaster, although this will require additional planning to ensure community participants understand the REA concepts and procedures. In any case, **community involvement in the REA should be sought whenever possible**. The **Community Level Assessment** module is specifically designed for this purpose.

The REA can be used by headquarters or donor staff to screen projects under design or review. In particular, Sections Four and Five of the **Organization Level Assessment** module can be used to quickly assess whether a proposed project has considered and is addressing salient environmental issues. The **Green Review of Relief Procurement** module is designed to screen whether procurement proposed under a project has taken into account steps to minimize negative impacts on the environment.

Personnel Requirements

Ideally an initial REA will be completed by a group of persons directly involved in the disaster response. A group approach promotes the presentation of various views and perspectives on environmental issues and disaster impact. This limits the chance that issues or problems will be missed in the initial assessment or an individual's own personal views will result in a narrow perspective of environmental conditions. This group process should be managed by one person charged with leading the assessment process, collecting background information, and recording and keeping a file of the assessment results.

The REA can be done by a single person. Care is needed, however, to ensure that this person has adequate time and means to collect the information needed to accurately complete the REA modules. In addition, having one person completing all four modules of the REA will likely take considerable time and detract from the rapid nature of the assessment. The assessment process laid out in the **Organization Level Assessment** module is best completed by a group of ten to twelve persons. This allows for a diversity of views and for the larger group to be broken-up into working groups for work on the rating forms. When the REA involves planned or on-going projects, the key staff of these projects should be involved in completing and updating the REA.

The **Community REA Questionnaire** (provided for in the **Community Level Assessment** module) can be done by one person, although it is preferable for at least two persons to work together on completing the questionnaire. To cover as many communities as possible, several teams can concurrently administer an assessment questionnaire or other data collection procedure to a number of communities.

The REA results should be updated periodically and this updating done by the same group which completed the original assessment. A single person can update a REA, although this person needs to have a good knowledge of how the disaster is progressing and of changes in impacts and relief requirements. As noted, the REA can be done with (or even by) disaster survivors. This will involve more pre-assessment preparation to ensure the community understands the concepts and basis for the REA process, and adds to the time and workload of the overall assessment. However, the benefits, in improved understanding of local concerns for the environment and closer links between survivor needs and assistance plans, can be significant and warrant the extra workload.

Time Required for Completion

The time needed to complete a full REA depends on:

• The nature of the disaster,

• Whether both **Organization** and **Community Level Assessments** are completed,
• The level of preparation of those completing the assessment work, and
• The amount of training on the REA which has been provided.

The time needed to complete the
Organization Level Assessment can range from under four hours to one and one half days, depending on participant familiarity with the REA and the *Guidelines*, the need for translation and the extent of preparations. It is recommended that four to six hours be allocated to preparation for the **Organization Level Assessment**, covering the collection of background information, drafting parts to the **Context Statement**, and translation of key materials as needed.

If a number of organizations are involved in the **Organization Level Assessment**, a second meeting of the participants in the initial assessment is recommended to validate results once the REA has been completed. This validation meeting can require up to two hours with a similar period of time for preparation of briefing materials. Time needed to complete the **Community Level Assessment** depends on whether the assessment can be based on existing information sources (i.e., other assessments) or whether there is a need for a separate community data collection effort. Experience indicates that administering a questionnaire or focus discussion process in a community requires two to four hours per group contacted. In practical terms, this means collecting information from one community per day if the communities are reasonably accessible, with the total number of days dependent on the number of communities included in the assessment and the number of survey teams.

The extraction and preliminary analysis of community information, whether from questionnaires, focused discussions or other assessment reports requires anywhere from four hours to one day depending on how well records are kept and the number of groups covered in the assessment. Needing to read several assessment reports to become familiar with the information available can add to the time required. Completing the preliminary analysis at the end of each community visit can shorten the time required to complete a preliminary analysis. As with the **Organization.**

Level Assessment,
Good planning and preparations are critical to a rapid completion of the assessment process.
Completing the **Consolidation and Analysis** module can require from three hours to up to a day and a half of group discussions and up to an additional one half day to write-up results. The time needed for this module can be shortened by having the analysis done by one person, although the advantage of using a group process for validation and buy-in to the assessment results is significant. The work needed to complete the **Green.**

Review of Relief Procurement module is relatively short if information is available on the services or materials to be procured. Ideally, the check list review should be completed as procurement specifications are developed or procurement plans are reviewed. In this situation, the **Green Review of Relief Procurement** should not add measurably to the time needed to complete the normal emergency procurement process. When considering the time needed to complete the REA it should be kept in mind that the REA is a **rapid, not a comprehensive**, assessment. The REA is not designed to clarify all possible environmental issues linked to a disaster, or to provide detailed answers to issues which are identified as being critical. Efforts to address issues identified during the assessment should take place after the assessment and not unnecessarily lengthen the assessment process itself. Completion of the whole REA by a single individual will take somewhat longer than completion with group participation, particularly because of the time needed to contact and interview knowledgeable persons. Updating or revising an initial REA, if done regularly and by persons knowledgeable about the disaster and who participated in the initial REA, should take no more than a couple of hours.The REA will generate follow-up activities. This work is closely related to tasks necessary for an efficient relief operation and should not add significantly to the disaster-related work load. However, these follow-up activities may lead to work in areas where relief operations have not been given sufficient attention, and generate new workloads.

Diversity

The gender, social, cultural, ecological, and economic diversity of the area covered by a rapid environmental impact assessment should be considered in organizing and conducting the assessment. Perception of environmental conditions, salient issues and ways to address environmental issues can vary by gender, age, social status, culture and economic status. Participants in the REA should reflect the gender, social and cultural diversity of the population within the area for which the assessment is being conducted. This is particularly true for the

Community Level Assessment where contacts with communities should include an accurate representation of the different groups within a community. In turn, this implies that persons participating in the REA be aware of the diversity of groups within the assessment target area. The REA is of little value if it does not represent the social environment of the area affected by a disaster.

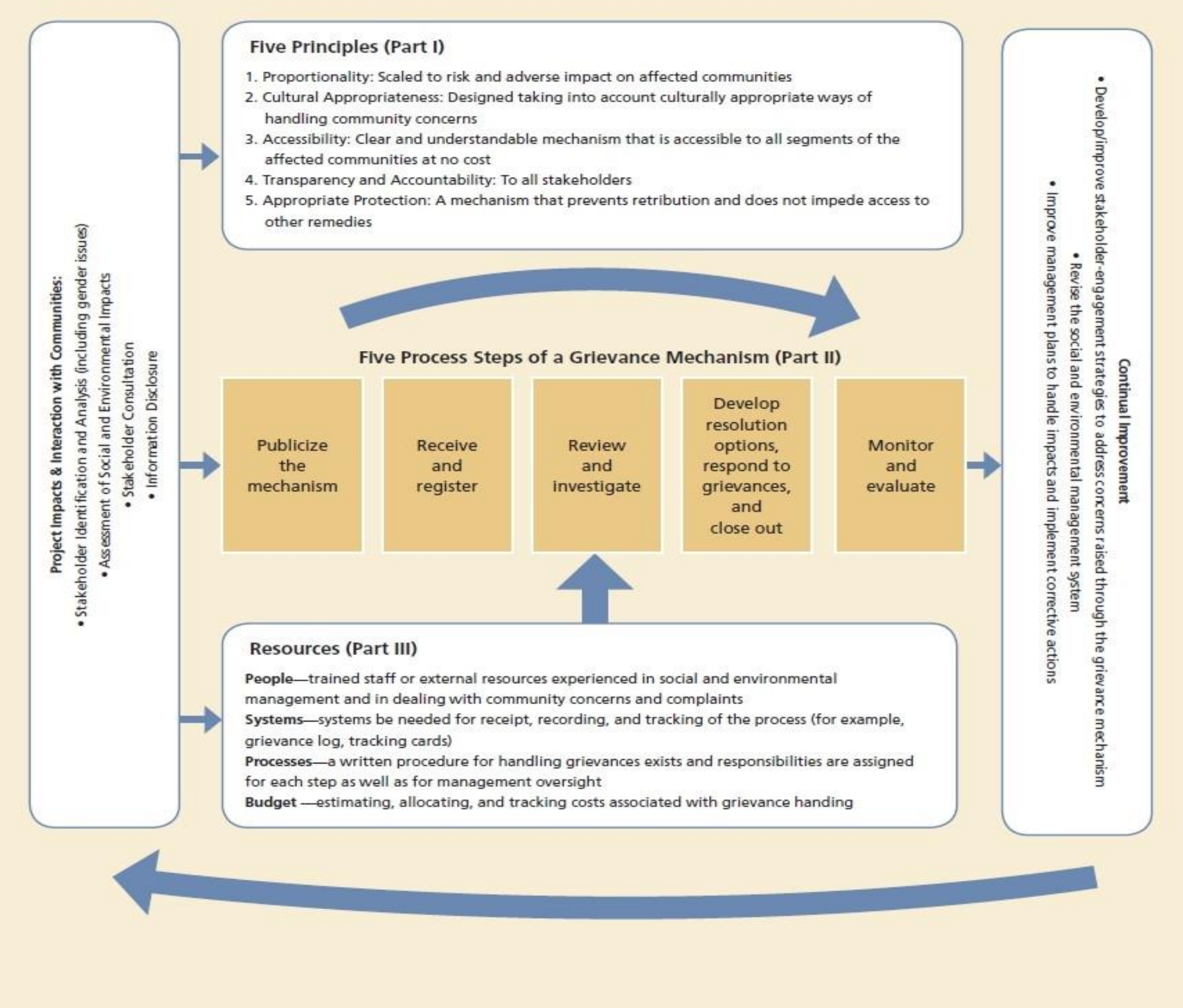
Monitoring and Evaluation

The REA can contribute to the monitoring and evaluation (M&E) of relief activities and environmental impacts. The initial REA provides a baseline on environmental conditions and issues, and an indication of possible environmental impacts of relief activities. REA updates provide information useful to monitor progress toward objectives and changes in impact on the environment. This information can be used in evaluating relief and environmental interventions. The REA can also point to environmental issues to be included in the follow-up to emergency interventions as well as identify possible indicators for a formal M&E system.

Users are cautioned that REA is not a stand-alone M&E system but a tool available to a formally organized and managed M&E process. Over time the REA results will likely become less important as formal M&E data collection systems are instituted. The UNHCR *Environmental Indicator Framework: A Monitoring System for Environment-Related Activities in Refugee Operations* provides a process and indicators which can be adapted to most disaster response situations and complement monitoring data collected through the use of the *Guidelines*.

Addressing the issues related to the Project Affected People :

FIGURE 1: Basic Design Elements of a Project-Level Grievance Mechanism



This Good Practice Note defines a grievance as a concern or complaint raised by an individual or a group within communities affected by company operations. Both concerns and complaints can result from either real or perceived impacts of a company's operations, and may be filed in the same manner and handled with the same procedure. The difference between responses to a concern or to a complaint may be in the specific approaches and the amount of time needed to resolve it. The term "grievance" implies that there may be a problem. In practice, however, the nature of feedback that communities may want to bring to a company's attention will vary, since communities often find it appropriate to use the same channels to communicate not only grievances but also questions, requests for information, and suggestions. Communities

A project-level grievance mechanism for affected communities is a process for receiving, evaluating, and addressing project-related grievances from affected communities at the level of the company, or project.[7] In the context of relatively large projects, this mechanism may also address grievances against contractors and subcontractors.

A project's grievance mechanism should be specifically designed with a focus on local communities affected by the project.[10] The task of understanding who will be potentially affected by project operations, and who will therefore use the company grievance mechanism to raise complaints, is not always straightforward and depends on the project's particular circumstances. Thus, it is beneficial to review who may be affected by the project, and the nature of the potential impact, during the broader stakeholder analysis phase of the Social and Environmental Assessment. Early and strategic interaction with communities will help ensure that the grievance mechanism is culturally acceptable to all affected groups within communities, integrates traditional mechanisms for raising and resolving issues, and reasonably addresses accessibility and other barriers that may prevent communities from raising their concerns

Principles of a Good Grievance Mechanism

Develop specific approaches acceptable to communities for raising and resolving grievances, depending on volume and types of grievances that are anticipated, and the remedies the company can offer. In this process, information disclosure and stakeholder consultation with communities are key. • Determine the level of detail for grievance mechanism procedures (for example, a brief procedure document. or an elaborate policy, detailed guidelines for staff, and procedures for contractors). • Decide on financial resources to invest in procedures for grievance receipt and tracking, such as number and locations of places where grievances can be collected, whether to establish a dedicated telephone line(s), and the type of tracking system to use (for example, a log or spreadsheet or a computerized system). • Determine the number and requirements of personnel dedicated to collecting grievances and managing or overseeing the entire process, and the expense their training will require. • Decide whether external resources are required, and how and to what extent to involve independent third parties. Comprehensive grievance mechanisms—based on a detailed policy, advanced systems, and dedicated staff time and resources—are especially useful in situations where companies anticipate a wide range of grievances due to ongoing risks to or adverse impacts on affected communities, and those where projects result in economic or physical displacement or affect indigenous peoples. Less comprehensive grievance mechanisms may be sufficient where there are very few people affected and impacts are likely to be low. These projects may opt for establishing a straightforward and less formalized mechanism.

Project Scale and Grievance Mechanisms

Projects with Potential Significant Impacts. Projects with potential significant adverse impacts that are diverse, irreversible, or unprecedented, and that pose risks to communities, will require a more extensive and far-reaching grievance mechanism. These grievance mechanisms are best established at the outset of the project, and backed up with significant human and financial resources. They may offer multiple options for addressing complaints, including operation or monitoring by third parties.

Projects with Medium Impacts. Adverse impacts of these projects are limited, site-specific, reversible, and readily addressed by mitigation. Even though the impacts may be limited, these projects should establish grievance mechanisms if projects can reasonably expect grievances from local communities. In these projects, the mechanism need not be as complex or extensive as that in a high-impact project.

Projects with No or Minimal Impacts. Even in projects involving minimal or no adverse social and environmental impacts, if the project is located near communities, and sporadic complaints can be expected, establishing a straightforward procedure and designating an individual within the company to act as a point of contact to receive complaints can foster positive engagement when issues arise.

1. The impacts of development projects occur in different forms. While significant benefits result for the society, the project area people may often bear the brunt of

adverse impacts. This can happen, for example, when they are forced to relocate to make way for such interventions. There is now a growing concern over the fate of the displaced people. This has given rise to the need to understand beforehand the implications of adverse project impacts so that mitigation plans could be put in place in advance.

2 The National R&R Policy, issued in 2007, recognizes the need to carry out Social Impact Assessment (SIA) as part of the resettlement planning and implementation processes. Section 4.1 in Chapter IV Social Impact Assessment (SIA) of the Policy reads as follows:

> Wherever it is desired to undertake a new project or expansion of an existing project, which involves involuntary displacement of 400 hundred or more families, *en masse* in plain areas, or two hundred or more families *en masse* in tribal or hilly areas, DDP blocks or areas mentioned in the Schedule V or Schedule VI to the Constitution, the appropriate Government shall ensure that a Social Impact Assessment (SIA) study is carried out in the proposed affected areas in such manner as may be prescribed.

3 While an assessment of social impacts prior to the commencement of a new project or expansion of an existing is now obligatory under the new national R&R policy, the appropriate guidelines for the purpose do not yet exist. This Handbook on Conducting Social Impact Assessments aims to fill this gap. It explains the basic concept of social impact assessment, the step-by-step process of conducting SIA, and the SIA methodology. In short, it aims to provide practical guidance on carrying out Social Impact Assessment, as envisaged in the national R&R policy, 2007.

4 There is going to be an increase in demand for a set of how-to-do guidelines on conducting social impact assessments, especially from Government resettlement planning and implementation agencies. This Handbook has been prepared to meet this demand for project personnel, both planners and practitioners, involved in conducting R&R operations.

5 In addition, this Handbook will also be useful to consultants, NGOs and the others involved in conducting social impact assessments. Applied social scientists, trainers, NGOs, others concerned with resettlement issues, and the affected people will also find in this Handbook much that is relevant to their interests.

6. This Handbook is organized into six chapters. Chapter I is a brief introduction to the Handbook. Chapter II explains the meaning of social impact assessment and what SIA can do to help design projects that genuinely respond to the needs of the affected people. Chapter III describes the methodology of data collection for purposes of impact assessment. Chapter IV presents an overview of the principles for social impact assessment. Chapter V outlines steps involved in carrying out social impact assessment. Finally, chapter VI provides guidance on preparing a SIA Report.

SOCIAL IMPACTS AND SOCIAL IMPACT ASSESSMENT

7 Planners and decision makers increasingly recognize the need for better understanding of the social consequences of policies, plans, programmes and projects (PPPPs). Social Impact Assessment (short form for Socio-economic Impact Assessment) helps in understanding such impacts.

8 Social Impact Assessment alerts the planners as to the likely benefits and costs of a proposed project, which may be social and/or economic. The knowledge of these likely impacts in advance can help decision-makes in deciding whether the project should proceed,

or proceed with some changes, or dropped completely. The most useful outcome of a SIA is to develop mitigation plans to overcome the potential negative impacts on individuals and communities.

9 SIAs can assist advocacy groups as well. A Social Impact Assessment report, done painstakingly, showing the real consequences of the project on affected people and suggesting alternative approaches, gives credibility to their campaigns.

<u>A Historical Overview</u>

10 Social scientists have long been involved in doing impact assessment, almost since the dawn of their discipline. A canal study carried out by Condorcet in the nineteenth century is believed to be the first Social Impact Assessment. (Prendergast 1989) However, Social Impact Assessment, as it is known today, emerged much later.

11 The beginnings of social impact assessment can be traced to developments as recent as those during the1970's. By this time, "development agencies began to use impact assessments – which were about predicting, before the start of a project, its likely environmental, social, and economic consequences – in order to approve, adjust, or reject it." (Roche 1999: 18)

12 From the early 1980s, several new methods of enquiry emerged, including Rapid Rural Appraisal (RRA), Participatory Action Research (PRA), Participatory Rural Appraisal (PRA) (Chambers 1997; Oommen 2007). These sought to make people and communities active participants, rather than mere objects of assessment.

13 By the early 1990s, social science professionals were also able to develop an acceptable set of SIA guidelines and principles. (IOCPGSIA: 1994 and 2003, and IAIA: 2003) Around this time, the practice of SIA also got firmly established among development agencies as a way to assess the impacts of development projects before they go ahead. SIA is now part of the formal planning processes in most development organizations. In some countries, SIA is a legal requirement.

14 Social impact assessments have been carried out for a variety of projects, including projects in such diverse sectors as water, sanitation and health, coal sector, urban transport systems, pastoral development programmes, and livelihood support projects (Cernea and Kudat 1997; Roche 1999). But it is for resettlement projects that SIAs have been found particularly useful. Modak and Biswas (1999:209) observe:

> The subject has evolved basically to identify project-affected people and find measures to mitigate negative impacts, or compensate irreversible losses following a participatory process

15 In recent years, much has been written on applications and methodology of Social Impact Assessment. The subject is widely taught, often in conjunction with other professional and academic courses, and training programmes. Numerous consulting firms have come up to offer SIA expertise in project preparation, implementation, monitoring and evaluation. These firms, along with skilled practitioners and academics are regularly hired by projects to produce SIA reports that are required in advance of proposed new projects for their approval.

16 In the beginning, SIA was carried out as part of Environmental Impact Assessment (EIA). Increasingly, SIA is now carried out as an exercise independently of EIA, because these are two different kinds of assessments.

Current Scene in India

17 In India, SIA has been generally carried out as part of the Environment Impact Assessment clearance process. As part of the EIA process it has therefore not received the attention it deserves.

18 Social Impact Assessment has now become an important part of the project preparation process, especially for the preparation of Resettlement Action Plans (RAPs). In this process, SIA is carried out as socio-economic survey that identifies social and economic impacts on people and communities facing project-induced displacement. In addition, data thus generated is used in designing mitigation measures as well as in monitoring mitigation implementation.

19 Resettlement policies have lately made social impact assessment a major part of the resettlement planning process. In 2006, a provision was included for conducting SIA in the Orissa R&R Policy 2006. The National R&R Policy 2007 has made a provision for conducting SIA whenever a new project or expansion of an existing project is undertaken. (See Annex IV) But this provision is limited to only those cases which involve displacement of 400 hundred or more families, *en masse* in plain areas, or two hundred or more families *en masse* in tribal or hilly areas, DDP blocks or areas mentioned in the Schedule V or Schedule VI to the Constitution. Undoubtedly, these are good beginnings, but as yet the guidelines to give effect to these policy provisions do not exist.

20 The World Bank, ADB, IFC, UNDP, as well as most multilateral and private agencies, including commercial banks, require some kind of prior social impact assessment for all the projects that they finance.

21 The issue is no longer whether SIA should be carried out or not, but how it should be carried out so that the local people benefit from the project and not lose from it, certainly not those who are poor to begin with.

What are Social Impacts?

22 Social Impacts are the changes that occur in communities or to individuals as a result of an externally-induced change. IOCPGSIA (2003: 231) defines social impacts as “the consequences to human populations of any pubic or private actions that alter the ways in which people live, work, play, relate to one another, organize to meet their needs, and generally cope as members of society. The term also includes cultural impacts involving changes to the norms, values, and beliefs that guide and rationalize their cognition of themselves and their society.” Social Impacts are both positive and negative.

23 Changes may effect: employment, income, production, way of life, culture, community, political systems, environment, health and well-being, personal and property rights, and fears and aspirations. These impacts can be positive or negative. In short, a social impact is a significant improvement or deterioration in people’s well-being.

24 Examples of projects with significant social impacts include: dams and reservoirs (disruption due to relocation), power and industrial plants (influx of work force, pressure on infrastructure), roads and linear projects (dislocation of activity networks), and landfill and hazardous waste disposal sites (seen as health risks).

Differential Impacts

25 Projects affect different groups differently. Some people tend to benefit, others lose. Often, impacts are particularly severe for vulnerable groups: tribal people, women-headed households, elderly persons, landless persons, and the poor.

Types of Impacts

26 Not all projects cause similar impacts. For example, impacts that are commonly experienced in urban projects are different from those in hydropower projects. The common hydropower project impacts include the following:

Submergence of vast areas, usually in hilly, sparsely populated regions, inhabited by agriculture-dependent rural and tribal communities

- Forced displacement (often resulting in impoverishment)
- Boomtowns (uncontrolled influx of construction workers, crime, social evils)
- Downstream adverse changes in agro-production systems
-

27 On the other hand, there is no submergence in urban projects. People are affected by loss of jobs, not by loss of agricultural lands.

28 The following is an illustrative list of possible impacts:

Social/Cultural

- Break-up of community cohesion
- Disintegration of social support systems
- Disruption of women's economic activities
- Loss of time-honoured sacred places of worship
- Loss of archeological sites and other cultural property

Economic

- Loss of agricultural lands, tress, wells
- Loss of dwellings and other farm buildings
- Loss of access to common property resources
- Loss of shops, commercial buildings
- Loss of businesses/jobs
- Overall reduction in income due to above losses

Public Infrastructure and services

- Government office buildings
- School buildings
- Hospitals
- Roads
- Street lighting

Identifying Impoverishment Risks

29 Identifying impoverishment risks which projects often create is part of the exercise to identify adverse project impacts. The impoverishment risks analysis model adds substantially to the tools used for explaining, diagnosing, predicting, and planning for development. (WCD: 297) The eight most common impoverishment risks to the project area people, as described by Cernea (1996), are as follows:

- *Landlessness*: Expropriation of land removes the main foundation upon which peoples' productive systems, commercial activities and livelihoods are constructed.

- *Joblessness*: Loss of employment and wages occurs more in urban areas, but it also affects rural people, depriving landless labourers, service workers, artisans, and small business owners of their sources of income.
- *Homelessness*: Loss of housing and shelter is temporary for the majority of displacees, but threatens to become chronic for the most vulnerable. Considered in a broader cultural sense, homelessness is also placenessness, loss of a group's cultural space and identity.
- *Marginalization*: Marginalization occurs when families lose economic power and spiral downwards. It sets in when new investments in the area are prohibited, long before the actual displacement. Middle-income farm households become small landholders; small shopkeepers and craftsmen are downsized and slip below poverty thresholds. Economic marginalization is often accompanied by social and psychological marginalization and manifests itself in a downward mobility in social status, displaced persons' loss of confidence in society and in themselves, a feeling of injustice and increased vulnerability.
- *Food Insecurity*: Forced displacement increases the risk that people will undergo chronic food insecurity, defined as calorie-protein intake levels below the minimum necessary for normal growth and work. Sudden drops in food crops availability and income are endemic to physical relocation and hunger lingers as a long-term effect.
- *Increased Morbidity and Mortality*: The health of affected persons tends to deteriorate rapidly due to malnutrition, increased stress and psychological traumas. Unsafe water supply and waste disposal tend to proliferate infectious disease, and morbidity decreases capacity and incomes. The risk is highest for the weakest population segments – infants, children, and the elderly.
- *Loss of Access to Common Property*: Loss of access to commonly owned assets (forestlands, water bodies, grazing lands, and so on) is often overlooked and uncompensated, particularly for the assetless.
- *Social Disarticulation*: Community dispersal means dismantling of structures of social organization and loss of mutual help networks. Although this loss of social capital is harder to quantify, it impoverishes and disempowers affected persons.

30 These adverse impacts must be identified by a SIA study. WCD (2000: 241) is emphatic that the impact assessment studies must identify and delineate various categories of adversely affected people in terms of the nature and extent of their rights, losses and risks. This signals a departure from the way that social impacts were assessed in the past and will empower the planners and stakeholders to incorporate the full extent of social impacts and losses in the decision-making process.

What is Initial Social Impact Assessment (ISIA)?

31 An Initial Social Impact Assessment (ISIA) is carried out if the project impacts are likely to be minor or limited, which can be easily predicted and evaluated, and for which mitigation measures can also be prescribed easily. Generally, information for ISIA is obtained during a field visit to areas that will be affected by the project and through discussions with people whom it may affect positively or otherwise. The ISIA is also done to confirm whether this indeed requires a full-scale Social Impact Assessment (SIA). Usually a comprehensive SIA is required for large projects, which entails a more detailed study, time, and resources.

What is Social Impact Assessment?

32 There is no generally agreed definition of Social Impact Assessment (SIA). It may be defined as a process that seeks to assess, in advance, the social repercussions that are likely to follow from projects undertaken to promote development, such as dams, mines, industries,

highways, ports, airports, urban development and power projects. It is a tool that can help decision-makers to foresee the likely negative impacts of their actions so that steps necessary to prevent or at least to contain them could be taken in time. As an aid to the decision making process, SIA provides information on social and cultural factors that need to be taken into account in any decision that affects the lives of project area people.

33 Goldman and Baum (2000:7) define Social Impact Assessment (SIA) as a method of analyzing what impacts actions may have on the social aspects of the environment. It involves characterizing the existing state of such aspects of the environment, forecasting how they may change if a given action or alternative is implemented, and developing means of mitigating changes that are likely to be adverse from the point of view of the affected population.

34 The IOCPGSIA (2003: 231) defines SIA in terms of efforts to assess, appraise or estimate, in advance, the social consequences that are likely to follow from proposed actions. These include: specific government or private projects, such as construction of buildings, siting power generation facilities, large transportation projects…

35 Finsterbusch and Freudenburg (2002: 409) define the three terms in '*Socio-economic Impact Assessment*' '(socio-economic, impact, and assessment) as follows:

Socio-economic: In essence, the *socio*-half of the term *socio-economic* can be seen as covering social and cultural impacts of development, and as incorporating the traditional subject matter of sociology, anthropology, and psychology, in particular, with input from other fields as well. The *economic*-half of the term is generally seen as including not only economics, but also demography and planning, again with input from other fields, as needed. These are emphases, rather than rigid distinctions.

> *Impacts*: The *impacts* are the direct as well as indirect "effects" or "consequences" of an action (such as constructing a dam, digging a coal mine, or building a highway). "In short, impacts include all of the significant changes that take place because of what an agency does and that would not have occurred otherwise"
>
> *Assessment*: In the SIA context, *assessment* tends to have an unusual meaning: The "assessment" of impacts is carried out before the impacts actually occur. In other words, an SIA is often anticipatory rather than empirical. It attempts to assist the planning process by identifying the likely effects before they take place. The estimates of likely future impacts are based on the existing empirical knowledge of the impacts of similar actions in the past.

Advantages of Doing Social Impact Assessment

The main advantages of doing a systematic Social Impact Assessment (SIA) include the following:

- *Identifying Affected Groups*: SIA helps in identifying people and groups who affect or are affected by the project
- *Allying Fears and Winning Trust*: SIA can help allay fears of affected groups and build a basis of trust and cooperation which is so essential for successful project implementation
- *Avoiding Adverse Impacts*: SIA provides the basis for preparing mitigation measures to avoid, reduce or manage adverse impacts
- *Enhancing Positive Impacts*: SIA preparation also helps identify measures to maximize/share project benefits
- *Reducing Costs*: Addressing social impacts at an early stage helps to avoid costly errors in future

- *Getting Approval Faster*: A well prepared SIA demonstrates that social impacts are taken seriously and helps in getting project clearance faster

37 Social impact assessment is predicated on the notion that decision makers should understand the consequences of their decisions before they act and that the people affected will not only be appraised of the effects, but have the opportunity to participate in designing their future. (IOCPGSIA 2003:248)

STEPS IN CONDUCTING
SOCIAL IMPACT ASSESSMENT

38 When planning to conduct a social impact assessment, time spent in preparation is rarely wasted. It is important, at the outset, to be clear about the purpose of the assessment, the unit of assessment, time available, the competence of the team for the task, and such other issues.

39 A social impact assessment process, as WCD (2000) envisaged, should be built on three elements:

- A detailed assessment of the socio-economic conditions of the people who may be negatively affected (Cernea's risk assessment model can be useful);
- A detailed study of the impacts in terms of the extent of displacement, the loss of livelihoods, the second-order impacts as a result of submergence, construction mitigation measures, downstream impacts, and host communities; and
- A detailed plan to mitigate these impacts and an assessment of the costs of such measures.

40 This chapter outlines the steps involved in carrying out the Social Impact Assessment process, and includes suggestions on how to follow them. (IOCPGSIA 1994)

Step 1: Define the Impact Area

41 The first step is to define the *Area of Impact*. The size of the area varies according to a project. A dam submerges a large, contiguous geographic area affecting several villages. The impact from a highway and other linear projects occurs along the corridor as small strips of land on either side of the road. The SIA team must get a map showing clearly demarcated area that will be affected by the project (both directly and indirectly).

42 In addition, field visit to the area needs to be undertaken to have a better understanding of the geographic limits of the area and the people living there.

Step 2: Identify Information/Data Requirements and their Sources

43 Review the existing data on impacts likely to follow from the project to see if that could be used for assessment purposes. This may provide disaggregated data according to caste, religion, sex and other administrative categories, such as persons below poverty line. The secondary should be checked as much for its adequacy as for its reliability.

44 This review will also help identify the need for collection of additional primary data through surveys and participatory methods.

Step 3: Involve All Affected Stakeholders

45 Share information and consult with all stakeholders. Stakeholders are people, groups, or institutions which are likely to be affected by a proposed intervention (either negatively or positively), or those which can affect the outcome of the intervention. Develop and implement an effective public involvement plan to involve all interested and affected stakeholders. The

first step in developing plans for consultation and participation is to identify stakeholders who will be involved in the consultative processes. The basic questions to consider in identifying stakeholders include:

- Who will be directly or indirectly and positively and negatively affected?
- Who are the most vulnerable groups?
- Who might have an interest or feel that they are affected?
- Who supports or opposes the changes that the project will produce?
- Whose opposition could be detrimental to the success of the project?
- Whose cooperation, expertise, or influence would be helpful to the success of the project?
-

<u>Step 4: Conduct Screening</u>

46 Social Impact Assessment (SIA) process begins with screening. Screening is undertaken in the very beginning stages of project development. The purpose of screening is to screen out "no significant impacts" from those with significant impacts and get a broad picture of the nature, scale and magnitude of the issues.

47 This helps in determining the scope of detailed SIA that would be subsequently carried out.

<u>Step 5: Carry Out Scoping in the Field</u>

48 The next step is scoping. Essentially, this involves visit to the project site, and consultation with all stakeholders. It is important to confirm their understanding of key issues. On-site appreciation of impacts is indispensable for projects that cause displacement on a large scale. The local knowledge can be invaluable in finding alternatives that help avoid or at least reduce the magnitude and severity of adverse impacts.

49 This is an initial assessment of likely impacts and not meant to determine the level of impact. It should only identify all of the issues and affected groups to get 'all the cards on the table'

50 The next step is undertaking Social Impact Assessment and the following are the major activities:

<u>Step 6: Prepare a Socioeconomic Profile of Baseline Condition</u>

51 To assess the extent of social impacts, it is necessary to assess the socio-economic conditions of the affected people. This assessment generally involves conducting a socioeconomic survey and a broad based consultation with all affected groups.

52 The socioeconomic profiling should not be restricted to adversely affected population. The survey should include those who benefit from the employment and other economic opportunities generated by the project.

<u>Step 7: Survey of Host Population</u>

53 This survey is carried out to see that in the host area enough land, income earning opportunities and other resources exist to sustain additional population from the affected area, and that this influx does not put pressure on local resources that the host population may resent. The other important thing to see is that the people being relocated and the hosts are socially from a similar socio-cultural background. The similarity in background helps greatly reduce social/ethnic frictions.

Step 8: Identify and Assess the Impacts

54 Once the range of impacts that are predictable has been identified, the next step is to determine their significance (that is, whether they are acceptable, require mitigation, or are unacceptable). Since many impacts are not quantifiable, it is impossible to rank them objectively. The community perceptions of an impact and those of the SIA team are not necessarily the same. The affected people should therefore be consulted in ranking impacts.

55 If impacts are found unacceptable, the SIA must clearly state that giving reasons. Generally, the Social Impact Assessment is expected to result in specific mitigation plans to address relevant social/resettlement issues and potential impacts.

Step 9: Develop a Mitigation Plan

56 Develop a mitigation plan to firstly avoid displacement, secondly to minimize it, and thirdly to compensate for adverse impacts. The major contribution of a SIA study is to help plan for, manage, and then mitigate any negative impacts (or enhance any positive ones) that may arise due to a proposed project.

PRINCIPLES FOR SOCIAL IMPACT ASSESSMENT

57 The principles to guide the concepts, process, and methods of conducting social impact assessment are by now well established. These are meant to ensure sound scientific enquiry. The principles are based on expert judgment of the professionals from relevant disciplines, including sociology, anthropology, development studies, economics, geography, policy planning, and management, and the best practices established in this area over the past thirty years.

Principles of SIA Good Practice

58 The principles for social impact assessment were first developed by the Inter-organizational Committee on Principles and Guidelines for Social Impact Assessment (IOCPGSIA 1994). Basically, these principles are as follows:

(1): *Involve the Diverse Public*

It is important to first identify all potentially affected groups and individuals, and involve them throughout the SIA process. This involvement must reach out to groups that are routinely excluded from decision making due to cultural, linguistic and economic barriers (lower caste and tribal groups, minorities and poor people). The involvement should be truly interactive, with communication flowing both ways between the agency and affected groups. This engagement will ensure that stakeholder groups understand what the project is about and the possible ways it might affect them, both positive and negative.

(2): *Analyze Impact Equity*

Projects affect different groups differently. Impacts should therefore be specified differentially for affected groups, not just measured in the aggregate. Identification of all groups likely to be affected is central to the concept of impact equity. There will always be winners and losers as a result of the decision to build a dam or undertake some other development work. SIA should identify who will win and who will lose, but no groups and individuals that are considered vulnerable due to race, ethnicity, caste, gender, occupation, age or other factors should have to bear the brunt of adverse social impacts.

(3): *Focus the Assessment*

Often, time and resources available for doing social impact assessment are very limited. In such circumstances, the best course is to focus on the most significant social impacts, giving high priority to impacts identified by the people themselves. It is well known that some groups low in power do not usually participate in project preparation stage, but SIA must ensure that their concerns are fully addressed. At the same time, the role of SIA practitioners in impact analysis and assessment remains important. They have the expertise to help prioritize issues, and are able to identify impacts often missed out by the people themselves.

In addition to impacts on households, an accurate assessment of loss to the community assets also needs to be carried out. This impact assessment should include the following: (a) Common property resources, (b) Public structures, (c) Cultural property, and (d) Infrastructure

(4): *Identify Methods and Assumptions and Define Significance*

SIA should use easily understood methods and assumptions that are transparent and replicable. The methods and assumptions used in the SIA should be made publicly available. A brief summary should clearly describe the methods used, the assumptions made, and the significance of impacts determined. This will allow decision makers as well as affected people to evaluate the assessment process.

(5): *Provide Feedback on Social Impacts to Project Planners*

The SIA findings are inputs for designing a project to mitigate negative impacts and enhance positive impacts. The project design process must ensure that all affected and interested persons get an opportunity to comment on the draft before it is given a final shape.

(6): *Use SIA Practitioners*

Trained social scientists using social science research methods alone will get the best results. An experienced SIA practitioner will know what data to look for. His familiarity with impacts that have occurred elsewhere under similar settings will be an asset. It will be easier for him to identify the full range of impacts and then select procedures appropriate for their measurement. The presence of a social scientist in the interdisciplinary team will reduce the probability of any major social impact remaining uncounted.

It is extremely important that the SIA practitioner be an independent social scientist, not a part of the regulatory authority sponsoring the SIA study.

(7): *Establish Monitoring and Mitigation Programmes*

The monitoring of important social impact variables and the mitigation programmes is critical to the SIA process. The monitoring and mitigation should be a joint responsibility of the project and the affected community.

A social impact assessment not only predicts the likely impacts, it should also identify means to mitigate those adverse impacts. Mitigation includes: avoiding the impact by not undertaking the project; or undertaking it with a modified design that reduce the impact; or by compensating for unavoidable and/or irreducible impacts.

(8): *Identify Data Sources*

Generally, SIAs draw on the following three sources of information: (a) Published scientific literature, (b) Secondary data sources including various government documents and official reports, and (c) Primary data from the affected area. All these three sources are important, but not all projects may need them in equal measure. Some SIAs may require more primary data from the affected area than the published materials from journals or books, for example.

The SIA can usefully consult previously published social science books, journal articles that document knowledge of impacts and case studies from similar projects. The best secondary data sources include census, compendium of statistics, land records data, and several government planning and development reports. Survey research, informant interviews, and participant observation are among the important primary data sources that can be used to verify data collected from other sources. Often, project area people are quite knowledgeable about the local socioeconomic situation and can provide a better understanding of the broader range of likely impacts.

(9): *Plan for Gaps in Data*

Often, data relevant and necessary to carry out an assessment is not available yet the SIA is to be carried out. In circumstances when information is incomplete or unavailable, it should be made abundantly clear that assessment has been made in the absence of relevant and necessary data, explaining why this could not be obtained.

SOCIAL IMPACT ASSESSMENT -METHODS AND TOOLS

59 Social Impact assessment study should be carried out as early in the project planning stage as possible. The basic objectives of this study are to provide:

- Baseline information about the social and economic conditions in the project area
- Information on potential impacts of the project and the characteristic of the impacts, magnitude, distribution, and their duration;
- Information on who will be the affected group, positively or negatively
- Information on perceptions of the affected people about the project and its impact
- Information on potential mitigation measures to minimize the impact
- Information on institutional capacity to implement mitigation measures

Examples of Questions to be Addressed in SIA

60 Some questions that are commonly addressed in social impact assessment include the following:

- Who are the key stakeholders? What do they already know about the proposed project, its impact and the measures being contemplated to mitigate its negative impact
- What are their interests? Are the objectives of the project consistent with their needs, interests and capacities?
- What is the impact of the project on various stakeholders, and particularly on women and vulnerable groups?
- What social factors affect the ability of stakeholders to participate or benefit from the operations proposed? (gender, caste, ethnicity, or income level)

- What institutional arrangements are needed for participation and project delivery?
- What are the risks which might affect the success of the project? (lack of commitment or capacity, resource crunch, incompatibility with existing conditions)
- How does the project address needs of different stakeholders?
- Do any of these issues pose risks to overall project success and sustainability?

Sources of Information

61 The SIA relies on both secondary and primary data.

(a) Secondary Source: Such sources of data include:

- Government census data
- Land records, including records of land transactions
- District gazetteers
- Other administrative records (such as NSS)
- Documents from non-governmental organiztions

(b) Primary Source: The existing data from secondary sources cannot however be a substitute for project-specific surveys. In addition, SIA derives much more relevant information directly from surveys of various kinds including socioeconomic survey, and meetings with the affected people.

Methods and Tools

62 Conducting social impact assessment involves the use of a broad array of data collection methods, quantitative and qualitative, common in social science research. Often, a combination of tools may be required to do social assessment. In addition to substantive analytical tools, SIA uses participatory methods that contribute to a better understanding of the project. These can also help increase the ownership of projects.

63 The choice of tools and methods will depend on several factors, such as the project and the affected people. The methods that work for urban projects may not prove much useful for projects located in tribal areas, for example. Other factors will include: time and resources constraints for social assessment, and the availability of experts.

64 Clarity on social assessment methodology is important. SIA often needs to use multiple units of analysis, such as households, individuals within the households, and communities. The household unit is generally used for purposes of resettlement planning. (A household may consist of a nuclear family, extended family, or a unit including non-related members).

65 It is important to always consider the gendered nature of impacts.

Data Collection Methods

66 There are several methods of collecting socioeconomic data for purposes of conducting social impact assessment. The methods generally in use include:

Quantitative Methods

- Land Acquisition Survey (persons with titles, those without titles and others including tenants, sharecroppers should all be counted)
- Census Survey
- Socioeconomic Survey (This should involve only a percentage of total population selected on a random basis)
- Other administrative records (such as NSS)

Qualitative Methods

- Key Informant Interviews
- Focus Group Discussions (FGDs)
- Rapid and Appraisal
- Public Hearing

<u>Qualitative Methods</u>

67 *(a) Key Informant Interview*: A questionnaire helps to establish baseline conditions prior to undertaking a project. The questions should cover all aspects of socioeconomic situation (such as religion, caste, family size, education, skills, occupation and income).

68 The design of the questionnaire is rather important. It should focus on key issues, yet be simple and in the local language. Persons selected to conduct the interviews should be properly briefed and trained to get the questionnaires completed.

69 The team conducting the interviews should include female members, as they alone are in a position to talk to women, especially in rural areas and among communities where there are restrictions on their movements.

70 The quality of information generated through interviews is dependent on a number of factors, which include the following:

- The relationship that the interviewer is able to establish with the respondent.
- Willingness to adjust interviews to the time convenient to respondents
- Ability to listen to answers patiently, and to probe and cross-check them in a thorough but polite way
- Recognizing that same questions can be asked (and answered) in several others ways
- Taking notes in a way that does not interrupt the flow of conversation and appear threatening

71 *(b) Focused Group Discussions (FGDs)*: In FGDs, one or more researchers guide a group discussion using probes but letting group members discuss the topic among themselves. The group has 6 to 10 participants to discuss issues set out by the researcher. The researcher usually uses an interview guide but minimally structures the discussion.

72 Focused Group Discussions (FGDs) Disadvantages:

1. They do not give quantitative estimates of characteristics of a population
2. They are susceptible to interviewer baises
3. There are many things that participants will not real in group situations

73 Focused Group Discussions (FGDs) Advantages

1. Group interviews can…provide background information for designing projects and programmes, generate ideas and hypotheses, for intervention models, provide feedback from beneficiaries, and help in assessing responses to recommended innovations. They are also useful for obtaining data for monitoring and evaluation purposes and for interpreting data that are already available. (Kumar 1987a v)

74 *(c) Rapid Appraisal*: Sometimes the approach known as 'rapid appraisal' (known by several different names) may be valuable. Partly, this approach arose as a reaction against time and budget consuming surveys. This low-cost method is based on in-depth interviews with critical informants known to be knowledgeable about the issues to be explored. In-depth interviewing is supplemented by analysis of secondary data and group interviews with

representatives of relevant groups in the community. The key to rapid appraisal techniques is to compress the research process so that data are collected, analyzed and put together in a useable form in the shortest possible time span.

75 *(d) Public Hearing*: A public meeting is open to all affected and interested persons. The team first describes the project and its likely impacts, both positive and negative, and then allows free discussion on all issues. People often provide useful feedback on the project and its impacts which can be a useful input to the process of decision-making

Quantitative Methods

76 *(a) Land Acquisition Survey*: Land acquisition for projects leads to displacement and loss of livelihoods for local people. A land acquisition assessment survey provides detailed information on who and how many will be adversely affected by land loss. This survey is largely based on government land records, land use maps, statistical information, and existing legislation and administrative practice with respect to land acquisition, and project planning documents, but the data often require on the spot verification during a field visit.

77 This is a rapid, low-cost preliminary assessment done at the project identification stage. The Land Acquisition Survey is expected to provide answers to questions such as the following:

- Where is the land that is required for the project?
- Who is the land's current owner?
- What is the tenure status of the present land users?
- What is the procedure for land acquisition?

78 Typically, the land acquisition survey includes only persons with legal title to land. The non-titled persons (sharecroppers, tenants, informal dwellers) are not included. This is often referred to as the "official" list of affected persons.

79 *(b) Census Survey*: This is the most important survey, as it helps to determine the exact number of people who will bear the brunt of adverse project impacts, and the total property affected. Since the purpose of the census survey is to prepare an inventory of all affected persons and properties, it should cover the following:

- All affected persons living in the project area
- All affected property
- The level and sources of all incomes, and the project's impact on them

80 Typically, the census uses the household as the basic unit for data collection. Data should be disaggregated by gender, caste, tribe and other social categories.

81 In addition, a comprehensive list of common property to be affected by a project should also be prepared. This will include:

- Common property resources: These include pastures, fishing ponds and forests including sources of building and craft materials, biomass for domestic energy.
- Public structures: These include schools, clinics, places for worship, bathing and washing places, community centres, lampposts, playgrounds, wells, and bus stops
- Cultural property: Cultural property includes archeological sites, monuments, burial grounds, places of historical or religious importance.
- Infrastructure: This includes all infrastructure destroyed or disrupted by project construction activities, including roads, bridges, power lines, and water and sewage lines.

82 *(c) Socioeconomic Survey*: This study generates information on impacts on critical socioeconomic aspects of the affected population. These include: demographic details (family size, sex ratio, literacy/education levels, population by caste, tribe, religion, gender, age groups, and vulnerable groups) socioeconomic production systems, sources of income, patterns of social organization and leadership, women's economic activities and income, ancestral property provisions and custom, levels of health and nutrition, etc.

83 In projects that do not involve a large population, socioeconomic survey and census are usually combined. In projects that cause large scale displacement, the socioeconomic survey is a separate sampled survey of roughly 10-20 percent of the total affected population, selected on a random basis. It is, however, important that the survey covers a statistically valid representative sample of all strata of the affected population (including women and other vulnerable groups).

84 The socioeconomic profiling should not be restricted to adversely affected population. The survey should include those who benefit from the employment and other economic opportunities generated by the project.

<u>The Limitations of Quantitative Methods</u>

85 Quantitative data collection methodology also has its limitations. Factors such as the adequacy of sample, the cooperation of respondents, the experience of the survey team and the adequacy of supervision over the team in the field can bias not only sampling but data collection as well.

86 SIA practitioners usually balance quantitative and qualitative methods of collecting data to ensure as complete an understanding of the project's impacts on the affected people as possible.

FORMAT OF A SOCIAL IMPACT - ASSESSMENT REPORT

87 Once a Social Impact Assessment has been completed, a formal Report with a brief Executive Summary should be prepared for submission to the authority which sponsored it.

<u>Contents of a SIA Report</u>

88 This Report should be divided into several distinct sections, each section dealing with different aspects of the SIA process.

Introduction: This section includes the purpose of the report. It describes its scope and how it is organized (provide brief outline of the contents of the report).

Description of the Project: Provide in this section brief details of the project, the objectives of the project, need for the project, the project location, the proposed schedule for implementation. Furnish a drawing showing the project layout, and its location.

Methods in Identifying Project Impacts: Describe the methods used in conducting the assessment, both quantitative and qualitative.

***Anticipated Project Impacts**:* Describe project impacts on different groups, both positive and negative, as identified by the SIA.

***Affected Population**:* This section contains details about the total affected population, such as male and female ratio, age profile, marital status, occupational structure, etc.

***Affected Vulnerable Groups**:* Provide details regarding all vulnerable affected households, including scheduled castes/scheduled tribes/other backward classes, Women-headed households, squatters and encroachers, disabled and those unable to work, elderly and children without support, and the very poor

Inventory of Losses to Households*:* This section contains full information on losses to both assets immovable as well immovable. These include land, houses, other structures, income and livelihood, and social networks

Losses to the Community*:* Provide a complete list of community property affected by the project. This will include all public buildings, common property resource (such as pastures and rivers), cultural property (includes archeological sites), and infrastructure (roads, bridges, and canals)

Public Consultation and Disclosure*:* This section will describe the process followed to involve the affected people and other stakeholders. It summarizes their comments and describes how these were addressed. Describe activities undertaken to share information

Findings and Recommendations*:* This section will provide an overall assessment of impacts and make recommendations for further action on the basis of the impact assessment, including abandonment of the project if in relation to the benefits the impacts are too severe to manage.

Mitigation Plan*:* If the recommendation is to mitigate the project impacts, provide details of an action plan for mitigation, including relocation and income and livelihood restoration plans.

Recommendations

89 On the basis of its findings the Report should finally make its recommendation to the sponsoring authority. It should clearly state whether the project could proceed as it is, or proceed with some changes, or dropped completely.

Sharing SIA Report with Stakeholders

90 The SIA sponsors should ensure that the Report is publicly made available once it has been formally submitted to them.

ISO 14000

The **ISO 14000** environmental management standards exist to help organizations (a) minimize how their operations (processes etc.) negatively affect the environment (i.e. cause adverse changes to air, water, or land); (b) comply with applicable laws, regulations, and other environmentally oriented requirements, and (c) continually improve in the above.

ISO 14000 is similar to ISO 9000 quality management in that both pertain to the process of how a product is produced, rather than to the product itself. As with ISO 9000, certification is performed by third-party organizations rather than being awarded by ISO directly. The ISO 19011 audit standard applies when auditing for both 9000 and 14000 compliance at once.

A brief history of environmental management systems

The concept of an environmental management system evolved in the early nineties and its origin can be traced back to 1972, when the United Nations organised a Conference on the Human Environment in Stockholm and the United Nations Environment Programme (UNEP) was launched (Corbett & Kirsch, 2001). These early initiatives led to the establishment of the World Commission on Environment and Development (WCED) and the adoption of the Montreal Protocol and Basel Convention.

In 1992, the first Earth Summit was held in Rio-de-Janeiro (Jiang & Bansal, 2001), which served to generate a global commitment to the environment (RMIT University). In the same year, BSI Group published the world's first environmental management systems standard, BS

7750. This supplied the template for the development of the **ISO 14000** series in 1996, by the International Organization for Standardization, which has representation from committees all over the world (ISO) (Clements 1996, Brorson & Larsson, 1999). As of 2010, ISO 14001 is now used by at least 223 149 organizations in 159 countries and economies.

Development of the ISO 14000 series

The ISO 14000 family includes most notably the ISO 14001 standard, which represents the core set of standards used by organizations for designing and implementing an effective environmental management system. Other standards included in this series are ISO 14004, which gives additional guidelines for a good environmental management system, and more specialized standards dealing with specific aspects of environmental management. The major objective of the ISO 14000 series of norms is "to promote more effective and efficient environmental management in organizations and to provide useful and usable tools - ones that are cost effective, system-based, flexible and reflect the best organizations and the best organizational practices available for gathering, interpreting and communicating environmentally relevant information"

Unlike previous environmental regulations, which began with command and control approaches, later replaced with ones based on market mechanisms, ISO 14000 was based on a voluntary approach to environmental regulation (Szymanski & Tiwari 2004). The series includes the ISO 14001 standard, which provides guidelines for the establishment or improvement of an EMS. The standard shares many common traits with its predecessor ISO 9000, the international standard of quality management (Jackson 1997), which served as a model for its internal structure (National Academy Press 1999) and both can be implemented side by side. As with ISO 9000, ISO 14000 acts both as an internal management tool and as a way of demonstrating a company's environmental commitment to its customers and clients (Boiral 2007).

Prior to the development of the ISO 14000 series, organizations voluntarily constructed their own EMS systems, but this made comparisons of environmental effects between companies difficult and therefore the universal ISO 14000 series was developed. An EMS is defined by ISO as: "part of the overall management system, that includes organisational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving and maintaining the environmental policy' (ISO 1996 cited in Federal Facilities Council Report 1999).

ISO 14001

The standard is not an environmental management system as such and therefore does not dictate absolute environmental performance requirements (National Academy Press 1999), but serves instead as a framework to assist organisations in developing their own environmental management system (RMIT University). ISO 14001 can be integrated with other management functions and assists companies in meeting their environmental and economic goals.

ISO 14001, as with other ISO 14000 standards, is voluntary (IISD 2010), with its main aim to assist companies in continually improving their environmental performance, whilst complying with any applicable legislation. Organisations are responsible for setting their own targets and performance measures, with the standard serving to assist them in meeting objectives and goals and the subsequent monitoring and measurement of these (IISD 2010). This means that two organisations that have completely different measures and standards of environmental performance, can both comply with ISO 14001 requirements (Federal Facilities Council Report 1999).

The standard can be applied to a variety of levels in the business, from organisational level, right down to the product and service level (RMIT university). Rather than focusing on exact measures and goals of environmental performance, the standard highlights what an organisation needs to do to meet these goals (IISD 2010). Success of the system is very dependant on commitment from all levels of the organisation, especially top management (Standards Australia/Standards New Zealand 2004), who need to be actively involved in the development, implementation and maintenance of the environmental management system (iso14001.com.au 2010). In 2008 there were an estimated 188 000 companies from 155 countries, certified as ISO 14001 compliant (ISO14001.com.au 2010)

ISO 14001 is known as a generic management system standard, meaning that it is applicable to any size and type of organisation, product or service, in any sector of activity and can accommodate diverse socio-cultural and geographic conditions (Standards Australia/Standards New Zealand 2004). All standards are periodically reviewed by ISO and new ones issued (Standards Australia/Standards New Zealand 2004).

Basic principles and methodology

The fundamental principle and overall goal of the ISO 14001 standard, is the concept of continual improvement (Federal Facilities Council Report 1999). ISO 14001 is based on the Plan-Do-Check-Act methodology (Standards Australia/Standards New Zealand 2004) which has been expanded to include 17 elements, grouped into five phases that relate to Plan-Do-Check-Act; Environmental Policy, Planning, Implementation & Operation, Checking & Corrective Action and lastly Management Review (Martin 1998).

Plan – establish objectives and processes required

Prior to implementing ISO 14001, an initial review or gap analysis of the organisation's processes and products is recommended, to assist in identifying all elements of the current operation and if possible future operations, that may interact with the environment, termed environmental aspects (Martin 1998). Environmental aspects can include both direct, such as those used during manufacturing and indirect, such as raw materials (Martin 1998). This review assists the organisation in establishing their environmental objectives, goals and targets, which should ideally be measurable; helps with the development of control and management procedures and processes and serves to highlight any relevant legal requirements, which can then be built into the policy (Standards Australia/Standards New Zealand 2004).

Do – implement the processes

During this stage the organisation identifies the resources required and works out those members of the organisation responsible for the EMS' implementation and control (Martin 1998). This includes documentation of all procedures and processes; including operational and documentation control, the establishment of emergency procedures and responses, and the education of employees, to ensure they can competently implement the necessary processes and record results (Standards Australia/Standards New Zealand 2004). Communication and participation across all levels of the organisation, especially top management is a vital part of the implementation phase, with the effectiveness of the EMS being dependant on active involvement from all employees (Federal Facilities Council Report 1999).

Check – measure and monitor the processes and report results

During the check stage, performance is monitored and periodically measured to ensure that the organisation's environmental targets and objectives are being met (Martin 1998). In addition, internal audits are regularly conducted to ascertain whether the EMS itself is being implemented properly and whether the processes and procedures are being adequately maintained and monitored (Standards Australia/Standards New Zealand 2004).

Act – take action to improve performance of EMS based on results

After the checking stage, a regular planned management review is conducted to ensure that the objectives of the EMS are being met, the extent to which they are being met, that communications are being appropriately managed and to evaluate changing circumstances, such as legal requirements, in order to make recommendations for further improvement of the system (Standards Australia/Standards New Zealand 2004). These recommendations are then fed back into the planning stage to be implemented into the EMS moving forward.

Continual Improvement Process

The core requirement of a continual improvement process (CIP) is different from the one known from quality management systems. CIP in ISO 14001 has three dimensions (Gastl, 2009):

- Expansion: More and more business areas get covered by the implemented EMS.
- Enrichment: More and more activities, products, processes, emissions, resources etc. get managed by the implemented EMS.
- Upgrading: An improvement of the structural and organizational framework of the EMS, as well as an accumulation of know-how in dealing with business related environmental issues.

Overall, the CIP-concept expects the organization to gradually move away from merely operational environmental measures towards a strategic approach on how to deal with environmental challenges.

Benefits

ISO 14001 was developed primarily to assist companies' in reducing their environmental impact, but in addition to an improvement in environmental standards and performance, organisations can reap a number of economic benefits including higher conformance with legislative and regulatory requirements (Sheldon 1997) by utilising the ISO standard. Firstly by minimizing the risk of regulatory and environmental liability fines and improving an organization's efficiency (Delmas 2001), leading to a reduction in waste and consumption of resources, operating costs can be reduced (ISO14001.com.au 2010). Secondly, as an internationally recognized standard, businesses' operating in multiple locations across the globe can register as ISO 14001 compliant, eliminating the need for multiple registrations or certifications (Hutchens 2010). Thirdly there has been a push in the last decade by consumers, for companies to adopt stricter environmental regulations, making the incorporation of ISO 14001 a greater necessity for the long term viability of businesses (Delmas & Montiel 2009) and providing them with a competitive advantage against companies that do not adopt the standard (Potoki & Prakash, 2005). This in turn can have a positive impact on a company's asset value (Van der Deldt, 1997) and can lead to improved public perceptions of the business, placing them in a better position to operate in the international marketplace (Potoki & Prakash 1997; Sheldon 1997). Finally it can serve to reduce trade barriers between registered businesses (Van der Deldt, 1997).

Organisations can significantly benefit from EMS implementation through the identification of large cleaner production projects (e.g. which can drastically cut electricity costs in manufacturing industries). ISO 14001 can be a very effective tool to identify these cost savings opportunities for some organisations. Some other organisations can falter in its planning, lack of senior management commitment and poor understanding of how it should be implemented and find themselves managing an ineffective EMS. Improvements that organisations can take include adequately planning its structure and allocating adequate resources, providing training, creating forums for discussion, setting measurable targets and work according to the philosophy of continuous improvement (Burden, 2010).

Certification

Once a business has fully developed and implemented their ISO 14001 compliant environmental management system, they can choose to apply for certification (also referred to as registration). Certification involves evaluation of the company's EMS system, including a comprehensive on-site audit, to determine whether it meets the ISO 14001 requirements (Martin 1998). If the company conforms to the ISO standard it is issued with a certificate which is generally valid for a period of three years (ISO14001.com.au 2010). In some countries, certification can only be granted by an ISO-accredited Certification Body: ANSI-ASQ National Accreditation Board in the USA, the United Kingdom Accreditation Service in the UK, or the National Accreditation Board in Ireland. Certification auditors need to be accredited by the International Registrar of Certification Auditors. Some countries however allow businesses to self-certify (Martin 1998).

List of ISO 14000 series standards

- **ISO 14001** Environmental management systems—Requirements with guidance for use
- **ISO 14004** Environmental management systems—General guidelines on principles, systems and support techniques
- **ISO 14015** Environmental assessment of sites and organizations
- **ISO 14020** series (14020 to 14025) Environmental labels and declarations
- **ISO 14031** Environmental performance evaluation—Guidelines
- **ISO 14040** series (14040 to 14049), Life Cycle Assessment, LCA, discusses pre-production planning and environment goal setting.
- **ISO 14050** terms and definitions.
- **ISO 14062** discusses making improvements to environmental impact goals.
- **ISO 14063** Environmental communication—Guidelines and examples
- **ISO 14064** Measuring, quantifying, and reducing **Greenhouse Gas** emissions.
- ISO 19011 which specifies one audit protocol for both 14000 and 9000 series standards together. This replaces **ISO 14011** meta-evaluation—how to tell if your intended regulatory tools worked. 19011 is now the only recommended way to determine this.