EIA OF HYDROPOWER PROJECTS - AN ANALYSIS

Submitted in partial fulfilment of the Degree of

Bachelor of Technology

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Certificate

This is to certify that project report entitled "**EIA OF HYDROPOWER PROJECTS – AN ANALYSIS**", submitted by **SHUBHAM CHOPRA AND AMAN THAKUR** in partial fulfillment for the award of degree of Bachelor of Technology in Civil Engineering to Jaypee University of Information Technology, Waknaghat, Solan has been carried out under my supervision.

This work has not been submitted partially or fully to any other University or Institute for the award of this or any other degree or diploma.

Date: **Supervisor**

Designation

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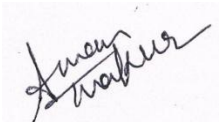

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ABSTRACT

Environmental Impact Assessment (EIA) can broadly be defined as a study of the effects of a proposed project, plan or program on the environment. The legal, methodological and procedural foundations of EIA were established in 1970 by the enactment of the National Environmental Policy Act (NEPA) in the USA. On January 27, 1994, the Union Ministry of Environment and Forests (MEF), Government of India, under the Environmental (Protection) Act 1986, promulgated an EIA notification making Environmental Clearance (EC) mandatory for expansion or modernisation of any activity or for setting up new projects listed in Schedule 1 of the notification. Since then there have been 12 amendments made in the EIA notification of 1994. The MoEF recently notified new EIA legislation in September 2006.

In this project, a review of EIA of hydropower projects in Himachal Pradesh has been made considering the recent natural hazard in Uttarakhand in 2013 and subsequent Supreme Court order to review all hydropower projects located in Hilly Areas. Analysis was made on the National and International Procedures on EIA of hydropower projects. Also new procedures were evaluated while analysing the case studies of Hydropower Projects. Measures are evaluated in Microsoft Excel and appropriately suggested.

Table of Contents

List of Tables

List of Figures

CHAPTER1. INTRODUCTION

1.1 ORIGIN OF EIA

Before the First World War, rapid industrialization and urbanization in western countries was causing rapid loss of natural resources. This continued to the period after the Second World War giving rise to concerns for pollution, quality of life and environmental stress. In early 60s, investors and people realized that the projects they were under taking were affecting the environment, resources, raw materials and people. As a result of this, pressure groups formed with the aim of getting a tool that can be used to safeguard the environment in any development. The USA decided to respond to these issues and established a National Environmental Policy Act in 1970 to consider its goal in terms of environmental protection. The USA became the first country to enact legislation on EIA. This was the first time that EIA became the official tool to be used to protect the environment. The United Nations Conference on the Environment in Stockholm in 1972 and subsequent conventions formalized EIA. At present, all developed countries have environmental laws whereas most of the developing countries are still adopting it (Lee, 1995). Multilateral and bilateral lenders included EIA requirements in their project eligibility criteria (OECD, 1996).

1.2 EIA IN DEVELOPING COUNTRIES

Until recently, EIA as a new concept was not readily understood and accepted as a tool in developing countries. Developers resisted and argued that it was anti development because laws and policies supporting it dictated that lands developments causing negative impacts should be discontinued. In a nutshell, EIA was considered just another bureaucratic stumbling block in the path of development. Secondly, it was conceived as a sinister means by which industrialized nations intend to keep developing countries from breaking the vicious cycle of poverty.

Thirdly, the experts in the developing countries were foreigners who were viewed as agents of colonization. The need for EIAs has become increasingly important and is now a statutory requirement in many developing countries. Historically, the choice of new projects was primarily based on one criterion: economic viability. Today, a second and a third choice criteria,

environmental and social impact, have become a strong yardstick, hence the triple bottom-line approach (economic, environmental and social) to project viability (Modak & Biswas, 1999).

1.3 HYDROPOWER PROJECTS IN INDIA

India ranks 5th in terms of exploitable hydro-potential on global scenario. India is the 7th largest producer of hydroelectric power, it produces 3.3 percentage of the world's total .Himachal Pradesh is extremely rich in its hydel resources. The state is having about twenty five percent of the national potential in this aspect. It has been estimated that about 21,244 MW of hydel power can be generated in the state by the construction of various hydel projects on the five perennial rivers.

Table:1.1 LIST OF HYDROPOWER PROJECTS IN INDIA AND THEIR CAPACITY

STATE	NO. OF PROJECTS	TOTAL CAPACITY(MW)
ANDAMAN & NICOBAR	1	5.25
ANDHRA PRADESH	15	4025
ASSAM	2	375
CHATTISGARH	1	12

GUJRAT	4	1995
HIMACHAL PRADESH	12	7027
JAMMU &KASHMIR	9	2363
ARUNCHAL	2	1005
JHARKHAND	2	134
KARNATAKA	12	3510
KERELA	10	1854.65
MADHYA PRADESH	8	2290
MAHARASHTRA	4	2452
MANIPUR	1	105
MEGHALAYA	4	167.2
NAGALAND	1	75
ORRISA	7	2628
PUNJAB	6	1297.3
RAJASTHAN	3	411
SIKKIM	2	570
TAMILNADU	25	2255.5
UTTARPRADESH	4	502
UTTRAKHAND	11	4296
WEST BENGAL	7	1426.5

1.4 PROJECT JUSTIFICATION

To review Environmental Impact Assessment of Hydropower Projects in Himachal Pradesh considering the recent natural hazards in Uttarakhand. Also Supreme Court have ordered to review EIA of hydropower projects present on Bhagirathi and Alakhnanda river , and hydropower projects present in hilly areas. So, we have decided to analyze two hydropower projects and compare the EIA done internationally and EIA done in India. One project which we have taken for EIA analysis is Himachal Pradesh Power Project Power Limited (HPPCL) Sainj located about 30kms from Kullu (H.P) and the other Project which we have taken is National Hydro Power Limited (NHPC) located in Kullu (H.P). These Justifications have been given in various newspapers and we are trying to analyze and do Environmental Impact Assessment (EIA) of Hydropower Projects. Also various projects has been put to shutdown as there EIA is not been done which will lead to a huge loss of energy ,also Surveying has been done of these projects but as EIA is not done properly these projects has been put to shutdown. So, here we are trying to justify why we have taken this project.

1.5 OBJECTIVES

To review Environmental Impact Assessment of Hydropower Projects in Himachal Pradesh considering the recent natural hazards in Uttarakhand considering a case study.

To compare national and international EIA procedures.

To evaluate new methodologies in EIA of Hydropower Projects.

To suggest corrective measures in Environmental Impact Analysis of Hydropower Projects.

CHAPTER 2.EIA LEGAL, POLICY AND INSTITUTIONAL FRAMEWORK

2.1 EIA in international environmental law context

Key Multilateral Environmental Agreements (MEAs) have seen review and improvements in EIA legal, policy and institutional arrangements. The key agreements are discussed below.

Convention on Environmental Impact Assessment in a Trans-boundary Context

This is the first multi-lateral EIA treaty. It looks at EIA in a trans-boundary context and entered into force in 1997. The Espoo Convention sets out the obligations of Parties to assess the environmental impact of certain activities at an early stage of planning. It also lays down the general obligation of states to notify and consult each other on all major projects under consideration that are likely to have a significant adverse environmental impact across borders.
Apart from stipulating responsibility of signatory countries with regards to proposals that have trans-boundary impacts, it describes the principles, provisions, procedures to be followed and list of activities, contents of documentation and criteria of significance that apply.

Rio Declaration

Principle 17 of Rio Declaration on Environment and Development calls for use of EIA as a national decision making instrument to be used in assessing whether proposed activities are likely to have significant adverse impact on the environment. It also emphasized the role of competent national authority in the decision making process.

UN Convention on climate change and Biological Diversity (1992) cited EIA as an implementing mechanism of these conventions.

Doha Ministerial Declaration encourages countries to share expertise and experience with members wishing to perform environmental reviews at the national level (November, 2001).

2.2 Multilateral and bilateral financial institutions environmental safeguards

Investment banks like African Development Bank (ADB), Asian Development Bank (ADB), European Bank for Reconstruction and Development (EBRD), European Investment Bank (EIB), Japanese Bank for International Cooperation (JBIC), World Bank (WB) have environmental safeguards to ensure that financing of projects is not only based on the precautionary principle, preventative action rather than curative treatment but sustainable development (WBCSD,2005). The EIA should examine project alternatives and identify ways of improving project selection, siting, planning, design and implementation by preventing, minimizing, mitigating and compensating for adverse environmental impacts.

2.3 National legislations

National legislation may include a statutory requirement for an EIA to be done in a prescribed manner for specific development activities. Most legislation lists projects for which EIA is a mandatory requirement. The statutory requirement to carry out an EIA for specific projects will, for example, require registered experts to carry out the study, the authority with the help of lead agencies and technical committees to review the EIA and approve the project.

Other national legal requirements that govern the use and protection of resources like water, fisheries, forests, wildlife, public health etc must be identified and complied with during an EIA.

2.4 Institutional framework

EIA institutional systems vary from country-to-country and reflecting different types of governance. In some countries, either the Ministry of Environment or a designated authority or Planning Agency administers EIA.

Environmental issues also involve many disciplines and many government bodies with general environmental and resource management laws. Data will therefore have to be collected and collated from a wide range of technical ministries, other government authorities and parastatals where applicable.

CHAPTER 3.PREPARATION OF TERMS OF REFERENCE (TOR)

Terms of Reference (TOR) sets out what is expected of a practitioner or a consultant when carrying out an EIA. TORs can be simple or elaborate but elaborate TORs are usually not recommended. There are no universal formats for terms of reference, which will be suitable for every study. However, there are general rules, which should be observed when preparing TOR for the EIA.

- The TOR should commence with a brief description of the program or project. This should include a plan of the area that will be affected either indirectly or directly.

- The study should ensure that the consultants or practitioners focus on the major issues and the most serious likely impacts identified during scoping e.g. air emission, waste water discharge etc. The opportunities for enhancing any positive benefits from the project should also be highlighted. This component of TOR is usually submitted to designated authority for scrutiny and approval.

- The TOR should contain explicit references to which safeguard policies may be relevant and which legal requirements should be applied.

- The TOR should give an indication of the team considered necessary for the study and a team leader identified. Depending on the scope of the study this may be multi-disciplinary. However, as the team should not be rigidly imposed on the consultant.

- If international experts are doing the EIA, it is important to make provision for local capacity building in the TOR. Apart from enabling in-country expertise to be built up, this will promote more involvement and understanding of the issues raised by the study.

- The expected date of commencement and time limit should be given and consultants program of work must be within the given time limit.

- The budget limit should be given in the TOR. The type of experts, and whether foreign or local, and the duration of their inputs will usually be the deciding cost factors although a large field survey or measurement program with laboratory analysis could significantly increase costs. Any assistance to be provided by the Client to reduce costs should be clearly stated in the TOR

- Reporting requirements should be clearly stated and should comply with local or international reporting guidelines. The format of EIS must be clear and the number of copies in soft and hard must be stated.

- TOR should make provision for the consultants to improve the terms of reference in order to improve the quality of EIA.

CHAPTER 4.ENVIRONMENTAL IMPACT ASSESSMENT (EIA) PROCESS

The first phase of an environmental assessment is called an Initial Environmental Examination (IEE) and the second is Environmental Impact Studies (EIS) or simply detailed EIA.

Initial Environmental Examination (lEE)

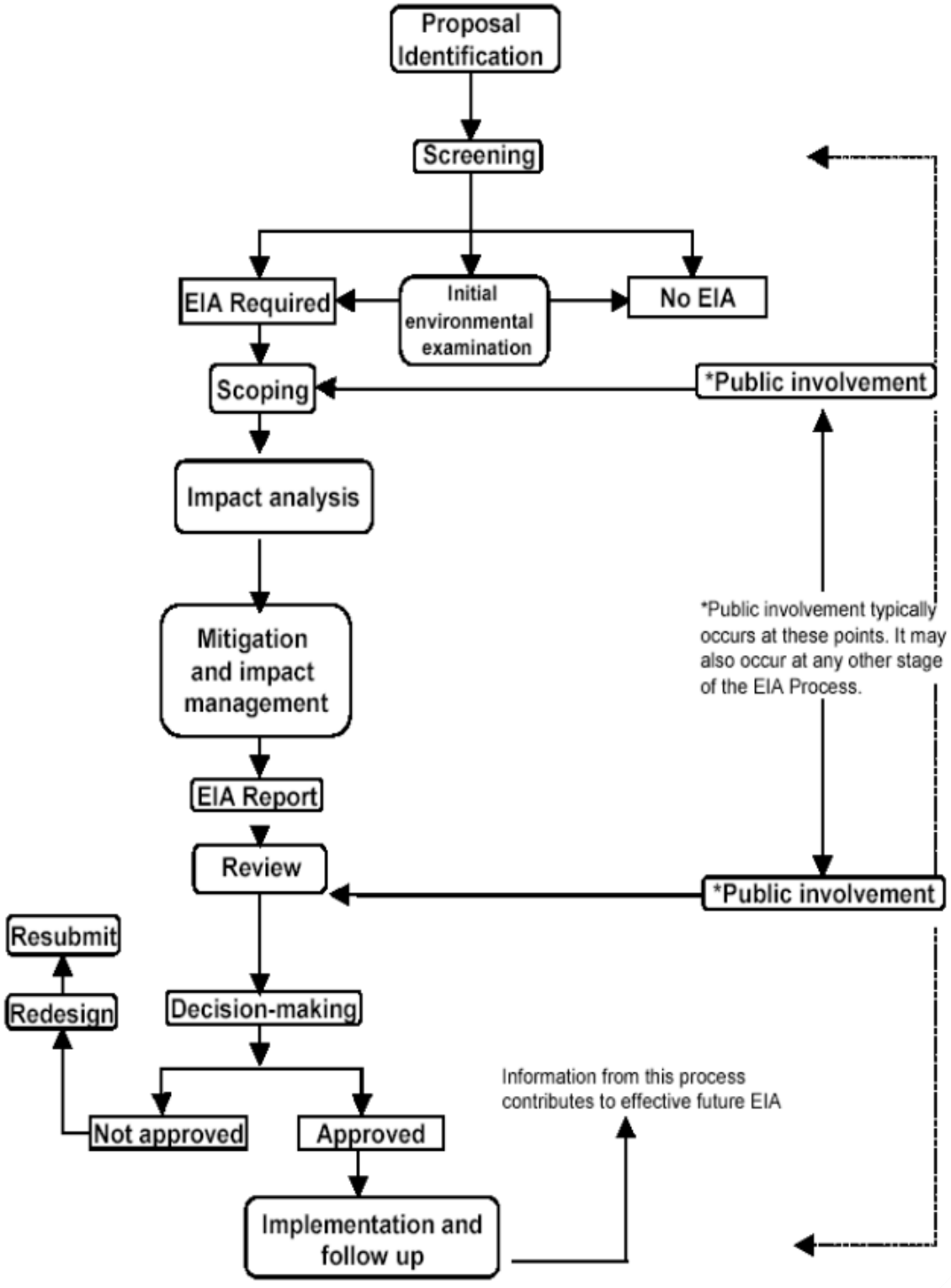
IEE is carried out to determine whether potentially adverse environmental effects are significant or whether mitigation measures can be adopted to reduce or eliminate these adverse effects. The IEE contains a brief statement of key environmental issues, based on readily available information, and is used in the early (pre-feasibility) phase of project planning. The IEE also suggests whether in-depth studies are needed. When an IEE is able to provide a definite solution to environmental problems, an EIA is not necessary. IEE also requires expert advice and technical input from environmental specialists so that potential environmental problems can be clearly defined.

Environmental Impact Assessment (EIA)

EIA is a procedure used to examine the environmental consequences or impacts, both beneficial and adverse, of a proposed development project and to ensure that these effects are taken into account in project design. The EIA is therefore based on predictions. These impacts can include all relevant aspects of the natural, social, economic and human environment. The study therefore requires a multi-disciplinary approach and should be done very early at the feasibility stage of a project. In other words, a project should be assessed for its environmental feasibility.

EIA should therefore be viewed as an integral part of the project planning process. Unlike the environmental audit (EA), which is conducted on existing projects, the EIA is applied to new projects and the expansion aspects of existing projects. The generalized EIA Process Flowchart is given as below:

Generalised EIA Process Flowchart



4.1 Screening

EIA process kicks off with project screening. Screening is done to determine whether or not a proposal should be subject to EIA and, if so, at what level of detail. Guidelines for whether or not an EIA is required are country specific depending on the laws or norms in operation. Legislation often specifies the criteria for screening and full EIA. Development banks also screen projects presented for financing to decide whether an EIA is required using their set criteria.

The output of the screening process is often a document called an **Initial Environmental Examination or Evaluation** (IEE). The main conclusion will be a classification of the project according to its likely environmental sensitivity. This will determine whether an EIA is needed and if so, to what detail.

4.2 Scoping

The aim of EIA is not to carry out exhaustive studies on all environmental impacts for all projects. Scoping is used to identify the key issues of concern at an early stage in the planning process. The results of scoping will determine the scope, depth and terms of reference to be addressed within the Environmental statement. Scoping is done to:

- Identify concerns and issues for consideration in an EIA
- Ensure a relevant EIA
- Enable those responsible for an EIA study to properly brief the study team on the alternatives and on impacts to be considered at different levels of analysis
- Determine the assessment methods to be used
- Identify all affected interests
- Provide an opportunity for public involvement in determining the factors to be assessed, and facilitate early agreement on contentious issues
- Save time and money
- Establish terms of reference (TOR) for EIA study

Scoping should be an ongoing exercise throughout the course of the project. The following environmental tools can be used in the scoping exercise

Checklists – Checklists are standard lists of the types of impacts associated with a particular type of project. Checklists methods are primarily for organizing information or ensuring that no potential impact is overlooked. They comprise list questions on features the project and environments impacts. They are generic in nature and are used as aids in assessment.

Matrices - Matrix methods identify interactions between various project actions and environmental parameters and components. They incorporate a list of project activities with a checklist of environmental components that might be affected by these activities. A matrix of potential interactions is produced by combining these two lists (placing one on the vertical axis and the other on the horizontal axis). They should preferably cover both the construction and the operation phases of the project, because sometimes, the former causes greater impacts than the latter. However, matrices also have their disadvantages: they do not explicitly represent spatial or temporal considerations, and they do not adequately address synergistic impacts.

Networks – these are cause effect flow diagrams used to help in tracing the web relationships that exist between different activities associated with action and environmental system with which they interact. They are also important in identifying direct and cumulative impacts. They are more complex and need expertise for their effective use.

Consultations – with decision-makers, affected communities, environmental interest groups to ensure that all potential impacts are detected. However there can be danger in this when excessive consultation is done and some unjustifiable impacts included in the TOR.

4.3 Baseline data collection

The term "baseline" refers to the collection of background information on the biophysical, social and economic settings proposed project area. Normally, information is obtained from secondary sources, or the acquisition of new information through field samplings, interviews, surveys and consultations with the public. The task of collecting baseline data starts right from the period of project inception; however, a majority of this task may be undertaken during scoping and actual EIA.

Baseline data is collected for two main purposes

- To provide a description of the current status and trends of environmental factors (e.g., air pollutant concentrations) of the host area against which predicted changes can be compared and evaluated in terms of significance, and
- To provide a means of detecting actual change by monitoring once a project has been initiated Only baseline data needed to assist prediction of the impacts contained in the TOR and scoping report should be collected.

4.4 Impact analysis and prediction

Predicting the magnitude of a development likely impacts and evaluating their significance is core of environmental assessment process. Prediction should be based on the available environmental baseline of the project area. Such predictions are described in quantitative or qualitative terms.

4.4.1 Considerations in impact prediction

Magnitude of Impact: This is defined by the severity of each potential impact and indicates whether the impact is irreversible or, reversible and estimated potential rate of recovery. The magnitude of an impact cannot be considered high if a major adverse impact can be mitigated.

Extent of Impact: The spatial extent or the zone of influence of the impact should always be determined. An impact can be site-specific or limited to the project area; a locally occurring impact within the locality of the proposed project; a regional impact that may extend beyond the local area and a national impact affecting resources on a national scale and sometimes trans-boundary impacts, which might be international.

Duration of Impact: Environmental impacts have a temporal dimension and needs to be considered in an EIA. Impacts arising at different phases of the project cycle may need to be considered. An impact that generally lasts for only three to nine years after project completion

may be classified as short-term. An impact, which continues for 10 to 20 years, may be defined as medium-term, and impacts that last beyond 20 years are considered as long-term.

Significance of the Impact: This refers to the value or amount of the impact. Once an impact has been predicted, its significance must be evaluated using an appropriate choice of criteria. The most important forms of criterion are:

- Specific legal requirements e.g. national laws, standards, international agreements and conventions, relevant policies etc.
- Public views and complaints
- Threat to sensitive ecosystems and resources e.g. can lead to extinction of species and depletion of resources, which can result, into conflicts.
- Geographical extent of the impact e.g. has trans- boundary implications.
- Cost of mitigation
- Duration (time period over which they will occur)
- Likelihood or probability of occurrence (very likely, unlikely, etc.)
- Reversibility of impact (natural recovery or aided by human intervention)
- Number (and characteristics) of people likely to be affected and their locations
- Cumulative impacts e.g. adding more impacts to existing ones.
- Uncertainty in prediction due to lack of accurate data or complex systems. Precautionary principle is advocated in this scenario.

4.4.2 Impact prediction methodologies

Several techniques can be used in predicting the impacts. These can be based on:

- Professional judgment with adequate reasoning and supporting data. This technique requires high professional experience.
- Experiments or tests. These can be expensive
- Past experience
- Numerical calculations & mathematical models. These can require a lot of data and competency in mathematical modeling without which hidden errors can arise
- Physical or visual analysis. Detailed description is needed to present the impact.
- Geographical information systems,

- Risk assessment, and
- Economic valuation of environmental impacts

4.5 Analysis of alternatives

Analysis of alternative is done to establish the preferred or most environmentally sound, financially feasible and benign option for achieving project objectives.

The World Bank directives requires systematic comparison of proposed investment design in terms of site, technology, processes etc in terms of their impacts and feasibility of their mitigation, capital, recurrent costs, suitability under local conditions and institutional, training and monitoring requirements . For each alternative, the environmental cost should be quantified to the extent possible and economic values attached where feasible, and the basic for selected alternative stated. The analysis of alternative should include a NO PROJECT alternative.

CHAPTER 5 .EIA IN DEVELOPING AND DEVELOPED COUNTRIES

- There are vast differences in the EIA system of developed and developing countries and within the developing countries.

- Different aspects of the EIA system such as consideration of alternatives, screening, scoping, EIA report preparation and its review, decision making process, monitoring and post auditing, mitigation, public participation, effectiveness and monitoring of the EIA system are used for this comparison.

5.1 Consideration of Alternatives

- This stage includes a range of alternatives and approaches such as different locations, scales and designs for proposed activity.
- In developing countries the consideration of alternatives is often weak due to different priorities of the governments. The central focus of mostly governments is the reduction of poverty. So no-action alternative is considered often .

The minimization of environmental damage after the project completion is mainly carried out in developing countries by the selection of preferences

Screening

- This stage is performed to know whether the proposed project needs an EIA or not. If the project falls in the category for which EIA is necessary then the screening process gives the degree of required assessment.
- In developing countries the screening process is rather weak because environmental agencies have little power, so often it is undertaken unsatisfactory.

Scoping

- In this stage those key issues and impacts are specified that are significant for additional investigation. With the utility of scoping process the boundary and limit of the investigation is also determined.
- This process is given same importance in developing countries as in the developed countries.
- It is performed properly as a result of requirements of the development assistance agencies such as World Bank.

5.2 EIA Report Preparation

- The EIA report that includes results of the carried EIA studies is presented to the decision making body and other interesting parties.
- The EIA reports are not available to the public and often considered confidential in some developing countries .
- These reports are weak on scoping, prediction and alternatives.
- The EIA reports are not properly communicated to the everyday people because they are often written in English language rather than in the endemic language.

5.3 EIA Report Review

- The adequacy and effectiveness of the EIA report is examined in review process. The information necessary for decision making process is also provided by this process.

Due to differences in administrative and consultative procedures review of the EIA reports varies widely in developing countries.

5.4 Monitoring and Post Auditing

- Environmental auditing is undertaken to see the performance and to examine and assess the potential environmental impacts due to development project. This is executed after the partial or complete implementation of the project.
- In developing countries monitoring and auditing of impacts is a missed or not conducted step in EIA compared with developed world.
- The shortfall of attention and commitment and sometimes the non-existent nature of monitoring system cause it harder to achieve the goals of sustainability.

5.5 Decision Making Process

- The rejection and approval or additional change in the project is decided in a decision making process.
- In developing countries the decision making approaches are closed to external scrutiny.
- The decisions are negatively affected by the corruption, social and economic factors.
- EIA is used to justify a before taken decision and to concern with remedial measures.
- Often the EIA process is considered after the planning and design process in developing countries, where it provides the mitigation measures that are too ineffective and insignificant to consider and difficult to implement

5.6 Public Participation

- The consideration about consultation and participation of public is different in developed and developing countries.
- In developed world this step is performed to take more environmental and social benefits and to avoid conflicts.
- While this is not the case in many developing countries where the public is often excluded or refused in decision making process.

5.7 Effectiveness of the EIA System

- The perception about the benefits and costs of the EIA system varies from one country to another country and even from stakeholder to stakeholder indeveloping countries.
- In some countries all stakeholders believe that the substantial benefits of the EIA system is more than the costs related to it. But for some stakeholders EIA is a mean of delaying and improving projects. For consultants EIA is a worthwhile process.
- The problems such as delays, financial resources, lack of expertise, lack of data and confidentially were the same in the developed countries at the time of application of the EIA system, which the developing countries are facing nowadays.

5.8 Monitoring of the EIA System

- Weak and little EIA system monitoring in developing countries is a principal hurdle to get the forecasted benefits of the conducted EIA studies.
- Not only is the absence of information existed but also the lack of interest in reviewing the operating system.
- In some developing countries the environmental agencies monitor different aspects of the EIA as a result of experience from former conducted studies

CHAPTER 6. EIA OF 100 MW SAINJ HYDROPOWER PROJECT BY HIMACHAL PRADESH POWER CORPORATION LTD. (HPPCL)

6. INTRODUCTION

6.1. 1 GENERAL

- The Himachal Pradesh State Electricity Board (HPSEB) proposes to develop the Sainj hydroelectric project with a total installed capacity of 100 MW in the state of Himachal Pradesh.
- The project is located up-stream of the Parbati Stage –III (520 M W)project, which at present is under construction.
- The proposed Sainj Hydro Electric project is located in Sainj Sub Tehsil of district Kullu at a distance of about 35 km from NH-21.
- The project is a runoff river scheme over river Sainj, a tributary of river Beas.

6.2. PROJECT DESCRIPTION

- The salient features of project are briefly described as below:
- 24.5 m high Diversion gated barrage at an elevation of +1733m, downstream of village Niharni on river Sainj.
- Two underground disilting tanks (145mx15mx7.5m) to exclude all silt particles down to 0.2 mm Size.
- A Head Race Tunnel (HRT) on the right bank of river Sainj, of about +6.3 km long with 3.76 m diameter designed to carry a discharge of 28.70 cumec.
- An underground pressure shaft of +2.75 m diameter, 550 in long to carry discharge into power house.
- An underground power house to be located on right bank of river Sainj near confluence of Jiwa Nallah and Sainj river, which will have two units of 50 MW each to provided total installed capacity of 100MW.

- A tail race tunnel (TRT) of 400 m long and 4.8 m D-shaped, will constructed for discharging the water back into river Sainj.
- Infrastructure works like construction of approach roads, bridge, colony office complex, school and hospital.
- Energy generation of 399.57 GWh and 436.90 GWh at 90% and 50% dependable years are envisaged as a result of commissioning of the project.
- The total land requirement for the project is 56.763 ha. The project is proposed to be completed in about 4.5 years.

6.3. ENVIRONMENTAL IMPACT ASSESSMENT STUDY

6.3.1 PHYSIO-CHEMICAL ASPECTS

6.3.1.1 Meteorology

The climate of the project area is characterized by cool and dry climate. Meteorologically, the year can be divided into three distinct seasons. Winter season sets in from the month of October and continues upto February, followed by summer season from March to June. The area receives rainfall under the influence of south-west monsoons over a period of three months from July to September. June is the hottest month of the year, with mean maximum and minimum monthly temperatures of the order of 32.9°C and 26.6°C respectively. January is the coldest month of the year. The annual average rainfall in the project area is 1459.2 mm. Majority of the annual rainfall is received under the influence of south-west monsoons. During the period from January to April, winter precipitation occurs in association with the passage of western disturbances. The winter precipitation accounts for nearly 40% of the annual rainfall. Relative humidity is maximum (91%) during the monsoon months, while it is minimum (50%) in the summer months of April-May.

6.3.1.2 Seismology

The project area falls in under seismic zone-V, as per IS: 1894: 2002 i.e highest seismic zone in Western Himalayas. In the past, the region has been affected with a number of strong earthquakes.

6.3.1.3 Soils

The soil in the study area is young like any other region of Himalayas. Soil on the slope above 30deg, due to erosion and mass wasting processing, are generally shallow and usually have very thin surface horizons. As a part of field studies, soil samples from the catchment area were collected and analyzed for various physio-chemical parameters. The pH of soil at various sites lies within neutral range.

6.3.1.4 Land Use Pattern

The major land use category in the study area is forestland, which accounts for almost 81.83% of the study area. The other major category is barren land accounting for about 9.64% of the study area. The agriculture land accounts for about 3.32% of the study area. The area under snow cover and water bodies account for about 2.76% and 2.36% respectively of the study area.

Land use cover	**Area (ha)**	**Percentage of Study Area (%)**
Dense vegetation	19,999	39.73
Open vegetation	21,199	42.10
Forest area	41,198	81.83
Agriculture land	1,670	03.32
Barren land /pasture land	4,854	09.64
Water body	1,187	02.36

Snow covered area	1,389	02.76
Built-up area/Exposed rock	54	00.11
Total	50,352	100.00

Table 6.1 Land Use Pattern

6.3.1.5 Water Resources

River Sainj is the major tributary of the river Beas, originating from west of Rakti Dhar at an elevation of +5500 m. The total catchment area of river Sainj intercepted at the barrage site is 408 sq.km. of which 176 sq.km. is permanently under snow (above elevation of 4250 m). The minimum flow for 90% dependable year is observed as 4.82 cumec in the month of November.

6.3.1.6 Noise Environment

Baseline noise data has been measured for three seasons. The day time equivalent noise level in summer and monsoon seasons at various sampling stations ranged from 32 to 45 dB(A), 34 to 46 dB(A). Likewise, daytime equivalent noise level in winter season ranged from 37.5 to 39.6 at various sampling stations which were well within the permissible limit specified for residential area.

6.3.2 ECOLOGICAL ASPECTS

6.3.2.1 Flora

- The proposed project lies in the Sainj valley. The study area comes under Sainj, Forest Range and Jiwa Forest Range under the Great Himalayan National Park Conservation Area (GHNPCA).
- The forest types observed in the study area include, the Himalayan Chir Pine forest, Broad leaf forest, Conifer mixed with broad leaf forest, Secondary scrubsand Sub-tropical Riverine Forest.

- Chir Pine (Pinus roxburghii) is the dominant forest category in the catchment area. The coniferous tree species, e.g. Cedrus deodara form the top storey inter-mixed with species of Acer, Prunus, etc.
- Some of the endemic Himalayan taxa are also reported from the Sainj Valley

Threatened Status of Flora: Of the trees species observed in the study area, Betula alnoides, which is rare species, was reported during survey. This tree species is of economic importance. Amongst shrubs, Desmodium gangeticumand Sorbus acupariabelong to rare category. Two species of herbs (Bistorta macrophylla and polygonatum verticiltum) are also of rare categoryobserved in the study area.

6.3.2.2 Fauna

- The proposed project lies in the vicinity of the Great Himalayan National Park (GHNP).
- The primates are represented by rhesus macaque (Macaca mulatta) and common langur (Presbytis entellus) and are found to occur between 1440m and 3420 m.
- Rare and endangered species have been reported sited in the study area.

6.3.2.3 Fisheries

The river Sainj and its tributaries have variety of cold water fishes dominated by trout.

Scientific Name	Local Name
Schizothorax plagiostromus	Snow Trout
Schizothorax progastus	Snow Trout
*Schizothorax richardsonii**	Snow Trout
*Salmo trutta fario**	Brown trout
*Salmo gairdneri gairdneri**	Rainbow trout
Barilius spp.	-
Nemacheilus spp.	-

Table 6.2 Fish types

6.3.3 SOCIO-ECONOMIC ASPECTS

- A comprehensive socio-economic primary survey was carried-out in those villages where land is proposed to be acquired for the proposed Sainj hydro-electric project.
- As per the survey, the total affected population is of the order of 436 persons in 148 families. Males and females constitute about 54.36% and 40.82% of the total affected population respectively.
- About 39.45% of the project-affected population is illiterate/ not going to school. The remaining population (60.55%) is either literate or is presently continuing with their education.
- Practically all the affected families reared domesticated animals for milk, meat, eggs and labor. Cows are mainly reared for their milk. It was observed that bulls are used extensively for ploughing the agricultural fields.
- No family was houseless. About 37% of the houses were electrified.

CHAPTER7. PREDICTION OF IMPACTS

7.1 IMPACT ON WATER ENVIRONMENT

7.1.1 Water quality

A) Construction phase

Sewage from labour colony: The peak migrant population is likely to be of the order of 3,200. The quantum of sewage generated due to this population is expected to be of the order of 0.18 mld. Even at minimum flow, sufficient dilution is available.Thus, no significant impact on water quality of river Sainj is envisaged during construction phase.

Effluent from crushersand other sources: The effluent from the crushers and other sources, like adit, tunnel, would contain high suspended solids. It is proposed to treat the effluents in settling tanks. Thus, no significant impact is envisaged.

B) Operation phase

Effluent from project colony: During operation phase, only a small number of O&M staff will reside in the colony. The sewage generated would be provided biological treatment before discharge.

7.1.2 Sediments

The proposed project is envisaged as a runoff the river scheme with a barrage. At regular intervals, the gates of the barrage shall be opened to flush the sediments. Thus, in the proposed project, sedimentation problems are not anticipated

7.1.3 Water Resources and downstream users

The river stretch downstream of the barrage site upto the confluence point of tail race discharge will have reduced flow for a length of about 8km. In the intervening stretch, the flow shall be implemented by(i) releases of flushing discharges from desilting chamber, (ii) contribution of flow from various streams/nallahs in the confluence of tail race disposaland (iii) gates of barrage will remain open leading to continuous flow in the downstream river stretch during monsoon months.The river stretch downstream of the

barrage site upto the confluence point of tailrace discharge (about 8 km) will have reduced flow i.e. 0.60 cumec. However, the flow will be augmented by contribution of flow from Kartol nallah (2.5 km downstream) joining the Sainj river on its right bank and other small khads joining the river from the left bank, which are Kotli, Khad (4 km downstream), Shana Khad (6 km downstream) and Nuhara Khad (7.5 km downstream) of the barrage. Thus, river Sainj will not be completely dry, in the intervening stretch. The reduction in flow or drying of the river in the intervening stretch is not likely to have any adverse impact on the downstream users. This is mainly because of the fact that settlements/ villages within this dry stretch are not dependent on the water of river Sainj, as the villagers use water of small streams or nallahs flowing adjacent to their habitation.

7.2 Impact on Air Environment

Pollution due to fuel combustion: The major construction equipment would be operated through electricity. Therefore, fossil fuel combustion would be minimal. Diesel would be used only in contingency. Thus, no significant impact on ambient air quality is expected as a result of operation of various construction equipment.No significant impact is envisaged. Emissions from various crushers: During crushing operations, there would be emissions of dust particles. Minimal impact is expected during construction phase. Therefore, commissioning of cyclone is suggested. Further, the labour camps would be located on the leeward side of the crusher with respect to predominant wind directions.

7.3 Impact on Noise Environment

The operation of construction equipment is likely to have insignificant impact on the ambient noise level. However, blasting can have adverse impact on wildlife, especially along the alignment of the tunnel portion.

7.4 Impacts on Land Environment

Impacts due to quarrying: In a hilly terrain, quarrying is normally done by cutting a face of the hill. A permanent scar is likely to be left, once quarrying activities are over. With the passage of time, they become a potential source of landslide. Thus it is necessary to implement appropriate slope stabilization and quarry reclaiming measures.

Impacts due to muck disposal : A large quantity of muck is expected to be generated as a result of tunneling operations, construction of roads, etc. The same requires to be suitably disposed. Normally, muck is deposited in low lying areas or depressions.

Impacts due to land acquisition: The total land to be acquired for the project is 56.763 ha. A part of this land is required for labour camps, quarry sites, muck disposal storage of construction material, siting of construction equipment, which will be required temporarily and returned once the construction phase is over. Permanent acquisition of land is required for barrage axis, submergence area, project colony, etc.

7.5 Impacts on Ecology

7.5.1 Terrestrial Ecology

Increased human interferences: A large population (3,200) is likely to congregate in the area during the project construction phase. This population residing in the area may use fuel wood (if no alternate fuel is provided). Therefore, alternate fuel should be provided to such population. Further, community kitchens should be provided using LPG or diesel as fuel. Acquisition of forest land: The total forest land to be acquired is about 47.993 ha. Disturbance to wildlife: The operation of various construction equipmentand blasting is likely to generate noise. These activities can lead to some disturbance to wildlife population. Further, the project area does not fall in the migratory routes of animals.

Impacts on protected areas: During project operation phase, the accessibility to the area will improve due to construction of roads, which in turn may increase human interferences leading to marginal adverse impacts on the terrestrial ecosystem. Sainj Wildlife Sanctuary (SW S) and Great Himalayan National Park (GHNP)is located within the study area. However, no land of the SWS and GHNP is proposedto be acquired for the project.

7.5.2 Aquatic ecology

A) Construction phase

Due to construction of the proposed Sainj Hydroelectric Project, about 0.8 Mm3 of muck and debris would be generated at various construction sites. Based on the geological nature of the rock and engineering property of the soil, about 30% of the muck generated will be utilized as construction material. The remaining 70% would be dumped at designated sites.

B) Operation phase

The completion of Sainj Hydroelectric Project would bring about significant changes in the riverine ecology, as the river transforms from a fast-flowing water system to a quiescent lacustrine environment. Amongst the aquatic animals, it is the fish life which would be most affected. The migratory fish species, e.g. snow trout and brown troutare likely to be adversely affected due to obstruction created by the proposed barrage. With the completion of barrage, flow in the downstream stretch of the river would be reduced considerably more so during the lean period.

7.6 Impacts on Socio-Economic Environment

Impacts due to influx of labour force: During the construction phase a large labour force, including skilled, semi-skilled and un-skilled labour force of the order of about 3200 persons, is expected to immigrate into the project area. During the construction phase, the most important negative impact would be due to the temporary settling of labour force leading to filth, in terms of domestic wastewater, human waste, etc.

Economic impacts of the project: Apart from direct employment, the opportunities for indirect employment will alsobe generated which would provide great impetus to the economy of the local area. Various types of business like shops, food-stall, tea stalls, etc. Besides a variety of suppliers, traders, transporters will concentrate here and benefit immensely as demandwill increase significantly for almost all types of goods and services. The locals will avail these opportunities arising from the project and increase their income levels. With the increase in the income levels, there will be an improvement in the infrastructure facilities in the area.

Impacts due to land acquisition: Another most important deleterious impact during construction phase will be that, pertaining to land acquisition. About 56.763 ha of land

proposed to be acquired for the proposed Sainj hydro-electric project. Of this about 8.77 ha is private land (un-irrigated land). . It is observed that about 216 PAFs are likely to lose land (agricultural and/or homestead) in varying proportions.

8.1 Methods of Impact Identification

EIA Methodologies – These are structured approaches for accomplishing one or more of the basic activities**

* * Impact identification, preparation of a description of the affected environment, impact prediction and assessment, selection of the proposed action from the alternatives evaluated to meet identified needs and summarization and communication of information

- useful, although not specifically required, through out the impact assessment study with certain ones being of greater value for specific activities
- Instructive to use portions of several methodologies for certain requisite activities
- there is no "universal" methodology which can be applied to all project types in all environmental settings
- must be selected based on appropriate evaluation and professional judgment, used with continuous application of judgment relative to data inputs and analysis and interpretation of results.

Purpose and Usefulness of Methodology

- Insure that all pertinent environmental factors are included in the study
- Provide a means for the synthesis of information and the evaluation of alternatives on a common basis.
- Usage of structured methodologies can provide the basis for evaluation of alternatives using a common framework of decision factors
- Useful in evaluating the cost- effectiveness of proposed impact-mitigation (IM) measures
- Some methodologies have features which are particularly useful in communicating impact information in summary form example -a simple interaction matrix

In this project we have chosen two following methodologies for determining or predicting essential environmental impacts by100MW Sainj Hydroelectric Power Project by Himachal Pradesh Power Corporation Ltd. (HPPCL):

1.Interaction matrices

2.Checklist method

1. Interaction-Matrix Methodologies

One of the earliest types of EIA methodologies

"Simple Interaction Matrix" – displays project actions or activities along one axis, with appropriate environmental factors listed along the other axis of the matrix. When a given action or activity is expected to cause a change in an environmental factor, this is noted at the intersection point in the matrix and further described in terms of separate or combined magnitude and importance considerations.

Leopold et al.(1971) developed simple interaction matrix .

Features: 100 specified actions and 90 environmental items

- Matrix can be expanded or contracted.
- It is very useful as a gross screening tool for impact identification purposes, and it can provide a valuable means for impact communication by providing a visual display of the impacted items and of the major actions causing impacts.
- Summation of the number of rows and columns designated as having interactions can offer insight into impact assessment.
- Leopold matrix can also be utilized to identify beneficial as well as detrimental impacts through the use of appropriate designators such as plus and minus signs.

The matrices prepared for the 100MW Sainj project ,both during constructional and operational phase are shown in the appendix A1.

2 .Checklist Methodologies

Checklist methodologies range from simple listings of environmental factors to highly structured approaches involving importance weightings for factors and the application of scaling techniques for the impacts of each alternative on each factor. "Simple Checklists" represent lists of environmental factors which should be addressed; however, no information is provided on specific data needs, methods for measurement, or impact prediction and assessment. "Descriptive checklists" refer to methodologies that include lists of environmental factors along with information on measurement and impact prediction and assessment.

- Represent collective professional knowledge and judgment of their developers – have professional credibility and usability
- Provide structured approach for identifying key impacts
- Extensive checklists do not represent better lists
- Easily modified to make them more pertinent to particular project types in given locations
- Stimulate or facilitate interdisciplinary team discussions during planning, conduction and/or summarization of EISs
- Carefully define utilized spatial boundaries and environmental factors. Any special terminology or impact codes used within the checklist should also be defined
- Documentation of the rationale basic to identifying key factors and/or impacts should be accomplished. Factor impact quantification and comparison to pertinent standards can be helpful
- Factors and/or Impacts from simple and descriptive checklists can be grouped together to demonstrate secondary and tertiary impacts and/or environmental interrelationships
- Rationale and Methodology used for importance weights (assigned to environmental factors/Impacts) should be clearly delineated
- Key Impacts which should be mitigated can be identified through systematic usage of simple or descriptive checklist .

The checklists prepared for the 100MW Sainj project ,both during constructional and operational phase are shown in the appendix A2 & A3.

8.2 Rating of the Impacts

They are major, minor and intermediate level. Information expressed by means of ranks other than numerical values for magnitude and importance can be included in the impact scales associated with identification of an interaction. Scales have also been used to describe the probability of occurrence of an impact, with the scale ranging from low to intermediate to high probability of impact.

Rating of impacts, both during constructional and operational phase ,is done in the appendix A4 & A5.

Annexure-I
Approved Terms of Reference (TOR)

(113)

तार :
Telegram : PARYAVARAN,
NEW DELHI
दूरभाष :
Telephone : 2436 2827
टेलेक्स :
Telex : W-66166 DOE IN
FAX : 4360678

भारत सरकार
पर्यावरण एवं वन मंत्रालय
GOVERNMENT OF INDIA
MINISTRY OF ENVIRONMENT & FORESTS
पर्यावरण भवन, सी. जी. ओ. कॉम्प्लेक्स
PARYAVARAN BHAVAN, C.G.O. COMPLEX
लोधी रोड, नई दिल्ली-110003
LODHI ROAD, NEW DELHI-110003

J-12011/33/07-IA.I 12.7.2007

Supld Engineer
Sainj Project Construction Circle
Himachal Pradesh State Electricity Board
Sarabai, Bhunter
Dist. – Kullu
H.P.

Subject - Sainj HEP (100 MW) in village Niharni Kullu district H.P – SCOPING regarding.

Sir,

This has reference to your letter No. HPSEB/SPCC/DB-WAPCOS/07-544-46 dated 10.5.2007 on the above mentioned subject.. The above mentioned proposal was considered by the EAC on 22nd June 2007. It was noted that the proposal involve construction of 24.50 m. high & 35 m long diversion gated barrage is proposed near village Niharni in Kullu district on river Sainj and a underground power house, to be located on right bank of river Sainj near confluence of Jiwa Nallah and Sainj river, which will have two units of 50 MW each to provide installed capacity of 100 MW.

2. The project lies in the vicinity of Great Himalayan National Park (GHNP) and forms part of Eco-development Zone which serves as a buffer Zone for the GHNP. The boundary of Sainj wildlife Sanctuary is about 3 km from the barrage site. The PA informed that forestry department of H.P. Government has no objection for locating the project near GHNP. No area of sanctuary will be required for the project. About 57 ha land consisting of 48 ha forest land and 9 ha agricultural land will be required for the project. Expected cost of the project is Rs.661.58 crores.

3. The Ministry of Environment and Forests hereby accords clearance for pre-construction activities in the proposed site, as per the provisions of

Environmental Impact Assessment Notification, 2006, along with the following Terms of Reference (TOR), for preparation of EIA report, These TORs are in addition to the proposed TORs mentioned in the FORM 1.

i. Sediment load unit to be given
ii. Under soil properties electrical conductivity and depth to be included.
iii. For data on stream flow, sediment flow, water quality etc. minimum data also to be included.
iv. DBA and consequent DMP are to be performed and discussed in the EIA.

4. As per the provisions of the EIA Notification of 2006, you are requested to submit EIA/EMP report to the State Pollution Control Board / Committee for conducting Public Hearing/ Public Consultation.

5. All the issues discussed in the Public Hearing /Public Consultations shall be addressed to and incorporated in the final EIA/EMP report and submitted to the Ministry for considering the proposal for Environment clearance.

Yours faithfully,

(Dr. S. Bhowmik)
Additional Director

Copy to:

1. The Secretary, Power Development Department, Government of Himachal Pradesh, Simla, H P.
2. The Secretary, Department of Environment, Government of Himachal Pradesh, Simla, H P.
3. Member Secretary, Himachal Pradesh State Pollution Control Board, Simla, H P.
4. The Regional Office, Ministry of Environment & Forests, Chandigarh.
5. Guard file.

(Dr. S. Bhowmik)
Additional Director

K Att.: Mr V. K. Tiwari

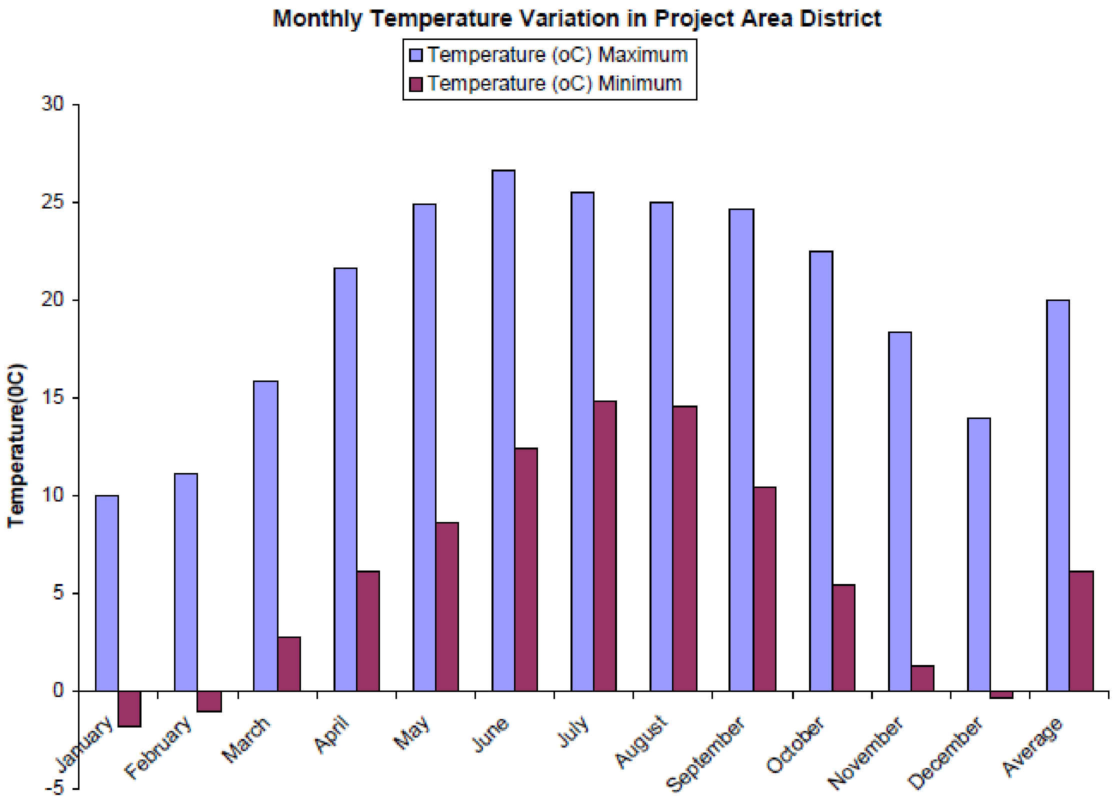
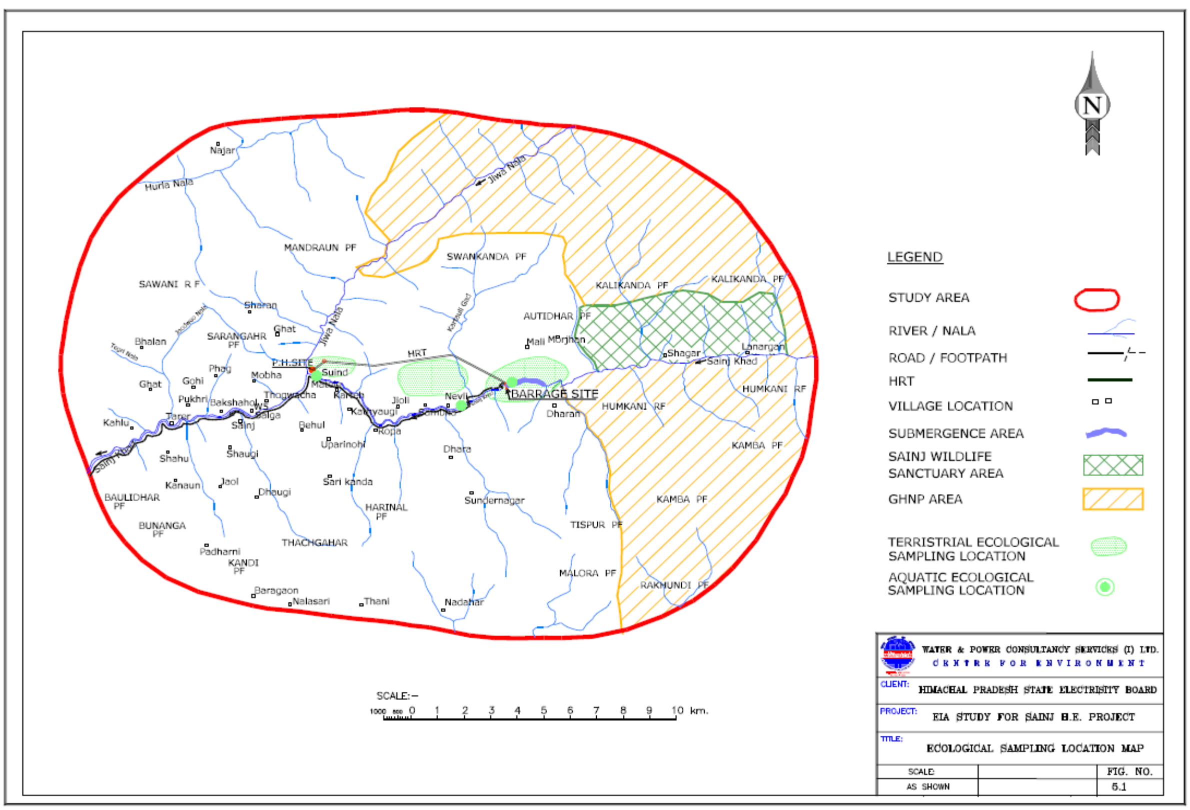
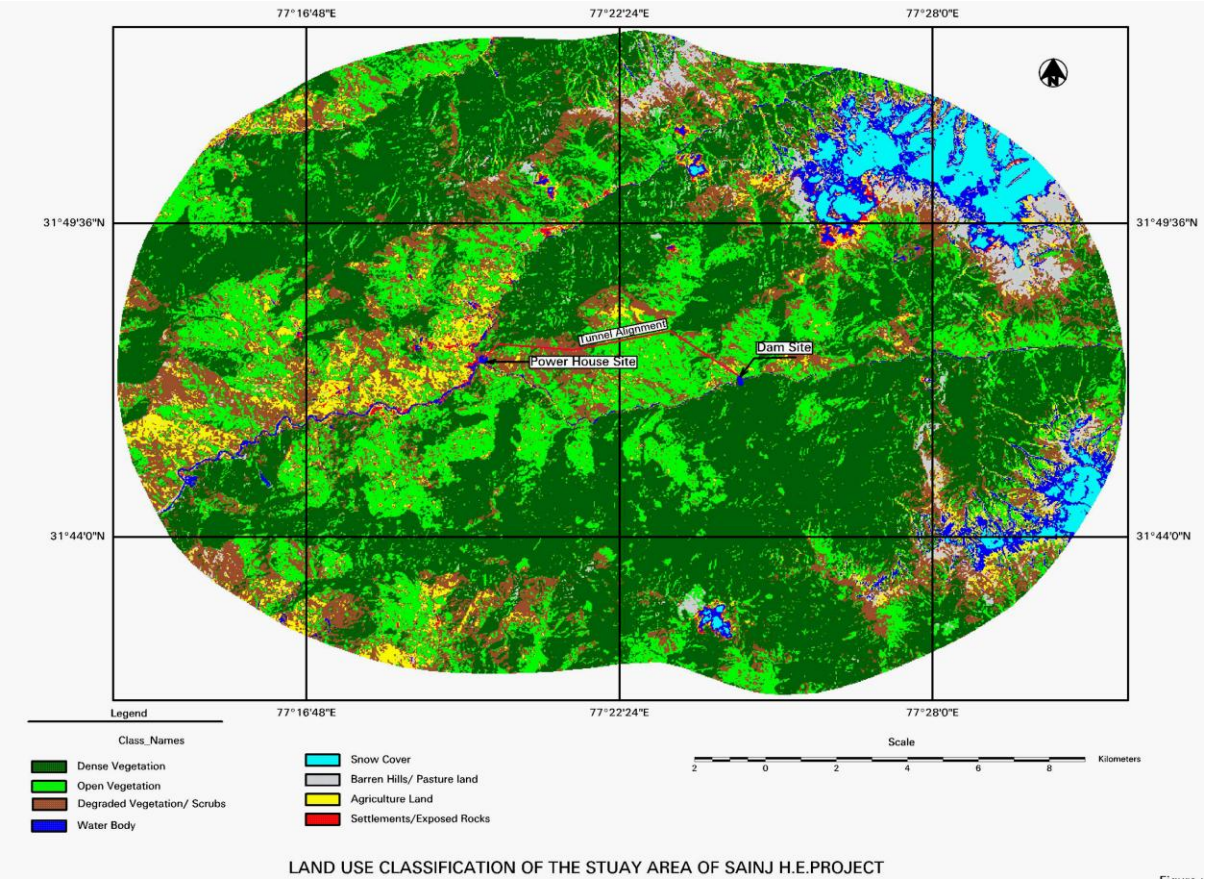

Monthly Temperature Variation in Project Area District
Temperature (oC) Maximum
Temperature (oC) Minimum
Temperature(0C)
30
25
20
15
10
5
0
-5
January
February
March
April
May
June
July
August
September
October
November
December
Average

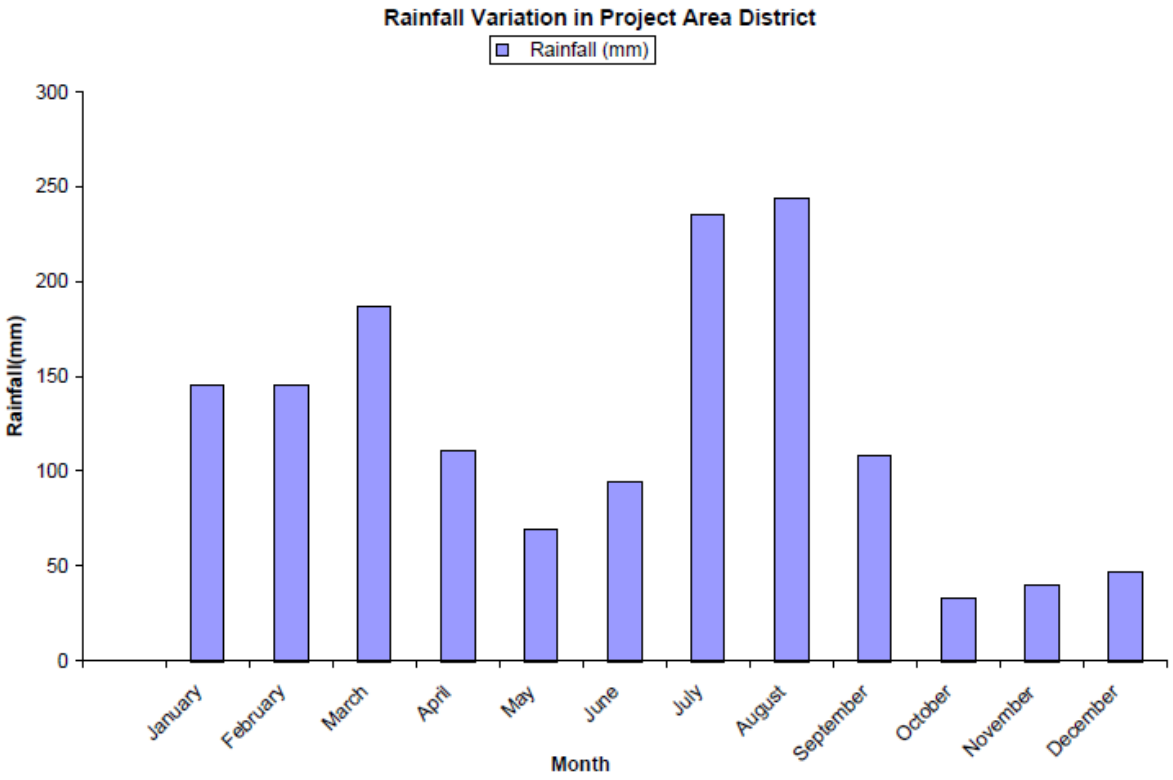
Table 8.2


N
LEGEND
STUDY AREA
RIVER / NALA
ROAD / FOOTPATH
HRT
VILLAGE LOCATION
SUBMERGENCE AREA
SAINJ WILDLIFE SANCTUARY AREA
GHNP AREA
TERRISTRIAL ECOLOGICAL SAMPLING LOCATION
AQUATIC ECOLOGICAL SAMPLING LOCATION
MANDRAUN PF
SWANKANDA PF
SAWANI R F
KALIKANDA PF
AUTIDHAR PF
HUMKANI RF
KAMBA PF
TISPUR PF
MALORA PF
RAKHUNDI PF
THACHGAHAR
HARINAL PF
BAULIDHAR PF
BUNANGA PF
KANDI PF
SARANGAHR PF
P.H.SITE
BARRAGE SITE
HRT
Jiwa Nala
Sainj Khad
SCALE:-
0 1 2 3 4 5 6 7 8 9 10 km.
WATER & POWER CONSULTANCY SERVICES (I) LTD.
CENTRE FOR ENVIRONMENT
CLIENT: HIMACHAL PRADESH STATE ELECTRICITY BOARD
PROJECT: EIA STUDY FOR SAINJ H.E. PROJECT
TITLE: ECOLOGICAL SAMPLING LOCATION MAP
SCALE: AS SHOWN
FIG. NO. 5.1



LAND USE CLASSIFICATION OF THE STUAY AREA OF SAINJ H.E.PROJECT

Table8. 4



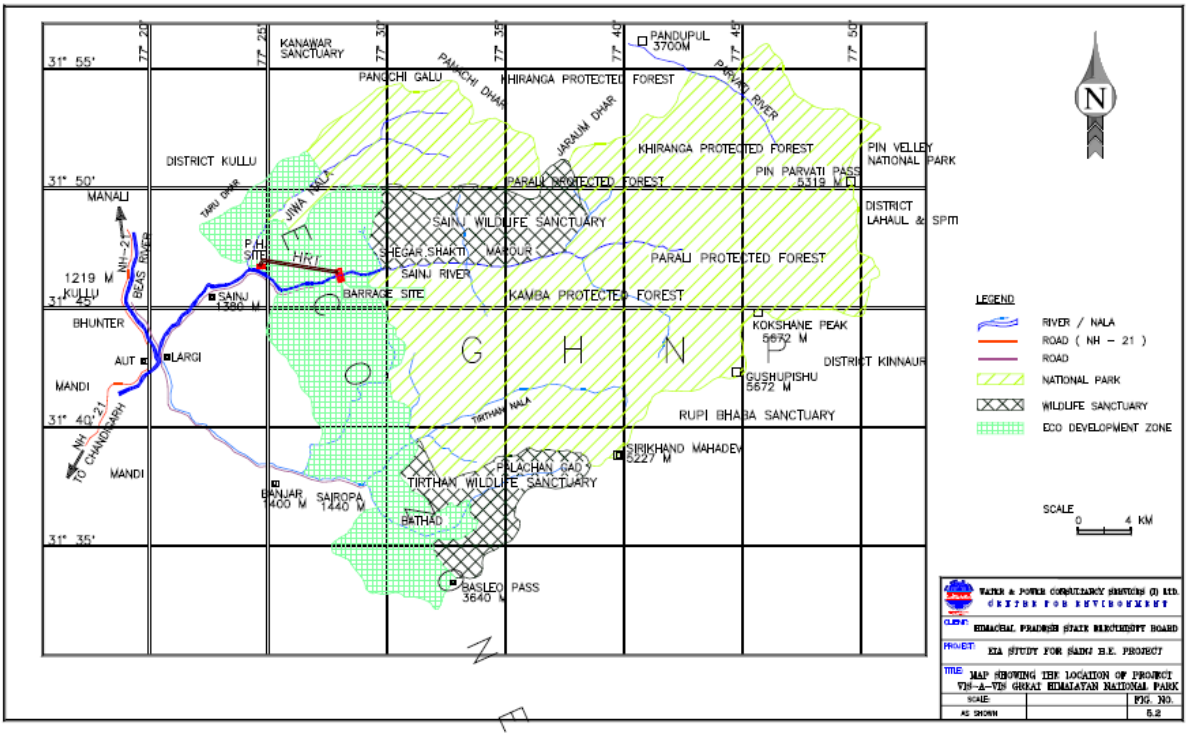


Table 8.5 Rainfall variation in Project area District

8.3 Anticipated Environmental Impact and Mitigation Measures

The impacts can be categorised as follows:

8.3.1 Environmental Impact Due to Project Location and design

The main adverse impact that the Project is likely to have on the environment, in terms of duration, extent, and severity, will be changes in the river hydrology, loss of agricultural and forestland, a decline in water quality, and resettlement, as outlined in the table below. Most of this impact will occur during project operation.

Features	Impact	Duration
Hydrology	Reduced river flows between barrage and tailrace outlet	Permanent
	Decline in river water quality	Permanent
Aquatic ecosystems	Altered river ecosystem	Permanent
	Prevention of upstream fish movement	Permanent
Land resources	Loss of agricultural and forest land	Permanent
Social	Resettlement of households	Permanent

Table 8.1 Primary Adverse Environmental and Social Impact of HEP

8.3.2 Altered Volume of River Flow

Being a glacier-fed river, the temperature as such is low. This along with other physical attributes has resulted in very low biological diversity in the river that is insufficient to support the fish population. In view of this, the impact that will result from the constructional and operational phase of the project is considered insignificant to the aquatic ecology of Sainj Hydropower Project. The water from Sainj River is not used for irrigation or drinking purposes owing to its low temperature and lack of irrigational facilities. There are neither many settlements along the river that need water from the river.

Environmental consideration requires a minimum flow into the river downstream of the diversion structures to meet the requirements for aquatic life, drinking water, wildlife, fisheries, riparian rights, and religious rites. The state's Hydro Power Policy of 2006 requires a minimum flow of 15% of water immediately downstream of the diversion structure of run-of-river schemes at all times including the lean season. It is strongly suggested that no more than 85% of the river water be diverted into the power channel, in conformance to the current practice being followed by MOEF(Ministry of Environment and Forestry) for grant of environmental clearance. The minimum flow has been worked out on the basis of the average of lean months' flow in December to February in a year of 90% dependability (as 1997 was) for Sainj river, and were measured at 3.90cumecs.

8.3.3 Land Acquisition and Land Use Conversion.

The impact of the Project includes: loss of land (agricultural and residential), structures (residential and community), income and livelihood (owners), and community and cultural sites. For the construction of the Project about 85.7 ha of land will be acquired from private owners and the Forest Department. Out of this 23.8 ha of land will be private land—agricultural land to be used for settlements, road construction, and project components. The land use of about 6.0 ha of private land for settlements will not change, as it will still fall under the land-use category "agriculture and settlement," but the land use of the balance of 17.8 ha will change from agriculture to forest, as extensive plantation in the area along roads and the dump area has been proposed. The underground components falling in forest area will not cause any impact on the

land use. Similarly the land use of forest area diverted for dump areas and quarry sites will not cause any impact on land use as these shall continue to be under forest land use class. Overall land requirement of the project is 85.7 ha out of which forestland is 61.9 ha and private land 23.8 ha.

8.3.4 Resettlement.

Since the project is a run-of-river type with trench weirs and hence no dam, no storage and therefore no submergence. Hence no dwellings, houses hamlets will be submerged. In fact, the area to be used for the Project is not populated; hence, no displacement or resettlement of population is involved. No rehabilitation is involved as no person is rendered landless. According to the socioeconomic survey, 4 villages are falling in affected zone. The field survey for demographic profile of affected villages revealed that in Pangi village, 11.8 ha private land will be affected. According to the land records and ground truth survey 253 household in Niharni village of Kullu district are likely to be affected due to the acquisition of land/house/shops for project. Only a part of the land is being acquired from the 253 households and none of the landowners is being displaced or is becoming land less/houseless.

Only one household is being resettled from the area being acquired for the Project in the village. Land of other three project affected villages has not yet been acquired. The affected household has expressed a preference to resettle within the vicinity of their present locations, to minimize disruption and to benefit from mutual support from kin groups, as well as new development opportunities generated by the Project. The Project will facilitate completion of relocation activities within a reasonable time frame. The affected households, whose agricultural lands have been acquired are using the compensation provided by HPPCL.

8.4 Environmental Impact of Pre-Construction and Construction Activities

The construction of the Sainj HEP will involve the removal of trees at the project site, excavation work, the installation of equipment, and civil works related to the construction of a desilting chamber, forebay, penstock, powerhouse, and other related works. Standard construction impact, pertaining mainly to specific construction activities, site disturbance, spoil

disposal, river flow disruption, and the influx of workers into the area, will occur.

8.4.1 Impact on Topography.

The topography will change during construction as tunnels are excavated, buildings put up, and fills and cuts made to level the power channel and construction powerhouse, forebay, desilting chamber, and penstock. Surface features will change as trees and soil are removed at the HEP powerhouse, trench weir, tunnel construction site, and all along the ROW to facilitate construction. The most conspicuous impact on the surface topography will be in the hilly region along the reserve forest for HEP. The impact will be local but irreversible as the presence of the HEP changes the features along the ROW.

8.4.2 Impact on Air Quality.

Dust emission from project's roads would be minimized by laying grits, ramming and compaction with regular water sprinkling. Besides, Project would be raising plantations (grasses, bushes, shrubs, and trees) along its roads not only to stabilize it but also reduce silt flow and reduce other adverse environmental impact like noise and air pollution. The adverse impact (on air, water, and noise levels) of operations aboveground will be negligible. During construction, excavation of the HEP channel and the movement of vehicles carrying construction materials will give rise to dust particles, temporarily affecting air quality at the site. Spraying the excavation site with water will greatly reduce the dust emission.

The ambient air quality recorded SPM concentration below the Central Pollution Control Board (CPCB) standard of 500 ug/m^3 for 24 hours for industrial areas. The level of gaseous air pollutants (SO_2 and NO_2) are also within limits. During major construction related activities i.e. site clearance, earth work excavation, blasting, boring, crusher operations and transportation of equipment, the marginal increase in the ambient air pollutants such as SPM, SO_2, and NO_2.

Exhaust Fumes from Vehicles.

Most of the machineries and equipments would be operating underground except transportation vehicles and DG sets. All machinery and vehicles are either electricity or diesel operated; as such SPM levels would not rise as ash contents are absent. DG set is only a standby arrangement to be run only is case of electricity breakdown. It would be located at tunnel and adit portals, which are away from habitations. Hence, its impact on air and noise environment would be negligible.

Combustion of fuel (diesel) emits SO_2. There may be short-term increase in SO_2 emissions, on assumption that all equipment operate at a common point and common time. Even that would be quite low (less than 04 $\mu g/m^3$). Hence, no major adverse impact on air quality is anticipated.

However, with the construction of the trench weir, powerhouse, colonies, and other infrastructure facilities in the area, air quality will be affected during construction. The movement of heavy vehicles and operation of other construction equipment will also add to the amount of noxious gases released into the atmosphere. The concentration of these kinds of gases and dust emission, however, will be cleared daily as the area is located in a valley and gusty winds are common in the morning and evening hours.

8.4.3 Impact on Terrestrial Ecology.

Land clearing, cutting, filling, and levelling may cause loss of vegetation, with irreversible impact on ecology. Transmission towers should not be located in thick vegetation to minimize tree loss and the need to compensate the tree owners. Tree cutting and compensatory afforestation must be done in consultation with the Forest Department of the state. Soil erosion generally results when herbaceous vegetation is removed from the soil and topsoil is loosened. But the impact would be confined primarily to the project site during the early stages of construction and must be minimized through paving and surface treatment, water sprinkling, and other mitigation measures.

8.4.4 Terrestrial Fauna.

Construction activities may disturb the fauna in the reserve forests and cause the animals to move elsewhere in the forest. Care will be taken not to disturb major wildlife habitat. Measures will include maintaining a greenbelt area around the project areas rich in vegetation. Restrictions on the number of trucks per hour and efforts to control noise levels will also help mitigate impact. There are no significant commercial fisheries that could be affected by the impact of construction on water quality.

8.4.5 Agriculture.

Agriculture will be affected by the permanent or temporary loss of agricultural land and crops due to construction activity. Land has already been acquired for the construction of the HEP. As far as possible, prime agricultural land has been avoided and in areas where the crop is standing,

construction will be done after crop harvesting. Adequate compensation will be given in exchange for the land and crops lost. The extent of land acquired for the Project and the compensation to be given are dealt with separately in the social assessment report.

8.4.6 Socioeconomics.

Job opportunities for the local population during construction will give great impetus to the local economy.

8.4.7 Resettlement.

The issues related to resettlement and rehabilitation are discussed separately in the social assessment report.

8.4.8 Cultural Sites.

There are no archaeological, historical or cultural important sites in the alignments for the barrage and the powerhouse; hence, no impact is envisaged in this regard.

8.4.9 Traffic and Transport.

Avoiding high-density areas, putting up proper traffic signs, providing proper access roads, and avoiding roadblocks will minimize traffic disturbance during construction.

8.4.10 Health and Safety.

Construction of the proposed project may have the following impact on the health of local residents and the workforce. The execution of the integrated Sainj HEP and appurtenant works is to be carried out under contract in 48 months' time. Infrastructure facilities will be developed at the same time. When construction starts the labor force of skilled, semiskilled, and unskilled labor will be deployed, and at a given point in time, a workforce of 1,200 will be engaged. The skilled manpower of about 360 persons will be imported from other parts of country.

8.4.11 Sewage.

The total construction time for the Project is about 4 years, which has the same processes as that of the Sainj project. At the peak of construction, there will be an estimated 1,200 workers, of which it is expected that 50% will be locally available. The domestic water requirement has been

estimated as 70 liters per person per day. Thus, total incremental water requirements work out to 42,000 liters per day. It is assumed that about 80% of the water supplied will be generated as sewage. Thus, total quantum of sewage generated is expected to be of the order of 33,600 liters per day. Community latrines and oxidation ditches can be constructed for the treatment of sewage from the labor camp so that it does not pollute the river water.

SOCIO-ECONOMIC ASPECTS

A comprehensive socio-economic primary survey was carried-out in those villages where land is proposed to be acquired for the proposed Sainj hydro-electric project. As per the survey, the total affected population is of the order of 436 persons in 148 families. Males and females constitute about 54.36% and 40.82% of the total affected population respectively.

About 39.45% of the project-affected population is illiterate/ not going to school. The remaining population (60.55%) is either literate or is presently continuing with their education. Practically all the affected families reared domesticated animals for milk, meat, eggs and labor. Cows are mainly reared for their milk. It was observed that bulls are used extensively for ploughing the agricultural fields. No family was houseless.

CHAPTER9. MITIGATION MEASURES FOR IMPACT MANAGEMENT

The objectives of this part are to collect "Good Practices" from all over the world with respect to specific measures that bring about favorable results at each stage of planning, constructing, and operating hydropower projects. These aim to avoid negative social and environmental impacts in implementing new hydropower projects and maintaining and managing existing hydropower plants and also to optimize the positive outcomes obtained and provide balanced and objective information to all the stakeholders including people who are directly affected by the projects.

Hydropower is a well established technology that uses using water without depleting it. It is the most reliable renewable energy and emits very low greenhouse gases. Yet, there is occasionally debate on the negative social and environmental impacts caused by some hydropower projects. These issues are now broadly understood by the scientific community and the general public. In awareness of these negative impacts, we are required to mitigate these impacts and to promote hydropower development that can be accepted by affected people and society. Based on our experiences and data, we need to clarify, what makes hydropower development sustainable, so that it is both technically and economically attractive as well as socially and environmentally friendly.

We decided to examine environmental impact mitigation measures.

Categories	Key Issue
A Biophysical Impacts	1. Biological Diversity 2. Hydrological Regimes 3. Fish Migration and River Navigation 4. Reservoir Sedimentation 5. Water Quality 6. Reservoir Impoundment
B Socio-Economic Impacts	7. Resettlements 8. Public Health

	9. Landscape and Cultural Heritages

Table 9.1 Mitigation Measures

9.1 BIOPHYSICAL IMPACTS

9.1.1 Biological Diversity

The following are the major measures taken to avoid loss of biodiversity.

- Understanding the influence of the project on the surrounding environment, and selection and implementation of appropriate conservation measures based on the environmental impact assessment

- Restricting the impacts on the ecosystem by constructing various types of structures underground

- Regeneration of vegetation by planting

- Conservation of a river ecosystem by maintaining flows capable of maintaining the river

- Implementing measures to prevent invasion of foreign species throughout the duration of projects ,including the construction period

- Follow-up studies after the measures are taken and evaluation of their effectiveness.

9.1.2 Hydrological Regimes

The following are the major measures taken to mitigate the influence of changes in hydrological regime.

- Recovery of a river ecosystem by keeping flow rates required for river maintenance

- Reservoir management considering the influence on local stakeholders

- Raising and maintaining river levels by installing weirs around estuaries

- Follow-up studies after the measures are taken and evaluation of effectiveness

9.1.3 Fish Migration and River Navigation

The following are the major measures taken to promote fish migration and to reduce mortality rates and damage to fish which pass through hydraulic turbines or spillways.

- Installation of a fishway in an existing dam, and implementation of measures to attract fish with a sodium lamp

- Installation of measures to direct fish at the intake (acoustic type, mercury lamp)

9.1.4 Reservoir Sedimentation

The following are the major measures taken to reduce or eliminate sediment flowing into reservoirs.

- Reduction of sediment by constructing flood bypass tunnels going around a reservoir

- Construction of small-scale weirs to trap earth and subsequent removal by dredging.

9.1.5 Water Quality

The following are the major measures taken to improve water quality in reservoirs and downstream areas.

- Temperature control considering the growth of fish by installing selective water intake facilities

- Reduction in water turbidity by selecting the operation of dams and constructing bypass tunnels

- Elimination the occurrence of abnormal odor or taste of the water in reservoirs by installing full thickness aeration and circulation facilities

- Reduction of outbreak of red tide in reservoirs by developing fresh water red tide treatment vessels

- Treatment of heavy metals discharged from copper mines located upstream of dam

9.1.6 Reservoir Impoundment

The following are measures taken to mitigate socialand environmental impacts relating to impoundment of reservoirs.

- Reductions in the scale of regulating reservoir levels and preservation of wetlands by maintaining appropriate water level

- Comparison of alternative reservoir water level reductions reflecting the results of environmental research.

9.2 SOCIO-ECONOMIC IMPACTS

9.2.1 Resettlement

The resettlement programs paying attention to the following points:

- Securement of employment opportunities so that resettled people may have a sustainable livelihood

- Maintenance of social infrastructure (roads, water services, communication establishments, schools, hospitals, etc.)

- Provision of sufficient information to communities and participation by the affected population in the resettlement process.

9.2.2 Public Health

-Deaths resulting from infectious diseases can be substantially reduced by improving various facilities including hospitals and community healthcare centers after resettlement.

- Information campaigns for communityinhabitants continuous monitoring of water quality and health risk assessment can be conducted when a temporary increase in mercury concentration of fish was caused by impoundment of the reservoir.

9.2.3 Landscape and Cultural Heritages

The following are the major measures taken to preserve natural beauty over the project area and protect cultural properties with high historic value:

- Design of power station buildings to conform with the surrounding landscape, on a project specific basis

- Design of soil dumps by a landscape designer considering the characteristics of surrounding areas

- Planting of soil dump sites and stone quarries based on the vegetation of the region

- Keeping the landscape of rivers in a natural environment as much as possible by constructing weirs using natural rocks to adjust the water level, and constructing small islands in impounded areas

- Restoration of the landscape surrounding an existing waterfall, during dam restoration work

RESULTS

- We have successfully completed the Environmental Impact Assessment taking a case of 100 MW Sainj HydroPower Project,HPPCL.In this we collected different Physcio-Chemical and Socio-Economic data and predicted various impacts of this project on environment.
- We tried to enlist the differences in EIA procedures in the developed and developing countries.
- Different methodologies using Excel Sheets to enhance impact prediction have been worked upon by us.
- In the end in order to eliminate serious Environmental Impacts or in some cases where total elimination is not possible, to reduce the effects of that impacts we have worked upon some "Good Practices in Hydropower" that can be followed in order to make the Hydropower projects Environmental friendly.

CONCLUSION

EIA certainly has a crucial role to play in addressing environmental issues surrounding project development and especially power projects. The integration of environment into development planning is the most important tool in achieving sustainable development. Environmental protection and economic development must thus be dealt with in an integrated manner. EIA process is necessary in providing an anticipatory and preventive mechanism for environmental management and protection in any development. Several developing countries are still at the infancy stage of operationalization of their EIA processes. The need for capacity building for quality EIA is also eminent in these countries.

Despite these small setbacks, environmental impact assessment has become an integral part of project planning one, which is continually being improved for posterity.

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ANNEXURE