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ENVIRONMENTAL ASSESSMENT GUIDELINE FOR INDUSTRIES

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Foreword

In 1999, the National Environment Commission published six sectoral environmental assessment guidelines for the mining, roads, industries, hydropower, power transmission lines and forestry sectors. These guidelines were intended to guide different project proponents through the process of acquiring an environmental clearance for their projects. These sectoral guidelines were later revised in the year 2003 to make them more practical and relevant to the Bhutanese context and also to streamline with the provisions of the Environmental Assessment Act 2000 and its Regulation 2002.

The revised sectoral guidelines of 2003 have played a very instrumental role in guiding the proponents and the sector agencies in the Environment Assessment (EA) process. However, these sectoral guidelines were long overdue for revision and through the World Bank IDF grant the guidelines were revisited and proposed for revision. All the relevant stakeholders were consulted several times for this revision and through the expert input from both local and international consultants the guidelines were revised to align with the changing government policies and rules and with the long-term objectives of protecting our pristine environment.

The NEC is grateful to the World Bank for their financial assistance to revise and update these guidelines. The revision and updating of these guidelines were accomplished through close consultation with all the relevant stakeholders. We would also like to express our gratitude and appreciation to all the ministries and stakeholders for their active participation, support and inputs. The NEC would also like to thank the team from the Centre for Science and Environment, New Delhi for their hard work and inputs in updating these guidelines especially Mr. Chandra Bhushan, Mr. Sujit Kumar Singh and Ms. Swati Singh Syambal. We are confident that the revised guidelines will be more useful documents that facilitate and expedite the environmental clearance process.

The environmental assessment process endeavors to mitigate and prevent undesirable impacts of developmental activities. It is in no way intended to hamper socio-economic development in Bhutan but to guide project proponents and sector agencies in making right investments in land, manpower, technology and mitigation measures to ensure that their projects have the least possible impacts on the environment. It's the sincere wish and hopes of NEC that all the stakeholders' make the best use of these guidelines, which in turn will help in protecting our fragile ecosystem. Sound implementation of these guidelines will go a long way in minimizing the negative impacts of developmental activities on Bhutan's environment.

Dr. Ugyen Tshewang
Secretary, NEC

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List of Abbreviations

APs	Affected parties
BAP	Biodiversity Action Plan
BAT	Best Available Technology
BOD	Biological Oxygen Demand
CA	Competent authority
CSE	Centre for Science and Environment
COD	Chemical Oxygen Demand
DM	Demineralisation
EA	Environmental Assessment
EC	Environmental Clearance
EIA	Environmental Impact Assessment
EMP	Environment Management Plan
EHS	Environmental Health and Safety
ETP	Effluent Treatment Plant
FDM	Fugitive Dust Model
HAPs	Habitat Action Plans
LDAR	Leak Detection and Repair

MEE	Multi-effect Evaporator
NEC	National Environment Commission
NOC	No Objection Certificate
NO_x	Oxides of Nitrogen
PAHs	Polycyclic Aromatic Hydrocarbons
PAP	Project-affected Population
PCE	Pollution control equipment
PM	Particulate matter
R&R	Resettlement and Rehabilitation Plan
SAPs	Species Action Plans
SCR	Selective Catalytic Reduction
SNCR	Selective Non-Catalytic Reduction
STP	Sewage Treatment Plant
SO_x	Oxides of Sulphur
CO_2	Carbon dioxide
PAN	Peroxy-acetyl nitrate
TDS	Total Dissolved Solids
ToR	Terms of Reference
TSS	Total Suspended Solids
USEPA	United States Environmental Protection Agency
VOCs	Volatile Organic Compounds

CHAPTER 1

An Introduction to the Industrial sector

1.1 Background

Industrial projects in most countries today require an Environmental Impact Assessment (EIA) study before they are accorded environmental clearance. This holds true for Bhutan as well. It is regulated ***under the Environmental Assessment (EA) Act, 2000 and Regulation for Environmental Clearance of Projects 2002.*** The EA Act and its Regulation establishes procedures for the assessment of potential effects of strategic plans, policies, programs and projects on the environment, and for the determination of policies and measures to reduce potential adverse effects and to promote environmental benefits. According to the EA Act, Environmental Clearance (EC) is mandatory for any project/ activity that may have adverse impact(s) on the environment. The Regulation for Environmental Clearance of Projects 2002 defines responsibilities and procedures for the implementation of the EA Act concerning the issuance and enforcement of environmental clearance. According to the legal framework, the National Environmental Commission (NEC) is the nodal agency for administering and granting Environmental Clearance (EC).

The scope of the guideline is as follows:

- Provide guidance and assistance to various stakeholders involved in the EA process.
- Assist the regulatory agency and EIA practitioners to understand the main areas of concern and use that understanding to enhance the quality of the EIA study and report.
- Inform the regulatory agency and EIA practitioners about the best environmental management practices in the industry sector.
- Assist the regulatory agency to better assess the EIA report and arrive at a sound decision.

1.2 An Introduction to Environmental Impact Assessment (EIA)

According to the United Nations Environment Programme's Division of Technology, Industry and Economics, an EIA is a tool used to identify the environmental, social and economic impacts of a project prior to decision-making. It aims to predict environmental impacts at an early stage in project planning and design, finding ways and means to reduce the adverse impacts, shaping projects to suit the local environment, and presenting options to decision-makers.
An EIA can bring about both environmental and economic benefits, such as reduction in costs and time taken for implementation and design of a project and lesser intervention of

legalities and regulations. A properly conducted EIA lessens conflicts by promoting community participation, informs decision-makers, and helps lay the base for environmentally sound projects (*See Box 1: Integration of EIA in the project cycle*).

1.2 Generic steps in the EIA process

The EIA process comprises of six key steps:

i. **Screening**: This first step helps decide whether an EIA is required for a project. An appropriately designed screening system can prove to be an effective tool to prevent the squandering of time and money on assessing projects with insignificant environmental impacts.

ii. **Scoping**: Scoping is considered the backbone of an EIA process, and is ideally undertaken at the project planning stage. The main objective of the scoping process is to establish the environmental and social priorities, set the boundaries for the study and define the Terms of Reference (ToR). Systematic and well planned scoping forms the basis of an effective and efficient EIA process. It also helps avoid unfocused and voluminous reports. Ideally, the role of scoping is to determine three key issues: a) Site alternatives, b) Design alternatives, c) Justifications for the project

SCOPING HELPS FIND ANSWERS TO QUESTIONS LIKE:

- What are the issues to be addressed?
- How should one proceed with the EIA study?
- What is the extent of the analysis needed?
- What is the infrastructure needed?
- What kind of people should be involved in the assessment?

iii. **Baseline data generation**: Baseline data provides a detailed description of the existing status of various environmental and social components in the study area. Both primary and secondary data is collected to describe this status.

iv. **Impact assessment**: In this step, the characteristics of potential impacts are identified, evaluated and predicted using the baseline information on one hand and the features of the project on the other (cause-effect relationship). Impact predictions are normally done by using common methodologies and models.

v. **Mitigation of impacts**: At this stage, the possible preventive, remedial and compensatory measures for each adverse impact are determined and recommended.

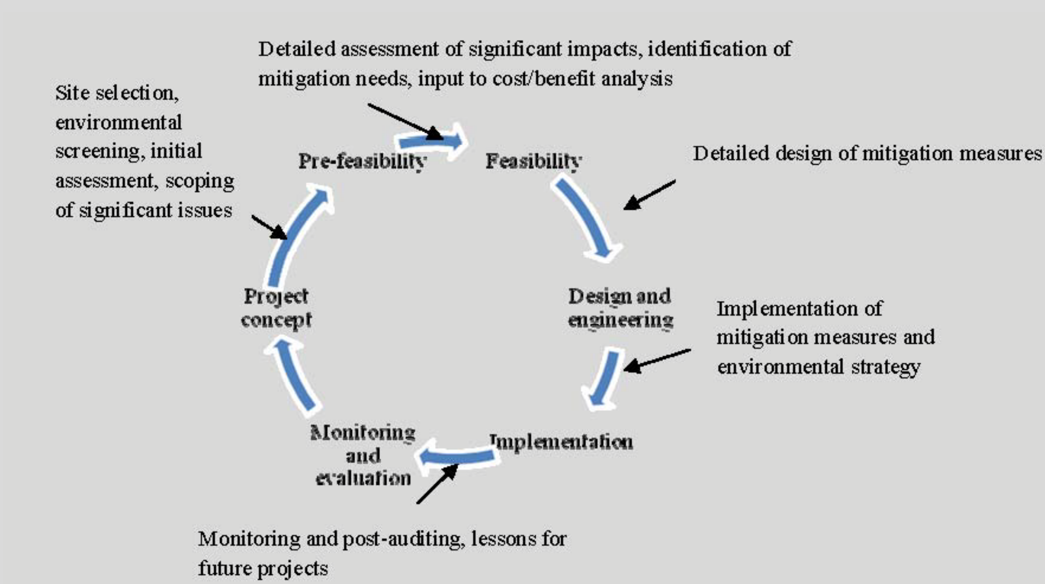
vi. **Environmental Management Plan**: An environmental management plan (EMP), also referred to as an impact management plan, is usually prepared as part of the EIA reporting process. It translates recommended mitigation and monitoring measures into specific actions that have to be carried out by the proponent. Depending upon specific requirements, the plan may be included in the EIA report or can be prepared as a separate document.

Box 1: Integration of EIA in the project cycle

Industrial project development is accomplished in six stages: (1) Project concept (2) Pre-feasibility (3) Feasibility (4) Design and engineering (5) Implementation and (6) Monitoring and evaluation. Environment Impact Assessment plays an important role in every stage of this cycle. Most of the EIA activities take place during the pre-feasibility and feasibility stages. Between project concept and pre-feasibility stage, the EIA process involves site selection, screening, initial assessment and scoping on significant issues. Detailed EIA assessment starts at the project feasibility stage. This includes an evaluation of significant impacts, including the gathering of baseline information, prediction and quantification of impacts, and a review of the EIA by the regulatory agency.

Following these initial steps, environmental protection measures are identified, environmental operating conditions are determined, and environmental management is established. In the last phase of the feasibility study, the monitoring needs are identified, and an environmental monitoring programme and environment management plan are formulated.

Environmental monitoring is designed to generate information on the actual impact due to the project activity, compliance with environmental conditions and the effectiveness of the environmental mitigation measures. The environmental management plan, which describes the mitigation measures, is considered in the project cycle right from the implementation of the project (during construction, operation and maintenance); the plan's aim is to reduce the environmental impacts.



1.3 Good practices in EIA

An EIA should not be used just as a tool for obtaining an environmental clearance; rather, the project implementer should see it as a management tool for sound planning of the industrial project. On the other hand, it should be the responsibility of NEC and the Competent Authorities to ensure that the project causes minimal environmental impacts and brings maximum social and economic benefits.

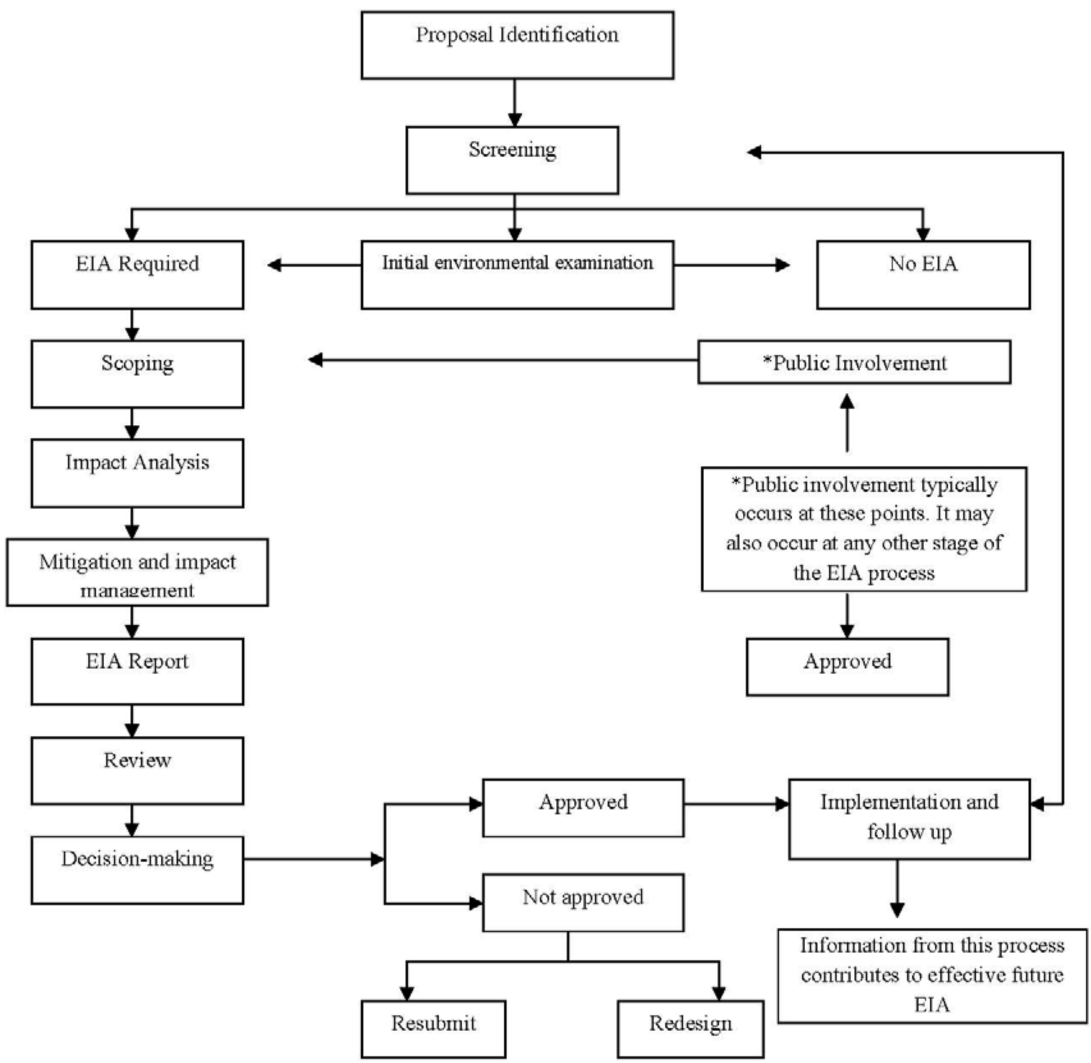
The effectiveness of the EIA process depends on many guiding factors – these include:

- The extent and kind of legal support it is getting in the host countries
- How the EIA is being conducted
- The stakeholders involvement at different stages
- The quality of the EIA report
- Accreditation status of consultants who prepare the EIA report
- Composition and skills of the review committee

As a good practice, it is always recommended to conduct an Initial Environmental Examination (IEE) of the project to determine if it requires an EIA or not. It is also advisable to involve the public from the very beginning from scoping process to the review of the EIA report (*See Figure 1.1: Best Practices in EIA*).It is also recommended to consider the size, scale, site sensitivity and pollution potential while deciding the study area, duration and scope of the EIA study.

Best practices in the EIA process include preparing a report which is comprehensive and focused, and contains only the significant parameters instead of data and information which are irrelevant to the overall assessment of the project. The extent of the assessment required should be decided after careful examination of likely impacts on the environmental and existing socio-economic settings at the project site.

Figure 1.1: Best practices in EIA



1.4 Environmental and socio-economic impacts of an industrial project

The environmental and social impacts of an industrial development project begin right from the construction phase and increases in manifold during the operational phase. If the project operations are not monitored and regulated properly, then, there may be some environmental and social impacts, which may extend beyond the project's decommissioning.

In any industrial development project the scale of impacts will depend on the nature of project, location sensitivity and the scale of project. Air pollution is caused due to the release of emissions from the manufacturing processes, storage yard and utilities. Land environment gets affected due to the disposal of liquid, solid and hazardous materials and wastes. Industrial development projects also cause significant impact on socio-economic environment, if the project requires large land areas for the project. Therefore, issues of displacement and loss of livelihood are key concerns, especially if the projects are proposed in populated areas. Moreover, if the land requirement is large, concerns such as impacts on biodiversity or changes in land use patterns also become significant (S*ee Table 1.2: Potential impacts of an industrial development project during project operation).*

Just as two different industrial projects are not completely identical in operation, process and environmental impacts, industrial projects are also not identical in terms of pollution potential. Some industries are reckoned as water polluting, some are air polluting, some are hazardous waste generating or some are a combination of these. However, there are some impacts, which are almost similar in all projects irrespective of the type of development (*See Table 1.1: Potential impacts during the construction phase).*

Table 1.1: Potential impacts during the construction phase

Activities/Issues	Potential Impacts
Land acquisition	• Displacement and loss of livelihood. • Loss of common properties. • Loss of cultural heritage • Loss of productivity of land • Impacts on indigenous people, if applicable.
Site clearing/deforestation	• Change in land use pattern • Land degradation • Landslides due to slope failure. • Erosion and loss of topsoil • Siltation of water bodies • Loss of natural habitat and habitat fragmentation. • Impact on flora and fauna • Loss or change of local ecosystems.
Civil works such as earth moving and building of structures	• Dust pollution • Generation of wastewater and site runoff. • Increase in sediment load in the nearby water bodies • Noise pollution

	• Loss of scenic value of the landscape
Emissions from heavy equipment operation	• Air pollution • Noise pollution • Effects on health of workers and local residents
Disposal of construction wastes	• Water pollution • Effects on health of workers and local population
Noise from heavy equipment operation	• Noise pollution • Annoyance for workers and local population
Influx of construction workers	• Pressure on local resource. Increased demand on the existing infrastructure, electricity, water and energy. • Generation of sewage. • Risk of spread of communicable diseases.

Source: Industry& Environnent Unit, Centre for Science & Environnent, 2012

Table 1.2: Potential Impacts of an industrial development project during project operation

Activities	Impacts
Emissions from combustion, processes and utilities	***Point source emission:*** • Particulate emission. • Release of gaseous pollutants (SOx, NOx, VOCs) and toxic gases. • Emissions of heavy metal. • Reduces visibility. • Green house gas emissions (CO_2) • Induces secondary pollutants such as formation of photochemical smog and PAN (peroxy-acetyl nitrate). • Odour and nuisance. • Ecological toxicity and health impacts. • Dust fumes of Cu, Zn (from Non ferrous metallurgical processes) **Non-point source emission (fugitive dust):** • Fugitive emissions during loading, unloading, transportation and storage of raw materials and product.
Water resource	• Ground and surface water depletion. • Change in physical and chemical characteristics of the surface and ground water such as increase in turbidity, increase in organic load, change in colour, change in temperature due to effluent discharge, etc. • Contamination of river, streams, lake, ponds, etc • Decrease in ecological productivity of the receiving water • Metal toxicity(i.e. mercury, cadmium, lead, chromium, arsenic, etc.) • Contamination of water leads to causes diarrhoea, skin irritation etc.
Noise hazards	• Occupational hazards and causes annoyance to the local community
Solid and hazardous wastes	• Impact on the environment - rivers, scenic areas, and roadsides.

	• Aesthetic impact. • Odour and nuisance. • Contamination of land and ground water due to leaching of heavy metals and organics. • Risk of corrosion and fire/explosion in case of corrosive and flammable substance. • Health impact due to poor management of waste.
Risk/disaster	• Onsite/offsite risk such as electrical, fire, explosion, process risks, release of toxic, fall from height and release of harmful chemical gases. • Road safety hazards.
Traffic	• Congestion/increased pressure on local roads.

CHAPTER 2

Scoping

2.1 Introduction

The primary function of scoping also referred to as setting the Terms of Reference (ToR) of an EIA, is to establish the environmental priorities and to set the boundaries for the study. The objective of the ToR is to make the assessment process concise and focused, and avoid creating a voluminous or data deficient report. The ToR provides the benchmark for data collection and limits the possibility of inefficiency in the EA process. It is also acts as a benchmark to be used by the Competent Authority/NEC to decide whether the EIA report has been compiled after meeting all the requirements or not.

There are various tools that can be used for scoping, such as ***questionnaire checklists, network method, comparison with other similar projects, matrix and ad-hoc methods, etc***. The selection of scoping tools largely depends on the size of the project and the existing environmental and social characteristics of the project area.

The ToR given below is a generic one and can be framed as per the project requirements. While framing the ToR, ground realities, background information of the study area (such as population in and around the project site), project-specific peculiarities, applicable laws, rules, guidelines and policies need to be considered to make the ToR relevant and precise. There may be a possibility that some parts of ToR are not applicable for a given project. A site visit is also recommended before framing the ToR; this enhances the scope of the EA process and makes it more efficient.

2.2 Terms of Reference (ToR) for an industrial project

The ToR should include the following conditions, details and components:

2.2.1 General information

- Executive summary of the project, which summarises the project characteristics, environmental and social issues, and the proposed mitigation measures.
- Information about the project proponent and his/her experience with following details (a) Name of the project (b) Name of the applicant (c) Present mailing address including telephone number, fax, and email (if any) (d) Name of the environmental focal person (e) Telephone number of environmental focal person
- The justification for the project.

- Project financial statement, project benefits and the project activity schedule.
- Name of organization/consultant preparing the EIA report, qualifications and experience of experts involved in the EA assessment and report preparation.
- List of all regulatory approvals and No Objection certificate (NOC) required for the project and the status of these approvals.
- A declaration from the consultant stating that the information disclosed in the EIA report is correct.

2.2.2 Essential maps for EA of an industrial project

- A map specifying the location of the project.
- A study area map indicating features such as locations of human settlements, locations of other industries or other air and water polluting sources.
- A map specifying the land use patterns of the project site and study area.
- A map marking the sensitive zones in the study area, such as forests, defence installations, international border, protected area etc.
- A contour map at 2 or 3 m interval of the plant site and study area.
- A map clearly delineating the locations of various monitoring stations (ambient air, water, noise and soil).
- The layout map of the plant showing the production unit, storage of raw materials/products, stacks, wastewater treatment plant, administrative buildings, canteen, proposed green belt, transportation route, roads, parking spaces and infrastructure including all utilities, such as fuel-filling station, power supply, water supply etc.
- Diagrammatic sketch and layout of the effluent treatment plant (ETP) and the sewage treatment plant (STP), if any
- A map indicating the flood ability of the area, if applicable.
- A layout map showing the solid and hazardous wastes disposal site, if applicable.
- A map showing the wastewater discharge points.

Note: Depending upon the type, size and location sensitivity, NEC can decide the study area and recommend appropriate scale for Environmental Assessment.

2.2.3 Project description

The manufacturing process and resource consumption

- Details of the manufacturing process with flow charts, the technology to be used, installed capacity, and the products to be manufactured and details of generation of by-products, if any. The EA should justify the selection of the technology with reference to resource conservation (energy and water) and pollution potential. The project proponent should provide certification of existing technologies, *wherever applicable*.

- List of raw materials to be used in the manufacturing process, their daily consumption, sourcing, and methods of storage.
- List of hazardous chemicals, toxic or inflammable substances (including carcinogenic materials) to be used in the process, their quantities and storage methods. The material safety data sheet of each individual hazardous chemical/solvent should be annexed with EIA report. Justification for use of any known carcinogenic or toxic chemicals/solvents in the process. If substitution/alternatives are not possible, then the detailed mitigation plan to reduce exposure risks.
- Mass balance to be provided, along with the quantitative details of inputs and potential wastes (liquid, solid and gaseous) to be generated, and their characteristics and quantities, if applicable.
- Description of utilities and services, their capacities, raw material requirement and pollution potential.
- Steam balance, including the quantity and type of fuel used, if applicable.
- Details of energy sourcing and requirement: If a captive power plant is proposed, the EIA report should provide the following details: Installed capacity, daily or annual fuel consumption, pollution potential and its management plan.
- If a Demineralization (DM) plant is used, then the details of quantity of DM water produced, chemical requirement, its handling and management, quantity and characteristics of DM plant wastewater and the treatment method for the same, if applicable.
- Details of water balance of the entire plant: This will include sourcing of water, quantities sourced, daily water consumption in kilolitres per day (including a break-up under heads such as process, domestic, cooling and others), quantity of effluents generated, and quantity of wastewater recycled/reused and discharged.
- Details of the workforce (administrative, production and environment and safety) to be employed in the project and the factory operating hours.

2.2.4 Activities for site preparation

Information on existing land use patterns in the study area

- Area acquired for the proposed project and the land use patterns at the project site and study area, with explanatory notes.
- Justification for the site selection, with explanatory notes.
- Land ownership patterns of the acquired land.
- Details of the topography of the study area.

- Details of water bodies such as lakes, streams, natural drains and rivers in the study area and their distances from the project site.
- The boundaries of the nearest human settlement and its distance from the project site.
- The flood plain boundary and flood ability of the area: The project proponents should prepare flood hazard zonation mapping (scale 1:5000 to 1; 10,000) scale indicating the peak and lean river discharge as well as flood occurrence frequency, if applicable.
- Presence of sensitive areas (if any) such as forests, national parks, historical or archaeological sites, residential areas, parks or playing fields, tourist resorts etc in the study area and their distances from the project site.

2.2.5 Baseline data

- *Data on ambient air quality:* This should include parameters such as PM_{10} and gaseous pollutants, and site-specific information on existing meteorological conditions such as temperature, humidity, rainfall and wind speed and direction.
- Details of forest land to be diverted (if applicable).
- Detailed information on existing natural drainage/run-off patterns at the project site, wherever applicable.
- Ambient noise data at the project site, including the processes/operations that are likely to generate noise including potential areas likely to be affected by noise as this is crucial from the occupational health point of view.
- Information on estimated quantity and quality of effluents to be generated – quality of both treated and untreated effluents: The data should include information for parameters like Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solids (TSS), Total Dissolved Solids (TDS), heavy metals and toxic chemicals (if applicable).
- In case treated effluents are disposed off in water bodies such as rivers or natural drains, then the water characteristics of the receiving water bodies, including the lean period flows -- details of downstream competitive users (including quantity) should also be provided, if applicable.
- If treated effluent discharged in the river, the lists of aquatic flora and fauna present in the river.
- Information on probable sources of stack emissions (including power plant, if applicable) – the number of stacks, their diameter, exit temperature and flow rates, and the proposed pollutant concentration from the stacks.
- Information on potential sources of air pollution, including fugitive emissions from processes, storage sites and ETPs and other sources that may generate fugitive dust.

- Details of the quantity of solid/hazardous wastes likely to be generated from utilities, processes and pollution control facilities -- in case of hazardous wastes, information is needed on waste characterisation.
- Details of the total length of the conveyor belt, if applicable, including the number of transfer points and dust suppression measures at the transfer points..
- Characteristics of topsoil, its thickness and estimates of total quantity of topsoil to be produced during land clearing; the EIA report should discuss the management plan for topsoil conservation and utilisation in the EMP.
- A detailed survey report and list of biodiversity (flora and fauna) in the study area, including at the project site, *if applicable*.
- Surface and sub-surface water characteristics in the study area.
- Baseline data on the health status of local communities and common diseases prevailing in the area, applicable when a project is proposed in an air-polluted area, if applicable.
- Studies on amount of CO_2 emissions per tonne of product and future plans to reduce the emissions, applicable for CO_2 generating industries.
- *Traffic:* Mode of transportation of raw materials and products
- Details of existing socio-economic status of the study area such as population density, human population close to the plant, economic profiles, literacy rates, common diseases, and infrastructure facilities available in the study area (such as conditions of roads, hospitals, educational institutes, water supply and sanitation) including displacement due land acquisition, if applicable.

2.2.6 Impact assessment

- Impacts of the construction phase of the project on ambient air, water, existing infrastructure and social structure.
- Impacts of point source and fugitive emissions on the ambient air quality, workers and local community.
- Impacts of the project on water availability and quality of ground and surface water resources – if the project discharges its effluents into surface water bodies such as rivers, then the impact of this discharge on the quality of the receiving medium and its aquatic life.
- Impacts of noise on workers and the local community.
- Impact of solid and hazardous wastes on land and water.
- Impact of mode of transportation of raw materials and products on existing traffic scenario and infrastructure.
- Impact of project on biodiversity: terrestrial and aquatic ecology.
- Socio-economic impacts of the project.

2.2.7 Risk assessment

- Identification of risk-prone areas based on potential risks and mitigation measures for the same.
- Identification of processes/operations that have the potential to impact onsite/offsite emergency, if applicable.
- A plan for emergency preparedness and a budget for ensuring safety and occupational health of workers and local community.

2.2.8 Mitigation and Environment Management Plan (EMP)

The EMP should discuss the mitigation measures to be taken against each impact, the timeline for completion, the responsible departments for implementation, the budget, post-monitoring provisions and the process of reporting to the concerned regulatory authority.

- Proposals for environmental management during initial stage of project construction, e.g. erosion and sediment control systems, noise and dust mitigation strategies, etc.
- Details of water pollution control, including justification of selection of treatment schemes, design criteria, size of treatment units and final discharge characteristics; tentative costs of the treatment plant, recurring expenditures and details of reuse of treated wastewater and efficiency of the wastewater treatment plant (the treated wastewater should confirm to prescribed national standards).Project proponent should also explore the possibility of zero discharge.
- Information on air pollution control technology for reducing point source emissions, including justification of the selection of pollution control equipment (PCE), technical specifications of the PCE, its efficiency, tentative costs, recurring expenditures including the height of the stacks with justification. Information on air pollution control technology for reducing point source emissions including height of the stacks. Also indicate the measures adopted for controlling fugitive emissions (Volatile Organic Compounds-VOCs). The report should also discuss how efficient these measures are and the budget set aside.
- Detailed management plan to reduce fugitive emissions during raw material and product handling, loading/unloading operations, transportation and storage -- this should be provided along with proper timelines and budgets. The project should also discuss the levels of mechanization incorporated in raw material and product handling, to ensure fugitive emissions remain well within the permissible limit.
- Provisions for covered storage yards for raw materials and products.
- Provisions for covered conveyor, bucket elevators or pneumatic transportation, wherever applicable.

- At the layout stage, care should be taken to minimize the number of transfer points, if applicable. The EMP should also discuss the provision for dust suppression at the transfer points.
- Details of mitigation measures for noise control, including noise abatement from equipments, operations and traffic.
- Technical description of the incinerator, characteristics of wastes to be incinerated, type of pollution control equipment and disposal methods of the ash residue, if applicable
- Illustration of the solvent recovery mechanism (if applicable), including recovery efficiency with respect to solvent consumption.
- Detailed management plans to improve the road network or existing roads to meet the projected traffic densities.
- Details of energy and water conservation measures, including budgets and schedules of completion.
- A detailed mitigation plan for biodiversity protection and conservation (if the project is likely to impact biodiversity).
- Detailed management plan for solid and hazardous wastes from the process, from wastewater treatment plant, including budgets and schedules of completion; information on design, including leachate collection and treatment systems, in case a hazardous waste disposal facility is proposed at the project site, if applicable.
- Mitigation measures to prevent land and water contamination from the chemical storage site.
- If any known carcinogenic chemicals/solvents are used and their substitution is not possible, then a detailed mitigation plan to minimize exposure risks.
- Details of the plant storm water collection and treatment system -- mitigation measures for storm water is crucial, especially if there is a river, agricultural land or a sensitive area adjoining the manufacturing plant.
- A flood management plan to protect the plant and surrounding areas, if applicable.
- Details of the plan for green belt development, including a diagrammatic sketch of the layout of the plant showing the proposed green belt with the tree density (i.e. number of trees/hectare).
- Details of the parking spaces, and provision for canteen and rest rooms for workers and drivers.
- Road safety measures planned to reduce road accidents.
- Best practices such as colour coding and labelling cleanliness to ensure safety and environmental compliance.
- The organizational set-up and requirement of manpower for environmental, health and safety management, including clear responsibilities.
- Documentation of impacts that cannot be mitigated, with proper reasons.

- Frequency of training and awareness programmes on environment and safety, and the annual budgets allocated for them.
- A water assistance plan for the local community, in case it is affected by pollution or scarcity of water resources due to the plant's operations, if applicable.
- Monitoring and establishment of lab facility for air, water, and noise study.

2.2.9 Mitigation and EMP for socio-economic impacts

- *Preparation of a resettlement and rehabilitation plan (R&R), if displacement is involved:* The plan should include details of the compensation provided, including land-for-land compensation, employment or money; provisions at the resettlement colony (such as basic amenities including housing, educational facilities, infrastructure and alternate livelihood potential); a clear timeline for implementation; responsibility; budgets; grievance mechanism, etc.
- Public consultation issues raised and commitments made by the project proponent on the same should be included separately in EA/EMP Reports in the form of tabular charts.
- The R&R plan should assess and take into consideration the impact of displacement on women and vulnerable communities such as landless labourers, tribal, etc., and prepare a detailed management plan to improve their status.
- A detailed compensation package for the community that is likely to lose its livelihood.
- Detailed EMP for improving and enhancing socio-economic conditions in and around the project site and the budgetary provisions.

CHAPTER 3

Impact Assessment

3.1 Introduction

The scientific and technical reliability of an EA study depends on the skills of the EA practitioners/reviewers, who estimate and review the nature and magnitude of the environmental change that the proposed project may entail. Impact prediction and evaluation is a vital exercise for assessing impacts, deciding alternatives, setting down mitigation measures and developing an environmental management plan. Predicting the magnitude of impacts and evaluating their significance is the core exercise of impact assessment. This process is also known as impact analysis and can be broadly broken down into three overlapping phases:

- *Identification*: To specify the impacts associated with each phase of the project and the activities undertaken
- *Prediction:* To forecast the nature, magnitude, extent and duration of the main impacts; and
- *Evaluation:* To determine the significance of residual impacts after taking into account how mitigation will reduce a predicted impact.

In assessing environmental impacts and their significance, some key concerns have to be kept in mind:

- Identity who or what is affected
- Description of how they are affected
- Evaluation against a set of consistent assessment criteria

Normally, in impact assessment, potential impacts can be categorized into various parameters ranging from its type and nature to magnitude and reversibility, each signifying its importance in impact prediction and decision making (*See Table 3.1: Parameters which determine impact characteristics*).

Table 3.1 Parameters which determine impact characteristics

Parameters	Description
Type	Positive or negative
Nature	Direct, indirect, cumulative
Magnitude or severity	Low, moderate, high
Timing	Short term, long term, intermittent, continuous
Duration	Temporary/permanent
Reversibility	Reversible/irreversible
Significance	Local, regional or global

Source: *EIA Training Resource Manual*, Second Edition 2002, United Nations Environment Programme (UNEP), p 263

Industrial projects have several environmental impacts, which have already been discussed in *Section 1.5Environmental and socio-economic impacts of industrial projects*. There are also some socio-economic and cultural impacts, which local communities feel most acutely in their everyday lives. It is, therefore, necessary that these impacts are given the prominence they deserve in the EA study, while describing the changes expected to result from major development projects. A consideration of socio-economic and cultural impacts should be integrated, wherever possible, into every discussion of physical and biological changes and not just treated separately as a minor issue.

3.2 Impact identification

In the EA of an industrial project, the potential impacts are globally well documented, and do not normally require extensive impact identification. However, there are some impacts such as displacement, loss of livelihoods, influence of topography and meteorology on water and air pollution, feasibility with respect to land use, geological characteristics, other sensitive receptors such as forest/biodiversity etc., which are site-specific and can only be identified once the data on them is available or generated. There are various tools that can be used for impact identification, such as questionnaires, checklists, network method, comparison with other similar projects, matrix and ad-hoc methods.

To ensure effective impact identification, one should always opt for a simple, logical and systematic approach. As a good practice in EA, it is always recommended to consider all potential project impacts and their interactions. At the same time, it is important to ensure that indirect and cumulative effects which may be potentially significant are not unintentionally omitted. All the identified impacts may not require a detailed analysis and evaluation – the level of detailing should match the scale, sensitivity and complexity of the impact. The choice of the chosen methodologies should reflect these criteria.

3.3 Impact prediction

Predictions of impacts are normally based on commonly used qualitative and quantitative methods and models. Expert judgment and comparison with similar projects can also be used for impact prediction. While there are a number of models for predicting impacts on physical environment (air, water and noise), modeling socio-economic and cultural impacts is difficult and is generally done through qualitative assessment or economic analysis. A model can be effective only if the input data is correctly inserted. The use of models, therefore, should be done with care and prudence considering factors like availability and reliability of data.

The sophistication of the prediction methods to be used should be kept in proportion to the 'scope' of the EA. For instance, a complete mathematical model of atmospheric dispersion should not be used if only a small amount of relatively harmless pollutants is emitted. However, if the project has very high air pollution potential then all possible modeling exercises should be done to predict the impact on ambient air quality.

All prediction techniques involve assumptions and uncertainties. While quantifying and stating an impact, these assumptions should be clearly identified. Also, uncertainty of prediction in terms of probability and the margins of error should be mentioned. *Table 3.2* gives the list of general prediction models/methods used for assessing the impact of industrial projects.

Note: *For small industrial projects, instead of using sophisticated models, the focus should be on mitigation measures and EMP.*

Table 3.2: General models/methods used for impact prediction

Impacts	Assessment method/model
Air quality(if applicable)	Air dispersion models • **ISCST 3** (appropriate for point, area and line sources; applicable for flat or rolling terrains; requires source data, meteorological data and receptor data as inputs). Note: *ISCST 3 is a common model widely used in India for the air pollution modelling* • **PTMAX** (screening model applicable for a single point source; computes maximum concentration and the distance of maximum concentration occurrence as a function of wind speed and stability class). • **PTDIS** (screening model applicable for a single point source; computes maximum pollutant concentration and its occurrence for the prevailing meteorological conditions; requires average meteorological data (wind speed, temperature, stability class etc.); used mainly to see the likely impacts of a single source. • Fugitive dust model (FDM)

Soil erosion(if applicable)	• Soil loss models such as revised universal soil loss equation (RUSLE)
Floods (if applicable)	• Peak flow hydrograph for rainfall-runoff events in large river basins or small urban watersheds • HEC-HMS • FLO-2D • TUFLOW
Ecology(if applicable)	• Ecological models • Comparative evaluation of conservation value • Expert opinion
Land use(if applicable)	• Map overlay techniques • Comparative valuation against structure and/or local plans
Noise, (if applicable)	• *Dhwani:* For prediction of impacts due to multiple noise sources, developed by NEERI, Nagpur, India • SoundPLAN: Noise and air pollution planning and mapping software • FHWA (Federal Highway Administration): Noise impact due to vehicular movement on highways
Socio-economic, (if applicable)	• Cost-benefit analysis • Metaphors and analogies: Experience gained in similar kinds of projects is used to predict the socio-economic impacts. • Extrapolative methods: Prediction based on the linear extrapolation of current trends. • Normative methods: Desired socio-economic goals specified, and an attempt made to project the social environment backwards in time to examine whether existing or planned resources and environmental programmes are adequate to meet the goals.
Potential risk and disaster	• Risk assessment

3.4. Impact evaluation

In impact evaluation, the predicted adverse impacts are judged for their significance. Therefore, the criteria for evaluating the significance of impacts and their effects should be set in advance (*See Box 2: Impact evaluation criteria*). The criteria for evaluating the significance should be based on local standards wherever possible. Where local standards are not available, acceptable international standards should be used (e.g. IFC, WHO or USEPA standards and guidelines of others countries, etc.). In all cases, the choice of the appropriate standard must be robust, defensible and relevant to the local situation. If there are no appropriate existing standards available, then the criteria should be developed and their use must be clearly explained in the EA. As a good practice in impact evaluation, it is better to use established procedures or guidelines, or relevant criteria which are comparable. While doing impact evaluation, it is equally important to understand the nature and characteristics of impacts on potential target areas, such as air, water, land, human beings, etc. to understand the significance, importance and intensity (*See Box 3:Possible evaluation criteria for determining impact significance*). It is also essential to find out the answers to the following three questions:

- Are there residual environmental impacts?
- If yes, are these likely to be significant?
- If yes, are these significant effects likely to occur? Is the probability high, moderate or low?

Box 2: Impact evaluation criteria

- Comparison with laws, regulations or accepted national or international standards.
- Consistency with international conventions or protocols.
- Reference to pre-set criteria such as conservation or protected status of a site, features or species.
- Consistency with government policy objectives.
- Comparison with best practices
- Existing environmental and social stress in the area.
- Extent of impact on biodiversity.
- Acceptability to local community or general public.
- Severity of the impact (reversible or irreversible).

Box 3: Possible evaluation criteria for determining impact significance

- No impacts
- No significant impacts without or with available and practicable mitigative measures
- Impacts, but significance not quantifiable
- Significant impacts even with available and practicable mitigation measures

CHAPTER 4

Mitigation and Environmental Management Plan (EMP)

4.1 Introduction

Mitigation is the process of providing solutions to prevent impacts, or reduce them to acceptable levels.

The objectives of mitigation are:

- To enhance the environmental and social benefits of a proposal;
- To avoid, minimize or remediate the adverse impacts; and
- To ensure that the residual adverse impacts are kept within acceptable levels

A good industrial project should incorporate environmental and social alternatives at the initial stages of project development. However, there are some which can be managed only after impact identification and prediction.

Mitigation measures can be classified into structural and non-structural measures.

- ***Structural measures*** include design or location changes, engineering modifications and construction changes, landscape or site treatment, mechanization and automation, etc.
- ***Non-structural measures*** include economic incentives, legal, institutional and policy instruments, provision of community services and training and capacity building. Non-structural measures are increasingly being used now. They can be applied to reinforce or supplement structural measures or to address specific impacts.

An Environmental Management Plan (EMP) is a framework for the implementation and execution of mitigation measures and alternatives. It usually covers all phases of the project, right from pre-construction to the operation and maintenance phases of the industrial project. The plan outlines mitigation measures that will be undertaken to ensure compliance with environmental laws and regulations and to eliminate adverse impacts. The objectives of an EMP, thus, are:

- To ensure that mitigation measures are implemented
- To establish systems and procedures for this purpose
- To monitor the effectiveness of mitigation measures
- To ensure compliance with environmental laws and regulations
- To take any necessary action when unforeseen impacts occur

The EMP outlines:

- The technical work schedule to carry out the mitigation, including details of the required tasks and reports and the necessary staff skills and equipment;
- Detailed accounting of the estimated costs to implement the mitigation plan; and
- Planned operations or implementation of the mitigation plan, including a staffing chart and proposed schedules of participation by the members of the project team, and activities and inputs from various government agencies.

The EMP should also address the formation of a monitoring committee, with the objective of finding out whether different pollution-related issues and social development programmes related to health, education, roads, infrastructure, employment etc., are keeping to the time schedule or not. In case of a delay, the reasons for the delay need to be identified and suggestions made for removing them.

EMP and post-project monitoring

A good Environmental Management Plan should contain the following:

- A summary of all potential impacts.
- A detailed description of recommended mitigation measures.
- A time-line for implementation of mitigation measures.
- Resource allocation and responsibilities for implementation
- A programme for surveillance, monitoring and auditing.
- A statement of compliance with relevant standards.
- A contingency plan when the impacts are greater than expected.

An EMP should also incorporate a monitoring plan that is carefully designed and is related to the predictions made in the EA and to key environmental indicators. The EMP should also outline the need for monitoring, its duration and reporting procedures. The programme for surveillance, monitoring and auditing should clearly identify the following:

- Parameters for monitoring all significant impacts, including impacts on bio-diversity and socio-economic impacts
- Monitoring locations, including sample surveys, to assess the socio-economic impacts
- Frequency of monitoring
- Reporting frequency to the regulatory agency
- Provision for annual environmental and social audit of the project

4.2 Mitigation measures and EMP for an industrial project

Many environmental and social impacts in case of an industrial project can be avoided by appropriate site selection. In most cases, site selection is governed by presence of raw material, labour and market. However, in case of the significant impact on environment or people, there is always an option of changing the site in this sector.

The technology used in the manufacturing process also has significant impact on the environment, especially with respect to pollution generation and resource consumption. The reviewer should encourage and ensure implementation of the Best Available Technology (BAT) for pollution control and abatement. For instance, Total Dissolved Solid (TDS) containing wastewater is reluctant to physical and biological treatment methods – hence, based on the water quality appropriate treatment should be suggested such as:

- Preference to technologies which do not generate TDS such as substitution of raw materials.
- Use of technologies, which remove TDS at the end of pipe, such as multi-effect evaporator (MEE) or reverse osmosis (RO).

As mentioned, consideration of alternatives be it raw material, technology or site – should be given serious consideration in preparation of a mitigation plan.

4.2.1 Mitigation measures during pre-construction stage

There can be considerable environmental impacts during the construction phase — mainly due to civil works such as site preparation, heavy earthmoving vehicle movement, site level rising, RCC foundation, etc. Construction phase impacts are usually temporary and a localised phenomenon, except the permanent changes they might introduce in the local landscape and land use patterns at the project site. However, these impacts should be given due consideration wherever applicable and detailed protocol/procedures should be implemented to prevent/mitigate the adverse impacts and occupational hazards. These include:

- Provision of continuous water spray in case of un-metalled roads or where there is a likelihood of fugitive dust emission.

- Use of personal protective devices, such as earplugs and masks, to mitigate occupational health hazards must be encouraged.

- The construction site should be provided with mobile toilets, safe drinking water, medical facilities, etc. for the workers.

- The approach roads to the project site should be widened to facilitate vehicular traffic.

- Noise-prone activities should be restricted in the night, particularly during the period between 10 PM and 6 AM, in order to have minimum environmental impacts.

- The green belt area should be delineated before the start-up of the earthwork; tree plantation should be done in this area so that the trees can grow to a considerable size by the time of the commissioning of the proposed project.

4.2.2 Mitigation measures for land

- Land clearing activities should be minimal.
- Removing vegetative cover only from the specific site on which construction is to take place would check the impact of soil erosion.
- Removed soil should be used immediately in horticulture and gardening.
- In case the manufacturing facility is close to a catchment area and receives heavy rainfall, there is potential to affect the river due to run off from the plant site. In such a case, if it is not possible to go for an alternative, then following mitigation measures are recommended to reduce the impacts:

    a. The plan for catchment and site treatment should be formulated on the basis of natural drainage and run-off.
    b. The locations of the ETP, waste storage site and disposal area should be adjusted on the basis of site contour.
    c. Storm water drains should be constructed all around the plant.

4.2.3 Mitigation measures for protection and conservation of sensitive locations

An alternative site is the best option for avoiding impacts on sensitive locations (such as forests, wildlife sanctuaries, rivers, lakes, ponds, national parks, archaeological sites, etc.). If an alternative site is not available, then the following measures are recommended:

- Buffer strips should be maintained between the project and the sensitive locations.
- Conservation plans should be prepared by experts in case of biodiversity-rich areas.
- Top priority should be accorded to enforcement and monitoring of impacts.
- In case the unit discharges its effluent in a river, it should take care the discharge does not affect the aquatic flora and fauna. If river flow is less during summer, plant should make other arrangements for disposing its effluent.

- Incorporation of best technology for air pollution control and adequate greenbelt development.
- Enforcement of stringent air emission standards.

4.2.4 General air pollution control measures: For the mitigation of air pollution refer *Table 4.1*: *Air pollution control measures.*

Table 4.1: Air pollution control measures

Pollutant	Source	Mitigation
Particulate matter (PM)	Main sources are the combustion of fossil fuels and numerous manufacturing processes	• Fuel switching • Height of the stacks should be optimum to ensure easy dilution and dispersion of pollutants. • Various control options: a) Fabric Filters- Applicability depends on flue gas properties including temperature (dry gas, <400F), chemical properties, abrasion and load. Typical air to cloth ratio range of 2.0 to 3.5 cfm/ft^2. Achievable outlet concentrations of 23 mg/Nm^3 **(99% efficiency)** b) Electrostatic Precipitator (ESP) - Precondition gas to remove large particles. Efficiency dependent on resistivity of particle. Achievable outlet concentration of 23 mg/Nm^3 **(97-99% efficiency)** c) Cyclone- Most efficient for large particles. Achievable outlet concentrations of 30 – 40 mg/Nm^3 **(74-95% efficiency)** d) Wet scrubber- Achievable outlet concentrations of 30 - 40 mg/Nm^3 **(93-95% efficiency)**
Fugitive dust	Loading, unloading, transport and open storage of solid materials; from exposed soil surfaces, including unpaved roads	• Use of dust control methods, such as enclosures, water suppression, or increased moisture content for open materials storage piles, including air extraction and treatment through a baghouse or cyclone for material handling sources, such as conveyors and bins • Use of water suppression for control of loose materials on paved or unpaved road surfaces *(See Table 4.2: Fugitive Emissions Controls and their efficiency).*
SO_2	Mainly produced by the combustion of fuels such as oil and coal and as a by-product from some chemical production or wastewater treatment processes.	• Control system selection is heavily dependent on the inlet concentration. a) For SO_2 concentrations in excess of 10%, the stream is passed through an acid plant not only to lower the SO_2 emissions but also to generate high grade sulphur for sale. b) For levels below 10%: **Absorption or 'scrubbing**,' where SO_2 molecules are captured into a liquid phase or adsorption, where SO_2 molecules are captured on the surface of a solid adsorbent. • Other control options are: a) Fuel switching (>90% efficiency): Alternate fuels may include low sulphur coal, light diesel or natural gas with consequent reduction in particulate

		emissions related to sulphur in the fuel. Fuel cleaning or beneficiation of fuels prior to combustion is another viable option but may have economic consequences b) Sorbent injection (30-70% efficiency): Calcium or lime is injected into the flue gas and the SO_2 is adsorbed onto the Sorbent c) Dry flue gas desulfurization (70-90% efficiency) d) Wet flue gas desulfurization (>90% efficiency): Produces gypsum as a by-product
NOx	Associated with combustion of fuel. May occur in several forms of nitrogen oxide, namely: nitric oxide (NO), nitrogen dioxide (NO_2) and nitrous oxide (N_2O), which is also a greenhouse gas.	• Means of reducing NOx emissions are based on the modification of operating conditions such as minimizing the resident time at peak temperatures, reducing the peak temperatures by increasing heat transfer rates or minimizing the availability of oxygen *(See Table 4.3: NOx prevention and control technologies)*
VOC	Equipment Leaks	• Implementing a leak detection and repair (LDAR) program that controls fugitive emissions by regularly monitoring to detect leaks, and implementing repairs within a predefined time period • Substitution of less volatile substances, such as aqueous solvents • Collection of vapours through air extractors and subsequent treatment of gas stream by removing VOCs with control devices such as condensers or activated carbon absorption
	Handling of chemicals in open vats and mixing processes	• Collection of vapors through air extractors and subsequent treatment with **destructive control devices** such as: a) **Catalytic Incinerators**: Used to reduce VOCs from process exhaust gases exiting paint spray booths, ovens, and other process operations b) **Thermal Incinerators**: Used to control VOC levels in a gas stream by passing the stream through a combustion chamber where the VOCs are burned in air at temperatures between 700º C to 1,300º C c) **Enclosed Oxidizing Flares**: Used to convert VOCs into CO_2, CO and H_2O by way of direct combustion

Source: IFC 2007. Environmental, Health, and Safety General Guidelines

Table 4.2: Fugitive emissions controls and their efficiency

Control Type	Control Efficiency
Chemical Stabilization	0%-98%
Hygroscopic salts Bitumens/adhesives	60%-96%
Surfactants Wet Suppression- Watering	0%-68% 12%-98%
Speed Reduction Traffic Reduction	0%-80% Not quantified
Paving (Asphalt/Concrete) Covering with Gravel, Slag or Road Carpet Vacuum Sweeping	85%-99% 30%-50% 0%-58%
Water Flushing/Broom Sweeping	0%-96%

Source: IFC 2007. Environmental, Health, and Safety General Guidelines

Table 4.3: NOx prevention and control technologies

	Percent Reduction by Fuel Type			**Comments**
Combustion modification (Illustrative of boilers)	**Coal**	**Oil**	**Gas**	
Low-excess-air firing	10-30	10-30	10-30	These modifications are capable of reducing NOx emissions by 50 to 95%. The method of combustion control used depends on the type of boiler and the method of firing fuel.
Staged Combustion	20-50	20-50	20-50	
Flue Gas Recirculation	N/A	20-50	20-50	
Water/Steam Injection	N/A	10-50	N/A	
Low-NOx Burners	30-40	30-40	30-40	
Flue Gas Treatment	**Coal**	**Oil**	**Gas**	**Comments**
Selective Catalytic Reduction (SCR)	60-90	60-90	60-90	Flue gas treatment is more effective in reducing NOx emissions than are combustion controls. Techniques can be classified as SCR, SNCR, and adsorption. SCR involves the injection of ammonia as a reducing agent to convert NOx to nitrogen in the presence of a catalyst in a converter upstream of the air heater. Generally, some ammonia slips through and is part of the emissions. SNCR also involves the injection of ammonia or urea based products without the presence of a catalyst.
Selective Non-Catalytic Reduction (SNCR)	N/A	30-70	30-70	

Source: IFC 2007. Environmental, Health, and Safety General Guidelines

4.2.5 Mitigation measures for protection and conservation of water resources

- Combined use of ground and surface water.
- Reuse of utility wastewater in the cooling tower after removing its salt content.
- Use of closed type cooling towers (instead of the open loop type).
- Use of air cooling (rather than water-cooling) in water-stressed areas.
- Recharge of groundwater through rainwater harvesting and construction of water retention structures in the study area.
- Installation of water meters at strategic positions.
- Regular accounting of water balance to identify losses.

Wastewater management: The mitigation measures to prevent contamination of water resources by wastewater are as follows:

- Approach for Zero discharge of wastewater
- Characterising the different wastewater streams arising from the process — segregating the effluents at source according to their contaminant type and load, before mixing with other streams, ensures that a treatment facility receives only those pollutants it can cope with. Moreover, it enables the application of recycling or reuse options for the effluent *See Table 4.4: Examples of industrial wastewater treatment approaches.*

Table 4.4: Examples of industrial wastewater treatment approaches

Pollutant/Parameter	Control Options/Principle	Common End of Pipe Control Technology
pH	Chemical, Equalisation	Acid/Base addition, Flow equalisation
Oil and Grease/ TPH	Phase separation	Dissolved Air Floatation, oil water separator, grease trap
Hi- BOD (>2Kg/m^3)	Biological Anaerobic	Suspended growth, attached growth, hybrid
Lo- BOD (<2 Kg/m^3)	Biological-Aerobic, Facultative	Suspended growth, attached growth, hybrid
COD- Non-Biodegradable	Oxidisation, Adsorption, Size exclusion	Chemical oxidation, Thermal oxidation, Activated Carbon, Membranes
Metals- Particulate and soluble	Coagulation, flocculation, precipitation, size exclusion	Flash mix with settling, filtration-traditional and tangential
Inorganics/ Non-metals	Coagulation, flocculation, precipitation, size exclusion, oxidation, adsorption	Flash mix with settling, filtration-traditional and tangential, Chemical oxidation, thermal oxidation, Activated carbon, Reverse Osmosis, Evaporation
Organics- VOCs and SVOCs	Biological-Aerobic, Anaerobic, Facultative; Adsorption, Oxidation	Biological : Suspended growth, attached growth, hybrid; Chemical oxidation, Thermal oxidation,

		Activated Carbon
Emissions- Odors and VOCs	Capture – Active or Passive; Biological; Adsorption, Oxidation	Biological : Attached growth; Chemical oxidation, Thermal oxidation, Activated Carbon
Color	Biological-Aerobic, Anaerobic, Facultative; Adsorption, Oxidation	Biological Aerobic, Chemical oxidation, Activated Carbon
Temperature	Evaporative cooling	Surface Aerators, Flow Equalization
Pathogens	Disinfection, Sterilization	Chlorine, Ozone, Peroxide, UV, Thermal
Toxicity	Adsorption, Oxidation, Size Exclusion, Concentration	Chemical oxidation, Thermal oxidation, Activated Carbon, Evaporation, crystallization, Reverse Osmosis

Source: IFC 2007. Environmental, Health, and Safety General Guidelines

- Recycling and reuse of process and utility wastewater.
- Adoption of best treatment option or appropriate treatment technology depending on the characteristic of the wastewater:

  a. If COD, BOD and TDS are high, the most effective treatment technology is forced evaporation followed by biological method.
  b. If COD and BOD high but TDS is low, the most effective treatment technology is biological treatment.
  c. If COD and TDS are high, but BOD is low, then effective treatment technology is incineration.
  d. If COD high, but BOD and TDS is low, effective treatment technology is solvent recovery or chemical recovery from the waste stream.
  e. If COD low, BOD high and TDS low, again biological treatment is most effective treatment technology.

Table 4.5: Storm water and sanitary wastewater treatment approach

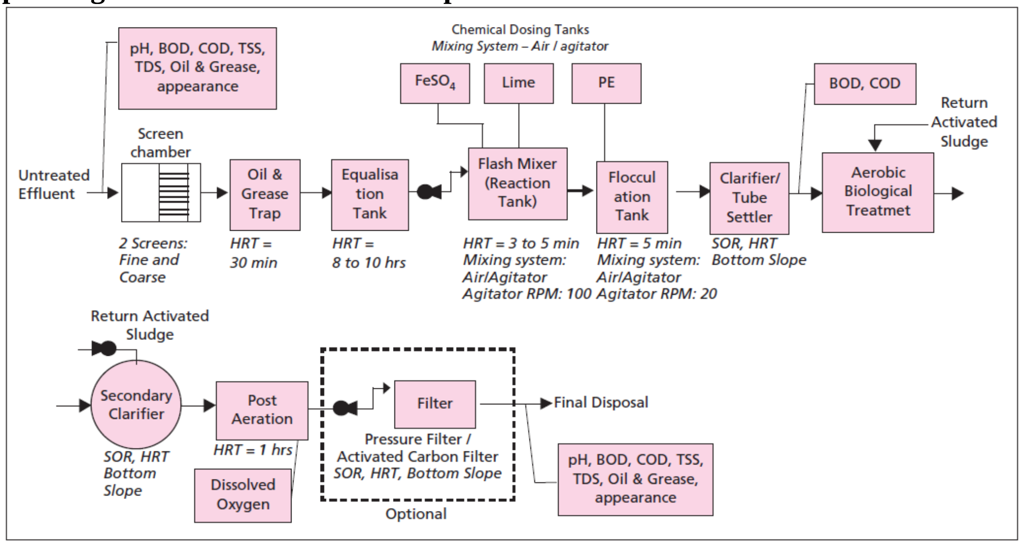
Pollutant	**Source/ Stage**	**Mitigation**
Storm water	Stormwater includes any surface runoff and flows resulting from precipitation, drainage or other sources. Typically stormwater runoff contains suspended sediments, metals, petroleum hydrocarbons, Polycyclic Aromatic Hydrocarbons (PAHs), coliform, etc. Rapid runoff, even of uncontaminated stormwater, also degrades the quality of the receiving water by eroding stream	• Stormwater should be separated from process and sanitary wastewater streams in order to reduce the volume of wastewater to be treated prior to discharge • Surface runoff from process areas or potential sources of contamination should be prevented • Where this approach is not practical, runoff from process and storage areas should be segregated from potentially less contaminated runoff • Runoff from areas without potential sources of contamination should be minimized (e.g. by minimizing the area of impermeable surfaces) and the peak discharge rate should be reduced (e.g. by using vegetated swales and retention ponds) • Where stormwater treatment is deemed necessary to protect

	beds and banks.	the quality of receiving water bodies, priority should be given to managing and treating the first flush of stormwater runoff where the majority of potential contaminants tend to be present • When water quality criteria allow, stormwater should be managed as a resource, either for groundwater recharge or for meeting water needs at the facility • Oil water separators and grease traps should be installed and maintained as appropriate at refuelling facilities, workshops, parking areas, fuel storage and containment areas. • Sludge from stormwater catchments or collection and treatment systems may contain elevated levels of pollutants and should be disposed in compliance with local regulatory requirements, in the absence of which disposal has to be consistent with protection of public health and safety, and conservation and long term sustainability of water and land resources
Sanitary waste water	Sanitary wastewater from industrial facilities may include effluents from domestic sewage, food service, and laundry facilities serving site employees. Miscellaneous wastewater from laboratories, medical infirmaries, water softening etc. may also be discharged to the sanitary wastewater treatment system.	• Segregation of wastewater streams to ensure compatibility with selected treatment option (e.g. septic system which can only accept domestic sewage) • Segregation and pre-treatment of oil and grease containing effluents (e.g. use of a grease trap) prior to discharge into sewer systems • If sewage from the industrial facility is to be discharged to surface water, treatment to meet national or local standards for sanitary wastewater discharges • If sewage from the industrial facility is to be discharged to either a septic system, or where land is used as part of the treatment system, treatment to meet applicable national or local standards for sanitary wastewater discharges is required. • Sludge from sanitary wastewater treatment systems should be disposed in compliance with local regulatory requirements, in the absence of which disposal has to be consistent with protection of public health and safety, and conservation and long term sustainability of water and land resources.

Source: IFC 2007. Environmental, Health, and Safety General Guidelines

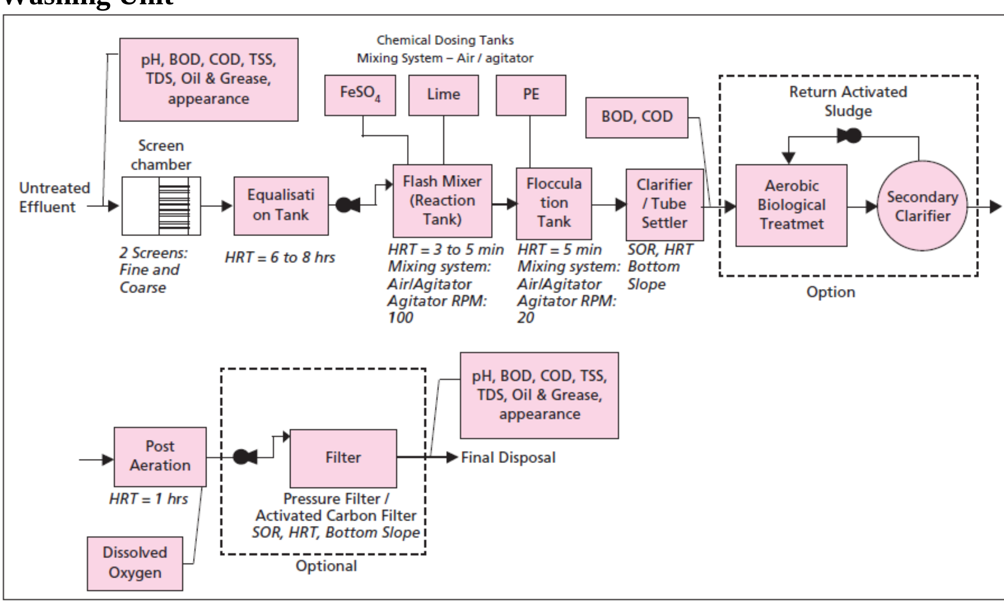
Examples of wastewater treatment approaches in textile industry are as follows:

Figure 4.1: Flow diagram for Effluent Treatment Plant and parameters – dyeing, printing cotton and blended textile products



Source: *Guide for Assessment of Effluent Treatment Plants, Department of Environment Ministry of Environment and Forest, Bangladesh, June, 2008*

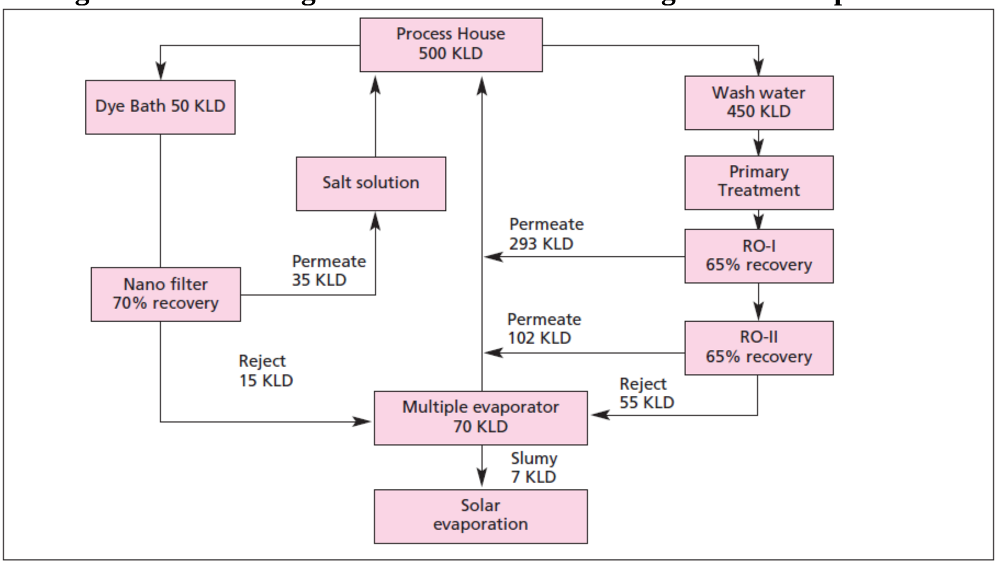
Figure 4.2: Flow diagram for Effluent Treatment Plant and parameters – Garment Washing Unit



Source: *Guide for Assessment of Effluent Treatment Plants, Department of Environment Ministry of Environment and Forest, Bangladesh, June, 2008*

In addition, conventional treatment is not always sufficient in removing complex contaminants from the wastewater. Hence, it requires *advanced method of treatment also referred to as tertiary treatment. The advance method can either be used as stand alone or in combination with conventional treatment method.* It has been proved practically that textile unit can achieve *zero discharge* and can reduce substantial quantity of raw water intake by using advance treatment method (See *Figure 4.3: Flow diagram to achieve zero discharge in a textile plant).*

See Figure 4.3: Flow diagram to achieve zero discharge in a textile plant



Note: RO = Reverse Osmosis

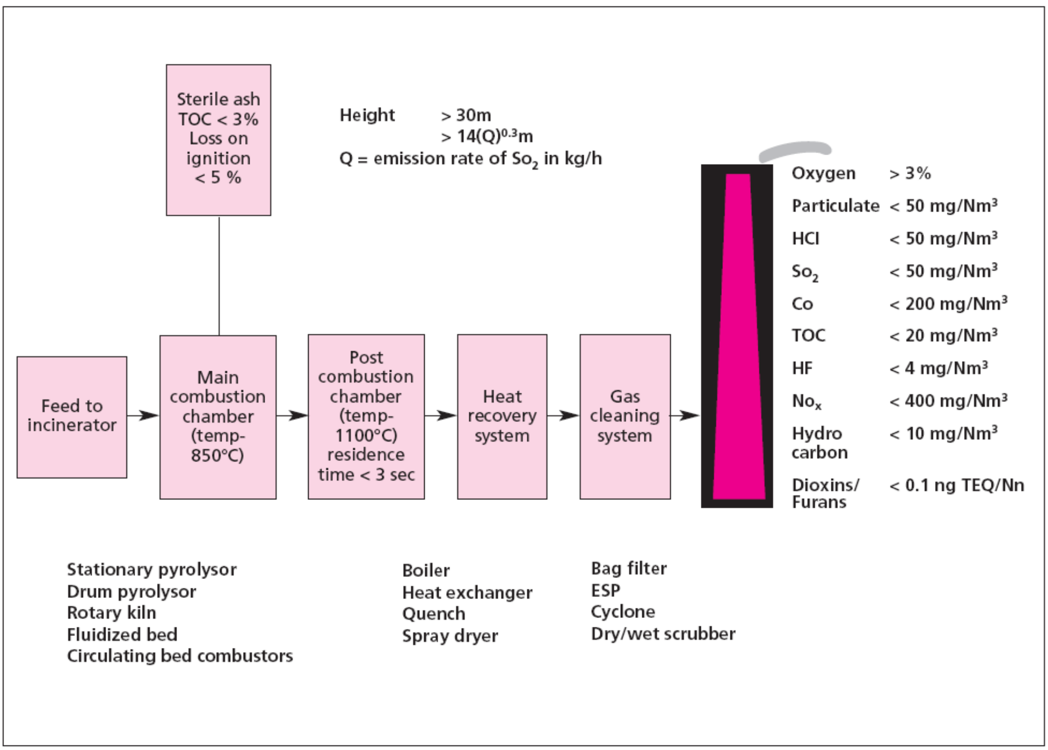
4.2.6 Mitigation measures for solid and hazardous wastes

- Construction waste should be used for filling low lying areas
- STP sludge from colony or plant should be used as manure for horticulture or gardening.
- Based on chemical characteristics, the ETP sludge should be adequately disposed off. For example, if the sludge has hazardous characteristics, it should be disposed off in a sanitary landfill or at a common hazardous landfill site.
- Spent oil should be disposed off only through authorized vendors.
- Incineration and secure landfills wherever applicable in case of hazardous waste

Note: Incineration is commonly adopted in chemical based industries for disposing hazardous or solid waste. The Incinerators should have a post-combustion chamber, equipped with a heat recovery system, scrubbing system and a tall chimney as per the statutory requirements. The incineration of waste produces gaseous emissions and also the burnt out ash has to be disposed off in a secured landfill *(See Figure 4.4: Flow diagram for incineration and emission concentrations).* When incinerating is adopted, the EA reviewer and practitioner need to keep following things in mind:

- Incineration of chlorinated hydrocarbon will produce HCl. Therefore, the reviewer must see whether the cleaning/scrubbing system is equipped with an incinerator.
- Combusting organic and inorganic sulphur compounds would generate sulphur dioxide. A cleaning or scrubbing system is required in such a case.
- Wastes containing fluorides and bromides produce highly corrosive acids which may cause a severe corrosion problem in the surroundings. The reviewer must see whether the incinerator is equipped with a cleaning system for this.
- If the waste contains phosphorous, it produces phosphorous pentoxide. Hence, it requires a cleaning system.

Figure 4.4: Flow diagram for incineration and emission concentrations



Note: If incineration is adopted for hazardous wastes, it should be fitted with proper air control device and the ash generated should be disposed in landfill.

4.2.7 Chemical storage and management

- Underground storage tanks should be lined (preferably, double RCC lined).
- In case of chemical storage, especially that of hazardous chemicals, there should be RCC flooring coupled with embankments all around.
- Designated storage area with spill collection system.
- Underground storage of solvents or fuel is more practicable in cases where the water table is low. In case of high water table, storage above the ground is the best solution.
- Following are some of the management options for underground storage:
    a) Avoid storing highly soluble organic materials.
    b) Assess the corrosion potential of soil.
    c) For installing new structures, the storage site should be lined with impermeable liners or structures (such as concrete vaults) under and around the tanks, followed by monitoring ports at the lowest point of the liner or structure.
    d) Location of the monitoring wells should be identified by considering the groundwater flow.
- Layout of the plant is important from environment and safety point of view. For instance, fugitive emissions can be reduced drastically by a proper layout – fewer joints in the pipes carrying solvents would generate lesser fugitive emissions and vice versa. It is important that the reviewer should check the types and numbers of pumps, seals, valves etc.
- The number of flanges should be less; more the flanges, higher would be the probability of fugitive emissions.
- If the solvent is hazardous (such as potential to cause cancer), it should be stored in a closed loop.
- Pumps should be double sealed.
- The quantification and addition of chemicals should be computerised.
- There should be restricted entry into the area and operators involved in the handling of chemicals should be trained.
- Roads should be wide enough to support free movement of vehicles.
- Water must be sprayed on solvent storage tanks, which have a low boiling point, particularly during summers.
- Solvent storage tanks should have a provision of lightning conductors.
- Storage containers should have legible signs indicating the contents of the container, health hazard warnings (where necessary), and spill clean-up procedures in case of emergencies.

4.2.8 Mitigation measures for socio-economic impacts: Displacement becomes a significant issue in the industry sector when land requirement is large. The best practices in land acquisition and R&R are as follows:

- Land should not be acquired without the consent of the majority of the project-affected population (PAP). The project proponent should receive 'free, prior and informed consent' from the PAP.

- The PAP should include not only landholders but also people dependent on land for livelihood like share-croppers, landless labourers, etc.

- The R&R plan should be a comprehensive framework within which compensation, benefit sharing and community development plans are integrated and the roles of local communities, governments and companies are clearly delineated.

- Compensation for land should be based on the current market price.

- The R&R plan should be framed in consultation with the PAP.

- The PAP should have a say in the selection of the resettlement site and design of the housing and other infrastructure facilities.

- Attempt should be made to resettle the displaced people as near as possible to the project sites, so that they can obtain access to facilities as well as economic benefits generated from the project. The R&R plan should recognise not only landholders, but also those dependent on land for livelihood like share-croppers and landless labourers, etc. Compensation should also be provided to them.

- There should be a provision for a life-time monthly pension for the old, disabled and widows (who have no alternate livelihoods).

- Basic amenities should be provided at the new resettlement site. This should include roads, safe drinking water, sanitation facilities, educational and health facilities, markets, community centers, playgrounds, etc.

- There should be a provision for employment to at least one family member from each project affected household. All unskilled and semi-skilled direct employment created in the project should ideally go to the PAPs.

- Financial assistance and training for self-employment should be provided to the PAPs.

- There should be a provision for land-for-land compensation for indigenous communities.

- No physical displacement should be resorted to till the complete R&R package has been implemented.

- Instead of acquiring the land, options should be explored to take the land on lease from the PAP by paying an annual lease rent. The compensation plan should explore the option for benefit-sharing with the PAP.

- Displacement should be used as an opportunity for development. A good resettlement and Rehabilitation (R&R) plan should have components as listed in *Table 4.6: Recommended outline for R&R plan:*

Table 4.6 Recommended outlines for R&R plan:

Topic	Contents
Scope of land acquisition and resettlement	• Describe, with the use of maps, the scope of land acquisition and why it is necessary for the main investment project. • Describe alternative options that can be considered to minimize land acquisition and its effects, and why the remaining effects are unavoidable. • Summarise key effects in terms of land acquired, assets lost, and people displaced from homes or livelihoods. • Specify primary responsibilities for land acquisition and resettlement.
Socio-economic information	• Define, identify and provide details of the people to be affected. • Describe likely impacts of land acquisition on affected people, taking into account social, cultural, and economic parameters. • Identify all losses for the people affected by land acquisition. • Provide details of any common property resources. • Specify how the project will impact the poor, indigenous people, ethnic minorities, and other vulnerable groups, including women, and any special measures needed to restore fully, or enhance, their economic and social base.
Objectives, policy and framework	• Describe the purposes and objectives of land acquisition and resettlement. • Describe the key national and local land, compensation and resettlement policies, laws, and guidelines that apply entitlements to the project. • Prepare an eligibility policy and entitlement matrix for all categories of loss, including compensation rates.
Consultation, and grievance redress Participation	• Identify project stakeholders. • Describe mechanisms for stakeholder participation in planning, management, monitoring, and evaluation. • Identify local institutions or organizations to support the affected people. • Review potential role of non-government organizations (NGOs) and community-based organizations (CBOs). • Establish procedures for addressing the grievances of the affected people.
Relocation of housing and settlements	• Identify options for relocation of housing and other structures, including replacement housing, replacement cash compensation, and self-selection. • Specify measures to assist with transfer and establishment at new sites. • Review options for developing relocation sites, if required, in terms of location, quality of site, and development needs. • Provide a plan for layout, design and social infrastructure for each site. • Specify means for safeguarding income and livelihoods.

	• Identify special measures for addressing gender issues and those related to vulnerable groups. • Identify any environmental risks and show how these will be managed and monitored.
Income restoration strategy	• Identify livelihoods at risk. • Develop an income restoration strategy with options to restore all types of livelihoods. • Specify job opportunities in a job creation plan, including provisions for income substitution, retraining, self-employment and pensions, where required. • Prepare a plan to relocate and restore businesses, including income substitution, where required. • Identify any environmental risks and show how these will be managed and monitored.
Institutional framework	• Identify main tasks and responsibilities in planning, negotiating, approving, coordinating, implementing, financing, monitoring and evaluating land acquisition and resettlement. • Review the mandate of the land acquisition and resettlement agencies and their capacity to plan and manage these tasks. • Provide for capacity building, including technical assistance, if required. • Specify the role of NGOs, if involved and that of organizations of affected populations in resettlement planning and management.
Resettlement budget and financing	• Identify land acquisition and resettlement costs. • Prepare an annual budget and specify timing for release of funds. • Specify sources of funding for all land acquisition and resettlement activities.
Implementation schedule	• Provide a time schedule showing start and finish dates for major resettlement tasks. • Show how the affected people will be provided for before demolition begins.
Monitoring and evaluation	• Prepare a plan for internal monitoring of resettlement targets, specifying key indicators of progress, mechanisms for reporting, and resource requirements. • Prepare an evaluation plan, with provision for external, independent evaluation of extent to which policy objectives have been achieved. • Specify participation for people.

4.2.9 Mitigation for risk and occupation safety

- The layout of the project should be such that the high-risk zones (such as production, storage of chemicals/products, ETPs, incinerator etc.) are separated from the low-risk zones (such as administration, laboratories, canteens etc.). Green belt development shall be at the periphery and not within the plant area – the plant area should have an open lawn *(applicable for chemical industry)*. Roads inside the plant area should be broad and spacious so that fire brigades can operate smoothly. All high-risk zones must be easily accessible.
- Hazard and risk-prone areas should be identified and characterised by conducting risk assessment.
- On-site and off-site disaster management plans, based on impact magnitude and its severity.

Occupational safety

- Personal protective equipment (hand gloves, safety goggles, nose masks and helmets) to be provided to all the employees working in the plant.
- Training for employees to educate them about the hazardous nature of chemicals used in the process.
- Workers can be rotated within jobs so that they are not faced with continuous noise exposure for a long period of time.
- Trained medical personnel and first aid facilities as well as safety equipment such as fire extinguishers and fire alarms to be made available at place of work.
- Medical examinations to be conducted for the workers from time to time. If significant occupational health problems are observed, the management should take appropriate measures.
- Identification and implementation of management procedures including process safety, training, management of change, incident investigation, employee participation, contractor training and oversight.
- Developing and implementing an emergency response programme, including emergency response procedures, emergency equipment, training, review and updates.

4.2.10 Mitigation measures for noise

- Noise-prone areas at the plant to be identified and clearly marked. Unauthorised persons should not be allowed entry in these areas. Workers engaged in these areas should be provided earplugs and muffs.
- Providing silencers or enclosures for noise-generating machines such DG sets, compressors, etc.
- The exposure time of workers should be reduced by practising work rotation.
- Green belt to be provided to act as noise attenuator.
- Regular maintenance of machinery,
- Anti-vibration mounts to be fitted on machines or enclosures.
- Walls to be fitted with sound-absorbing material.

4.2.11 Odour control measures: Techniques for prevention or minimization of odour include:

- Substituting odour-intensive substances with less impacting compounds
- Installing and modifying equipment to reduce use of odorous chemicals.
- Routing of stack emissions through boilers to reduce odour emissions.

4.2.12 Others

- Separate environment or EHS department to look after environment, health and safety management.
- Provisions for parking, rest rooms and canteens for workers and drivers.
- Adoption of environment and safety management tools (such as ISO 14001 and 18001).
- The layout of the plant must ensure adequate space for green belt development.
- Fire fighting systems should be installed to meet emergency situations.
- Use of display boards and colour coding should be practised.

CHAPTER 5

Review of an EIA report for an industrial project

5.1 Introduction

The purpose of reviewing an EIA report is to take decisions with respect to the following:

- Should the project be cleared in the form proposed by the project proponent?
- Should the project be modified to reduce the impacts and then cleared?
- Is the ‘No project’ option justified, considering the social and environmental cost?
- If the project is cleared, then what conditions may be prescribed for compliance during design, construction and operation of the project?

5.2 Composition of the EA review team

To ensure a proper review of the EIA report, the review committee should include experts from diverse fields with a good understanding of the industrial project and potential impact areas. The reviewers should be technically sound and competent enough to review the report. They should be able to make valuable suggestions/ recommendations to the project proponent for taking corrective action. Ideally, in the case of industrial projects, the team should comprise of the following experts:

- **A civil/mechanical/chemical/electrical engineer and experts** who are well versed with the process and technology and potential impacts of industrial projects.
- **An environmental scientist/engineer** to overview the adequacy of mitigation options suggested for air, water and waste management.
- **A groundwater expert/hydrologist** to review and assess the hydrology of the study area and the drainage pattern.
- **A social science expert/anthropologist** to review the social issues and the resettlement and rehabilitation plan.
- **A biodiversity expert/botanist** who can review the biodiversity issues, biodiversity conservation and afforestation plan.
- **A meteorological expert** who can review the meteorological parameters and adequacy and compatibility of air pollution model.
- **A geologist** to review the geological risks and associated impacts.
- **A safety engineer and occupational health expert** who can review the levels of safety, mechanization, disaster management plans, occupational hazards and

mitigation strategies to combat these hazards at the planning and operational stages.

- **Nominees** of the regulatory agency.

5.3 Reviewing an EIA report for an industrial project

While reviewing the EIA report, the following key aspects needs to be carefully examined:

- Has the EIA report evaluated the beneficial and adverse impacts of the project properly and clearly?
- Which are the unavoidable adverse impacts? Are they acceptable?
- Is the proposed mitigation plan sufficient to manage and control all adverse impacts?
- What kinds of safeguards need to be incorporated to ensure that the mitigation plan is implemented effectively?
- What are the parameters which need to be monitored during project construction and operation so that the state of the environment can be studied throughout the project life?
- Is the project acceptable to the local communities?
- Are the concerns of the local communities genuine and has the EIA report adequately addressed these concerns?
- Will the project improve the socio-economic status of the local communities?

Guidelines for using the reviewer checklist:

By using the *reviewer checklist for an industrial project*, the reviewer will be able to gauge the acceptability of the EIA report. This can eventually assist in determining the environmental feasibility of the project being assessed.

Scorecard approach: The checklist is designed to follow a "scorecard" approach, using a possible scoring range of 0-10. Scores for each relevant item in the checklist are totalled, and a calculation of the percentage of the total possible score is made.

Relevance: The checklist is a generic checklist for the industrial projects. Not all questions may be relevant to all the industrial projects. Therefore, the first step is to determine the ***relevance*** of each question, for the specific project being considered. For each question that is relevant, "1" is entered in the box under Column "A" of the checklist, "Is question relevant for *this* project?" Because the number of relevant parameters varies from project to project, the possible total score for each EIA report will vary accordingly.

Adequacy: It is then necessary to determine the ***adequacy*** of the EIA report in answering only those questions that are judged to be relevant. Under the "adequacy" heading (Column "B"), the reviewer is asked to assign a numeric score from 0-10. The numeric scoring for the various elements of the EIA report, based on their level of completeness, clarity, and quality, is as follows:

9-10: **Excellent:** Information provided is clear, comprehensive and detailed, with no gaps or weaknesses.

7-8: **Good:** Information provided is comprehensive, has only very minor weaknesses which are not of importance to the decision-making process.

5-6: **Adequate:** Information provided has some minor weaknesses, but the deficiencies do not strongly compromise the decision process; no further work is needed to add to the environmental information.

3-4: **Weak:** Information provided has gaps and weaknesses which will hinder the decision process; some additional work is needed to complete the information.

1-2: **Very poor:** Information provided has major gaps or weaknesses which would prevent the decision process from moving ahead; major work is required to rectify.

0: **Absent:** Information needed for decision-making is not included in the report, and needs to be provided in its entirety.

Importance: It is also necessary to determine the importance. In many cases, some of the issues is relevant for the project but is not very important or significant in impact assessment. For instance; name of project, project schedule is relevant for the project but it has not much importance in environmental and social impact assessment. Therefore, while assigning the value for ***importance***, reviewer should always keep in his/her mind the level of importance, a) relevant but least important, b) relevant but average important, c) relevant but most important.

In addition, for each relevant item, the reviewer is instructed to fill in comments for each relevant item. This should be made a mandatory procedure, so that the justification for assigning a specific value for adequacy as well as importance is well documented. For those items where the information provided in the EIA report is not adequate, it should be indicated in the far-right column what types of information are still required, in order to adequately address the question.

As a rule of thumb, an EIA report achieving a score in the range of 50-60% or higher should be considered acceptable. Borderline scores, or scores much lower than this limit, indicate that the EIA report is likely not acceptable. It should be noted, that while this design (i.e., using a numeric scorecard, and requiring reviewers to provide comments and justifications for their itemized determinations) is intended to minimize subjectivity, this "semi-quantitative" approach cannot totally eliminate all subjectivity from the review process, because the assignment of numeric scores is itself, by nature, a subjective process.

At the end of each section of the checklist, space is left for "other questions." The space provided here may be used to elaborate on the listed questions in each section (referencing the question number), or to add questions that may have specific relevance for the project being reviewed.

Overall Evaluation: There are six components that need to be evaluated to give the total score.

1. Applicant Information
2. Project Description
3. Baseline information
4. Impact Assessment
5. Mitigation and Environmental Management Plan (EMP)
6. Other Requirements

The final section of the checklist provides a framework for giving an overall evaluation of the EIA report. Each topic covered in the checklist is assigned a score, from 1-10, according to the same system used in the main section of the checklist. The resulting value provides a further basis for determining whether or not the environmental information presented is adequate ("acceptable" or "not acceptable") for making an informed determination about the quality of the EIA report. This is simply a way to cross-check the results that were obtained through a detailed itemized review of the EIA report *(Refer reviewer checklist).*

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