Environmental Impact Assessment (Final Draft)

April 2018

IND: Assam Power Sector Investment Program – Tranche 3

120 MW Lower Kopili Hydroelectric Project

Volume 2: Annexures

Prepared by Assam Power Generation Corporation Limited (APGCL), Government of Assam for the Asian Development Bank.

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ANNEXURE PART 1 - ASSESSMENT DOCUMENTS

Annex 1: RAPID ENVIRONMENTAL ASSESSMENT (REA) CHECKLIST

HYDROPOWER

(As circulated with Categorization Form)

Instructions:

(i) The project team completes this checklist to support the environmental classification of a project. It is to be attached to the environmental categorization form and submitted to the Environment and Safeguards Division (RSES) for endorsement by Director, RSES and for approval by the Chief Compliance Officer.

(ii) This checklist focuses on environmental issues and concerns. To ensure that social dimensions are adequately considered, refer also to ADB's (a) checklists on involuntary resettlement and Indigenous Peoples; (b) poverty reduction handbook; (c) staff guide to consultation and participation; and (d) gender checklists.

(iii) Answer the questions assuming the "without mitigation" case. The purpose is to identify potential impacts. Use the "remarks" section to discuss any anticipated mitigation measures.

Country/Project Title:	IND/Assam Power System Investment Program – Tranche 3 (Lower Kopili Hydroelectric Project)
Sector Division:	SAEN

A. Basic Project Design Data

1. Dam height, m = 70.13
2. Surface area of reservoir, (ha) = 620
3. Estimated number of people to be displaced = 177 affected families
4. Rated power output, (MW) = 120

Other Considerations:

1. Water storage type: _x_ reservoir _x_ run of river
   ___ pumped storage
2. River diversion scheme: ___ trans-basin diversion ___ in-stream flow regulation
   _x_ in-stream diversion
3. Type of power demand to address: _x_ peak load _x_ base load

Screening Questions	Yes	No	Remarks
B. Project Location Is the dam and/or Project facilities adjacent to or within any of the following areas?			
▪ Unregulated river		x	There are 2 dams and reservoirs upstream, developed in 1980s. The proposed Lower Kopili Hydroelectric Project (LKHEP) was conceived as the final part of a cascade scheme including the tow upstream facilities.
▪ Undammed river tributaries below the proposed dam	x		Around 6 tributaries to the Kopili River before confluence with Brahmaputra.
▪ Unique or aesthetically valuable land or water form		x	
▪ Special area for protecting biodiversity		x	Some state and district reserved forest will be acquired but these forest areas are not defined based on biodiversity value.
▪ Protected Area		x	
▪ Buffer zone of protected area		x	
▪ Primary forest		x	
▪ Range of endangered or threatened animals	x		A biodiversity assessment is being prepared. Database analyses indicate that the project area is not in a biodiversity hotspot and the impacts on endangered or threatened species should be minimal. There are anecdotal reports of elephants and Chinese pangolins in the project area which need to be confirmed via further surveys.
▪ Area used by indigenous peoples	x		Separate assessment will be conducted by the social safeguard team.
▪ Cultural heritage site		x	There are no cultural heritage sites identified in the project area.
▪ Wetland		x	
▪ Mangrove		x	
▪ Estuary		x	
C. Potential Environmental Impacts Will the Project cause…			
▪ short-term construction impacts such as soil erosion, deterioration of water and air quality, noise and vibration from construction equipment?	x		Temporary impacts due to construction activities.
▪ disturbance of large areas due to material quarrying?	x		Total amount of coarse material and fine aggregates required for the proposed project is estimated to be 1,245,000 m^3. Three sites have been selected for quarrying.
▪ disposal of large quantities of construction spoils?	x		The total amount of muck disposal is estimated to be 984971 m^3.

Screening Questions	Yes	No	Remarks
▪ clearing of large forested area for ancillary facilities and access road?	x		Total forest land to be acquired for the project is about 523 ha.
▪ impounding of a long river stretch?	x		The reservoir covers an area of 6.2 km^2.
▪ dryness (less than 50% of dry season mean flow) over a long downstream river stretch?	x		About 5 km of river channel will be partly dewatered; minimum environmental flow = 20% of dry season.
▪ construction of permanent access road near or through forests?	x		13.04 km of new access road will be constructed and involve removal of trees and vegetation.
▪ creation of barriers for migratory land animals	x		Anecdotal reports of elephants and Chinese pangolins in the project area. Additional surveys recommended to confirm presence, routes, and mitigation measures.
▪ loss of precious ecological values due to flooding of agricultural/forest areas, and wild lands and wildlife habitat; destruction of fish spawning/breeding and nursery grounds?		x	Project area is degraded due to human activity including complete loss of biota in the river due to upstream acid drainage. There is no high-value biodiversity in the area based on available reference material. Supplemental survey may be necessary as part of EMP.
▪ deterioration of downstream water quality due to anoxic water from the reservoir and sediments due to soil erosion?		x	Design and operations indicate minimal potential for anoxic conditions in reservoir (based on estimated Froude number which indicates low potential for reservoir stratification leading to anoxic conditions).
▪ significant diversion of water from one basin to another?		x	No inter-basin diversion
▪ alternating dry and wet downstream conditions due to peaking operation of powerhouse?	x		Project will run at a full capacity (baseload) in high-flow season and in peaking mode during low-flow season.
▪ significant modification of annual flood cycle affecting downstream ecosystem, people's sustenance and livelihoods?		x	Normal flow resumes below tailrace outlet of main powerhouse. Supplemental assessment to be conducted as necessary as part of EMP.
▪ loss or destruction of unique or aesthetically valuable land or water forms?		x	
▪ proliferation of aquatic weeds in reservoir and downstream impairing dam discharge, irrigation systems, navigation and fisheries, and increasing water loss through transpiration?		x	River has a very low nutrient load, low sediment load and no fish population. River is not navigable in the project area.
▪ scouring of riverbed below dam?		x	No evidence of scouring at upstream dam which have been operation since late 1980s.
▪ downstream erosion of recipient river in trans-basin diversion?		x	Not applicable.
▪ increased flooding risk of recipient river in trans-basin diversion?		x	Not applicable.
▪ decreased groundwater recharge of downstream areas?	x		Potential impacts limited to partially dewatered channel between dam and powerhouse. Bedrock in project area is granitic; very low porosity & permeability. Inherently low groundwater storage volume.
▪ draining of downstream wetlands and riparian areas?		x	

Screening Questions	Yes	No	Remarks
▪ decline or change in fisheries below the dam due to reduced peak flows and floods, submersion of river stretches and resultant destruction of fish breeding and nursery grounds, and water quality changes?		x	River ecology deteriorated due to upstream acid mine drainage. Feasibility assessment will be conducted to determine if water quality can be restored using anoxic limestone drains and constructed wetlands.
▪ loss of migratory fish species due to barrier imposed by the dam?		x	Upstream acid drainage has killed fish and other biota in the river. There is an opportunity for restoration and ecosystem rehabilitation.
▪ formation of sediment deposits at reservoir entrance, creating backwater effect and flooding and waterlogging upstream?	x		River has very low visible sediment load. There is no visible evidence of these potential impacts at the existing upstream reservoir.
▪ significant disruption of river sediment transport downstream due to trapping in reservoir?	x		Minimal sediment present and sediment sluicing is incorporated in the design.
▪ environmental risk due to potential toxicity of sediments trapped behind the dams?	x		No industries upstream except for 2 cement plants, 1 of which appears to be abandoned. Upstream acid mine drainage may cause acid sediments.
▪ increased saltwater intrusion in estuary and low lands due to reduced river flows?		x	Not applicable.
▪ significant induced seismicity due to large reservoir size and potential environmental hazard from catastrophic failure of the dam?	x		Seismic assessment has been conducted and design parameters have been established.
▪ cumulative effects due to its role as part of a cascade of dams/ reservoirs?	x		Cumulative and induced impact assessment to be conducted.
▪ depletion of dissolved oxygen by large quantities of decaying plant material, fish mortality due to reduced dissolved oxygen content in water, algal blooms causing successive and temporary eutrophication, growth and proliferation of aquatic weeds?		x	Minimal potential for biomass accumulation and minimal potential for anoxic conditions. (See notes above on ecosystem degradation due to upstream acid drainage).
▪ risks and vulnerabilities related to occupational health and safety due to physical, chemical, biological, and radiological hazards during project construction and operation?	x		Occupational health and safety standards will be followed as well as industry guidelines/standards on construction, operation and maintenance.
▪ large population influx during project construction and operation that causes increased burden on social infrastructure and services (such as water supply and sanitation systems)?	x		Contractors will be encouraged to recruit local labor to the maximum extent. Contractors will be required to provide adequate sanitation facilities, solid waste management, etc., and implement HSE program in accordance with best practices.
▪ creation of community slums following construction of the hydropower plant and its facilities?		x	
• social conflicts if workers from other regions or countries are hired?	x		Social safeguards team to provide assessment. Contractors will be encouraged to recruit local labor to the maximum extent.
▪ uncontrolled human migration into the area, made possible by access roads and transmission lines?		x	Project area is adjacent to existing state road.
▪ disproportionate impacts on the poor, women, children or other vulnerable groups?	x		Additional assessment being conducted by social safeguards team.

Screening Questions	Yes	No	Remarks
▪ community health and safety risks due to the transport, storage, and use and/or disposal of materials likely to create physical, chemical and biological hazards?	x		Nearby communities will be relocated due to reservoir impoundment. Routine risks, e.g., from fuel storage and potential spills, explosives used for tunneling, which pertain mainly to construction workforce.
• risks to community safety due to both accidental and natural hazards, especially where the structural elements or components of the project (e.g., dams) are accessible to members of the affected community or where their failure could result in injury to the community throughout project construction, operation and decommissioning?	x		Access to project facilities will be restricted. Catastrophic dam failure is always a remote but theoretical possibility. Project facilities will be designed to meet expected seismic and meteorological risks: 30+ years of operations of upstream Kandhong and Umrangso hydropower plants suggested that potential for catastrophic incidents is extremely low.

Climate Change and Disaster Risk Questions The following questions are not for environmental categorization. They are included in this checklist to help identify potential climate and disaster risks.	Yes	No	Remarks
• Is the Project area subject to hazards such as earthquakes, floods, landslides, tropical cyclone winds, storm surges, tsunami or volcanic eruptions and climate changes (see Appendix I)? 1.		x	Project area is not subjected to any extraordinary risks.
▪ Does the Project use or depend on resources which could be affected by climate change such as changes in temperature, precipitation, or extreme events (e.g. increased erosion which reduces generation efficiency, glacial melt which could affect generation potential)?			
▪ Are there any demographic or socio-economic aspects of the Project area that are already vulnerable (e.g. high incidence of marginalized populations, rural-urban migrants, illegal settlements, ethnic minorities, women or children)?			
▪ Could the Project potentially increase the climate or disaster vulnerability of the surrounding area (e.g. by diverting water from areas where drought is increasing, or encouraging settlement in earthquake zones)?			

Note: Hazards are potentially damaging physical events.

Annex 2: DETAILED DESCRIPTION OF POLICY, LEGAL, AND ADMINISTRATIVE FRAMEWORK

1. INTRODUCTION

1. A comprehensive review of the relevant parts of the policies, acts, and regulations of Government of India (GoI) was carried out, as required for the EIA process for the LKHEP project and Associated Facilities.[1] This included a description of environmental policy framework, relevant legislation and standards, etc., that will assist the Executing Agency (EA) in compliance with the various Acts, Rules, and Standards. In this section, the procedure for obtaining environmental clearance (EC) from the Ministry of Environment, Forests, and Climate Change (MoEF&CC) is also described, along with a checklist of environmental permits/clearances required for the proposed project and also to meet India's international commitments. The social related policies, key legal instruments and international best practices applicable to tribal rights and their involuntary displacement are included in Combined Resettlement and Tribal Development Plan (RTDP) document; section IV – Policy and Legal Framework.

2. The LKHEP project will also be guided by IFC's and ADB Policies, Guidelines and Performance Standards.

3. This chapter is arranged as follows:

2. National Environmental Policy Framework
3. National Environmental Statues and Legislation
4. Social Regulatory Requirements of India and State
5. Occupational Health and Safety
6. State of Assam Statues and Legislation
7. National Applicable Environmental Standards
8. Governance Structures for LKHEP and Associated Facilities
9. Procedures to Obtain Environmental Clearance In India
10. Category of The Project And Corresponding EC Applicability
11. Environmental Permits/Clearances Required for the Project
12. International Agreements and Commitments
13. International Labor Organization Conventions
14. IFC EHS Guidelines
15. ADB Safeguard Policy Statement 2009
16. ADB Prohibited Investment Activities List (PIAL)

[1] Power evacuation system viz 220 kV DC TL from MPH site of LKHEP to existing 132 kV S/S at Sankardev Nagar; upgrade of existing 132 kV S/S to 220 kV S/S at Sankardev Nagar; and 33 kV SC TL from APH site of LKHEP to existing 132 kV S/S at Umrangsu.

2. NATIONAL ENVIRONMENTAL POLICY FRAMEWORK

S. No.	Name of Policy	Applicability	Brief Description
1	National Forest Policy 1988[2]	Yes	The National Forest Policy 1988 emphasizes the role of forests in the national economy and in ecology. The basic objectives of National Forest Policy are given below: • Maintenance of environmental stability through preservation and where necessary, restoration of the ecological balance that has been adversely disturbed by serious depletion of the forests of the country; • Conserving the natural heritage of the country by preserving the remaining natural forests with the vast variety of flora and fauna, which represent the remarkable biological diversity and genetic resources of the country; • Checking soil erosion and denudation in the catchment areas of rivers, lakes, and reservoirs in the interest of soil and water conservation, for mitigating floods and droughts and for the retardation of siltation of reservoirs; • Checking the extension of sand dunes in the desert areas of Rajasthan and along the coastal tracts *(Note: not applicable to LKHEP project)*; • Increasing the sustainability of the forest/tree cover in the country through massive afforestation and social forestry programmes especially on all denuded degraded and unproductive lands; • Meeting the requirements of fuel wood, fodder, minor forest produce and small timber of the rural and tribal populations; • Increasing the productivity of forests to meet essential national needs; • Encouraging efficient utilization of forest produce and maximizing substitution of wood; and • Creating a massive people's movement with the involvement of women for achieving these objectives and to minimize pressure on existing forests.
2	Policy statement for Abatement of Pollution, 1992[3]	Yes	The policy takes a comprehensive approach to integrate environmental and economic aspects in development planning; stress is laid on preventive aspects for pollution abatement and promotion of technological inputs to reduce industrial pollutants; and through reliance upon public cooperation in securing a clean environment to respond to the coming challenges. The objective is to integrate environmental considerations into decision making at all levels. To achieve this, steps have to be taken to:

[2] http://www.moef.gov.in/sites/default/files/introduction-nfp.pdf
[3] http://www.moef.gov.in/sites/default/files/introduction-psap.pdf

S. No.	Name of Policy	Applicability	Brief Description
			• Prevent pollution at source; • Encourage, develop and apply the best available practicable technical solutions; • Ensure that the polluter pays for the pollution and control arrangements; • Focus protection on heavily polluted areas and river stretches; and • Involve the public in decision making.
3	National Conservation Strategy and Policy Statement on Environment and Development, 1992[4]	Yes	The policy lays emphasis on conservation of natural resources such as Land and Water, Atmosphere, Biodiversity and Biomass.
4	National Environmental Policy, 2006[5]	Yes	The dominant theme of this policy is that while conservation of environmental resources is necessary to secure livelihoods and well-being of all, the most secure basis for conservation is to ensure that people dependent on particular resources obtain better livelihoods from the fact of conservation than from degradation of the resource.
5	Water Policy of India, 2002[6]	Yes	National Water Policy of India with respect to hydropower generation states that "water resource development projects should to the extent possible, be planned and developed as multipurpose projects. Provision of drinking water should be a primary consideration. The projects should provide for irrigation, flood mitigation, hydroelectric power generation, navigation, pisciculture and recreation wherever possible".
6	Wildlife Conservation Strategy 2002[7]	No	Conservation of wildlife, involves the protection of entire ecosystems. As per the Wildlife Conservation Strategy, no diversion of forest land for non-forest purposes from critical and ecologically fragile wildlife habitat shall be allowed. Lands falling within 10 km of the boundaries of National Parks and Sanctuaries are identified and/or notified as eco-fragile zones or ecologically sensitive areas (ESA). Notifications declaring areas as ESAs are issued under the Environment (Protection) Act 1986, and the process is ongoing. Therefore, all projects/activities being conceptualized, developed, implemented or funded within 10 km of wildlife sanctuaries or national parks should take note of the measures suggested in this Strategy document.

[4] http://www.moef.gov.in/sites/default/files/introduction-csps.pdf
[5] http://www.tnpcb.gov.in/pdf/nep2006e.pdf
[6] http://www.indiawaterportal.org/sites/indiawaterportal.org/files/National%20Water%20Policy_%28MoWR%29_2002.pdf
[7] http://www.moef.nic.in/sites/default/files/WILDLIFE%20CONSERVATION%20STRATEGY%202002.pdf

S. No.	Name of Policy	Applicability	Brief Description
			Note: The LKHEP project and Associated Facilities will not affect any areas within 10 km of wildlife sanctuaries or national parks of Assam.
7	National Policy on Hydropower Development, 1998[8]	Yes	The Hydropower Development Policy has an objective to prevent a decline in hydro share and to undertake measures for maximizing vast hydroelectric potential in India especially in the North and Northeastern Regions including Assam. As per the India's 11th Plan, hydro stations account for only 25% of the total installed capacity as against the ideal hydro - thermal mix of 40:60. The total hydro potential assessed by Central Electricity Authority (CEA) at 60% load factor is 84,044 MW. With the completion of the hydro projects under current construction the hydro potential utilized would increase to 22%. The objectives of the policy include the following: • Ensuring targeted capacity addition during 9th Plan (and the subsequent plans – the 11th Plan targets total capacity addition of 15,627 MW in the hydropower sector)[9]; • Exploitation of vast hydroelectric potential at a faster pace; • Promoting small and mini hydro projects; • Strengthening the role of Public Sector Undertaking (PSUs) /State Electricity Boards (SEBs) for taking up new hydro projects; • Increasing private investment in development of hydropower; • Supporting public sector by greater private investment through Independent Power Producers (IPPs) and joint ventures; and • Consideration of private sector participation as vital for large scale development of hydropower.
8	Policy for Development of Small Hydropower (SHP) 2007 Assam[10]	No	Applicable to projects up to 25 MW
Guidelines			
9	National Board for Wildlife (NBWL)[11]	Yes	Provides guidelines for linear infrastructure intrusions in natural areas pertaining to roads and power lines; stipulates that 'to prevent electrocution deaths of Asian elephants, the height above the ground at the lowest point of the lowest conductor or grounding wires (at the maximum sag point) of power lines, whether insulted or bare, passing through all natural areas with known presence or movement of Asian elephants, shall be a minimum of 20 ft. (6.6 meters) above the ground on level terrain

[8] http://powermin.nic.in/Policy-Hydro-Power-Development
[9] http://planningcommission.nic.in/plans/planrel/fiveyr/12th/pdf/12fyp_vol2.pdf
[10] http://www.apgcl.org/Assam%20SHP%20Policy%20Aug%2016,%202007.pdf
[11] http://www.moef.nic.in/legis/wildlife/so1092(e).htm

S. No.	Name of Policy	Applicability	Brief Description
			(less than 20 degrees) and a minimum of 30 feet (9.1 meters) above the ground on steeper terrain (slope of more than 20 degrees).[12] These standards have been implemented while designing the 220 kV power transmission line from LKHEP to the Lanka substation.
10	Central Electricity Authority (CEA)[13]	Yes	The Central Electricity Authority (CEA) is tasked with performing the duties related to monitoring of the hydropower projects in pursuance of 73 (f) of Electricity Act, 2003. The progress of each project is monitored continuously through frequent site visits, interaction with the developers, and critical study of monthly progress reports. Chairperson, CEA holds review meeting with the developers and other stakeholders to sort out the critical issues. The CEA also provides guidelines for laying transmission and distribution lines in areas critical from the point of view of saving wildlife. The guidelines suggest provision of suitable spikes provided e.g. on 33 kV and 11kV poles at the height of 1.21 meters (four feet) and 2.1 meters (seven feet) to ward off animals coming close to the poles and damaging them by rubbing their bodies against them, particularly elephants. These standards have been implemented while designing the 33kV construction power line from LKHEP to the Umrangso substation.

3. NATIONAL ENVIRONMENTAL STATUES AND LEGISLATION

S. No	Environmental Statutes and Legislation	Applicability	Duration of Compliance	Brief Description
1	The Environmental Impact Assessment (EIA) Notification, 2006 and Amendments (up to 2012)	Yes	Pre-Construction, Construction and Operation	The Notification imposes restrictions and prohibitions on new projects or activities and also on the expansion or modernization of existing projects or activities based on their potential environmental impacts. **LKHEP:** As per EIA Notification, 2006 of GoI hydroelectric power generation projects have been classified under Category A, item 1 (c) “River Valley projects” of the EIA Notification, 2006 and require preparation of an EIA Report and Environmental Clearance (EC). Whenever

[12] http://envfor.nic.in/assets/FIRSTDraft%20guidelines%20roads%20and%20powerlines.pdf
[13] http://www.cea.nic.in/

S. No	Environmental Statutes and Legislation	Applicability	Duration of Compliance	Brief Description
				a project is accorded an EC, a set of recommendations and conditions are stipulated by the Appraisal Committee for compliance by the Project Proponent / investor while the project is under implementation and later under operation. **Associated Facilities:** As per EIA Notification, 2006 of GoI, power transmission and distribution projects are not listed as environmentally sensitive projects and hence, no Environmental Clearance (EC) is required from the MoEF&CC or from the State-level Environment Impact Assessment Authority. Clearance from the Assam Forest Department is required only in cases where a project is constructed on forestland or requires cutting of forest trees.[14] An EMP for the 220kV transmission line has been prepared as part of the EIA as per SPS 2009 requirements. Refer *to Section 1.9 of this Chapter for procedures for obtaining an EC in India corresponding to the category of the project.*
2	The National Environmental Appellate Authority Act, 1997	Yes	Pre-construction and Construction	This Act was established to hear grievances arising out EC cases under the Environmental Protection Act (EPA), 1986 by the establishment of a National Environment Appellate Authority (NEAA). A person aggrieved by an order granting environmental clearance in a given area for establishing an industry may, within 30 days from the date of such an order, appeal to the NEAA. The appellant can be a person, who owns or controls the project, an association of persons, Central or State Government or any local authority. The Authority shall dispose of the appeal within 90 days from the date of filing the appeal.

[14] Assam Forest Department; web-link: http://assamforest.in/common/

S. No	Environmental Statutes and Legislation	Applicability	Duration of Compliance	Brief Description
3	National Environment Tribunal Act, 1995	Yes	Pre-construction, Construction and Operation	The National Environment Tribunal Act prescribes the procedure and substantive law relating to compensation for the death of, or injury to, a person and damage to property and environment, by any industry wherein a hazardous substance is used or is a by-product. It also provides for the establishment of a National Environment Tribunal for effective and expeditious disposal of such grievances. The tribunal would have jurisdiction over matters specified in the Public Liability Insurance Act, 1991. The tribunal would receive claims of compensation by the person who has sustained the injury or by his or her legal representative.
4	National Green Tribunal Act, 2010	Yes	Pre-construction, Construction and Operation	This Act provides for the establishment of National Green Tribunal for the effective and expeditious disposal of cases relating to environment protection, conservation of forests and other natural resources, and giving relief and compensation for damages to persons and property. The tribunal has jurisdiction over all civil cases relating to environment. It would deal with all environmental laws on air and water pollution, the Environmental Protection Act (EPA), the Forest Conservation Act (FCA), and the Biodiversity Act. Also the relief and compensation under this act is in severance to the relief paid under Public Liability Insurance Act, 1991.
5	The Biodiversity Act, 2002 and Rules, 2004	Yes	Pre-construction, Construction and Operation	Umbrella legislation aimed at conservation of biological resources and associated knowledge as well as facilitating access to them in a sustainable manner and through a just process.
6	Wetlands (Conservation & Management) Rules, 2010	No	-	Provides restriction of activities such as solid waste dumping, reclamation, setting up of new industries on ecologically sensitive and /or protected wetlands. *Note: The LKHEP project and Associated Facilities will not affect any wetlands.*
7	The Wildlife (Protection) Act, 1972 and Amendments (2006); The Wildlife Protection Rules	No		All projects/activities being conceptualized, developed, implemented and/or funded within wildlife sanctuaries or national parks should take cognizance and comply

S. No	Environmental Statutes and Legislation	Applicability	Duration of Compliance	Brief Description
	1995			with the provisions of these rules and obtain required clearances from the National Board for Wildlife /Chief Wildlife Warden. *Note: LKHEP project and Associated Facilities will not affect any Wildlife Sanctuaries and/or National Parks.*
8	The Indian Forest Act, 1927	Yes	Pre-construction	All projects/activities being conceptualized, developed, implemented and/or funded within forests should take cognizance and comply with the provisions of these rules and obtain required clearances from the MoEF&CC
9	Forest (Conservation) Act, 1980, and Amendments (1988) • Forest (Conservation) Rules, 1981, Amendments 1992 and 2003 • Guidelines for diversion of forest lands for non-forest purpose under the Forest (Conservation) Act, 1980	Yes	Pre-Construction, Construction and Operation	**Forest Clearance:** The MoEF&CC has gazetted a statutory notification called the Forest (Conservation) Act, 1980. According to this Act permission of MOEF&CC is required for use of any forest land. The application form for forest clearance includes: project description; detailed map; alternatives and reasons for rejection of alternatives; population benefited; employment granted; details of flora and fauna in the area; density and other specific details of vegetation; status as wildlife sanctuary, biosphere reserve, national park, nature reserve; rare or endangered species; habitat for migrating fauna; vulnerability to erosion; number of displaced families; scheduled caste/scheduled tribes involved in displacement; rehabilitation plan; and details of the compensatory afforestation (CA) scheme. The application includes a detailed route marked on Survey of India map. The Project Proponent submits forest clearance applications to the concerned Divisional Forest Officer (DFO). The locations of reserved forest (RF) and protected forest (PF) are checked and marked on a map, and the forest clearance application in the required format is prepared jointly by Project Proponent and the Forest Department. **Forest Diversion:** For diversion of forestland in Wildlife Sanctuaries / National Parks: in view of the orders of the Supreme

S. No	Environmental Statutes and Legislation	Applicability	Duration of Compliance	Brief Description
				Court of India, the State Governments have been advised not to submit any proposal for diversion of forestland under FCA, 1980 without seeking prior permission of the Supreme Court. For seeking permission of Supreme Court, the Project Proponent should submit the proposal to the Chief, Wild Life Warden (CWLW) in the prescribed Performa. For small development and public utility projects involving diversion of forest land up to 5 Hectares (ha), the State Government may authorize the Nodal Officer or any other officer to submit the proposals directly to the Regional Office of the MoEF&CC. All proposals relating to diversion of forest land up to 40 ha shall be sent directly to the concerned Regional office of the MoEF&CC by the State Government. All other proposals shall be sent by the State Government to the Secretary, MoEF&CC. **Guidelines for ROW:** The Act also offers guidelines on the right-of-way (RoW) and tree cutting. Where routing of transmission / distribution lines through the forest areas cannot be avoided, these should be aligned in such a way that it involves the least amount of tree cutting. Below each conductor, a width clearance of 3 meters (m) would be permitted for the movement of tension stringing equipment. The trees on such strips would have to be felled if necessary but after stringing work is completed, and the natural vegetation will be allowed to regenerate. Felling/pollarding/pruning of trees will be done with the permission of the local forest officer whenever necessary to maintain the electrical clearance. One outer strip shall be left clear to permit maintenance of the power line. Under the Act: • For transmission line voltage of 220 kV, the width of ROW is equal to 25 m

S. No	Environmental Statutes and Legislation	Applicability	Duration of Compliance	Brief Description
				• For transmission line voltage of 132kV, the width of ROW is equal to 18 m to 20 m • For distribution line voltage of 33 kV, the width of ROW is equal to 15 m and for distribution line voltage of 11 kV, the width of ROW is equal to 7 m *Note: APGCL has initiated the Forest Clearances with the Assam Forest Department for LKHEP project in November 2014; and is pending Stage I and II approval.* **Compensatory Afforestation (CA)** • If non-forest land is not available, compensatory plantation is to be established on degraded forest lands, which must be twice the forest area affected or lost. • If non-forest land is available, compensatory forest are to be raised over an area equivalent to the forest area affected or lost.
10	The Environment Protection Act, 1986; The Environment Protection Rules 1986 and Amendments (2009)	Yes	Pre-construction, Construction and Operation	The Environmental Protection Act (EPA) was introduced in 1986 as an umbrella legislation that provides a holistic framework for the protection and improvement to the environment, and the prevention of hazards to human beings, other living creatures, plants and property. In terms of responsibilities, the Act and the associated Rules requires for obtaining environmental clearances for specific types of new/expansion projects (addressed under EIA Notification, 2006) and for submission of an Environmental Statement to the State Pollution Control Board annually.[15] It empowers the Central Government to establish authorities charged with the mandate of preventing environmental pollution in all its forms and to tackle specific environmental problems that are

[15] Environmental Statement as per Rule 14 to the Environment (Protection) Rules, 1991

S. No	Environmental Statutes and Legislation	Applicability	Duration of Compliance	Brief Description
				peculiar to different parts of the country. It also empowers Central government to take measures necessary to protect and improve the quality of the environment by setting standards for emissions and discharges; regulating the location of industries; management of hazardous wastes, and protection of public health and welfare.
11	The Air (Prevention and Control of Pollution) Act, 1981; The Air (Prevention and Control) Rules 1982 and Amendments (1988)	Yes	Construction and Operation	The Act prohibits the construction and operation of any industrial plant without the consent of State Pollution Control Boards (SPCBs). The Act assigns powers and functions to the Central Pollution Control Board (CPCB) and the SPCBs for prevention and control of air pollution and all other related matters. For the prevention and control of air pollution, the State Government, in consultation with the SPCB has the powers to set standards for emissions from automobiles, impose restrictions on use of certain industrial plants and prohibit emissions of air pollutants in excess of the standards laid down by the SPCB. It can also make an application to the court for restraining persons from causing air pollution. In addition, it also has the power of entry and inspection, power to obtain information and power to take samples of air emissions and conduct the appropriate follow up. The Act also allows for appropriate penalties and procedures for non-compliance. This Act empowers the CPCB and SPCBs for prosecuting offenders and issuing licenses for construction and operation of any facility. National ambient air quality standard for different regions e.g. industrial, residential is notified under this Act. Air quality monitoring during construction and operation phases, particularly for obtaining consent for establishment and operation will be done under this Act. To empower the Central and State Pollution Boards to meet grave emergencies, the Air (Prevention and Control of Pollution) Amendment Act, 1987, was

S. No	Environmental Statutes and Legislation	Applicability	Duration of Compliance	Brief Description
				enacted. The Boards were authorized to take immediate measures to tackle such emergencies and recover the expenses incurred from the offenders. The power to cancel consent for non-fulfillment of the conditions prescribed has also been emphasized in the Air Amendment Act.
12	Water (Prevention & Control of Pollution) Act, 1974 Water (Prevention & Control of Pollution) Rules, 1975 and Amendments (1989)	Yes	Construction and Operation	It provides for the prevention and control of water pollution and the maintaining or restoring of water for any establishment. All projects/activities/industries that are being developed, implemented, established, operational and/or being funded, that would lead to generation, treatment of sewage or effluent and further discharge into a stream or well or sewer or land should take cognizance of the provisions or this Act/Rules and take required consent to establish or operate from the State Pollution Control Board/Committee
13	Water (Prevention & Control of Pollution) Cess Act, 1977 Water (Prevention & Control of Pollution) Cess Rules, 1978 and Amendments	Yes	Operation	It provides for the levy and collection of a Cess on water consumed by industries and local authorities. All projects/activities/industries that being developed, implemented, established, operational and/or being funded, that would consume water or give rise to sewage effluent or trade effluent should take cognizance of this Act/Rule and pay required Cess on water consumed to the prescribed authority.
14	Noise Pollution (Regulation and Control) Rules, 2000 and the Noise Pollution (Regulation and Control) (Amendment) Rules, 2010	Yes	Pre-construction, Construction and Operation	It provides for regulations to control ambient noise levels in public places from sources such as industries/construction works/community events, etc. All projects/activities/establishments being constructed, operational and/or funded that deal with sound emitting equipment while operational or during construction should take cognizance of the provisions/standards of these Rules and ensure compliance
15	Ozone Depleting Substances (ODS) Regulation and Rules, 2000 as amended in 2005	Yes	Operation	It provides for regulatory measures so as to ensure progressive phasing out of domestic production and imports of ODS.

S. No	Environmental Statutes and Legislation	Applicability	Duration of Compliance	Brief Description
				All businesses/activities/industries being implemented, operational and/or funded that involves the use/ processing/ imports/ exports of Ozone depleting substances should take cognizance and comply with the provisions/schedules of these Rules. *Note:* Applicable *to LKHEP project and Associated Facilities only in case of any activity using ODS.*
16	The Hazardous Waste (Management, Handling and Trans-boundary Movements) Rules, 2008 (Amended 2010)	Yes	Construction and Operation	The Rules require industries to classify wastes into categories and manage them as per the prescribed guidelines and obtain prior authorization for handling, treatment, storage and disposal of Hazardous Wastes. They also provide guidelines for the import and export of hazardous waste in India. Para 25 of the Hazardous Wastes (Management, Handling and Trans-boundary Movement) Rules 2008 mentions about Liability of Occupier, Transporter, Operator of any waste facility and Importer. It suggests that the occupier and the operator of the facility shall be liable to pay financial penalties as levied for any violation of the provision under these rules by the SPCB with the prior approval of the SPCB.
17	The Manufacture, Storage and Import of Hazardous Chemical Rules, 1989	Yes	Construction and Operation	It deals with measures, regulations and controls so as to reduce environmental, safety and health risks while manufacturing, handling and storage of hazardous chemicals. The Rule will apply if storing hazardous materials on site. *Note: Applicable to LKHEP project and Associated Facilities only in case of storing hazardous materials on site.*
18	Biomedical Waste (Management and Handling) Rules, 1998 and amended in 2003	No	-	These Rules were formulated along parallel lines, for proper disposal, segregation, transport etc. of infectious wastes.
19	Batteries (Management and Handling) Rules, 2001 and further amendments	Yes	Construction and Operation	It provides for regulations towards proper management & handling of Lead Acid Batteries so as to avoid, mitigate, and minimize adverse impact on environment

S. No	Environmental Statutes and Legislation	Applicability	Duration of Compliance	Brief Description
				and human health. *Note: Applicable to LKHEP project and Associated Facilities only in case of any activity being implemented/ operational that involves the handling, purchase and use of batteries.*
20	Notification on Special Areas/ Restricted Activities	No		Notification deals with environmental issues in specific notified zones/areas in different regions and imposition of restrictions/prohibitions on certain industries or activities. All projects/activities being conceptualized, developed, implemented, operational and/or funded should verify the existence/ proximity of any notified area in and around the project site and is found should take cognizance of the provisions of the applicable Special Area Notification
21	The Electricity Act, 2003 and Amendments (2007) and Rules 1956, and Amendments	Yes	Construction and Operation	The Electricity Act 2003 has provision for the Government to make rules specifically for 'the avoidance of public nuisance, environmental damage and unnecessary damage to the public and private property by such works' (Section 67-2-k). Rule 29(1) generally stipulates attention to safety for humans, animals, and property and rules have been also framed for vertical clearance of lines above buildings and streets and other power-lines. *Note: No rules have been framed so far related to environmental aspects for construction and maintenance of power lines; these have been captured in the Environmental Management Plan prepared for the 220 kV transmission line following SPS 2009 and IFC EHS guidelines for Electric Power Transmission and Distribution, in particular EMF exposure limits to sensitive receptors, and occupational health and safety measures.*
22	No Development Zone around refinery at Numaligarh, East of	No		*The LKHEP project and transmission system component are not located around refinery at*

S. No	Environmental Statutes and Legislation	Applicability	Duration of Compliance	Brief Description
	Kaziranga, 1996 (Notification)			*Numaligarh, East of Kaziranga.*

4. SOCIAL REGULATORY REQUIREMENTS OF INDIA AND STATE

S. No	Type of Regulation related to Land and Labor	Applicability	Duration of Compliance	Brief Description
1	The Land Acquisition Act, 1894 and Amendments	Yes.	Pre-Construction	It provides for facilitation in land acquisition for public purposes in cases where land to acquired has private claims. This Act is superseded by Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013. *Refer to the Resettlement and Tribal Development Plan (RTDP) document for details and applicability.*
2	Draft National Tribal Policy	Yes	Pre-Construction and Construction	The proposed policy addresses the issues such as enhancement of human development index of scheduled tribes, improvement of infrastructure in areas where they dominate to ensure their control over the natural resources, displacement of scheduled tribes from their habitat and relocation, distribution of wealth and opportunities among them and empowerment. *Refer to the Resettlement and Tribal Development Plan (RTDP) document for details and applicability.*
3	Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013[16]	Yes	Pre-Construction and Construction	A broad conceptual and ideological framework for rehabilitation and resettlement, it provides prerequisite data (group-wise and area-wise), on which a Rehabilitation Action Plan (RAP) can be based. The Plan provides concepts, principles and framework as well as projections for various alternatives of rehabilitation. It tries to understand and describe the general socio-economic dynamics of the population to be displaced. Moreover, it gives order of expenditure for the implementation of R&R measures. *Refer to* the *Resettlement and Tribal Development Plan (RTDP) document for details and applicability.*
4	The Scheduled Tribes and Other Traditional Forest Dwellers	Yes	Pre-Construction and	It recognizes and provides for forests rights and occupation in forest land by forest dwelling Scheduled Tribes and other traditional forest dwellers that are integral to the sustainability of the forest ecosystem.

[16] http://indiacode.nic.in/acts-in-pdf/302013.pdf

S. No	Type of Regulation related to Land and Labor	Applicability	Duration of Compliance	Brief Description
	(Recognition of Forest Rights) Act 2006 and Rules 2007		Construction	*Refer to the Resettlement and Tribal Development Plan (RTDP) document for details and applicability.*
5	The Provision of the Panchayat (Extension to the Scheduled Areas) Act, 1996[17]	No		This law enacted by the GOI covers the "Scheduled areas", which are not covered in the 73rd Amendment (or Panchayati Raj Act of the Indian Constitution). It was enacted on 24 December 1996 to enable Gram Sabah to self-govern their natural resources. It is an Act to provide for the extension of the provisions of Part IX of the Constitution relating to the Panchayats and the Scheduled Areas. Article 244(2) provides for the Sixth Schedule23 to the Constitution and applies to the administration of certain 'tribal areas' in the States of Assam, Meghalaya, Tripura and Mizoram. *Refer to the Resettlement and Tribal Development Plan (RTDP) document for details and applicability.*
6	Indian Treasure Trove Act, 1878 (as modified up to September 1949)	No		*The LKHEP project and Associated Facilities do not affect any sites affected by the Act.*
7	The Antiquities and Art Treasures Act, 1972	No		*The LKHEP project and Associated Facilities do not affect any sites affected by the Act.*
8	Minimum Wages Act, 1948	Yes	Pre-construction, Construction, and Operation	The Minimum Wages Act, 1948 provides for fixing minimum rates of wages in scheduled industries. The Act purports to achieve to prevent exploitation of labor and the purpose that authorities under this Act have been empowered to take steps to prescribe minimum rates of wages in certain employments where labor is ignorant or less organized.
9	Payment of Wages Act, 1936 and Amendments	Yes	Pre-construction, Construction, and Operation	The Payment of Wages Act, 1936 is a central legislation which applies to the persons employed in the factories and to persons employed in industrial or other establishments specified in sub-clauses (a) to (g) of clause (ii) of section 2 of this Act. This Act does not apply to workers whose wages payable in respect of a wage period average INR 1,600/- a month or more. This Act has been enacted with the intention of ensuring timely payment of wages to the workers and for payment of wages without unauthorized deductions. The salary in factories/establishments employing less than 1000 workers is required to be paid by 7th of every month and in other cases by 10th day of every month. A worker, who either has not been paid wages in time or

[17] http://www.in.undp.org/content/dam/india/docs/UNDP-Policy-Brief-on-PESA.pdf

S. No	Type of Regulation related to Land and Labor	Applicability	Duration of Compliance	Brief Description
				an unauthorized deductions have been made from his/her wages, can file a Claim either directly or through a Trade Union or through an Inspector under this Act, before with the Authority appointed under the Payment of Wages Act. The power for hearing and deciding Claims under this Act has been vested at present with the Presiding Officer of a Labor Court.
10	Workmen's Compensation Act, 1923 (Amended 2009)	Yes	Pre-construction, Construction and Operation	Workmen's Compensation Act 1923 is a central legislation which provides for payment of compensation for injuries suffered by a workman in the course of and arising out of his / her employment according to the nature of injuries suffered and disability incurred, where death results from the injury, the amount of compensation is payable to the dependents of the workmen. All the Deputy Labor Commissioner has been appointed as Commissioner under Workmen's Compensation Act. Where an employer is in default in paying the compensation due under this Act, within one month from the date it fell due, the Commissioner shall direct that the employer in addition to the amount of arrears, pay simple interest there on at the rate of 12% per annum or on such higher rates.
11	The Contract Labor (Regulation & Abolition) Act, 1970 and Rules	Yes	Pre-construction, Construction and Operation	With a view to removing the difficulties of contract labor and bearing in mind the recommendations of various commissions and committees and the decisions of the Supreme Court, the Contract Labor (Regulation and Abolition) Act was enacted in 1970. This Act seeks to regulate the employment of contract labor in certain establishments and to provide for its abolition under certain circumstances.
12	The Employees Provident Fund. and Miscellaneous Provisions act, 1952	Yes	Pre-construction, Construction and Operation	The Act is a piece of social security enactment designed to provide for a scheme to make provisions for the future of industrial workers and their dependents in case of their retirement and in the event of their premature death. The benefits are applicable to a wide range of employees working in factories, mines, plantations, construction industries, educational institutions and other classes of establishments in a short period. The Contractor will provide and produce necessary proof and declaration to APGCL regarding compliance of all the provisions, making of timely deposits etc. otherwise a sum of 5% of the gross bill amount will be deducted against EPF deposit from the bill.
13	Employers' Liability Act No. 24 of 1938	Yes	Pre-construction, Construction	The Act provides scenarios in which the employer may or may not have to take liability for certain accidents and damages faced by employees. It applies to a wide range of industries. Compensation benefits for

S. No	Type of Regulation related to Land and Labor	Applicability	Duration of Compliance	Brief Description
			and Operation	injured party in case of liability taken up by employers have also been mentioned in the Act.
14	Payment of Bonus Act, 1965 and Amendment Act No.43 of 1977 and No.48 of 1978 and amendments	Yes	Pre-construction, Construction and Operation	The Payment of Bonus Act imposes statutory liability upon the employers of every establishment covered under the Act to pay bonus to their employees. It further provides for payment of minimum and maximum bonus and linking the payment of bonus with the production and productivity. The Act applies to every factory where 10 or more workers are working and every other establishment in which 20 or more persons are employed, on any day during an accounting year. The Payment of Bonus Act, 1965, gives the employees a statutory right to a share in the profits of his employer. The Act enables the employees to get a minimum bonus equivalent to one month's salary or wages (8.33% of annual earnings) whether the employer makes any profit or not. But the Act also puts a ceiling on the bonus and the maximum bonus payable under the Act is equivalent to about 2.5 months' salary or wage (20% of annual earnings).
15	The Personal Injuries (Compensation Insurance) Act, 1963 (as amended)	Yes	Pre-construction, Construction and Operation	This Act provides for imposing liability on employers to pay compensation to workmen sustaining personal injuries and to provide for the insurance of employers against such liability. The act defines the cases under which the employer is liable to pay compensation to the affected employee. It also guides the compensation policy to be followed in case of such events. The Contractor will take into account all the above said financial liabilities in his quoted rates and nothing extra, whatsoever, will be payable to him on this account.
16	The Child Labor (Prohibition and Regulation) Act, 1986	Yes	Pre-construction, Construction and Operation	The Act addresses the issue of Child Labor which is social concern. This Act prohibits the engagement of children below the age of 14 years in certain employments and regulates the conditions of work of children in certain other employments. The Act prohibits employment of child in about 13 occupations and about 51 processes. The Act provides no child shall be permitted or required to work between 7p.m. and 8 a.m., for more than 3hrs before he/she has an interval for rest at least one hour. Every child employed in an establishment shall be allowed in each week a holiday for one whole day. The Act also levies the penalty on those who employs or permits any child to work in the occupations and processes in which employment of children is prohibited.

S. No	Type of Regulation related to Land and Labor	Applicability	Duration of Compliance	Brief Description
				This condition will be strictly monitored and enforced and no one under 18 should be employed on the HEP construction site (high risk).
17	The Bonded Labor (Abolition) Act 1976	No		*The EA for the LKHEP project and Associated Facilities do not engage with bonded labor. This condition will be strictly enforced and monitored.*
18	The Trade Union Act, 1926	No		-
19	Interstate Migrant Workers Act 1979	Yes	Pre-construction, Construction and Operation	In case workers and laborers working at the project sites are migrants from other States. For employment and Contracts, APGCL will give preference to persons from within Assam.

5. OCCUPATIONAL HEALTH AND SAFETY

S. No	Name of Regulation related to Occupational Health and Safety	Applicability	Duration of Compliance	Brief Description
1	Public Liability Insurance Act (PLIA), 1991, and Amendments (1992) and Rules, 1991	Yes	Pre-construction, Construction and Operation	The Act covers accidents involving hazardous substances and insurance coverage. Where death or injury results from an accident, this Act makes the owner liable to provide relief as is specified in the Schedule of the Act. The PLIA was amended in 1992, and the Central Government was authorized to establish the Environmental Relief Fund, for making relief payments.
2	Explosives Rules, 2008 (under Act of 1884)	Yes	Pre-construction and Construction	It provides for regulations for the manufacture, possession, use, sale, transport, import and export of explosives in India. It provides for details and specification on storage areas, safe distances, specification for vehicles for transportation, etc. towards hazard risk mitigation. All project/ activities/ industries/ businesses that are being implemented, operational and/or funded that deal with manufacture, import, export, transport, possession, sell or use of any explosives should take cognizance and comply with the provisions of this Act and obtain required license/authorization for the same.

S. No	Name of Regulation related to Occupational Health and Safety	Applicability	Duration of Compliance	Brief Description
3	Factories Act, 1948 and Amendments (1987)	Yes	Pre-construction, Construction, and Operation	The Factories Act, 1948 was a post-independence statute that explicitly showed concern for the environment. The primary aim of the 1948 Act has been to ensure the welfare of workers not only in their working conditions in the factories but also their employment benefits. While ensuring the safety and health of the workers, the Act contributes to environmental protection. The Act contains a comprehensive list of 29 categories of industries involving hazardous processes, which are defined as a process or activity where unless special care is taken, raw materials used therein or the intermediate or the finished products, by-products, wastes or effluents would: • Cause material impairment to health of the persons engaged • Result in the pollution of the general environment *In case of LKHEP project and Associated Facilities, this Act relates to workers related safety during Construction; and in-case project proponent/operator has more than ten full time employees during the operations phase of the project.*
4	Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996	Yes	Pre-construction and Construction	The Act was enacted in 1996 with an objective to provide a comprehensive Central Legislation for workers and laborers. It provides for regulation of employment and conditions of service of the building and other construction workers with respect to their safety, health and welfare measures in every establishment which employs 10 or more than 10 workers. The exception made is only in respect of residential houses for own purpose constructed with a cost not exceeding INR 1.0 Million and such other activities to which the provisions of Factories Act, 1948 and Mines Act, 1952 apply. The Act also has provision for immediate assistance in case of accidents, old age pension, loans for construction of house, premium for group insurance, financial assistance for education, to meet medical expenses, maternity benefits etc. The Act also requires constitution of Advisory Committee at the Central and the State levels and safety committees in every establishment employing 500 or more workers.

S. No	Name of Regulation related to Occupational Health and Safety	Applicability	Duration of Compliance	Brief Description
5	The Building and other Construction Workers' Welfare Cess Act, 1996	Yes	Pre-construction and Construction	The Act provides for the levy and collection of a Cess on the cost of construction incurred by employers with a view to augmenting the resources of the Building and Other Construction Workers' Welfare Boards constituted under the Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996. The Act provides for regulating the employment and conditions of service of building and other construction workers and also provides for their safety, health and welfare measures and other matters connected therewith or incidental thereto.
6	Central Motor Vehicle Act 1988 & Rules, 1989 and Amendments (2001)	Yes	Pre-construction, Construction and Operation	It provides for regulations, measures and standards to be adopted by motor vehicle for increased road safety, pollution-control and to reduce risks in case of transportation of hazardous and explosive materials. All projects/activities/industries that are being implemented, operational and/or funded that employ the use of motor vehicles for transportation of material/goods should take cognizance of this Act, adhere to the standards and use registered/permitted vehicles
7	National Building Code, 2005 – Part IV: Fire and Life Safety	Yes	Construction	Imposes restrictions on construction of buildings in different fire zones; classifies buildings based on occupancy; and provides specifications for fire protection measures, evacuation of buildings.
8	Petroleum Act, 1934 and Rules 2002	Yes	Pre-construction, Construction and Operation	In cases of storage of diesel on site, an approval is to be sought from the Chief Inspectorate of Explosives for storage of diesel >2500 litres or in containers >1000 litres capacity.
9	Gas Cylinder Rules and Static and Mobile Pressure Vessels (Unfired) Rules, 1981	No	Pre-construction, Construction and Operation	It provides for regulations on import, transport, storage, use, filling and possession of any compressed gas cylinders so as to reduce associated risks and hazards to the environment, health and safety. *Note: Applicable only if there are any pressurized liquid stored or handled on LKHEP project site*

S. No	Name of Regulation related to Occupational Health and Safety	Applicability	Duration of Compliance	Brief Description
10	CEA (Safety Requirements for Operation, Construction and Maintenance of Electric Plants and Electric Lines) Regulations 2008 and Amendments (2010)[18]	Yes	Construction and Operation	The Electric Plants and Electric Lines to be suitable for a full range of ambient and other environmental conditions as prevailing at the project site.
11	Indian Electricity Rules, 1957 and Amendments (2000)	Yes	Construction and Operation	It provides for regulating the supply, transmission, generation, and use of electricity which includes precautionary measures to be adopted in construction, installation and maintenance of transmission, distribution, generation and use of electricity.

6. STATE OF ASSAM STATUES AND LEGISLATION

S. No.	Assam Regulations, Acts, and Legislation	Applicability	Brief Description
1	Assam Ancient Monuments and Records Act, 1959[19]	No	Provide provisions for the preservation and protection of ancient and historical monuments and records in Assam. *Note: The LKHEP project and Associated Facilities do not affect any areas subject to the above Act.*
2	Forest related Acts and Rules • Karbi Anglong (Mikir) Hills District Forest Act, 1957 including Karbi Anglong District (Forest) (Amendment) Act, 1965[20] • Assam Forest Protection Force Act, 1986 • Assam Compensatory Afforestation Fund Rules, 1994; and GOA Guidelines for Compensatory Afforestation, 2000 • Assam Forest Regulation, 1891 including Assam Forest Regulation (Amendment) Act,		Under the Karbi Anglong (Mikir) Hills District Forest Act, 1957 including Karbi Anglong District (Forest) (Amendment) Act, 1965, the Executive Committee of the (Autonomous) District Council is empowered to constitute any land at the disposal of the (Autonomous) District Council into a "Village Forest" for the collective benefit of the village community Under the Assam Forest Regulation, 1891 including Assam Forest Regulation (Amendment) Act, 1995, forests may exist in at least four categories:

[18] http://www.cea.nic.in/reports/regulation/tech_std_reg.pdf
[19] http://asi.nic.in/nmma/nmma_assam_02.pdf
[20] Note that this village forest is different from the one that is envisaged under the Assam Forest Regulation (1891) or the Indian Forest Act, 1927.

S. No.	Assam Regulations, Acts, and Legislation	Applicability	Brief Description
	1995 • The Assam Forest (Removal And Storage of Forest Produce) Regulation Act, 2000 • Assam Revolving Fund (Forest Department) Rules, 2000 • The Assam Forest (Forum of Appeal) Rules 2001 • Assam Forest (Rewards) Rules, 2002 • Assam (Control of Felling and Removal of Trees from Non-Forest Lands) Rules, 2002 • Assam Forest Policy 2004 • The Assam Joint Forest Management Rules, 2004 • The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act ,2006 (FRA 2006) • Forest Rights Act, 2006		Reserved Forests, Village Forests, Un-classed State Forests and those forests and wasteland which are not the property of the government. The term "unsettled tracts" has also been used in the Regulation and the State government has been empowered to reserve trees in such unsettled tracts. Rules under Assam (Control of Felling and Removal of Trees from Non-Forest Lands) Rules, 2002 prescribe how tree plantations raised in non-recorded forest areas by individuals or institutions are to be governed. Assam Forest Policy has the following objectives: (i) maintain environmental stability, (ii) conserve the natural heritage of the state, (iii) provide livelihood support and alternatives to forest fringe dwellers, (iv) increase the tree cover of the State, (v) meet the livelihood needs of rural poor and tribes in fuel wood and NTFP, (vi) demarcate all forest lands, irrespective of ownership, (vi) promote research on forest related topics and (vii) encourage the conservation of the genetic diversity and the traditional ecological knowledge of Assam. Policy advocates community participation. The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 (FRA 2006) offers guidelines to protect wildlife, forest and biodiversity, prevent destructive practices affecting their cultural and natural heritage and regulate access to community forest resources.
15	Assam Biodiversity Rules, 2010	Yes	Prescribes tasks for the Assam State Biodiversity Board with regards to the Biodiversity Act 2002.
16	Assam National Park Act, 1968	No	*The LKHEP project and Associated Facilities do not affect any areas subject to the Act.*
17	Assam Land and Revenue Regulation, 1886	Yes	
18	Assam Irrigation Act, 1983	Yes	

S. No.	Assam Regulations, Acts, and Legislation	Applicability	Brief Description
19	Assam Fishery Rules, 1953	No	This rules deals with fishing and associated commercial activities. *This is not applicable to the LKHEP project*.
20	Wildlife Protection Rules, 1980	Yes	This rules deals in licencing and permitting for hunting and management of protected areas in State. *This rule is applicable to the LKHEP since the project area is located in forest areas and has presence of wild animals.*

7. NATIONAL APPLICABLE ENVIRONMENTAL STANDARDS

7.1 WATER QUALITY

4. To ascertain and categorize the existing water quality and its designated best use in and around the project area, the results of the analysis of water quality will be compared with the water quality standards as prescribed by CPCB. Table 2.1 presents the use based classification of surface water in India whereas water quality standards are presented in Table 2.2.

Table 2.1: Use Based Classification of Surface Water in India[21]

Use based classification of surface waters in India Designated-Best-Use	Class of Water	Criteria
Drinking Water Source Without Conventional Treatment but After Disinfection	A	• Total Coliforms Organism MPN/100ml shall be 50 or less • PH between 6.5 and 8.53. • Dissolved Oxygen 6mg/l or more • Biochemical Oxygen Demand 5 days 20°C 2mg/l or less
Outdoor bathing (Organized)	B	• Total Coliforms Organism MPN/100ml shall be 500 or less • PH between 6.5 and 8.53. • Dissolved Oxygen 5mg/l or more • Biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Drinking water source after conventional treatment and disinfection	C	• Total Coliforms Organism MPN/100ml shall be 5000 or less • pH between 6 to 9 • Dissolved Oxygen 4mg/l or more • Biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Propagation of Wild life and Fisheries	D	• pH between 6.5 to 8.5 • Dissolved Oxygen 4mg/l or more • Free Ammonia (as N) 1.2 mg/l or less
Irrigation, Industrial Cooling, Controlled Waste disposal	E	• pH between 6.0 to 8.5 • Electrical Conductivity at 25oC micro mhos/cm. Max.2250 • Sodium absorption Ratio Max. 26 • Boron Max. 2mg/l
	Below-E	• Not meeting A, B, C, D & E Criteria

Table 2.2: Indian Standard Drinking Water Specification As Per IS 10500:1991

S. No.	Substance/ Characteristic	Desirable Limit	Permissible limit (in the absence of alternative source)	Remarks

[21] http://www.cpcb.nic.in/Water_Quality_Criteria.php

S. No.	Substance/ Characteristic	Desirable Limit	Permissible limit (in the absence of alternative source)	Remarks
1	Colour, Hazen units, Max	5	25	Extended to 25 if toxic substance are not suspected in absence of alternate sources
2	Odor	Unobjectionable		a) Test cold and when heated
				b) Test at several dilution
3	Taste	Agreeable		Test to be conducted only after safety has been established
4	Turbidity NTU, Max	5	10	
5	pH value	6.5 to 8.5	No relaxation	
6	Total Hardness (as $CaCO_3$) mg/lit	600	600	
7	Iron (as Fe) mg/lit, Max	0.3	1.0	
8	Chlorides (as Cl) mg/lit Max	250	1000	
9	Residual Free Chlorine, mg/lit Max	0.2		To be applicable only when water is chlorinated. Treated at consumer end. When protection against viral infection is required, it should be Min 0.5 mg/lit
10	Dissolved Solids mg/l, Max	500	2000	
11	Calcium (as Ca) mg/l, Max	75	200	
12	Copper (as Cu) mg/l, Max	0.05	1.5	
13	Manganese (Mn) mg/l Max	0.1	0.3	
14	Sulphate (As SO_4), Max	200	400	May be extended up to 400 provided (as Mg) does not exceed 30
15	Nitrate (as NO_3) mg/l, Max	45	100	
16	Fluoride (as F) mg/l, Max	1.0	1.5	
17	Phenolic Compounds (as C_6H_6OH) mg/l Max	0.001	0.002	
18	Arsenic (as As) mg/l	0.05	No relaxation	To be tested when pollution is suspected
19	Lead (as Pb) mg/l	0.05	No relaxation	
20	Anionic Detergents (as MBAS) mg/l	0.2	1.0	
21	Chromium (as Cr) mg/l	0.05	1.0	To be tested when pollution is suspected
22	Mineral Oil mg/l	0.01	0.03	
23	Alkalinity mg/l	200	600	
24	Total Coliform	95% of the sample should not contain coliform in 100 ml. 10 coliform /100 ml		

7.2 AIR QUALITY STANDARDS (India and IFC EHS Guidelines)

5. Revised National Ambient Air Quality Standards (NAAQS) for major pollutants were notified by the CPCB in November 2009. The NAAQS prescribe specific standards for industrial, residential, rural and other ecologically sensitive areas. These are presented in Table 2.3.

Table 2.3: Revised National Ambient Air Quality Standards[22, 23] V/s IFC EHS Guidelines

Ambient Air Quality Parameter	Averaging Period	IFC EHS Guideline Value		GoI Standards for Industrial, Residential, Rural and Other Areas	GoI Ecologically Sensitive Area (notified by Central Government)
Sulfur dioxide (SO_2) ($\mu g/m^3$)	24-hr	125	(Interim target 1)		
		50	(Interim target 2)		
		20	(guideline)	80	80
	10 min	500	(guideline)		
	Annual	None		50	20
Nitrogen dioxide (NO_2) ($\mu g/m^3$)	1 Year	40	(guideline)	40	30
	24 Hour	None		80	80
	1 Hour	200	(guideline)		
PM_{10} ($\mu g/m^3$)	1 Year	70	(Interim target 1)		
		50	(Interim target 2)		
		30	(Interim target 3)		
		20	(guideline)	60	60
	24-hr	150	(Interim target 1)		
		100	(Interim target 2)		
		75	(Interim target 3)		
		50	(guideline)	100	100
$PM_{2.5}$ ($\mu g/m^3$)	1 year	35	(Interim target 1)		
		25	(Interim target 2)		
		15	(Interim target 3)		
		10	(guideline)	40	40
	24-Hour	75	(Interim target 1)		
		50	(Interim target 2)		
		37.5	(Interim target 3)		
		25	(guideline)	60	60
Ozone (O_3) ($\mu g/m^3$)	8-hr daily max	160	(Interim target 1)		
		100	(guideline)	100	100
Lead (Pb) $\mu g/m^3$)	Annual			0.5	0.5
	24 hours			1.0	1.0
Carbon	8 hours			2000	2000

[22] Source: Central Pollution Control Board - NAAQS Notification dated November 18, 2009; Web-link: http://cpcb.nic.in/upload/Publications/Publication_514_airqualitystatus2009.pdf

[23] * Annual Arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform interval.

** 24 hourly 08 hourly or 01 hourly monitored values, as applicable shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

NOTE: Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigation.

Ambient Air Quality Parameter	Averaging Period	IFC EHS Guideline Value		GoI Standards for Industrial, Residential, Rural and Other Areas	GoI Ecologically Sensitive Area (notified by Central Government)
Monoxide (CO) µg/m^3	1 hour			4000	4000
Ammonia (NH_3) µ/m^3	Annual			100	100
	24 hours			400	400

7.3 AMBIENT NOISE STANDARDS

6. Ambient noise level standards have been notified by the MoEF&CC under Noise (Regulation & Control) Rules 2000 and also in the Schedule III of the Environmental (Protection) Rules 1986. Noise levels are measured in dB (A) Leq which denotes the time weighted average of the level of sound in decibels on scale A which is relatable to human hearing. These are presented in Table 2.4.

Table 2.4: MoEF&CC Ambient Noise Level Standards[24,25] V/s IFC EHS Guidelines

Receptor	IFC EHS Guidelines		GoI NAAQS	
	Daytime	Nighttime	Daytime	Nighttime
	7:00-22:00	22:00-7:00	6:00-22:00	22:00-6:00
Residential	55	45	55	45
Institutional; educational			None	None
Industrial	70	70	75	70
Commercial			65	55
Silence Zone	None	None	50	40

Note: (1) Daytime: 6 AM to 9 P.M., Night-time 9 PM to 6 AM;
(2) Silence zone is an area up to 100 m around premises as hospitals, educational institutions and courts.
Source: Central Pollution Control Board, New Delhi

7. Noise standards in the work environment are specified by Occupational Safety and Health Administration (OSHA-USA) which in turn are being enforced by Government of India (GoI) through model rules framed under the Factories Act. These are presented in Table 2.5.

Table 2.5: Occupational Safety and Health Administration (OSHA) Noise Standards

Total Time of Exposure per Day in Hours (continuous or short term exposure)	Sound pressure level dB(A)
8	90
6	92
4	95

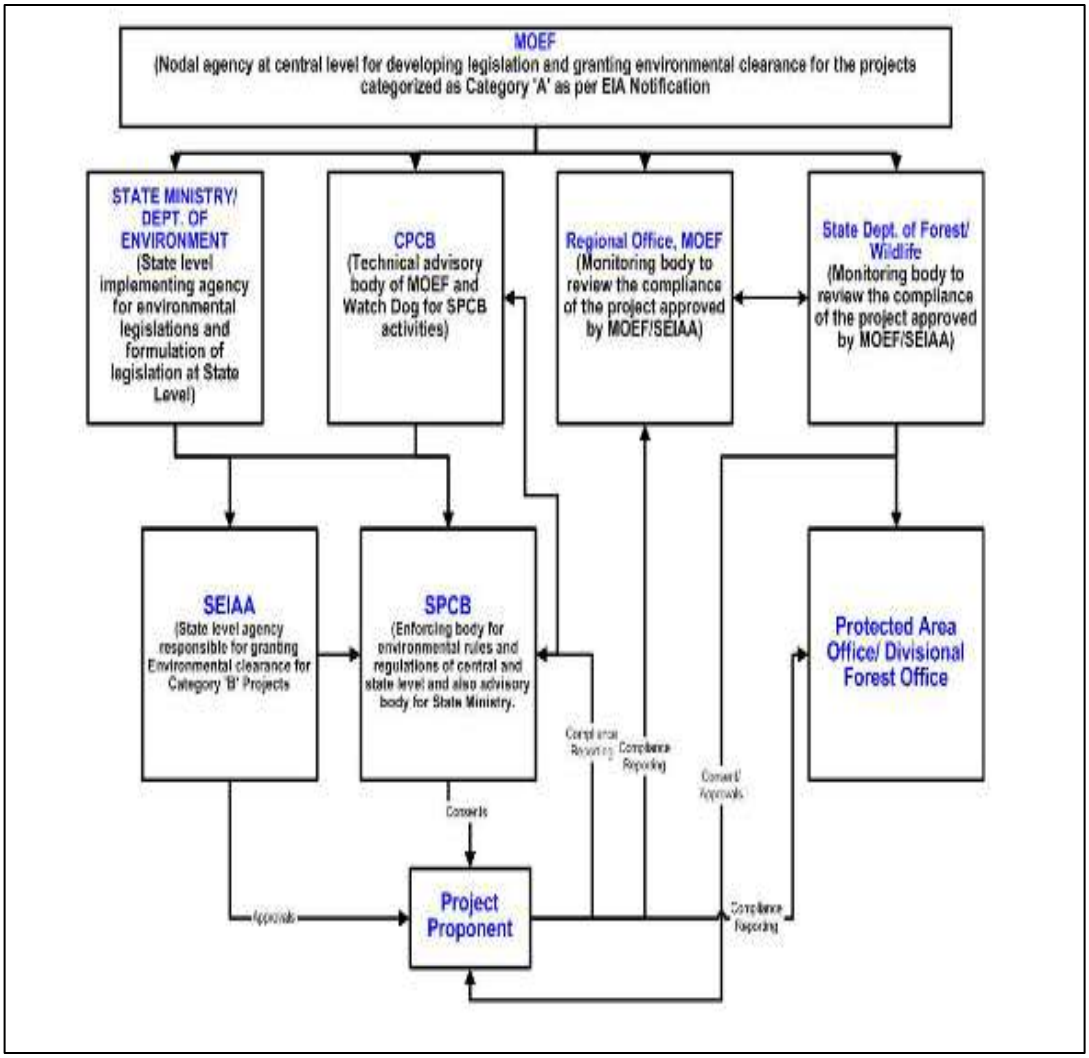
[24] Source: Central Pollution Control Board
[25] * Day time means from 6.00 a.m. to 10.00 p.m. Night time means from 10.00 p.m. to 6.00 a.m.
** Silence zone is an area comprising not less than 100 meters around hospitals, educational institutions, courts, religious places or any other area which is declared as such by the competent authority Mixed categories of areas may be declared as one of the four above mentioned categories by the competent authority.

Total Time of Exposure per Day in Hours	Sound pressure level dB(A)
3	97
2	100
3/2	102
1	105
¾	107
½	110
¼	115
Never	>115
Note: No exposure in excess of 115 dB(A) is to be performed. Note that IFC EHS guidance indicates 85 dB (A) as a limit for 8 hour exposure.	

8. The project will also follow the IFC EHS guidelines (**http://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/policies-standards/ehs-guidelines**).

8. GOVERNANCE STRUCTURES FOR LKHEP AND ASSOCIATED FACILITIES

Figure 2.1: Environmental Legal Administrative Framework in India



9. The implementation of the LKHEP project and Associated Facilities will be governed by the Government of India (GOI) and Government of Assam (GOA) environmental policies, statues and legislation as well as International Best Practices related to environment. The State Pollution Control Board of Assam (SPCB, Assam) is tasked to ensure that environmental clearances and environmental standards are complied with by the EA (project proponent/operator) during project implementation. These regulations impose restrictions on project activities to minimize and/or mitigate likely impacts on the environment. It is the responsibility of the EA to ensure that the project is consistent with the policy, legal and administrative framework across all hierarchy - National, State, Municipal and local.

10. The India legal and administrative framework for environmental protection, forests conservation and wildlife protection is presented in Figure 2.1.

11. The governance structures that will be involved both at local and state level for the LKHEP project and Associated Facilities are described below.

8.1 MINISTRY OF ENVIRONMENT, FORESTS & CLIMATE CHANGE, GOI[26]

12. The Ministry of Environment, Forests & Climate Change (MOEF&CC) under the GOI is the lead agency for environmental statutes, legislation and standards including forestry and wildlife management. It is organized under two main themes namely a) Environmental Wing, and (b) Forests and Wildlife Wing. It frames rules and issues guidelines that will then be translated by the State Governments. It delivers central and external financial assistance to the states and communities through specific policies and programs like the National Afforestation Programme, etc.

8.2 THE STATE POLLUTION CONTROL BOARD OF ASSAM, GOA[27]

13. The State Pollution Control Board of Assam is an autonomous statutory organization constituted in June 1975 under the provision of section 4 of the Water (Prevention & Control of Pollution) Act 1974 with a view to protecting the environment and preventing and controlling the pollution of water and air in the State of Assam, occupying a prominent niche in progressive and industrial development of the country. It is mandated with the tasks of enforcement of the provisions of various acts, rules, and legislation and monitoring thereof; issuance of No Objection Certificate (N.O.C) and Consent to industries and other development projects.

8.3 THE ASSAM REVENUE DEPARTMENT

14. The Revenue Department has authority over the land in the Un-classed State Forests and is responsible for the notification process that leads to the reservation of a forest.

8.4 THE ASSAM DEPARTMENT OF ENVIRONMENT AND FORESTS[28]

15. The mandate of the Forest Department is to manage the Forest, Forest produces and Wildlife of the State of Assam. It has a Principal Chief Conservator of Forests and Head of Forest Force (PCCF & HOFF) at its head who reports to the State Government. The Forest Department is organized in wings each having a distinct task. The major wings are (i) general

[26] The Ministry of Environment, Forests, and Climate Change (MOEF&CC) lists all Environmental Acts and Rules which may be accessed at the following web-link: http://www.moef.gov.in/sites/default/files/introduction-csps.pdf
[27] http://www.pcbassam.org/consent.htm
[28] http://assamforest.in/common/

forestry (ii) social forestry, (iii) wildlife, and (iv) research, education and planning, each headed by an officer in the rank of Chief Conservator of Forests (CCF) with the exclusion of the Wildlife wing whose head has the rank of PCCF. Conservators of Forests (CFs) and Divisional Forest Officers (DFOs) are the senior officers operating at the circle (CF) and division (DFO) levels respectively. Below the DFO, the frontline staffs are the Rangers, Foresters and Guards.

8.5 THE ASSAM BIODIVERSITY BOARD (ASBB)[29]

16. The Assam State Biodiversity Board (ASBB) is the government agency tasked to lay down procedure and guidelines to govern the activities under section 23 of the Biodiversity Act (2002) and prescribe to the Assam Biodiversity Rules (2010). The Board will advise the government on any matter concerning conservation of biological diversity, sustainable use of its components and fair and equitable, sharing of benefits arising out of the use of biological resources and acknowledge; and provide technical assistance and guidance to the departments of the State Government.

8.6 THE AUTONOMOUS (DISTRICT) COUNCILS

17. The Schedule VI of the Constitution of India established several autonomous district councils (ADCs) in the northeast India. They provide a simple administrative structure for resident tribal peoples to safeguard their customs and traditional ways of living, thereby facilitating the management of their own affairs. There are three Autonomous Councils in Assam: the Bodo-land Territorial Area Districts, the Dima Hasao (North Cachar Hills) Autonomous Council and the Karbi Anglong Autonomous Council. The LKHEP lies in the Dima Hasao and the Karbi Anglong autonomous districts of the Assam State.

18. The article (244) of the constitution provides for a separate scheme of administration for the tribal areas designated as “autonomous districts”. The Panchayati Raj Institutions[30] do not extend to these areas. These councils have certain legislative and executive functions vested in them. They are empowered to legislate upon all the subjects transferred which interalia include the allotment, occupation and use of land; the management of forests other than reserve forests; the use of canals and watercourses for agriculture, and the regulation of the practice of jhum or other forms of shifting cultivation. In the field of forestry, they are in charge of the human resources, financial management, and implementation of the forestry sector development programmes. The revenue from forestry operations accrues to them, and is afterwards reflected in the State budget. They can constitute District Council Reserve Forest (DCRF). The Conservator of Forest (CF) and Divisional Forest Officers (DFO) under the Council’s authority are borrowed from the Assam Forest Department. With regard to the allotment, occupation, and use of land, the State Government can supersede the laws and regulations of the ADC’s laws, if the State Government wants to compulsorily acquire any land, whether occupied or unoccupied, for a public purpose in accordance with the law for the time being in force authorizing such acquisition (Section 3(a) of Schedule VI.

[29] http://www.asbb.gov.in/index.html

[30] The Panchayati Raj Institutions are the grass-root units of local self-government in India. In Assam, the Assam Panchayat Act 1994 introduces a three-tier system – Gaon Panchayat (village), Anchalik Panchayat (several villages) and ZillaParishad (district). Elections are held every five years, with reservation of seats for Scheduled Castes, Scheduled Tribes and Women (73rd Amendment of the Constitution, 1992).

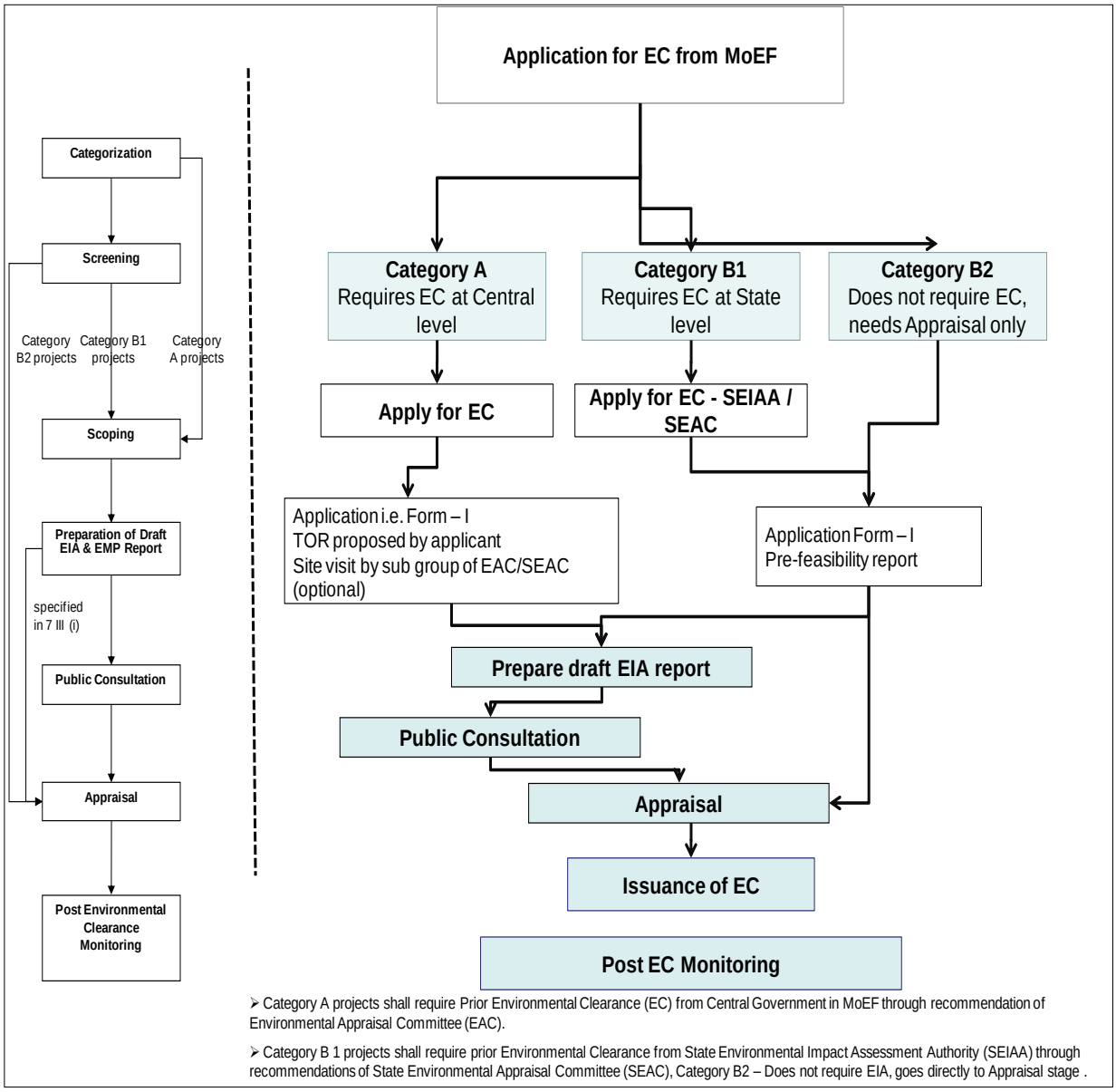
9. PROCEDURES TO OBTAIN ENVIRONMENTAL CLEARANCE IN INDIA

19. EIA Notification (2006) set screening criteria to classify new and expansion projects based on potential environmental impacts as follows: Category A, B1 and/or B2.[31]

20. Figure 2.2 show the procedure for obtaining an EC in India corresponding to the category of the project.

[31] Under the Environment Impact Assessment (EIA) Notification 2009 of GoI, the environmental classification of projects is determined by MoEF&CC, GoI and there are two possible outcomes: **Category A**: A project or activity is classified as Category A if it is likely to have significant negative impacts and is thus one of the types of project listed in this category in the EIA Notification. Such projects require EIA, plus Environmental Clearance (EC) from MoEF&CC; and **Category B**: A project or activity is classified as Category B if it is likely to have fewer negative impacts and is listed in this category in the EIA Notification. These projects require EC from the State Environment Impact Assessment Authority (SEIAA), who classify the project as B1 (requiring EIA) or B2 (not requiring EIA), depending on the level of potential impacts. Projects classified as B2 require no further study. http://envfor.nic.in/legis/eia/so1533.pdf

Figure 2.2: Environmental Clearance Process in India



- Category A projects shall require Prior Environmental Clearance (EC) from Central Government in MoEF through recommendation of Environmental Appraisal Committee (EAC).
- Category B 1 projects shall require prior Environmental Clearance from State Environmental Impact Assessment Authority (SEIAA) through recommendations of State Environmental Appraisal Committee (SEAC), Category B2 – Does not require EIA, goes directly to Appraisal stage .

10. CATEGORY OF THE PROJECT AND CORRESPONDING EC APPLICABILITY

10.1 EIA NOTIFICATION, GOVERNMENT OF INDIA

21. **EC Applicability to LKHEP:** As per EIA Notification (2006) of GOI hydroelectric power generation projects have been classified under Category A, item 1 (c) "River Valley projects" of the EIA Notification, 2006 and require preparation of an EIA Report and EC. Whenever a project is accorded an EC, a set of recommendations and conditions are stipulated by the Appraisal Committee for compliance by the investor while the project is under implementation and later under operation.

22. A Public Hearing is required for hydroelectric projects as a part of EC process. The EA (project proponent/operator) is required to make a request through a letter to the Member Secretary of the State Pollution Control Board of Assam (SPCB) of Assam, in whose jurisdiction the project is located, to arrange the public hearing within the prescribed statutory period. In case the project site is covering more than one District or State, the public hearing is mandated in each District, State in which the project is located and the applicant shall make separate requests to each concerned Pollution Control Board for holding the public hearing as per this procedure.

23. The EA (project proponent/ operator) has to enclose with the letter of request, at least 10 hard copies and an equivalent number of soft (electronic) copies of the draft EIA Report with the generic structure given in Appendix III including the Summary EIA report in English and in the official language of the state/local language, prepared strictly in accordance with the Terms of Reference communicated after Scoping (Stage-2) by the MOEF&CC. Simultaneously the applicant has to arrange to forward copies, one hard and one soft, of the above draft EIA Report along with the Summary EIA report to the following authorities or offices, within whose jurisdiction the project will be located:

- District Magistrate/District collector/Deputy commissioner/s
- Zila Parishad or Municipal Corporation or Panchayat Union
- District Industries Office
- Urban Local Bodies (ULBs) / PRIs Concerned/Development authorities/ Autonomous Councils
- Concerned Regional Office of MoEF&CC

24. Following panel constitution, The SPCB releases notice for the public hearing in one major National Daily and one Regional Vernacular Daily, inviting objections from the people likely to be affected by a project covered under the EIA notification. Its proceedings are then issued by the SPCB to MoEF&CC with a copy to the EA (project proponent/operator).

25. **EC Applicability to Power Evacuation System:** As per EIA Notification (2006) of GoI, power transmission and/or distribution projects are not listed as environmentally sensitive projects. Hence, no environmental clearance is required from the MOEF&CC or from the State-level Environment Impact Assessment Authority for the above. Clearance from the Assam Forest Department is required only in cases where a project is constructed on forestland or requires cutting of forest trees.

10.2 ASIAN DEVELOPMENT BANK SAFEGUARD POLICY (SPS 2009)

26. ADB requires consideration of environmental issues in all aspects of its operations and the requirements for mainstreaming environmental safeguard are embodied in SPS 2009. SPS 2009 applies to all projects that require financing from ADB.

27. **Screening and Categorization:** Under SPS 2009, projects are screened and categorized based on their potential environmental impacts. The nature of the environmental assessment required for a project depends on the significance of its environmental impacts, which are related to the type and location of the project, the sensitivity, scale, nature and magnitude of its potential impacts, and the availability of cost-effective mitigation measures. Projects are assigned to one of the following four categories:

i. **Category A**. Projects could have significant adverse environmental impacts. An EIA is required to address significant impacts.

ii. **Category B**. Projects could have some adverse environmental impacts, but of lesser degree or significance than those in category A. An IEE is required.

iii. **Category C**. Projects are unlikely to have adverse environmental impacts. No EIA or IEE is required, although environmental implications are reviewed.

iv. **Category FI**. Projects involve a credit line through a financial intermediary or an equity investment in a financial intermediary. The financial intermediary must apply an environmental management system, unless all projects will result in insignificant impacts.

28. **Category of the Proposed Project:** LKHEP project is an Environment Category A, Resettlement Category A, and Indigenous Peoples Category A ("triple A")." Given this, safeguard documents meet all national requirements as well as the requirements of ADB's Safeguard Policy Statement 2009 (SPS 2009).

29. **Environmental Management Plan:** An EMP that addresses the potential impacts and risks identified by the environmental assessment shall be prepared. The level of detail and complexity of the EMP and the priority of the identified measures and actions will be commensurate with the project's impact and risks.

30. **Public Disclosure:** The EIA will be put in an accessible place (e.g., local government offices, libraries, community centers, etc.), and a summary translated into the local language for the project-affected people and other stakeholders. ADB will post the following safeguard documents on its website so affected people, other stakeholders, and the general public can provide meaningful inputs into the project design and implementation.

11. ENVIRONMENTAL PERMITS/CLEARANCES REQUIRED FOR THE PROJECT

31. As per the policies and legal framework, the following approvals/clearances maybe required for the LKHEP project and Associated Facilities (see Table 2.6). The EA (project proponent/operator) shall review the applicability of the same and update the status accordingly.

Table 2.6: Requirement for Environmental Permit / Clearances for the Proposed Project

S. No	Environmental Permit / Clearance	Status
0	Site Clearances from various State departments	In progress
1	Techno-economic Clearance of Detailed Project Report (DPR) from CEA	Obtained
2	Environmental Public Hearing by the State Pollution Control Board of Assam (SPCB, Assam)	Conducted on 10th January 2017
3	No Objection Certificate/Consent to Establish by the SPCB, Assam	To be obtained by contractor
4	Environmental Clearance by the MOEF&CC, as per EIA notification, 2006 under Environment (Protection) Act, 1986	Granted on 5th December 2017
5	Forest Clearance for diversion forest land by the State agencies, MOEF&CC.	Expected in March 2018.
6	Private Land acquisition under Land Acquisition Act, 1894, and Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act, 2013	In progress
7	Clearance form Standing Committee of National Board for Wild Life (NBWL) under Wildlife Protection Act, in case, any part of National Park / Wildlife Sanctuary is within 10 km radius of the project, as applicable	Not applicable
8	No Objection from Irrigation and Public Health Department (IPH), Government of Assam, as applicable	To be obtained
9	No Objection from Department of Fisheries, Government of Assam, as applicable	To be obtained
10	No Objection from Department of Railways, Government of Assam, as applicable	To be obtained
11	No Objection from Public Works Department, Government of Assam, as applicable	To be obtained
12	Registration under Building and Other Construction workers Act, 1996	To be obtained

12. INTERNATIONAL AGREEMENTS AND COMMITMENTS

32. Environmental problems which migrate beyond the jurisdiction (Trans-boundary) require power to control such issues through international co-operation by either becoming a Contracting Party (CP) i.e. ratifying treaties or as a Signatory by officially signing the treaties and agreeing to carry out provisions of various treaties on environment and social safeguards. India is a party to such conventions and is also a member country to the United Nations Framework Convention on Climate Change (UNFCCC). The relevant international conventions are listed below.

S. No.	International Agreements and Commitments	Brief Description
Nature Conservation		
1	Convention on Wetlands of International Importance (Ramsar Convention)[32]	This convention was signed by India in 1981 and ratified in February 1982. The convention requires protection of identified wetlands of international importance as identified under Ramsar convention. Assam has a freshwater lake (Dipor Beel), designated as a wetland under the Ramsar Convention (November 2002). *Ramsar notified lake in Assam is situated south-west of Guwahati city in Kamrup district, and is not affected by or is close to the LKHEP project or Associated Facilities.*
2	Convention on International Trade in Endangered Species of Fauna and Flora (CITES)[33]	This convention was signed by India in 1976. The Convention aims to ensure that international trade in specimens of wild animals and plants does not threaten their survival.
3	The Wildlife Trade Monitoring Network (TRAFFIC)[34]	TRAFFIC works globally on trade in wild animals and plants in the context of both biodiversity conservation and sustainable development.
4	Convention on Migratory Species (CMS)[35]	India is contracting party to the convention on conservation of migratory species of wild animals and migratory species.
5	Coalition Against Wildlife Trafficking (CAWT)[36]	The GOI is represented in CAWT by the MOEF&CC, which also manages Project Tiger.
6	Convention on Biological Diversity (CBD)[37]	India is a party since February 1994by Ratification; and since September 2003 by Protocol.
7	International Tropical Timber Organization (ITTO)[38]	India is one of the 10 participating Asia & Pacific Countries. ITTO was established under the auspices of the United Nations in 1986 amidst increasing worldwide concern for the fate of tropical forests; while establishing considerable agreement that the tropical timber trade was one of the keys to economic development in those same countries.
8	United Nations Forum on Forests (UNFF)[39]	The UN Forum on Forests is an intergovernmental body to strengthen political commitment and action with main objective to promote "… the management, conservation and sustainable development of all types of forests and to strengthen long-term political commitment to this end…"It was established in 2000.
9	International conventions	Some animals and plant species found in Assam are included in the IUCN

[32] Ramsar Convention is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. According to the Ramsar list of Wetlands of International Importance, there are 25-26 designated wetlands in India that are threatened; http://south-asia.wetlands.org/OurWetlands/OverviewofallwetlandswithRamsarstatus/tabid/634/Default.aspx

[33] https://www.cites.org/

[34] http://www.traffic.org/

[35] CMS, also known as the Bonn Convention aims to conserve terrestrial, aquatic, and avian migratory species whilst recognizing that States must be the protectors of species living within or pass through their corresponding national jurisdictions. Hence, the Parties to the Convention adhere to strictly protecting such species, conserving or restoring the places where they live; http://www.cms.int/

[36] http://www.cawtglobal.org/india/

[37] According to CBD, States, in accordance with the Charter of the United Nations and the principles of international law, have the sovereign right to exploit their own resources pursuant to their own environmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction. India is a party to the Cartagena Protocol on Bio safety to CBD which aims to ensure the safe handling, transport and use of living modified organisms resulting from modern biotechnology that may have adverse effects on biological diversity, taking also into account risks to human health; http://www.cbd.int/convention/

[38] http://www.itto.int/sfm_detail/id=12390000

[39] http://www.un.org/esa/forests/index.html

S. No.	International Agreements and Commitments	Brief Description
	such as the International Union for Conservation of Nature and Natural Resources (IUCN)[40]	Red List and Category II category. The LKHEP projects will not affect these sensitive areas. The project is not expected to alter bird migration or affect any species on the IUCN list.
10	Global Tiger Forum (GTF)[41]	The GTF highlights the rationale for tiger preservation and provide leadership and common approach throughout the world in order to safeguard the survival of the tiger, its prey and its habitat. The Forum was conceived in New Delhi India in the 1990s.
Hazardous Material		
11	Cartagena Protocol on Bio safety[42]	The Cartagena Protocol on Bio safety to the Convention on Biological Diversity is an international agreement which aims to ensure the safe handling, transport and use of living modified organisms (LMOs) resulting from modern biotechnology that may have adverse effects on biological diversity, taking also into account risks to human health. It was adopted on 29 January 2000 and entered into force on 11 September 2003. India signed the Protocol in 2000 and it came into force in 2003.
12	Strategic Approach to International Chemicals Management (SAICM)[43]	SAICM is a policy framework to promote chemical safety around the world, with an overall objective to achieve the sound management of chemicals throughout their life cycle so that, by 2020, chemicals are produced and used in ways that minimize significant adverse impacts on human health and the environment. This "2020 goal" was adopted by the World Summit on Sustainable Development in 2002 as part of the Johannesburg Plan of Implementation.
13	Stockholm Convention on Persistent Organic Pollutants (POPs)[44]	The Stockholm Convention on Persistent Organic Pollutants (POPs): Mindful of the precautionary approach as set forth in Principle 15 of the Rio Declaration on Environment and Development, the Objective of POPs is to protect human health and the environment from persistent organic pollutants
14	Basel Convention on the Control of Trans-boundary Movement of Hazardous Waste and Their Disposal[45]	The Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal was adopted on 22 March 1989 by the Conference of Plenipotentiaries in Basel, Switzerland, in response to a public outcry following the discovery, in the 1980s, in Africa and other parts of the developing world of deposits of toxic wastes imported from abroad. The overarching objective of the Basel Convention is to protect human health and the environment against the adverse effects of hazardous wastes. Its scope of application covers a wide range of wastes defined as "hazardous wastes" based on their origin and/or composition and their characteristics, as well as two types of wastes defined as "other wastes" - household waste and incinerator ash.
15	Rotterdam Convention on Prior Informed Consent (PIC) for certain Hazardous Chemicals and Pesticides in International Trade	The Rotterdam Convention on the Prior Informed Consent (PIC) Procedure for Certain Hazardous Chemicals & Pesticides in international Trade was adopted by India at the Conference of Plenipotentiaries at Rotterdam in 1998

[40] IUCN provides a comprehensive analysis of the global conservation status, trends, and threats to species viz the IUCN Red List or Red Data List. The IUCN Red list establishes a baseline from which to monitor the change in status of species; provides a global context for the establishment of conservation priorities at the local level; and on a continuous basis, monitor the status of a representative selection of species (as biodiversity indicators) that cover all the major ecosystems of the world. http://www.iucnredlist.org/about/overview

[41] http://www.globaltigerforum.com/

[42] https://bch.cbd.int/protocol

[43] http://www.saicm.org/

[44] http://chm.pops.int/Home/tabid/2121/mctl/ViewDetails/EventModID/871/EventID/407/xmid/6921/Default.aspx

[45] http://www.basel.int/TheConvention/Overview/tabid/1271/Default.aspx

S. No.	International Agreements and Commitments	Brief Description
Atmospheric Emissions		
16	United Nations Framework Convention on Climate Change (UNFCCC)	
17	Kyoto Protocol	The Kyoto protocol was signed by India in August 2002 and ratified in February 2005. The convention pertains to the United Nations framework on Climate Change. The 3rd Conference of the Parties to the Framework Convention on Climate Change (FCCC) in Kyoto in December 1997 introduced the Clean Development Mechanism (CDM) as a new concept for voluntary greenhouse-gas emission reduction agreements between industrialized and developing countries on the project level.
18	Paris Agreement	The Paris Agreement was ratified by India on 2 October 2016. The agreement entered into force on 4 November 2016, thirty days after the date on which at least 55 Parties to the Convention accounting in total for at least an estimated 55 % of the total global greenhouse gas emissions have deposited their instruments of ratification, acceptance, approval or accession with the Depositary.
19	United Nations Convention to Combat Desertification (UNCCD)[46]	Convention to combat desertification and mitigate the effects of drought through national action programs that incorporate long-term strategies supported by international cooperation and partnership arrangements.
20	Montreal Protocol (on Ozone Depleting Substances)	India signed the Montreal Protocol along with its London Amendment on 17-9-1992 and also ratified the Copenhagen, Montreal and Beijing Amendments on 3rd March 2003.
Marine Environment		
21	International Whaling Commission (IWC)	Not applicable

Source: MoEF&CC, India

13. INTERNATIONAL LABOR ORGANIZATION CONVENTIONS

33. India has also ratified many of the International Labor Organization conventions that are relevant to the LKHEP project and Associated Facilities including:

- C1 Hours of Work (Industry) Convention, 1919 (14:07:1921, ratified);
- C5 Minimum Age (Industry) Convention, 1919 (09:09:1955, ratified):
- C11 Right of Association (Agriculture) Convention, 1921 (11:05:1923, ratified):
- C14 Weekly Rest (Industry) Convention, 1921 (11:05:1923, ratified);
- C29 Forced Labor Convention, 1930 (30:11:1954, ratified) & C105 Abolition of Forced Labor Convention, 1957 (18:05:2000, ratified);
- C100 Equal Remuneration Convention, 1951 (25:09:1958, ratified);
- C107 Indigenous and Tribal Populations Convention, 1957
- C111 discrimination (Employment and Occupation) Convention, 1958 (03:06:1960, ratified).

[46] http://www.unccd.int/en/Pages/default.aspx

14. IFC GUIDELINES

34. International Finance Corporation (IFC) applies the EHS Guidelines (General) to manage social and environmental risks and impacts and to enhance development opportunities in its private sector financing in its member countries eligible for financing. Together, eight Performance Standards establish standards that the client is required to meet throughout the project life.[47]

35. The applicability of the Performance Standards is established during the Environmental and Social Impact Assessment process. While implementation of the actions is necessary to meet the requirements of IFC EHS Guidelines are managed through the project proponent/operator's Social and Environmental Management System. The project proponent/operator shall follow all the SPS 2009 and IFC EHS guidelines for Electric Power Transmission and Distribution, in particular EMF exposure limits to sensitive receptors, and occupational health and safety measures and should also ensure that all appointed contractors / subcontracts (subcontractors of the contracts) follow the IFC EHS guidelines and standards on Environmental and Social Sustainability.

15. ADB SAFEGUARD POLICY STATEMENT 2009

36. The Safeguard Policy Statement (SPS, 2009) builds upon the three previous safeguard policies on the environment, involuntary resettlement, and indigenous peoples, and brings them into one single policy that enhances consistency and coherence, and more comprehensively addresses environmental and social impacts and risks. The SPS 2009 aims to promote sustainability of project outcomes by protecting the environment and people from projects' potential adverse impacts by avoiding adverse impacts of projects on the environment and affected people, where possible. This involves minimizing, mitigating, and/or compensating for adverse project impacts on the environment and affected people when avoidance is not possible. The intention is to help borrowers/clients to strengthen their safeguard systems and develop the capacity to manage environmental and social risks. Specific directions are summarized below.

37. With the completion of the supplemental environmental assessment studies as required for ADB approval, including (i) cumulative impact assessment (also required by MOEF&CC), (ii) integrated water resource management, and (iii) water quality restoration and biodiversity enhancement,[48] this EIA and the corresponding EMP is consistent with the themes and instructions in the ADB Safeguard Policy Statement and also serves the requirements of GOI.

15.1 SAFEGUARD REQUIREMENTS

38. The safeguard policies require that: (i) impacts are identified and assessed early in the project cycle; (ii) plans to avoid, minimize, mitigate, or compensate for the potential adverse

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[47] The Performance Standards may be seen at following web-link: http://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/ifc+sustainability/our+approach/risk+management/performance+standards/environmental+and+social+performance+standards+and+guidance+notes

[48] The scope of work and TORs are being reviewed by ADB-SAEN now and will be forwarded to PMU/APGCL shortly such that the consultant recruitment can begin as soon as possible. The SEA scope can be completed in stages, with major deliverables completed by Q2, Q3, and Q4 2016.

impacts are developed and implemented; and, (iii) affected people are informed and consulted during project preparation and implementation. The policies apply to all ADB-financed projects, including private sector operations, and to all project components.

39. A key concern of ADB is that the Project does not result in degradation of sensitive ecosystems including critical and natural habitat. The SPS 2009, Appendix 1, paragraph 27, states that "the project mitigation measures should be designed to achieve at least no net loss of biodiversity," which could be achieved by post-project restoration of habitats or "through the creation or effective conservation of ecologically comparable areas," i.e. an ecological "offset." SPS 2009 provides the working definition of critical habitat as: habitat required for the survival of (i) globally endangered and/or critically endangered species, (ii) nationally endangered or critically endangered species, (iii) endemic/restricted range species, and (iv) migratory/congregatory species. Any Important Bird Areas (IBA) should be considered as critical habitat until further notified.

15.2 ROLES AND RESPONSIBILITIES

40. A basic principle of the three existing safeguard policies is that implementation of the provisions of the policies is the responsibility of the borrower/client. Borrowers/clients are required to undertake social and environmental assessments, carry out consultations with affected people and communities, prepare and implement safeguard plans, monitor the implementation of these plans, and prepare and submit monitoring reports. ADB's role is to explain policy requirements to borrowers/clients, help borrowers/clients meet those requirements during project processing and implementation through capacity-building programs, ensure due diligence and review, and provide monitoring and supervision. Considerable attention is devoted to the project processing and approval phase of the project cycle, although ADB's role in monitoring safeguard compliance continues during project implementation. ADB's project completion reports and project performance evaluation reports include review of the implementation of safeguards.

15.3 COMPLIANCE SYSTEM

41. ADB has established arrangements for monitoring projects' compliance with its safeguard policies. With the support of the Environment and Social Safeguard Division, ADB's Chief Compliance Officer is responsible for advising management and operations departments on safeguard compliance and related operational procedures and guidelines. Compliance with the safeguard policies is monitored throughout the project cycle. If a project poses risks of noncompliance, actions to ensure compliance are recommended at the Management Review Meeting, and project compliance is reviewed again at a Staff Review Committee meeting. Operations departments take steps to ensure that outstanding safeguard requirements are met before Board approval.

15.4 ACCOUNTABILITY MECHANISM

42. ADB adopted an accountability mechanism whereby people adversely affected by ADB-financed projects can: express their grievances; seek solutions; and, report alleged violations of ADB's operational policies and procedures, including safeguard policies. ADB's accountability mechanism comprises two separate, but related, functions: (i) consultation, led by ADB's special project facilitator, to assist people adversely affected by ADB-assisted projects in finding

solutions to their problems; and, (ii) providing a process through which those affected by a project can establish acceptable solutions to their individual issues.

16. ADB PROHIBITED INVESTMENT ACTIVITIES LIST (PIAL)

1.	Production or activities involving harmful or exploitative forms of forced labor[49] or child labor[50]
2.	Production of or trade in any product or activity deemed illegal under host country laws or regulations or international conventions and agreements or subject to international phase outs or bans, such as pharmaceuticals,[51] pesticides, and herbicides,[52] (b) ozone-depleting substances,[53] (c) polychlorinated biphenyls[54] and other hazardous chemicals,[55] (d) wildlife or wildlife products regulated under the Convention on International Trade in Endangered Species of Wild Fauna and Flora,[56] and (e) trans-boundary trade in waste or waste products[57]
3.	Production of or trade in weapons and munitions, including paramilitary materials
4.	Production of or trade in alcoholic beverages, excluding beer and wine[58]
5.	Production of or trade in tobacco
6.	Gambling, casinos, and equivalent enterprises
7.	Production of or trade in radioactive materials,[59] including nuclear reactors and components thereof
8.	Production of, trade in, or use of un-bonded asbestos fibres[60]
9.	Commercial logging operations or the purchase of logging equipment for use in primary tropical moist forests or old growth forests
10.	Marine and coastal fishing practices such as large scale pelagic drift net fishing and fine mesh net fishing, harmful to vulnerable and protected species in large numbers and damaging to marine biodiversity and habitats.

[49] Forced labor means all work or services not voluntarily performed, that is, extracted from individuals under threat of force or penalty

[50] Child labor means the employment of children whose age is below the host country's statutory minimum age of employment or employment of children in contravention of International Labor Organization Convention No. 138 "Minimum Age Convention"(www.ilo.org).

[51] List of pharmaceutical products subject to phase outs or bans is available at http://www.who.int.

[52] A list of pesticides and herbicides subject to phase outs or bans is available at http://www.pic.int.

[53] A list of the chemical compounds that react with and deplete stratospheric ozone resulting in the widely publicized ozone holes is listed in the Montreal Protocol, together with target reduction and phase-out dates. Information is available at http://www.unep.org/ozone/montreal.shtml.

[54] A group of highly toxic chemicals, polychlorinated biphenyls are likely to be found in oil-filled electrical transformers, capacitors, and switchgear dating from 1950 to 1985.

[55] A list of hazardous chemicals is available at http://www.pic.int.

[56] A list is available at http://www.cites.org.

[57] As defined by the Basel Convention; see http://www.basel.int.

[58] This does not apply to investee companies who are not substantially involved in these activities. Not substantially involved means that the activity concerned is ancillary to an investee company's primary operations.

[59] This does not apply to the purchase of medical equipment, quality control (measurement) equipment, and any equipment for which ADB considers the radioactive source to be trivial and adequately shielded.

[60] This does not apply to the purchase and use of bonded asbestos cement sheeting where the asbestos content is less than 20%.

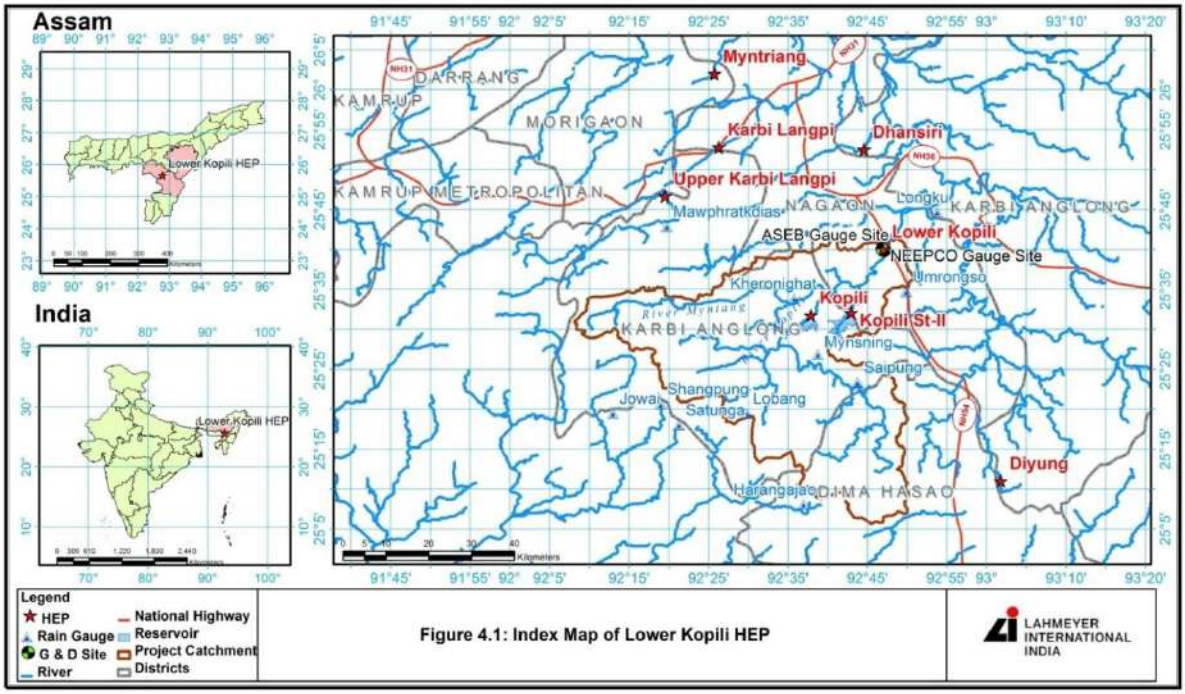
Annex 3: HYDROLOGICAL ASSESSMENT

1. This section summarises the key findings of the hydrological assessments carried out for LKHEP. Detailed hydrological study is presented in Chapter 6 of the DPR (Volume 1A_Main Report, Sep 2015).

1. INTRODUCTION

2. The Kopili River, a left bank tributary of the Brahmaputra, originates in the state of Meghalaya in the Borail range at an altitude of about 1,600m and has a total length of 297km up to its confluence with Brahmaputra In its upper reaches, the major tributaries of river Kopili are Kharkor, Myntriang, Dinar, Longsom, Amring, Umrong, Longku and Langkri. The Lower Kopili Hydro Electric Project is being planned as a run-of-the-river scheme with sufficient pondage in the Dima Hasao and Karbi Anglong districts of Assam. The catchment area of Kopili Basin is 2,076.62 km^2 and lies within coordinates 25°8´ and 25°41´North and 92°6´ and 92°49´ East. The catchment is bound by the Jaintia hills in the west and the south Cachar and Milir Hills in the East. An index map showing the location of the rain gauges in the catchment area is depicted in Figure 3.1.

Figure 3.1: Location of Rain gauges in the Catchment Area



2. RIVER SYSTEM AND BASIN CHARACTERISTICS

3. The river Kopili comes out of the Shillong plateau into the plains of Nagaon district of Assam through numerous rapids and falls traversing a distance of 120 km at Panimur. From 80 km to Panimur, both the banks of the Kopili River are covered with dense forest. From Panimur, the river Kopili separates Karbi Anglong district from North Cachar Hills district up to its confluence with Diyung River on its right at 135 km. After the confluence with Diyung, Kopili flows into the Nagaon district in a north-westerly direction. The Jamuna River with a catchment

of 3,960 sq.km flows to the Kopili at Jamunamukh. The river then flows in western direction, and further downstream, the Umkhen- Borapani River which rises in the Shillong plateau and drains an area of 2,038 sq.km joins Kopili at a distance of 254 km from the left. The Killing River, known as Umiam in its upper reaches draining an area of about 1,445 sq.km, flows into Kopili from the left at about 280km. The Kopili River finally flows to Kalang, a spill channel of Brahmaputra, near Hatimukh after traversing a distance of 290 km and draining a total area of about 16,421 sq.km.

3. The catchment area up to the proposed dam site is 2,076.62 sq.km. Nearly 95% of the area is covered with forest and about 5% is under cultivation. The total length of the river up to the dam site is 110 km and the mean slope is 13.02 m/km.

3. RIVER CHARACTERISTICS

4. Lower Kopili is a fast flowing perennial river. In the first 70 km from its source up to the confluence with Kharkor, the Kopili River drops by about 886 m and in the next 40 km drop is about 186 m. Several stretches in this 40 km offer scope for harnessing hydro power potential. The bed level of Kopili River at Longku (proposed dam site of Lower Kopili Hydroelectric Project) is 168 m.

4. CATCHMENT AREA

5. The catchment is fan shaped, having a length of 69.8 km and a width of 56.64 km. The total catchment area at proposed dam site is 2,076.62 sq.km. Catchment area of the Lower Kopili dam site downstream of Umrongso and Khandong dam is 788sq.km. The highest elevation in the catchment is 1,600 m. The catchment of the Kopili River up to the proposed Lower Kopili dam site lies on the leeward side of the Borail and K&J (Khasi & Jaintia) Hills range. It is covered with deep sub-tropical vegetation.

6. Catchment area map is enclosed as Figure 3.2, which also shows the distribution of catchment area under different elevation zones. The catchment is fan shaped, having a length of 69.8 km and a width of 56.64 km. The total catchment area at proposed dam site is 2,076.62 km². Catchment area of the Lower Kopili dam site, downstream of Umrongso and Khandong dam is 788 km². The highest elevation in the catchment is 1,600 m. The catchment of the Kopili River up to the proposed Lower Kopili dam site lies on the leeward side of the Borail and K&J (Khasi & Jaintia) Hills range. It is covered with deep subtropical vegetation. Major portion of the catchment has mild to moderate slope of 1-15% (Refer Figure 3.3), the southern corner has steep slopes exceeding 50%. Figure 3.4 presents the aspects of the terrain.

Figure 3.2: Catchment Area Map

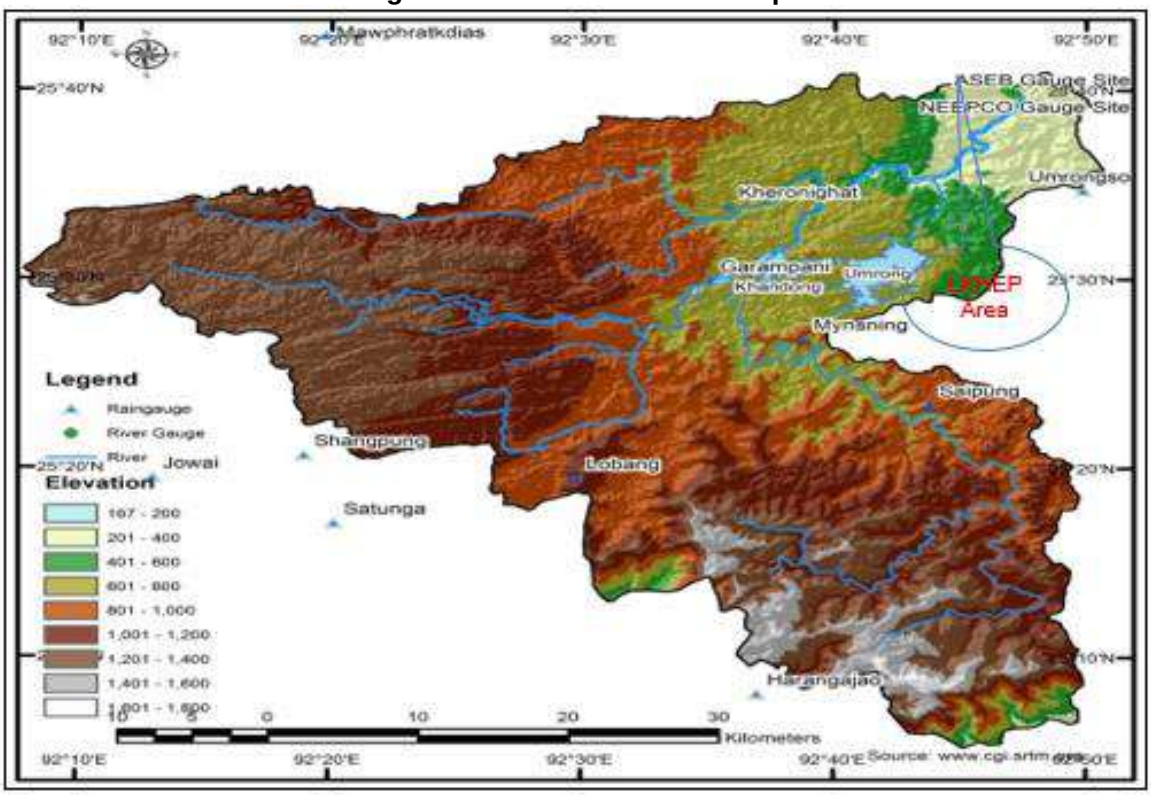


Figure 3.3: Slope Map

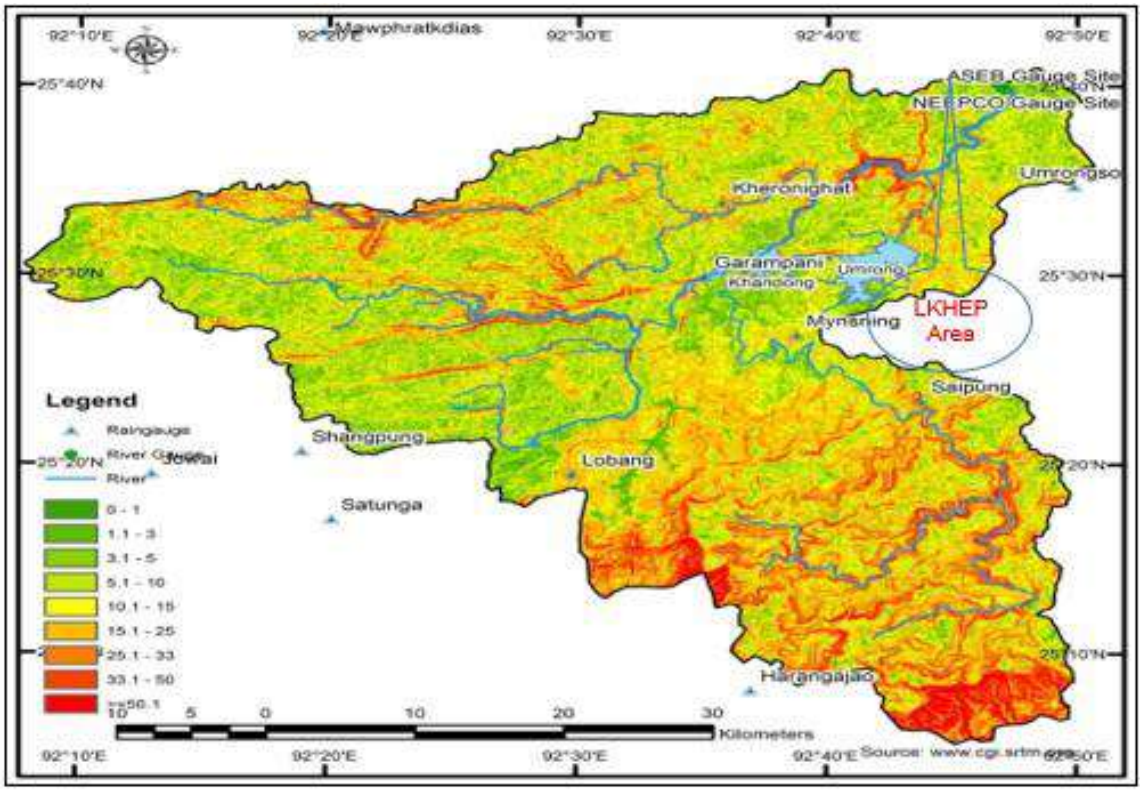
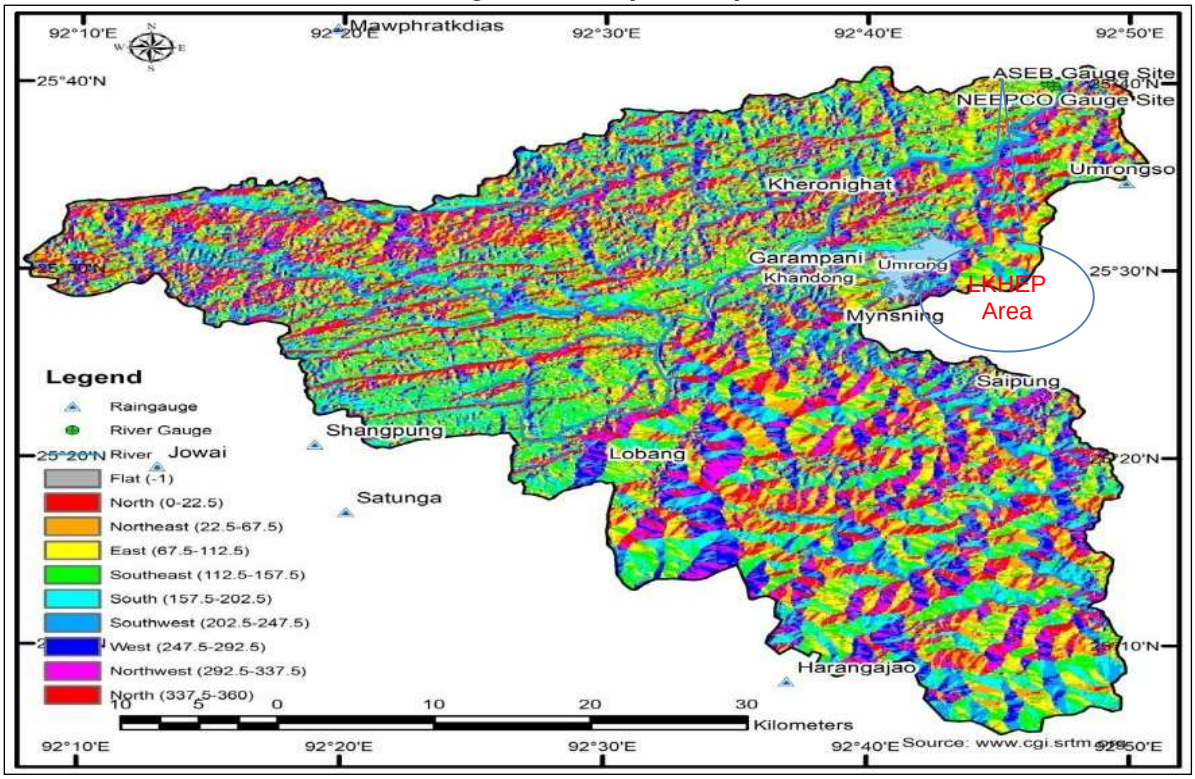


Figure 3.4: Aspect Map



4. HYPSOMETRIC CURVE

7. A hypsometric curve is an empirical cumulative distribution function of elevations in a catchment. The hypsometric curve for the project is prepared from SOI toposheets of scale 1:50,000 with 20 m contour interval. The catchment area of the Lower Kopili River up to dam site is 2,076.62 km². The distribution of catchment area in different elevation zones is given in **Table 3.1.**

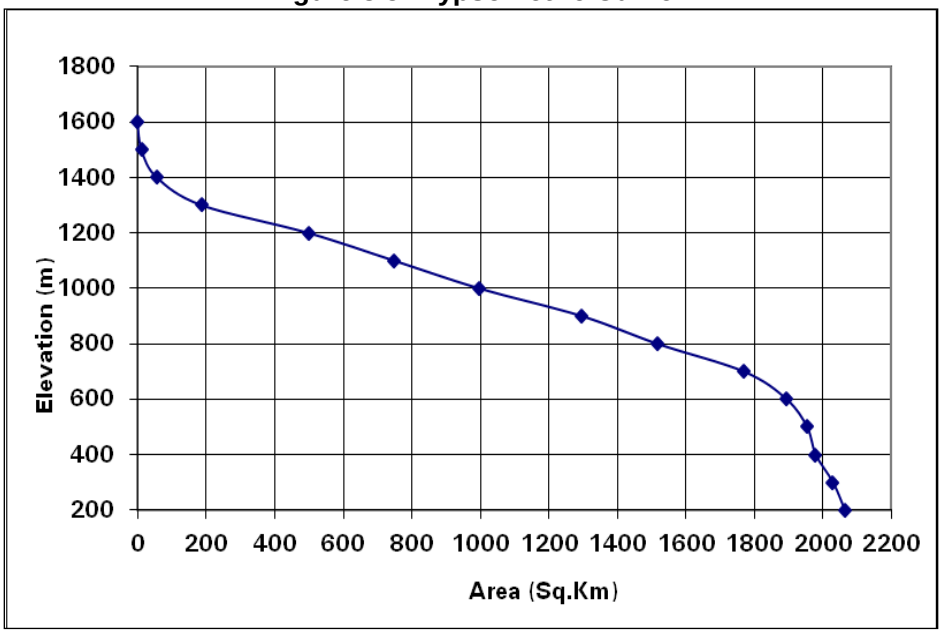
Table-3.1: Distribution of Catchment Area in Different Elevation Zones

Contours (m)	Area below (km^2)	Area above (km^2)	Incremental Area	
			km^2	% of Total Area
1,600	2,076.62	0.00	11.49	0.55
1,500	2,065.13	11.49	44.81	2.16
1,400	2,020.33	56.29	130.48	6.28
1,300	1,889.85	186.77	311.86	15.02
1,200	1,577.99	498.63	250.40	12.06
1,100	1,327.59	749.03	248.28	11.96
1,000	1,079.31	997.31	299.52	14.42
900	779.79	1,296.84	220.99	10.64
800	558.80	1,517.83	252.18	12.14
700	306.62	1,770.00	124.34	5.99
600	182.28	1,894.34	59.42	2.86
500	122.86	1,953.76	25.22	1.21
400	97.63	1,978.99	50.64	2.44

Contours (m)	Area below (km^2)	Area above (km^2)	Incremental Area	
			km^2	% of Total Area
300	46.99	2,029.63	34.51	1.66
200	12.48	2,064.14	12.48	0.60
168	0.00	2,076.62	0.00	0.00

8. The Hypsometric curve for the project is plotted in Figure 3.5. Assuming the Permanent Snowline elevation is at EL 4,500 m above mean sea level (a.m.s.l.), the hypsometric curve shows that the entire Lower Kopili catchment lies below this level.

Figure 3.5: Hypsometric Curve



9. The catchment receives good amount of annual rainfall in the monsoon season. As it is located on the leeward side of the range, the annual rainfall, however, is not uniform throughout and gradually diminishes towards the lower reaches. While the average annual rainfall of the upper catchment; up to Khandong dam site (Garampani) is 2,192mm, it is only 1,626mm for the intervening catchment up to Lower Kopili dam site at Longku. The rainfall is spread over 8 months, from March to October. Heavy rainfall occurs in the months of May to October.

5. CLIMATE

10. The region experiences four seasons viz., the winter (starting from late November and continuing up to March), the Pre-Monsoon (April and May), South-West Monsoon (end of May to September) and Post Monsoon (October to beginning of November).

11. **Precipitation:** In the upper catchment of Kopili up to Khandong Dam site, there are seven ordinary Rain Gauge (R.G.) stations, more or less evenly distributed over the catchment at (1) Shangpung, (2) Satunga (3) Mawphratkdias (4) Saipung (5) Garampani (6) Lobong (7) Mynsning. In the same reach immediately below the Khandong reservoir, there is another ordinary R.G. Station at Umrongso in the Umrong Nallah sub-catchment. Monthly rainfall data of these stations for varying length of period from 1962 to 2006 have since been available with M/s

NEEPCO as detailed below. In the intervening lower catchment, one ordinary R.G. station was set up by the Assam State Electricity Board (ASEB) in 1980 at LKHEP dam site at Longku.

12. Daily and monthly rainfall data of this station is available from March to May 1980 and from Jan 1981 to Dec 1986. In addition, daily rainfall data of three other rain gauge stations (Harangajao, Kheronighat and Jowai) maintained by IMD was also available for varying length of period from 1977 to 2006 as summarized in Table 3.1a.

Table 3.1a: Availability of Rainfall Data

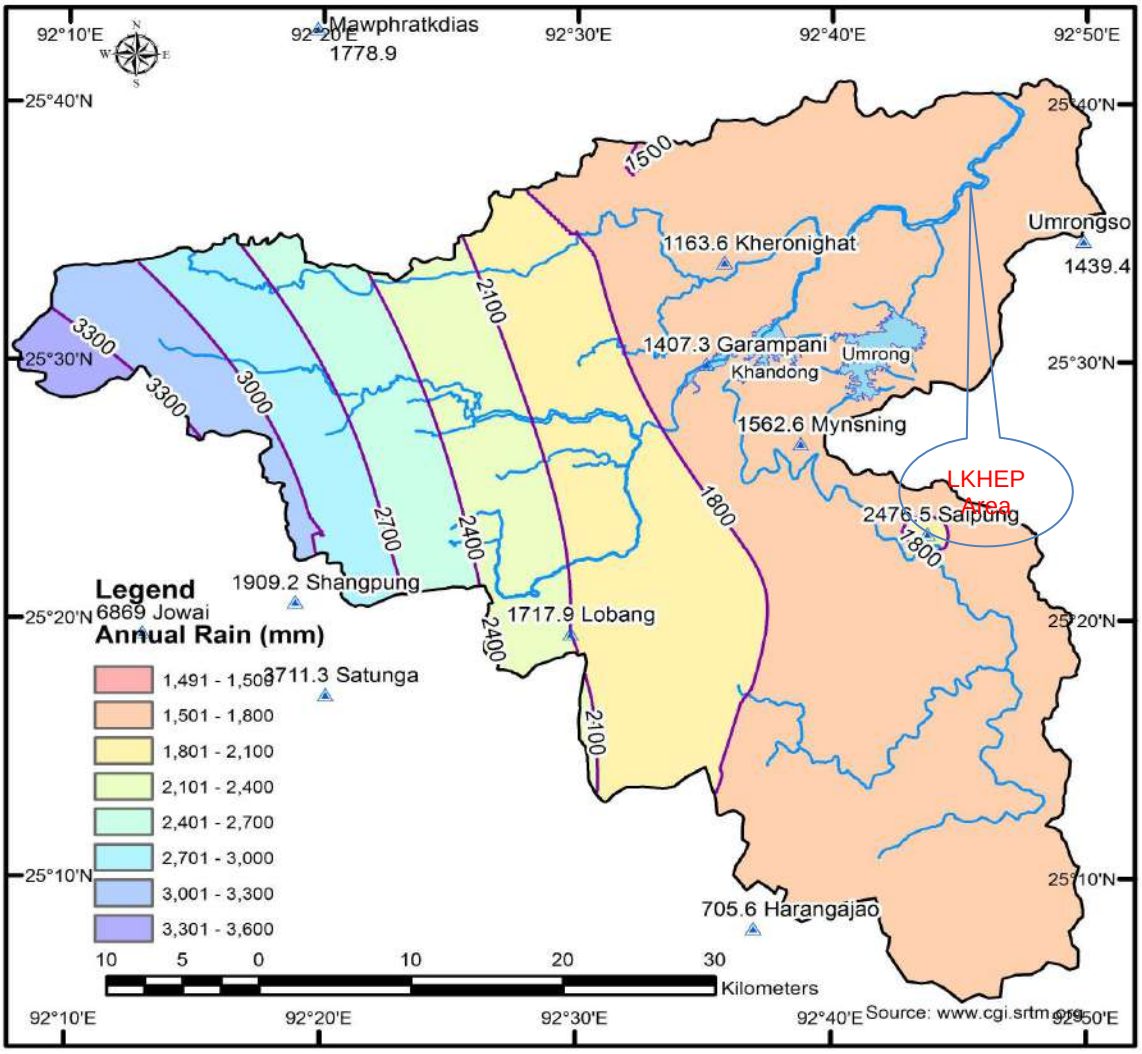
Sl. No.	Rain Gauge Station	Available Rainfall Data
1.	Garampani	Jan 1963 to Dec 1967, Jan 1970 to Dec 1974, Jan 1977 to Dec 1986 & Jan 1999 to Dec 2006.
2.	Harangajao	Jan 1991 to Dec 1999
3.	Jowai	Jan 1983 to Dec 2005
4.	Kheronighat	Jan 1977 to Jan 1996 & Jan 1998 to Nov 2006
5.	Lobang	Jan 1963 to Dec 1967, Jan 1970 to Dec 1974 & Jan 1977 to Dec 1986
6	Longku	Jan 1963 to Dec 1967, Jan 1970 to Dec 1974 & Jan 1977 to Dec 1986
7.	Mawphratkdias	Jan 1963 to Dec 1967, Jan 1970 to Dec 1974 & Jan 1977 to Dec 1986
8.	Mynsning	Jan 1963 to Nov 1967, Jan 1970 to Dec 1974 & Jan 1977 to Dec 1986
9.	Saipung	Jul 1962 to Nov 1967, Jan 1970 to Dec 1974 & Jan 1977 to Dec 1986
10.	Satunga	Feb 1963 to Dec 1967, Jan 1970 to Dec 1974 & Jan 1977 to Dec 1986
11.	Shangpung	Jul 1962 to Dec 1967, Jan 1970 to Dec 1974 & Jan 1977 to Dec 1986
12.	Umrongso	Jan 1963 to Dec 1967, Jan 1970 to Dec 1974 & Jan 1977 to Dec 1986

13. The mean annual rainfall over the catchment has been computed as 1,946mm, using interpolation considering average annual rainfall for all the stations, and has been furnished in Figure 3.6. The catchment rainfall has been mentioned by the CWC to be of the order of 1,557 mm. The catchment extends over a zone with annual rainfall varying between 1,500 mm and 3000mm. The region experiences heavy rainfall from cyclonic storms and southwest monsoon from May to October, which is about 90% of the annual rainfall.

14. **Temperature:** Depending on the elevation, the high hills belong to temperate zone while lower hills and valleys are in the sub-tropical agro climate zone. Temperature in the region varies generally from a maximum of 23°C to 32°C in summer to a minimum of 6°C to 14°C in winter.

15. **Humidity:** The average relative humidity varies between 73% and 84%.

Figure 3.6: Distribution of Mean Annual Rainfall over the Catchment



6. WATER AVAILABILITY

16. Detailed hydrological analysis has been carried out during the feasibility and detailed design stages, based on the available historical data provided by CWC (nodal agency in India). Additional hydrological studies including modeling and simulations have been carried out as part of the Integrated Water Resources Management Plan (provided as an addendum to the EIA in a separate volume).

17. Detailed flow analysis has been carried out for available historical flow data (Jan 1955 to Dec 1996, Sep 1976 to Dec 1978, July 1979 to Dec 1992, May 1998 to 2010). Mass Curve of cumulative annual inflow volumes for the two periods (1979-80 to 1992-93 and 1998-99 to 2009-10) in reverse chronological order brings out difference of slope between these two periods, indicating internal inconsistency. Therefore, only discharge data for the period 1998-99 to 2009-10 has been considered for assessment of water availability. This has concurrence of the CWC (vide Memo. No. C.W.C. U.O. No. 4/215/2011-Hyd (NE)/ 1201 dated 14.05.2012).

18. The annual flow volume estimates for the period 1998-99 to 2009-2010 has been considered together to arrive at the 90% and 50% dependable hydrologic year, based on Weibull Plotting position formula, shown in **Table 3.2**.

Table 3.2: Dependability of Annual Flow Volumes

S. No.	Year	Flow (MCM)	Sorted		Exceed. Prob. %
			Year	Flow	
1	1998	2,483.6	2008	2,990.8	7.7
2	1999	2,553.9	2000	2,958.4	15.4
3	2000	2,958.4	2007	2,809.6	23.1
4	2001	2,506.0	2002	2,792.8	30.8
5	2002	2,792.8	1999	2,553.9	38.5
6	2003	2,440.2	2001	2,506.0	46.2
7	2004	2,184.4	1998	2,483.6	53.8
8	2005	2,434.7	2009	2,450.2	61.5
9	2006	2,381.0	2003	2,440.2	69.2
10	2007	2,809.6	2005	2,434.7	76.9
11	2008	2,990.8	2006	2,381.0	84.6
12	2009	2,450.2	2004	2,184.4	92.3

19. The summary results of dependable flow analysis for 90% and 50% dependable years are shown in Table 3.3.

Table 3.3: Dependable Year Flow Volumes

Dependability	Dependable Water Year (June – May)	Annual Flow Volume (MCM)
90%	2004-05	2,184.4
50%	1998-99	2,483.6

20. The flow duration curve based on all averages of 10-day period discharge data (so, 3 periods in each month) is presented in Figure 3.7. Flow Duration Curve for 90% and 50% dependable years have been portrayed in Figure 3.8 and 3.9, respectively.

Figure 3.7: Ten-Daily Flow Duration Curve Based on Series Provided by CWC

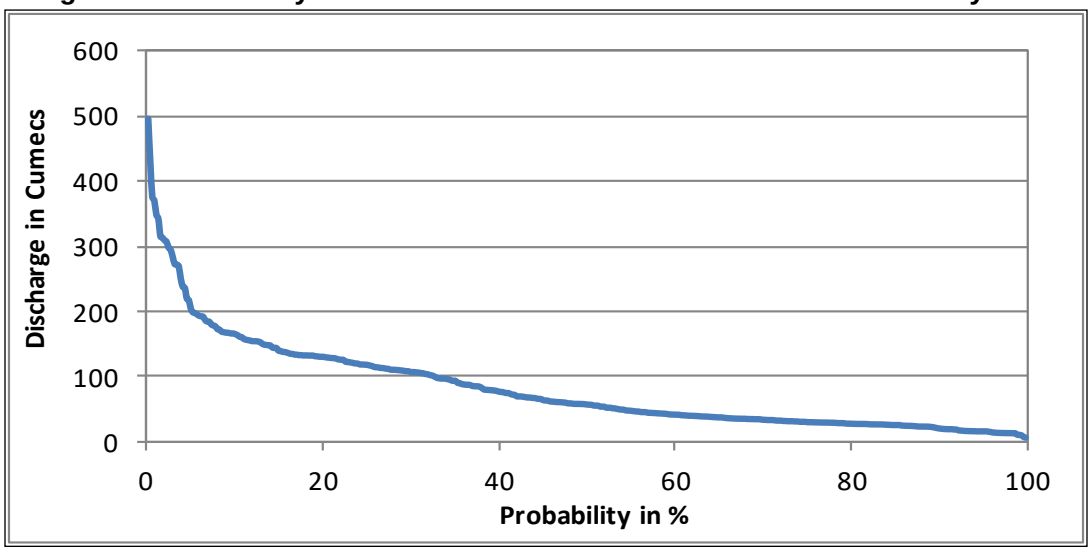


Figure 3.8: Flow Duration Curve for 90% Dependable Year: 2004-05

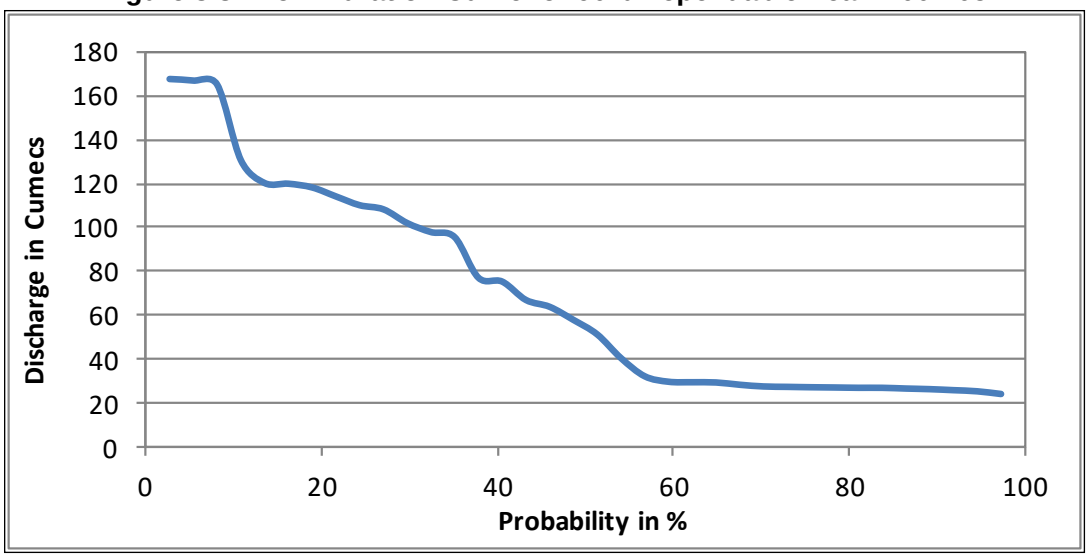
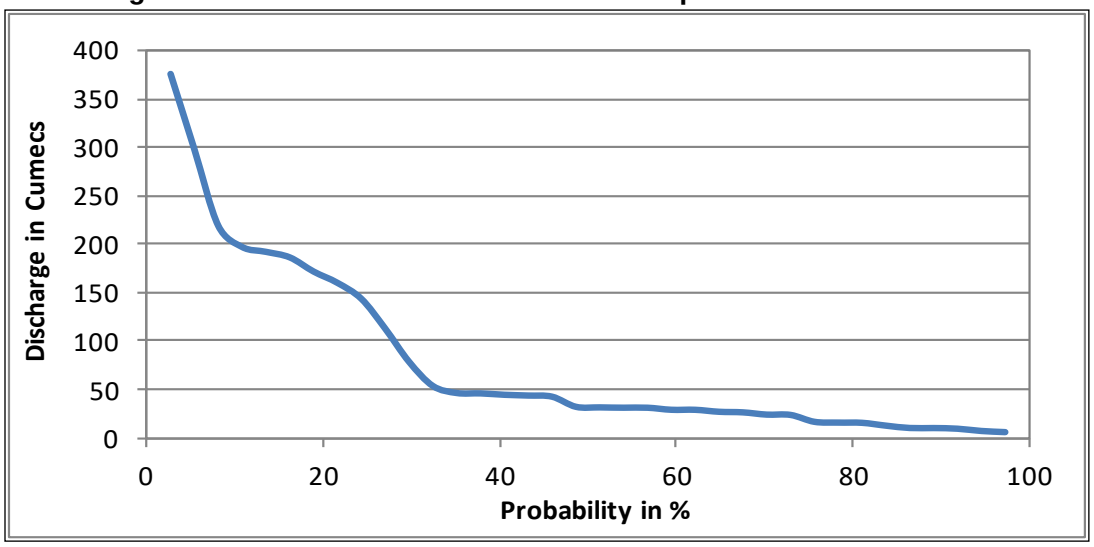


Figure 3.9: Flow Duration Curve for 50% Dependable Year: 1998-99



21. As per the DPR, water availability for various return periods have been studied. The floods of various return period as estimated in the DPR are given in Table 3.4.

Table 3.4: Adopted Flood discharge for various return periods

Return Period (Years)	Annual Peak Flood (cumec)	Non-monsoon (Nov – April) Flood (cumec)
25	7,339	842
50	8,306	952
100	9,266	

22. The Lower Kopili Hydro Electric Project will be a run-of-river cum storage scheme on the Kopili river at Longku. The scheme has been designed to run at full potential in monsoon season and operate as a peaking station in lean season. The existing Kopili Project is located upstream of Longku dam site. The project consists of two reservoirs at Khangdong and another at Umrong and two power stations; Khangdong power station with installed capacity 3 x 25 MW and Kopili power station with installed capacity of 4 x 50 MW. The water availability at the proposed Longku Dam site is controlled by these upstream schemes. The water available at the Longku dam site will consist of the following components:

- Tail race releases from Kopili Power Station (4 x 50 MW)
- Inflow from intermediate catchment between Khangdong and Longku Dam site
- Spill from Khangdong and Umrong Reservoir.

23. The operation of Lower Kopili power station will not be affected by the operation of Khangdong and Kopili power station on upstream as KHHEP has provision for volume regulation in a large storage reservoir, which will take into account the variations in regulated discharge from upstream power stations and monthly variations in inflows from the immediate upstream catchments.

24. The annual flow volume estimates for the period 1979-80 to 2009-2010 has been considered together to arrive at the 90%, 75% and 50% dependable hydrologic year. Long-term river flow series was established in the form of ten-day discharge values; computed from the

available daily discharge data. The 50% and 90% dependable years were worked out as 1998-1999 and 2004-05 with annual flow volume as 2,483.6 MCM and 2,184.4 MCM respectively. The design discharge for power generation is 112.71 cumec.

25. The 10-day discharges for the 90% dependable year are given in Table 3.5.

Table 3.5: 10 daily flows for 90% dependable year

Month	10-daily period	Discharge (cumec)
June	I	6.54
	II	79.95
	III	41.28
July	I	63.76
	II	84.02
	III	74.09
August	I	130.34
	II	75.96
	III	43.02
September	I	132.54
	II	86.02
	III	133.25
October	I	106.21
	II	86.35
	III	50.32
November	I	44.38
	II	37.50
	III	18.79
December	I	22.30
	II	22.11
	III	23.07
January	I	21.83
	II	18.87
	III	21.35
February	I	21.69
	II	20.09
	III	21.94
March	I	20.61
	II	21.68
	III	21.07
April	I	16.08
	II	15.98
	III	16.31
May	I	53.43
	II	81.94
	III	116.88

7. DESIGN FLOOD

26. The proposed dam at Longku site is a large dam as its gross storage (106.29 MCM) is more than 60 MCM and the head is more than 30 m. Hence as per the IS code, the inflow design flood for the dam should be the Probable Maximum Flood (PMF). The summary of Design Flood values for different return periods is given in Table 3.6.

Table 3.6: Summary of Design Flood Values for Different Return Periods

Return period	Flood discharge (m^3/s)
25 years (Nov-May)	720
25 years	4,220
50 years	4,800
100 years	5,375
SPF	7,510
PMF (accounting for failure of upstream dams)	11,030

27. The reservoir of Lower Kopili Hydroelectric Project is formed by the construction of 70.13 m high concrete gravity dam and has a capacity of 106.29 Mm^3 at FRL of EL 226.00 m. The minimum drawdown level is EL 202.00 m providing a live storage of 77.29 Mm^3.

28. The flood routing study is not required because the project is a run-of-river scheme with limited water storage only meant for peaking power generation during non-monsoon season. Maximum Water Level (MWL) in the reservoir is fixed for passage of the PMF with one gate inoperative. Under the condition when the PMF value of 11,030 m^3/s passes through the sluice spillways MWL is at EL 229.60 m. For passing PMF, 8 nos. of sluice gates of size of 7.10 x 8.65 m are proposed assuming one gate inoperative.

8. DIVERSION FLOOD

29. According to IS 14815: 2000 – Design Flood for River Diversion Works – Guidelines (vide Clause 4.1, Page 2) the following should be considered while deciding the diversion flood capacity for concrete dams and barrages: a) Maximum non-monsoon flow observed at the Dam site or, b) 25-year return period flow, calculated on the basis of non-monsoon yearly peaks. The higher of the above two should be taken as the capacity of the design flood.

30. Based on the entire data available, the observed maximum daily Non-monsoon flow in the River Kopili near the HEP site is 570.41 m^3/s, observed on 3rd March 1961. In the more recent period, the maximum observed non-monsoon flow is 453.14 m^3/s, observed on 6th April 1984. Over the last decade, the maximum value observed for the non-monsoon period is 297.15 m^3/s, observed on 15th November 2002. It appears that the peak non-monsoon flow has reduced over the period; which is likely due to the flood attenuation effects of Khandong and Umrong reservoir hydropower projects upstream of the current project, commissioned in steps between 1984 and 2004 (Sharma et al., 2011). Analysis for homogeneity of data using t-test shows that non-monsoon annual flood peaks are consistent over the entire period. This is justifiable, as both the reservoirs serve the sole purpose of hydropower generation without any diversion for consumptive use (Umrong is only a pick-up reservoir, receiving and storing outflow from the Khandong Power House); therefore changed peak flow pattern should not be significantly different from the pre-construction period as the losses due to percolation and evaporation from the reservoir bodies would be the only losses. Further, it has been collected

during site visit that one of the reservoirs has un-gated spillway, while the other operates with gates fully open for passing flood. Consideration of the entire data set of observed daily discharge pertaining to 40 years in three different periods (1955-56 to 1968-69, 1979-80 to 1992-93 and 1998-99 to 2009-10) appears to provide an over conservative estimate. Therefore, data for the two latest periods have been considered together for the purpose of flood frequency analysis for estimation of diversion flood. The design diversion flood adopted as for Lower Kopili Dam site is 720 m^3/s. This has received the approval of the CWC (vide CWC U.O. No. 4/215/2011-Hyd (NE)/1201 dated 14.05.2012).

9. SEDIMENTATION

31. Sediment load of upper stage Kopili reservoir was analyzed by the CWC and was estimated to be 281 m^3/km^2/year (0.59 acre feet/square mile/year) at Garampani. Silt composition was considered to be 50% fine, 25% medium and 25% coarse. Due to proximity and similar nature of catchment of the Lower Kopili Project on the same river at about 20 km downstream of the upper stage Kopili Project, the same silt load is assumed to be applicable for the Lower Kopili reservoir also. The new zero elevation and area of the reservoir are found as EL174 m and 0.23 Mm^2.

32. As a part of DPR studies, sedimentation studies have been carried out considering a siltation rate of 1mm per year (0.1Ha-m/km^2/year), following recommendations of CWC. It has been carried out for a reservoir design life of 70 years, in stages of 10 years. Blocks of 15 years were chosen for the initial years to reduce computation. Revised Area – Capacity – Elevation curves of the reservoir after operation of the reservoir for 15, 30, 45, 60 and 70 years have been plotted to get the New Zero Elevations.

33. CWC has suggested to carry out sedimentation studies ignoring trapping of sediment in the upper reservoirs, as they are designed for power generation only. Also, regular flushing is carried out to flush out the deposited sediments. Therefore, sediment contribution at the rate of 0.1Ha-m/km^2/year from the entire catchment area of 2,076.62 sq.km was considered to be reaching the Lower Kopili reservoir. The New Zero Elevation after 70 years of reservoir operation has been estimated as 207.241m. However, the actual sedimentation is expected to reach much lower levels as under sluice spillways are envisaged. The MDDL is fixed at EL 202.00 m. Necessary arrangement has been made for flushing of sediment deposited in the vicinity of power intake by providing low level sluice spillways in the dam nearer to the intake. The invert level of the intake tunnel is at EL 186.00 m. Crest level of the Sluice spillways is at EL 181.00 m. Sill level of the Power intake for the Auxiliary Power House is at much higher elevation which is at EL 194.65 m.

10. POWER POTENTIAL

34. The proposed Lower Kopili Project is a run-of-the-river scheme with pondage at Longku site. Since this project is a single purpose scheme, the entire live storage will be utilized for power generation. For the purpose of energy estimate, the head loss has been estimated as 6m and net head has been worked out. Based on studies for installed capacity 110 MW, 2 units of 55 MW each, has been selected as installed capacity for this scheme.

35. The design energy in a 90% dependable year with installed capacity of 110 MW is 452.19 MU at 46.93% load factor and 95% plant availability. However, the plant can operate at 15% over loading in monsoon season and thereby the annual generation can increase up to 465.00 MU with 100% plant availability. Power generation studies have been carried out for all

the years and the average annual generation with 100% plant availability and 15% overloading is 500.70 (PLF 51.96 %) In addition, there will be generation of energy when the live storage of 77.29 MCM in the reservoir is utilized completely, which happens possibly once in a year. If this is done just before the monsoons, the reservoir water level will be replenished during the subsequent monsoon period. With the design discharge of 112.71 m^3/s, additional generation at full capacity of 110 MW is estimated as 7.94 days. This will enable the plant to generate an additional energy of around 20.96 MU every year. In order to generate power to meet diurnal peak load, the project is proposed to be operated in the mode of diurnal peaking. Lower Kopili Hydroelectric project can be operated more or less at full plant capacity in the five months during monsoon season (June to October) and therefore diurnal peaking operation is possible only in non-monsoon months (Nov to May). It has been envisaged to operate the reservoir at FRL throughout the year, to gain maximum advantage of the head available. It has been proposed to utilize the environmental release for generating hydropower by passing it through turbines of a dam toe power house named as Auxiliary Power House. This will act as a base load plant, generating power which is proposed to be used also for local use. The annual energy generation in a 90% dependable year with 95% plant availability is estimated as 39.03 MU.

Annex 4: REPORT ON VEGETATION AND FAUNAL ASSESSMENT STUDIES

1. General

1. This section present the ecological (floral and faunal) studies carried out in the project influence area. As recommended by the Expert Appraisal Committee of MoEF&CC, the biodiversity study for the LKHEP was conducted by a reputed institute in India (Centre for Inter-Disciplinary Studies for Mountain and Hill Environment–CISMHE, Delhi University, India; one of the top institutes recommended by the Ministry of Environment, Forests and Climate Change, Government of India – nodal agency for grant of environment clearance).

2. The study area represents diverse biological assemblages unique in structure, composition, and spatial pattern. These have been under a long influence of local communities. The following section highlights floral and faunal diversity, based on the field studies carried out by CISMHE (2015).

3. Section 2 presents the description of the study area for terrestrial ecology, section 3 presents the methodology adopted for recording the terrestrial ecology, flora and fauna profile, community structure while section 4 and 5 presents the findings of the field study.[61] Similarly, section 6 presents the description of the study area for aquatic ecology; section 7 presents the methodology adopted for recording the aquatic ecology while section 8 presents the findings of the field study.[62]

2 Description of the Study Area: Terrestrial Ecology

4. The description of vegetation of the project area has been presented in terms of project impact zones which correspond to topographic/elevational class within the 10 km radius influence/impact zone of the project. The number of samples and locations of the sampling sites (within an impact zone of 10 km radius) were selected based on the review of the secondary data, topographical and floristic composition, professional judgment, and discussions with the local forestry officials. The sampling locations are selected to collect the representative data on flora diversity in the project area. Further surveys will be undertaken in the pre-construction and construction phases, and will focus on contiguous habitats in and around worksites, as well as the forest patch south of the project area, which will be the focus of the biodiversity conservation efforts.

5. Table 4.1 presents the sites selected for recording of the terrestrial ecology (topography, floral and faunal accounts). Observations were made with respect to both project area and project appurtenances. The sampling locations are presented in Figure 4.1.

Table 4.1: Description of Study Area for Terrestrial Ecology (Flora and Fauna)[63]

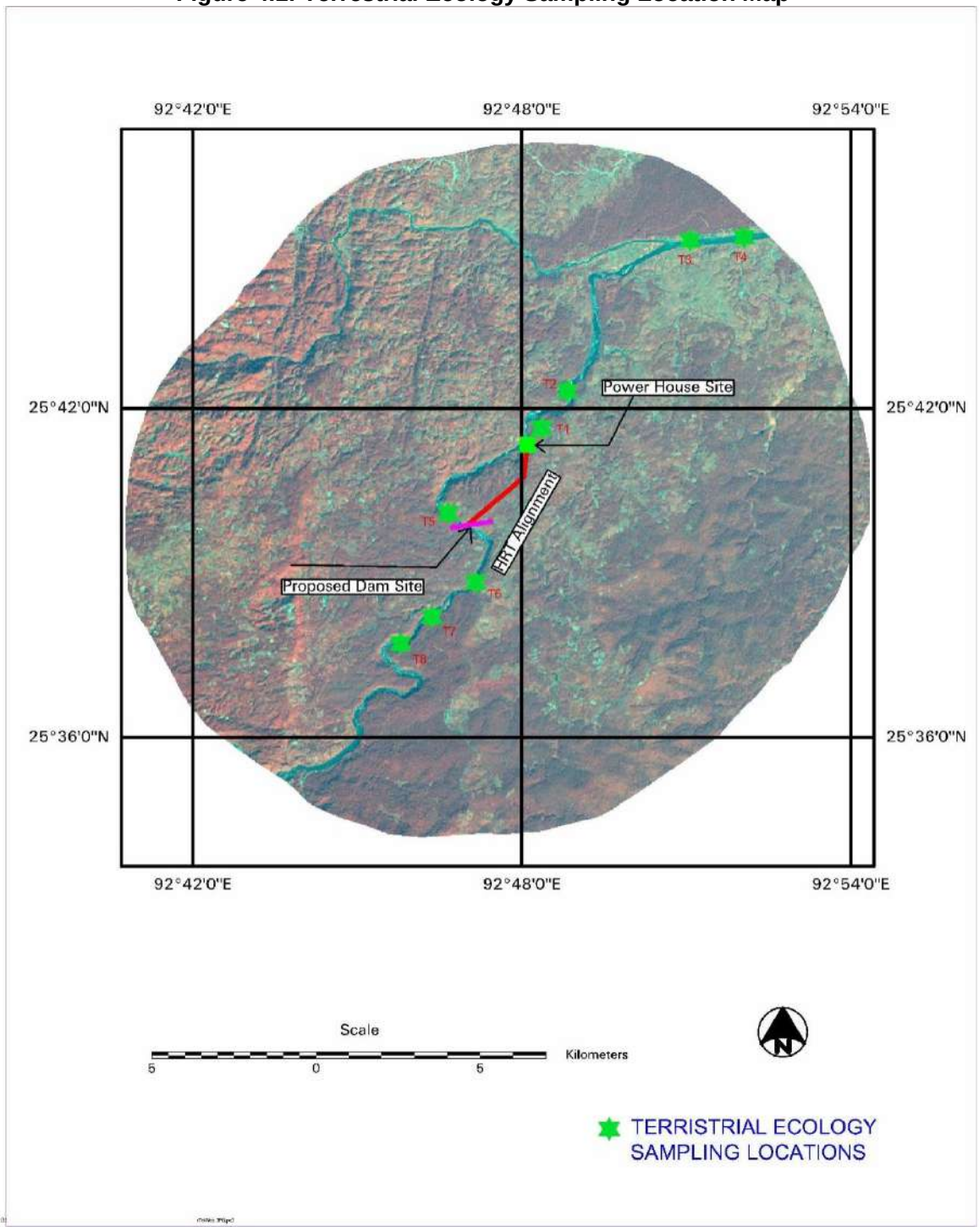
Study Site	Location*	Description
A.	**Project Influence Area (Power House (PH) site & downstream (d/s) area): Area between Panimore-Patharkore and Kala Nala**	
Site 1	Chota Longpher village on Right	PH site area of river Kopili and adjoining d/s RB streams

[61] Chapter 8: Ecological Aspects, WAPCOS EIA Study.
[62] Chapter 8: Ecological Aspects, WAPCOS EIA Study.
[63] Table 8.2, Chapter 8 WAPCOS EIA Study.

Study Site	Location*	Description
	Bank (RB) & Adjoining area covering Left Bank (LB)	like Longkongsam Nala (~0.5 km d/s), & perennial stream - Kala Nala / Longchitung nala (1.5- 2.0km) in d/s PH site
Site 2	Panimore –Patherkore	Panimore (RB) – picnic spot both on RB & LB on river Kopili water fall location about 7-8km d/s of PH site
B.	**Dam Site (d/s) to PH site (u/s) Zone: Area beyond Kala Nala and up to Longphu Basti**	
Site 3	d/s Dam site to PH site	Longku village to Longpher basti – both situated on RB of river Kopili
Site 4	Charchim village & Phang-longsu village on LB and bada Longku on RB of river Kopili	Charchim nala catchment in Charchim village located on LB. Other small streams - Soho nala (1.5km d/s), Phanglongsu nala (3.0km); all present in the area between dam site to PH site
C.	**Dam Site & Catchment / Submergence Zone: Area between Longphu basti & Digram Basti**	
Site 5	Longku Dam Site	Longku village-camp on RB of river Kopili & Rongtarme village on LB of river Kopili
Site 6	Longku village to Mongle village (RB villages)	Confluence of Longku village nala with river Kopili at ~1km upstream (u/s) dam site –RB stream. Open mixed jungle from river bank (village Longku) to village Mongle (RB village 5km from dam site in u/s location)
Site 7	Rongtarni village (LB village) & Discharge site/ gauge reading site on RB (~4-5 km u/s dam site)- towards Digram basti	Submergence Zone : Longsomepi nala /Dong ikpi nala of L.B. joins river Kopili ~4.5 u/s dam site and discharge site on RB of river Kopili river towards Digram basti in the catchment area

* The right bank (RB) of river falls in Dima Hasao district and Left Bank (LB) forms the boundary of Karbi Anglong district

Figure 4.1: Terrestrial Ecology Sampling Location Map[64]



[64] Figure 8.1

3. Methodology

3.1 Vegetation Survey

6. **Data Collection:** WAPCOS utilized both primary and secondary data for conducting floral investigation in the study area. Primary data collection was carried out for three seasons within 10 km radius of the proposed project area (catchment-submergence zone, dam site, PH site and d/s PH site up to 10 km river reach length). Published documents, research papers, and reports issued by the Forest Department were utilized as sources of secondary data.

7. **Phyto-sociology Attributes:** Primary data collection used a nested quadrat technique for vegetation sampling. The size and number of quadrates were determined using species area curve (Mishra, 1968) and the running mean method (Kershaw, 1973). To study the phyto-sociological attributes, the quadrate sizes were as follows: 10 m x 10 m for trees, 5 m x 5 m for shrubs, and 1m x 1m for herbs and grasses. A total 25 no. quadrates were formed at each study site at different elevations while ensuring representation of attributes from both left bank and right bank of river Kopili. Enumeration of vegetation was done for each quadrate and quantitatively analyzed as per the method developed by Curtis and Macintosh (1950), and Mishra (1968). The tree species diversity in different forest types was determined using Shannon Wiener information function (Shannon and Wiener, 1963) and Evenness Index formula, respectively.

8. **Identification of Rare, Endangered and Threatened plant species:** Rare and endangered species were identified utilizing IUCN Red List[65] and Red Data Book, and other available literature, and information on flora and herbarium pertaining to the rare/ endangered species of Assam.

9. **Medicinal and Economic important Plants:** An ethno-botanical survey was carried out for identification of wild plants used by the local communities of the area.

10. **Community Structure[66]:** In order to understand the community structure of the study area, vegetation samplings were carried out across different locations. The locations were as follows:

- Submergence area (upstream of Longphu Basti, Kopili river banks V1),
- Dam site (near Longphu Basti, river Kopili V2),
- Power house site (u/s near Kala Nala, Kopili V3) and
- Downstream of Power house (near Panimore-patharkore, Kopili V4)

3.2 Faunal Survey

11. **Data collection:** WAPCOS utilized both primary and secondary data for conducting faunal investigation of the study area. Primary data collection was carried out during pre-

[65] IUCN provides a comprehensive analysis of the global conservation status, trends, and threats to species viz the IUCN Red List or Red Data List. The IUCN Red list establishes a baseline from which to monitor the change in status of species; provides a global context for the establishment of conservation priorities at the local level; and on a continuous basis, monitor the status of a representative selection of species (as biodiversity indicators) that cover all the major ecosystems of the world. http://www.iucnredlist.org/about/overview

[66] Community is an association or assemblage of plant and animal population that occupy a particular territory or habitat and having a typical composition and structure.

monsoon season in the study area up to 10 km radius from the proposed project area (catchment-submergence zone, dam site, PH site and d/s PH site up to 10 km river reach length). Published documents, research papers, reports issued by the Forest Department, and outputs from consultation with residing villagers / local forest rangers (for recent / past / direct sightings, etc.) were utilized as sources of secondary data.

12. The general methodology employed in the study area is as follows:

- Butterflies: the standard 'Pollard Walk' methodology was employed. All butterfly species observed while trekking along the fixed transects (foot trails) between sites were recorded in writing and photographs taken for identification; Sampling was conducted for 1 hour stretch on each transect (n=4).
- Avifauna (birds): the 'Point Sampling' methodology was employed. All avifauna species observed while trekking along the fixed transects (foot trails) between sites were spotted with the aid of binoculars, field guides, recorded in writing and photographs taken for identification; Sampling was conducted for 1 hour stretch on each transect (n=4).
- Mammals: the 'Direct Count on open width (20 m) transect' mythology was employed. All mammal species observed and signs (droppings, pug marks etc.) were noticed while trekking along the fixed transects (foot trails) between sites were recorded in writing and photographs taken for identification; Sampling was conducted for 1 hour stretch on each transect (n=4). Information on recent /past sightings by residing villagers and local forest rangers was also recorded.
- Reptiles and Amphibians: All reptiles and amphibians (mainly lizards and frogs) were recorded by the 'Direct Count on open width (20 m) transect' methodology. Sampling was conducted for 1 hour stretch on each transect (n=4).

4 FINDINGS - FLORA

4.1 VEGETATION TYPE IN THE STUDY AREA

Study Site A.	Project Influence Area (Power House (PH) site & downstream (d/s) area): Area between Panimore-Patharkore and Kala Nala

13. For the **Project Influence Area,** the lower reaches are characterized by Assam Valley Tropical Semi Evergreen forest while the middle reaches (lying especially in the Haflong Forest Division of district Dima Hasao) are characterized by East Himalayan Moist Mixed Deciduous forest converging into Sub Tropical Wet Hill forest on higher elevations.

14. The area around **Panimore-Patharkore Basti** has Moist Mixed Deciduous forests, seen on porous and well drained soil. The dominant tree canopy comprises of Tectona grandis, Dillenia pentagyna, Holarrhena pubescens, Bombax ceiba, Ficus bengalensis, Wrightea tomentosa, Albizia procera, Walsura robusta, Syzygium cumini, Sterculia villosa, etc. Undergrowth is not rich, and comprises of few small trees and spreading shrubs (Abroma angusta, Aralia thomsoni, Clerodendrum serratum, Lanatana camara, Mimosa rubicaulis, etc.). Climbers and epiphytes are not common; however, some large tree trunks are clothed with few epiphytic ferns like Drynaria mollis, Pyrrosia adnascens, P. nuda, Vittariaamboinensis, etc. Fruit trees like Bel, Citrus, Kathal, Mango, Guava, etc. are observed near Basti area.

15. The area between **Panimore-Patharkore to Kala Nala** comprises of Moist Mixed Deciduous forests with a few Semi Evergreen forest type species. The top storey consists of Artocarpus chama, Bauhinia variegata, Bleischmiedia roxburghiana, Gmelina arborea, Holarrhena pubescens, Magnolia caveana, M. hodgsonii, Pterospermum acerifolium, Schima wallichii, Sterculia villosa, etc. The tree trunks are often clothed with twiners and climbers. The shrub species are bamboos (Bambusa tulda), Abroma angusta, Chromolaena odoratum, Clerodendrum serratum, Lantana camara, Mimosa rubicaulis, Neillia thyrsiflora and Urena lobata. The climber species are Beaumontia grandiflora, Coculus orbiculatus, Combretum decandrum, Dioscorea hamiltoni, Mikania macrantha, Porana paniculata, Rhaphidophora decursiva and Stephania glabra. The river terraces stability is maintained by few Evergreen or Deciduous tree species like Flacourtia jangomas, Homonoia riparia, Lagerstroemia speciosa, Pterospermum acerifolium, etc.

16. The vegetation in the PH site comprises of dense storied Tropical Semi Evergreen forest with some riparian tree species at lower reaches. The top storey consists of Artocarpus chama, Beilschmiedia roxburghiana, Haplophragma adenophyllum, Homalium schlichii, Holarrhena pubescens, Meliosma pinnata, Protium serratum, Pterospermum acerifolium, Sterculia urens, S. villosa, etc. Second storey is also dense Evergreen forest and consists of Baccurea sapida, Crativa religiosa, Colona floribunda, Cycas pectinata, Ficus glomerata, Lagerstroemia parviflora, Mallotus philippinensis, Meliosma pinnata and Samanea saman, etc. Shrub species comprises of Ambrosisa artemisifolia, Bambusa tulda, Chromolaena odoratum, Clerodendrum serratum, Lantana camara, Maytenus senegalensis, Mimosa rubicaulis, etc. The ground floor is covered with ferns, grass, and herbs such as Bidens pilosa, Commelina bengalensis, Cyanotis vaga, Hedyotis scadens, Lygodium salicifolium, Mikania macrantha, Mimosa pudica, Oplismenus compositus, Saccharum longisetosum, Sida cordata and Themedaarundinacea, etc.

Study Site B.	Dam Site (downstream (d/s) to PH site (upstream (u/s) Zone: Area beyond Kala Nala and up to Longphu Basti

17. Around **Kala nala**, Moist Mixed Deciduous forest dominates the top storey and comprises of Artocarpus chama, Bleischmiedia roxburghiana, Haplophragma adenophyllum, Homalium schlichii, Holarrhena pubescens, Meliosma pinnata, Protium serratum, Pterospermum acerifolium, Sterculia urens, S. villosa, etc. Second storey is dense with varied undergrowth. The second storey comprises of Baccurea sapida, Crativa magna, Colona floribunda, Cycas pectinata, Ficus glomerata, Lagerstroemia parviflora, Samanea saman, etc.. The **herbaceous flora** includes species of ferns, grasses and herbs such as Bidens pilosa, Commelina bengalensis, Cyanotis vaga, Hedyotis herbacea, Lygodium salicifolium, Mikania macrantha, Mimosa pudica, Oplismenus compositus, Saccharum longisetosum, Sida cordata and Themeda arundinacea.

18. Around **Longphu Basti**, a patchy Moist Mixed Tropical forest occurs along the road easement. The forest comprises of Albizia procera, Beilschmiedia roxburghiana, Holarrhena pubescens, Persea parviflora, Pterospermum acerifolium, Sterculia villosa, Stereospermum chelonoides, Aegle marmelos, Casearia vareca, Clausena excavata, Colona floribunda, Ficus glaberrima, Micromelum integerrimum, Sarcosperma arboreum and Wrightea arborea, etc.

19. The vegeration around the upper reaches of the **proposed dam site** comprises of Mixed Tropical Semi-Evergreen forest while the lower reaches comprises of a Riparian Fringing forest. Along the banks of river Kopili, the top storey is comprised of Albizia procera, Beilschmiedia roxburghiana, Dysoxylum binectariferum, Ficus virens, Garcinia paniculata, Holarrhena

pubescens, Persea parviflora, Protium serratum, Pterospermum acerifolium, Sterculia villosa and Stereospermum chelonoides, etc. Middle storey is represented by Bauhinia variegata, Casearia vareca, Clausena excavata, Ficus glaberrima, Homonoia riparia, Ixonanthes khasiana, Micromelum integerrimum, Samanea saman, Sarcosperma arborea and Syzygium cumini, etc. Shrub elements comprises of Andrachne cordifolia, Bambusa tulda, Boehmeria platyphylla, Chromolaena odoratum, Combretum acuminatum, Dracaeana angustifolia, Ficus scandens, Jatropha gossypifolia, Lantana camara, Leea aequata, Maytenus senegalensis, Mimosa rubicaulis, Paedera foetida and Strobilanthes auriculata, etc. Few climbers are observed like Beumontia grandiflora, Clematis buchananiana, Cissus adnata, Mikania macrantha, Stephania glabra and Thunbergia coccinea. Epiphytic moss and ferns are present as well. Herbaceous flora includes species of terrestrial ferns, grass, and herbs such as Achyranthes aspera, Ageratum conyzoides, Adiantum proliferum, Biophytum reinwardtii, Capillipedium assimile, Chrysopogon lancearis, Crassocephalum crepedioides, Crotolaria cytisoides, Hedyotis scandens, Mimosa pudica, Nephrolepis auriculata, Oxalis corniculata, Paspalum dilatatum and Saccharum longisetosum. Some dense evergreen patches of Homonoiariparia colonise in the flooded area along the banks of river Kopili with profuse undergrowth. The other plants in this zone are Camelia kisii, Flacourtia jangomas, Ixonanthes khasiana, etc.

Study Site C.	Dam Site & Catchment / Submergence Zone: Area between Longphu basti & Digram Basti

20. The left bank area of river Kopili covers the District Council Reserve Forest (RF) of Karbi Anglong Forest Sub-Division which borders Rongtarne village opposite and across from Longphu Basti. The upstream area of **Longphu** from the bank of river Kopili is moderately sloped with fairly dense Mixed Semi Evergreen forest. The impenetrable growth of large trees and evergreen shrubs provide rich habitat for **wild elephants** (addressed in the Critical Habitat assessment and biodiversity management plan) and other mammals. The forest comprises of Colona floribunda, Dysoxylum binactariferum, Elaeocarpus tectorius, Magnolia gustavii, M. hodgsonii, Protium serratum, Sapium baccatum, Sterculia urens, Stereospermum chelonoides, Terminalia citrina, etc. Shrubs comprises of species such as Abroma, Boehmeria, Clerodendrum, Chromolaena, Hydrangea, Leea, and Trevesia. Cimbers and epiphytes are not common. Orchids belonging to the species of Bulbophyllum, Cymbidium and Dendrobium are also observed. The ground floor is occupied by terrestrial ferns, grass, and herbs. The **herbaceous flora** comprises of Adiantum, Arisaema, Athyrium, Begonia, Commelina, Cyanotis, Hedychium, Impatiens, Oplismenus, Persicaria, Polygonum, Pteris, and Saccharum.

21. The **submergence / catchment area** upstream of the dam site is in the vicinity of Longku village (Right Bank) and Rongtarne village (Left Bank). The vegetation in the area is characterized by dense storied Semi Evergreen forest on the middle reaches. The lower reaches comprise of patchy Riparian vegetation. At right bank of river Kopili, , the top storey comprises of Aglaia hiernii, A. perviridis, Brucia sumatrana, Artocarpus chama, Bauhinia variegata, Holarrhena pubescens, Lagerstroemia parviflora, Lepisanthes senegalensis, Miliosma pinnata, Persea odoratissima, Pterospermum acerifolium and Terminalia citrina, etc.. Second storey comprises of moderate sized tree species like Beilschmiedia roxburghiana, Colona floribunda, Bridelia retusa, Casearia vareca, Ficus glaberrima, F. virens, Sarcosperma arborea, Syzygium cumini, etc. Shrub species are Andrachne cordifolia, Aralia thomsoni, Bambusa tulda, Boehmeria macrophylla, Chromolaena odoratum, Leea aequata and Salacia jenkinsii, etc.. Climbers and epiphytes are not common. However, some epiphytic flora comprises of ferns like Antrophyum obovatum, Pyrrosia adnascens, P. obovata and Vittaria flexuosa, etc. Terrestrial ferns are few viz. Equisetum ramosissimum, Nephrolepis auriculata,

Pteris vittata, Selaginella repanda and Athyrium drepanopterum etc.. Common trailing species are Beumontia grandiflora, Dioscorea bulbifera, Lygodium salicifolium, Mikania macrantha, Rhaphidophora decursiva and Stephania glabra etc.. The epiphytic flora comprises of ferns like Antrophyum obovatum, Pyrrosia adnascens, P. obovata and Vittaria flexuosa etc. Terrestrial ferns are few viz. Equisetum ramosissimum, Nephrolepis auriculata, Pteris vittata, Selaginella repanda and Athyrium drepanopterum etc.

4.2 PLANT SPECIES IN THE STUDY AREA

22. The list of plant species recorded in the study area are presented Table 4.2.

Table 4.2: List of Plant Species Recorded in the Study Area[67]

S. No.	Plant Species	Family	Local Name	Uses	Habit	IWPA Status	IUCN Status
	Trees						
1	*Magnolia caveana*	Magnoliaceae	Phul-sopa	Timber	Trees	-	DD
2	*M. hodgsonii*	Magnoliaceae	Dat-bhola	Timber	Trees	-	-
3	*Michelia glabra*	Magnoliaceae	Pan-sopa	Timber	Trees	R	-
4	*Miliusa globose*	Anonaceae	Jhora-Bhanora	Fire-wood	Trees	V	-
5	*Casearia vareca*	Flacourtiaceae	Sikarguti	Timber	Trees	-	-
6	*Flacourtia jangomas*	Flacourtiaceae	Ponial	Medicinal	Trees	-	-
7	*Garcinia paniculata*	Cluciaceae	Bubi Kowa	Timber	Trees	-	-
8	*Ixonanthes khasiana*	Ixonantheceae	-		Trees	V	VU
9	*Camellia kissi*	Theaceae	-	-	Trees	-	LC
10	*Schima wallichii*	Theaceae	Laukya	Timber	Trees	-	-
11	*Sterculia urens*	Sterculiaceae	Karai	Timber	Trees	-	-
12	*S. villosa*	Sterculiaceae	Udal	Timber	Trees	-	-
13	*Pterospermum acerifolium*	Sterculiaceae	Hati paila	Timber	Trees	R	VU
14	*Colona floribunda*	Tiliaceae	Larubanda	-	Trees	-	-
15	*Grewia serrulata*	Tiliaceae	Dun	-	Trees	-	-
16	*Elaeocarpus tectorius*	Elaeocarpaceae	Seleng	Timber	Trees	-	-
17	*Clausena heptaphylla*	Rutaceae	-	-	Trees	-	-
18	*Aegle marmelos*	Rutaceae	Bel	Medicinal	Trees	-	-
19	*Brucea sumatrana*	Simarubaceae	-	-	Trees	-	-
20	*Protium serratum*	Burseraceae	Thutmala	-	Trees	-	-
21	*Aglaia hiernii*	Meliaceae	Ameri	Timber	Trees	-	NT
22	*A. perviridis*	Meliaceae	-	-do-	Trees	-	VU
23	*Dysoxylum binectariferum*	Meliaceae	Banderdima	-do-	Trees	-	-
24	*Walsura robusta*	Meliaceae	Lali	-do-	Trees	-	-
25	*Lepisanthes senegalensis*	Sapindaceae	Ting-ting	Timber	Trees	-	-

[67] Table 8.1

S. No.	Plant Species	Family	Local Name	Uses	Habit	IWPA Status	IUCN Status
26	*Meliosma pinnata*	Sabiaceae		-do-	Trees	-	-
26	*Mangifera sylvatica*	Anacardiaceae	Sinnin	Timber	Trees	-	LC
27	*Erythrina stricta*	Papilionaceae	TaungKathit	Timber	Trees	-	-
28	*Bauhinia variegata*	Caesalpiniaceae	Kachnar	Vegetables	Trees	-	LC
29	*Albizia procera*	Mimosaceae	Safed Siris	Timber	Trees	-	-
30	*Samanea saman*	Mimosaceae	-	-	Trees	-	-
31	*Terminalia citrina*	Combretaceae	-	-	Trees	-	-
32	*Syzygium cuminii*	Myrtaceae	Jamun		Trees	-	-
33	*Lagerstroemia parviflora*	Lythraceae	Seedha	-	Trees	-	-
34	*Sarcosperma arboreum*	Sarcospermaceae	Kalikath	-	Trees	-	-
35	*Holarrhena pubescens*	Apocynaceae	Kewar	Medicinal	Trees	-	LC
36	*Wrightia tomentosa*	Apocynaceae	Dudhi	Medicinal	Trees	-	-
37	*Ehretia acuminata*	Boraginaceae	Shawahi	-	Trees	-	-
38	*Heterophragma adenophyllum*	Bignoniaceae	Pethan	Timber	Trees	-	-
39	*Stereospermum chelonoides*	Bignoniaceae	Padal	-	Trees	-	-
40	*Oroxylum indicum*	Bignoniaceae	Phari	Medicinal	Trees	-	-
42	*Premna interrupta*	Verbencaeae	-	-	Trees	-	-
43	*Tectona grandis*	Verbencaeae	Teak	Timber	Trees	-	-
44	*Beilschmiedia roxburghiana*	Lauraceae	Kamatti		Trees	-	-
45	*Persea parviflora*	Lauraceae	-	-	Trees	-	-
46	*Cinnamomum bejolghota*	Lauraceae		-	Trees	-	-
47	*Bridelia assamica*	Euphorbiaceae	-	-	Trees	V	VU
48	*Bacaurea sapida*	Euphorbiaceae	Kala Bogati		Trees	-	-
49	*Phyllanthus emblica*	Euphorbiaceae	Amla	Medicinal	Trees	-	-
50	*Glochidion hirsutum*	Euphorbiaceae	-	-	Trees	-	-
51	*Sapium baccatum*	Euphorbiaceae	Billa	Timber	Trees	-	-
52	*Mallotus philippinensis*	Euphorbiaceae	Raini	Fire-wood	Trees	-	-
53	*Macaranga denticulata*	Euphorbiaceae	Burna	-	Trees	-	-
54	*Homonoia riparia*	Euphorbiaceae	Sheran	-	Trees	-	LC
55	*Trema aboinensis*	Ulmaceae	-	-	Trees	-	-
56	*Ficus glaberrima*	Moraceae	Kakhri	-	Trees	-	-

S. No.	Plant Species	Family	Local Name	Uses	Habit	IWPA Status	IUCN Status
57	*F. hispida*	Moraceae			Trees	-	-
58	*F. virens*	Moraceae			Trees	-	-
59	*Artocarpus chama*	Moraceae	Lutta	-	Trees	-	-
60	*Villebrunea integrifolia*	Urticaceae	-	-	Trees	-	-
61	*Lithocarpus elegans*	Fagaceae	Arkaula	Timber	Trees	-	-
62	*Castanopsis indica*	Fagaceae	Dalne Katus	-	Trees	-	-
63	*Cycas pectinate*	Cycadaceae	Thakal		Trees	-	VU
	Shrubs						
1	*Capparis acutifolia*	Capparidaceae		-	Shrub	-	-
2	*Abroma angusta*	Sterculiaceae	Ulat Kamabal	Medicinal	Shrub	-	-
3	*Aspidopterys roxburghiana*	Malpighiceae	-		Shrub	-	-
4	*Murraya paniculata*	Rutaceae		-	Shrub	-	-
5	*M. koenigii*	Rutaceae	Gandhla	Medicinal	Shrub	-	-
6	*Salacia jenkinsii*	Celastraceae			Shrub	En	-
7	*Maytenus senegalensis*	Celastraceae		-	Shrub	-	-
8	*Leea aequata*	Leeaceae			Shrub	-	-
9	*L. crispa*	Leeaceae			Shrub	-	-
10	*Indigofera dosua*	Papilionaceae		-	Shrub	-	-
11	*Desmodium triquetrum*	Papilionaceae		-	Shrub	-	-
12	*Rubus acuminatus*	Rosaceae		-	Shrub	-	-
13	*R. paniculatus*	Rosaceae			Shrub	-	-
14	*R. moluccanus*	Rosaceae			Shrub	-	-
15	*R. ellipticus*	Rosaceae			Shrub		
16	*Combretum decandrum*	Combretaceae		-	Shrub	-	-
17	*Aralia thomsoni*	Araliaceae			Shrub	-	-
18	*Trevesia palmata*	Araliaceae		-	Shrub	-	-
19	*Leptodermis suaveolens*	Rubiaceae		-	Shrub	-	-
20	*Paederia foetida*	Rubiaceae		-	Shrub	-	-
21	*Chromolaena odoratum*	Asteraceae		-	Shrub	-	-
22	*Jasminum subtriplinerve*	Oleaceae	-		Shrub	-	-
23	*J. attenuatum*	Oleaceae			Shrub	-	-
24	*Ipomoea carnea*	Convolvulaceae		-	Shrub	R	LC
25	*Strobilanthes auriculata*	Acanthaceae	-		Shrub	-	-
26	*Phlogacanthus thyrsiflorus*	Acanthaceae	-		Shrub	-	-
27	*Lantana camara*	Verbenaceae		-	Shrub	-	-

S. No.	Plant Species	Family	Local Name	Uses	Habit	IWPA Status	IUCN Status
28	*Clerodendrum colebrookianum*	Verbenaceae	-		Shrub	-	-
29	*Plectranthus ternifolius*	Lamiaceae		-	Shrub	-	-
30	*Loranthus odoratus*	Loranthaceae		-	Shrub	-	-
31	*Andrachne cordifolia*	Euphorbiaceae		-	Shrub	-	-
32	*Fluggea microcarpa*	Euphorbiaceae		-	Shrub	-	-
33	*Ficus scandens*	Moraceae			Shrub	-	-
34	*F. lanceolata*	Moraceae			Shrub	-	-
35	*Boehmeria macrophylla*	Urticaceae		-	Shrub	-	-
36	*B. platyphylla*	Urticaceae			Shrub	-	-
37	*Calamus floribundus*	Arecaceae		-	Shrub	-	-
38	*Bambusa tulda*	Poaceae			Shrub	-	-
39	*B. pallid*	Poaceae			Shrub	-	-
40	*Dendrocalamus hamiltonii*	Poaceae	-		Shrub	-	-
	Climbers						
1	*Cocculus orbiculatus*	Menispermaceae		-	Climber	-	-
2	*Pericampylus glaucus*	Menispermaceae		-	Climber	-	-
3	*Stephania glabra*	Menispermaceae		-	Climber	-	-
4	*Buettneria pilosa*	Sterculiaceae		-	Climber	-	-
5	*Toddalia asiatica*	Rutaceae	Kyanza	-	Climber	-	-
6	*Carayita mollissima*	Vitaceae		-	Climber	-	-
7	*Cissus adnata*	Vitaceae			Climber	-	-
8	*Tetrastigma discolor*	Vitaceae		-	Climber	-	-
9	*Bauhinia vahlii*	Caesalpiniaceae			Climber	-	-
10	*Mimosa rubicaulis*	Mimosaceae		-	Climber	-	-
11	*Vallaris solanacea*	Apocynaceae		-	Climber	-	-
12	*Marsdenia tinctoria*	Asclepiadaceae		-	Climber	-	-
13	*Porana paniculata*	Convolvulaceae		-	Climber	-	-
14	*Thunbergia grandiflora*	Acanthaceae		-	Climber	-	-
15	*Aristolochia roxburghiana*	Aristolochiaceae	-		Climber	-	-
16	*Dioscorea bulbifera*	Dioscoreaceae		-	Climber	-	-
17	*Smilax aspericaulis*	Smilacaceae		-	Climber	-	-
	Herbs						

S. No.	Plant Species	Family	Local Name	Uses	Habit	IWPA Status	IUCN Status
1	*Sida acuta*	Malvaceae		-	Herb	-	-
2	*Oxalis corniculata*	Oxalidaceae	-		Herb	-	-
3	*Biophytum reinwardtii*	Oxalidaceae	-		Herb	-	-
4	*Trigonella foenum-graecum*	Papilionaceae			Herb	-	-
5	*Melilotus indica*	Papilionaceae		-	Herb	-	-
6	*Crotolaria cytisoides*	Papilionaceae	-		Herb	-	-
7	*Mimosa pudica*	Mimosaceae	Lazvanti		Herb	-	LC
8	*Hedyotis vestita*	Rubiaceae	-		Herb	-	-
9	*H. sacndens*	Rubiaceae		-	Herb	-	-
10	*Crepis japonica*	Asteraceae		-	Herb	-	-
11	*Mikania macrantha*	Asteraceae	-		Herb	-	-
12	*Xanthium strumarium*	Asteraceae	-		Herb	-	-
13	*Eclipta alba*	Asteraceae		Medicinal	Herb	-	LC
14	*Convolvulus arvensis*	Convolvulaceae	-		Herb	-	-
15	*Strobilanthes khasiana*	Acanthaceae	-		Herb	-	-
16	*Mazus delavayi*	Scrophulariaceae		-	Herb	-	-
17	*Ocimum sanctum*	Lamiaceae	Tulsi	Medicinal	Herb	-	-
18	*Perilla frutescens*	Lamiaceae	-		Herb	-	-
19	*Plantago major*	Plantaginaceae		-	Herb	-	LC
20	*Alternanthera sessilis*	Amaranthaceae	-		Herb	-	LC
21	*Achyranthes aspera*	Amaranthaceae	Chirchita	Medicinal	Herb	-	-
22	*Gomphrena globosa*	Amaranthaceae	-		Herb	-	-
23	*Polygonum hydropiper*	Polygonaceae	-		Herb	-	LC
24	*Persicaria barbata*	Polygonaceae	-		Herb	-	LC
25	*Pepromia pellucida*	Piperaceae	-		Herb	-	-
26	*Euphorbia hirta*	Euphorbiaceae		-	Herb	-	-
27	*Curcuma longa*	Zingiberaceae		Medicinal	Herb	-	-
28	*Commelina bengalensis*	Commelinaceae	-		Herb	-	-
29	*Arisaema concinum*	Araceae	-		Herb	-	-
30	*Cyperus niveus*	Cyperaceae		-	Herb	-	-
31	*C. rotundus*	Cyperaceae	Motha	Medicinal	Herb	-	LC
32	*C. iria*	Cyperaceae	-		Herb	-	LC
33	*C. cyperoides*	Cyperaceae		-	Herb	-	LC
34	*Fimbristylis dichotoma*	Cyperaceae	-		Herb	-	LC

S. No.	Plant Species	Family	Local Name	Uses	Habit	IWPA Status	IUCN Status
35	*Saccharum spontaneum*	Poaceae	-		Herb	-	LC
36	*Arundo donax*	Poaceae		-	Herb	-	LC
37	*Setaria verticillata*	Poaceae	-		Herb	-	-
38	*Eragrostis tenella*	Poaceae	-		Herb	-	-
39	*E. tremula*	Poaceae		-	Herb	-	-
40	*Paspalum dilatatum*	Poaceae	-		Herb	-	-
41	*Digitaria adscendens*	Poaceae	-		Herb	-	-
42	*Cynodon dactylon*	Poaceae	Durva	Medicinal	Herb	-	-
43	*Echinochloa colona*	Poaceae	-		Herb	-	LC
44	*Oplismenus compositus*	Poaceae	-		Herb	-	-
45	*Brachiaria ramosa*	Poaceae	-		Herb	-	LC
46	*Chrysopogon lancearis*	Poaceae	-		Herb	-	-
47	*Sporobolus diander*	Poaceae	-		Herb	-	-
48	*Panicum paludosum*	Poaceae	-		Herb	-	-
49	*Poa annua*	Poaceae			Herb	-	LC
50	*Elusan indica*		grass		Herb	-	-
51	*Boehavia diffusa*			-	Herb	-	-
52	*Comalina bengalensis*				Herb	-	-
53	*Ameranthus spinosus*				Herb	-	-
	Ferns						
1	*Equisetum ramosissimum*	Equisetaceae			herb	-	-
2	*Seleginella repanda*	Selginellaceae			herb	-	-
3	*S. helferi*	Selginellaceae			herb	-	-
4	*Angiopteris sylhetensis*	Angiopteridaceae			herb	-	-
5	*Lygodium salicifolium*	Lygodiaceae			Twiner	-	-
6	*Adiantum proliferum*	Adiantaceae			herb	-	-
7	*Nephrolepis auriculata*	Pteridaceae			herb	-	-
8	*Pteris vittata*	Pteridaceae			herb	-	LC
9	*Athyrium drepanopterum*	Athyraceae			herb	-	-
10	*Oleandra undulate*	Oleandraceae	Deciduoud fern	***(Plate)***	herb	-	-

LC = least concerned, NT = near threatened, VU = vulnerable, DD = data deficient, EN = endangered, R = rare, V = vulnerable, I = intermediate

4.3 Community Structure

4.3.1 Density and Abundance of Woody Vegetation

23. At the submergence / catchment area (upstream of Longphu, RB of river Kopili), the tree stratum was dominated by Magnolia gustavii and Sarcosperma arboreum having maximum density (50 trees/ha). The associated species in the tree layer were Colona floribunda, Homonoia riparia, Mangifera sylvatica, Lepisanthes senegalensis, Elaeocarpus tectorius, Meliosma pinnata, Samanea saman, Holarrhena pubescens, Stereospermum chelonoides, Sterculia urens, Sapium baccatum and Terminalia citrina. In saplings layer, the dominant species (in terms of density) were Lepisanthes senegalensis and Colona floribunda. In the shrub stratum, Bambusa tulda was the most dominant species. Other competing species in the layer were Chromolaena odoratum, Salacia jenkinsii, Andrachne cordifolia, Lantana camara, Ficus scandens, Mimosa rubicaulis, Capparis acutifolia and Aralia thomsoni (see Table 4.3).

24. At the dam site (near Longphu, RB of river Kopili), the tree stratum was dominated by Homonoia riparia having both maximum frequency (50%) and density (90 trees/ha). The associated species of the tree layer were Holarrhena pubescens, Persea parviflora, Dysoxylum binectariferum, Stereospermum chelonoides, Sterculia villosa, Walsura robusta, Garcinia paniculata, Ixonanthes khasiana and Casearia vareca. In saplings layer, Clausena excavata was the dominant species (in terms of density). Other species present in the layer were Sterculia villosa, Sarcosperma arborea, Homonoia riparia, Walsura robusta, etc. In the shrub layer, Bambusa tulda was the dominant species followed by Chromolaena odoratum. Other competing species in the layer were Ficus scandens, Leea aequata, Lantana camara, Jatropha gossypifolia, Paedera foetida and Maytenus senegalensis (see Table 4.3).

25. At the power house site (Kala nala, RB of river Kopili), the tree stratum was dominated by Protium serratum having maximum frequency (40%) and density (80 trees/ha). The associated species in the tree layer were Sterculia villosa, Holarrhena pubescens, Homalium schlichii, Walsura robusta, Syzygium cumini, Mangifera sylvatica, Beilschmiedia roxburghiana, Baccaurea sapida, Lepisanthes senegalensis, Colona floribunda, Magnolia caveana, Haplophragama adenophyllum, Artocarpus chama, Cycas pectinata and Pterospermum acerifolium. In the sapling layer, Sterculia villosa was the most dominant species (in terms of density). In the shrub layer, Chromolaena odoratum was the most dominant species. Other competing species in the layer were Bambusa tulda, Murraya koenigii, Clerodendrum serratum, Ambrosia artemisifolia, Mimosa rubicaulis and Uraria crinata.

26. Downstream of the PH site (near Panimore-Patherkore picnic spot /waterfall site), the tree stratum was dominated by Tectona grandis having maximum frequency (30%) and density (100 trees/ha). The associated species in the tree layer were Azadirachta indica, Ficus bengalensis, Protium serratum, Bombax ceiba, Wrightea arborea, Albizia procera, Syzygium cumini, Flacourtia jangomas, Adanthera pavonia, Magnolia rabaniana and Sterculia villosa. In the sapling layer, Wrightea arborea was recorded as the most dominant species. In the shrub layer Chromolaena odoratum was the most dominant species. Other competing species in the lower storey were Clerodendrum serratum, Lantana indica, Urena lobata, Bambusa tulda, Tabernaemontana grandiflora, Neillia thyrsiflora, Ficus racemosa, Aralia thomsoni and Abroma angusta.

27. Overall, the maximum numbers of trees were recorded from near the power house (PH) site (Kala nala, RB of Kopili and Phanglengsu nala on LB). In comparison, the proposed dam site (near Longphu, RB of river Kopili) and submergence/catchment area (upstream of Longphu Basti, on RB of river Kopili and Rongtarne village on LB of river Kopili) did not show as many tree species. This may be due to past and ongoing land use change (e.g. practice of Jhum cultivation), absence of seedlings, and extensive felling of trees for various purposes including timber (see Table 4.3). Jhum cultivation is a common practice undertaken by the residing (local) tribal communities and consists of tree felling and land clearing for use of cultivation, typically for 2 to 3 years. The communities then allow the land to regenerate for next 15-20 years as per local interaction.

28. Across all sites / stands the total tree density ranged from 410 trees/ha at Submergence / catchment area (upstream of Longphu, RB of river Kopili) to 440 trees/ha at downstream of PH site (near Panimore-Patherkore, RB of river Kopili). In the sapling layer, highest density was recorded near the PH site. Absence of seedlings of all major tree species indicates heavy anthropogenic pressure in the area. The total density for shrubs varied from 6,300 to 11,600 individuals' ha^{-1}; it was comparatively higher at the submergence area at 11,600 individuals' ha^{-1}) as compared to other sites. The maximum individual shrub density was recorded for Bambusa tulda (7,600 individual ha^{-1}) at the submergence site (V1).

29. The total basal area (TBA)[68] ranged from 270.66 ha at the dam site (near Longphu Basti, RB of river Kopili) to 430.89 ha at downstream of PH site (near Panimore Patherkore, RB of river Kopili). The highest mean basal area was recorded for Ficus bengalensis (5.144 ha) at downstream of PH site while the lowest mean basal area (0.073 ha) was recorded for Sapium baccatum at the submergence area. Protium serratum, Holarrhena pubescens, Ficus bengalensis and Magnolia gustavii were the dominant species with an Importance Value Index (IVI)[69] of 68.17, 64.28, 63.52, 41.07 near the PH site, dam site, downstream of PH site, and submergence site, respectively.

Table 4.3: Attributes of Woody Vegetation in the Study Area[70]

S. No.	Species	Frequency (F%)	Density (ha^{-1})	TBA (m^2ha^{-1})	IVI	H
V1 Submergence Area (Upstream (u/s) of Longphu Dam –Discharge site)						
TREES						
1	*Homonoia riparia*	10	40	7.29	15.29	
2	*Sapium baccatum*	10	10	0.73	5.72	
3	*Elaeocarpus tectorius*	20	20	41.20	25.06	
4	*Colona floribunda*	30	40	6.64	21.12	
5	*Magnolia gustavii*	50	50	40.04	41.07	
6	*Protium serratum*	10	10	1.59	6.01	
7	*Dysoxylum binecteriferum*	20	20	1.98	11.62	
8	*Mangifera sylvatica*	30	30	27.11	25.70	
9	*Lepisanthes senegalensis*	30	30	23.36	24.42	
10	*Holarrhena pubescens*	10	20	44.84	23.28	
11	*Lithocarpus elegans*	10	10	1.96	6.14	
12	*Sarcosperma arboreum*	30	50	27.37	30.67	

[68] Basal area is the common term used to describe the average amount of an area(usually an acre) occupied by tree stems. It is defined as the total cross-sectional area of all stems in a stand measured at breast height, and expressed as per unit of land area (typically square feet per acre).

[69] IVI or Importance Value Index is a measure of how dominant a species is in a given forest area. It is a standard tool used by foresters to inventory a forest.

[70] Table 8.3

S. No.	Species	Frequency (F%)	Density (ha^{-1})	TBA (m^2ha^{-1})	IVI	H
13	*Meliosma pinnata*	20	20	3.25	12.05	
14	*Michelia glabra*	10	10	9.50	8.73	
15	*Stereospermum chelonoides*	10	10	11.30	9.34	
16	*Sterculia urens*	10	10	25.43	14.19	
17	*Samanea sama*	10	20	8.60	10.86	
18	*Terminelia citrina*	10	10	9.50	8.73	
	Total	**330**	**410**	**291.71**		**2.72**
Saplings						
1	*Elaeocarpus tectorius*	10	100	3.14	17.25	
2	*Meliosma pinnata*	10	100	3.30	17.52	
3	*Homonoia riparia*	20	200	6.28	34.50	
4	*Camelia kissi*	10	100	1.13	13.85	
5	*Lepisanthes senegalensis*	30	400	5.14	49.77	
6	*Miliusa globosa*	10	200	4.02	24.00	
7	*Casearia graveolens*	10	100	4.52	19.59	
8	*Stereospermum chelonoides*	10	100	2.54	16.24	
9	*Colona floribunda*	20	400	20.74	69.53	
10	*Baccaurea sapida*	10	100	1.13	13.85	
11	*Holarrhena pubescens*	10	100	7.07	23.90	
	Total	**150**	**1,900**	**59.01**		**2.21**
Shrubs						
1	*Bambusa tulda*	60	7,600	93.22	158.44	
2	*Salacia jenkinsii*	20	600	9.23	20.76	
3	*Aralia thomsoni*	10	100	3.80	8.08	
4	*Ficus heterophylla*	10	400	3.66	10.57	
5	*Arachne cordifolia*	20	500	4.75	16.75	
6	*Mimosa rubicaulis*	10	100	1.13	6.20	
7	*Boehmeria macrophylla*	10	200	2.19	7.81	
8	*Leea crispa*	20	200	2.08	12.28	
9	*Chromolaena odoratum*	20	700	6.06	19.39	
10	*Maytenus senegalensis*	10	300	2.65	9.00	
11	*Capparis acutifolia*	10	200	3.08	8.44	
12	*Lantana camara*	10	500	8.25	14.67	
13	*Leptodermis suaveolens*	10	200	1.90	7.61	
	Total	**220**	**11,600**	**141.99**		**1.44**
V2 Dam site (near Longphu basti, River Kopili)						
Trees						
1	*Holarrhena pubescens*	50	80	72.30	64.28	
2	*Ficus virens*	10	10	6.22	8.38	
3	*Dysoxylum binectariferum*	20	20	33.01	24.37	
4	*Stereospermum chelonoides*	10	20	2.70	9.46	
5	*Walsura robusta*	10	10	4.78	7.85	
6	*Garcinia paniculata*	10	10	6.36	8.43	
7	*Protium serratum*	10	10	37.99	20.12	
8	*Persea parviflora*	30	80	64.95	54.16	
9	*Ficus glaberrima*	10	10	5.02	7.94	
10	*Samanea saman*	20	20	11.75	16.51	
11	*Beilschmiediea roxburghiana*	10	20	1.61	9.06	
12	*Homonoia riparia*	50	90	7.37	42.67	
13	*Ixonanthes khasiana*	10	10	0.75	6.36	
14	*Casearia vareca*	10	10	1.96	6.81	
15	*Sterculia villosa*	10	20	13.87	13.59	

S. No.	Species	Frequency (F%)	Density (ha^{-1})	TBA (m^2ha^{-1})	IVI	H
	Total	**270**	**420**	**270.66**		**2.31**
Saplings						
1	*Micromelum integerrimum*	10	100	4.91	12.16	
2	*Syzygium cumini*	10	100	3.80	11.10	
3	*Clausena excavata*	40	1,200	18.99	69.67	
4	*Sarcosperma arborea*	10	400	10.17	25.31	
5	*Samanea saman*	10	100	7.07	14.23	
6	*Walsura robusta*	20	300	5.16	22.57	
7	*Haplophragma adenophyllum*	10	100	6.15	13.36	
8	*Sterculia villosa*	20	400	4.52	24.66	
9	*Holarrhena pubescens*	10	100	6.15	13.36	
10	*Persea parviflora*	20	300	15.68	32.64	
11	*Albizia procera*	10	100	4.52	11.79	
12	*Brucea sumatrana*	10	100	1.54	8.94	
13	*Phyllanthus emblica*	10	100	6.15	13.36	
14	*Homonoia riparia*	20	300	9.61	26.83	
	Total	**210**	**3,700**	**104.43**		**2.24**
Shrubs						
1	*Ficus scandens*	20	900	10.17	21.49	
2	*Maytenus senegalensis*	10	100	113.04	58.74	
3	*Andrachne cordifolia*	10	100	1.13	5.17	
4	*Lantana camara*	10	400	3.66	9.54	
5	*Chromolaena odoratum*	70	2,700	23.37	64.61	
6	*Bambusa tulda*	80	3,300	29.11	77.24	
7	*Jatropha gossypifolia*	20	400	3.66	13.11	
8	*Combretum decandrum*	10	200	1.73	6.51	
9	*Combretum acuminatum*	10	100	1.13	5.17	
9	*Leea aequata*	10	500	8.83	13.06	
10	*Mimosa rubicaulis*	10	200	7.06	9.05	
11	*Indigofera dosua*	10	200	2.26	6.76	
12	*Paedera foetida*	10	400	3.73	9.57	
	Total	**280**	**9,500**	**208.88**		**1.89**
V3 PH site at RB of River Kopili (near Kala nala / Charchim confluence)						
Trees						
1	*Protium serratum*	40	80	106.13	68.17	
2	*Holarrhena pubescens*	20	20	22.23	18.59	
3	*Sterculia villosa*	20	30	17.66	19.46	
4	*Pterosperum acerifolium*	10	10	1.81	6.09	
5	*Miliosma pinnata*	10	10	0.80	5.75	
6	*Cycas pectinata*	10	10	0.73	5.72	
7	*Syzygium cumini*	20	20	8.60	13.90	
8	*Walsura robusta*	20	20	2.77	11.89	
9	*Lagerstroemia parviflora*	10	20	2.93	8.92	
10	*Sterculia urens*	20	20	17.31	16.90	
11	*Samanea saman*	10	10	0.75	5.73	
12	*Mallotus philippinensis*	10	10	1.81	6.09	
13	*Mangifera sylvatica*	10	20	44.05	23.07	
14	*Drypetes assamica*	10	10	0.74	5.72	
15	*Baccaurea sapida*	10	20	1.47	8.41	
16	*Homalium schlichii*	20	20	7.47	13.51	
17	*Haplophragma adenophyllum*	10	10	2.64	6.38	
18	*Artocarpus chama*	10	10	7.08	7.91	

S. No.	Species	Frequency (F%)	Density (ha^{-1})	TBA (m^2ha^{-1})	IVI	H
19	*Magnolia caveana*	10	10	2.69	6.39	
20	*Crativa religiosa*	10	10	6.36	7.66	
21	*Beilschmiedia roxburghiana*	20	20	19.34	17.60	
22	*Lepisanthes senegalensis*	10	10	13.27	10.04	
23	*Colona floribunda*	10	10	1.81	6.09	
	Total	**330**	**410**	**290.46**		**2.92**
Saplings						
1	*Pterospermum acerifolium*	10	300	12.90	25.72	
2	*Sterculia villosa*	60	1,000	19.60	69.67	
3	*Syzygium cumini*	10	100	1.23	7.73	
4	*Sterculia urens*	10	100	1.04	7.51	
5	*Aquilaria agallocha*	10	100	1.13	7.62	
6	*Mallotus philippinensis*	10	100	7.07	14.41	
7	*Trema amboinensis*	10	100	1.13	7.62	
8	*Clausena excavata*	10	200	2.57	11.59	
9	*Camellia kissi*	20	400	5.31	23.37	
10	*Homonoia riparia*	20	300	4.62	20.26	
11	*Flacourtia jangomas*	10	500	5.65	22.09	
12	*Phyllanthus emblica*	10	300	5.51	17.28	
13	*Albizia procera*	10	100	1.17	7.66	
14	*Lannea coromandelica*	10	100	6.97	14.30	
15	*Walsura robusta*	10	100	2.01	8.62	
16	*Wrightia tomentosa*	10	100	1.54	8.09	
17	*Colona floribunda*	10	200	1.73	10.63	
18	*Magnolia hodgsonii*	10	200	6.28	15.83	
	Total	**250**	**4,300**	**87.44**		**2.58**
Shrubs						
1	*Clerodendrum serratum*	10	500	5.65	14.80	
2	*Chromolaena odoratum*	70	5,000	43.27	120.54	
3	*Ambrosia artemisiifolia*	10	200	1.90	8.42	
4	*Bambusa tulda*	70	4,600	40.57	114.32	
5	*Murraya koenigii*	20	600	5.39	20.19	
6	*Mimosa rubecaulis*	10	100	1.17	6.81	
7	*Uraria crinata*	10	100	0.93	6.57	
8	*Maytenus senegalensis*	10	200	1.83	8.35	
	Total	**210**	**11,300**	**100.72**		**1.25**
V4 Downstream (d/s) of PH site (Panimore-Patherkore picnic spot - water fall)						
Trees						
1	*Sterculia villosa*	10	10	9.50	7.81	
2	*Adanthera pavonia*	10	10	1.96	6.06	
3	*Wrightea tomentosa*	20	20	3.47	12.02	
4	*Magnolia pterocarpa*	10	10	18.14	9.82	
5	*Ficus hirsuta*	10	10	0.80	5.79	
6	*Azadirachta indica*	20	40	32.67	23.34	
7	*Syzygium cumini*	10	20	7.47	9.61	
8	*Aquilaria agallocha*	10	10	9.50	7.81	
9	*Holarrhena pubescens*	20	20	6.07	12.62	
10	*Bombax ceiba*	20	20	24.53	16.91	
11	*Protium serratum*	20	30	26.46	19.63	
12	*Ficus bengalensis*	20	40	205.78	63.52	
13	*Terminalia catapa*	10	10	9.85	7.89	

S. No.	Species	Frequency (F%)	Density (ha^{-1})	TBA (m^2ha^{-1})	IVI	H
14	*Holoptelea integrifolia*	10	10	1.13	5.87	
15	*Samanea saman*	10	10	1.52	5.96	
16	*Aegle marmelos*	10	10	1.96	6.06	
17	*Mangifera indica*	10	10	25.43	11.51	
18	*Albizia procera*	20	20	10.05	13.54	
19	*Flacourtia jangomas*	10	20	1.98	8.34	
20	*Tectona grandis*	30	100	31.35	40.00	
21	*Cycus pectinata*	10	10	1.26	5.90	
	Total	**300**	**440**	**430.89**		**2.74**
Saplings						
1	*Glochidion hirsutum*	10	200	6.92	43.05	
2	*Lagerstromia parviflora*	10	100	4.52	29.79	
3	*Adanthera pavonia*	10	200	4.02	35.65	
4	*Wrightea tomentosa*	30	600	14.42	112.98	
5	*Ficus bengalensis*	10	100	1.13	21.14	
6	*Tectona grandis*	10	100	7.07	36.27	
7	*Holarrhena pubescens*	10	100	1.13	21.14	
	Total	**90**	**1,400**	**39.21**		**1.67**
Shrubs						
1	*Clerodendrum serratum*	20	900	8.24	39.39	
2	*Lantana indica*	20	700	6.65	33.64	
3	*Urena lobata*	20	600	5.19	29.69	
4	*Bambusa tulda*	10	200	1.70	11.81	
5	*Mimosa rubecaulis*	10	100	1.13	9.30	
6	*Ficus racemosa*	10	200	2.57	13.22	
7	*Chromolaena odoratum*	40	3,000	27.98	116.44	
8	*Aralia foliosa*	10	100	3.14	12.55	
9	*Tabernaemontana grandiflora*	10	200	2.34	12.84	
10	*Neillia thyrsiflora*	10	200	1.63	11.70	
11	*Abroma angusta*	10	100	1.21	9.42	
	Total	**170**	**6,300**	**61.78**		**1.73**

4.3.2 Herbaceous Vegetation Accounts

30. The seasonal variation among herbaceous species is presented in Tables 4.4 to 4.6 Maximum diversity, abundance and species richness for herbaceous vegetation was recorded during the monsoon season.

31. Oplismenus compositus was the dominant species with maximum density (21000 plants/ha) during the monsoon season at the submergence area (upstream of Longphu Basti) (see Table 4.4). It was followed by Cyperus iria (16000 plants/ha). However, as per the IVI values, Cyperus iria was the dominant species (47.36) followed by Oplismenus compositus (44.22), Arisaema concinnum (40.92) and Curcuma aromatica (31.95) during monsoon. The lowest IVI of 6.79 was recorded for Adiantum venustum.

32. At the dam site ((near Longphu, RB of river Kopili), Chrysopogon lancearis was the dominant species with maximum density (100,000 plants/ha) during the monsoon season. It was followed by Saccharum longisetosum (48,000 plants/ha) (See Table 4.4). Maximum value of IVI was observed for Saccharum longisetosum (108.27) followed by Chrysopogon lancearis (101.09). The minimum IVI of 6.22 was recorded for Cissus adnata.

33. At the PH site, Cyanotis vaga was the most dominant species with maximum density (30,000 plants/ha) during the monsoon season. It was followed by Saccharum spontaneum, S. longisetosum and Oplismenus compositus (in terms of density). As per the IVI values, Saccharum longisetosum was the dominant species (75.48) followed by Saccharum spontaneum (44.39) and Cyanotis vaga (36.52). The minimum IVI value of 4.84 was recorded for Lygodium salicifolium.

34. Downstream of the PH site, Cyrtococcum accrescens was the most dominant species with maximum density (85000 plants/ha) during the monsoon season. Maximum IVI value was observed for Cyrtococcum accrescens (103.66) followed by Anisomeles indica (48.81). The lowest IVI of 6.43 was recorded for Paspalum scrobiculatum.

4.3.3 Species (Flora) Diversity

35. The diversity index value (H) in the tree layer ranged from 2.31 at the dam site to 2.92 at the PH site. The species diversity for sapling and shrub strata ranged from 1.67 to 2.58 and 1.25 to 1.89, respectively (see Tables 6.4 to 6.6). The diversity in tree layers especially at the dam site was low and this may be attributed to anthropogenic activities in the area e.g. deforestation, road construction, lopping of branches for fuel-wood, fodder, timber, etc. Note: The low species diversity (in the disturbed site) can be attributable to high exploitation of tree species followed by dominance of some tree species that h are tolerable to such disturbances. For instance, tropical forest stands of northeast region of India were studied for effects of anthropogenic disturbances on plant diversity, and community attributes along the disturbance gradient (Rao, et.al., 1990; Bhuyan, et.al., 2003; Misra, et.al., 2004). Similarly survey observations showed that the recorded shrub diversity was higher on open canopied dam site as compared to other forest sites because open canopy provides high opportunity for the recruitment of shrubs. The value of species diversity (H) in the herbaceous layer from dam site to PH site ranged from 1.55 -to 2.46, 1.91-2.91, 1.86-2.12 during monsoon, winter (post monsoon) and summer seasons, respectively (see Tables 4.4 to 4.6).

Table 4.4: Attributes of Herbaceous Flora during Monsoon Season[71]

S. No.	Herb Species	Frequency (F%)	Density (ha^{-1})	IVI	Species Diversity H
V1 Submergence area (Upstream (u/s) of Longphu Dam –Discharge site)					
1	*Cyperus cyperoides*	10	4,000	10.48	
2	*Oplismenus compositus*	40	21,000	44.22	
3	*Pogonatherum paniceum*	20	7,000	17.52	
4	*Hedyotis scandens*	10	4,000	9.59	
5	*Paliosanthes macrophylla*	20	6,000	22.93	
6	*Cyperus iria*	30	16,000	47.36	
7	*Curcuma aromatica*	30	8,000	31.96	
8	*Arisaema concinnum*	10	2,000	40.92	
9	*Phymatosorus longissima*	20	6,000	22.93	
10	*Lygodium salicifolium*	10	4,000	11.64	
11	*Pteris linearis*	10	5,000	15.06	
12	*Adiantum venustum*	10	2,000	6.79	
13	*Pepromia pellucida*	10	4,000	9.59	
14	*Athyrium drepanopterum*	10	2,000	9.03	

[71] Table 8.4

S. No.	Herb Species	Frequency (F%)	Density (ha^{-1})	IVI	Species Diversity H
	Total	**240**	**91,000**		**2.37**
V2 Dam site (near Longphu basti, River Kopili)					
1	*Saccharum longisetosum*	40	48,000	108.27	
2	*Mnesithea laevis*	10	5,000	8.55	
3	*Adiantum proliferum*	10	10,000	10.54	
4	*Lygodium salicifolium*	10	4,000	7.84	
5	*Chrysopogon lancearis*	60	100,000	101.09	
6	*Equisetum ramossisimum*	10	20,000	17.25	
7	*Athyrium drepanopterum*	10	4,000	11.51	
8	*Cissus adnata*	10	2,000	6.22	
9	*Hedyotis vistata*	30	11,000	21.74	
10	*Mimosa pudica*	10	2,000	6.99	
	Total	**200**	**206,000**		**1.55**
V3 PH site at RB of River Kopili (near Kala nala / Charchim confluence)					
1	*Saccharum longisetosum*	20	16,000	75.48	
2	*Mikania macrantha*	10	4,000	7.27	
3	*Oplismenus compositus*	40	13,000	26.06	
4	*Cyperus cyperoides*	10	2,000	5.99	
5	*Carex foliosa*	10	2,000	6.14	
6	*Cyperus rotundus*	10	3,000	6.26	
7	*Cyanotis vaga*	30	30,000	36.52	
8	*Carex myosurus*	20	4,000	12.68	
9	*Cocculus macrocarpus*	10	2,000	5.63	
10	*Chrysopogon lancearis*	10	12,000	15.13	
11	*Hedyotis scandens*	10	2,000	5.63	
12	*Saccharum spontaneum*	10	24,000	44.39	
13	*Neanotis hirsuta*	10	5,000	9.19	
14	*Digitaria ciliaris*	10	2,000	5.48	
15	*Biophytum reinwardii*	10	2,000	5.62	
16	*Panicum auritum*	10	12,000	12.86	
17	*Themeda strigosa*	10	12,000	14.84	
18	*Lygodium salicifolium*	10	1,000	4.84	
	Total	**250**	**148,000**		**2.46**
V4 Downstream (d/s) of PH site (near Panimore-Patherkore picnic spot-Kopili water fall)					
1	*Hedyotis corymbosa*	20	8,000	19.63	
2	*Cyrtococcum accrescens*	60	85,000	103.66	
3	*Lygodium salicifolium*	20	2,000	12.27	
4	*Carex myosurus*	20	3,000	12.27	
5	*Mimosa pudica*	10	2,000	6.55	
6	*Digitaria adscendens*	10	10,000	12.82	
7	*Paspalum scrobiculatum*	10	2,000	6.43	
8	*Anisomeles indica*	10	4,000	48.81	
9	*Sporobolus diander*	10	8,000	10.81	
10	*Brachiaria reptans*	20	4,000	11.93	
11	*Panicum auritum*	10	10,000	13.25	
12	*Spodiopogon lacei*	10	20,000	28.20	
13	*Cyperus cyperoides*	20	3,000	13.39	
	Total	**230**	**161,000**		**1.74**

Table 4.5: Attributes of Herbaceous Flora during Winter Season[72]

S. No.	Herb Species	Frequency (F%)	Density (ha-1)	IVI	Species Diversity H
V1 Submergence area (Upstream (u/s) of Longphu Dam –Discharge site)					
1	*Sida acuta*	30	20,000	12.48	
2	*Oxalis corniculata*	40	15,000	23.54	
3	*Trigonella foenum-graecum*	10	7,000	32.14	
4	*Achyranthes aspera*	10	2,000	10.53	
5	*Cyperus rotundus*	20	3,000	3.4	
6	*Setaria verticillata*	50	52,000	6.45	
7	*Alternanthera sessilis*	20	8,000	20.45	
8	*Biophytum reinwardtii*	10	5,000	43.12	
9	*Plantago major*	20	3,000	8.34	
10	*Brachiaria ramosa*	30	24,000	2.35	
11	*Poa annua*	20	12,000	15.61	
12	*Mazus delavayi*	10	6,000	4.36	
13	*Euphorbia hirta*	10	3,000	3.78	
14	*Crotolaria cytisoides*	20	80,000	11.54	
15	*Eragrostis tenella*	40	60,000	30.25	
16	*Paspalum dilatatum*	30	2,000	31.45	
17	*Cynodon dactylon*	50	16,000	40.21	
	Total	**420**	**318,000**		**2.37**
V2 Dam site (near Longphu basti, river Kopili)					
1	*Achyranthes aspera*	30	3,000	20.15	
2	*Cyperus rotundus*	20	5,000	15.32	
3	*Setaria verticillata*	40	25,000	74.62	
4	*Alternanthera sessilis*	10	2,000	23.54	
5	*Biophytum reinwardtii*	40	3,000	42.01	
6	*Plantago major*	10	2,000	17.25	
7	*Brachiaria ramosa*	30	40,000	41.84	
8	*Poa annua*	20	20,000	22.31	
9	*Mazus delavayi*	10	1,000	6.32	
10	*Euphorbia hirta*	10	2,000	7.2	
11	*Crotolaria cytisoides*	20	3,000	6.22	
12	*Eragrostis tenella*	30	16,000	17.12	
13	*Paspalum dilatatum*	20	1,100	6.1	
	Total	**290**	**123,100**		**1.91**
V3 PH site at RB of river Kopili (near Kala nala / Phanglengsu confluence)					
1	*Achyranthes aspera*	20	9,000	11.97	
2	*Cyperus rotundus*	10	12,000	21.05	
3	*Setaria verticillata*	30	41,000	49.25	
4	*Alternanthera sessilis*	20	2,000	11.35	
5	*Biophytum reinwardtii*	30	32,000	3.78	
6	*Plantago major*	10	2,000	3.54	
7	*Brachiaria ramosa*	40	30,000	36.52	
8	*Poa annua*	30	8,000	22.35	
9	*Mazus delavayi*	10	3,000	4.2	
10	*Euphorbia hirta*	10	2,000	5.47	
11	*Crotolaria cytisoides*	20	3,000	8.75	
12	*Eragrostis tenella*	30	32,000	47.52	

[72] Table 8.5

S. No.	Herb Species	Frequency (F%)	Density (ha-1)	IVI	Species Diversity H
13	*Paspalum dilatatum*	20	6,000	16.74	
14	*Cynodon dactylon*	50	24,000	35.84	
15	*Oplismenus compositus*	30	17,000	2.15	
16	*Gomphrena globosa*	10	2,000	4.68	
17	*Themeda strigosa*	20	12,000	14.84	
	Total	**390**	**237,000**		**2.51**
V4 Downstream (d/s) of PH site (near Panimore-Patherkore picnic spot-Kopili water fall)					
1	*Sida acuta*	40	22,000	35.48	
2	*Oxalis corniculata*	50	7,000	46.85	
3	*Trigonella foenum-graecum*	20	2,000	19.54	
4	*Achyranthes aspera*	20	1,000	12.42	
5	*Cyperus rotundus*	30	2,000	10.65	
6	*Setaria verticillata*	30	46,000	52.45	
7	*Alternanthera sessilis*	20	9,000	6.96	
8	*Biophytum reinwardtii*	10	2,000	10.24	
9	*Plantago major*	10	3,000	5.39	
10	*Brachiaria ramosa*	30	18,000	24.35	
11	*Poa annua*	20	15,000	37.12	
12	*Mazus delavayi*	10	3,000	2.14	
13	*Euphorbia hirta*	20	1,000	3.64	
14	*Crotolaria cytisoides*	10	2,000	4.57	
15	*Eragrostis tenella*	20	4,000	28.2	
	Total	**340**	**137,000**		**2.18**

Table 4.6: Attributes of Herbaceous Flora during Summer Season[73]

S. No.	Species	Frequency (F%)	Density (ha-1)	IVI	Species Diversify H
V1 Submergence area (Upstream (u/s) of Longphu Dam –Discharge site)					
1	*Achyranthes aspera*	20	6,000	9.6	
2	*Xanthium strumarium*	50	16,000	52.3	
3	*Eclipta alba*	30	3,000	23.14	
4	*Cyperus rotundus*	10	7,000	8.35	
5	*Cyperus iria*	20	2,000	36.25	
6	*Euphorbia hirta*	30	23,000	40.35	
7	*Sida acuta*	40	13,000	44.21	
8	*Oxalis corniculata*	10	2,000	25.32	
9	*Melilotus indica*	30	6,000	23.46	
10	*Saccharum spontaneum*	10	5,000	15.36	
11	*Setaria verticillata*	20	4,000	14.29	
12	*Sporobolus diander*	10	2,000	8.37	
	Total	**280**	**89,000**		**2.01**
V2 Dam site (near Longphu basti, river Kopili)					
1	*Achyranthes aspera*	20	3,000	8.12	
2	*Euphorbia hirta*	20	8,000	11.85	
3	*Sida acuta*	50	46,000	102.35	
4	*Oxalis corniculata*	10	5,000	5.36	

[73] Table 8.6

S. No.	Species	Frequency (F%)	Density (ha-1)	IVI	Species Diversify H
5	*Cyperus niveus*	40	100,000	42.31	
6	*Fimbristylis dichotoma*	30	210,000	52.34	
7	*Crotolaria cytisoides*	20	14,000	11.56	
8	*Eragrostis tenella*	40	3,000	2.35	
9	*Paspalum dilatatum*	10	4,000	9.65	
10	*Cynodon dactylon*	20	5,000	15.7	
11	*Oplismenus compositus*	30	2,000	6.22	
12	*Xanthium strumarium*	40	9,000	21.74	
13	*Cyperus rotundus*	10	4,000	3.82	
14	*Eclipta alba*	10	2,000	7.22	
	Total	**350**	**415,000**		**1.86**
V3 PH site at RB of river Kopili (near Kala nala / Phanglengsu confluence)					
1	*Euphorbia hirta*	30	2,000	23.47	
2	*Sida acuta*	40	20,000	21.23	
3	*Oxalis corniculata*	30	40,000	31.42	
4	*Crotolaria cytisoides*	10	2,000	5.99	
5	*Eragrostis tenella*	40	3,000	42.02	
6	*Paspalum dilatatum*	30	5,000	6.26	
7	*Cynodon dactylon*	60	48,000	46.32	
8	*Oplismenus compositus*	40	32,000	16.58	
9	*Gomphrena globosa*	10	2,000	4.38	
10	*Ocimum sanctum*	10	3,000	13.54	
11	*Mimosa pudica*	20	1,000	4.27	
12	*Trigonella foenum-graecum*	10	1,200	32.18	
13	*Digitaria adscendens*	30	35,000	37.29	
14	*Chrysopogon lancearis*	10	26,000	4.96	
15	*Persicaria barbata*	20	4,000	3.7	
16	*Hedyotis vestita*	10	2,000	6.39	
	Total	**400**	**226,200**		**2.12**
V4 Downstream (d/s) of PH site (near Panimore-Patherkore picnic spot-Kopili water fall)					
1	*Cyperus rotundus*	20	2,000	15.32	
2	*Cyperus iria*	30	3,000	16.45	
3	*Euphorbia hirta*	40	2,000	35.21	
4	*Sida acuta*	40	45,000	63.14	
5	*Oxalis corniculata*	20	30,000	53.21	
6	*Melilotus indica*	10	12,000	21.36	
7	*Saccharum spontaneum*	20	7,000	22.31	
8	*Setaria verticillata*	30	49,000	6.8	
9	*Sporobolus diander*	10	12,000	8.34	
10	*Strobilanthes khasiana*	30	3,000	11.93	
11	*Alternanthera sessilis*	10	23,000	9.86	
12	*Gomphrena globosa*	20	1,000	14.85	
13	*Crepis japonica*	30	2,000	3.3	
14	*Mikania macrantha*	10	1,000	3.54	
15	*Commelina bengalensis*	20	3,000	14.38	
	Total	**340**	**195,000**		**1.98**

5 Findings – Fauna

36. Table 4.7 to 4.11 presents the species composition in the study area (mammals, Avifauna, reptiles, amphibians and butterflies, etc.)

Table 4.7: Species Composition in the Study Area (Mammals)[74]

S. No.	Species	Family	Common Name	Conservation Status[75]	
				IUCN	IWPA
1	*Macaca mulatta*	Cercopitheitidae	Rhesus Macaque	LC	II
2	*Trachypithecus pileatus*	Cercopitheitidae	Capped Langur	VU	I
3	*Viverricula indica*	Viverridae	Small Indian Civet	LC	II
4	*Paguma larvata*	Viverridae	Masked Palm Civet	LC	II
5	*Herpestes urva*	Herpestidae	Crab Eating Mongoose	LC	IV
6	*Herpestes edwardsii*	Herpestidae	Indian Grey Mongoose	LC	IV
7	*Rusa unicolor*	Cervidae	Sambar	VU	III
8	*Bos gaurus*	Bovidae	Gaur	VU	I
9	*Manis pentadactyla*	Manidae	Chinese Pangolin	CR	I
10	*Rattusrattus*	Muridae	House Rat	LC	V
11	*Chiropodomys gliroides*	Muridae	Pencil-tailed Tree Mouse	LC	V
12	*Rhizomys pruinosus*	Spalacidae	Hoary Bamboo rat	LC	V
13	*Cannomys badius*	Spalacidae	Lesser Bamboo Rat	LC	V
14	*Petaurista philippensis*	Sciuridae	Common Giant Flying Squirrel	LC	IV
15	*Petauristapetaurista*	Sciuridae	Common Giant Flying Squirrel	LC	IV
16	*Hylopetes phyrei*	Sciuridae	Phayre's Flying Squirrel	LC	IV
17	*Suncus murinus*	Soricidae	House Shrew	LC	IV
18	*Rousettus leschenaulti*	Rhinolophidae	Indian Fulvus Fruit Bat	LC	V
19	*Pteropus giganteus*	Pteropodidae	Indian Flying Fox	LC	-
20	*Pipistrellus tenuis*	Vespertilionidae	Indian Pygmy Bat	LC	-
21	*Hystrix brachyura*	Hystricidae	Chinese Porcupine	LC	II
22	*Elephas maximus*	Mammal	Elephant	EN	I

Table 4.8: Species Composition in the Study Area (Avifauna)[76]

S.No.	Scientific Name	Common Name	Threat Status[77]		Distribution
			IUCN	IWPA	Habit
	Anatidae				
1	*Anas platyrhynchos*	Mallard	LC	IV	RW
	Rallidae				
2	*Amaurornis phoenicurcus*	White-breasted Water Hen	LC	IV	R
	Phalacrocoracidae				
3	*Phalacrocorax carbo*	Great Cormorant	LC	IV	RW
	Ardeidae				

[74] Table 8.8
[75] LC = least concerned, NT = near threatened, VU = vulnerable, EN = endangered, CR = critically endangered
[76] Table 8.9
[77] LC = least concerned, NT = near threatened, VU = vulnerable, EN = endangered, R = widespread Resident, r = local resident, W = Widespread winter visitor

S.No.	Scientific Name	Common Name	Threat Status[77]		Distribution
			IUCN	IWPA	Habit
4	*Casmerodius albus*	Great Egret	LC	IV	RW
5	*Bubulcus ibis*	Cattle Egret	LC	IV	R
	Tringidae				
6	*Tringa glareola*	Spotted Sandpiper	LC	IV	W
	Charadriidae				
7	*Vanellus indicus*	Rediwattled Lapwing	LC	IV	R
	Accipitridae				
8	*Aviceda leuphotes*	Black Baza	LC	I	R
	Phasianidae				
9	*Lophura leucomelanos*	Kaleej Pheasant	LC	IV	R
10	*Polyplectron bicalcaratum*	Grey Peacock-pheasant	LC	I	R
11	*Gallus sonneratii*	Jungle Fowl	LC	IV	R
12	*Pavo cristatus*	Peacock	LC	I	R
	Megalaimidae				
13	*Megalaima asiatica*	Blue-throated Barbet	LC	IV	R
14	*Megalaima haemacephala*	Coppersmith Barbet	LC	IV	R
	Meropidae				
15	*Merops leschenaultia*	Chestnut Bee-eater	LC	IV	R
	Halcyonidae				
16	*Halcyon smyrnensis*	White-throated Kingfisher	LC	IV	R
	Coracidae				
17	*Coracias benghalensis*	Indian Roller	LC	IV	R
	Picidae				
18	*Micropternus brachyurus*	Eastern Rufus Woodpecker	LC	IV	R
19	*Picus canus*	Grey-faced Woodpecker	LC	IV	R
	Bucerotidae				
20	*Aceros undulatus*	Wrethed Hornbill	LC	IV	R
21	*Anthracoceros albirostris*	Oriantal Pied Hornbill	LC	IV	R
	Psittacidae				
22	*Psittacula cyanocephala*	Blossom headed Parakeet	LC	IV	R
	Columbidae				
23	*Columba livia*	Rock Pigeon	LC	IV	R
24	*Streptopelia chinensis*	Spotted Dove	LC	IV	R
25	*Treron phoenocoptera*	Bengal green Pigeon	LC	IV	R
	Cuculidae				
26	*Eudynamis scolopacea*	Indian Koel	LC	IV	R
	Sturnidae				
27	*Acridotheres tristis*	Indian Myna	LC	IV	R
28	*Gracula religiosa*	Jungle Myna	LC	IV	R
	Corvidae				
29	*Corvus splendens*	Common Crow	LC	V	R
30	*Dicrurus hottentottus*	Spangled Drongo	LC	IV	R
31	*Dicrurus adsimillis*	North Indian Black Drongo	LC	IV	p
32	*Dicrus leucophaeus*	Assam Grey Drongo	LC	IV	R
33	*Tephrodornis pondicerianus*	Indian wood Shrike	LC	IV	R
	Pycnonotidae				
34	*Spizixos canifrons*	Finch billed Bulbul	LC	IV	R
35	*Pycnonotus atriceps*	Black headed Bulbul	LC	IV	R
36	*Pycnonotus striatus*	Striated green Bulbul	LC	IV	R
	Muscicapidea				
37	*Brachypteryx stellata*	Gould's Shortwing	LC	IV	R

S.No.	Scientific Name	Common Name	Threat Status[77]		Distribution
			IUCN	IWPA	Habit
38	*Muscicapa dauurica*	Asian Brown Flycatcher	LC	IV	Rw
39	*Ficedula parva*	Red-throated Flycatcher	LC	IV	W
40	*Ficedula hyperythra*	Snowy-browed Flycatcher	LC	IV	R
41	*Eumyias thalassina*	Verditer Flycatcher	LC	IV	R
42	*Niltava macgrigoriae*	Small Niltava	LC	IV	R
	Sylviidae				
43	*Cettia brunnifrons*	Grey Bush Warbler	LC	IV	R
44	*Acrocephalus dumetorum*	Reed Warbler	LC	IV	W
45	*Seicercus burki*	Golden Spectacled Warbler	LC	IV	R
46	*Garrulax caerulatus*	Grey-sided Laughingthrush	LC	IV	R
47	*Pellorneum albiventre*	Assam brown Babbler	LC	IV	R
48	*Macronous gularis*	Yellow breasted Babbler	LC	IV	R
49	*Timalia pileata*	Red capped Babbler	LC	IV	R
50	*Pomatorhinus horsfieldii*	Slaty-headed Scimitar-babbler	LC	IV	R
51	*Liocichla phoenicea*	Red-faced Liocichla	LC	IV	R
52	*Sitta Formosa*	Beautiful Nuthatch	VU	IV	R
53	*Phylloscopus fuligiventer*	Smoky Leaf Warbler	LC	IV	SW
54	*Phylloscopus affinis*	Tickell's Leaf Warbler	LC	IV	SW
	Nectarniidae				
55	*Arachnothera magna*	Streaked Spider Hunter	LC	IV	R
56	*Aethopyga nipalensis*	Green-tailed Sun bird	LC	IV	R
57	*Dicaeum erythrorhynchos*	Pale-billed Flower packer	LC	IV	R
	Passeridae				
58	*Passer domesticus*	House Sparrow	LC	IV	R
59	*Motacilla alboides*	White Wagtail	LC	IV	R

Table 4.9: Species Composition in the Study Area (Reptiles)[78]

S. No.	Species	Family	Common Name	Conservation Status [79]	
				IUCN	IWPA
1	*Testudo sp*	Testudinidae	Tortoise	-	IV
2	*Takydromus khasiensis*	Lacertidae	Java Grass Lizard	-	-
3	*Calotes emma*	Agamidae	Grassy Forest Crested lizard	LC	-
4	*Calotes versicolor*	Agamidae	Oriental Garden Lizard	LC	-
5	*Calotes irawadi*	Agamidae	-	LC	-
6	*Calotes jerdoni*	Agamidae	Indo-Chinese Forest Lizard	LC	-
7	*Japalura planidorsata*	Agamidae	Smooth-scaled mountain lizard	LC	-
8	*Cyrtodactylus khasiensis*	Gekkonidae	Khasi Hills bent-toed Gecko	-	-
9	*Gekko gecko*	Gekkonidae	Tokay gecko	-	-
10	*Hemidactylus frenatus*	Gekkonidae	Common house gecko	LC	-
11	*Hemidactylus platyurus*	Gekkonidae	Flat-tailed House Gecko	-	-
12	*Tropidurus torquatus*	Tropudoridae	Lizard	LC	-
13	*Varanus bengalensis*	Varanidae	Common Indian Monitor	LC	II
14	*Varanus salvator*	Varanidae	Water Monitor	LC	II
15	*Eutropis multifasciata*	Scincidae	East Indian Brown Mabuya	-	-
16	*Eutropis macularia*	Scincidae	Bronze Mabuya	LC	-
17	*Eutropis quadricarinatus*	Scincidae	Beautiful Mabuya	LC	-
18	*Sphenomorphus maculatus*	Scincidae	Spotted Forest Skink	-	-
19	*Tropidophorus assamensis*	Scincidae	Water Skink	LC	-
20	*Python molurus*	Pythonidae	Burmese Python	VU	I
21	*Crotalus durissus*	Viperidae	Neotropical Rattlesnake	LC	IV

[78] Table 8.10
[79] LC = least concerned, NT = near threatened, VU = vulnerable, EN = endangered

S. No.	Species	Family	Common Name	Conservation Status [79]	
				IUCN	IWPA
22	*Trimeresurus albolabris*	Viperidae	Green Pit Viper	LC	IV
23	*Amphiesma stolata*	Colubridae	Striped keelback	-	IV
24	*Xenochrophis piscator*	Colubridae	Checkered keelback snake	-	II
25	*Ahaetulla nasutus*	Colubridae	Green Vine Snake	-	-
26	*Ptyas mucosus*	Colubridae	Dhaman or Rat snake	-	II
27	*Boiga siamensis*	Colubridae	Eyed Cat Snake	-	IV
28	*Boiga gokool*	Colubridae	Arrow-back Tree Snake	-	IV
29	*Ophiophagus hannah*	Elapidae	King cobra	VU	II
30	*Naja kaouthia*	Elapidae	Common cobra	LC	II
31	*Bungarus fasciatus*	Elapidae	Banded krait	LC	IV
32	*Bungarus caeruleu*	Elapidae	Common krait	LC	IV

Table 4.10: Species Composition in the Study Area (Amphibian)[80]

S. No.	Species	Family	Common Name	Conservation Status	
				IUCN	IWPA
1	*Duttaphrynus melanostictus*	Bufonidae	Asian Common Toad	LC	-
2	*Amolops gerbillus*	Ranidae	-	LC	IV
3	*Clinotarsus alticola*	Ranidae	Assam Hill Frog	LC	IV
4	*Humerana humeralis*	Ranidae	-	LC	IV
5	*Hylarana leptoglossa*	Ranidae	Cope's Assam Frog	LC	IV
6	*Hylarana tytleri*	Ranidae	Common Green Frog	LC	IV
7	*Euphlyctis cyanophlyctis*	Dicroglossidae	Indian Skipper Frog	LC	-
8	*Zakerana nepalensis*	Dicroglossidae	Nepal Cricket Frog	LC	-
9	*Zakerana pierrei*	Dicroglossidae	Pierre's Wart Frog	LC	-
10	*Fejervarya teraiensis*	Dicroglossidae	Terai Wart Frog	LC	-
11	*Hoplobatrachus tigerinus*	Dicroglossidae	Indian Bull Frog	LC	-
12	*Limnonectes laticeps*	Dicroglossidae	Big Headed Frog	LC	-
13	*Kaloula pulchra*	Microhylidae	Banded Bull Frog	LC	-
14	*Microhyla ornate*	Microhylidae	Ornate Narrow-mouthed Frog	LC	-
15	*Microhyla butleri*	Microhylidae	Painted Chorus Frog	LC	-
16	*Leptobrachium smithi*	Megophryidae	Smith's Litter frog	LC	-
17	*Polypedates leucomystax*	Rhacophoridae	Common Tree Frog	LC	-
18	*Rhacophorus maximus*	Rhacophoridae	Nepal flying frog	LC	-
19	*Rhacophorus bipunctatus*	Rhacophoridae	Himalayan Flying Frog	LC	-

LC = least concerned

Table 4.11: Species Composition in the Study Area (Butterflies)[81]

S. No.	Species	Family	Common Name	Threat Status[82]	
				IUCN	IWPA
1	*Princeps polytes*	Papilionidae	Common Mormon	-	-
2	*Papiliohelenushelenus*	Papilionidae	Red Helen	-	-
3	*Papilioparisparis*	Papilionidae	Paris Peacock	-	-
4	*Atrophaneura aristolochiae*	Papilionidae	Common Rose	-	-
5	*Leptocircuscuriuscurius*	Papilionidae	White Dragontail	-	-
6	*Graphiumsarpedonsarpedon*	Papilionidae	Common Bluebottle	-	-
7	*Graphiumxenoclesxenocles*	Papilionidae	Great Zebra	-	-

[80] Table 8.11
[81] Table 8.12
[82] LC – least concerned

S. No.	Species	Family	Common Name	Threat Status[82]	
				IUCN	IWPA
8	*Eurema blanda silhetana*	Pieridae	Three Spot Grass Yellow	-	-
9	*Eurema hecabe contubernalis*	Pieridae	Common Grass Yellow	-	-
10	*Gandaca harina assamica*	Pieridae	Tree Yellow	-	-
11	*Hebomiaglaucippeglaucippe*	Pieridae	Great Orange Tip	-	-
12	*Pieris napi montana*	Pieridae	Greenvein White	-	-
13	*Pieris canidia indica*	Pieridae	Indian Cabbage White	-	-
14	*Appias lyncida hippoides*	Pieridae	Chocolate Albatross	-	-
15	*Parantica aglea melanoides*	Nymphalidae	Glassy Tiger	-	-
16	*Parantica sita*	Nymphalidae	Chestnut Tiger	-	-
17	*Faunis arecsilaus*	Nymphalidae	Common Faun	-	-
18	*Polyura eudamippus*	Nymphalidae	Great Nawab	-	-
19	*Polyuraathamasathamas*	Nymphalidae	Common Nawab	-	-
20	*Neptis namba*	Nymphalidae	Yellow Sailer	-	-
21	*Neptis magadha khasiana*	Nymphalidae	Spotted Sailer	-	II
22	*Neptis hylah*	Nymphalidae	Common Sailer	-	-
23	*Pantoporia dindinga assamica*	Nymphalidae	Grey-lined Lascar	-	-
24	*Athyma perius*	Nymphalidae	Common Sergent	-	-
25	*Athyma nefte inara*	Nymphalidae	Colour Sergent	-	-
26	*Athyma kanwa phorkys*	Nymphalidae	Dot-Dash Sergent	-	-
27	*Orsotrioenamedusmedus*	Nymphalidae	The Nigger	-	-
28	*Melanitis leda ismene*	Nymphalidae	Common Evening Brown	-	-
29	*Mycalesis perseus blasius*	Nymphalidae	Common Bushbrown	-	-
30	*Mycalesis malsarida*	Nymphalidae	Plain Bushbrown	-	II
31	*Doleschallia bisaltide indica*	Nymphalidae	Autumn Leaf	-	-
32	*Kallima inachus*	Nymphalidae	Orange Oakleaf	-	-
33	*Hestina nama*	Nymphalidae	Circe	-	-
34	*Vindulaerotaerota*	Nymphalidae	Cruiser	-	-
35	*Tanaecia julii sedeva*	Nymphalidae	Common Earl	-	-
36	*Euthalia telchinia*	Nymphalidae	Blue Baron	-	I
37	*Junonia lemonias*	Nymphalidae	Lemon Pansy	-	
38	*Junonia almana*	Nymphalidae	Peacock Pansy	LC	-
39	*Cethosia biblis tisamena*	Nymphalidae	Red Lacewing	-	-
40	*Cirrochroa aoris*	Nymphalidae	Large Yeoman	-	-
41	*Acytolepis puspa*	Lycaenidae	Common Hedge	-	-
42	*Udara albocaerulea*	Lycaenidae	Albocaerulean	-	-
43	*Cyaniris placida*	Lycaenidae	Plain Hedge Blue	-	-
44	*Nacaduba kurava*	Lycaenidae	Transparent 6 Lineblue	-	-
45	*Nacaduba hermus nabo*	Lycaenidae	Pale 4 Lineblue	-	-
46	*Arhopalaemolphusemolphus*	Lycaenidae	Green Oakblue	-	-
47	*Arhopala atrax*	Lycaenidae	Indian Oakblue	-	-
48	*Arhopala aberrans*	Lycaenidae	Pale Bushblue	-	-
49	*Flos adriana*	Lycaenidae	Variegated Plushblue	-	-
50	*Caletacaletadecidia*	Lycaenidae	Angled Pierrot	-	-
51	*Abisara neophron*	Lycaenidae	Tailed Judy	-	-
52	*Zemeros flegyas indicus*	Lycaenidae	Punchinello	-	-
53	*Bibasis sena*	Hesperiidae	Orange-tail Awl	-	-
53	*Odontoptilum angulata*	Hesperiidae	Chestnut Angle	-	-
55	*Pelopidas assamensis*	Hesperiidae	Great Swift	-	IV
56	*Caltoris plebeia*	Hesperiidae	Tufted Swift	-	-

Ecological profile across Longku Dam Site of Kopili river

6 Description of the Study Area - Aquatic Ecology

37. Table 4.12 presents the sites selected for recording of the aquatic ecology. The study area was divided into three study areas having a holistic view of river ecology i.e. a) submergence area; b) dam site to power house (PH) site area; and c) downstream (d/s) influence area of 26 km longitudinal length. Observations were recorded with respect to both

project area and project appurtenances (including river Amring). The sampling locations are presented in Figure 4.2.

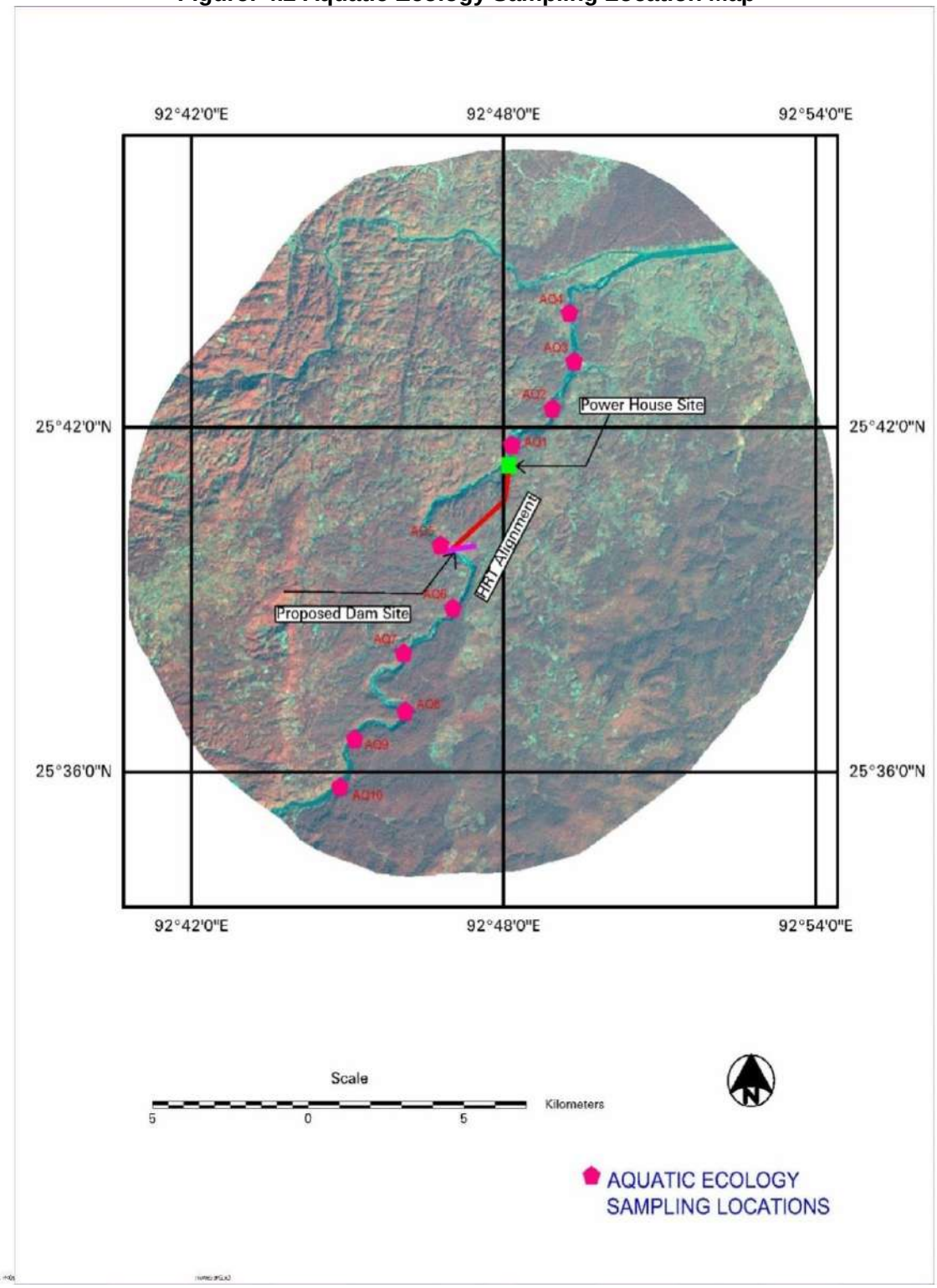
Table 4.12: Details of Study Sites in the Study Area (on river Kopili and its Tributaries)[83]

Study Area	Location*	Description
A.	**Project Influence Area (Power House (PH) site & downstream (d/s) area) :- Area between Panimore - Patharkore and Kala nala**	
Site 1	PH site - River Kopili	Power House Site at Chota Longpher village
Site 2	Kala nala / Longchitung nala	Kala nala, a perennial stream is 2.0 km d/s of the PH site. Longchitung Longkongsam nala also joins river Kopili on its RB at 0.5km d/s from the PH site, and it is a seasonal stream, with limited flow.
Site 3	D/s of PH site - River Kopili	Panimoor picnic spot on river Kopili, water fall location 8 km d/s. No major change in flow.
Site 4	River Amring at Amring	A major tributary of river Kopili with confluence at LB of river Kopili at over 10 km from PH site. Note: before its confluence, river Amring runs almost parallel to river Kopili for few kilometres, and falls within 10km radius. River Amring is unaffected by activities of the proposed project. (2000 MCM)
B.	**Dam Site (d/s) to PH site (u/s) zone:- Area beyond Kala nala and up to Longphu Basti**	
Site 5	Longku Dam site - river Kopili	River regime survey between Longku and Longpher basti
Site 6	Phanglongsu /Charchim nala	The LB streams joining River Kopili near Charchim village: charchim nala (2.0km), Soho nala (1.5km d/s), Phanglongsu nala (3.0km). All streams are seasonal except for Phanglongsu nala which is a perennial stream originating in vicinity of Phanglongsu village and Charchim village hills. The river reach in this section (Site 6) lacks any major RB streams. Limited flows with these streams.
C.	**Dam Site (u/s) & Catchment / Submergence zone:- Area between Longphu basti & Digram Basti**	
Site 7	Longku nala (Salni-longku nala)	RB stream near village Chhota Longku; confluence with river Kopili at ~1km upstream (u/s) dam site.
Site 8	Dong ikpi nala, and Longsomepi nala	L.B stream near village Rongtarni; confluence with river Kopili at ~3.5 km u/s dam site.
Site 9	River Kopili	Discharge site ~4 km u/s of dam site- in submergence zone

* The right bank (RB) of river falls in Dima Hasao district and Left Bank (LB) forms the boundary of Karbi Anglong district

[83] Table 8.13, Chapter 8 WAPCOS EIA Study

Figure: 4.2 Aquatic Ecology Sampling Location Map[84]



[84] Figure 8.2, Chapter 8 WAPCOS EIA Study

7. Methodology

38. **Determination of the river /stream morphology** i.e. the type of habitats, substratum, riparian covers, bank conditions, flow patterns, type of valleys, flood prone areas, etc., is based on the criteria described by Rosgen (1996) and habitat inventory described by Armontrout (1998), Myers and Swanson (1992) and Rosgen (1996).

39. **Stream order classification** is based on Horton's (1954) approach and modified by Strahler (1954, 1957). As per this classification system, all ultimate headwaters are called first order streams; a stream formed by union of two such streams are designated second order; and whenever two streams of a particular order join, they form next order, and so on. Habitat structures were observed in the river stretches from downstream (d/s) to upstream (us) at a fixed points including longitudinal (visual) survey of submergence, dam site and influence zone of dam toe (of proposed project).

40. **Plankton** samples were collected using a Tericot Ring Net (fine silk cloth of mesh size 20-25 µm). Up to 100 liters composite water samples were collected from the river surface up to a depth of 60 cm and filtered through the Tericot Ring Net to produce bulk samples of 1 liter each. The 1 liter bulk samples were preserved in 2% formalin solution for laboratory analysis. The 1 liter bulk sample was separated into ten replicate water samples of 15 ml each and centrifuged at 1,500 rpm for 10 minutes. After centrifuging, the volume of aliquot concentrate was measured. The Aliquot concentrate of 0.1 ml in each replicate water sample was studied under a light microscope for enumeration of phytoplankton and zooplankton population by employing a plankton chamber of 0.1 ml capacity. The density was estimated by using drop count method (Bhatt et al., 2005) and standards methods of APHA (1992, 1998).

41. **Benthic macro-invertebrates**[85] were collected by sieve (mesh size 100 µm) from pebbles, cobbles, and gravels at a sediment depth of 15 cm at different elevations while Periphyton-Epilithic[86] phytobenthos[87] were obtained by scrapping 4x4 square cm rock surfaces and boulders by hard brush and preserved in 3% formalin solution. The density was estimated by using drop count method (Bhatt et al., 2005) and standards methods of APHA (1992, 1998).

42. All collected specimens were identified using **keys** formulated by scholars such as Pennak (1953), Edmondson (1959), Ward and Whipple (1959), Needham and Needham (1962), Trivedy and Goel (1984), Sarod and Kamat (1984), Hustedt and Jensen (1985), Battish (1992), Edington and Holdren (1995) and APHA (1992, 1998).

43. **Fish occurrences** were determined by ocular inspection and sampling using gill net, cast net, scoop net, hand net, hook-line, etc. All collected specimens were identified up to species level using **keys** formulated by Jayaram (1981), Menon (1987) and Talwar and Jhingran (1997). IUCN Red Data List (2008) was utilized for identifying any threatened, endangered and vulnerable species in the study area. The Conservation Assessment Management Plan of Biodiversity Conservation Prioritization Project Workshop (CAMP-BCPP, 1997) was followed to understand the threats and conservation status of Indian fish species.

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[85] Benthic macro-invertebrates are organisms without backbones that inhabit the bottom substrates (for example, sediments, debris, logs, macro-phytes, and filamentous algae) of their habitats, for at least part of their life cycle (Rosenberg and Resh 1993). http://www.water.ncsu.edu/watershedss/info/macroinv.html

[86] Freshwater organisms attached or clinging to plants and other objects projecting above the bottom sediments.

[87] Phytobenthos are good indicators of nutrient enrichment and other pressures, and can be used to assess river water quality

44. The species diversity index was calculated using Shannon's species diversity index (H) formula.

8. Findings

45. The health of aquatic ecosystem of river Kopili was assessed by recording different biotic communities namely zooplankton, phytoplankton, and phytobenthos under micro flora and fauna; macro-invertebrates and macrophytes under macro flora and fauna; and vertebrate group represented by fish fauna. Note: the aquatic ecology in and around the proposed project and surrounding areas (river Kopili) has been affected grievously by acid drainage due to illegal and uncontrolled rat hole mining upstream in State of Meghalaya. Table 4.13 shows the comparison of acidity in Kopili river and tributaries. Findings of the field study are discussed below.

Table 4.13: pH profile (acidity) of River Kopili and its tributaries /streams in the Study

Sl. No.	Name of Location	By River Course Route (Km)	pH Range
1.	Kopili river before Confluence Point	-	7.2-7.6
2.	Kharkar river before Confluence Point	-	3.2-3.5
3.	Confluence Point of Kopili and Kharkar River	0	3.7-4.3
4.	Kopili river before Upper Kopili HEP (North-West Point)	4	3.7-4.3
5.	Kopili HEP	10.6	4.1-4.4
6.	Umrangso Reservoir	15	4.1-4.4
7.	Myntang river before Kopili Confluence point	17	4.2-4.8
7.	Lower KEP site	41	4.1-4.4
8.	Kopili river at Downstream of Power House	49	4.1-4.4
9.	Mynriang River before Confluence point with Kopili River	55	6.9-7.2
10.	Kopili-Mynriang Confluence point	55	6.5-7.0
11.	Local Stream near Dayang Mukh	68	7.1-7.2
12.	Kopili river near Akantu	91	6.8-7.0
13.	Local Stram near Baliram Pathar	137	7.0-7.3
14.	Local Stream near Nalipar	182	7.0-7.3
15.	Local Stream near Bundura Duba	185	7.0-7.3
16.	Kopili river at Dharamtul	205	7.1-7.3

8.1 Phytoplanktons

46. Phytoplankton comprises of filamentous algae - Cyanophyceae (blue green) and Chlorophyceae (blue), and Non-filamentous algae - Bacillariophyceae algae. A total of 43 species were recorded across the study area. The findings are presented in Tables 4.13 and 4.14.

47. In filamentous algae, a total of 9 taxa from Cyanophyceae and 7 taxa from Chlorophyceae were recorded. Oscillatoria sp., Spirogyra sp., Zygnema sp., and Pediastrum simplex were most abundant taxa among filamentous algae at site S2, S4, S6, S7 and S8.

48. In non-filamentous algae, Achnanthidium minutissimum, Synedra ulna, Achnanthidium affinis and Gomphonema intricatum were most common species and represented at 5 out of 9 sites. Synedra ulna, Planothidium lanceolata and Achnanthidium minutissima were the most

represented taxa in the diatom community accounting for more than 10% at least at one site, except S4. Amphora, Cyclotella, Epithemia, Hantzschia, Mastogloia and Pleurosigma were the least represented taxa in the diatom community.

Table 4.13: Phytoplankton Observed in River Kopili and its tributaries /streams in the Study Area[88]

S. No.	Phytoplankton Taxon / Species	S. No.	Phytoplankton Taxon / Species
	Chlorophyceae- Green Algae		***Bacillariophyceae - Diatoms***
1	*Actinastrum sp.*	22	*Achnanthidium sp.*
2	*Ankistrodesmus falcatus*	23	*Navicula spp*
3	*Closterium acutum*	24	*Synedra spp*
4	*Tetraspore sp*	25	*Fragillaria spp*
5	*Cosmarium sp.*	26	*Nitzeschia spp*
6	*Oedogonium sp.*	27	*Amphora sp.*
7	*Oocystis solitaria*	28	*Cymbella spp*
8	*Cladophora sp.*	29	*Coconeis spp*
9	*Ulothrix sp.*	30	*Surirella sp.*
10	***Zygnema sp.***	31	*Gomphonema spp*
11	***Spirogyra sp.***	32	*Hantzschia amphioxys*
12	***Pediastrum simplex***	33	*Mastogloia sp.*
13	*P. duplex /spp*	34	*Pleurosigma sp.*
14	*Scenedesmus dimorphus*	35	*Planothidium lanceolata*
15	*Selenastrum westii*	36	*Cyclotella sp.*
16	*Coelastrum sp.*		***Cyanophyceae- Blue green algae***
17	*Chlorella sp.*	37	***Oscillatoria sp.***
18	*Chlorococcum sp.*	38	*Microcystis sp.*
19	*Desmidium sp.*	39	*Gloeocapsa sp.*
	Euglenophyceae / Flagellates	40	*Anacystis sp.*
20	*Euglena vedinas*	41	*Microcystis sp.*
21	*Chlamydomonas sp*	42	*Merismopedia sp.*
		43	*Spirullina sp.*

[88] Table 8.14, Chapter 8 WAPCOS EIA Study

Table 4.14: Phytoplankton Density, Species Richness (N), and Diversity in the Study Area[89]

Index / Seasons / Study Sites	PH Site & d/s area				Dam to PH site		Dam Site & Catchment area		
	1	2	3	4	5	6	7	8	9
Phytoplankton	PH Site River Kopili	Kalanala (RB river Kopili)	Panimur-river Kopili	River Amring & Confluence with river Kopili (LB)	Dam Site river Kopili	Phang-longsunala (LB of river Kopili)	Longkunala (RB of Kopili)	Dongikpi-longso-mepi (LB river Kopili)	River Kopili u/s dam site
Monsoon									
Shannon H'	- -	1.46	- -	1.56	- -	1.41	1.42	1.41	- -
Shannon Hmax	- -	1.58	- -	1.60	- -	1.49	1.46	1.48	- -
Shannon J'	- -	0.92	- -	0.98	- -	0.95	0.97	0.96	- -
Species (N)	- -	38	- -	40	- -	31	29	30	- -
Density (Cells/L)	- -	358	- -	624	- -	245	175	221	- -
Winter									
Shannon H'	- -	1.53	- -	1.56	- -	1.46	1.45	1.46	- -
Shannon Hmax	- -	1.58	- -	1.63	- -	1.49	1.49	1.51	- -
Shannon J'	- -	0.97	- -	0.95	- -	0.98	0.97	0.97	- -
Species (N)	- -	38	- -	43	- -	31	31	32	- -
Density (Unit/L)	- -	595	- -	1291	- -	424	348	390	- -
Summer									
Shannon H'	- -	1.46	- -	1.58	- -	1.52	1.54	1.49	- -
Shannon Hmax	- -	1.57	- -	1.63	- -	1.59	1.59	1.59	- -
Shannon J'	- -	0.93	- -	0.97	- -	0.96	0.97	0.94	- -
Species (N)	- -	37	- -	43	- -	39	39	39	- -
Density (Cells/L)	- -	447	- -	914	- -	377	372	342	- -

8.2 Phytobenthos

49. Phytobenthos were represented by filamentous algae - Cyanophyceae (blue green) and Chlorophyceae (green) and Non-Filamentous algae – Bacillariophyceae. A total of 21 species of diatoms were recorded in the phytobenthic community as compared to 43 species in planknotic community. The findings are presented in **Tables 4.15 and 4.16**. Filamentous algae was similar between phytoplankton and phytobenthos, represented by 9 taxa. Gloeocapsa sp., Spirogyra sp., Zygnema sp. and Pediastrum simplex were most abundant taxa in phytobenthic community. Cyclotella sp., Cymbella ventricosa, Epithemia sp., Gomphonema olivaceum, Navicula capitata and Navicula rostellata were absent in benthic community while Gomphonema parvulum was the most common (represented at 5 out of 9 study sites). Navicula cryptocephala, Synedra ulna, Hantzschia amphioxys, Nitzschia sublinearis, Planothidium lanceolata, Gomphonema parvulum, Gomphonema affine, Cocconeis placentula var. euglypta, Achnanthidium affinis, Cymbella affinis and Fragilaria intermedia were the most represented taxa accounting for more than 10% at least at one site.

[89] Table 8.15, Chapter 8 WAPCOS EIA Study

Table 4.15: Phytobenthos Observed in River Kopili and its tributaries /streams in the Study Area[90]

S. No.	Phytobenthos Taxa	S. No.	Phytobenthos Taxa
1	*Closterium acutum*	12	*Nitzeschia sp.*
2	*Cosmarium sp.*	13	*Amphora sp.*
3	*Chronococcus elongatus*	14	*Oscillatoria sp.*
4	*Oocystis solitaria*	15	*Anabaena sp.*
5	*Pediastrum simplex*	16	*Gomphonema sp.*
6	*Zygnema sp.*	17	*Coconeis spp*
7	*Cladophora sp.*	18	*Merismopedia sp.*
8	*Oedogonium sp.*	19	*Spirullina sp.*
9	*Ulothrix sp.*	20	*Ealkatothrix sp*
10	*Epithema sp*	21	*Euastrium sp.*
11	*Fragillaria sp.*		

Table 4.16: Phytobenthos Density, Species Richness (N), and Diversity in the Study Area[91]

Index/ Seasons / Study Sites	PH Site & d/s area				Dam to PH site		Dam Site & Catchment area		
	1	2	3	4	5	6	7	8	9
Phytobenthos	PH Site River Kopili	Kala nala (RB river Kopili)	Panimur-river Kopili	River Amring & Confluence with river Kopili (LB)	Dam Site river Kopili	Phang-longsu nala (LB of river Kopili)	Longku nala (RB of Kopili)	Dong ikpi-longso-mepi (LB river Kopili)	River Kopili u/s dam site
Monsoon									
Shannon H'	- -	1.13	- -	1.21	- -	1.03	1.08	1.04	- -
Shannon Hmax	- -	1.18	- -	1.23	- -	1.08	1.11	1.08	- -
Shannon J'	- -	0.96	- -	0.98	- -	0.95	0.97	0.96	- -
Species (N)	- -	15	- -	17	- -	12	13	12	- -
Density (cells/cm²)	- -	192	- -	200	- -	78	64	77	- -
Winter									
Shannon H'	- -	1.22	- -	1.28	- -	1.14	1.10	1.09	- -
Shannon Hmax	- -	1.28	- -	1.32	- -	1.18	1.18	1.18	- -
Shannon J'	- -	0.96	- -	0.97	- -	0.97	0.94	0.93	- -
Species (N)	- -	19	- -	21	- -	15	15	15	- -
Density (cells/cm²)	- -	458	- -	682	- -	344	338	340	- -
Summer									
Shannon H'	- -	1.23	- -	1.27	- -	1.20	1.21	1.06	- -
Shannon Hmax	- -	1.28	- -	1.32	- -	1.26	1.26	1.18	- -
Shannon J'	- -	0.96	- -	0.96	- -	0.96	0.96	0.91	- -
Species (N)	- -	19	- -	21	- -	18	18	15	- -
Density (cells/cm²)	- -	260	- -	446	- -	184	170	132	- -

[90] Table 8.16, Chapter 8 WAPCOS EIA Study
[91] Table 8.17, Chapter 8 WAPCOS EIA Study

8.3 Zooplanktons

50. The chief component of the zooplankton community across the study area was Rotifers and cladocera larvae. The findings are presented in **Tables 4.17 and 4.18**. The taxa observed across the study area were Collurella sp., Fillinia sp., Lecane spp., Keratella sp. (Rotifers) and Bosmina sp. (Cladocera). In addition, various unidentified nano-zooplankton were also observed.

Table 4.17: Zooplankton Observed in the Study Area[92]

S. No.	Zooplankton Taxon / Species	S. No.	Zooplankton Taxon / Species
	Protozoa		
1	*Arcella discoida*	13	*Rotaria sp*
2	*Ceratium sp.*		**Copepoda**
3	*Diffuzia sp.*	1	*Cyclops leuckarti*
4	*Paramecium sp.*	2	*Diaptomus sp.*
5	*Vorticella sp.*	3	*Mesocyclops hyalinus*
6	*Didinium sp*	4	*Mesocyclops Hyalimus*
7	*Amoeba sp.*	5	*Microcyclops various*
8	*Nebalia sp*		**Cladocerans**
	Rotifera	1	*Daphinia corinata*
1	*Asplanchnopus brightwelli*	2	*Ceriodiaphnia cornusa*
2	*Brachionus sp.*	3	*Daphinia pulex*
3	*B. rubens*	4	*Daphnia circinata*
4	*B.bidens*	5	*Moina branchiate*
5	*B. caudatus*	6	*Chydorus ovulis*
6	*Filinia longiseta*	7	*Alona macrocopa*
7	*Keratella tropica*	8	*Bosmina loniotris*
8	*Lecane luna*		**Crustacean**
9	*Monostylla bulla*	1	*Nauplii larve*
10	*Polyarthra vulgaris*		**Ostracods**
11	*Trichocera longiseta*	1	*Heterocypris sp*
12	*Euchlanis sp*	2	*Cypris sp*

[92] Table 8.18, Chapter 8 WAPCOS EIA Study

Table 4.18: Zooplankton Density, Species Richness (N), and Diversity in the Study Area[93]

Index/Seasons / Study Sites	PH Site & d/s area				Dam to PH site		Dam Site & Catchment area		
	1	2	3	4	5	6	7	8	9
Zooplankton	PH Site River Kopili	Kala nala (RB river Kopili)	Pani mur-river Kopili	River Amring & Confluence with river Kopili (LB)	Dam Site river Kopili	Phang-longsu nala (LB of river Kopili)	Longku nala (RB of Kopili)	Dongikpi-longso-mepi (LB river Kopili)	River Kopiliu/s dam site
Monsoon									
Shannon H'	- -	1.13	- -	1.32	- -	1.02	0.88	0.93	- -
Shannon Hmax	- -	1.15	- -	1.34	- -	1.04	0.90	0.95	- -
Shannon J'	- -	0.98	- -	0.98	- -	0.98	0.97	0.98	- -
Species (N)	- -	14	- -	22	- -	11	8	9	- -
Density (Counts/L)	- -	64	- -	103	- -	43	23	32	- -
Winter									
Shannon H'	- -	1.37	- -	1.52	- -	1.32	1.32	1.34	- -
Shannon Hmax	- -	1.42	- -	1.57	- -	1.36	1.34	1.36	- -
Shannon J'	- -	0.97	- -	0.97	- -	0.97	0.98	0.99	- -
Species (N)	- -	26	- -	37	- -	23	22	23	- -
Density (Counts/L)	- -	196	- -	298	- -	156	130	130	- -
Summer									
Shannon H'	- -	1.26	- -	1.31	- -	1.29	1.18	1.24	- -
Shannon Hmax	- -	1.30	- -	1.34	- -	1.30	1.20	1.28	- -
Shannon J'	- -	0.97	- -	0.98	- -	0.99	0.98	0.97	- -
Species (N)	- -	20	- -	22	- -	20	16	19	- -
Density (Counts/L)	- -	110	- -	190	- -	86	68	70	- -

8.4 Macro-Invertebrates

51. Marco-invertebrates are influenced by natural or anthropogenic disturbances (Rosenberg and Resh, 1993), and these are widely used as indicators of short and long-term environmental changes in both lentic and lotic systems[94]; thus providing a facility for examining both temporal changes and effects of prolonged exposure to intermittent discharges (or variable concentrations) of pollutants (Hellawell, 1986).

52. Macro-invertebrates fauna are represented by 15 species belonging to order Ephemeroptera, Diptera, Odonata and Hemiptera. The findings are presented in **Tables 4.19 and 4.20**. Except for Ephemeropteran nymphs, all species recorded across the study area are indicators of deteriorated water quality (Mylliemngap and Ramanujam, 2011). The low density and diversity of macro-invertebrates maybe attributed to the moderate to high water contamination, and impact of acidic water on the substratum and habitat structure due to acid drainage from illegal and uncontrolled rat hole mining upstream in State of Meghalaya.

[93] Table 8.19, Chapter 8 WAPCOS EIA Study

[94] **Lentic** ecosystem refers to the static water habitats like ponds, lakes swamps and marshes and **lotic** ecosystem refers to the dynamic water habitats like rivers, brooks, etc. Both ecosystems have fresh water source.

Table 4.19: Macro-benthos Invertebrate fauna in the Study Area[95]

Phylum /Oder	Family	Benthos Taxa /Species
Insecta		
Ephemeroptera	Ephemeridae	*Ephemera nadinac*
		Ephemera sp
	Ephemerellidae	*Ephemerella indica*
	Baetidae	*Baetis simplex*
		Baetis festivus
	Caenidae	*Caenis latipennis*
	Heptageniidae	*Epeorus gilliesi*
Odonata	Libellulidae	*Orthetrum sp*
Diptera	Chironomidae	*Chironomus sp*
	Chironomidae	*Simulium sp*
Hemiptera	Aphids, Bugs, Necton *& misquotes larvae*	*Cloeon sp, Argia sp, Culex sp., Geris sp, Anisops sp,*
Annelids		
Oligochaetes		
Haplotaxida	Naididae	*Dero dorsalis*
Haplotaxida	Tubificinae	*Tubifex sp*
	Freshwater Prawn	*Macrobrachium sp (M.rosenbergii)*
Molluscan	Gastropoda	Pila sp
		Vivipara bengalensis
		Thiara sp
	Pelecypoda	Lymnaea sp
		Lamellidens sp
	Potamidae	Indian river Crab, keakura

Table 4.20: Macro-benthos Density, Species Richness (N), and Diversity in the Study Area[96]

Index/Seasons / Study Sites	PH Site & d/s area				Dam to PH site		Dam Site & Catchment area		
	1	2	3	4	5	6	7	8	9
Macro-invertebrates / Benthos	PH Site River Kopili	Kala nala (RB river Kopili)	Panimur-river Kopili	River Amring & Confluence with river Kopili (LB)	Dam Site river Kopili	Phang-longsu nala (LB of river Kopili)	Longku nala (RB of Kopili)	Dong ikpi-longso-mepi (LB river Kopili)	River Kopili u/s dam site
Monsoon									
Shannon H'	--	0.94	- -	1.08	- -	1.00	0.69	0.97	- -
Shannon Hmax	--	1.04	- -	1.11	- -	1.04	0.70	1.00	- -
Shannon J'	--	0.91	- -	0.97	- -	0.96	0.99	0.97	- -
Species (N)	--	11	- -	13	- -	11	5	10	- -
Density (indiv./m^2)	--	44	- -	66	- -	33	11	22	- -
Winter									
Shannon H'	--	0.94	- -	1.04	- -	0.98	0.99	1.01	- -
Shannon Hmax	-	1.04	- -	1.11	- -	1.04	1.04	1.04	- -
Shannon J'	-	0.90	- -	0.93	- -	0.94	0.95	0.97	- -
Species (N)	- -	11	- -	13	- -	11	11	11	- -
Density (indiv./m^2)	- -	130	- -	188	- -	102	58	64	- -
Summer									
Shannon H'	- -	0.71	- -	0.95	- -	0.94	0.92	0.95	- -
Shannon Hmax	- -	0.95	- -	1.11	- -	1.00	0.95	1.00	- -

[95] Table 8.20, Chapter 8 WAPCOS EIA Study
[96] Table 8.21, Chapter 8 WAPCOS EIA Study

Index/Seasons / Study Sites	PH Site & d/s area				Dam to PH site		Dam Site & Catchment area		
	1	2	3	4	5	6	7	8	9
Macro-invertebrates / Benthos	**PH Site River Kopili**	**Kala nala (RB river Kopili)**	**Panimur-river Kopili**	**River Amring & Confluence with river Kopili (LB)**	**Dam Site river Kopili**	**Phang-longsu nala (LB of river Kopili)**	**Longku nala (RB of Kopili)**	**Dong ikpi-longso-mepi (LB river Kopili)**	**River Kopili u/s dam site**
Shannon J'	- -	0.75	- -	0.85	- -	0.94	0.96	0.95	- -
Species (N)	- -	9	- -	13	- -	10	9	10	- -
Density (indiv./m^2)	- -	68	- -	226	- -	56	48	76	- -

8.5 Fish Communities

53. A total of **54 ichthyo species** have been recorded in river Kopili during a survey[97] led by the Science Probe. The survey was conducted in three stretches: a) Panimur (upstream stretch); b) Kalighat (midstream stretch); and c) Kheroni (downstream stretch). Of 54 fish species, **22** fish species belonging to 12 families were reported in the Panimur stretch. Of the 12 families recorded, Cyprinidae was the largest family accounting for nearly 48% of the total species. Panimur stretch has been designated as picnic spot with 8 to 10 m height water fall on a rocky substratum, which enters in to a wider valley. The habitat changes from rocky substratum to sandy banks with a large pool habitat downstream as it approaches the confluence with river Amring. This confluence results in mixing of acidic water of river Kopili with alkaline water of river Amring, thus helping the river Kopili to sustain life in downstream areas. Note: The upper reach of river Kopili (upstream of Panimur) is under the influence of lime and coal mining. The aquatic ecology in and around this area and in the immediate vicinity of the proposed project has been affected by acid drainage due to illegal and uncontrolled rat hole mining upstream in State of Meghalaya.

54. WAPCOS field work involved extensive fishing with the help of local fishing community. A total of 4 species namely Garragotylagotyla, Daniorerio, Puntius sophore and Barilius bendelisis were caught in side streams (small tributaries – not in the main channel) along the downstream influence zone (near PH site and 4 km downstream of PH site) while no fish were present or caught in the immediate vicinity of the proposed dam site. Consultations with local communities confirmed the absence of fish in the river Kopili. Findings of Ichthyofaunal composition in the study area in d/s section (Panimur stretch of Kopili river- upstream of confluence point of Amring river) are presented in Table 4.21 whereas findings of the field surveys (by project) are presented in Table 4.22. There are no migratory fish species observed in Kopili River or its tributaries (Das and Sharma, 2012, The Science Probe, 1(1): 21-29pp).

Table 4.21: Ichthyofaunal Composition and Conservation Status of fish in the Study Area[98]

S. No.	Scientific Name	Family	Common Name	IUCN Conservation Status
1	*Gudusia chapra*	Clupeidae	River Shad	LC
2	*Labeo bata*	Cyprinidae	Minor Carp	LC
3	*L. rohita*	Cyprinidae	Rohu	LC
4	*Puntius sophore*	Cyprinidae	Softfin Swamp Barb	LC
5	*Salmophasia bacaila*	Cyprinidae	Rozorbelly Minnow	LC
6	*Amblypharyngodon mola*	Cyprinidae	Indian Carplet	LC

[97] The Science Probe, 1(1): 21-29 pp, as referenced in WAPCOS EIA Study (2015)
[98] Table 8.22, Chapter 8 WAPCOS EIA Study

S. No.	Scientific Name	Family	Common Name	IUCN Conservation Status
7	*Aspidoparia jaya*	Cyprinidae	-	LC
8	*A. morar*	Cyprinidae	Morar	LC
9	*Barilius barna*	Cyprinidae	Barna Baril	LC
10	*B. bendelisis*	Cyprinidae	Common Baril	LC
11	*Danio rerio*	Cyprinidae	Zebra Fish	LC
12	*Garragotylagotyla*	Cyprinidae	Common Garra	LC
13	*Lepidocephalichthys guntea*	Cobitidae	Guntea Loach	LC
14	*Mystus armatus*	Bagridae	Kerala Mystus	LC
15	*Eutropiichthys vacha*	Schilbeidae	Vacha/Basa	LC
16	*Xenentodon cancila*	Belonidae	Needle Fish	LC
17	*Nandusnandus*	Nandidae	Gangetic Leaffish	LC
18	*Glossogobius giuris*	Gobiidae	Bareye Gobi	LC
19	*Anabas testudineus*	Anabantidae	Climbing Perch	DD
20	*Trichogaster fasciatus*	Osphronemidae	-	LC
21	*Channa orientalis*	Channidae	Snakehead	Not assessed
22	*C. punctatus*	Channidae	Spotted Snakehead	LC

Table 4.22: Fish Species Found in side streams (downstream small tributaries) and Conservation Status

S. No.	Scientific Name	Family	Common Name	IUCN Conservation Status
1	*Garra gotyla*	Cyprinidae	Gotyla / Ngamus sengum	LC
2	*Danio rerio*	Cyprinidae	Zebrafish	LC
3	*Puntius sophore*	Cyprinidae	Spotfin Swamp Barb	LC
4	*Barilius bendelisis*	Cyprinidae	Barila/Korang	LC

LC = least concerned, DD = data deficient

Annex 5: CRITICAL HABITAT ASSESSMENT FOR LKHEP

1. This Annexure contains the following sections:

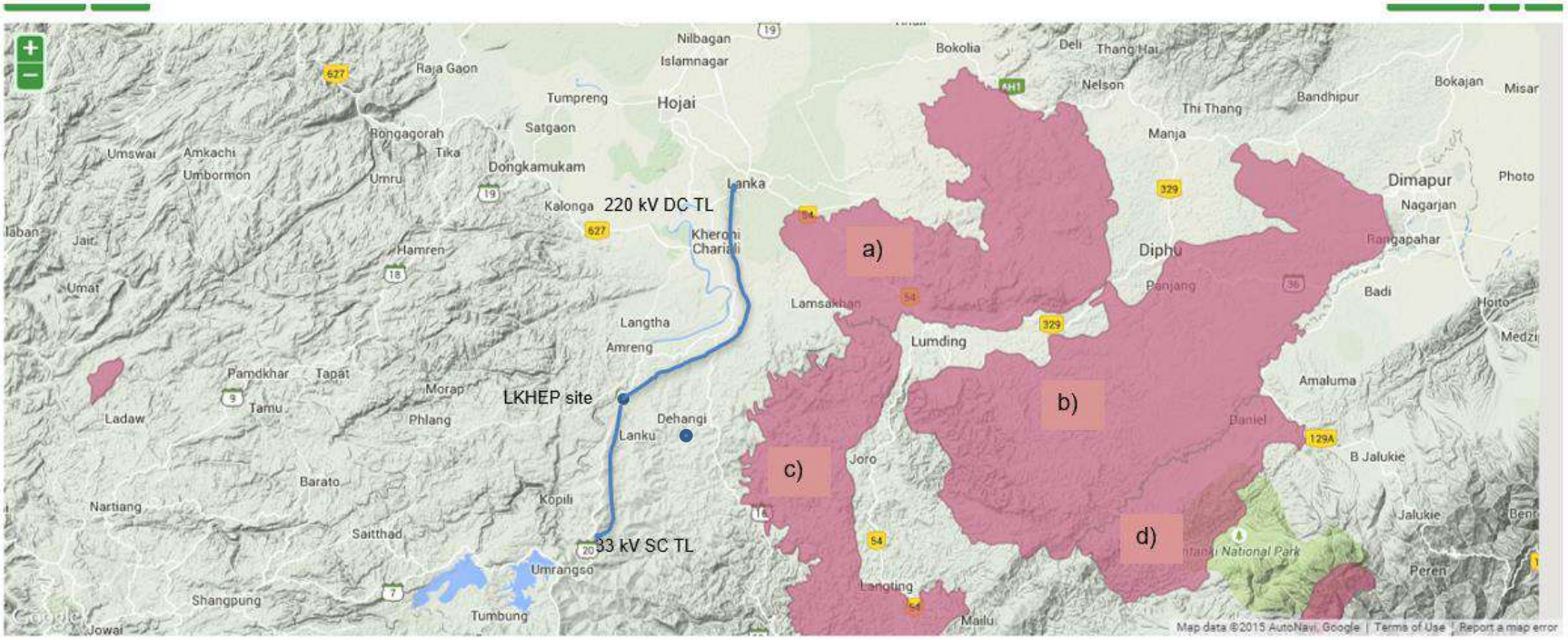
A. Introduction
B. Mapping Important Species and Biodiversity Areas corresponding to LKHEP site and Associated Facilities
C. Findings: Mapping Species via IBAT
D. Distribution and Habitat Requirements of Endangered and India's Schedule 1 Wildlife, Birds, and Plants
E. Results and Discussion
F. Forest Details (Maps) Near the Project Area

A. Introduction

2. This Critical Habitat Assessment has been performed as an important part of the environmental impact assessment (EIA) process for the proposed project. Although there are no legally protected areas or biological corridor (the ADB SPS 2009 notes that critical habitats include legally protected areas such as the national parks, wildlife sanctuaries, biological corridors) in and around the proposed project area, nearly 95% of the catchment area of the proposed project comprises of State forests in Assam.

B. Mapping Important Species and Biodiversity Areas corresponding to LKHEP site and Associated Facilities

Figure B.1: Map Showing Important Species and Biodiversity Areas



Note:

a) Lumding Marat Longri: Triggers CR/EN, VU
b) Dhansiri Reserve Forest: Triggers CR/EN, VU, migratory birds/congregations
c) Langting-Mupa Reserve Forest: Triggers CR/EN, VU
d) Intaki National Park: Triggers CR/EN, VU, other. Note: this National Park is located in Nagaland.

Figure B.2: Map showing Species Grid via IBAT [99]

[99] The threatened species grid layer found in IBAT for Business is derived directly from the species distribution maps produced as part of each individual (IUCN) Red List assessment. The species distribution maps, commonly referred to as "limits of distribution" or "field guide" maps, aim to provide the current known distribution of the species within its native range. The limits of distribution are determined by using known occurrences of the species, along with knowledge of habitat preferences, remaining suitable habitat, elevation limits, and other expert knowledge of the species and its range. A polygon displaying the limits of a species distribution is essentially meant to communicate that the species likely only occurs within this polygon, but it does not mean that it is distributed equally within that polygon or occurs everywhere within that polygon.

C. Findings: Mapping Species via IBAT

3. The IUCN Red List deals with species of widely varying range sizes - from restricted range species limited to a single 1 square km site to species whose ranges exceed many hundreds of thousands of square km, despite possibly being quite rare within that vast range. Therefore, one must be conscious of these factors when using the Globally Threatened Species Grid within IBAT. When one clicks on a grid cell within IBAT and reveals the species underlying that grid cell, they are revealing species whose "limits of distribution" intersect with that grid cell. This should not be confused with actual occurrence; rather, this should be interpreted as possible occurrence. Results are provided in Table C.1 and Table C.2. Note: Some Critical (CR)/Endangered (EN) species are common to both grids.

4. Species considered as Least Concern (LC) under IUCN conservation status were not included in Table C.1 and C.2 (see below); these are, however, listed and discussed in Chapter IV: Description of the Baseline Environment since some of these were reported in the study area during primary and secondary data collection.[100]

5. Based on findings (of Mapping Species via IBAT), a detailed assessment of Distribution and Habitat Requirements of CR/ EN and India Schedule I Species was done. The criterion utilised and findings are described in Section E of this Annexure II. Species reported / observed / sighted in the wider project area that are endemic were also included in the detailed assessment.

Table C.1: Possible Occurrence of Species: List for Grid 76452[101]

Taxonomic group	Species	Common name	IUCN Red List Category Schedule I[102]	Remarks
Amphibians	*Ingerana borealis*	Boreal Floating Frog	VU	
Birds	*Alcedo hercules*	Blyth's Kingfisher	NT	
Birds	*Anhinga melanogaster*	Oriental Darter	NT	
Birds	*Arborophila atrogularis*	White-cheeked Partridge	NT	
Birds	*Asarcornis scutulata*	White-winged Duck	EN	Common to both grids
Birds	*Aythya baeri*	Baer's Pochard	CR	Common to both grids
Birds	*Aythya nyroca*	Ferruginous Duck	NT	

[100] For the context of detailed assessment of distribution and habitat requirements of critical and endangered and India Schedule I species, the study area comprises of a) Submergence area; b) Area within 10 km of the periphery of the submergence area; c) Area to be acquired for locating the various project appurtenances; d) Area within 10 km of various project appurtenances; d) Catchment area intercepted at the dam site extending up to diversion structure of LKHEP project as well as the proposed length of TL corridors. The primary and secondary data collection was conducted by WAPCOS in 2015.

[101] LC = least concerned, NT = near threatened, VU = vulnerable, EN = endangered, CR = critically endangered, DD = Data Deficient

[102] Schedule I of Indian Wildlife Protection Act (1972).

Taxonomic group	Species	Common name	IUCN Red List Category Schedule I[102]	Remarks
Birds	*Buceros bicornis*	Great Hornbill	NT	
Birds	*Chaetornis striata*	Bristled Grassbird	VU	
Birds	*Circus macrourus*	Pallid Harrier	NT	
Birds	*Clanga clanga*	Greater Spotted Eagle	VU	
Birds	*Clanga hastata*	Indian Spotted Eagle	VU	
Birds	*Columba punicea*	Pale-capped Pigeon	VU	
Birds	*Emberiza aureola*	Yellow-breasted Bunting	EN	Common to both grids
Birds	*Ephippiorhynchus asiaticus*	Black-necked Stork	NT	
Birds	*Esacus recurvirostris*	Great Thick-knee	NT	
Birds	*Falco chicquera*	Red-headed Falcon	NT	
Birds	*Graminicola bengalensis*	Rufous-rumped Grassbird	NT	
Birds	*Gyps bengalensis*	White-rumped Vulture	CR	Common to both grids
Birds	*Gyps tenuirostris*	Slender-billed Vulture	CR	Common to both grids
Birds	*Haliaeetus leucoryphus*	Pallas's Fish-eagle	VU	
Birds	*Heliopais personatus*	Masked Finfoot	EN	Common to both grids
Birds	*Houbaropsis bengalensis*	Bengal Florican	CR	Common to both grids
Birds	*Icthyophaga humilis*	Lesser Fish-eagle	NT	
Birds	*Icthyophaga ichthyaetus*	Grey-headed Fish-eagle	NT	
Birds	*Leptoptilos dubius*	Greater Adjutant	EN	Not common to both grids
Birds	*Leptoptilos javanicus*	Lesser Adjutant	VU	
Birds	*Limosa limosa*	Black-tailed Godwit	NT	
Birds	*Luscinia pectardens*	Firethroat	NT	
Birds	*Mareca falcata*	Falcated Duck	NT	

Taxonomic group	Species	Common name	IUCN Red List Category Schedule I[102]	Remarks
Birds	*Mycteria leucocephala*	Painted Stork	NT	
Birds	*Numenius arquata*	Eurasian Curlew	NT	
Birds	*Paradoxornis flavirostris*	Black-breasted Parrotbill	VU	Endemic to Assam plains
Birds	*Pelecanus philippensis*	Spot-billed Pelican	NT	
Birds	*Pellorneum palustre*	Marsh Babbler	VU	Endemic to Assam plains
Birds	*Prinia burnesii*	Rufous-vented Prinia	NT	
Birds	*Psittacula alexandri*	Red-breasted Parakeet	NT	
Birds	*Psittacula eupatria*	Alexandrine Parakeet	NT	
Birds	*Psittacula finschii*	Grey-headed Parakeet	NT	
Birds	*Psittacula roseata*	Blossom-headed Parakeet	NT	
Birds	*Sarcogyps calvus*	Red-headed Vulture	CR	Common to both grids
Birds	*Sterna acuticauda*	Black-bellied Tern	EN	Common to both grids
Birds	*Sterna aurantia*	River Tern	NT	
Birds	*Treron phayrei*	Ashy-headed Green-pigeon	NT	
Birds	*Turdus feae*	Grey-sided Thrush	VU	
Birds	*Vanellus duvaucelii*	River Lapwing	NT	
Fishes	*Anguilla bengalensis*	Indian Mottled Eel	NT	
Mammals	*Aonyx cinerea*	Asian Small-clawed Otter	VU	
Mammals	*Arctictis binturong*	Binturong	VU	
Mammals	*Berylmys mackenziei*	Kenneth's White-toothed Rat	DD	
Mammals	*Bos gaurus*	Gaur or Indian Bison	VU	
Mammals	*Capricornis thar*	Himalayan Serow	NT	
Mammals	*Elephas maximus*	Asian Elephant	EN	Common to both grids

Taxonomic group	Species	Common name	IUCN Red List Category Schedule I[102]	Remarks
Mammals	*Helarctos malayanus*	Sun Bear	VU	
Mammals	*Hoolock hoolock*	Western Hoolock Gibbon	EN	
Mammals	*Lutrogale perspicillata*	Smooth-coated Otter	VU	
Mammals	*Macaca arctoides*	Stump-tailed Macaque	VU	
Mammals	*Macaca assamensis*	Assam Macaque	NT	
Mammals	*Macaca leonina*	Northern Pig-tailed Macaque	VU	
Mammals	*Manis pentadactyla*	Chinese Pangolin	CR	Common to both grids
Mammals	*Melogale personata*	Large-toothed Ferret Badger	DD	
Mammals	*Melursus ursinus*	Sloth Bear	VU	
Mammals	*Naemorhedus griseus*	Chinese Goral	VU	
Mammals	*Nycticebus bengalensis*	Bengal Slow Loris	VU	
Mammals	*Panthera pardus*	Leopard	NT	
Mammals	*Panthera tigris*	Tiger	EN	
Mammals	*Ratufa bicolor*	Black Giant Squirrel	NT	
Mammals	*Rusa unicolor*	Sambar	VU	
Mammals	*Trachypithecus pileatus*	Capped Langur	VU	
Mammals	*Ursus thibetanus*	Asiatic Black Bear	VU	
Mammals	*Viverra zibetha*	Large Indian Civet	NT	
Plants	*Aldrovanda vesiculosa*	Waterwheel	EN	Common to both grids
Plants	*Magnolia hookeri*	Angkang White Magnolia	DD	
Reptiles	*Blythia reticulata*	Blyth's Reticulate Snake	DD	
Reptiles	*Crocodylus palustris*	Mugger	VU	
Reptiles	*Gavialis gangeticus*	Gharial	CR	Common to both grids

Taxonomic group	Species	Common name	IUCN Red List Category Schedule I[102]	Remarks
Reptiles	*Python bivittatus*	Burmese Python	VU Schedule I	Common to both grids
Reptiles	*Typhlops bothriorhynchus*	Gunther's Blind Snake	DD	
Snails and Slugs	*Auriculodes gangetica*		DD	

Table C.2: Possible Occurrence of Species: List for Grid 76371[103]

Taxonomic group	Species	Common name	IUCN Red List Category Schedule I[104]	Remarks
Amphibians	*Ingerana borealis*	Boreal Floating Frog	VU	
Birds	*Aceros nipalensis*	Rufous-necked Hornbill	VU	
Birds	*Alcedo hercules*	Blyth's Kingfisher	NT	
Birds	*Anhinga melanogaster*	Oriental Darter	NT	
Birds	*Arborophila atrogularis*	White-cheeked Partridge	NT	
Birds	*Asarcornis scutulata*	White-winged Duck	EN Schedule I	Common to both grids Not sighted or reported in the project area during ground survey. Detailed assessment conducted
Birds	*Aythya baeri*	Baer's Pochard	CR	Common to both grids. Not sighted or reported in the project area during ground survey. Detailed assessment conducted
Birds	*Aythya nyroca*	Ferruginous Duck	NT	
Birds	*Buceros bicornis*	Great Hornbill	NT	
Birds	*Chaetornis striata*	Bristled Grassbird	VU	
Birds	*Circus macrourus*	Pallid Harrier	NT	

[103] LC = least concerned, NT = near threatened, VU = vulnerable, EN = endangered, CR = critically endangered, DD = Data Deficient

[104] Schedule I of the Indian Wildlife Protection Act (1972).

Taxonomic group	Species	Common name	IUCN Red List Category Schedule I[104]	Remarks
Birds	*Clanga clanga*	Greater Spotted Eagle	VU	
Birds	*Clanga hastata*	Indian Spotted Eagle	VU	
Birds	*Columba punicea*	Pale-capped Pigeon	VU	
Birds	*Emberiza aureola*	Yellow-breasted Bunting	EN	Common to both grids Not sighted or reported in the project area during ground survey. Detailed assessment conducted.
Birds	*Ephippiorhynchus asiaticus*	Black-necked Stork	NT	
Birds	*Falco chicquera*	Red-headed Falcon	NT	
Birds	*Gallinago nemoricola*	Wood Snipe	VU	
Birds	*Gyps bengalensis*	White-rumped Vulture	CR Schedule I	Common to both grids Not reported or sighted in the project area during ground survey. Detailed assessment conducted
Birds	*Gyps tenuirostris*	Slender-billed Vulture	CR Schedule I	Common to both grids Not sighted or reported in the project area during ground survey. Detailed assessment conducted
Birds	*Haliaeetus leucoryphus*	Pallas's Fish-eagle	VU	
Birds	*Heliopais personatus*	Masked Finfoot	EN	Common to both grids Not sighted or reported in the project area during ground survey. Detailed assessment conducted
Birds	*Houbaropsis bengalensis*	Bengal Florican	CR Schedule I	Common to both grids Not sighted or reported in the project area during ground survey. Detailed assessment conducted.
Birds	*Icthyophaga humilis*	Lesser Fish-eagle	NT	
Birds	*Icthyophaga ichthyaetus*	Grey-headed Fish-eagle	NT	
Birds	*Leptoptilos javanicus*	Lesser Adjutant	VU	

Taxonomic group	Species	Common name	IUCN Red List Category Schedule I[104]	Remarks
Birds	*Limosa limosa*	Black-tailed Godwit	NT	
Birds	*Luscinia pectardens*	Firethroat	NT	
Birds	*Mareca falcata*	Falcated Duck	NT	
Birds	*Mycteria leucocephala*	Painted Stork	NT	
Birds	*Numenius arquata*	Eurasian Curlew	NT	
Birds	*Paradoxornis flavirostris*	Black-breasted Parrotbill	VU	Common to both grids Endemic to Assam plains Not sighted or reported in the project area during ground survey. Detailed assessment conducted.
Birds	*Pellorneum palustre*	Marsh Babbler	VU	Common to both grids Endemic to Assam plains Not sighted or reported in the project area during ground survey. Detailed assessment conducted.
Birds	*Perdicula manipurensis*	Manipur Bush-quail	EN	Not found in the other grid. Endemic to Assam plains Not sighted or reported in the project area during ground survey. Detailed assessment conducted.
Birds	*Prinia burnesii*	Rufous-vented Prinia	NT	
Birds	*Psittacula alexandri*	Red-breasted Parakeet	NT	
Birds	*Psittacula eupatria*	Alexandrine Parakeet	NT	
Birds	*Psittacula finschii*	Grey-headed Parakeet	NT	
Birds	*Psittacula roseata*	Blossom-headed Parakeet	NT	
Birds	*Sarcogyps calvus*	Red-headed Vulture	CR	Common to both grids Not sighted or reported in the project area during ground survey. Detailed assessment conducted

Taxonomic group	Species	Common name	IUCN Red List Category Schedule I[104]	Remarks
Birds	*Sitta formosa*	Beautiful Nuthatch	VU	
Birds	*Spelaeornis longicaudatus*	Tawny-breasted Wren-babbler	VU	Not common to both grids. Endemic to the left bank of Brahamputra basin Not sighted, but reported in the project area during ground survey. Detailed assessment conducted.
Birds	*Sterna acuticauda*	Black-bellied Tern	EN	Common to both grids Not sighted or reported in the project area during ground survey. Detailed assessment conducted
Birds	*Sterna aurantia*	River Tern	NT	
Birds	*Threskiornis melanocephalus*	Black-headed Ibis	NT	
Birds	*Treron phayrei*	Ashy-headed Green-pigeon	NT	
Birds	*Turdus feae*	Grey-sided Thrush	VU	
Birds	*Vanellus duvaucelii*	River Lapwing	NT	
Fishes	*Anguilla bengalensis*	Indian Mottled Eel	NT	
Mammals	*Aonyx cinerea*	Asian Small-clawed Otter	VU Schedule I	Not sighted in the project area during ground survey
Mammals	*Arctictis binturong*	Binturong	VU Schedule I	Not sighted in the project area during ground survey
Mammals	*Berylmys mackenziei*	Kenneth's White-toothed Rat	DD	
Mammals	*Bos gaurus*	Gaur or Indian Bison	VU Schedule I	Common to both grids Sighted in the project area during ground survey; possible occurrence in open forests in the lower reaches especially flood plains of the project area. Detailed assessment conducted
Mammals	*Capricornis thar*	Himalayan Serow	NT	

Taxonomic group	Species	Common name	IUCN Red List Category Schedule I[104]	Remarks
Mammals	*Elephas maximus*	Asian Elephant	EN Schedule I	Common to both grids Not sighted in the project area during ground survey, but reported by locals in the project area. Detailed assessment conducted.
Mammals	*Harpiocephalus mordax*	Greater Hairy-winged Bat	DD	
Mammals	*Helarctos malayanus*	Sun Bear	VU Schedule I	Not sighted in the project area during ground survey
Mammals	*Hoolock hoolock*	Western Hoolock Gibbon	EN Schedule I	Common to both grids. Not sighted or reported in the project area during ground survey. Detailed assessment conducted
Mammals	*Lutrogale perspicillata*	Smooth-coated Otter	VU	
Mammals	*Macaca arctoides*	Stump-tailed Macaque	VU	
Mammals	*Macaca assamensis*	Assam Macaque	NT	
Mammals	*Macaca leonina*	Northern Pig-tailed Macaque	VU	
Mammals	*Manis pentadactyla*	Chinese Pangolin	CR Schedule 1	Common to both grids Not sighted, but reported in the project area during ground survey and during stakeholder consultations; highly restricted in the distribution; inhabiting lower hills especially teak forests. Detailed assessment conducted.
Mammals	*Melogale personata*	Large-toothed Ferret Badger	DD	
Mammals	*Melursus ursinus*	Sloth Bear	VU Schedule I	Common to both grids. Not sighted or reported in the project area during ground survey.
Mammals	*Naemorhedus griseus*	Chinese Goral	VU	
Mammals	*Nycticebus bengalensis*	Bengal Slow Loris	VU	

Taxonomic group	Species	Common name	IUCN Red List Category Schedule I[104]	Remarks
Mammals	*Panthera pardus*	Leopard	NT	
Mammals	*Prionailurus viverrinus*	Fishing Cat	EN Schedule I	Not found in the other grid. Not sighted or reported in the project area during ground survey. Detailed assessment conducted.
Mammals	*Ratufa bicolor*	Black Giant Squirrel	NT	
Mammals	*Rusa unicolor*	Sambar	VU	Common to both grids Sighted during ground survey; reported as common and widely distributed; Found in the inner and dense parts of forests in the project area. Detailed assessment conducted.
Mammals	*Trachypithecus pileatus*	Capped Langur	VU Schedule I	Common to both grids Not sighted, but reported in the project area during ground survey. Detailed assessment conducted.
Mammals	*Ursus thibetanus*	Asiatic Black Bear	VU	
Mammals	*Viverra zibetha*	Large Indian Civet	NT	
Plants	*Aldrovanda vesiculosa*	Waterwheel	EN	Common to both grids Not reported in the project area during ground survey. Detailed assessment conducted.
Reptiles	*Blythia reticulata*	Blyth's Reticulate Snake	DD	
Reptiles	*Crocodylus palustris*	Mugger	VU	
Reptiles	*Gavialis gangeticus*	Gharial	CR Schedule I	Common to both grids Not sighted or reported in the project area during ground survey. Detailed assessment conducted.
Reptiles	*Ophiophagus hannah*	King Cobra	VU	
Reptiles	*Python bivittatus*	Burmese Python	VU	Common to both grids Not sighted, but reported in the project

Taxonomic group	Species	Common name	IUCN Red List Category Schedule I[104]	Remarks
				area during ground survey. Detailed assessment done.
Reptiles	*Typhlops bothriorhynchus*	Gunther's Blind Snake	DD	
Snails and Slugs	*Auriculodes gangetica*		DD	

D. Distribution and Habitat Requirements of Endangered and India's Schedule 1 Wildlife, Birds, and Plants[105]

6. Critical habitat assessment is an important part of the environmental impact assessment (EIA) process for the proposed project, given that the submergence of land due to the LKHEP reservoir will have a resultant impact on the flora and fauna as nearly 95% of the catchment area of the proposed project are State forests. Note: the associated facility (power evacuation system) will not affect any forest areas.

7. India supports a number of threatened (protected/endangered) species of animals and plants, including those with possible occurrences / sightings in the study area. It is therefore necessary to determine if the study area itself (the project footprints and immediately adjacent areas) is critical for the survival of any threatened species.

8. This assessment is based on the latest IUCN data and maps for the key species of concern. All information in this Critical Habitat Assessment will be reviewed on a species basis by the Assam State Wildlife Division, Department of Environment and Forests for comments and accuracy. The detailed analysis and species-specific data are noted below.

9. **Criteria that the analysis responds to**: The objective of this critical habitat assessment is to: (i) determine if critical habitat is present in the study area; and, (ii) determine if there will be any measurable adverse impacts, following the definitions and requirements within ADB's Safeguard Policy Statement (SPS, 2009). Specifically, the SPS 2009 defines critical habitat as[106]:

- Critical habitat is an area that has high biodiversity value. It includes (ADB Sourcebook, 2012):
    - habitat required for the survival of critically endangered or endangered species;
    - areas having special significance for endemic or restricted-range species;
    - sites that are critical for the survival of migratory species;
    - areas supporting globally significant concentrations or numbers of individuals of congregatory species;

[105] Schedule I of the Indian Wildlife Protection Act (1972) INSERT WEBLINK
[106] Asian Development Bank Safeguard Policy Statement (SPS 2009); http://www.adb.org/documents/safeguard-policy-statement

- areas with unique assemblages of species or that are associated with key evolutionary processes or provide key ecosystem services; and
- areas having biodiversity of significant social, economic, or cultural importance to local communities.

- Furthermore, Appendix 1, Para 28 of the SPS 2009 sets out specific requirements for projects that may affect critical habitat, such that, no project activity will be implemented in areas of critical habitat unless the following requirements have been met:

- There are no measurable adverse impacts, or likelihood of such, on the critical habitat which could impair its high biodiversity value or the ability to function.
- The project is not anticipated to lead to a reduction in the population of any recognized endangered or critically endangered species or a loss in area of the habitat concerned such that the persistence of a viable and representative host ecosystem be compromised.

10. In order to identify if the project area is critical for the survival of threatened species, quantitative thresholds for critical habitat determination described in the International Finance Corporation (IFC) Performance Standard 6, Guidance Note 2012 have also been used as guidance (see below). Specifically, the IFC describes critical habitat in two tiers as follows[107]:

- **Tier one:**
  - Habitat required to sustain >10 percent of the global population of a critical (CR) or endangered (EN) species/subspecies where there are known, regular occurrences of the species and where that habitat could be considered a discrete management unit for that species.
  - Habitat with known, regular occurrences of CR or EN species where that habitat is one of 10 or fewer discrete management sites globally for that species.

- **Tier two:**
  - Habitat that supports the regular occurrence of a single individual of a CR species and/or habitat containing regionally-important concentrations of a Red listed EN species where that habitat could be considered a discrete management unit for that species/subspecies.
  - Habitat of significant importance to CR or EN species that are wide-ranging and/or whose population distribution is not well understood and where the loss of such a habitat could potentially impact the long-term survivability of the species.
  - As appropriate, habitat containing nationally/regionally important concentrations of an EN, CR or equivalent national/regional listing.

11. IFC Guidance (Performance Standard 6) regarding endemic species was also considered. An endemic species is defined as one that has greater than or equal to 95% of its global range inside the country or region of analysis. The Tier 1 and Tier 2 sub-criteria for Criterion 2 are defined as follows:

[107] http://www.ifc.org/wps/wcm/connect/bff0a28049a790d6b835faa8c6a8312a/PS6_English_2012.pdf?MOD=AJPERES

High Conservation Value Types and Performance Standard 6

HCV Type	Performance Standards
HCV 1: Areas containing globally, regionally or nationally significant concentrations of biodiversity values	Critical habitat in most cases. See paragraphs GN55–GN112 for further guidance.
HCV 1.1: Protected areas	
HCV 1.2: Rare, threatened or endangered species	
HCV 1.3: Endemic species	
HCV 1.4: Seasonal concentrations of species	
HCV 2: Globally, regionally or nationally significant large landscape-level areas where viable populations of most if not all naturally occurring species exist in natural patterns of distribution and abundance.	Natural habitat, and may be critical habitat if areas contain high biodiversity values as identified in paragraph 16 of Performance Standard 6.
HCV 3: Areas that are in or contain rare threatened or endangered ecosystems	Critical habitat
HCV 4: Areas that provide basic ecosystem services in critical situations	Priority ecosystem services as defined by paragraph 24 of Performance Standard 6. See paragraphs GN126–GN142 for further guidance.
HCV 4.1: Areas critical to water catchments	
HCV 4.2: Areas critical to erosion control	
HCV 4.3: Areas providing critical barriers to destructive fire	
HCV 5: Areas fundamental to meeting basic needs of local communities	Priority ecosystem services as defined by paragraph 24 of Performance Standard 6. Client requirements defined in Performance Standard 5 are also applicable. See paragraphs GN126–GN142 for further guidance.
HCV 6: Areas critical to local communities' traditional cultural identify (areas of cultural, ecological, economic	Priority ecosystem services as defined by paragraph 24 of Performance Standard 6. Client requirements

GN65. For Criteria 1 through 3, the project should determine a sensible boundary (ecological or political) which defines the area of habitat to be considered for the Critical Habitat Assessment. This is called the "discrete management unit," an area with a definable boundary within which the biological communities and/or management issues have more in common with each other than they do with those in adjacent areas (adapted from the definition of discreteness by the Alliance for Zero Extinction). A discrete management unit may or may not have an actual management boundary (e.g., legally protected areas, World Heritage sites, KBAs, IBAs, community reserves) but could also be defined by some other sensible ecologically definable boundary (e.g., watershed, interfluvial zone, intact forest patch within patchy modified habitat, seagrass habitat, coral reef, concentrated upwelling area, etc.). The delineation of the management unit will depend on the species (and, at times, subspecies) of concern.

- Tier 1: Habitat known to sustain ≥ 95 percent of the global population of an endemic or restricted-range species where that habitat could be considered a discrete management unit for that species (e.g., a single-site endemic).

- Tier 2: Habitat known to sustain ≥ 1 percent but < 95 percent of the global population of an endemic or restricted-range species where that habitat could be considered a discrete management unit for that species, where adequate data are available and/or based on expert judgment.

12. Relevant aspects of the IFC Guidance Note 6 - Biodiversity Conservation and Sustainable Management of Living Nature Resources (January 2012) are highlighted in the text box.

13. **Identification of the DMU:** Critical habitat assessment requires the definition of a

discrete management unit (DMU) that can guide the analysis of whether or not the project area will impinge on critical habitat for threatened or India protected species. A DMU is an area with a clearly demarcated boundary within which the biological communities and/or management issues have more in common with each other than they do with those in adjacent areas. While different species may have different habitat requirements and ranges, which would dictate different discrete management units, for assessment in the case of LKHEP project area the threatened species grid found in IBAT was utilized. Therefore, for the purpose of the critical habitat assessment for the LKHEP project, the discrete management unit (DMU) is defined as the threatened species grid cell 76371 (see map in Figure A.2 and Table A.2).

14. Detailed description of the baseline environment for the study area is presented in Chapter IV: Description of Baseline Environment.

15. **Species assessed:** For the Critical Habitat Assessment, the range and habitat requirements of each of the critical/endangered species found in the IBAT grid cell 76371 were addressed. Some of these species are common with grid 76452, i.e. possibility of occurrences is common in both grid areas. Those species which have been observed or reported in and near project are (in the DMU) are also considered in more detail on a species specific basis. These details are provided below in the Section E: Results and Discussion (see below). For each species, a conclusion regarding whether or not Tier 1 and 2 criteria (under the IFC Guidance Note 6) are triggered by the project area (i.e., whether or not the project area is habitat critical to the survival of endangered species) is provided.

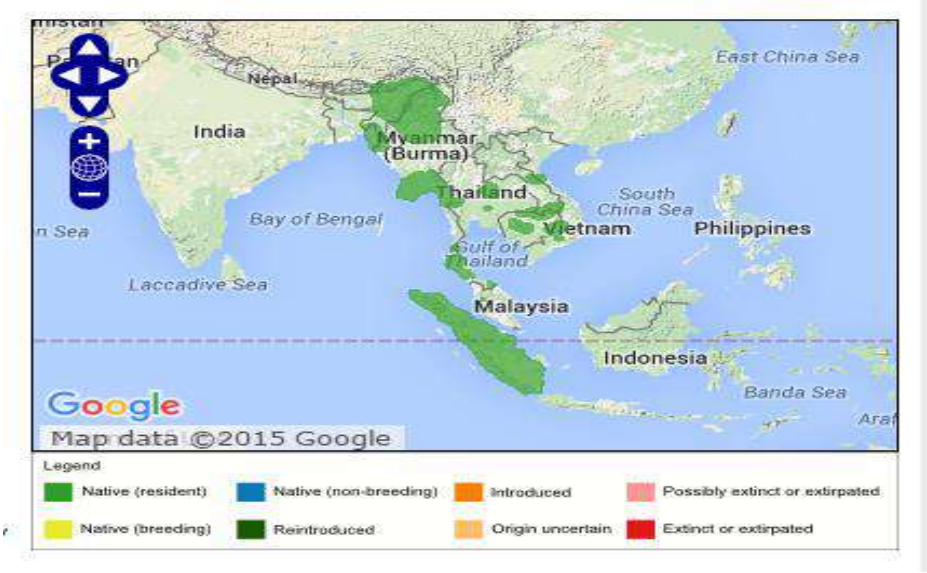
E. Results and Discussion

Taxonomic group	Species	Common name	IUCN Red List Category Schedule I[108]	Remarks	Present in the project area
Birds	*Asarcornis scutulata*	White-winged Duck	EN Schedule I	Common to both grids	No

Source: IUCN

16. **Range:** Asarcornisscutulata or White-winged Duckwas historically widely distributed from **North-East India** and Bangladesh, through South-East Asia to Java and Sumatra, Indonesia. It has undergone a dramatic decline, such that its population is now estimated at c.1000 individuals, comprising c.200 in Laos, Thailand, Vietnam and Cambodia, c.150 on Sumatra, Indonesia, **c.450 in India** (Choudhury 2000) and Bangladesh (A. Choudhury in litt. 2007) and in the "low hundreds" in Myanmar (J. C. Eames in litt. 2007) following the identification of a significant population numbering tens of individuals in the proposed Hukuang Tiger Reserve. In **India**, it has been recorded from Assam, Meghalaya, Nagaland and Manipur (no recent report), with unconfirmed reports from Tripura and Mizoram. Its current distribution is chiefly in the eastern lowlands of Assam (A. Rahmani in litt. 2012).

[108] Schedule I of the Indian Wildlife Protection Act



17. **IFC Criteria**: In India this species is listed as protected on Schedule I of the IWPA. Its distribution range has been recorded in eastern lowlands of Assam while the project area is located in central Assam. The bird is typically found in Assam's Nameri National Park (which is at a distance of 195 km from the project area). It is unlikely that the distribution range overlaps with the project area which does not support or consist of any nationally protected sites / parks / wildlife sanctuaries / eco-sensitive zones. Therefore, the project influence area has no habitat importance (as this is recorded in eastern lowland of Assam and project is located in Central Assam) for White-winged Duck. As such, the project area does not trigger Tier 1 and 2 criteria for White-winged Duck.

18. **Conclusion Regarding Project Interactions with Critical Habitat:** The project area is beyond the distribution range of the White-winged Duck as this is recorded in eastern lowland of Assam and project is located in Central Assam. As the project area has no habitat value for White-winged Duck, no interactions are expected.

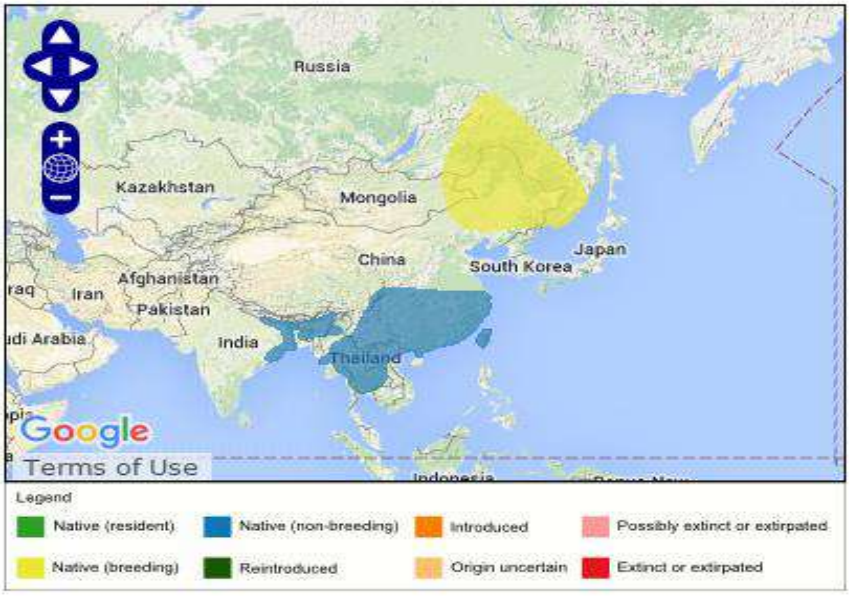
Taxonomic group	Species	Common name	IUCN Red List Category Schedule I[109]	Remarks	Reported in the project area
Birds	*Aythya baeri*	Baer's Pochard	CR	Common to both grids	No

Source: IUCN

19. **Range:** *Aythyabaeri* or Baer's Pochard breeds in the Amur and Ussuri basins in Russia . It winters mainly in eastern and southern mainland India, Bangladesh (maximum winter total of 17 individuals in the last five years, down from 1,000 - 2,000 individuals [Chowdhury et al. 2012]) and Myanmar. Smaller numbers occur in Japan, North Korea, South Korea (very few records in the latter three countries in recent years [N. Moores in litt. 2005]), Hong Kong, Taipei, Nepal (now a very rare visitor and absent in some years [H. S. Baral in litt. 2007]), Bhutan, Thailand (occurring in small numbers having suffered significant declines, e.g. around four or five individuals occur at Bung Boraphet, down from >420 birds in 1988 [P.

[109] Schedule I of the Indian Wildlife Protection Acts

Round in litt. 2007]), Lao PDR (only one confirmed record [J. Tordoff in litt. 2007]), and Vietnam (very rare in recent years [J. Tordoff in litt. 2007]) and is a rare migrant to Mongolia. A drastic decline and range contraction has occurred in the species' wintering range, with the species ceasing to winter in regular numbers at any site outside of mainland in east asia as of winter 2010/11.



20. **IFC Criteria**: The Baer's Pochard has been reported as very rare with one confirmed record in Lao DPR (2007). It is a migratory wetland species with the wintering range limited to mainland east asia while the project area is located in central Assam, India. Also this is not reported in the project area neither during surveys nor during consultations (as there are no wetlands in the project area). Therefore, the project influence area has no habitat importance for Baer's Pochard. As such, the project area does not trigger Tier 1 and 2 criteria for Baer's Pochard.

21. **Conclusion Regarding Project Interactions with Critical Habitat:** While the bird may occur in north-eastern India, they have not been recorded for this specific region. The project area is beyond the distribution range of the Baer's Pochard. As the project area has no habitat value for Baer's Pochard, no interactions are expected.

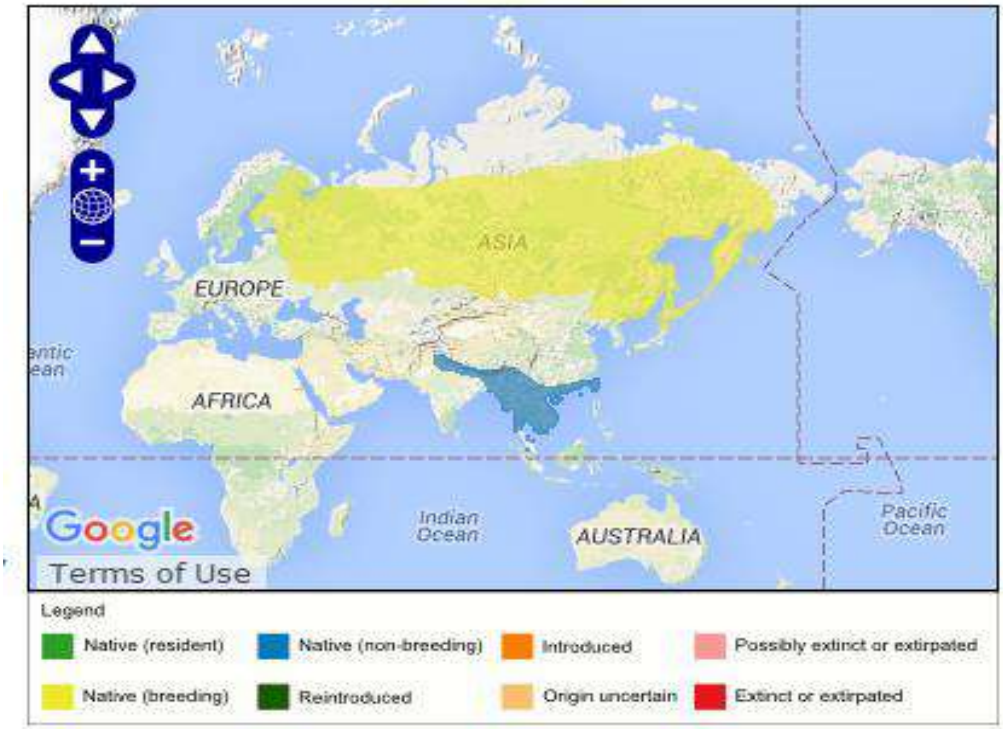
Taxonomic group	Species	Common name	IUCN Red List Category Schedule I[110]	Remarks	Reported in the project area
Birds	*Emberiza aureola*	Yellow-breasted Bunting	EN	Common to both grids.	No

Source: IUCN

[110] Schedule I of the Indian Wildlife Protection Act

22. **Range:** Emberizaaureola or Yellow-breasted Bunting breeds across the northern Palaearctic (from Finland, Belarus and Ukraine in the west, through Kazakhstan, and Mongolia, to far eastern Russia, Korea and northern Japan). In the autumn, birds stop-over in large numbers to moult in the Yangtze Valley, before continuing on to their winter quarters**. It winters in a relatively small region in** South and South-East Asia, which includes eastern Nepal, **North-eastern India**, Bangladesh, Myanmar, Cambodia, Laos, Vietnam, Thailand (Byers et al. 1995). It was formerly one of the most abundant breeding passerines across vast swathes of Siberia, but although there have been no systematic surveys, a severe decline has been noted in most breeding areas and it has completely disappeared from parts of its former breeding range since the early 1990s. **Although a range-wide survey is required, numbers at wintering sites throughout its range have also shown rapid declines over the last twenty years (S. Chan, M. Williams, J. W. Duckworth and N. Moores in litt. 2003, T. Evans, M. Gilbert, M. Williams and S. Chan in litt. 2007).** Based on evidence from wintering grounds in Cambodia the species is said to be clearly declining (T. Gray in litt. 2013). In Nepal, declines in the population and number of localities occupied have been noted since 1990 (C. Inskipp and H. S. Baral in litt. 2013). It also appears to have declined at the Hail Haorwetl and in north-eastern Bangladesh since the mid-1980s (P. Thompson in litt. 2013). It should be noted that interpretation of the species' status in its non-breeding range based on the usually fragmentary information available is hindered by the erratic appearance of very large flocks (J. W. Duckworth in litt. 2013).

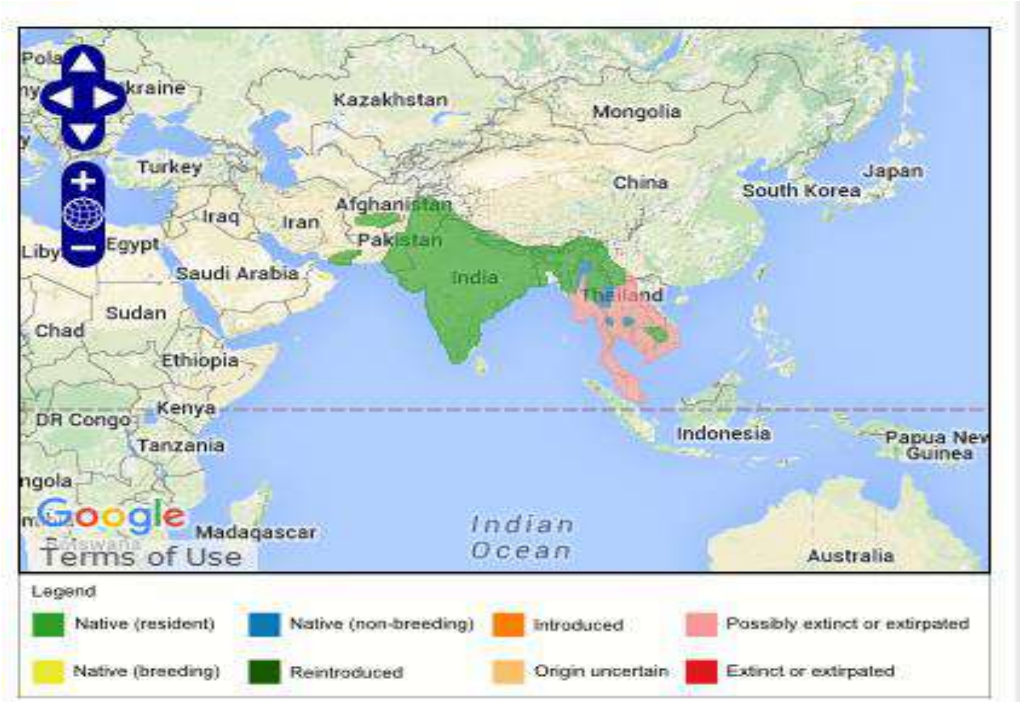
23. **IFC Criteria**: The wintering range is limited to a relatively small region including north-eastern India. They have never been recorded for this specific region. It is unlikely that the project area has any habitat importance for Yellow-breasted Bunting (which makes sporadic and unpredictable stops in mostly wetland areas in the winter). As such, the project area does not trigger Tier 1 and 2 criteria for Yellow-breasted Bunting.



24. **Conclusion Regarding Project Interactions with Critical Habitat:** The birds have not been recorded for this region. The project area is beyond the normal over-wintering distribution range of the Yellow-breasted Bunting. As the project area has no habitat value for Yellow-breasted Bunting, no interactions are expected.

Taxonomic group	Species	Common name	IUCN Red List Category Schedule I[111]	Remarks	Present in the project area
Birds	*Gyps bengalensis*	White-rumped Vulture	CR Schedule I	Common to both grids.	No

Source: IUCN



25. **Range:** Gyps bengalensis or White-rumped Vulture occurs in Pakistan, India, Bangladesh, Nepal, Bhutan, Myanmar, Thailand, Laos, Cambodia and southern Vietnam, and may be extinct in Malaysia, (BirdLife International 2001). It is included in Schedule I of the IWPA and has been recorded from south-east Afghanistan and Iran where its status is currently unknown. As recently as 1985 the species was described as "possibly the most abundant large bird of prey in the world" (Houston 1985). However, it disappeared from most of South-East Asia in the early 20th century and the only viable populations in the region are found in Myanmar and Cambodia, mainly in the north (both probably in the low hundreds of individuals) (HtinHla 2003, Anon 2003, 2005; Eames 2007 a, b; Hance 2009). Given the lack of intensive agriculture and associated chemical use in South-East Asia and the continued presence of large areas of suitable habitat for the species, the primary reason behind its decline in this part of its range is thought to be the demise of large ungulate populations and improvements in animal husbandry

[111] Schedule I of the Indian Wildlife Protection Act (1972)

resulting in a lack of available carcasses for vultures (Anon 2003, 2005). Since the mid-1990s, it has suffered a catastrophic decline (over 99%) across the Indian Subcontinent (the majority of its historic range), first noticed in Keoladeo National Park, India (Prakash et al. 2003), but mirrored in Pakistan (Gilbert et al. 2006) and Nepal (Baralet al. 2005, Chaudhary et al. 2012), to the point that the species is highly threatened with extinction. Found at upper elevation limit of 1,500 meters.

26. **IFC Criteria**: In India this species is listed as protected on Schedule I of the IWPA; its distribution range has shown catastrophic decline across the Indian Subcontinent. It has not been recorded in the project area, which does not support any nationally protected sites/parks/wildlife sanctuaries/eco-sensitive zones, nor open plains which the vulture prefers. Therefore, it is assumed that the project area has no habitat importance for White-rumped Vulture. As such, the project area does not trigger Tier 1 and 2 criteria for White-rumped Vulture.

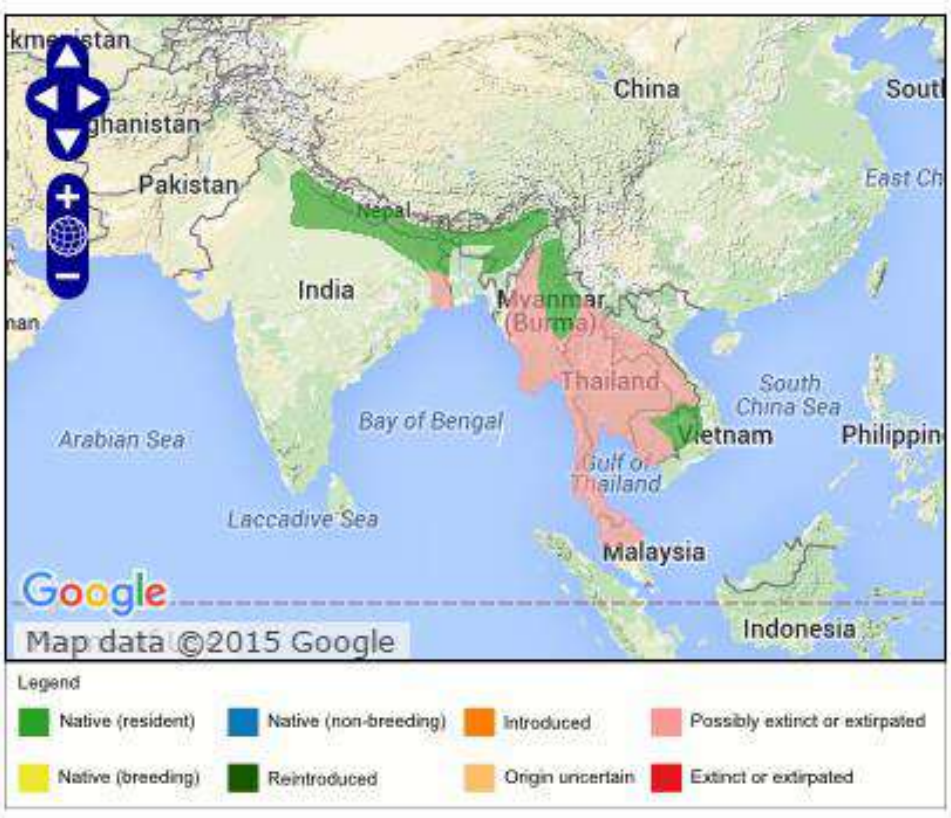
27. **Conclusion Regarding Project Interactions with Critical Habitat:** Within the wide range of the White-rumped Vulture, the project area lacks parks, protected areas, and plains that would support the vulture. It is therefore assumed that the project area has no habitat value for White-rumped Vulture, and no interactions are expected.

Taxonomic group	Species	Common name	IUCN Red List Category Schedule I[112]	Remarks	Present in the project area
Birds	*Gyps tenuirostris*	Slender-billed Vulture	CR Schedule I	Common to both grids.	No

Source: IUCN

28. **Range:** Gyps tenuirostris or Slender-billed Vultureis found in India north of, and including, the Gangetic plain, west to at least Himachal Pradesh and Haryana, south to southern West Bengal (and possibly northern Orissa), east through the plains of Assam, and through southern Nepal, and north and central Bangladesh (BirdLife International 2001). In India and Nepal, the species was common until very recently, but since the mid-1990s it has suffered a catastrophic decline of up to 96.8%, with a combined average decline in India of this species and G. indicus of over 16% annually between 2000 and 2007 (Prakash et al. 2007). Found at upper elevation limit of 2,000 meters.

[112] Schedule I of the Indian Wildlife Protection Act (1972)



29. **IFC Criteria**: In India this species is listed as protected on Schedule I of the IWPA; its distribution range has shown catastrophic decline across the Indian Subcontinent. It is unlikely that the distribution range overlaps with the project area which does not support any nationally protected sites / parks / wildlife sanctuaries / eco-sensitive zones, nor the plains that this bird prefers. Therefore, the project area is not expected to have habitat importance for Slender-billed Vulture. As such, the project area does not trigger Tier 1 and 2 criteria for Slender-billed Vulture.

30. **Conclusion Regarding Project Interactions with Critical Habitat:** The project area is not a preferred habitat for the Slender-billed Vulture, and none have been observed there. As the project area has no habitat value for Slender-billed Vulture, no interactions are expected.

Taxonomic group	Species	Common name	IUCN Red List Category Schedule I[113]	Remarks	Present in the project area
Birds	*Heliopais personatus*	Masked Finfoot	EN	Common to both grids	No

Source: IUCN

[113] Schedule I of the Indian Wildlife Protection Act

31. **Range:** Heliopaispersonatus or Masked Finfoot is patchily distributed from **north-eastern India** and Bangladesh through Myanmar, Thailand, Cambodia, Laos and Vietnam to Peninsular Malaysia, Sumatra and Java (one record) Indonesia (BirdLife International 2001). Populations are apparently in steep decline throughout its range such that its population is now thought to number in the low thousands at most and possibly fewer than 1,000 mature individuals (J. C. Eames in litt. 2007). It is found at an upper elevation up to1,220 meters.

32. **IFC Criteria**: Masked Finfoot is patchily distributed across South Asia including in north-eastern India. However, there have been no records of this bird in the region and it is highly unlikely that the project area provides critical habitat to the Masked Finfoot, since it is too low an altitude for the bird. Tier 1 criteria are not triggered, as there is no possibility of 100 mature Masked Finfoot (10% of the global population) living in the project area. Tier 2 criteria are not triggered, since the project area does not support any nationally protected sites/parks/wildlife sanctuaries/eco-sensitive zones at the appropriate altitude, or regionally important concentrations of Masked Finfoot.

33. **Conclusion Regarding Project Interactions with Critical Habitat:** The birds have not been recorded for this specific region (too low an altitude). As the project area has no habitat value for Masked Finfoot, no interactions are expected.

Taxonomic group	Species	Common name	IUCN Red List Category Schedule I[114]	Remarks	Present in the project area
Birds	*Houbaropsis bengalensis*	Bengal Florican	CR Schedule I	Common to both grids	No

Source: IUCN

[114] Schedule I of the Indian Wildlife Protection Act (1972)

34. **Range:** *Houbaropsisbengalensis* or Bengal Floricanas two disjunct populations, one in the **Indian Subcontinent**, and the other in South-East Asia (BirdLife International 2001). The former occurs from Uttar Pradesh, **India**, through the terai of Nepal, to **Assam** and northeastern part of India, and historically to **Bangladesh.** It has declined dramatically and only survives in small, highly fragmented populations. Declines have apparently continued in Nepal, even inside the protected Royal Chitwan National Park (Baral *et al*. 2003), but they may have stabilised in India (Rahmani 2001). **Surveys and interviews with staff at four protected areas in the North Bank area of Assam suggest that the species has been largely absent from three of them since 2000 (Brahma and Lahkar 2009)**. It inhabits lowland dry, or seasonally inundated, natural and semi-natural grasslands, often interspersed with scattered scrub or patchy open forest.

35. **IFC Criteria**: In India this species is listed as protected on Schedule I of the IWPA; it is a grassland species and its distribution range has been recorded in protected areas such as the Manas National Park of Assam (located at a distance of 365 km from the project area) and largely absent since 2000. It is extremely unlikely that the distribution range overlaps with the project area which does not support any nationally protected sites/parks/wildlife sanctuaries/eco-sensitive zones with suitable lowland grasslands. Therefore, the project area has no habitat importance for the Bengal Florican. As such, the project area does not trigger Tier 1 and 2 criteria for the Bengal Florican.

36. **Conclusion Regarding Project Interactions with Critical Habitat:** The project area does not provide the appropriate habitat for the Bengal Florican. As the project area has no habitat value for Bengal Florican, no interactions are expected.

Taxonomic group	Species	Common name	IUCN Red List Category	Remarks	Present in the project area

			Schedule I[115]		
Birds	*Paradoxornis flavirostris*	Black-breasted Parrotbill	VU	Common to both grids Endemic	No

Source: IUCN

37. **Range:** *Paradoxornisflavirostris* or Black-breasted Parrotbillis endemic to the Indian subcontinent, where it is known from the plains and foothills of the Brahmaputra valley in Assam, **north-east India** (BirdLife International 2001). Historically, it was also recorded in Bangladesh and possibly eastern Nepal. Formerly described as locally common, there are recent records from just four sites, one in northeastern India and three in Assam, at one of which it appears to be common. It may be found at the upper limit of 2,500 meters. The population is estimated to be around 1,500 – 7,000 mature individuals.

38. **IFC Criteria**: The bird is not IUCN critical or endangered, so it does not trigger Tier 1 criteria. Also, because this bird is only IUCN "vulnerable" and not Schedule I of IWPA, the project area does not trigger Tier 2 criteria since there are no recorded or reported nationally or regionally important concentrations of Black-breasted Parrotbill in the project area. With regard to endemic-specific criteria, given that there are 3 sites across Assam and no reports of the bird from the project area, it is unlikely the project area will support ≥ 95% (6,650) birds, and the project area cannot be considered a DMU; furthermore, there are recent records from four protected areas: Kaziranga, Manas (Choudhury 2007) and Dibru-Saikhowa National Parks and D'Ering Wildlife Sanctuary, all situated at a considerable distance from the project area. Neither Tier 1 nor Tier 2 sub-criteria for Criterion 2 (endemic species) are triggered by the project area (it is not critical habitat for the endemic Black-breasted Parrotbill).

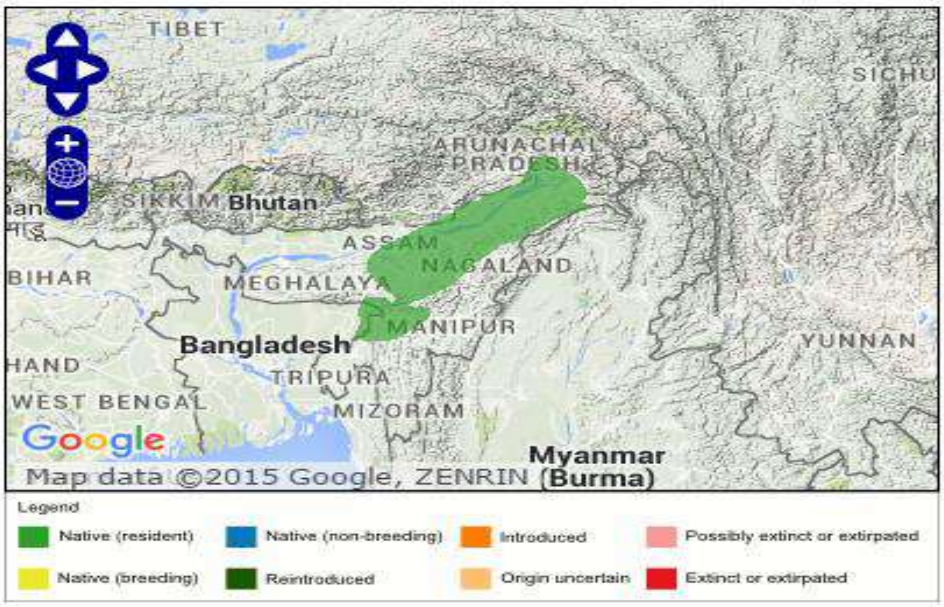
39. **Conclusion Regarding Project Interactions with Critical Habitat:** The project area does not provide the appropriate plains and foothills habitat required for the Black-breasted Parrotbill. As the project area has no habitat value for Black-breasted Parrotbill, no interactions are expected.

Taxonomic group	**Species**	**Common name**	**IUCN Red List Category Schedule I[116]**	**Remarks**	**Present in the project area**
Birds	*Pellorneum palustre*	Marsh Babbler	VU	Common to both grids Endemic	No

Source: IUCN

[115] Schedule I of the Indian Wildlife Protection Act
[116] Schedule I of the Indian Wildlife Protection Act

40. **Range:** Pellorneumpalustre or Marsh Babbler is endemic to the Brahmaputra floodplain, its associated tributaries and adjacent hill ranges in Assam, and Meghalaya, **India** and eastern **Bangladesh** (BirdLife International 2001). It is poorly known, but was formerly described as locally common. There are recent records from just five sites such as from Dibru-Saikhowa, Manas and Kaziranga National Parks, in Assam, and also West Bhanugach Reserve Forest in Bangladesh, although this is not a strictly protected area. The population size is preliminarily estimated to fall into the band 10,000-19,999 mature individuals. This equates to 15,000-29,999 individuals in total, rounded here to 15,000-30,000 individuals. It is found at upper elevation limit of up to 800 meters.



41. **IFC Criteria**: The bird is not IUCN critical or endangered, so it does not trigger Tier 1 criteria. Also, because this bird is only IUCN "vulnerable" and not Schedule I of IWPA, the project area does not trigger Tier 2 criteria since there are no recorded or reported nationally or regionally important concentrations of Marsh Babbler in the project area. With regard to endemic-specific criteria, given that there are 3 sites across Assam and no reports of the bird from the project area, it is unlikely the project area will support ≥ 95% (19,000) birds, and the project area cannot be considered a discrete management unit (DMU); furthermore, there are recent records from four protected areas: Dibru-Saikhowa, Manas and Kaziranga National Parks, in Assam, all situated at a considerable distance from the project area. Neither Tier 1 nor Tier 2 sub-criteria for Criterion 2 (endemic species) are triggered by the project area (it is not critical habitat for the endemic Marsh Babbler).

42. **Conclusion Regarding Project Interactions with Critical Habitat:** The project area does not have the required floodplain habitat for the Marsh Babbler. As the project area has no habitat value for Marsh Babbler, no interactions are expected.

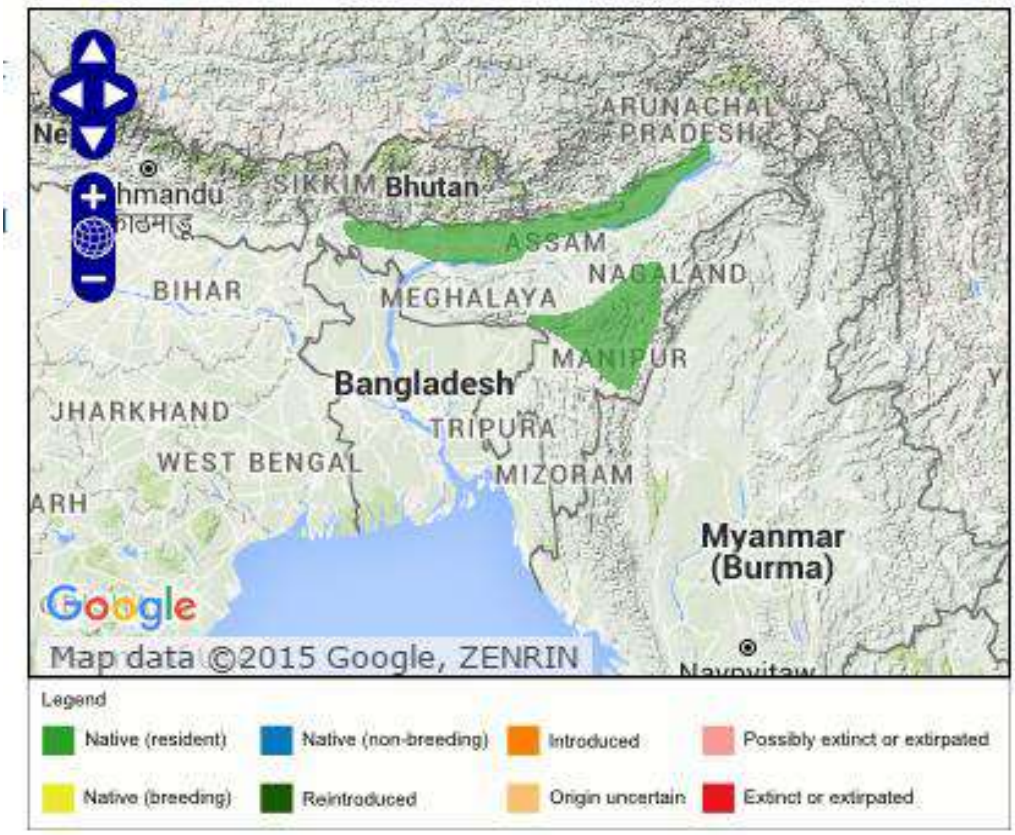
Taxonomic group	Species	Common name	IUCN Red List Category Schedule I[117]	Remarks	Present in the project area

[117] Schedule I of the Indian Wildlife Protection Act

Birds	*Perdicula manipurensis*	Manipur Bush-quail	EN	Not found in the other grid. Endemic	No

Source: IUCN

43. **Range:** *Perdiculamanipurensis* or Manipur Bush-quail is known historically from northern West Bengal, **Assam** and Manipur in north-eastern India, with unconfirmed historical records from Nagaland and Meghalaya in **India** and Chittagong, Chittagong Hill Tracts and Sylhet districts, Bangladesh. **The nominate race occurs in Manipur and neighbouring Assam south of the Brahmaputra, while race*inglisi* occurs from West Bengal to Assam north of the Brahmaputra** (BirdLife International 2001). It was described historically as local, but not very rare, although even by the 1930s it was documented as declining in Manipur. There was a gap in records after 1932 punctuated by just one unconfirmed report, from Dibru-Saikhowa National Park / Wildlife Sanctuary, Assam, in March 1998, until it was rediscovered in Manas National Park, Assam, where one bird was seen in 2006 (Anon. 2006). Given the lack of recent records, and the lack of remaining suitable grassland habitat, any remaining populations must be very small and fragmented. The population is now pre-cautionarily estimated to lie within the band 1,500-3,700 mature individuals.



44. **IFC Criteria**: The Manipur Bush-quail has been reported in Dibru-Saikhowa National Park / Wildlife Sanctuary (Assam) in March 1998 (unconfirmed report) and rediscovered in Manas National Park (Assam) in 2006, both of which are 511 and 365 km away from the project area, respectively. More recently it was again spotted in Manas National Park in 2015. Owning to very small and fragmented population, its distribution range is unlikely to be in the project area, which does not have the suitable grassland habitat, in any case. Therefore, the project

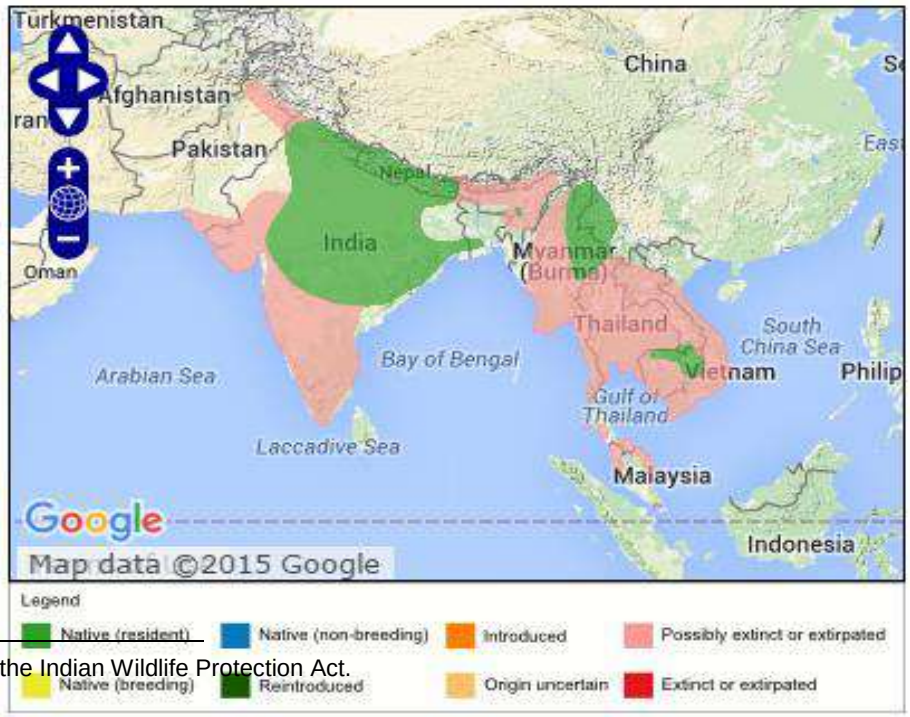
area has no habitat importance for Manipur Bush-quail. As such, the project area does not trigger Tier 1 and 2 criteria for Manipur Bush-quail. With regard to endemic-specific criteria, given that there are 2 sites across Assam and no reports of the bird from the project area, it is unlikely the project area will support ≥ 95% (3,515) birds, and the project area cannot be considered a DMU; furthermore, there are recent records from at least one protected area: Manas National Park, in Assam, situated at a distance of 365 km from the project area. Neither Tier 1 nor Tier 2 sub-criteria for Criterion 2 (endemic species) are triggered by the project area (it is not critical habitat for the endemic Manipur Bush-quail).

45. **Conclusion Regarding Project Interactions with Critical Habitat:** The project area does not have the suitable grassland habitat required by the Manipur Bush-quail. As the project area has no habitat value for Manipur Bush-quail, no interactions are expected.

Taxonomic group	Species	Common name	IUCN Red List Category Schedule I[118]	Remarks	Present in the project area
Birds	*Sarcogyps calvus*	Red-headed Vulture	CR	Common to both grids	No

Source: IUCN

46. **Range:** Sarcogypscalvus or Red headed vulture occurs in Pakistan (previously regular, now a rare straggler with two in Tharparker in 2002 the first record since 1980 [Nadeem et al. 2007]), Nepal (uncommon, population estimated to be 200-400 individuals [Inskipp et al. in press. 2013]), **India** (sparsely distributed and declining, now rare or absent from some areas, e.g. parts of Gujarat and the north-eastern States, but still fairly common in the west Himalayan foothills). Recent information indicates that in India the species started undergoing a rapid decline (41% per year) in about 1999, and declined by 91% between the early 1990s and 2003 (Cuthbert *et al.* 2006). It is typically found in the upper elevation limits up to 2,500 meters.



[118] Schedule I of the Indian Wildlife Protection Act.

47. **IFC Criteria**: The range of Red-headed Vulture is sparsely distributed in India and in particularly it is rare or absent e.g. parts of Gujarat and north-eastern States. They have never been recorded for this region. It is unlikely that the project area has any habitat importance for Red-headed Vulture, as it lacks the dry grasslands habitat that the vulture prefers. As such, the project area does not trigger Tier 1 and 2 criteria for Red-headed Vulture.

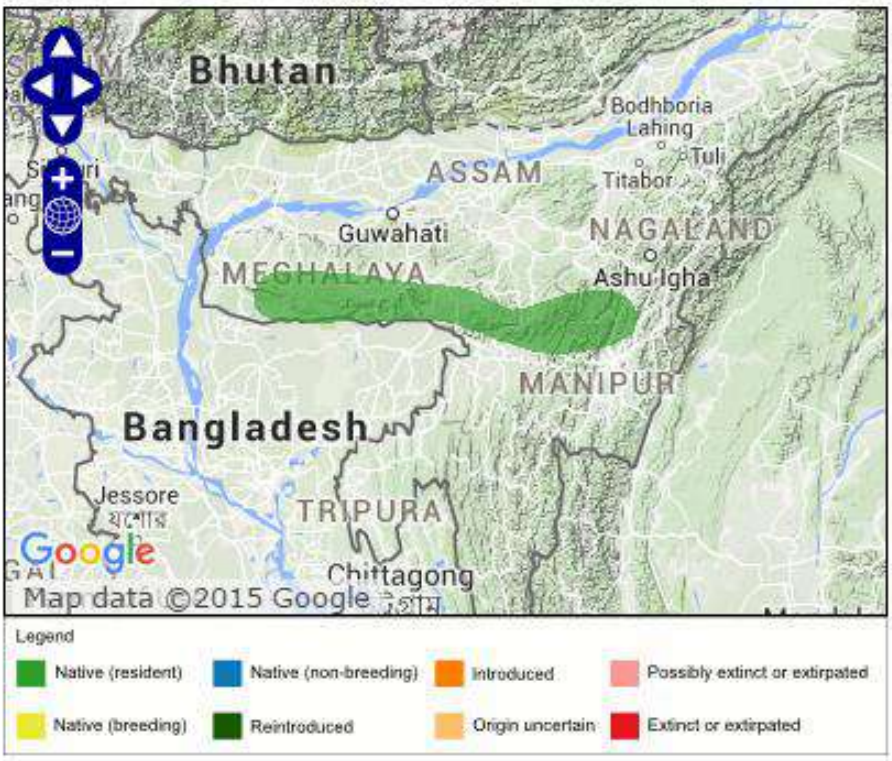
48. **Conclusion Regarding Project Interactions with Critical Habitat:** The birds have not been recorded for this region. The project area lacks suitable habitat for this vulture. As the project area has no habitat value for Red-headed Vulture, no interactions are expected.

Taxonomic group	Species	Common name	IUCN Red List Category Schedule I[119]	Remarks	Present in the project area
Birds	*Spelaeornis longicaudatus*	Tawny-breasted Wren-babbler	VU	Not common to both grids. Endemic to the left bank of Brahamputra basin	Not sighted, but reported in the project area (anecdotal information), possibly migrating to higher elevations.

Source: IUCN

49. **Range:** *Spelaeornis longicaudatus* or Tawny-breasted Wren-babbler is **endemic to hills south of the Brahmaputra river, north-eastern India**, including the Khasi Hills of Meghalaya, **North Cachar Hills of Assam**, and Naga Hills of Nagaland (BirdLife International 2001). Formerly, it was quite common and widespread within this limited range (particularly in the Khasi Hills), but there are very few recent records. However, this partly reflects a paucity of ornithological fieldwork because of security problems. It is found in the upper elevation up to 2000 meters. It is probably sedentary in dense undergrowth of moist broadleaved evergreen (particularly oak *Quercus* and *Rhododendron* forests) or pine *Pinus* forests, favouring ravines and steep, rocky, boulder-strewn hillsides covered with moss, ferns and orchids, between 1,000-2,000 meters. It is insectivorous, mainly terrestrial, occurring solitarily or in pairs, and is silent and unobtrusive. Breeding takes place during April-June. The population is estimated to be around 2500-9999 mature individuals.

[119] Schedule I of the Indian Wildlife Protection Act



50. **IFC Criteria**: The bird is not IUCN critical or endangered, so it does not trigger Tier 1 criteria. Also, because this bird is only IUCN "vulnerable" and not Schedule I of IWPA, the project area does not trigger Tier 2 criteria since there are no recorded nationally or regionally important concentrations of Tawny-breasted Wren Babbler in the project area. With regard to endemic-specific criteria, there are 2 sites (Khasi Hills and North Cachar Hills) in Assam and reports of the bird from the project area, although no direct sighting. It is not plausible that the Tawny-breasted Wren-babbler is present in the project area (except passing through), since the elevations are too low. It is extremely unlikely that the project area will support ≥ 95% (9,499) birds, and as such the project area cannot be considered a discrete management unit (DMU). Furthermore, identified protected areas such as Barail, Pulie Badge and Intanki protected areas are more likely to support populations. Neither Tier 1 nor Tier 2 sub-criteria for Criterion 2 (endemic species) are triggered by the project area (it is not critical habitat for the endemic Tawny-breasted Wren-babbler) but to the Brahamaputra basin.

51. **Conclusion Regarding Project Interactions with Critical Habitat:** It is not plausible that Tawny-breasted Wren-babbler are present in the project area, since this prefers much higher elevations (1,000 to 2,000 masl); the project area is about 200-300 masl. As such, no special mitigation measures or habitat offsets are required for this bird.

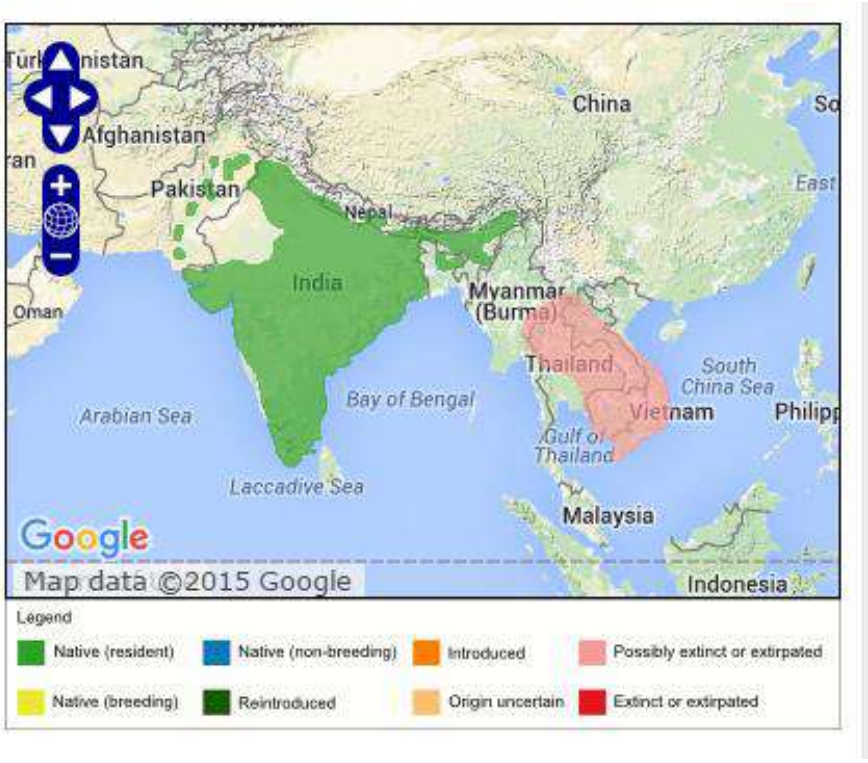
Taxonomic group	Species	Common name	IUCN Red List Category Schedule I[120]	Remarks	Present in the project area
Birds	*Sterna*	Black-	EN	Common to both	No

[120] Schedule I of the Indian Wildlife Protection Act

	acuticauda	bellied Tern		grids	

Source: IUCN

52. **Range:** *Sterna acuticauda* or Black-bellied Ternis known from south Yunnan (now very rare), **Pakistan** (fairly common in north Sind and Punjab), **India** (widespread and locally fairly common, but some evidence for localized declines), **Nepal** (once locally fairly common, declining since the early 1990s at least, and judged to be a rare and very local visitor in the lowlands, with a maximum population of 20 estimated in 2011 [C. Inskipp and H. S. Baral *in litt*. 2011]), **Bangladesh (**previously common, now a local breeder; the provenance of some recent records has been questioned [P. Thompson *in litt*. 2011]),**Myanmar** (previously abundant, now declining rapidly and a scarce to uncommon resident, with some surveys since 2002 failing to record the species at all [J. C. Eames *in litt*. 2012]), **Thailand** (formerly resident in the north-west, now very rare and probably extinct as breeding species), **Laos** (previously bred in large numbers along the Mekong channel, now very rarely recorded), **Cambodia** (in early 1960s the species was apparently fairly common along the Mekong; the last breeding record was of just two pairs in 2003 [C. Poole *in litt.* 2003], and it is now considered probably extinct there [Goes*et al*. 2010]) and **Vietnam** (formerly occurred regularly in Cochin, east asia , and occasionally in Annam, but now probably extinct). There has been a precipitous decline in South-East Asia and it is now almost extinct in the region. Despite its large range, the species may now number fewer, perhaps significantly fewer, than 10,000 mature individuals (Perennial *et al*. 1994, S. Manhood *in litt*. 2012). The population is estimated at 6,700-17,000 mature individuals.



53. **IFC Criteria**: In India the Black-bellied Tern is known from a number of protected areas throughout its range, including Harike Wildlife Sanctuary (Punjab), Keoladeo National Park (Rajasthan), Rajiv Gandhi National Park (formerly known as Nagarhole, Karnataka), Dibru-Saikhowa National Park (Assam) and Kaziranga National Park (Assam).It has not been reported

from the project area, and it is unlikely that the distribution range overlaps with the project area which does not support any nationally protected sites / parks / wildlife sanctuaries / eco-sensitive zones with the required low-elevation river habitat. Therefore, it is not expected that the project area has habitat importance for Black-bellied Tern. As such, the project area does not trigger Tier 1 and 2 criteria for Black-bellied Tern.

54. **Conclusion Regarding Project Interactions with Critical Habitat:** The birds have not been recorded for this region, given the lack of suitable habitat. As the project area has no habitat value for Black-bellied Tern, no interactions are expected.

Taxonomic group	Species	Common name	IUCN Red List Category Schedule I[121]	Remarks	Present in the project area
Mammals	*Bos gaurus*	Gaur or Indian Bison	VU Schedule I	Common to both grids	Yes. Anecdotal reports in the project area; apparently present in open forests in the lower reaches, especially flood plains, which are more common north of the project area.

Source: IUCN

55. **Range**: Gaur historically occurred throughout mainland south and Southeast Asia and Sri Lanka. It currently occurs in scattered areas in the following range states: Bhutan, Cambodia, east asia, **India**, Lao PDR, Malaysia (Peninsular Malaysia only), Myanmar, Nepal, Thailand, and Viet Nam, but is extinct in Sri Lanka and also, as a resident, apparently in Bangladesh (Grubb 2005; MdAnwarul Islam in litt. 2008; Hedges in prep.). **The species is now seriously fragmented within its range, and the mapped distribution is generalized, especially in India, Myanmar, east asia and Malaysia**. The domesticated form of Gaur, considered by IUCN a separate species (*Bos frontalis*; Mythun, Mithan or Gayal), occurs in parts of India, east asia, and Myanmar as feral, semi-feral, and domestic animals. This animal is excluded from the red-listing considerations for Gaur. The global population is estimated to lie within 13,000–30,000 animals. Field data suggest that the proportion of mature individuals in the population is likely to be 0.4–0.6, indicating a total of 5,200–18,000 mature individuals, with no population known to have over 1,000 individuals (S. Hedges pers. comm. 2000). The Gaur occurs from sea level up to at least 2,800 m asl (Wood 1937; Wharton 1968; Choudhury 2002). Despite the many reports that call it an animal of hill-country, low-lying areas seem to comprise optimal habitat (Choudhury 2002): in Conry's (1989) study area, elevations ranged from 46 to 1,079 m asl but the three radio-tracked Gaur only used areas below 381 m. Elevations below 61 m were used most intensively and all three animals selected these low lying areas; elevations above 61 m were selected against or used in proportion to availability (Conry 1989). Similarly, in the Tenasserim–Dawna mountains, Thailand, signs of Gaur were more abundant in the lowlands than in the hills, noting that this was the opposite of the patterns that would be predicted if hunting (itself concentrated heavily in the lowlands) was the chief determinant of population densities, although solitary animals were found mainly in the hills (Steinmetz et al. 2008). Gaur habitat to be "characterized by (1) large, relatively undisturbed forest tracts, (2) hilly terrain

[121] Schedule I of the Indian Wildlife Protection Act (1972)

below an altitude of 5,000 to 6,000 ft (1,500–1,800 m asl), (3) availability of water, and (4) an abundance of forage in the form of coarse grasses (including bamboo), shrubs, and trees".

56. **IFC Criteria**: The Gaur is not IUCN critical or endangered, so it does not trigger Tier 1 criteria. In India this species is listed as protected on Schedule I of the IWPA, and two nationally protected areas, the Nameri National Park and Manas National Park in Assam support these species (located at a distance of 195 km and 365 km from the project area, respectively). Its distribution is fragmented within its range, and the mapped distribution is generalized, especially in India (and also in countries Myanmar, east asia, and Malaysia). There have been anecdotal reports of the animal from the project area, although no direct sightings have been made. It is plausible that the Gaur is present in the project area but it is unlikely that the project area will support more than 10% of the global population (this would be 520 to 1,800 animals) in the project area. Also, there are gaur habitat locations throughout south and south-east Asia, and even within Assam, on the north bank of the Brahmaputra. The project area is not considered a gaur management site. Also, Tier 2 criteria are not triggered, since the project area does not support nationally or regionally important concentrations of gaur.

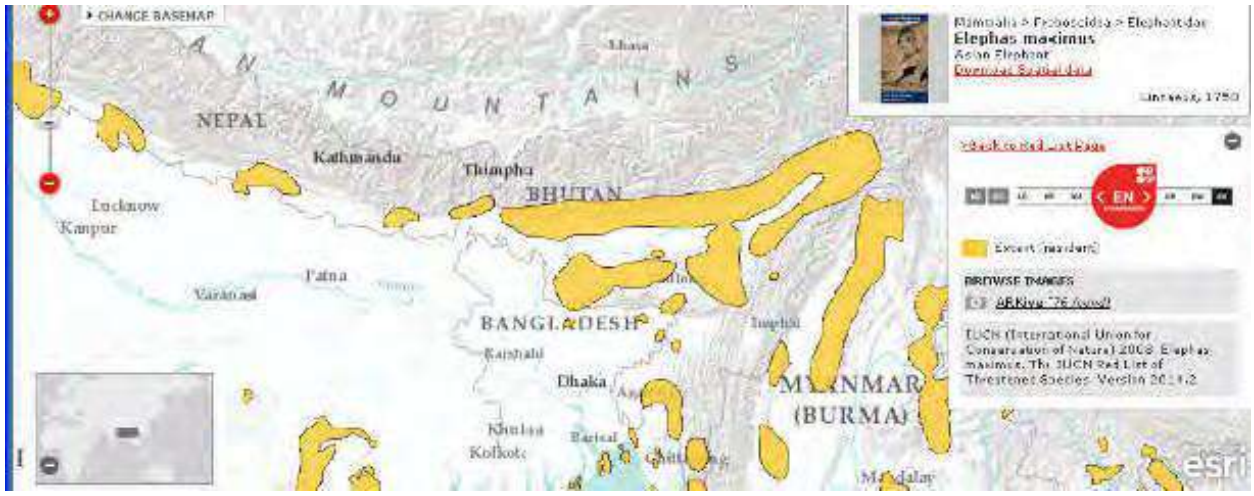
57. **Conclusion Regarding Project Interactions with Critical Habitat:**. Most of the gaur population is in the India protected areas such as Nameri and Manas National Parks. It is therefore concluded that the proposed project clearing areas and work sites are not critically important to gaur. However, it is plausible that gaur may be present in the project area (though the project area is not in the prime habitat and range of the gaur). As such, no special mitigation measures or habitat offsets are required for this animal. However, conservation actions will be part of the EMP (during construction and during the initial project operation) such as conducting a comprehensive survey and monitoring in and around the project area to establish its range, distribution and population status in the project area whilst assessing its habitat requirements and identifying threats.

Taxonomic group	Species	Common name	IUCN Red List Category Schedule I[122]	Remarks	Present in the project area
Mammals	*Elephas maximus*	Asian Elephant	EN Schedule I	Common to both grids.	Yes. Not sighted during ground survey, but reported by locals in the project area (north and south of proposed worksites).

Source: IUCN

58. **Range:** Asian elephants still occur in isolated populations in 13 states, with a very approximate total range area of 486,800 km² (Sukumar 2003; but see Blake and Hedges 2004). The species occurs in Bangladesh, Bhutan, **India**, Nepal, and Sri Lanka in South Asia and Cambodia,,east asia, Indonesia (Kalimantan and Sumatra) Lao PDR, Malaysia (Peninsular Malaysia and Sabah), Myanmar, Thailand, and Viet Nam in South-east Asia.

59. Once widespread in India, the species is now restricted to four general areas: **north-eastern India, central India, north-western India, and southern India. In north-eastern India, the elephant range extends from the eastern border of Nepal in northern West Bengal through western Assam along the Himalaya foothills as far as the Mishmi Hills. From here it extends into eastern India, the plains of upper Assam, and the foothills of Nagaland**. **Further west, it extends to the Garo Hills of Meghalaya through the Khasi Hills, to parts of the lower Brahmaputra plains and Karbi Plateau.** Elsewhere in the south in Tripura, Mizoram, Manipur, and the Baraak valley districts of Assam, isolated herds occur (Choudhury, 1999). A recent estimate for the global population size of the Asian elephant was 41,410–52,345 animals Sukumar (2003) while for India the population size is estimated to be around 26,390 – 30,770.



60. **IFC Criteria**: In Assam the Asian elephant is known from a number of protected areas including Kaziranga National Park, Manas National Park, and Orang National Park and some elephant reserves such as Chirang-Ripu, Sontipur, Dehing-Patkai, Kaziranga-KarbiAnglong,

[122] Schedule I of the Indian Wildlife Protection Act

Dhansiri-Lungding. There are confirmed sightings and reports of the animal from the project area by the local population including at various river crossings (upstream of LKHEP – outside reservoir area and downstream (4-5 km downstream of TRT), although there were no sightings and signs during the ground survey. It is plausible that the distribution range overlaps with the project area which does not support any nationally protected sites/parks/wildlife sanctuaries/eco-sensitive zones, but it is unlikely that the project area supports more than 10 % of the global population (which would be 4,141 – 5,234 animals). Also, there are many elephant habitat locations throughout India (total population size in India is estimated to be 26,390 – 30,770. The project area is not considered a discrete management unit for the elephant. Hence, it does not trigger Tier 1 criteria. Also, Tier 2 criteria are not triggered, since the project area does not support nationally or regionally important concentrations of elephant.

61. **Conclusion Regarding Project Interactions with Critical Habitat:** Most of the elephant population in Assam is found in protected areas and dedicated elephant reserves. However, it is plausible that the elephant may be present in the project area or utilizing part of the area as an elephant corridor (though there are no demarcated /identified corridors and project area is not in the prime habitat and range of the elephant). However, conservation actions as proposed by the IUCN will be part of the EMP (during construction, and during the initial project operation) such as conducting a comprehensive survey and monitoring in and around the project area to establish its range, distribution and population status in the project area while assessing its habitat requirements, identifying threats, and maintaining habitat connectivity by securing corridors.[123] In particular, the large forest patch south of the project worksites will be subject to a camera trap survey, and it is proposed to construct several river fords for elephant movements, should they occur in the area, and in case the reservoir flooding obstructs cross-river elephant movements.

Taxonomic group	Species	Common name	IUCN Red List Category Schedule I[124]	Remarks	Present in the project area
Mammals	*Hoolock hoolock*	Western Hoolock Gibbon	EN Schedule I	Common to both grids	No

Source: IUCN

62. **Range:** This species is found in eastern Bangladesh, **north-eastern India** (**Assam**, Manipur, Meghalaya, Mizoram, Nagaland, and Tripura), and north-western Myanmar (west of the Chindwin River). **The distribution in India is restricted to points south of the Brahmaputra and east of the Dibang (DingbaQu) Rivers (Choudhury 2001).** Animals that once were common in the plains of northeastern India (north-easternmost India) before that habitat was cultivated for agriculture and tea are not so anymore (Islam and Feeroz 1992). The

[123] Conservation actions proposed by the IUCN: Conservation actions: This species is listed on CITES Appendix I. The most important conservation priorities for the Asian elephant are: 1) conservation of the elephant's habitat and maintaining habitat connectivity by securing corridors; 2) the management of human–elephant conflicts as part of an integrated land-use policy that recognizes elephants as economic assets from which local people need to benefit or at least no suffer; 3) better protection to the species through improved legislation and law enforcement, improved and enhanced field patrolling, and regulating/curbing trade in ivory and other elephant products. Monitoring of conservation interventions is also needed to assess the success or failure of the interventions so that adjustments can be made as necessary (i.e. adaptive management). Reliable estimation of population size and trends will be needed as part of this monitoring and adaptive management approach.

[124] Schedule I of the Indian Wildlife Protection Act (1972)

boundary between the two species of *Hoolock* is the Chindwin River, which flows into the Ayerawady (Irrawady) River. At the headwaters in the north there is a hybrid zone or cline between the two species (since they are almost certainly not reproductively isolated). Das *et al*. (2006) reported the discovery of a population of *H. leuconedys* in northeast India, which has traditionally been considered to be part of the range of *H. hoolock*. This species occurs in several of India's north-eastern states, but populations there tend to be isolated. It is common in certain areas of occurrence, but rare in others due to intense hunting by local tribes (Choudhury 1991), and is considered rare throughout its range (Choudhury 2001). The species was found in all forested patches in north-eastern India about 30 years ago, but they are reduced to a few forest fragments now. The total population in north-eastern India was estimated to be about 2,600, of which the majority—about 2,000—occurs in the state of Assam (Molur *et al*. 2005). A population of about 170 gibbons has more recently been identified as *H. leuconedys* (Das *et al*. 2006) and should be subtracted from the population estimate if this identity is proven.

63. **IFC Criteria**: In India this species is listed as protected on Schedule I of the IWPA; it is a forest-dweller species that, depending on its locale, inhabits tropical evergreen rainforests, tropical evergreen and semi-evergreen forests, tropical mixed deciduous forests, and subtropical broadleaf hill forests. Its distribution range has been recorded in protected area such as Kaziranga National Park, Manas National Park and Gibbon Wildlife Sanctuary[125]. It has not been reported from the project area and it is extremely unlikely that the distribution range overlaps with the project area which does not support any nationally protected sites / parks / wildlife sanctuaries / eco-sensitive zones. If the gibbon were to occur in the project area, it would most likely use the large contiguous forest patch south of the project area, which remains relatively undisturbed. Therefore, the project area is assumed to have no or little habitat importance for the Western Hoolock Gibbon, given better habitat nearby. As such, the project area does not trigger Tier 1 and 2 criteria for the Western Hoolock Gibbon

64. **Conclusion Regarding Project Interactions with Critical Habitat:** The project area is beyond the known distribution range of the Western Hoolock Gibbon. As the project area has no habitat value for Western Hoolock Gibbon, no interactions are expected.

Taxonomic group	Species	Common name	IUCN Red List Category Schedule I[126]	Remarks	Present in the project area
Mammals	*Manis pentadactyla*	Chinese Pangolin	CR Schedule 1	Common to both grids	Yes, Reported by locals

Source: IUCN

65. **Range:** This species occurs in the Himalayan foothills of Nepal, southern Bhutan and north and **north-eastern India**, possibly north-eastern Bangladesh, northern and western Myanmar, to northern and Annamite regions of Lao PDR and northern Viet Nam, northwest Thailand, and through south of the Chiangjiang - the Yangtze River, to Hainan, Taipei, east asia, and Hong Kong SAR. However, it has likely been extirpated from parts of its current range (the limits of which are poorly known and may never be elucidated) due to high levels of

[125] Enhancing protection for the species, the Government of Assam upgraded the status of the Hoollongapar Reserve Forest in the Jorhat District of Assam to a Gibbon Wildlife Sanctuary in 1997, making this the first Protected Area ever named after a primate species.

[126] Schedule I of the Indian Wildlife Protection Act (1972)

exploitation historically. It exists at high altitudes, especially in the southern and western parts of its range, though also occurs at much lower altitudes, for example in Hong Kong and likely in the northeast of its range. Its latitudinal range is thought to overlap considerably with that of *Manis javanica*, with *Manis pentadactyla* tending to occur in hills and mountains and the former more generally found at lower altitudes. However, recent interviews with hunters in Viet Nam suggest that the two species can be found in the same areas of forest, and that the differences between them are ecological, relating to diet and habitat use, rather than altitude (P. Newton pers. comm. 2008). The species is marginally present in northern India (Bihar) and has been recorded in north-eastern India (**Assam,** Meghalaya, Nagaland, Manipur, Tripura, Mizoram, Sikkim and the northern part of West Bengal) (Srinivasulu and Srinivasulu 2012, Tikader 1983, Zoological Society of India 2002). This species was reported in the 1980s as common in the undisturbed hill forests of northeastern part of India, however, little is known about the total population in India (Tikader 1983, Zoological Survey of India 1994). Yet, trade figures suggest this species is under severe hunting pressure in north-eastern India (Misra and Hanfee 2000, Challender *et al.* in prep.). In India, this species is protected being listed in Schedule I of IWPA.

66. **IFC Criteria**: In India this species is listed as protected on Schedule I of the IWPA; Its range has been recorded as highly restricted in the distribution; inhabiting lower hills especially teak forests. The River Teesta valley in Sikkim is the primary habitat of the Chinese Pangolin.[127] It has been reported from the project area and there are confirmed sightings of the mammal by the local population. It is plausible that the distribution range overlaps with the project area which does not support any nationally protected sites / parks / wildlife sanctuaries / eco-sensitive zones, but it is unlikely that the project area supports more than 10 % of the global

[127] WWF, India http://www.wwfindia.org/about_wwf/priority_species/lesser_known_species/chinese_pangolin/

population.[128] The project area is not considered a discrete management unit for the Chinese Pangolin. Hence, it does not trigger Tier 1 criteria. Also, Tier 2 criteria are not triggered, since the project area likely does not support nationally or regionally important concentrations of Chinese Pangolin (the large contiguous forest patch south of the project area is a much better habitat than the project worksite areas, and will receive attention in the biodiversity management plan (a camera trap survey to determine presence of Chinese pangolins). As such, the project area does trigger Tier 1 and 2 criteria for the Chinese Pangolin.

67. **Conclusion Regarding Project Interactions with Critical Habitat:** The project area is not in the prime habitat and range of the Chinese Pangolin (there is better forest habitat south of the project area). However, conservation actions as proposed by the IUCN will be part of the EMP (during pre-construction, construction, and during the initial project operation) such as conducting a comprehensive survey and monitoring in and around the project area to establish its range, distribution and population status in the project area whilst assessing its habitat requirements and identifying and mitigating threats.

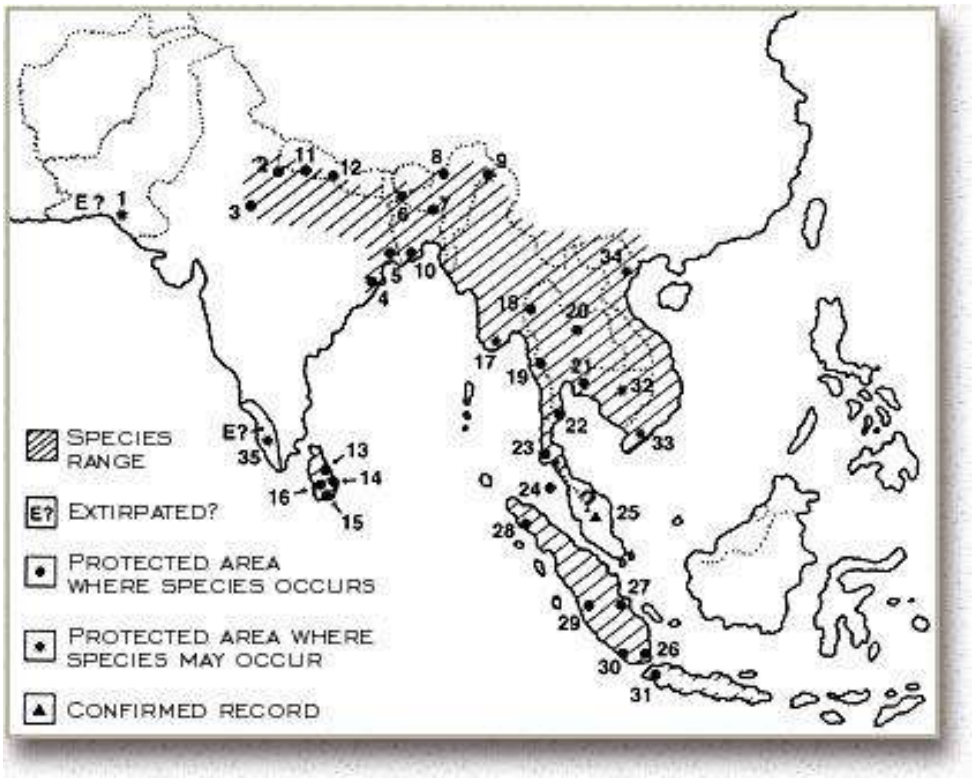
Taxonomic group	Species	Common name	IUCN Red List Category Schedule I[129]	Remarks	Present in the project area
Mammals	*Prionailurus viverrinus*	Fishing Cat	EN Schedule I	Not found in the other grid.	No

Source: IUCN, WWF

68. **Range**: Prionailurus viverrinus or Fishing Cat has a broad but discontinuous distribution in Asia, with large gaps - some the result of its association primarily with wetlands, some the result of recent extirpation, and some supposed due to a lack of confirmed records. In Pakistan, the only known population was in the Indus river valley (Roberts 1977), but there are no recent records to confirm it still occurs. **The fishing cat has been extirpated in recent years from parts of India, including the Bharatpur region (Rajasthan) of western India** (Shomita Mukherjee, Jamal Khan pers. comms. 2007), home to Keoladeo National Park, one of the few areas in India were fishing cats were studied (Mukerjee 1989, Haque and Vijayan 1993). **It has possibly disappeared also from the southern Western Ghats** (Nowell and Jackson 1996; Shomita Mukherjee and Jamal Khan pers. comms. 2007). However, there is also a new record from Umred (near Nagpur) in central India, an area well outside of the fishing cat's known range, when a dead fishing cat that had been killed by a vehicle was found (Anon 2005). It is primarily found in the terai region of the Himalayan foothills, and eastern India into Bangladesh, where it is widely distributed and locally common in some areas (Khan 2004); although in eastern India few prime habitats remain (Kolipaka 2006). As per WWF, India wetlands are the favorite habitats of the fishing cat and it is mainly found in the mangrove forests of the Sundarbans, on the foothills of the Himalayas along the Ganga and Brahmaputra river valleys and in the Western Ghats. It is found in upper elevation up to 1525 meters.

[128] There is virtually no information available on population levels of any species of Asian pangolin either at the global or national level anywhere across the species' range. Furthermore, this species was reported in the 1980s as common in the undisturbed hill forests of northeastern India, however, little is known about the total population in India (Tikader 1983, Zoological Survey of India 1994). Yet, trade figures suggest this species is under severe hunting pressure in Northeast India (Misra and Hanfee 2000, Challender *et al.* in prep.).

[129] Schedule I of the Indian Wildlife Protection Act



69. **IFC Criteria:** In India this species is listed as protected on Schedule I of the IWPA; its range has been recorded typically in wetlands and confirmed to occur in protected areas including Sundarbans (West Bengal), Jim Corbett National Park (Uttarakhand), Dudwha National Park (Uttar Pradesh), and Kaziranga National Park (Assam). It has not been reported from the project area and it is extremely unlikely that the distribution range overlaps with the project area which does not support any nationally protected sites / parks / wildlife sanctuaries / eco-sensitive zones (see map) with the preferred wetland habitat. There is no possibility of Tier 1 and 2 criteria being triggered.

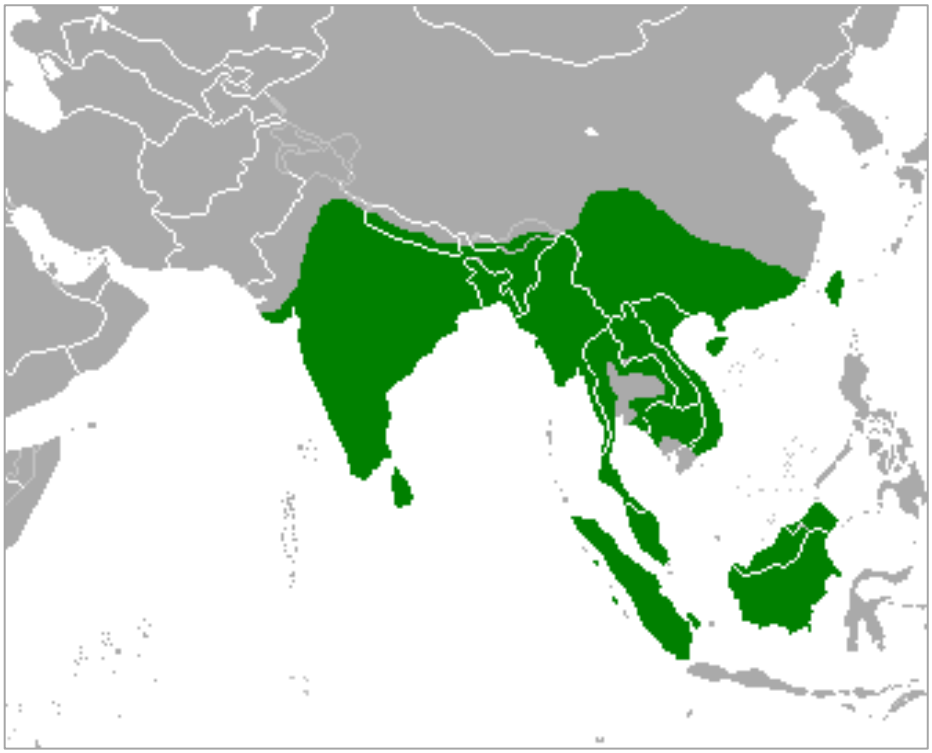
70. **Conclusion Regarding Project Interactions with Critical Habitat:** There is no concern for fishing cats, as they do not occur in the project area.

Taxonomic group	Species	Common name	IUCN Red List Category Schedule I[130]	Remarks	Present in the project area
Mammals	*Rusa unicolor*	Sambar	VU	Common to both grids	Yes. Reported as common and widely distributed; Found in the inner and dense parts of forests in the project area.

Source: IUCN

[130] Schedule I of the Indian Wildlife Protection Act (1972)

71. **Range:** The Sambar extends from India and Sri Lanka east along the southern Himalayas (including Nepal and Bhutan) through much of east asia and Hainan Island) to Taipei, (where it occurs in the central and eastern parts; Lin, C.-Y. and Lee, L.-L. pers. comms. 2008). Further south it occurs in Bangladesh, throughout mainland Southeast Asia (Myanmar, Thailand, Lao PDR, Cambodia, Viet Nam, West Malaysia) and many of the main islands of the Greater Sundas (excepting Java): Sumatra, Siberut, Sipora, Pagi and Nias islands (all Indonesia), and Borneo (Malaysia, Indonesia, and Brunei) (Grubb 2005). The current distribution is now highly fragmented in much of this range (see Population). Payne *et al*. (1985) also listed the Philippines, but the Sambar does not occur there. A record from Ujung Kulon, Java, in van Schaik and Griffiths (1996: 107) is presumably an error for Javan Deer *R. timorensis*. The Sambar has been introduced widely outside its native range, e.g.: San Luis Obispo Country, California; the Gulf Prairies and Edwards Plateau regions of Texas (Ables and Ramsey 1974); the St. Vincent Islands, Franklin Country, Florida (Lewis *et al*. 1990); Australia (Slee 1984, Freeland 1990); New Zealand (Kelton and Skipworth 1987); and Western Cape Province, South Africa (Lever 1985). These introduced populations are not included on the distribution map.



72. In **India**, although the Sambar occurs widely and in many habitat types, large populations occur in well-secured protected areas, nowhere is it now regionally abundant (Sankar and Acharya 2004). **It has been recorded in 208 protected areas** (National Wildlife Database, Wildlife Institute of India, cited in Sankar and Acharya 2004); **its distribution outside protected areas is now generally highly scattered**. Sambar status is best in the three southern Indian states of Karnataka, Tamil Nadu and Kerala (N. Prakash pers. comm. 2014). Most protected areas (tiger reserves, national parks, wildlife sanctuaries) in these states appear to have stable or even increasing Sambar local populations and they are easily one of the most common ungulates encountered in protected areas (N. Prakash pers. comm. 2014). Protected areas in Karnataka in particular have high densities of Sambar (N. Prakash pers. comm. 2014). Hunting and poaching has been more problematic in areas of Kerala, but it also

has some very well protected areas and there is also constant in-migration from protected areas outside of Kerala, this is especially so in the Nilgiri Biosphere Reserve area (N. Prakash pers. comm. 2014). The situation outside protected areas in the three southern states is however often very different and “mostly in the red”, but there are a few exceptions, like the Valparai Plateau in Tamil Nadu where Sambar is very common, and can be found on private lands (Sridhar *et al.* 2008, N. Prakash pers. comm. 2014). In the southern Western Ghats in particular and some parts to the north of this, there has been no noticeable decline in Sambar distribution in the last twenty years (D. Mudappa pers. comm. 2014). However there are indications, based on interview data that abundance has been declining in the Western Ghats (Pillay *et al.* 2011). In other central and east Indian states Sambar is “very rare”, “extremely patchy and in severe decline” “owing to severe hunting pressures, insurgency, rapidly spreading mines (both bauxite and iron-ore)” (N. Prakash pers. comm. 2014). The reported ecological densities of Sambar in India mostly fall within 1–10 animals per km^2 within the protected area network, and depending on the varying levels of protection efficacy: Similar surveys at Kaziranga National Park (Assam) found too few Sambar to estimate populations there (Karanth and Nichols 2000), this presumably representing habitat characters rather than defective protection.

73. **IFC Criteria**: The animal is not IUCN critical or endangered, so it does not trigger Tier 1 criteria. Also, because this animal is only IUCN “vulnerable” and not Schedule I of IWPA, the project area does not trigger Tier 2 criteria since there are no recorded nationally or regionally important concentrations of Sambar in the project area although the animal has been reported from the area.

74. **Conclusion Regarding Project Interactions with Critical Habitat:** In India, although the Sambar occurs widely and in many habitat types, large populations occur in well-secured protected areas. Its distribution outside protected areas is now generally highly scattered. It is plausible that the Sambar may be present in the project area (though the project area is not considered as a critical habitat for the animal). As such, no special mitigation measures or habitat offsets are required for this animal. However, conservation actions will be part of the EMP (during construction and during the initial project operation) such as conducting a comprehensive survey and monitoring in and around the project area to establish its range, distribution and population status in the project area whilst assessing its habitat requirements and identifying threats.

Taxonomic group	Species	Common name	IUCN Red List Category Schedule I[131]	Remarks	Present in the project area
Mammals	*Trachypithecus pileatus*	Capped Langur	VU Schedule I IWPA	Common to both grids	Yes. Not sighted, but reported in the project area.

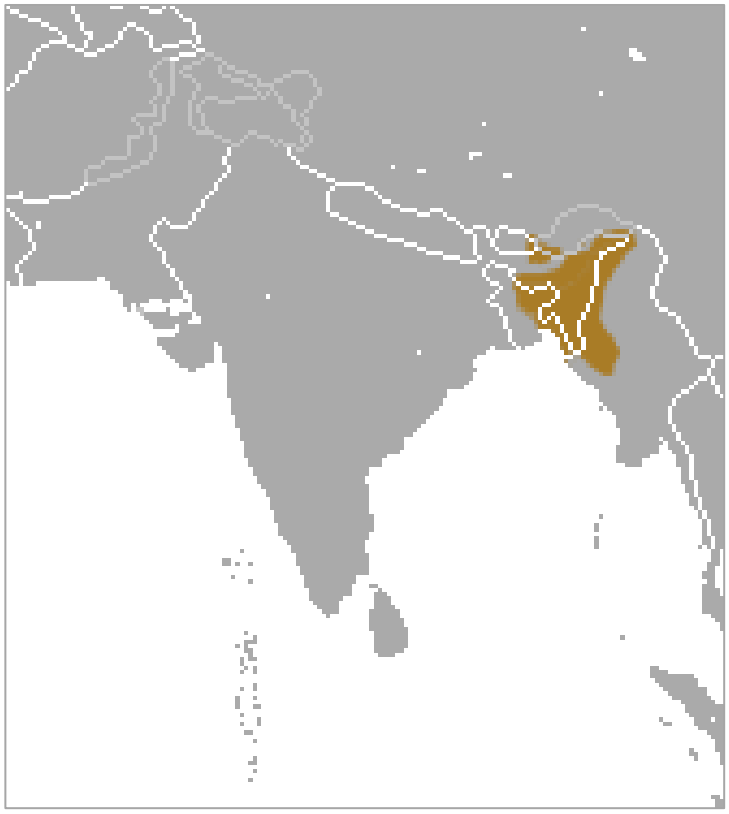
Source: IUCN

75. **Range:** The species occurs in Bangladesh, Bhutan, **north-eastern India** (**Assam**, Manipur, Meghalaya, Mizoram, Nagaland, and Tripura), and north-western Myanmar. South Asian populations of *Trachypithecuspileatus* subspecies are known to exist in adjacent and

[131] Schedule I of the Indian Wildlife Protection Act

sometimes overlapping areas of India, Bangladesh, Bhutan, and Myanmar. Various populations exist between 10 and 3,000 m in elevation (Molur *et al.*2003).

76. *Trachpithecuspileatuspileatus:* Occurs in north-eastern India (**Assam**, Meghalaya, and Nagaland) and north-western Myanmar. **Widely distributed in the highlands south and east of the Brahmaputra** and west of the Chindwin (Myanmar); in Myanmar found in the Chin Hills south to Mount Victoria; in India, the KarbiAnglong, Khasi, Garo, Naga, and Jaintia Hills, along with the Karbi Plateau and the Barail Range in Assam (Groves 2001). *Trachypithecuspileatusdurga*: Occurs in north-eastern and south-eastern Bangladesh and north-eastern India. Found adjoining the range of *T. p. pileatus* to the north, but at lower altitudes, from nearly sea-level up to 600 m; known from the Naga Hills, Lakhimpur, Golaghat, Cachar Hills, Samaguting, and Sibsagar (Groves 2001).*Trachypithecuspileatus brahma:* Occurs in north-eastern India, where known only from the Dafla Hills, north of the Brahmaputra (Groves 2001). *Trachypithecuspileatustenebricus*: Occurs in Bhutan and north-eastern India. Found in the Manas region to the north of the Brahmaputra River (from 100 up to nearly 2,000 m) into Bhutan (Groves 2001; Molur *et al*. 2003). Low elevation 10 m and Upper elevation 3000 m. All South Asian populations are listed under Schedule I, Part I of the Indian Wildlife (Protection) Act (Srivastava and Mohnot2001), amended up to 2002, and are also listed under Appendix I in CITES.



77. **IFC Criteria**: The Capped Langur is not IUCN critical or endangered, so it does not trigger Tier 1 criteria. In India this species is listed as protected on Schedule I of the IWPA, and one nationally protected area, the Nameri National Park (Assam) support these species (located at a distance of 195 km from the project area). Its distribution range is fragmented overall but widely distributed across India, in the highlands south and east of the Brahmaputra and west of

the Chindwin. There are reports of the primate from the project area, although no direct sighting. It is plausible that the Capped Langur is present in the project area but it is unlikely that the project area is considered a discrete management unit for the capped langur. Also, Tier 2 criteria are not triggered, since the project area is not likely to support nationally or regionally important concentrations of the capped langur. If they occur in the region, they would more likely inhabit at the large contiguous forest patch to the south of the project worksites, where a camera trap survey will be undertaken as part of the biodiversity management plan.

78. **Conclusion Regarding Project Interactions with Critical Habitat:** The capped langur population in India is situated in protected areas such as Nameri National Park (Assam), and it is also widely distributed in the highlands south and east of the Brahmaputra and west of the Chindwin (in Myanmar). It is therefore concluded that the proposed project clearing areas and work sites are not critically important to capped langur. However, it is plausible that the capped langur may be present in the project area (though the project area is not in the prime habitat and range of the capped langur). As such, no special mitigation measures or habitat offsets are required for this primate. However, conservation actions will be part of the EMP (during construction and during the initial project operation) such as conducting a comprehensive survey and monitoring in and around the project area (as noted above) to establish its range, distribution and population status in the project area whilst assessing its habitat requirements, and identifying threats.

Taxonomic group	Species	Common name	IUCN Red List Category Schedule I[132]	Remarks	Present in the project area
Plants	*Aldrovanda vesiculosa*	Waterwheel	EN	Common to both grids	No

Source: IUCN

79. **Range:** Historically, *Aldrovanda vesiculosa* or Waterwheel occurred throughout western, central, southern, northern and eastern Europe, from coastal areas in western and southern France, throughout northern and central Italy, Austria and Germany to Poland, Belarus, Bulgaria, Croatia, the Czech Republic, Greece, Hungary, Lichtenstein, Lithuania, Montenegro, the Ukraine, Romania, the Caucasus, Volga, Ussuri, Amur, Lipetsk and St Petersburg areas of Russia, Serbia, Slovakia and Turkey; with several sites known throughout Asia in Bangladesh, **India,** the Manchuria region of east asia, Kazakhstan, Uzbekistan, North and South Korea, and Japan; extending down to East Timor and several coastal areas in southwest, northwest, north, east and southeast Australia. Populations have also been recorded from Botswana, Burundi, Cameroon, Chad, Ghana, Malawi, Mozambique, Rwanda, South Africa, South Sudan, Tanzania, Togo, Uganda and Zambia throughout Equatorial Africa. Presently, this species remains distributed scarcely throughout Europe in Bulgaria, Greece, Hungary, Lithuania, Poland, Romania, the St Petersburg and Lipetsk areas of Russia, Serbia and the Ukraine; persists in northern and southeastern Australia; and remains in Botswana and South Africa. It is regionally extinct for India. Two extinct locations in two regions.

- Throughout the extensive salt marshes east of Calcutta. Extinct, first recorded in 1832, and last observed in 1903 (Zaman 2011).
- Swampland in Manipur state. Extinct, last recorded in 1961 (Zaman 2011)

[132] Schedule I of the Indian Wildlife Protection Act

- Two additional unspecified locations, including the first documented collection of *A. vesiculosa* by Plukenet in 1696 and another referenced by Cohn in 1850, are both likely to originate from the large Calcutta marshlands (Kaminski 2006, Plukenet 1696).

80. **IFC Criteria**: The project area in not specific as habitat (lacking swampland) for this species. Therefore IFC criteria are not triggered.

81. **Conclusion Regarding Project Interactions with Critical Habitat:** No interactions are expected.

Taxonomic group	Species	Common name	IUCN Red List Category Schedule I[133]	Remarks	Present in the project area
Reptiles	*Gavialis gangeticus*	Gharial	CR Schedule I	Common to both grids	No

Source: IUCN

82. **Range:** The western-most historic occurrence of the Gharial was the Indus River in present day Pakistan and the eastern-most (albeit from only two records in the scientific literature) was the Irrawaddy River in present day Myanmar. Today three widely separated breeding subpopulations are left in **India (Chambal River, Girwa River and Son River)** and one in Nepal (Rapti/Narayani River). The Chambal River holds by far the largest breeding subpopulation with an estimated 48% of the total population. The total number of nests found in the Chambal Sanctuary in 2006 was 68. The only other large breeding population of Gharial in India is in the Katerniaghat Wildlife Sanctuary (Uttar Pradesh, India) where 20 nests were found in 2006. The one other known breeding population in India is the Son River Sanctuary where two nests were found in 2006 (Andrews 2006). Since most female Gharial nest every year in captivity, it is reasonable to assume that the above cited nest counts indicate the presence of 90 reproducing female Gharial in India. Assuming that the sex ratio reported by Hussain (1999) in the Chambal of 14% males is the same in Katerniaghat and Son, there would be an inferred total of 13 mature male gharials throughout India. Considering the reported paucity of mature males (being very conspicuous with their gharas) on the Chambal in the surveys of 2005 and 2006, it is likely that there are extremely few mature males in that river (Andrews 2006, R.J. Rao pers. comm.). Along with a total of 20 nesting females, six mature male Gharial were counted by independent observers in 2006 (B.C. Choudhury, H.V. Andrews, R. Whitaker, pers. obs.). The total estimated number of mature Gharial in the three remaining wild breeding subpopulations in India is therefore 107 based on observed nest numbers and inferred numbers of mature males. There are two other small, non-reproducing populations of Gharial in India (Ken River in Madhya Pradesh and Mahanadi River in Orissa).

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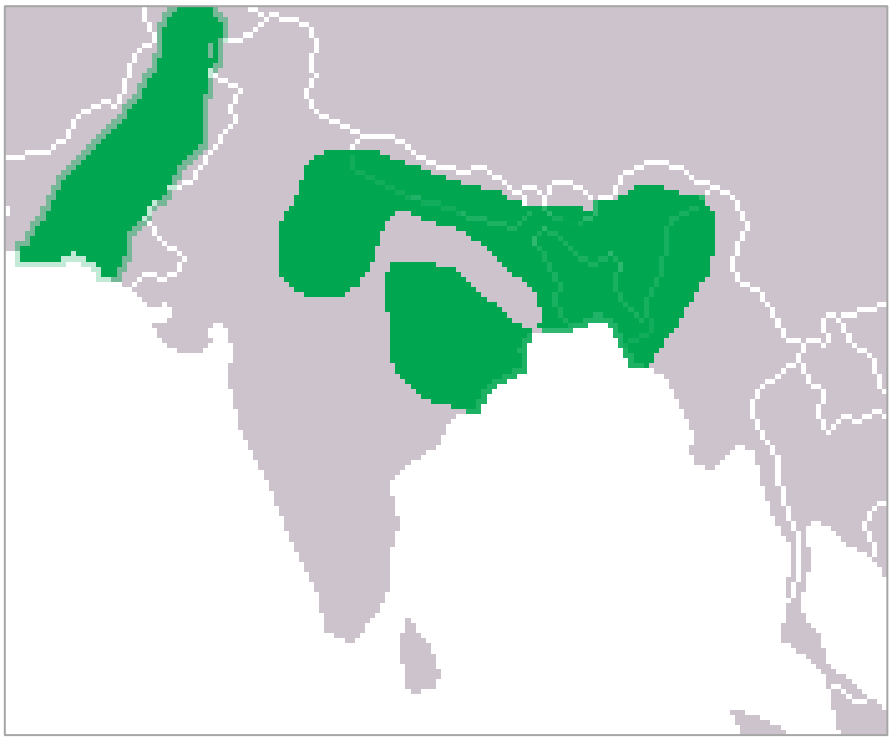

83. **IFC Criteria**: In India this species is listed as protected on Schedule I of the IWPA; its distribution range has shown catastrophic decline across the Indian Subcontinent. It is unlikely that the distribution range overlaps with the project area, since there are no large flowing rivers with extensive sand banks in the area (the usual habitat of this crocodile). The project area has no habitat importance for the Gharial. As such, the project area does not trigger Tier 1 and 2 criteria for the Gharial.

84. **Conclusion Regarding Project Interactions with Critical Habitat:** The project area is beyond the distribution range of the Gharial. As the project area has no habitat value for the Gharial, no interactions are expected. As such, no special mitigation measures or habitat offsets are required for this reptile.

Taxonomic group	Species	Common name	IUCN Red List Category Schedule I[134]	Remarks
Reptiles	*Python bivittatus*	Burmese Python	VU	Common to both grids Not sighted, but reported in the project area during ground survey. Detailed assessment done.

Source: IUCN

85. **Range:** This species occurs from India, where it has a very disjunct distribution and is known from only two small, isolated areas in the northeast, through Nepal to Indonesia and Hainan. It is absent from Peninsular Malaysia, with a southern limit to its distribution in mainland Asia of SuratThani in Thailand (M. Auliya and T. Chan-ard pers. comm. September 2011). This

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snake is absent from Borneo and Sumatra; Borneo has traditionally been included (erroneously) in the species' distribution based on a record of skins from a port in East Kalimantan (M. Auliya pers. comm. September 2011). In Indonesia it has only been confirmed from Java, Nusa Barung, Bali, Sumbawa, and possibly also Lombok, as well as in south Sulawesi (M. Auliya September 2011). It is absent from the Nicobar and Andaman Islands. Whitaker and Captain (2004) report it from Nepal and Bangladesh. As *Python molurus*, the species has been reported from between 10 and 4,050 m asl.

86. **IFC Criteria**: The reptile is not IUCN critical or endangered, so it does not trigger Tier 1 criteria. Also, because this reptile is only IUCN "vulnerable" and not Schedule I of IWPA, the project area does not trigger Tier 2 criteria since there are no recorded nationally or regionally important concentrations of Burmese Python in the project area. Although it has been reported from the project area, the project area is not considered as a critical habitat for the reptile. It is native to northeastern India..

87. **Conclusion Regarding Project Interactions with Critical Habitat:** The project area is beyond the normal distribution range of this python. As the project area has no apparent habitat value for the python, no interactions are expected.

Taxonomic group	Species	Common name	IUCN Red List Category Schedule I[135]	Remarks
Plant	*Ixonanthes khasiana*	-	VU' Schedule V	Common to both grids. Reported in the project area during ground survey. Detailed assessment done.

Source: IUCN

88. **Range:** This species' occurrences are known from the Syreyngam, Khasi and the Jaintea Hills in Meghalaya and Bhutan Hill in Assam. The species is found in rainforest over 1,000 m. High rates of habitat loss have affected the entire range. No collections appear to have been made more recently than 1937 on the population of this species.

89. **IFC Criteria**: This plant is not IUCN critical or endangered, so it does not trigger Tier 1 criteria. Also, because this plant is not included in Schedule I of IWPA, the project area does not trigger Tier 2 criteria since there are no recorded nationally or regionally important concentrations of this plant in project area (elevation is too low) as this is mostly concentrated in Khasi and Jaintia hills of Meghalaya. Although it has been reported from the project area, the project area is not considered as a critical habitat for the plant (elevation too low). It is native to Meghalaya (Khasi and Jaintia hills).

90. **Conclusion Regarding Project Interactions with Critical Habitat:** The project area is beyond the main distribution range of the Ixonanthes khasiana. As the project area has no habitat value for the Ixonanthes khasiana, no interactions are expected.

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Taxonomic group	Species	Common name	IUCN Red List Category Schedule I[136]	Remarks
Plant	*Aglaia hiernii*	Ameri	NT	Reported in the project area during ground survey. Detailed assessment done.

Source: IUCN

91. **Range:** Reported in Indonesia (Sumatera); Malaysia (Peninsular Malaysia). Occurring between 20 and 1,700 m, this tree is found in primary and secondary forest and in old wasteland. Habitat destruction is a potential threat to the species.

92. **IFC Criteria**: This plant is not IUCN critical or endangered, so it does not trigger Tier 1 criteria. Also, because this plant is not included in Schedule I of IWPA, the project area does not trigger Tier 2 criteria since there are no recorded nationally or regionally important concentrations of this plant in project area as this is mostly concentrated in Indonesia (Sumatera); Malaysia (Peninsular Malaysia). Although it has been reported from the project area, the project area is not considered as a critical habitat for the plant.

93. **Conclusion Regarding Project Interactions with Critical Habitat:** The project area is beyond the normal distribution range of the *Aglaia hiernii*. As the project area has no critical habitat value for the *Aglaia hiernii*, no interactions are expected.

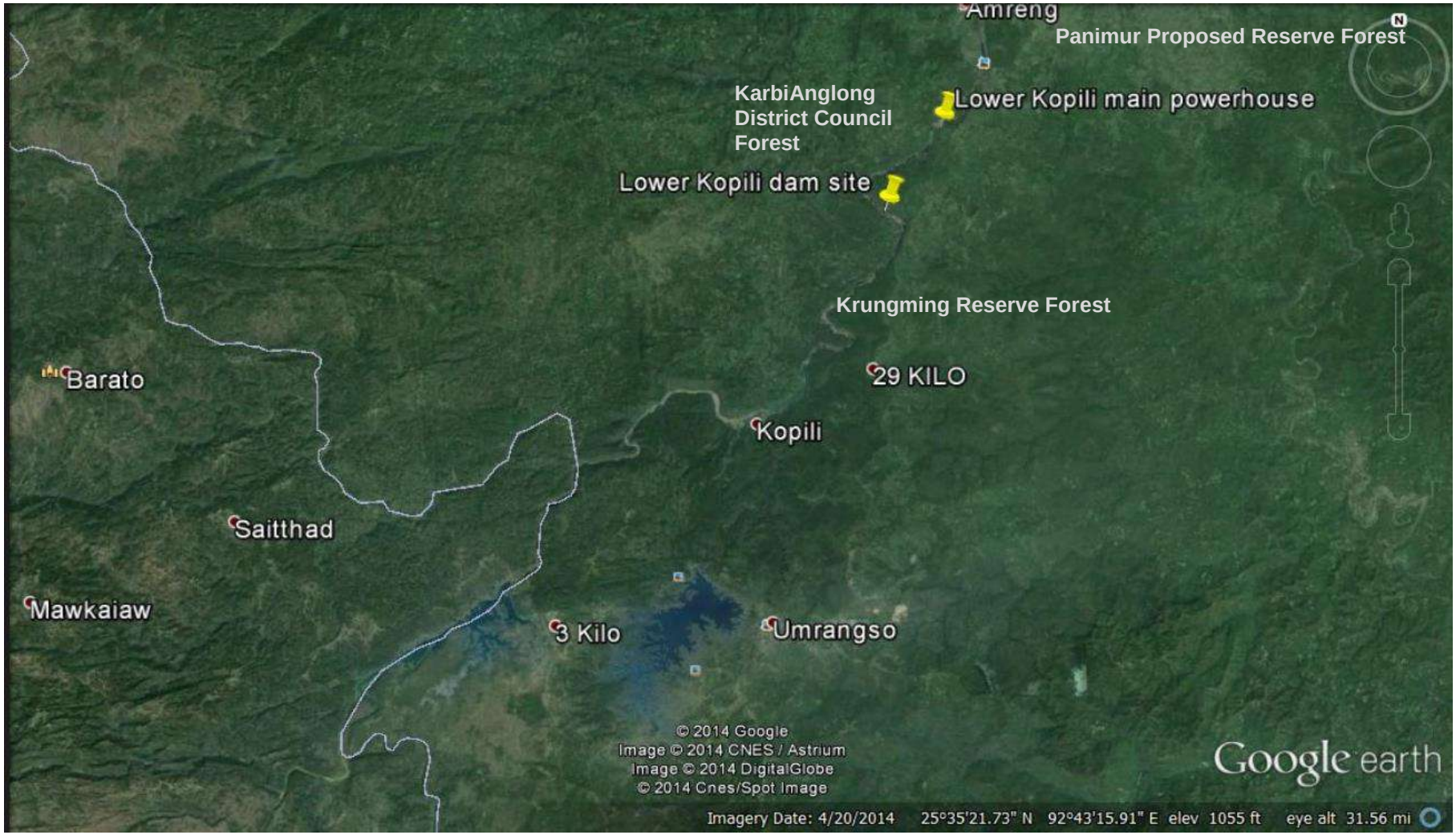
[136] Schedule I of the Indian Wildlife Protection Act

F. Forest Details Near Project Area

Figure F.1: LKHEP site – Dam Site and Main Power House

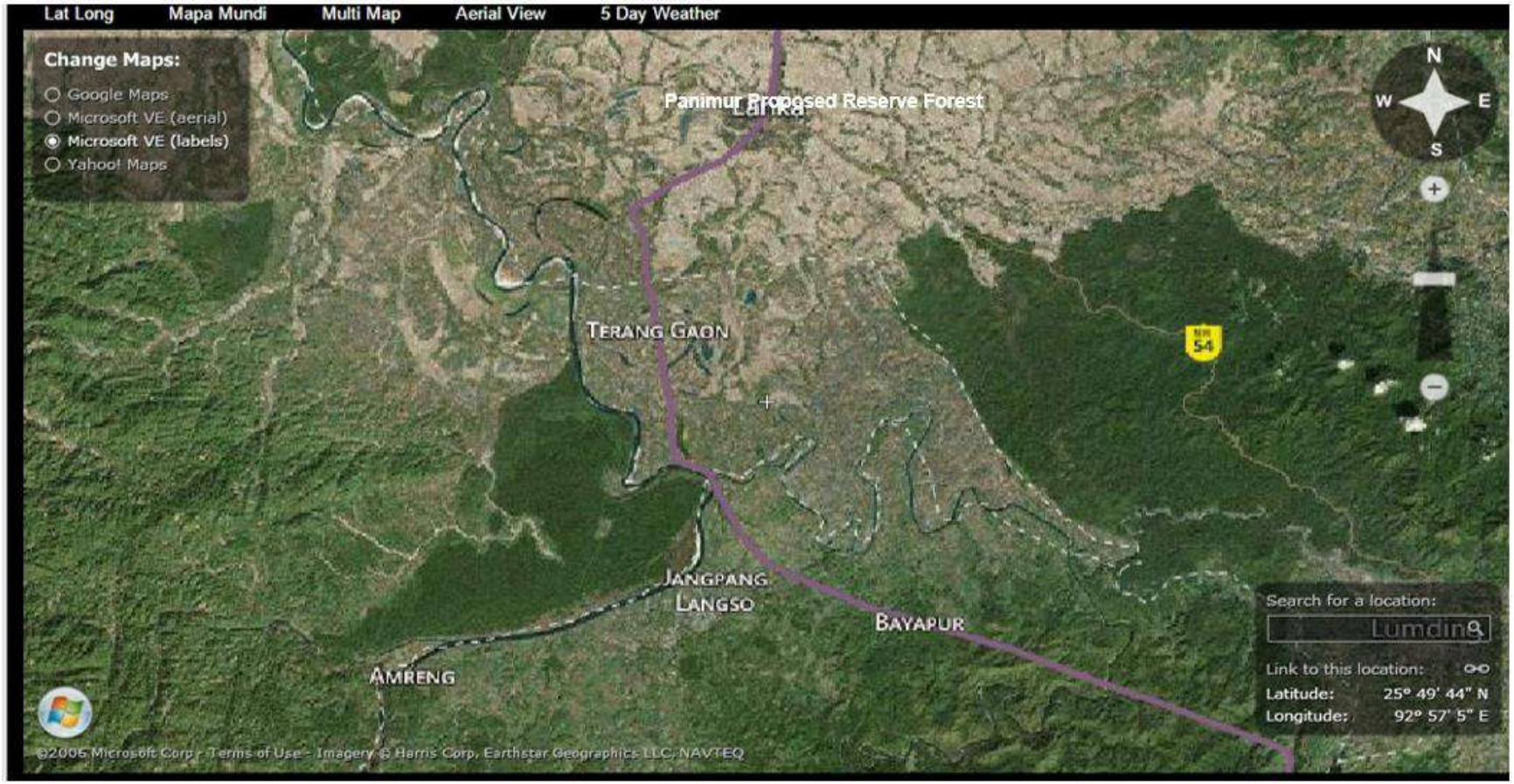
Note: The location of the reserve / district council forest is an approximate location

Figure F.2: Area Extending from LKHEP Site towards Umrangso



Note: the location of the reserve/ district council forest is an approximate location.

Figure F.3: Area Extending from LKHEP Site towards Lanka



Note: The location of reserve / district council forest is an approximate location

ANNEX 6: STAKEHOLDER CONSULTATION AND PARTICIPATION RECORD

A. Details of Consent Seeking Consultations: APGCL, ADB, LEKHPAPA, APs, and Village Headmen – Attendance Sheets of Participants

19/03/2015

Assam Power Sector Investment Programme T-3

Consultation Attendance Sheet

Date: 19/03/2015 Place LANKU, DIMA HASAO, ASSAM

Sl no	Name	Profession/Occupation	Signature with Phone No
1.	JOYSING ENGHI	President – L. KHEPAPA	[signature] 09401235772
2.	[illegible]	Village headman G.B. of Dignamdisa	[signature]
3.	Biramsing Enghi	A. Seg [illegible]	[signature] 9481229654
4.	Welson Phanglo	Village [illegible]	[signature] 19/3/2015
5.	Phobilal Kemprai	Dikhrom Disa village	[signature]
6.	Joyon Phonglo	Dikra Disa	[signature] 19/3/2015
7.	Bitot Kro	[illegible] farm +91 99544-23978	[signature]
8.	PRABIN HOJAI	G. Secretary	[signature] 19/3/15
9.	Bidyasing Enghi	Secretary contractor	[signature]
10.	Anupam	Consultant ADB	[signature] 9435631512
11.	[illegible] Hussain Hazarika	AGM APGCL	[signature] 19/3/15
12	Bipul Hojai	Dima Langku	[signature]

Assam Power Sector Investment Programme T-3

Consultation Attendance Sheet

Date: // // Place______________________________

Sl no	Name	Profession/Occupation	Signature with Phone No
13	Joyjit Naiding	Dima Langkai [illegible]	J. Naiding [illegible]
14	Tilak Siyantonping [illegible]	Consultant	[illegible]
15	Jayanta Bora [illegible]	Consultant	[illegible]
16	[illegible]	Engineer / Consultant	[illegible]
17	Sambar Durrani [illegible]	~~[illegible]~~ Engineer/ Consultant	[illegible]

Photographs of Consultations at LKHPP Site-19/03/2015

B. Details of Consent Seeking Consultations: APGCL, ADB, LEKHPAPA, APs, and Village Headmen – Attendance Sheets of Participants

02/06/2015

Assam Power Sector Investment Programme T-3

Consultation Attendance Sheet

Date: 02/06/2015 Place LANKU M.E SCHOOL COMPOUND (Village LANKU)

Sl no	Name	Profession/Occupation	Signature with Phone No
1	JOYBON KRO	G.B of Barolongku	[illegible]
2	Balendra Warisa	G.B of Digromdisa	[illegible]
3	HEMARI DERA	G.B of Lunulangso	[illegible] 9401682888
4	LANGTUK TERON	G.B of Krongmeng-langso	[illegible]
5	HEMARI TERON	G.B of Tortelangso	H Teron
6	DAYAL BAHLARY	G.B of Sokpuru	Dayal [illegible]
7	THANGBORON WARISA	G.B of Dimalongku	[illegible]
8	Lemananda Naiding	S.K	[illegible]
9	Sri. Elbertson Teron	UP M.L. Mso.	[illegible]
10	KAILASH HOJAI	G.B of Wapandisa	KAILASH HOJAI
11	BOLENDRO THOSENID	G.B of Disabra	[illegible]
12	Rone Bhadra Hasnu	President/ADSU	[illegible] 9531030355

Assam Power Sector Investment Programme T-3

Consultation Attendance Sheet

Date: // // Place__________________________________

Sl no	Name	Profession/Occupation	Signature with Phone No
13	Jonojoy Haflongbar	Ranger ...	
14	Maidon Langthasa	Member.	
15	Robinson Teron	Karbi Student Association (K.S.A.) ...	9954903241
16	Longsing Rongpi	G. Secy. Karbi Student Association (KSA)	9401672213
17	Birensing Engti	... (LKHEP)	9401221454
18	Dorimu Terang	Member (LKHEP)	9401335958
19.	Mensing Ronghi	Mouzadar Amri Mouza	23/01/15 9435577692
20	Jopsing Phangcho	LKHAPAPA Member	
21	Joyem Phangcho	LKHAPAPA member	
22	Biren Sing Engti	LKHAPAPA Member	
23	Shri Amit Jidung.	Deputy Ranger Panimur Range.	
24	Jayanta ...	ADSU.	

Consultation Photographs 02/06/2015






C. Details of Consent Seeking Consultations: APGCL, ADB, LEKHPAPA, APs, and Village Headmen – Attendance Sheets of Participants

24/11/2015

Assam Power Sector Investment Programme T-3

Consultation Attendance Sheet

Date: 24/11/2015 Place LONGKHU ME SCHOOL

Sl no	Name	Profession/Occupation	Signature with Phone No
1	Sri Dhansing Phangcho	LKHEPAPA Member	[illegible]
2	Sri Joysing Thang	LKHEPAPA Office Secy.	[illegible]
3	[illegible]	GB Dehorsengdisa	
4	Biunsing Engti	LKHEPAPA Member	[illegible] 9401146217
5	Jaysing Kro	LKHPAPA G/B	[illegible]
6	HEMTCH	G.B. of Rongkhelan	L.T.I. Hemari
7	Hemari Teron	GB Tarkelangso	[illegible]
8	Hemarekiring	GB Lariilangso	[illegible]
9	[illegible]	GB Chotolangpher	
10	Ningkaeng Engti	G.B. Mungkele	L.T.I. Ningkang Engti
11	Bidyasing Engti	LKHEPAPA Executive Members	[illegible] 24/11/15 (M) 8413[illegible]
12	Sing Engti	GB [illegible] Longku	[illegible]

②

Assam Power Sector Investment Programme T-3

Consultation Attendance Sheet

Date: 24/11/ [illegible] Place Longku M E School

Sl no	Name	Profession/Occupation	Signature with Phone No
13	Sri Lapiz Ranghang	Langku Village	[signature]
14	" Welson Phangcho	Longlangso, Well	[signature]
15	Holendro Thosen	G.B of Disabra	L.T.I of Holendro Thosen
16	Sri Sew Teron	Toskelangso	[signature]
17	Thangloren Wanisa	G.B of Dima Longku	L.T.I of Thangloren Wanisa
18	Thaisringdao Langpi	Dima NN [illegible]	[signature]
19	Beovel Teron	private School Teacher	[signature] 9401292764
20	Remon Hojai	Dama Longku	K. Hojai
21	Phobilal Rongpi	Digrendisa	[signature]
22	Majori Hanse	Chadolongphur	M Hanse
23	Harsing Teron	Torchelangso	H Teron
24	Guchim Daimari	Kalanala Kachari	G D

①

Assam Power Sector Investment Programme T-3

Consultation Attendance Sheet

Date: 24/11/2015 **Place** LONGKU J MG SCHOOL

Sl no	Name	Profession/Occupation	Signature with Phone No
25	Sri Debanath Kemprai	Disatron	[illegible]
26	Maishandisa	Kampoi Langkupar. – M.K	
27	Probindro Kemprai	Digramdisa	
29	Vothoya Hojai	Wapendisa	
29	Sayfongthanglo	Digramdisa	Sephanglo
30	Sing Phuna	Bonolongku	Sing Phuna
31	Sonon Sing Lofti	Bono longku	[illegible]
32	Khorsing Terang	Borolongku	[illegible]
33	Bipul Hojai	Dima Longku	B Hojai
34	Thojan Kemprai	Dima Longku	[illegible]
35	Defal Kemprai	Digramdisa	[illegible]
36	Surendra Bathari	Longku	[illegible]

(4)

Assam Power Sector Investment Programme T-3

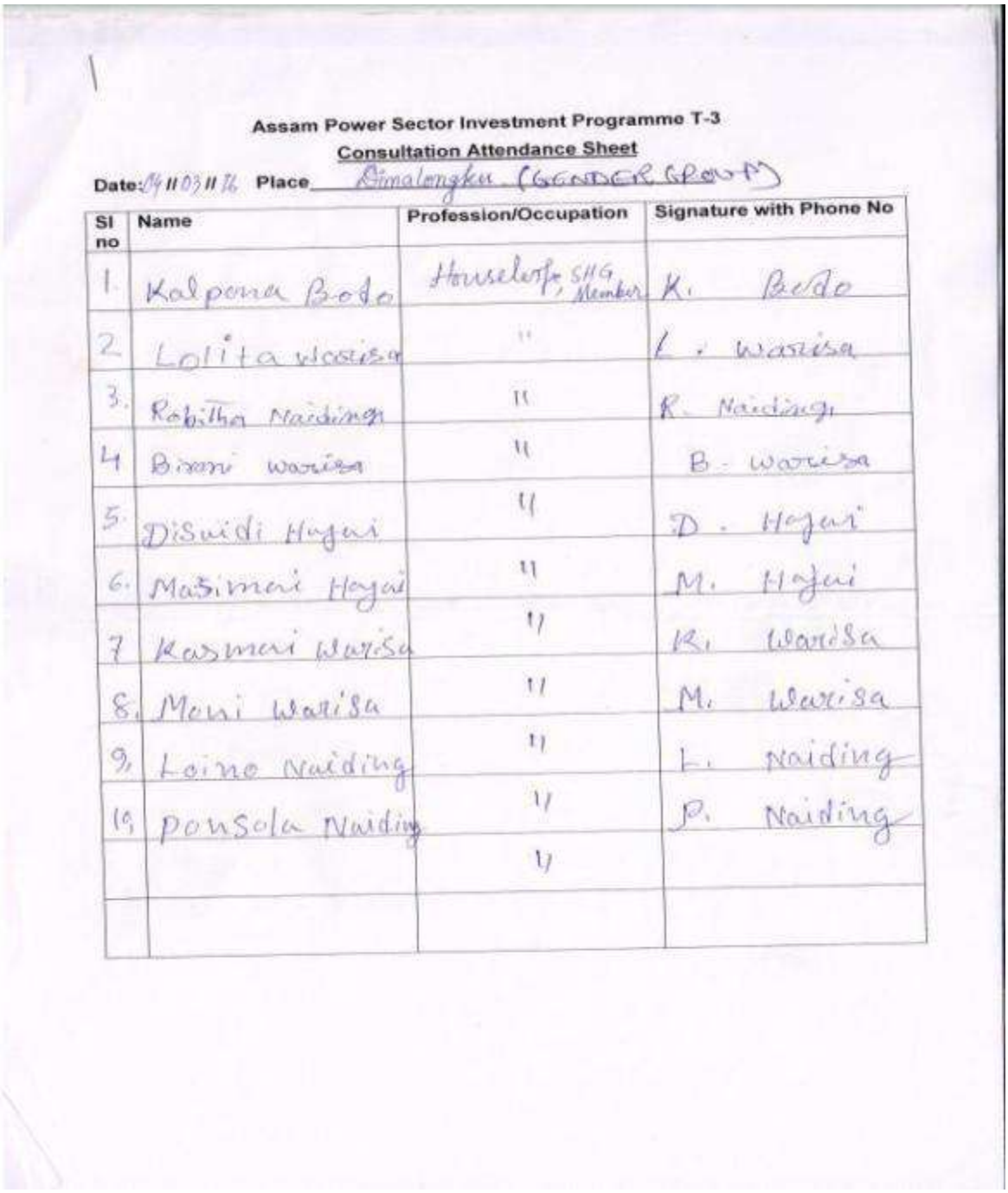
Consultation Attendance Sheet

Date: 24/11/2015 Place: Longtou ME School

Sl no	Name	Profession/Occupation	Signature with Phone No
37	Longki Engti	Business	[signature] 9401875658
38	Mohan S. Phangcho	N.G.O.-Secretary Rural development [illegible] Secretary	[signature] 9435100701
39	Robinson Teron	Karbi Students' Association President	[signature] 9435584553
40	Bamphi Engti	Asst. L.N.P.A.C.	[signature]
41	Longsing Rongpi	Karbi Students' Association Diana Hasao [illegible] Comm. G Secretary	[signature] 9401672213
42	Joyon Phonglo	L.K. H.E.P.A.P.A. Member	[signature] 9401781971
43	JOYSING ENGHI	President - L. KHEPAPA	[signature] 9401235772
44	Doyanan Hojai	Ndalitongkolo	[signature] Phone No 9854699316

Consultation Photographs 24/11/2015 (attended by ADB Staff)

D. Record of Gender Consultation Attendance Sheet of Six Villages and Photographs



Assam Power Sector Investment Programme T-3

Consultation Attendance Sheet

Date: 14/03/16 Place Dimalongkai (GENDER GROUP)

Sl no	Name	Profession/Occupation	Signature with Phone No
1.	Kalpana Bodo	Housewife, SHG Member	K. Bodo
2.	Lolita Warisa	"	L. Warisa
3.	Rabitha Naiding	"	R. Naiding
4	Bimi Warisa	"	B. Warisa
5.	Disuidi Hojai	"	D. Hojai
6.	Masimani Hojai	"	M. Hojai
7	Kasmani Warisa	"	K. Warisa
8.	Moni Warisa	"	M. Warisa
9.	Laino Naiding	"	L. Naiding
10.	Ponsola Naiding	"	P. Naiding
		"	

Assam Power Sector Investment Programme T-3

Consultation Attendance Sheet

Date: 5/11/3/11/2014 **Place** Borolongku (GRADER GRAND)

Sl no	Name	Profession/Occupation	Signature with Phone No
1	Monjini Ronghangpi	Housewife & SHG Members	M. Ronghangpi
2	Sonam Timungpi	"	S.T
3	Kasong Engtipi	"	Engtipi
4	Basapi Terangpi	"	
5	Kache Patorpi	"	
6	Mekri Engtipi	"	
7	Ka-el Terangpi	"	
8	Basapi Phangchopi	"	
9	Junaki Kropi	"	Juno Kropi
10	Kampi Engtipi	"	
11	Bijno Kropi	Student	Bi Kropi
12	Basiri Phangchopi	"	B.P.h

Assam Power Sector Investment Programme T-3

Consultation Attendance Sheet

Date: 5// 03//2016 Place Digrendisa (GENDER GROUP)

Sl no	Name	Profession/Occupation	Signature with Phone No
1.	Nobita Kemprai	House wife	Nobita Kemprai
2	Sarojini Langtha	"	Sarojini Langtha
3	Debita Hasnu	"	Debita Hasnu
4.	Sangita Naiding	"	[thumb impression]
5	[illegible]	Student	[illegible]
6.	Ibomphula Naiding	"	[thumb impression]
7	Robda Phonglo	House wife	[thumb impression]
8.	Dila Kemprai	Student	[illegible]
9.	Mali Nunisa	House wife	Mali Nunisa
10	Archana Hofjangbar	"	Archana Hofjangbar
11.	Joybitha Jidung	"	J. Jidung
12	Lalita Kemprai	Student.	Lalita Nunisa

Assam Power Sector Investment Programme T-3 (TORTELONGSU)

Consultation Attendance Sheet

Date: 06/03/2016 Place: TOTO LANGSU GENDER GROUP

Sl no	Name	Profession/Occupation	Signature with Phone No
13	Demilu Phonglo	VILLAGER HOUSEWIFE	[signature]
14	Sunulori Hafflongbar	"	[signature]
15	Ringlimai Thonglo	"	[signature]
16	Naihangi Wattilia	"	[signature]
17	Ringlduda Hojphila	"	[signature]
18	Binota Naiding	"	[signature]
19	Jobai Kathari	"	[signature]
20	Romina Naiding	"	[signature]
21	Rusi Daulagphu	"	[signature]

Assam Power Sector Investment Programme T-3

Consultation Attendance Sheet

Date: // // Place TOTOLANGSHU (GENDER, PGN/CONSULTATION)

Sl no	Name	Profession/Occupation	Signature with Phone No
1	Sai Teron	Housewife	[signature]
2	Sany Tisso	"	S. Tisso
3	Ral Sing Teon	"	[signature]
4	Hari Sing Teron	"	H.S Teron
5	Umai Pator	Student	[signature]
6	Udel son Teron	"	[signature]
7	Robin Sonchinthey	"	[signature]
8	Bimol Sing Teron	"	[signature]
9	Raivong Phangcho	"	[signature]

Assam Power Sector Investment Programme T-3

Consultation Attendance Sheet

Date: 0 / 03 / 2016 Place Kxungminglangso (GENDER GROUP)

Sl no	Name	Profession/Occupation	Signature with Phone No
1	Kasang Enghipi	Housewife	[redacted]
2	Mina Enghipi	Student	Mina Enghi
3	Kajit Enghipi	Housewife	[redacted]
4	Sila Jirsopi	Housewife	[redacted]
5	Kasang Enghipi	Housewife	[redacted]
6	Kaku Enghipi		
7.	Elizabeth Hansepi	Student	E. Hansepi
8	Kaku Hansepi	Housewife	[redacted]

Assam Power Sector Investment Programme T-3

Consultation Attendance Sheet

Date: 06/05/2016 **Place** KARBINLANGSO (GENDER FGD[CONSULTATION)

Sl no	Name	Profession/Occupation	Signature with Phone No
1	Kache Terongpi	Student	K. Terongpi
2	Kasang Terangpi	Housewife	K. Terongpi
3	Omphu Terengpi	"	O. Terongpi
4	Kadom Kropi	"	
5	Kasamp Phangchojp	"	
6	Jinni Teronpi	"	
7	Ruplin Kropi	"	
8	Kasang Beypi	"	
9.	Rina Phangchopi	"	
10.	Basapi Timungpi	"	
11.	Kanam Tikopi	"	

Selected Photographs of Gender Consultations

E. Record of Consultations with the Physically Displaced Persons on 06- March 2016

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Assam Power Sector Investment Programme T-3

Consultation Attendance Sheet

Date: 06/03/2016 Place: DEMALONGKU (DIMALANKU) - DISPLACED VILLAGE CONSULTATION

Sl no	Name	Profession/Occupation	Signature with Phone No
1	Bidyasing Engti	Contractor	[signature] 9435681512
2	Hemari Phura	Student	[signature]
3	Lapsing Ronghang	Service	[signature] 09435876753
4	Sondor Teron		[signature]
5	Sawan Sing Engti	Student	[signature] 9577209006
6	Ramaswen Ronghang	Student	Kama
7	Jaysing Terang	Cultivation	[signature]
8	Maloti Terangpi	Student	[signature]

ANNEX 7: PUBLIC HEARING REPORT

(2)

Proceeding for Public Hearing for Proposed "Lower Kopili Hydro-Electric Power Project" with Capacity 120MW in Karbi Anglong & Dima Hasao District of Assam. By M/S Assam Power Generation Corporation Ltd., Assam.
Venue: At Longku, APGCL Project site, Dist: Dima-Hasao, Assam. on 10/01/2017 at 11:30AM.

PANEL MEMBERS:

1. Sri Dipak Jidung, ACS, Addl. Dist. Magistrate, Dima Hasao.
2. Sri B. K. Baruah, Chief Env. Engineer, Pollution Control Board, Assam.

AGENDA OF PUBLIC HEARING:

1. Selection of president
2. Authorised Representative of Pollution Control Board, Assam will explain the purpose of the Public Hearing.
3. Presentation in details of the project by M/S Assam Power Generation Corporation Ltd., Assam.
4. Views of public/NGOs etc. regarding environmental impact of this project and mitigation measures.

At the begining, Sri B.K. Baruah, Chief Env. Engineer, Pollution Control Board, Assam explained the purpose of the public hearing as per the MoEF Notification, 2006.

As per the agenda Sri Utpal Dutta, OSD, APGCL briefly narrating of the proposed projects and requested their EIA study Consultant Representative of WAPCOS Limited. Mr. P. D. Karkhanis (CE) WAPCOS for represent the EIA Study Report.

Mr. P. D. Karkhanis (CE), representative of WAPCOS Limited represent in details of the project proponents.

VIEWS OF PUBLIC:

Joy Singh Engti, President, Lower Kopili Hydro-Electric project Affected Peoples Association, arise the question that sand presently availing/extracted from Kopili river

after establishment of project what will be the effect comes in the river Kapili. After that he arises the compensation on related questions and so on.

Mr. Probin Hojai, Secretary, LKHE project affected peoples Association welcome the proposed project and submitted a memorandum for their demand points in the proposed project Area peoples and explain the details of the memorandum.

Mr. Dorsingh Engti, on behalf of local people of Longku area also raised the same type of question of Rehabilitation and social & economic development plan of the APGCL etc and so on.

Mr. Kamedi Inghi raised the question of resettlement of the effected area of project area, he belongs in Karbi Anglong district of Assam.

Mr. Joysing Durong, Asstt. Secretary, Dima Hasao Rural Dev. Society an NGO suggested to fix a date for fulfil the demand of local people by APGCL and so on.

Mr Martin Terang, local people raised the question that whether the picnic spot in the down stream of Kopili River will be save from the project. He also suggested to plant with local fruit species.

During the time of public Hearing 3 Nos Memorandum from local people received.

The Addl. district Magistrate, Dima Hasao said that all the grievances raised by the public will be fulfilled by APGCL authority. He also asked APGCL authority to follow all the norms during and after proposed project start. The people supported his suggestion by clapping hands.

People supported the "Lower Kopili Hydro-electric Power Project" of APGC.

RESOLUTION:-

Considering the ecological, technical,

(3)

POLLUTION CONTROL BOARD ASSAM

scientific and socio-economic aspects related to the proposed "Lower Kopili Hydro-Electric Power project" of APGCL and taking into consideration of opinion and suggestion made by the public present in the public hearing held on 10th Jan, 2014, it is unanimously resolved to allow APGCL to take up the proposed "Lower Kopili Hydro-Electric Power project" incorporating with all pollution control measures proposed by the project proponent and to comply with the provision of all existing environmental laws.

Dated, 10th January, 2014.

10/1/14

(Sri B. K Baruah)
Chief Env. Engineer
Pollution Control Board, Assam

Chief Env Engineer
Pollution Control Board, Assam
Bamunimaidam, Guwahati-21

10/1/14

(Dipak Bidung)
ACS, Addl. Dist. Magistrate
Dima Hasao, Assam

Addl. Deputy Commissioner
Dima Hasao District, Haflong

(2)

Attendance of Public Hearing for proposed "Lower Kopili Hydro-Electric Power project" with capacity 120MW in Karbi Anglong & Dima Hasao District of Assam. By M/S Assam Power Generation Corporation Ltd., Assam. Venue: At Longku, APGCL project Site, Dist: Dima Hasao Assam. on 10/01/2017 at 11:30AM.

SL. NO.	NAME	ADDRESS	Signature.
1.	Vingkrang Engti	Vill - Mongkilleng	
2.	Grayson Teron.	Vill - Boro Longku (G.P.)	[signature]
3.	Bosin. doo Thaosen	Longku	[signature]
4	Hemaro Dera	Loka Longkuo	[signature]
5.	Phobilal Kempai.	Digoremedia.	[signature]
6.	Thajen Kempai	Dimalongku	[signature]
7	Balandro warisa.	Digramcleisa.	[signature]
8	kemen	DIMA LONKU	[signature]
9.	Prem Lama	Krung langolisa (29 km)	Prem Lama
10.	Elisha Chinthong	Umrongso proper	Chinthong
11.	Hannon Longhangpi	Larulangso	[signature]
12.	Lobela Phonglo	Ditrem Disa	
13.	Kache Terongpi	Boralongku	
14.	Lema Terongpi	Laulangso	
15.	Phemon Kempai	Umrongso.	[signature]
16.	Joyking Durop	Umrangso	[signature]
17.	Kauena Englipi	Mungkele	[signature]
18.	Roshmary Englipi	Mungkele	Ros
19	Saved Phangcho	Rongkhelan Umrongso	[signature]
20	Mensing Ronghi	Umrongso Amri Hourg	[signature]
21	Jaysing Engti	B/Langklam, Post, L. Langpi	[signature]
22	Khir Rongpi	Vo- Anplaklangso	[signature]
23	Bamsing Engti	Langkmi	
24	Purnima Terangpi	Boro ELong ku	
25	Anjuly Terangpi	Boro Long KU	
26	Kane Phangchopi	Boro Long KU	[signature]
27	Moina Phurapi	Boro Long Ku	

Attendance of Public Hearing of Proposed "Lower Kopili Hydro-Electric Power Project"

Sl.no	Name	Address	Signature
28	Kale Khopi	Boro Longku.	K. Khopi
29	Kale Terangpi	Boro longku	K. Terangpi
30	Punai phangcho	Longku	[illegible]
31	Maloti Terangpi	Boro Longku	[illegible]
32	Serlin Terongpi	Boro longku	[illegible]
33	Ruity Terangpi	Boro Longku	Ruity
34	Seta Engtipi	Boro Longku	
35	Kache Enghipi	Boro Longku	
3[illegible]	Kanet Terangpi	Boro Longku.	
36	Surju Bisokorma	Longku II (G.P)	[illegible]
37.	HEMPI TCH	Hempi TC Rongkhola Village (Gaon Burha)	TCAIT
38.	Khasri	Dikram Disa	
39.	Samgsing Rangpi	Boro longku	
40 -	[illegible]	[illegible]	[illegible]
41.	Sarmen phangcho.	Umrangso.	[illegible]
42	Joy Sing Terang	B/Longku	[illegible]
4[illegible]	Mohan Sing Jeron	Donka Rev Circle Dongkamukam East Karbi Anglong	[illegible]
50	Bipin Bey.	do	[illegible]
[illegible]	Joychand Kengpi	Langsoi-II (Diyungbra)	Ikenpi
52	Bipul Hojai	Dima Longku	[illegible]
53	Apolal Warisa	Dima Longku	A. Warisa
54.	Longsing Rongpi	c/o ARO's office Donka Rev. circle, Dongkamukam West K/A	[illegible] 10/9/17 Tuesday
55	Sam Sing Warisa	"	[illegible]
56	Hiral Hojai	Diyungbra	[illegible]
57	Dilip [illegible]	Longku	[illegible]
58	Bipmani Rongphar	18 Km U/Su	[illegible]
59	Prafulla chetia	do	[illegible]
60	Meghnath Gahri	Longku	[illegible]

Attendance of Public Hearing of Proposed "Lower Kopili Hydro-Electric Power Project". (3)

Sl. no.	Name	Address	Signature
61	Sondekha Hojai	upper disa	
62	Someche Hojai	- do	
63	puja phonglo	Dima Longku	P. phonglo
64	Dishola Naiding	Longku pur	
65	Priya Hojai	Dima Longku	P. Hojai
66	Hemaxi Jatear G.B	Tosdelango	[illegible]
67	Sung Engti GB	Chotolangtu	[illegible]
68	Bidyasing Engti	Boroloongku	[illegible]
69	Lihangi Warisa	Digram disa	
70	Rjib Torm	Boro longku	R.T
71	Hari Sing Ronghang	Torte langso	[illegible]
72	Lotha Naiding	Longkupur	L Naiding
73.	Mondira Kemprai	Dima Longku	M. K.
74	Moni. Warisa.	Dima Longku	M. W.
75.	Shamfula Naiding	Longku pur	
76.	[illegible]	[illegible]	[illegible]
77.	Shine liti Kamprai	Digram disa	
18	Sika Patorpi	longku	
19	Misbong Koo		
20	Basapi Rongkangpi	Longku	
21	Kacha Koopi	Long Ku	
22	Simeepi	Baralongku	
23.	Moina Engtipi	Mong Klam	[illegible]
24	Pritgha Englipi	Mongkla	[illegible]
85	Elvin Engti	Rongkhelan, Umrongso	[illegible]
86	Latifoon Hanse	Rongkhelan, Umrongso	[illegible]
87.	Niroб Chetry	Krung Thung Lang disa	[illegible]
88	-	-do-	
89	Sri Robinson Rongphar	chotolongku	[illegible]
90	Sri Longsi Bey	chotolongku	[illegible]
91.	Rensing phangcho	Soro Langklam	[illegible]
92	Fransis Engti	Koundlangsu	[illegible]
93	Jaysing Ronghi	umrongso	[illegible]
94	Sri-Mohansing Phangcho	Longku	Sphangcho 10/12/2007

Attendance of Public Hearing of Proposed "Lower Kopili Hydro-Electric Power Project.

Sl.no	Name	Address	Signature
95	Robin Son Tenon	Umrongso	
96	Longsing Roggi G. Selo Karbi Students' Association Dima Hasao committee Umrongso.	Umrongso	10/1/17
97	BORSING ENGHEE, MSc, M.Ed. LLB	Borolangklam	
98	Augustine Engti. Ed. Secretary KSA Dima Hasao Dist. Committee, Umrongso	Umrongso	
99	Devenson Engti B.A (English)	Mungkole	
100	Amin phangcho	Borolangklam	
101	Long Engti	Borolangklam	
102	Sharmila Naiging	Uppa Aka	
103	Lorino Naiding	Dima Longku	
104	Moipai Hajai	Dima Longku	
105	Maimai Hajai	Dima Longku	
106	Kaimai Warisa	Dima Longku	
107	sunjita Ribsa	Dima Longku	
108	Bijani Warisa	Dima Longku	
109	Robita Naiding	Dima Longku	
110.	Daido Di Thaosen	Disapra	
111	Seema Enghipi	Boro langklam	
112	Kari Awoongpi	Soto Longku	
113.	Rikri enghipi		
114.	Kaidong Enghipi	Soto longku	
115.	Kareng Rangpipi	Soto Longku	
116.	Phaima Rangthipi	Longku pur	
117.	Kaseng Enghipi	Mondle	
	Alisha Ronghangpi	Boro Long Ku	
	Sorali Ronghangpi	Boro Long Ku	

(A)

Attendance of Public Hearing of Proposed
" Lower Kopili Hydro Electric Power Project "

Sl.no.	Name	Address	Signature
120	Ranima Naiding	Digrem disa	R. Naiding
121	Ringsmai Phonglo	Digreem disa	R. Phonglo.
122	Romila Phonglo	Digrem disa	[illegible]
123	Sapali Hojai	Dima Longku	S. Hojai
123	Nali Naiding	Waprodisa	N. Naiding
124	Nunita Kemprai	Langkupur.	N. Kemprai
125	Nobita Kemrai	Digram disa.	N. Kemrai
126	Pulita Langthosa	Digram disa	P. Langthosa
127	Sonita Naiding	Disabra	S. Naiding
128	Samai Thousen	Disabra	
129	Rungram Naiding	"	
130	Hantamon Kemprai	"	
131	Pintu Kemprai	"	
132	Kave Engtipi	Chotolangpar	
133	Karik Kropi	"	
134	Kapang Teroupi	"	
135	Prine Beypi	"	P Bey pi
136	Karong Rongphupi	B/Loukhu	
137	Maloti Phungchopi	Choto langpher	M. Phungchopi
138	Karong Phangchopi	"	
139	Juli Rongpipi	"	
140	Karong Teroupi	"	
141	Karong Engtipi	"	
142	Nalini Kemprai	Disabra	N. Kemprai
143	Archna Kemprai	" "	A. Kemprai
145	Albina Kemprai	Disabra	A. Kemprai
146	Rashmi Hojai	"	R. Hojai
147	Polbitha Kemprai	Disabra	P. Kemprai
148	K. Sarbing Terang	Boro Loukhu	
149	Beren Sing Engti	Mungkeli	[illegible]
150	Jeffrey Chenthong	Vo-onglaukilangso	J. Chenthong
151	Sanjay Terang	Boro Langlai	[illegible]
152	Hemari Terang	Lorulangso	[illegible]
153	Alband Hanse	Lorulangso	[illegible]
154	Joysing Teron	Chotolangpar	[illegible]

Attendance of Public Hearing of Proposed
"Lower Kopili Hydro-Electric Power Project."

Sl.no	Name	Address	Signature
155	Robinson Engti	Mungkere	R. Engti
156	Orsing Teron	Umrongso	Orsing Teron
157	Ajit phangcho	B-Longku	Ajit
158	Samsing Teron	Tortelangso	[illegible]
159	Khonsing Terang	B/Longku	[illegible]
160	Sanjib Chetri	Gobindanagar	Chetri
161	Pitambar upadhay	Lower Tumbung	[illegible] 10/01/17
162	ईश्वर बहादुर सोनार	[illegible]	[illegible]
163			
164	Govin upadhaya.	Lower Tumbung	[illegible]
165			
166	[illegible]	[illegible]	[illegible]
167	LongkiRongrang	Longku	[illegible]
168	Doben Rongheng	B/Longku	D Rong
169	Hemani Englei	mungkele	[illegible]
170	Sittemari Engti	"	Hengo
171	" Hemari Durong	"	[illegible]
172	Probin Hojai GS. LKHEPAPA	Longku	[illegible]
173	Arabinda Das, Asstt. Engineer	P.C.B. Assam, Silchar	[illegible] 10/01/17
174	Nagen Chandra Bora, AE	-do-	[illegible]
175	Dilip Teron.	Asstt. Rev Officer Dentu P. Circ	[illegible]
176	KRISHNA PHATOWALI	MD: APGCL	[illegible]
177	Utpal DUHA	OSD APGCL	[illegible] 10.01.017
178	Prasanta Khaund	CGM (H&C) APGCL	[illegible] 10/01/17
179	P. D Korkhanis	Chief Engineer, WAP [illegible]	[illegible]
180	Mira Sarma	[illegible] GM Desp[illegible]	[illegible] 10/01/17
181	Antara Baruah	GM(HQ), APGCL	[illegible] 10/1/17
182	Santi Mazumdar	Project Director (PMU), APGCL	[illegible]
183	R.C. Talukdar	DGM(C)	[illegible] 10/1/17
184	R. Enghi	ARO, N.C. Hills A/council	[illegible]

(5)

Attendance of Public Hearing of Proposed "Lower Kopili Hydro-Electric Power Project

Slno.	Name	Address	Signature
185	Dipak Jidung ACS, ADC	DC's Office, Haflong	[signature]
186	B K Baruah	PCBA, Gty	[signature]
187	Bijoy Poudel	Gobinda Nagar, Uso	[signature]
188	Preetam Joishi	Gobinda Nagar, "	P. Joishi
189	Hemanta Joishi	-Do-	[signature]
190	Deepak Chedri	Mikephung	[signature]
191	Bhanu Poudel	Gobinda Nagar	[signature]
192	Chandan Sharma	-Do-	[signature]
193	Jibon Sharma	"	J Sharma
194	Lalsa Lama Gen. Secy	Dima Hasao Rural Dev. Society (NGO)	
195	Kennedy Fonglee	Rongtasme	Khonei
196	Purushottam Joishi	Gobindanagar / USO	[signature]
197	Madhab Upadhyay	L. Tuning	[signature]
198	Kishan Gurung	Kopili	[signature]
199	Geeta Poudel	Gobinda Nagar	[signature]
200	Narayan Paudel	Gobinda Nag	N
201	Prem Pd. Joishi	"	Prem
202	Kiran Joishi	"	[signature]
203	Arjun Chetri	Mimphung	[signature]
204	Bishnu Neupane	L. Tuning	[signature]
205	Lal Pd Joishi	G. Nagar	
206	Mahadeb Sharma	G. Na	M
207	Sri Dil Kumar Subba		[signature]
208	Churamoni Lepathaga	Rong Anfiny	[signature]
	Elam Marak	Lonthu	[signature]

(B.K. Baruah) 10/1/17
Chief Env Engineer
Pollution Control Board, Assam
Bamunimaidam, Guwahati-21

(D. Jidung) ACS 10/1/17
ADC, Dima Hasao
Addl. Deputy Commissioner
Dima Hasao District, Haflong

Photographs of Public Hearing Proceedings

Public Hearing Notice displayed at several locations

Gathering at Public Hearing Venue

Presentation of Project and EIA by Project Proponent and Consultant

Interaction from Participants

ANNEX 8: CLIMATE RISK AND VULNERABILITY ASSESSMENT REPORT

(To be Provided Later as Separate Volume)

ANNEXURE PART 2 – MANAGEMENT DOCUMENTS

ANNEX 9: BIODIVERSITY CONSERVATION AND MANAGEMENT PLAN

1 INTRODUCTION

1. The need for conservation, preservation and management of biological diversity arises because of threats to natural ecosystems by anthropogenic activities. The construction of the dam and other project ancillaries is likely to disturb the natural ecosystem, and thus there is a need for conservation, preservation and management of the biodiversity. Activities that may affect the biodiversity due to the proposed project would include land acquisition, felling of forests, disturbance to wildlife and avian habitat such as for road construction, blasting and excavation for tunnels, quarrying, dumping of excavated materials, and human population pressure on the resources at the project site and both upstream and downstream of the project. These activities cannot be prevented, but they can be mitigated. The main concern is the loss of reserved forest lands (total land 522.37 Ha) and possible occurrences of wildlife in and around the project area.

2 POTENTIAL IMPACTS

2. Impacts on biodiversity[137] was assessed by mapping the study area[138] with respect to (i) IUCN Red list, (ii) protected areas / biological corridors, (iii) important species and biodiversity areas, (iv) forests, and (v) other potentially sensitive habitats.[139] For distribution and habitat requirements of endangered species, a detailed analysis and species-specific data was noted.[140]

3. Detailed assessment of distribution and habitat requirements of critical, endangered and Schedule I species and criterion utilized are provided in Annexure II. Note: All the information in this critical habitat assessment will be reviewed on a species basis by the Wildlife Division, Department of Environment and Forests for updating and accuracy.

4. The impacts due to pre-construction, construction, and operation of the proposed project (LKHEP) and the power evacuation system that will affect various habitats and biodiversity of the project area as well as mitigation and monitoring are also described in next sections.

2.1 PRE-CONSTRUCTION STAGE

5. Land acquisition – both temporary and permanent, and conversion of forests to create access roads, housing/office colonies, dam construction site, etc. will result in permanent loss of habitat and associated biodiversity, as areas are no longer accessible or attractive to terrestrial

[137] International Union for Conservation of Nature (IUCN) defines biodiversity as "the variability among living organisms from all sources including terrestrial, marine and other aquatic ecosystems, and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems."

[138] As per the methodology adopted for the EIA, the study area for the EIA study consists of the following: 1. Submergence area; 2. Area within 10 km of the periphery of the submergence area; 3. Area to be acquired for locating the various project appurtenances; 4. Area within 10 km of various project appurtenances; and 5. Catchment area intercepted at the dam site extending up to diversion structure of LKHEP project (see Chapter I Introduction). **Note the term study area and project area have been used interchangeably in this chapter.**

[139] The threatened species grid layer found in IBAT for Business was utilized.

[140] Critical habitat determination as per International Finance Corporation (IFC) Performance Standard 6, Guidance Note 2012

wildlife; and temporary loss of habitat and associated biodiversity in the power evacuation (transmission) corridor due to vegetation clearing and disturbance of terrestrial wildlife during tower construction activities; equipment in the area may inhibit wildlife movements. Note: temporary land acquisition will revert to rehabilitated or wild state after completion of construction activities.

2.2 CONSTRUCTION STAGE

6. Anticipated loss of habitat and disturbance of terrestrial wildlife, avifauna and other species during construction activities, increase in poaching, etc.

2.3 OPERATION STAGE

7. Maintenance of the LKHEP and power evacuation system (transmission line corridors) as a right-of-way (ROW). Biodiversity impacts during operation phase will be minimal as affected areas will return to the state of equilibrium as vegetation re-grows in the project area.

3 KEY FINDINGS

8. The proposed project will not impinge on any Protected Area / Biological Corridors or corresponding buffer zones.

9. The proposed project does not affect important species and biodiversity areas (both upstream and downstream of project area).

10. The proposed project does not affect areas included under International Union for Conservation of Nature and Natural Resources (IUCN) 141 Level II category. However, stakeholder consultations and field observations confirmed that the biodiversity of the area is complex. Affected stakeholders confirmed the presence (and movement) of Asian elephants, Chinese pangolins, monkeys, stags, deer, wild boars, jackals, bears, and woodpeckers in and around the study area.[142]

4 POTENTIAL IMPACT ON BIODIVERSITY AND MITIGATION MEASURES[143]

S. No	Potential Impact on Biodiversity	Mitigation Measure	Remarks

[141] IUCN provides a comprehensive analysis of the global conservation status, trends, and threats to species viz the IUCN Red List (or Red Data List); the Red list establishes a baseline from which to monitor the change in status of species; provides a global context for the establishment of conservation priorities at the local level; and on a continuous basis, monitor the status of a representative selection of species (as biodiversity indicators) that cover all the major ecosystems of the world. http://www.iucnredlist.org/about/overview

[142] The Krugming Reserve Forest (RF) in Dima Hasao and the District Council RF in Karbi Anglong is home to wild elephants among other animals. The affected communities experience frequent movement of elephants from Longku side and Panimur side – both situated on the right bank of River Kopili in Dima Hasao. Wild elephants also cross left bank to right bank from within the District Council RF in Karbi Anglong up to and across to Dima Hasao. The movement of wild elephants is typically intensified during the rainy season when these animals move out from the Reserve Forest area in search of food to other nearby areas. Note: the forest ranger Panimur did not know of a specific elephant corridor. Additionally, the Reserve Forests also hosts animal species such as Stag (moso), Chinese Pangolin, Deer (meesai), Wild Boar, Monkeys (magusa), Jackal, Birds such as the wood pecker (daojgaima), and some reptiles.

[143] NOTE: Mitigation and Monitoring tables will be made available in the local language and placed at local Autonomous District Council (ADC) offices, LKHEP project site offices, local library, schools, etc.

S. No	Potential Impact on Biodiversity	Mitigation Measure	Remarks
Pre-Construction Stage			
1	Loss of forest cover due to land acquisition (temporary / permanent)	• Compensatory afforestation plans and programmes • Cut only trees marked by the Forest Department • Ensure that the area is cleared as per directives/delineation of Forestry staff	• Collaborate with Department of Environment and Forests to minimize impact on forests: once the contractor has been awarded the work, the project must ensure that the contractor and his engineer work closely with the forestry field staff. • The Contractor must ensure that only those trees that are marked are felled, and that land clearing does not exceed beyond the designated area delineated by the Forestry staff. • All felled trees must also be removed carefully to avoid damaging nearby trees (then trees will be replanted under the compensatory afforestation program in the area that is cleared; See Compensatory Afforestation section of this chapter; tree cutting and subsequent afforestation will be carefully monitored).
Construction Stage			
2	Loss of Biodiversity, Disturbance / accidents/ injury, to wildlife and avian fauna.	• Creation of a greenbelt around the perimeter of various project appurtenances, selected stretches along reservoir periphery, access roads to compensate for the loss of habitat (see Chapter 10 – Greenbelt development of EMP) • Conservation actions as proposed by IUCN (during construction and during the initial project operation) such as conducting a comprehensive survey and monitoring in and around the project area to establish range, distribution and population status of vulnerable and critical habitats in the project area for assessing its habitat requirements and identifying threats will be undertaken. • Biodiversity Conservation and Wildlife Management	• Rescue and release of wildlife species encountered during construction works: the contractor will be required to contact the Park office in case any wildlife /avifauna are encountered or injured by accident during construction works. The rescue, treatment, and release of wildlife will be done immediately and be as per protocols followed by the Wildlife Division of Department of Environment and Forest and Prevention of Cruelty to Animals Act, 1986). • Some other measures: ○ Provision of wild fruit plantation for wildlife ○ Annual bird count of migratory birds by involving locals and bird experts ○ Rehabilitation with local fruit bearing species in gaps ○ Anti-grazing drive in drawdown area to protect the bird breeding areas in proximity to reservoir during breeding season ○ Construction of check posts / watch towers in key locations

S. No	Potential Impact on Biodiversity	Mitigation Measure	Remarks
		Plan • Compliance with guidelines issued by the National Wildlife Board of India for linear intrusion in natural area pertaining to roads and power lines. • Compliance with guidelines issued by the Central Electricity Authority (CEA) and IFC EHS guidelines for Electric Power Transmission and Distribution for laying transmission lines in areas critical from the point of view of saving wildlife.	
Operation Stage			
3	Loss of biodiversity due to felling of trees	• Cut only trees marked by the Department of Environment and Forests; otherwise tree top lopping only • Afforestation program to re-vegetate and restore the area to its natural state	• See remark in row 1 • Regular clearing of the vegetation within ROW, especially near the tower foundations, will maintain stunted vegetation and reduce the quality of wildlife habitat; however, areas between the tower foundations can be allowed to grow to a height of about two meters, which will provide cover for most wildlife that need to move through the ROW

5 MONITORING MEASURES[144]

Mitigation Measure	Indicators	Period	Responsibility	Monitoring	Frequency
Compensatory afforestation (see Compensatory afforestation section of this Chapter)	Acres of land replanted, in areas designated by Department of Forests	All Phases	Project management and Social Forestry Division with local forestry staff	APGCL	Quarterly
Cut off only those trees marked by the Forestry staff	Number of trees felled in excess of those marker	Pre-Construction	Contractor and Project management	APGCL	Quarterly
Ensure that area cleared is as Per directives / delineation of	Land clearance as per demarcation	Pre-Construction	Contractor and Project management	APGCL	Quarterly

[144] NOTE: Mitigation and Monitoring tables will be made available in the local language and placed at local Autonomous District Council offices, LKHEP project site office, local library, schools, etc.

Mitigation Measure	Indicators	Period	Responsibility	Monitoring	Frequency
Forestry staff					
Creation of a greenbelt around the perimeter of various project appurtenances, selected stretches along reservoir periphery, access roads to compensate for the loss of habitat (see Chapter 10 – Greenbelt development of EMP)	Length of Greenbelt developed. Number of roads with green belt	Construction and Operation	Project management and contractor	APGCL	Quarterly
Biodiversity Conservation and Wildlife Management Plan (see separate section below)	As per biodiversity plan	All Phases	Project management, Wildlife Division of Department of Environment and Forest staff, Assam Biodiversity Board	APGCL	Quarterly
Hand over road to the Department of Environment and Forest for Compensatory Afforestation program to re-vegetate and restore the area to its natural state	Unused access roads re-planted/ no erosion	Operation	Project management	APGCL	Quarterly

6 BIODIVERSITY CONSERVATION AND WILDLIFE MANAGEMENT PLAN

11. The Biodiversity Conservation and Wildlife Management Plan for the proposed project have been framed with an objective to:

- Conserve and preserve natural ecosystems around the proposed project;
- Minimize project impacts on rare, endangered or threatened species and rehabilitate keystone species, if any; and
- Develop the information database on biodiversity at the project site.

6.1 ESTABLISHMENT OF A BIODIVERSITY MANAGEMENT COMMITTEE

12. A Biodiversity Management Committee shall be constituted for effective implementation, monitoring and evaluation of the Biodiversity Conservation and Wildlife Management Plan for the project. The committee shall constitute representatives from the project authority, members of the Autonomous Council of Dima Hasao and Karbi Anglong, Department of Environment and Forests, Forests and Wildlife Division, and Assam Biodiversity Board. The committee will look after the demarcated conservation areas, monitor and enforce regulatory provisions and ensure

that the structure and functions of the natural ecosystems in the area are not changed or subjected to any threat. It would also propose other approaches for the biodiversity conservation plan, whenever deemed necessary (including the proposed measures for elephants and Chinese pangolins, mentioned previously).

6.2 CONSERVATION PLAN FOR FLORAL SPECIES

13. Impact on habitat is related to loss of vegetation due to temporary and permanent land acquisition required for the project area and Right of Way (RoW) clearing for the proposed transmission corridors. The LKHEP footprint is about 834.21 ha of which 95% of the catchment area at River Kopili dam site is forested (including reserved forest and proposed reserved forests).

14. **Rescue of Flora:** Since the project area has a rich biodiversity, efforts will be made to rescue and conserve any botanical species deemed worth conserving and cultivating for scientific and educational purposes. This is especially so for endemic species that may otherwise be damaged during brush / vegetation clearance or that may be lost by the submergence at the dam site. The project proponent /operator will seek technical assistance and collaboration of the Assam Biodiversity Board and Department of Environment and Forests in this matter prior to any road clearance or construction activities. After rescue, for the conservation of floral species, it will be placed in a selected site in such as an existing Botanical Garden. This activity will take place in the pre-construction phase of the LKHEP project. Specific sites, such as the submergence area, cleared areas for infrastructure, roads, and muck disposal, and RoW for power evacuation corridors will be surveyed in detail for this purpose, before any clearing activities take place.

15. **Up gradation of a recreational area at Panimur forest ranger station**: The Panimur forest ranger station which is currently utilized as a picnic spot by the general public will be up graded to improve the aesthetics of the surroundings. Tree cover will be expanded through systematic planning and implementation of afforestation program especially via plantation of native fruit and flower bearing trees. The indigenous fruit bearing plants are proposed to be planted so as to enrich the habitat. Picnic tables will be provided as constructed via recycled wood, and coverings will be provided at appropriate location for shade.

16. **Ensure Minimal Land Clearing and Removal of Vegetation**: The project proponent /operator will ensure that the land acquisition process (temporary and permanent)for conversion to other land uses such as for construction of dam, colonies, roads, etc., and temporary storage area for construction material, waste, etc., is as per the identified acreage and that there is no rampant clearing or felling of forests in and around work sites including when establishing the Right Of Way (ROW) for the power evacuation system. Only those trees identified and marked by the Department of Environment and Forests will be felled and removed from the project area.

17. **Rehabilitate and Restore All Cleared Sites**: All temporary land acquisition areas will be restored in collaboration with the Compensatory Afforestation Program, with fast growing local (native) species of trees and shrubs to allow the area to be rehabilitated to the wild state. Rescued Flora may be replanted here. Post construction audit will be conducted to compare biodiversity aspects before and after the project works.

6.3 WILDLIFE AND AVIFAUNA CONSERVATION

18. Project affected stakeholders have identified that there may be elephant corridors in and around the surrounding project area, although these were not clearly demarcated or confirmed by the Forest ranger in the area. Stakeholders confirmed past sightings of elephants, monkeys, stag, deer, wild boars, jackals, bears, and woodpeckers, Chinese Pangolin in and around the project area. Under IUCN conservation status, elephants are considered as endangered (EN) while Chinese Pangolins are considered as Critical (CR); both are on Schedule I of the Indian Wildlife Protection Act (1972) which is the highest protection accorded to species in India.

19. **Rescue and Release Program**: Land clearing may result in encounters with wildlife and avifauna; all wildlife and avifauna encounters will be logged. A program for capturing, treating/rehabilitating, and releasing wild animals / avifauna found in pain or distress, particularly as a result of human interference and project activities, will be initiated with the Forest Division at Haflong with assistance of the Wildlife Division, Department of Environment and Forests, and nearest local Animal hospital. The primary goal will be to treat and rehabilitate the wildlife / avifauna and release them back to the habitat from which they were collected (or safe adjacent areas). This component includes allocation of a site, design and construction of animal accommodation/ enclosures, treatment facilities, and equipment for the capture, treatment and release procedures, medicines, trained manpower/veterinarian, and a caretaker, as well as a data management and record keeping system.

20. **Promote Wildlife Surveys and Monitoring in and around the Project Area** (extending up to Kruming Reserve, Panimur (proposed) reserve forest and down to Diyung reserve forest on the right bank of the river Kopili and across to District Council Forest of Karbi Anglong on the left bank of the river Kopili. This activity is aimed at adding to the existing knowledge base on wildlife presence and movements in the vicinity of the project area. This is especially recommended so that the data collected can add to the baseline information collected during the EIA preparatory phase (adding to the seasonal data). Also, as project activities may be ongoing in animal corridors, the surveys will improve the understanding of wildlife presence, distribution, movements and seasonality in the wider vicinity of the project area. This will ensure strict monitoring of any encroachments, and also add to the biodiversity database especially for endangered species such as elephants. The presence of wildlife will be monitored by using camera traps provided by the project. This wildlife survey will be conducted with the assistance of the Wildlife Division, Department of Environment and Forests.

21. **Compensatory afforestation program for restoring habitat for avian fauna:** Disturbance of avifauna is expected during construction and operation activities in the project area. Habitat loss will be compensated via compensatory afforestation program (details provided in detailed Compensatory Afforestation section) and planting of species based on the climatic and edaphic conditions of the locality, ensuring composition of different species (trees and shrub) for successful growth. Species composition selection will be important in ensuring diversity of avifauna (this shall apply to wildlife as well) and will be decided in consultation with the Assam Biodiversity Board and Wildlife Division, Department of Environment and Forests. For power evacuation system (transmission corridors), the operation of overhead transmission lines will constitute a persistent threat to birds given the height (typically up to 45 m above ground) and the fact that conductors are thin and difficult for birds to detect and avoid. The impact on avian fauna could be relatively high in low visibility conditions, especially bad weather, but it is very difficult to quantify the risks. Bird mortalities that are observed and that can be attributed to the transmission lines will be recorded. Note that the project activities are not expected to alter bird migration or affect any important bird areas / species on the IUCN list.

22. Conservation actions as proposed by IUCN (during construction and during the initial project operation) such as conducting a comprehensive survey and monitoring in and around the project area to establish range, distribution and population status of vulnerable and critical habitats in the project area for assessing its habitat requirements and identifying threats will be undertaken.

6.3.1 ANTI-POACHING MEASURES

23. Hunting and poaching is a possibility due to the presence of construction workers. The possibility of hunting and trapping by workers during construction period will be site-specific and will decrease once the work is completed. The overall magnitude of impact is considered to be low, extent is site specific and duration is short period.

24. **Awareness Raising Programs**: With the construction of the access roads, the accessibility of humans to the LKHEP project area will increase, which may increase the risk of poaching. Raising awareness will be an important means to mitigate this risk. Awareness will be raised among workers and contractors regarding illegal poaching and copies of the Indian Wildlife Act, Biodiversity Act, Prevention of Cruelty to Animals Act (1986), other relevant Rules and Regulations as well as Biodiversity Mitigation and Monitoring tables (see section 2.4 and 2.5) will be made available in the local language. Copies will be made available at the project site and forest ranger stations of the vicinity. Workers must be made aware of the fines and penalties for poaching, as well as the risk of job loss, if caught in these illegal activities. This will be done during the pre-construction phase, but after the Contractor has been selected and continue intermittently through the construction phase.

25. **Strengthen Patrolling**: To minimize the risks of poaching, awareness raising programs will be combined with an increase in patrolling by local forest rangers (in coordination with forest department) and construction of check posts and watch towers at key locations. The choices of location of check posts and watch towers will be guided by consultations with forest rangers in the area. To support enhanced patrolling, the project will provide assistance through purchase of equipment such as GPS, binoculars cameras, bikes, camera traps, etc.

26. **Community Watch Program**: The project will also discuss possibilities for funding a community watch program, through hire of village guards to alert forest rangers officials of any illegal activities in the worker camps or at project sites.

6.3.2 MITIGATION OF HUMAN-WILDLIFE CONFLICT

27. As per a paper published by the Assam Biodiversity Board[145], “opencast coal mining upstream of the LKHEP project area (Meghalaya and Assam) have disturbed and destroyed wildlife habitat, as well as caused pollution. The workers, many of whom are poachers, have encroached on adjacent forestlands. New settlements have been developed due to other subsidiary activities. Construction of roads and other infrastructure projects destroy and fragment natural habitat, and allow encroachment, logging, and poaching to occur.” As a consequence, elephants, in particular, will have less space to live and may lose access to migratory routes (in the coal mining areas south of the project area). Human-elephant conflicts have the potential to increase. To minimize the human-wildlife conflict, funds will be provided for the concerned villages or Autonomous Councils (whichever is most relevant) in the project area

[145] Human–Elephant Conflicts in Northeast India; Human Dimensions of Wildlife, 9:261–270, 2004, accessed via Assam Biodiversity Board

to develop a proposal for mitigation of such conflicts and for strict monitoring of encroachment into elephant habitat. This plan will be formulated with assistance from the Wildlife Division, Department of Environment and Forests; and once approved, will be disseminated through workshops and meetings and implemented as per the proposal. The program will be tested in one village in PAI and if successful, then it may be replicated in other villages. In addition to this, camera trap surveys in the contiguous forest zone south of the project area and construction of river fords for elephants (south of the project area) are proposed.

6.4 COMPENSATORY AFFORESTATION PROGRAM

28. A key issue to be addressed is compensation for use of forests (reserved forests, proposed reserved forests, un-classed state forests). The ADB safeguard policy intimates that compensation payments be used for actual afforestation / reforestation efforts. The above will be reinforced by the ADB loan agreements that include assurances and conditions to the effect that forest compensation payments will go to actual afforestation and/or reforestation activities and the process to be subject to audit or other fiduciary review.

29. The India Forest (Conservation) Act, 1980 and Rules will be followed to ensure a systematic approach to rehabilitation and afforestation so that the Country's commitment to maintaining environmental stability through preservation and where necessary, restoration of the ecological balance that has been adversely disturbed by serious depletion of the forests (of the country) can be achieved. [146] In order to ensure that a successful afforestation and conservation program is achieved, the project proponent/operator will collaborate with the Department of Environment and Forests.

30. The Indian Forest Conservation Act (1980) stipulates:

- If non-forest land is not available, compensatory plantation is to be established on degraded forest lands, which must be twice the forest area affected or lost.
- If non- forest land is available, compensatory forest are to be raised over an area equivalent to the forest area affected or lost.

31. The total land requirement of the LKHEP project is 1577 Ha, with the following breakdown in land use pattern:[147]

- Reserved Forest Area – 522.37 Ha
- Private Land 1054 Ha

32. The forest land to be acquired for the project is 523 ha. Thus, a total of (523* 2) 1046 Ha of land will be utilized for compensatory afforestation. Note: The power evacuation system will not affect any forests as these will be avoided.

33. Another key feature of compensatory afforestation is that it should firstly focus on deforested areas in and around the project site preferably at site with a large circumference (in terms of Ha) such that a large number of tree saplings are replanted collectively; this provides saplings a better chance of survival, creates a healthy habitat, and will help in monitoring of the program. If enough large sites are not available, then it may not be restricted to project areas

[146] National Forest Policy, 1988; Also see Assam Compensatory Afforestation Fund Rules, 1994; and GOA Guidelines for Compensatory Afforestation, 2000 (details in Appendix I)
[147] Detailed Project Report, Volume IA_Main Report Part 1 of 2 and Part 2 of 2, updated September 2015.

but extend to other areas within the vicinity of project area. The program will also focus on barren areas that are located in the upper catchment, so that erosion can be minimized and the quality of water going into the reservoir maintained. After developing a mutually agreeable project proposal between the project proponent /operator, Haflong Forest Division, and Forest Division, Department of Environment and Forests, the Memorandum of Understanding (MOU) shall be drawn covering project activities for financing and execution.

34. Priority areas for replanting will be identified such as specific large areas in and around the project site preferably at sites with a large circumference (in terms of Ha), barren stretches around the upper catchment area, then along the State highway, edges and slopes of access roads, muck disposal sites, around the quarry sites, around permanent colonies and residencies, in the green belt (see Chapter 10 of EMP), and other barren areas characterized by overgrazing, forest fire damage, or tree felling).

35. Implementation and Monitoring: The Forest Division at Haflong, and Forest Division Department of Environment and Forests shall be responsible for implementation of afforestation activities, based on the MOU in direct collaboration with the project proponent / operator. The Forest Division at Haflong will be the focal agency for all the technical matters, including need-based monitoring and evaluation.

36. Monitoring will be very important for assessing the success of plantation and rehabilitation works. There will be three tiers of monitoring: (i) regular monitoring by the Forest Division at Haflong (partner implementer); (ii) ad hoc monitoring by the Forest Division, Department of Environment and Forests; and, (iii) joint monitoring by three agencies (partner implementer, department, and the project proponent/operator). The monitoring protocols will be outlined in the MOU.

6.5 ADDITIONAL MEASURES: WATER QUALITY RESTORATION AND BIODIVERSITY ENHANCEMENT

37. Aquatic species: the aquatic ecology in and around the surrounding project area (River Kopili) has been affected grievously by acid drainage due to illegal and uncontrolled rat hole mining upstream in State of Meghalaya and Assam. India's National Green Tribunal (NGT) passed a directive in April 2014 to ban rat hole mining in Meghalaya leading to some improvement to the downstream aquatic ecology; however, the issue continues to need attention.

38. The proposed project area offers a unique opportunity for active water quality and ecological restoration by treating acidic water with anoxic limestone drains and constructed wetlands at the upstream end of the reservoir. This approach to countering acidic water may be more cost-effective to implement than using stainless steel and other specialty materials ("chrome plating" vs. "green plating"). At minimum, the use of anoxic limestone drains and constructed wetlands is an insurance policy to protect the turbines, machinery, and equipment, while facilitating biodiversity enhancement. The biodiversity enhancements in the reservoir will partly offset biodiversity loss due to forest removal (i.e., an in situ bio-diversity offset). A water quality restoration plan has been prepared. A budget of $5 million has been proposed for implementation of pilot studies for WQRP.

7 IMPLEMENTATION AND MONITORING SCHEDULE FOR BIODIVERSITY CONSERVATION AND WILDLIFE MANAGEMENT PLAN

Activities	Indicators	Period	Responsibility	Monitoring	Frequency
Establishment of Biodiversity Management Committee	BMC established and Operational Reports of meetings of BMC	All Phases	Project proponent / project management unit (PMU)	Project proponent /PMU	Every quarter
Rescue of flora	Number of floral species rescued	Pre-construction	Partner Implementer	Project proponent/PMU	After pre-construction phase
Up gradation of a recreational area at Panimur forest ranger station	Recreational area established and operational	Construction	Partner Implementer	Project proponent/ PMU	Every quarter
Ensure minimal land clearing and removal of vegetation	% of trees felled as per marking by forestry staff	Pre-construction	Partner Implementer	Project proponent / PMU	Every quarter
Rehabilitate and Restore All Cleared Sites	Number of sites restored and rehabilitated; degree of restoration	Construction and Operation	Partner Implementer	Project proponent / PMU	Every quarter
Rescue and release program	Number of wildlife species rescued, treated and released	Pre-Construction Construction and Operation	Partner Implementer with assistance of Wildlife Division and Local Animal Hospital	Project proponent / PMU	Every Quarter
Promote wildlife surveys	Number of surveys Conducted Number and diversity of wildlife species caught on camera traps	Construction and Operation	Partner Implementer with assistance of Wildlife Division	Project proponent / PMU	Every Quarter
Awareness raising	Number of awareness raising meetings held by project Date of	Construction and Operation	Partner Implementer	Project proponent / PMU	Every quarter

Activities	Indicators	Period	Responsibility	Monitoring	Frequency
	distribution of Acts and regulations				
Strengthen patrolling	Number of patrols carried out Budget for equipment purchase handed over to Park and forestry staff	Construction and Operation	Partner Implementer	Project proponent / PMU	Every quarter
Mitigation of human wildlife conflict	Proposal developed for human-wildlife mitigation Implementation of pilot program	Construction and Operation	Partner Implementer with assistance of Wildlife Division	Project proponent / PMU	Every Quarter

7.1 BUDGET

Target Areas	Cost INR (lakhs)
Establishing Biodiversity Management Committee	20
Conservation Plan for Floral Species	
Rescue of Flora	20
Up-gradation of a recreational area at Panimur forest ranger station	20
Wildlife and Avifauna Conservation	
Rescue and Release Program[148]	70
Promote Wildlife Surveys and Monitoring in and around the Project Area, and river fords for elephants	43
Compensatory afforestation program for restoring habitat for avian fauna	15+10+16.7
Anti-Poaching Measures	
Awareness Raising Program	10
Strengthen Patrolling - Construction of check posts watch towers - Communication equipment - Transportation	25+40
Community Watch Program / Guards	42
Mitigation of Human-Wildlife Conflict	20
Compensatory Afforestation Program	**1,558.09**

[148] The costs may consist of "On-call" staff for trapping/tranquilizing wildlife and moving them, and related expenses; Facilities, equipment, and staff time for handling injured animals; and Contingency for unexpected conservation measures.

TOTAL	1,909.79

7.2 BREAK DOWN OF ESTIMATED COST FOR COMPENSATORY AFFORESTATION

39. The cost of afforestation on degraded forest land is INR1,558.09 lakhs. The details are given in Table1. The unit cost for compensatory afforestation (density will vary from area to area) is given in Table 2. The year wise maintenance cost for seven years is given in Tables 3 to 9. In addition to above the project proponent will pay for the NPV, which shall be estimated by the Department of Environment and Forests.

Table 1: General Abstract of Compensatory Afforestation on Degraded Forest Land

Particular	Area (ha)	Rate (Rs./ha)	Amount (Rs.lakh)
Cost of afforestation including cost of material (Refer Table-2.2)	1,046	69,390	725.82
1st year maintenance (Refer Table-2.3)	1,046	9,870	103.24
2nd year maintenance (Refer Table-2.4)	1,046	8,810	92.15
3rd year maintenance (Refer Table-2.5)	1,046	7,670	80.23
4th year maintenance (Refer Table- 2.6)	1,046	6,960	72.80
5th year maintenance (Refer Table- 2.7)	1,046	5,510	57.63
6th year maintenance (Refer Table- 2.8)	1,046	4,910	51.36
7th year maintenance (Refer Table-2.9)	1046	5,100	53.35
Total			**1,236.58**
Contingencies (% of Total Cost)	5%		61.83
Total			1,298.43
Departmental Charges	20%		259.68
Total			**1,558.09**

Table 2: Unit cost for Compensatory Afforestation on Degraded Forest Land

Particulars of works	Unit	Qty.	Rate (Rs.)		Amount (Rs.)
Survey and demarcation of plantation area including marking of sections, l/path and preparation of map	ha	1	450	ha	450
Carriage of angle iron fence post up to 2 m long and 8 to 10 cm dia over distance 1 km	Nos	60	300	per hundred per km	180
Preparation/digging of holes 20-30 cm dia and 45 cm deep	Nos	60	1,200	per hundred	720
Fixing of angle iron fence posts	Nos	60	500	per hundred	300
Carriage of B/wire over average distance of 1 km up hills	Qtls	1	150	per Qtls. Per km	150
Stretching and fixing of barbed wire in each stand (3 stands)	Rmt	540	10	per Rmt.	5,400
Bush cutting in the plantation site	ha	1	750	per ha	750
Interlacing of thorny bushes in B/wire	Rmt	180	3	per Rmt.	540
Preparation of inspection path 60 cm wide	Rmt	250	15	per Rmt	3,750
Layout of pits	ha	1	500	ha	500
Digging of pits 45x45x45 cm (40% of total)	Nos	440	1,200	per hundred	5,280

Particulars of works	Unit	Qty.	Rate (Rs.)		Amount (Rs.)
Digging of pits 30x30x30 cm (60% of total)	Nos	660	900	per hundred	5,940
Filling of pits 45x45x45 cm	Nos	440	200	per hundred	880
Filling of pits 30x30x30 cm (60% of total)	Nos	660	150	per hundred	990
Carriage of naked root plants over distance 2 km up	Nos	400	100	per hundred per km	800
Carriage of plants in P/bags over distance 2 km up hills	Nos	700	150	per hundred per km	2,100
Planting of entire plants raised in P/bags	Nos	700	300	per hundred	2,100
Planting of Naked root plants	Nos	400	200	per hundred	800
Nursery cost of plants	Nos	1,100	9	per plant	9,900
Total					**41,530**
Add on account of increase on wage rate		0.00%			0
Total					41,530
Soil and moisture conservation works (25% of initial planting)		1 ha		25%	10,383
Total					51,913
Add Tribal increase				25%	12,978
Total					64,891
Add cost of B/wire including cost of U nails		75 Kg		60	4,500
Grand Total					**69,391**
Rounded					**69,390**

Table 3: 1st Year Maintenance 25 % Mortality

Particulars of works	Unit	Qty.	Rate (Rs.)		Amount (Rs.)
Redigging of pits 45x45x45 cm	Nos	110	600	per hundred	660
Redigging of pits 30x30x30 cm	Nos	165	450	per hundred	743
Filling of pits 45x45x45 cm	Nos	110	100	per hundred	110
Filling of pits 30x30x30 cm	Nos	165	75	per hundred	124
Planting of polythene bags plants	Nos	175	300	per hundred	525
Planting of Naked root plants	Nos	100	200	per hundred	200
Carriage of polythene bags plants over a distance of 2 km uphills	Nos	175	150	per hundred	525
Carriage of Naked root plants over a distance of 2 km	Nos	100	100	per hundred	200
Nursery cost of plants	Nos	275	9	per plants	2475
Repair of fence	Rmt	180	2	per Rmt.	360
Repair of inspection path		L/S			600
Repair of soil and moisture conservation works		L/S			1,000
Total					7,521
Add on account of increase on wage rate		5.00 %			376
Total					7,897

Add Tribal increase		25%	1231.71		1,974
Grand Total					**9,872**
Rounded					**9,870**

Table 4: 2nd Year Maintenance 20 % Mortality

Particulars of works	Unit	Qty.	Rate (Rs.)		Amount (Rs.)
Redigging of pits 45x45x45 cm	Nos	88	600	per hundred	528
Redigging of pits 30x30x30 cm	Nos	132	450	per hundred	594
Filling of pits 45x45x45 cm	Nos	88	100	per hundred	88
Filling of pits 30x30x30 cm	Nos	132	75	per hundred	99
Planting of polythene bags plants	Nos	140	300	per hundred	420
Planting of Naked root plants	Nos	80	200	per hundred	160
Carriage of polythene bags plants over a distance of 2 km uphills	Nos	140	150	per hundred	420
Carriage of Naked root plants over a distance of 2 km	Nos	80	100	per hundred	160
Nursery cost of plants	Nos	220	9	per plants	1,980
Repair of fence	Rmt	180	2	per Rmt.	360
Repair of inspection path		L/S			600
Repair of soil and moisture conservation works		L/S			1,000
Total					6,409
Add on account of increase on wage rate		10%			640.9
Total					7,049.9
Add Tribal increase		25%	1231.71		1,762.475
Grand Total	**6158.57**				**8,812.375**
Rounded	**6160**				**8,810**

Table 5: 3rd Year Maintenance 15 % Mortality

Particulars of works	Unit	Qty.	Rate (Rs.)		Amount (Rs.)
Redigging of pits 45x45x45 cm	Nos	66	600	per hundred	396
Redigging of pits 30x30x30 cm	Nos	99	450	per hundred	446
Filling of pits 45x45x45 cm	Nos	66	100	per hundred	66
Filling of pits 30x30x30 cm	Nos	99	75	per hundred	74
Planting of polythene bags plants	Nos	105	300	per	315

Particulars of works	Unit	Qty.	Rate (Rs.)		Amount (Rs.)
				hundred	
Planting of Naked root plants	Nos	60	200	per hundred	120
Carriage of polythene bags plants over a distance of 2 km uphills	Nos	105	150	per hundred	315
Carriage of Naked root plants over a distance of 2 km	Nos	60	100	per hundred	120
Nursery cost of plants	Nos	165	9	per plants	1,485
Repair of fence	Rmt	200	2	per Rmt.	400
Repair of inspection path		L/S			600
Repair of soil and conservation works		L/S			1,000
Total					5,337
Add on account of increase on wage rate		15%			801
Total					6,137
Add Tribal increase		25%	1231.71		1,534
Grand Total					**7,672**
Rounded					**7,670**

Table 6: 4th Year Maintenance 15 % Mortality

Particulars of works	Unit	Qty.	Rate (Rs.)		Amount (Rs.)
Redigging of pits 45x45x45 cm	Nos	66	600	per hundred	396
Redigging of pits 30x30x30 cm	Nos	99	450	per hundred	446
Filling of pits 45x45x45 cm	Nos	66	100	per hundred	66
Filling of pits 30x30x30 cm	Nos	99	75	per hundred	74
Planting of polythene bags plants	Nos	105	300	per hundred	315
Planting of Naked root plants	Nos	60	200	per hundred	120
Carriage of polythene bags plants over a distance of 2 km uphills	Nos	105	150	per hundred	315
Carriage of Naked root over a distance of 2 km	Nos	60	100	per hundred	120
Nursery cost of plants	Nos	165	9	per plants	1,485
Repair of fence	Rmt	200	2	per Rmt.	400
Repair of inspection path		L/S			450
Repair of soil and conservation works		L/S			450
Total					4,637
Add on account of increase on wage rate		20%			927
Total					55,64
Add Tribal increase		25%	1231.71		1,391

Particulars of works	Unit	Qty.	Rate (Rs.)		Amount (Rs.)
Grand Total					**6,955**
Rounded					**6,960**

Table 7: 5th Year Maintenance 10 % Mortality

Particulars of works	Unit	Qty.	Rate (Rs.)		Amount (Rs.)
Redigging of pits 45x45x45 cm	Nos	44	600	per hundred	264
Redigging of pits 30x30x30 cm	Nos	66	450	per hundred	297
Filling of pits 45x45x45 cm	Nos	44	100	per hundred	44
Filling of pits 30x30x30 cm	Nos	66	75	per hundred	50
Planting of polythene bags plants	Nos	70	300	per hundred	210
Planting of Naked root plants	Nos	40	200	per hundred	80
Carriage of polythene bags plants over a distance of 2 km uphills	Nos	70	150	per hundred	210
Carriage of Naked root plants over a distance of 2 km	Nos	40	100	per hundred	80
Nursery cost of plants	Nos	110	9	per plants	990
Repair of fence	Rmt	200	2	per Rmt.	400
Repair of inspection path		L/S			450
Repair of soil and moisture conservation works		L/S			450
Total					3,525
Add on account of increase on wage rate		25%			881
Total					4406
Add Tribal increase		25%	1231.71		1101
Grand Total					**5507**
Rounded					**5510**

Table 8: 6th Year Maintenance 10 % Mortality

Particulars of works	Unit	Qty.	Rate (Rs.)		Amount (Rs.)
Redigging of pits 45x45x45 cm	Nos	44	600	per hundred	264
Redigging of pits 30x30x30 cm	Nos	66	450	per hundred	297
Filling of pits 45x45x45 cm	Nos	44	100	per hundred	44
Filling of pits 30x30x30 cm	Nos	66	75	per hundred	50
Planting of polythene bags plants	Nos	70	300	per hundred	210
Planting of Naked root plants	Nos	40	200	per hundred	80

Particulars of works	Unit	Qty.	Rate (Rs.)		Amount (Rs.)
Carriage of polythene bags plants over a distance of 2 km uphills	Nos	70	150	per hundred	210
Carriage of Naked root plants over a distance of 2 km	Nos	40	100	per hundred	80
Nursery cost of plants	Nos	110	9	per plants	990
Repair of fence	Rmt	150	2	per Rmt.	300
Repair of inspection path		L/S			250
Repair of soil and conservation works		L/S			250
					3025
Add on account of increase on wage rate		30%			907
Total					3,932
Add Tribal increase		25%	1,231.71		983
Grand Total					**4,915**
Rounded					**4,910**

Table 9: 7th Year Maintenance 10 % Mortality

Particulars of works	Unit	Qty.	Rate (Rs.)		Amount (Rs.)
Redigging of pits 45x45x45 cm	Nos	44	600	per hundred	264
Redigging of pits 30x30x30 cm	Nos	66	450	per hundred	297
Filling of pits 45x45x45 cm	Nos	44	100	per hundred	44
Filling of pits 30x30x30 cm	Nos	66	75	per hundred	50
Planting of polythene bags plants	Nos	70	300	per hundred	210
Planting of Naked root plants	Nos	40	200	per hundred	80
Carriage of polythene bags plants over a distance of 2 km uphills	Nos	70	150	per hundred	210
Carriage of Naked root plants over a distance of 2 km	Nos	40	100	per hundred	80
Nursery cost of plants	Nos	110	9	per plants	990
Repair of fence	Rmt	150	2	per Rmt.	300
Repair of inspection path		L/S			250
Repair of soil and moisture conservation works		L/S			250
Total					3,025
Add on account of increase on wage rate		35%			1,059
Total					4,083
Add Tribal increase		25%	1231.71		1,021
Grand Total					**5,104**
Rounded					**5,100**

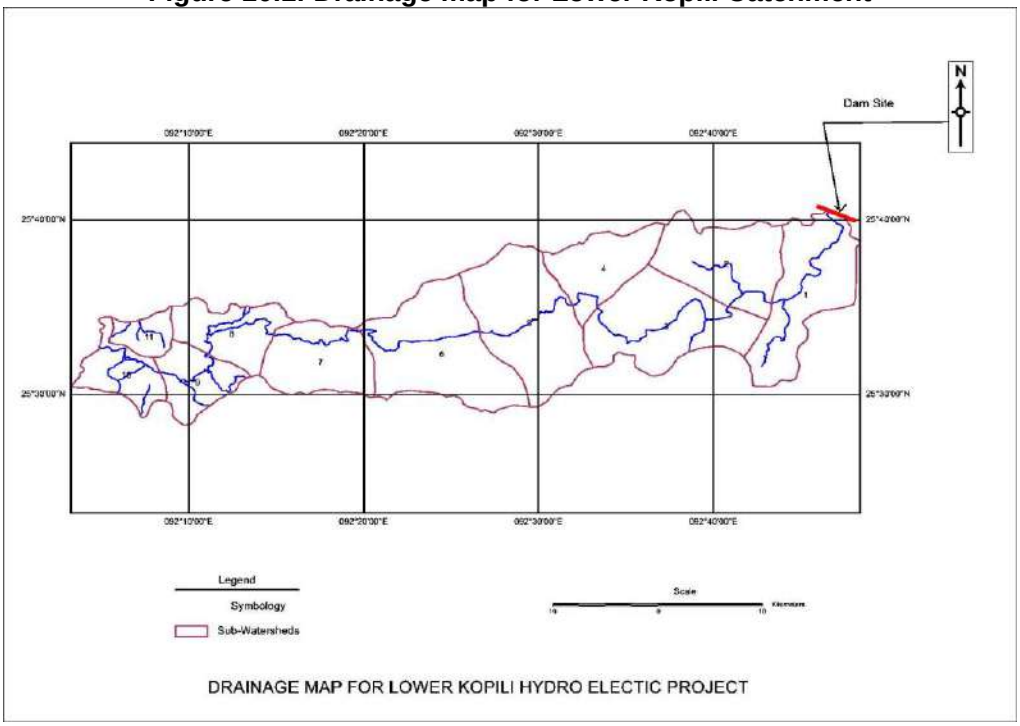
ANNEX 10: CATCHMENT AREA TREATMENT PLAN

1. NEED FOR CATCHMENT AREA TREATMENT (CAT)

1. Accelerated soil erosion in the catchment area of the reservoirs and transport of detached material through the drainage network gives rise to a series of problems, notably depletion of flow capacity, steady loss of storage capacity, consistent drop in hydro-electric power generation and frequent floods. The loss of dead and live storage leads to heavy economic losses due to reduced life span of reservoirs. Therefore, extensive soil conservation and watershed management programmes are needed to minimize the damage to the catchment and mitigation of soil erosion problems. As a part of the CEIA study, a Catchment Area Treatment Plan has been prepared. Silt Yield Index (SYI) method has been used to prioritize sub-watershed into various erosion categories.

2. The CAT Plan has been formulated for intervening draining catchment i.e. up to the proposed diversion structure of Lower Kopili H. E. Project on Kopili river. The total catchment area at proposed Lower Kopili HEP site is 2,076.62 km^2 while at proposed Kopili Dam HEP is 1,256 km^2. Thus, the free draining catchment area proposed to be treated in the present study is 820.62 km^2 (82,062 ha). The sub-watersheds in the catchment area considered for the present study are given in Figure 10.1.

Figure 10.1: Drainage map for Lower Kopili Catchment



3. The catchment area treatment involves:

- Understanding of the erosion characteristics of the terrain and,
- Suggesting remedial measures to reduce the erosion rate.

4. In the present study the `**Silt Yield Index' (SYI)**, method has been used. In this method, the terrain is subdivided into various watersheds and the erodibility is determined on a relative basis. SYI provides a comparative erodibility criteria of the catchment (low, moderate, high etc.) and does not provide the absolute silt yield.

2 APPROACH FOR THE STUDY

5. A detailed database on natural resources, terrain conditions, soil type of the catchment area and socio-economic status etc. is a pre-requisite to prepare treatment plan keeping in view the concept of sustainable development. Various thematic maps have been used in preparation of the CAT plan. Geographic Information System (**GIS**) is a computerized resource data base system, which is referenced to a geographic coordinate system. In the present study, real coordinate system has been used. The GIS is a tool to store, analyze and display various spatial data. In addition, GIS, because of its special hardware and software characteristics, has a capacity to perform numerous functions and operations on the various spatial data layers residing in the database. GIS provides the capability to analyze large amounts of data in relation to a set of established criteria. In order to ensure that latest and accurate data is used for the analysis, satellite data has been used for deriving land use data. Ground truth studies, too, have been conducted.

6. The various steps, covered in the study, are as follows:

- Definition of the problem
- Data acquisition and preparation
- Output presentation

7. The above mentioned steps are briefly described in the following paragraphs:

2.1 Definition of the Problem

8. The requirements of the study were defined and the expected outputs were finalized. The various data layers of the catchment area to be used for the study are as follows:

- Slope Map
- Soil Map
- Land use Classification Map
- Current Management Practices
- Catchment Area Map.

2.2 Data Acquisition and Preparation

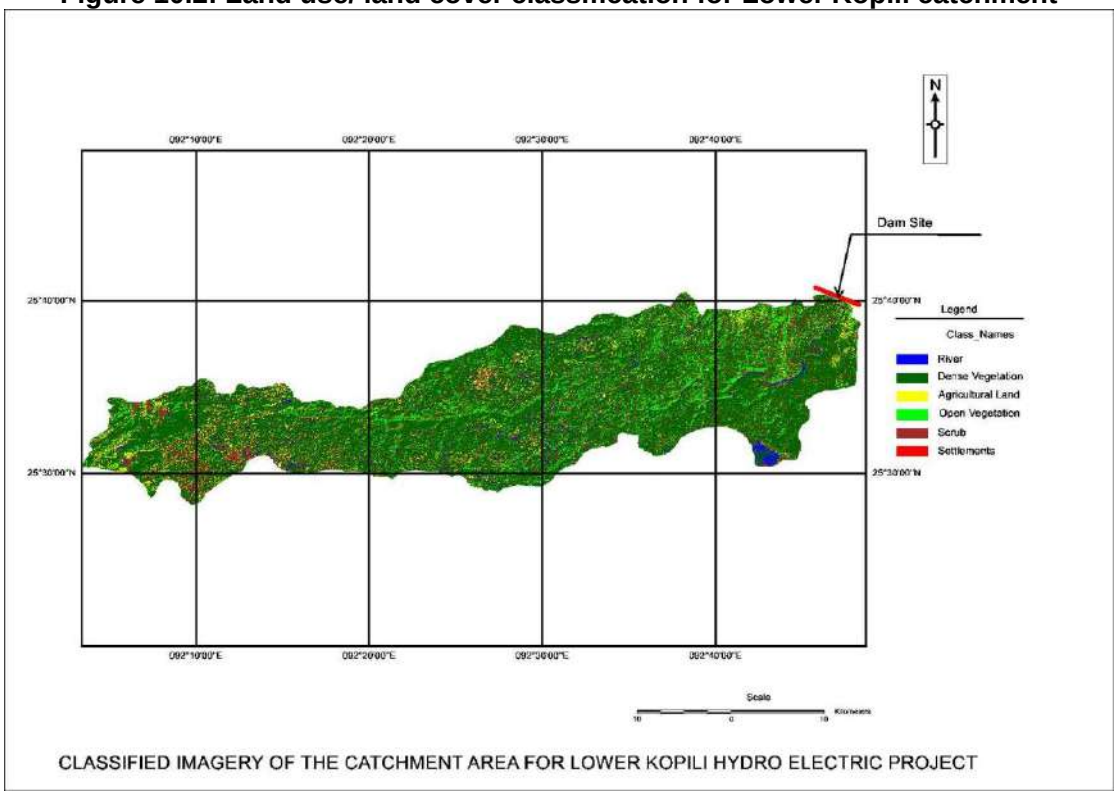
9. The data available from various sources has been collected. The ground maps, contour information, etc. were scanned, digitized and registered as per the requirement. Data was prepared depending on the level of accuracy required and any corrections required were made. All the layers were geo-referenced and brought to a common scale (real co-ordinates), so that overlay could be performed. A computer program using standard modeling techniques was used to estimate the soil loss. The formats of outputs from each layer were firmed up to match the formats of inputs in the program. The grid size to be used was also decided to match the level of accuracy required, the data availability and the software and time limitations. Ground truthing and data collection was also included in the procedure.

10. For the present study, Resourcesat-2, LISS-IV digital satellite data was used for interpretation & classification. The data has been procured in raw digital format and has been geo-referenced using Survey of India topographical sheets with the help of standard data preparation techniques in standard image processing software. The interpretation of geo-referenced satellite data has been done using standard enhancement techniques, ground checks and experiences of qualified professionals. A detailed ground truth verification exercise has been undertaken as a part of field survey to enrich the image interpretation process. The classified land use map of the free draining catchment area, considered for the study, is shown as Figure 10.2. The land use pattern of the catchment area is summarized in Table 10.1.

Table 10.1: Land use classification for free draining catchment at diversion site

Land use/Land cover	Area (ha)	Distribution (%)
River	1,517	1.85
Dense Vegetation	52,058	63.44
Open Vegetation	9,392	11.45
Agricultural Land	4,412	5.38
Scrubs	14,605	17.80
Settlements	77	0.09
Total	**82,062**	**100.00**

Figure 10.2: Land use/ land cover classification for Lower Kopili catchment



11. Derived contours from topographical maps were used for preparation of Digital Elevation Model (DEM) of the free draining catchment area and to prepare a slope map. The first step in generation of slope map is to create surface using the elevation values stored in the form of contours or points. After marking the catchment area, all the contours on the topographical maps were derived. The output of the digitisation procedure was the contours as well as points

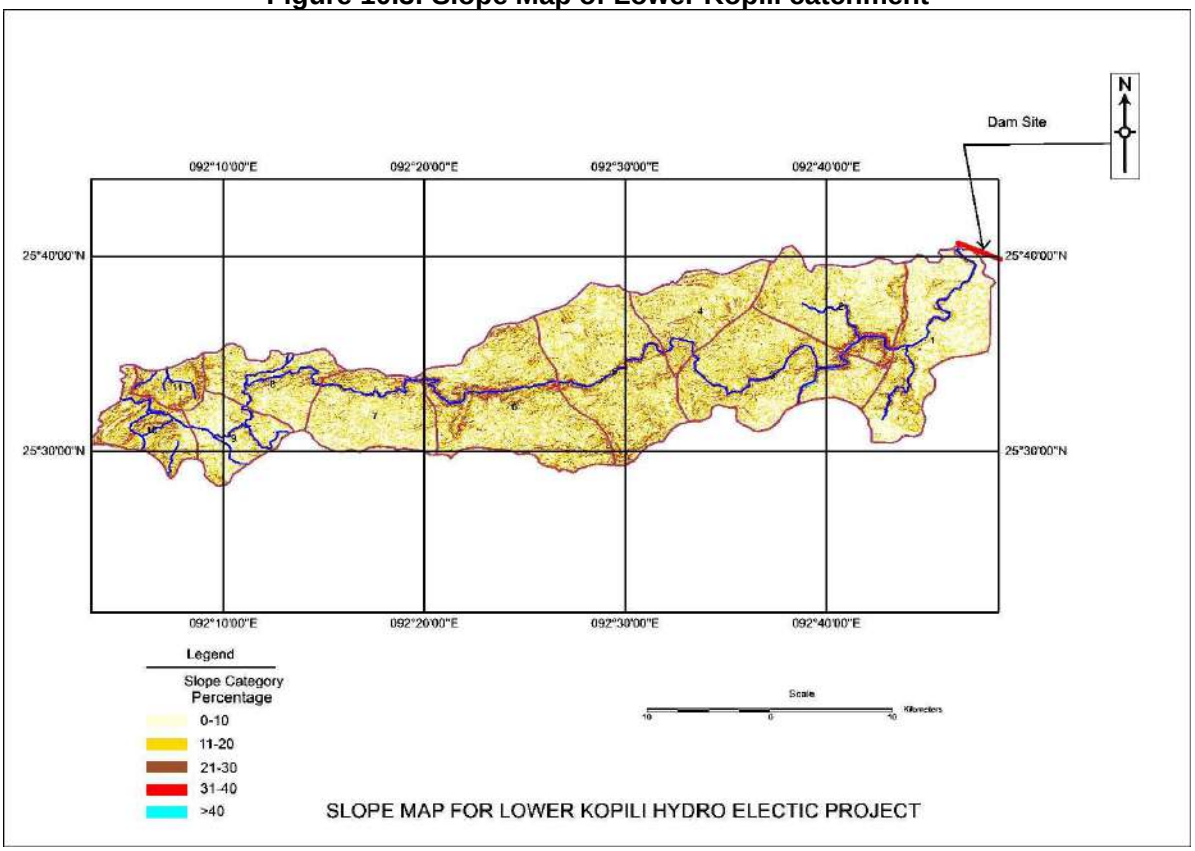
contours in form of x, y & z points. (x, y - location and z - their elevation). All this information was in real world co-ordinates (latitude, longitude and height in meters above sea level).

12. A Digital Terrain Model (DTM) of the area was then prepared, which was used to derive a slope map. The slope was divided in classes of slope percentages. The slope map is enclosed as Figure 10.3. The Area under different slope categories are given in Table 10.2

Table 10.2: Area under various slope category

Slope categories (%)	Area (ha)	Area (%)
0-10	41,555	50.64
10-20	30,098	36.68
20-30	8,458	10.31
30-40	1,724	2.10
>40	227	0.28
Total	**82,062**	**100.00**

Figure 10.3: Slope Map of Lower Kopili catchment



3. ESTIMATION OF SOIL LOSS USING SILT YIELD INDEX (SYI) METHOD

13. In `**Silt Yield Index' (SYI)**, method, the terrain is subdivided into various watersheds and the erodibility is determined on relative basis. SYI provides a comparative erodibility criteria of catchment (low, moderate, high, etc.) and do not provide the absolute silt yield. SYI method is widely used mainly because of the fact that it is easy to use and has lesser data requirement. Moreover, it can be applied to larger areas like sub-watersheds, etc.

14. The SYI model, considering sedimentation as product of erosivity, erodibility and arial extent was conceptualized in the All India Soil and Land Use Survey (AISLUS) as early as 1969 and has been in operational use since then to meet the requirements of prioritization of smaller hydrologic units within river valley project catchment areas.

15. The erosivity determinants are the climatic factors and soil and land attributes that have direct or reciprocal bearing on the unit of the detached soil material. The relationship can be expressed as:

Soil erosivity = f (Climate, physiography, slope, soil parameters, land use/land cover, soil management)

Silt Yield Index

16. SYI is defined as the Yield per unit area and SYI value for hydrologic unit is obtained by taking the weighted arithmetic mean over the entire area of the hydrologic unit by using suitable empirical equation.

Prioritization of Watersheds/Sub-watersheds

17. The prioritization of smaller hydrologic units within the vast catchments is based on the SYI of the smaller units. The boundary values or range of SYI values for different priority categories are arrived at by studying the frequency distribution of SYI values and locating the suitable breaking points. The watersheds/ sub-watersheds are subsequently rated into various categories corresponding to their respective SYI values.

18. The application of SYI model for prioritization of sub-watersheds in the catchment areas involves the evaluation of:

a) Climatic factors comprising total precipitation, its frequency and intensity,
b) Geomorphic factors comprising land forms, physiography, slope and drainage characteristics,
c) Surface cover factors governing the flow hydraulics and
d) Management factors.

19. The data on climatic factors can be obtained for different locations in the catchment area from the meteorological stations whereas the field investigations are required for estimating the other attributes.

20. The various steps involved in the application of model are:

- Preparation of a framework of sub-watersheds through systematic delineation
- Rapid reconnaissance surveys on 1:50,000 scale leading to the generation of a map indicating erosion-intensity mapping units.
- Assignment of weightage values to various mapping units based on relative silt-yield potential.
- Computing Silt Yield Index for individual watersheds/sub-watersheds.
- Grading of watersheds/sub-watersheds into very high, high, medium, low and very low priority categories.

21. The area of each of the mapping units is computed and silt yield indices of individual sub-watersheds are calculated using the following equations:

Silt Yield Index

22. To calculate SYI, the methodology developed by All India Soil & Land Use Survey (Department of Agriculture, Govt. of India) has been followed, where each erosion intensity unit is assigned a weightage value. When considered collectively, the weightage value represents approximately the relative comparative erosion intensity. A basic factor of K = 10 was used in determining the weightage values. The value of 10 indicates a static condition of equilibrium between erosion and deposition. Any addition to the factor K (10+X) is suggestive of erosion in ascending order whereas subtraction, i.e. (10-X) is indicative of deposition possibilities.

23. Delivery ratios were adjusted for each of the erosion intensity unit. The delivery ratio suggests the percentage of eroded material that finally finds entry into reservoir or river/ stream. Area of each composite unit in each sub-watershed was then estimated.

24. SYI was calculated using following empirical formula:

$$SYI = \frac{\sum (Ai * Wi) * Di * 100}{Aw}; \quad \text{where } i = 1 \text{ to } n$$

where

Ai = Area of i^{th} unit (EIMU)
Wi = Weightage value of i^{th} mapping unit
n = No. of mapping units
Aw = Total area of sub-watershed.
Di = Delivery ratio

25. Delivery ratios are assigned to all erosion intensity units depending upon their distance from the nearest stream. The criteria adopted for assigning the delivery ratio are as follows:

Nearest Stream	Delivery Ratio
0 - 0.9 km	1.00
1.0 - 2.0 km	0.95
2.1 - 5.0 km	0.90
5.1 - 15.0 km	0.80
15.1 - 30.0 km	0.70

26. The SYI values for classification of various categories of erosion intensity rates for the catchment area under study are given in Table 10.3.

Table 10.3: Criteria for erosion intensity rate

Priority categories	SYI Values
Very high	> 1300
High	1200-1299
Medium	1100-1199
Low	1000-1099
Very Low	<1000

27. The erosion category of the various watersheds in the catchment area as per the SYI index has been estimated. The objective of the SYI method is to prioritize sub-watersheds in a catchment area for treatment. The selected areas under very high, high and medium erosion categories are to be treated at the project proponent's cost. Hence, the CAT plan has been suggested for very high and high erosion categories, as a part of the EIA study, the expenses of which have to be borne by project proponents.

4. WATERSHED MANAGEMENT – AVAILABLE TECHNIQUES

28. Watershed management is the optimal use of soil and water resources within a given geographical area so as to enable sustainable production. It implies changes in land use, vegetative cover, and other structural and non-structural action that are taken in a watershed to achieve specific watershed management objectives. The overall objectives of watershed management programme are to:

- increase infiltration into soil;
- control excessive runoff;
- manage & utilize runoff for useful purpose.

29. Following Engineering and Biological measures shall be suggested for the catchment area treatment depending upon the requirement and suitability:

a. Engineering measures
   - Brushwood Check Dam
   - Stone masonry
   - Check dams

b. Biological measures
   - Development of nurseries
   - Plantation/afforestation
   - Pasture development
   - Gap Plantation

30. The basis of site selection for different biological and engineering treatment measures under CAT are given in Table 10.4.

Table 10.4: Basis for selection of catchment area treatment measures

Treatment Measures	Basis for Selection
Social forestry, fuel wood and fodder grass development	Near settlements (away from flooding zones) to control tree felling
Brushwood check dams	Over small gullies or at the starting stretch of gullies
Pasture Development (plain areas in downstream sections)	Open canopy, barren land, degraded surface
Afforestation	Open canopy, degraded surface, high soil erosion, gentle to moderate slope
Barbed wire fencing (in some cases)	In the vicinity of afforestation work to protect it from grazing by farm animals, etc.
Step drain	To check soil erosion in small streams, steps with concrete base are prepared in sloppy area where silt erosion in the stream and bank erosion is high due to turbidity of current.
Nursery	Centrally located points for better supervision of proposed afforestation, minimize cost of transportation of seedling and

Treatment Measures	Basis for Selection
	ensure better survival.

5. CATCHMENT AREA TREATMENT PLAN

31. In the present report, CAT Plan as per the slope, land use pattern, soil characteristics has been suggested based on the prioritization of sub watersheds using SYI method. The CAT plan has been suggested for Sub-watersheds with high and very high erosion categories. The objective of the SYI method is to prioritize sub-watershed in a catchment area for treatment. The erosion category of various watersheds in the catchment area as per SYI Method is given in Tables 10.5 and 10.6. The details are shown in Figure 10.4. The area under different erosion categories is given in Table 10.7.

Table 10.5: Erosion intensity categorization as per SYI classification

Watershed number	Area (ha)	SYI values	Category
W1	9,913	1080	Low
W2	8,674	1230	High
W3	11,070	1070	Low
W4	5,797	1160	Medium
W5	11,953	1170	Medium
W6	12,541	1210	High
W7	6,680	1220	High
W8	5,289	1180	Medium
W9	4,204	1160	Medium
W10	3,934	1220	High
W11	2,006	1210	High
Total	**82,062**		

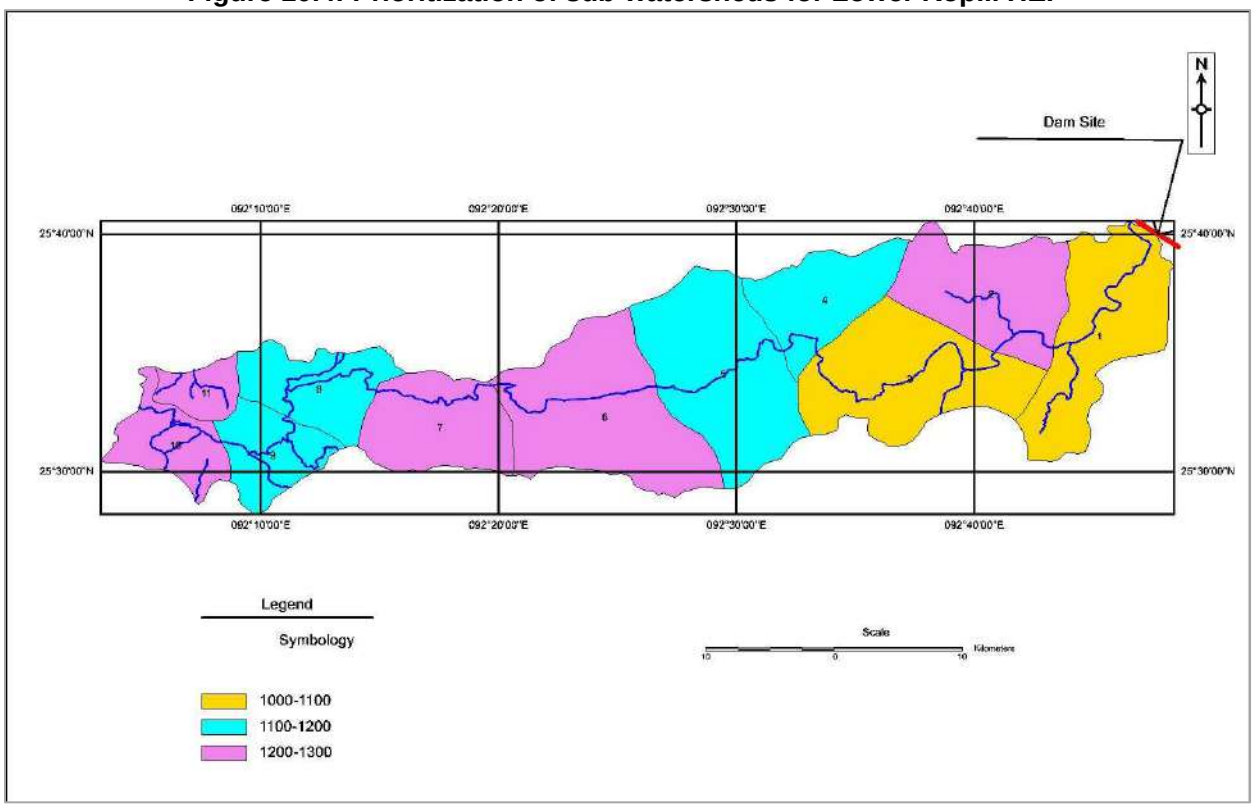
Table 10.6: Prioritized SYI value of erosion intensity rates with sub-watershed code

Priority categories	SYI Values	Sub Watershed codes
High	1200-1299	W2,W6,W7,W10,W11
Medium	1100-1199	W4,W5,W7,W8
Low	1000-1099	W1,W3

Table 10.7 : Area under different erosion categories

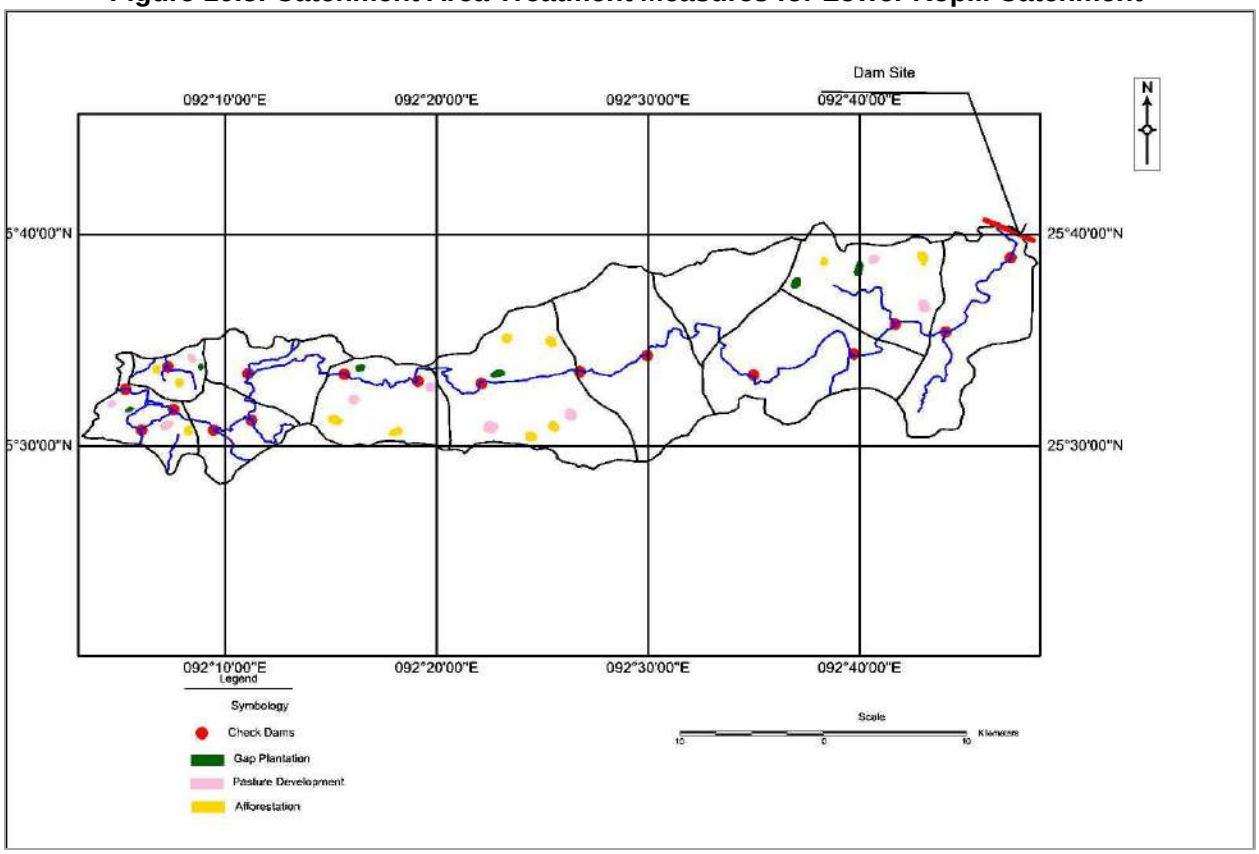
Category	Area (ha)	Area (Percentage)
Low	20,984	25.57
Medium	27,243	33.20
High	33,836	41.23
Total	**82,062**	**100.00**

Figure 10.4: Prioritization of sub-watersheds for Lower Kopili HEP



32. The selected areas under erosion has to be treated by the project proponents, which accounts for about 48.84% of the total free draining catchment area. Sub-watershed wise proposed treatment measures in these sub watersheds superimposed over SOI toposheets are given in Table-9.6 and have been shown in Figure 10.5. It is proposed that treatment measures shall be implemented over five years and shall be co-terminus with the construction of dam.

Figure 10.5: Catchment Area Treatment Measures for Lower Kopili Catchment



6 COST ESTIMATES

33. The cost required for Catchment Area Treatment is **Rs. 1,223.7 lakh**. The details are given in Table 10.8.

Table 10.8: Cost estimate for Catchment Area Treatment of Lower Kopili H. E. Project

S. No.	Item	Rate* (first year) (Rs.)	Unit	Target	
				Physical	Financial (Rs. lakh)
Biological Measures					
1.	Afforestation	120,000/ha	ha	683	576.0
3.	Gap Plantation	50,000/ha	ha	281	140.5
4.	Pasture development (in open areas in plains downstream sections)	30,000/ha	ha	574	172.2
5.	Nursery development	280,000/no.	no.	5	14.0
6.	Maintenance of nursery	140,000/no.	no.	5	7.0
7.	Vegetative fencing	65,000/km	km	20	13.0
8.	Watch and ward for 5 years @ 10 persons	12,000/man-month	Man-months	600	72.0
Engineering Measures					
9.	Check Dams	250,000	Nos.	17	42.5
	Total				**1,037.2**

Total cost for Biological and Engineering measures	=	Rs. 1,037.2 lakh
Administrative expenditure		
Government Expenditure 5% of Total (including O&M)	=	Rs. 51.86 lakh
Establishment cost 8% of Total	=	Rs. 82.976 lakh
Contingency @5% of Total	=	Rs. 51.86 lakh
Total	**Rs.**	**1,223.7 lakh**

ANNEX 11: FISH HABITAT MANAGEMENT PLAN

1. INTRODUCTION

1. As a result of impoundment of rivers by dams the physical structure of riverbeds may change, physicochemical environment may get impacted, upstream - downstream linkages may get cut. In spite of this the fisheries management concerns were not given due importance in the past while deciding the dam design alternatives. This situation has been improved since environmental impact assessment (EIA) became universally mandatory for most types of dam projects and presently all possible measures are taken to make the dam projects, as far as possible, eco-friendly.

2. Status and Further Monitoring

2. During field investigations extensive fishing was conducted at various sites with the help of hired fishermen. A total of 4 species *namely Garra gotyla, Danio rerio, Puntius sophore* and *Barilius bendelisis* could be landed from the downstream part of influence zone (near power house and 4 km downstream of powerhouse site) in the side streams only however, found absent in the Kopili river. In the immediate surroundings of proposed dam site, none of the fish could be landed during the primary survey. Local people had also been interviewed with respect to the presence of fish species. The people were of the opinions that no fish species are present from the immediate vicinity of Lower Kopili H.E. project. Absence of fish diversity in the vicinity area can be attributed to the acidic water of coal mining activities, which affect the water quality adversely.

3. The recommended Environmental Flows will be maintained in the river to maintain possibilities of aquatic life/fisheries in the river.

4. Although presence of fishes in river is rare, during construction effort will be made to remove any fish that might be present before construction. During operation phase, fish will be monitored in the reservoir and downstream sections, but only if the pH increases by proper measures and fish start to inhabit at the river in the project area.

ANNEX 12: PUBLIC HEALTH DELIVERY PLAN

1. INTRODUCTION

1. The construction of dam may involve many diversified activities and require a large number of laborers. The change in population density through immigrants/influx may cause new health problems in this region. People may carry different types of contagious diseases if any and spread in locality. Influx of human work force may also bring stress on available drinking water sources and sanitary facilities. The additional sewage generated may contaminate drinking water sources resulting in spread of various communicable diseases, if proper precautionary measures are not taken. As a part of Environmental Management Plan, a detailed plan for development of public health and medical facilities has been prepared which includes diseases such as STDs, HIV, etc. Since project area is malaria prone, specific measures to deal with Malaria are presented below.

2. PUBLIC HEALTH DELIVERY SYSTEM

2.1 Control of malaria

2. The increase in water fringe area provides suitable habitats for the growth of vectors of various diseases and they are likely to increase the incidence of water-related diseases. Malaria is the water related major vector-borne disease. Thus, malaria control measures which aim at control spread of malaria as well as destroying the habitat and interrupting the life cycle by mechanical or biological or chemical means need to be implemented. Various Primary Health Centres in the nearby villages and Hospital at District Head Quarters can coordinate the anti-malarial operations in association with the project authorities.

3. The suggested measures are given in following paragraphs:

- Site selected for habitation of workers should not be in the path of natural drainage (1 km away).
- Adequate drainage system to dispose storm water drainage from the labor colonies should be provided (to avoid standing water).
- Distribution of anti-malaria pills among workers and nearby villages.
- Awareness programs.

2.2 Development of medical facilities

4. A population of about 2,800 is likely to congregate during the construction phase. The labor population will be concentrated at two or three sites. There is no medical facility in the immediate vicinity of the project area (nearest is Urmrangso). It is recommended that necessary medical facilities (ambulance and first aid post at each site with central clinic capable of dealing with serious emergency incident) be developed at the project site. It is further recommended that the dispensary should be developed during project construction phase itself, so that it can serve the labor population migrating in the area as well as the local population.

5. The details of manpower, infrastructure requirement for this dispensary are given as below.

Manpower

6. Two doctors can be employed in the dispensary and will reside in the staff quarters adjacent to the dispensary. The para-medical staff required for assistance to these doctors is given in Table 12.1.

Table 12.1: Details of Para-medical staff for dispensary

Para medical staff	Number
Auxiliary Nurse	2
Male Multipurpose Health worker	2
Attendants	2
Driver	2
Total	**8**

Infrastructure

7. A building shall be constructed to provide basic preventive and curative services to the labor colony with facilities for maternal and child health services, control of communicable diseases and medical care for minors. The building should have a waiting hall with a sitting capacity of 30-40 people. The building should have arrangements for the following:

- Two rooms for doctors
- One room for staff
- Two rooms for stores
- One general ward to accommodate 10 beds
- One minor operation theater/ dressing room
- One garage with space for three vehicles

8. Residential accommodation is to be provided to the essential staff in the campus.

Proposed Health Facilities at Construction sites and labor camp

9. It is possible that during the construction work, the technical staffs operating different equipment are not only exposed to the physical strain of work but also to the physical effects of the environment in which they are working. The workers and other technical staff may come up with common manifestations such as insect bites, fever, diarrhea, work exhaustion and other diseases. In addition they may invariably come up with injuries caused by accidents at work site. Under all circumstances, workers need immediate medical care.

10. A first-aid post is to be provided at each of the major construction sites (first aid box should be accessible within 1 minute), so that workers are immediately attended to in case of an injury or accident. This first-aid post will have at least the following facilities:

- First aid box with essential medicines including ORS (oral rehydration salts) packets
- First aid appliances-splints and dressing materials
- Stretcher, wheel chair, etc.

Health Extension Activities

11. The health extension activities will have to be carried out in the villages situated in the nearby areas. It is important to inculcate hygienic habits of environmental sanitation specially with respect to water pollution by domestic wastes. There would be possibility of the transmission of communicable diseases due to migration of labor population from other areas at the construction site. The doctors from the dispensary shall make regular visits to nearby villages and organize health promotional activities with the active participation of the local village Panchayat, NGOs and available local health functionaries. The health functionaries would undertake the following tasks as a part of health promotional activities:

- Collect water samples to ascertain the portability of water from different sources so as to monitor regular disinfection of drinking water sources.
- Maintain close surveillance on incidence of communicable diseases in these villages.
- Maintain close liaison with the community leaders and health functionaries of different departments, so that they can be mobilized in case of an emergency.

3. COST ESTIMATES

12. The cost required for implementation of various public health measures shall be Rs. 628.12 Lakhs. The details are given in the following paragraphs:

A. Expenditure on salaries

Dispensary

Post	**Number**	**Monthly Emoluments (Rs.)**	**Annual Expenditure (Rs.)**
Doctors	2	80,000	1,920,000
Nurse	2	20,000	480,000
Male Multi-purpose Health Workers	2	20,000	480,000
Attendants	2	10,000	240,000
Drivers	2	10,000	240,000
Total			**3,360,000**
Minimum number of First Aid Posts (more may be required)			
Health Assistants	2	20,000	480,000
Dressers	2	10,000	240,000
Total			**4,080,000**

Total Expenditure = Rs.40.80 lakh per year

B. Expenditure on Material and Supplies

Dispensary		
Non-recurring		
i)	1 Vehicle	Rs. 1,000,000
ii)	Furniture, etc.	Rs. 500,000
iii)	Hospital equipment	Rs. 1,000,000
iv)	Ambulance (minimum 2)	Rs. 2,000,000
Total		**Rs.45,00,000**
Recurring		
i)	Drugs and Medicine,	Rs. 100,000/yr
ii)	Contingencies	Rs. 50,000/yr
iii)	2 First-Aid Posts at construction sites	Rs. 120,000/yr
iv)	R & M of Ambulance -2 No.	Rs. 900,000/yr
Total		**Rs. 1,170,000/yr**

Infrastructure

13. Dispensary: Considering the number of rooms, staff quarters and open space etc., it is estimated that 465 sq. meter of plot will be required for dispensary, of which about 375 sq. meter will be the built-up land which includes staff quarters, etc. The construction cost for RCC structure will be Rs. 2,000/sq. feet excluding land cost. The cost of construction of Dispensary will be Rs.80.00 lakh.

14. 2 First-Aid Posts: These are of temporary nature and will be constructed. The cost for construction of two First Aid Posts shall be of the order of Rs.5.0 lakh @Rs. 2.5 lakh/First-air post.

15. The total cost for developing the infrastructure will be Rs.85 lakh.

A. Recurring Expenditure

*	Expenditure on salaries	:	Rs. 4,080,000/yr
*	Expenditure on materials & supplies	:	Rs. 1,170,000/yr
	Sub-Total		**Rs. 5,250,000/yr**
Total expenditure for 4 years (A) : (considering 10% escalation per year period)			**Rs. 243.60 lakh**

B. Non-Recurring Expenditure

*	Infrastructure (Construction of Dispensary & 2 First aid posts)	:	Rs. 85 lakhs
*	Expenditure on materials, supplies and equipment	:	Rs. 45 lakhs
	Total (B)		**Rs. 130 lakhs**
	Total A + B		**Rs. 373.60 lakh**

4. DISPOSAL OF BIO-MEDICAL WASTE

16. Dispensaries use a variety of drugs including antibiotics, cytotoxics, corrosive chemicals etc. a part of which is generated as a solid waste. With greater emphasis on disposables, the quantum of solid waste generated in a hospital is quite high. As per the Bio-Medical Waste (Management and Handling) Rules 1998, the bio-medical waste has been classified into various categories which are outlined in Table 12.2.

Table 12.2 :Categories of bio-medical waste as per the Bio-Medical Waste (Management and Handling) Rules 1998

Waste Category No.	Waste category type
Category No. 1	**Human Anatomical Waste** Human tissues, organs, body parts
Category No. 2	**Animal Waste** Animal tissues, organs, body parts, carcasses, bleeding parts, fluid, blood and experimental animals used in research, waste generated by veterinary hospitals, colleges, discharge from hospitals, animal houses
Category No. 3	**Micro-biology and Biotechnology wastes** Wastes from laboratory cultures, stocks or specimens of micro-organisms, live or attenuated vaccines, human and animal cell culture used in research and infections agents from research and industrial laboratories, wastes from production of biologicals, toxins, dishes and devices used for transfer of cultures
Category No. 4	**Waste sharps** Needles syringes, scalpels, blades, glass, etc. that may cause punctures and cuts, including both used and unused drugs
Category No. 5	**Discarded medicines and cytotoxic drugs** Wastes comprising of outdated, contaminated and discarded medicines
Category No. 6	**Soil Waste** Items contaminated with blood and body fluids including cotton, dressings, soiled plaster casts, lines bleedings other material contaminated with blood.
Category No. 7	**Solid Waste** Wastes generated from disposable items other than the waste sharps, such as tubings, catheters, intravenous sets, etc.
Category No. 8	**Liquid waste** Waste generated from laboratory and washing, cleaning, housekeeping and disinfecting activities
Category No. 9	**Incineration Ash** Ash from incineration of any bio-medical waste
Category No. 10	**Chemical Waste** Chemicals used in production of biologicals, chemicals used in disinfection, as insecticides, etc.

17. Out of the categories listed in Table-12.2, the biomedical waste categories to be generated in the dispensary proposed to be developed as a part of the project are given in Table 12.3.

Table 12.3 :Categories of bio-medical waste to be generated in the dispensary proposed to be developed as a part of the project

Waste Category No.	Waste category type
Category No. 1	**Human Anatomical Waste** Human tissues, organs, body parts
Category No. 4	**Waste sharps** Needles syringes, scalpels, blades, glass, etc. that may cause punctures and cuts, including both used and unused drugs
Category No. 5	**Discarded medicines and cytotoxic drugs** Wastes comprising of outdated, contaminated and discarded medicines
Category No. 6	**Soil Waste** Items contaminated with blood and body fluids including cotton, dressings, soiled plaster casts, lines bleedings other material contaminated with blood.
Category No. 7	**Solid Waste** Wastes generated from disposable items other than the waste sharps, such as tubings, catheters, intravenous sets, etc.
Category No. 8	**Liquid waste** Waste generated from laboratory and washing, cleaning, housekeeping and disinfecting activities
Category No. 9	**Incineration Ash** Ash from incineration of any bio-medical waste
Category No. 10	**Chemical Waste** Chemicals used in production of biologicals, chemicals used in disinfection, as insecticides, etc.

18. The bio-medical waste must be segregated in accordance to the guidelines laid under Schedule-I of Bio-medical Waste (Management and Handling) rules notified by Ministry of Environment and Forests. The proposed colour coding and container for disposal are given in Table 12.4.

Table 12.4: Colour coding and type of container for disposal of Bio-medical waste

Colour coding	Type of container	Waste category
Yellow	Plastic bag	Category 1and category 6
Red	Disinfected container/ plastic bag	Category 6 and category 7
Blue/white transparent	Plastic bag/ puncture proof container	Category 4 and category 7
Black	Plastic bag	Category 5, category 9 and category 10 (solid)

19. The treatment measures recommended for various categories of waste is outlined in Table 12.5.

Table 12.5 :Recommended treatment measures of various categories of waste

Waste type	Recommended treatment
Category No. 1 – Human Anatomical wastes	Incineration
Category No. 4 – Waste sharps	Secured landfill
Category No. 5 – Discarded medicines and cytotoxic drugs	Secured landfill

Waste type	Recommended treatment
Category No. 6 – Solid Waste	Incineration
Category No. 7 - Solid Waste	Incineration
Category No. 8 – Liquid waste	Treatment through an Effluent Treatment Plant (ETP)
Category No. 9 – Incineration Ash	Secured landfill
Category No. 10 – Chemical waste	Secured land fill

20. All waste should be appropriately stored and transported by licenced contractor to designated facilities, and all transfers logged.

21. It is proposed to treat the effluent generated from the dispensary prior to its disposal. An amount of Rs.50.00 lakh has been earmarked for the above.

5. BUDGET FOR PUBLIC HEATH DELIVERY SYSTEM

22. The total budget earmarked for Public Health delivery system shall be Rs. 423.60 lakh (Refer Table 12.6).

Table 12.6 :Budget for Public Health Delivery System

S.No.	Item	Cost (Rs. lakh)
1.	Commissioning and operation of public health facilities	373.60
2.	Disposal of bio-medical waste	50.00
	Total	**423.60**

ANNEX 13: MUCK DISPOSAL PLAN

1. GENERAL

1. The total quantity of muck generation has been estimated to be about 10.05 lac m^3. Considering, 40% swelling, the total muck to be handled is 14.07 lac m^3. About 35% material of muck shall be used as construction material Thus, 9.85 lac m^3 of muck is planned to be disposed at the identified disposal areas. The holding capacity of disposal areas is estimated as 10.32 lac m^3.

2. The component wise detail of muck to be generated and identified zones for accommodating the muck generated is given in Tables 13.1 and 13.2 respectively. The location of muck disposal sites is shown in Figure 13.1.

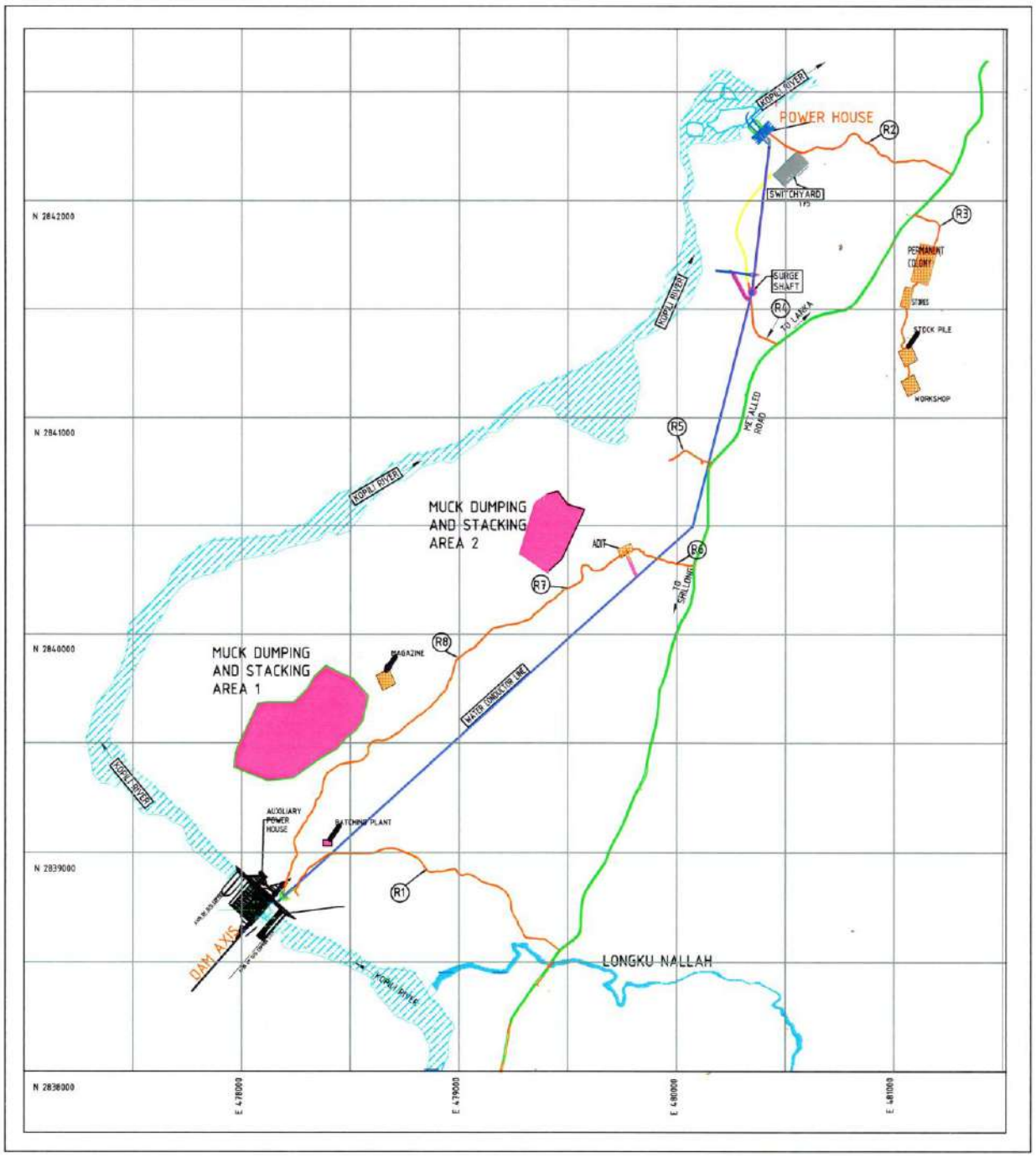
Table 13.1: Component wise details of muck to be generated

Project Component	Quantity of Muck/Debris generated (m^3)	Quantity of muck with 40% swell factor (m^3)	Total Quantity of muck/debris including swell factor (m^3)	Estimated quantity of muck/debris proposed to be utilized 30% of total muck considered) (m^3)	Estimated quantity of muck/debris proposed to be dumped (m^3)	Name of the dumping site as shown in the plan
µ/s Coffer Dam	10,894	4,357	15,251	4,575	10,676	AREA 1
D/s Coffer dam	5,199	2,080	7,279	2,183	5,096	
Diversion Channel	51,473	20,589	72,062	21,618	50,443	
Dam	434,542	173,817	608,359	182,507	425,851	
Power House	28,141	11,256	39,397	11,819	27,577	AREA 2
Surge Shaft	21,561	8,624	30,185	9,055	21,129	
Valve house	54,667	21,867	76,534	22,960	53,573	
Tail Race	71,830	28,732	100,562	30,167	70,393	
Auxiliary Power House Tailrace	76,615	30,646	107,261	32,178	75,082	AREA 1
HRT & Adits	221,716	88,686	310,402	93,120	217,281	AREA1 & AREA 2
Pressure Shaft	27,458	10,983	38,441	11,532	26,909	AREA 2
Auxiliary Pressure Shaft	980	392	1,372	412	960	AREA 2
Total	**1,005,076**	**402,029**	**1,407,105**	**422,126**	**984,971**	

Table 13.2: Muck Disposal Area and Capacities

Specifications	Dumping Area A 1	Dumping Area A2
Area (m^2) approx	60,000	52,000
Capacity (m^3) approx	561,000	471,250
Distance from HFL (m) approx	800	540

Figure 13.1 Location of Muck Disposal Site



3. Muck, if not securely transported and dumped at pre-designated sites, can have serious environmental impacts, such as:

- Muck, if not disposed properly, can be washed away into the main river which can cause negative impacts on the aquatic ecosystem of the river.
- Muck disposal can lead to impacts on various aspects of environment. Normally, the land is cleared before muck disposal. During clearing operations, trees are cut, and undergrowth perishes as a result of muck disposal.
- In many of the sites, muck is stacked without adequate stabilisation measures. In such a scenario, the muck moves along with runoff and creates landslide like situations. Many a times, boulders/large stone pieces enter the river/water body, affecting the benthic fauna, fisheries and other components of aquatic biota.
- Normally muck disposal is done at low lying areas, which get filled up due to stacking of muck. This can sometimes affect the natural drainage pattern of the area leading to accumulation of water or partial flooding of some area which can provide ideal breeding habitat for mosquitoes.

2. RESTORATION OF MUCK DISPOSAL SITES

4. The unused material (198 lakh cum of muck) would be piled at an angle of repose at the proposed dumping sites. For stabilization of dumped materials various engineering and phyto-remedial measures are being proposed in the management plan.

2.1 Engineering Measures

5. The Plan and Cross-Section of each Muck Disposal Site is Shown In Figures 13.2 and 13.3 respectively.

Figure 13.2: Plan and Cross-Section of Muck disposal Site-1

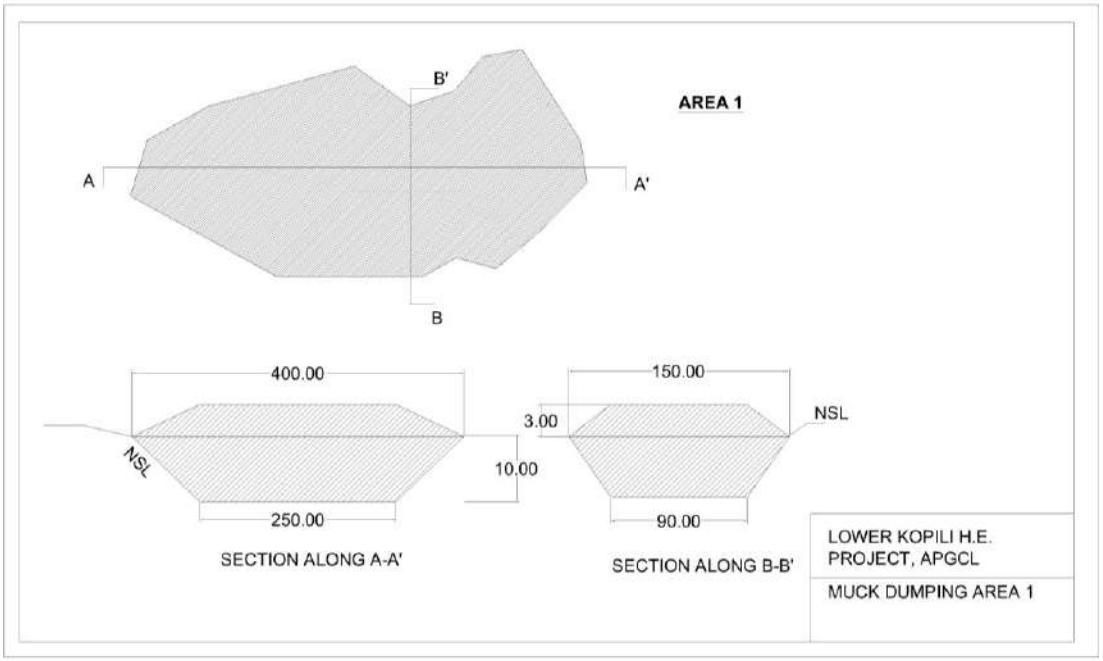
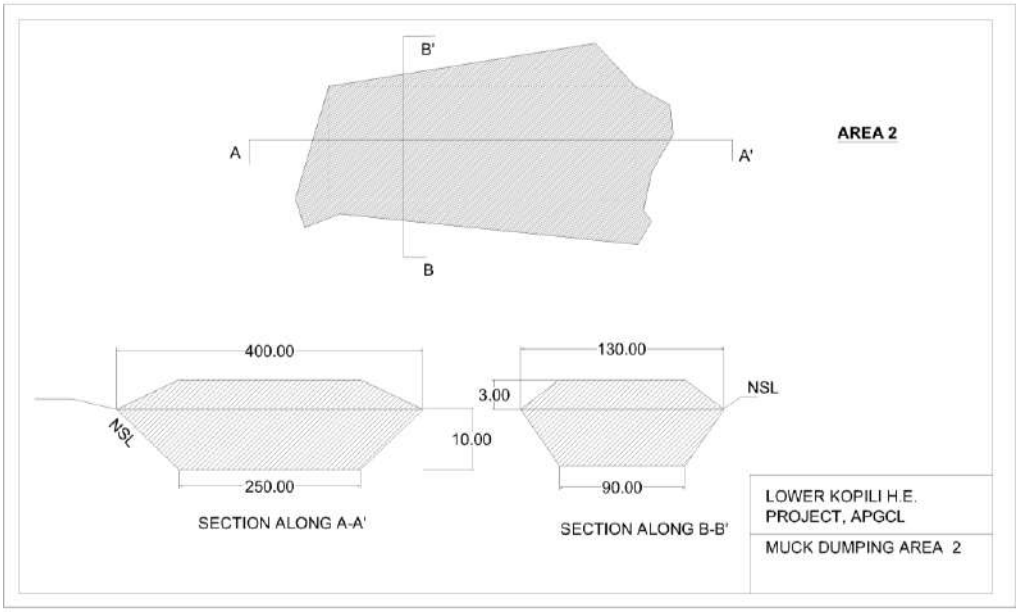


Figure 13.3: Plan and Cross-Section of Muck disposal Site-2



2.2 Phyto-remediation of Muck Disposal Areas

6. The work plan formulated for re-vegetation of the muck disposal areas through "Integrated Biological and Biotechnological Approach" is based on following parameters:

1. Depending upon the quality of muck material formulation of appropriate blends of organic waste and soil to enhance the nutrient status of rhizosphere.
2. Isolation and screening of specialized strains of rnycorrhizal fungi, rhizobium, azotobacter and phosphate solubilizers (bio-fertilizers inoculum) suitable for the dumped material.
3. Mass culture of plant specific bio fertilizer and mycorrhizal fungi to be procured from different institutions/organizations which are engaged in the phyto-remediation activity of degraded areas.
4. Plantation of dumping sites/areas using identified blend and bio fertilizer inoculum.

7. The afforestation with suitable plant species, which can adapt to local habitat, will be undertaken.

8. The cost for remediation includes the cost of turfing of slopes, preparation of ground, spreading of manure, providing 5 cm of soil cover, provision of retaining wall and transportation and carriage etc. It also includes the cost of fencing, watch and ward, irrigation, etc.

9. Proper dumping shall be done over the designated dumping sites. The waste material dumped at spoil tips would comprise mainly of loose rock fragments that would be mechanically compacted and properly leveled with suitable safe slopes and retaining walls/crate walls shall be constructed so that in no case the dumped material is washed away into the river. Construction material like stones, sand, etc. required for the construction of road should be obtained mostly from the excavated material to minimize the environmental damage. The efforts shall be made to utilize maximum dumped material for the project activities and backfilling.

2.2.1 Re-vegetation of Spoil Tips

10. After proper dumping of the muck all three dumping sites shall be rejuvenated using bio-technological approach. The area shall be restored through plantation and turfing on the slope.

2.2.2 Soil Working and Plantation Techniques

11. Isolation and screening of specialised strains of mycorrhizal fungi, rhizobia, azotobacters and phosphate solubilizers (biofertilizer inoculum) in accordance with the suitability for the spoil tips will be done at site, based on following:

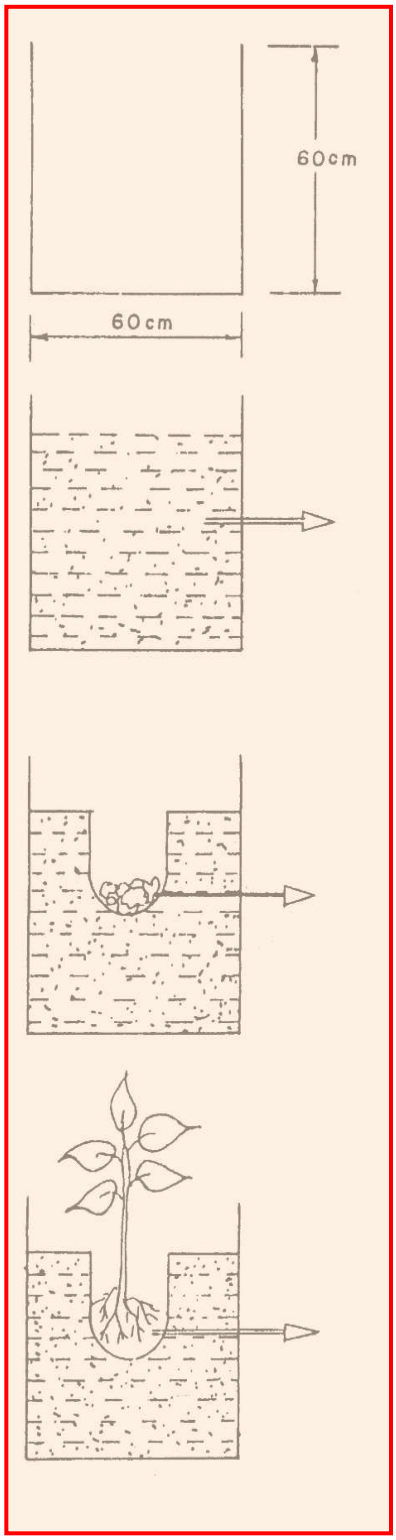
- Inoculation of plants with specific biofertilizers and mycorrhizal strains.
- Periodical evaluation of rhizosphere development for physical, chemical and microbiological parameters.
- Monitoring of growth response in different plant species periodically and identification of corrective measures, if necessary. Mass culture of plant specific biofertilizers and mycorrhizal fungi.

12. The pitting details are as follows:

- Total No. of pits : 1,800 per ha
- Size of each pit : 0.6 m x 0.6m
- Spacing between pits : 2.5m x 2.0m

13. The excavated material from the pits will be mixed with 43.2 litre of external soil, 10 kg of apple peel and 5 kg of farmyard manure, and 2 kg of vermi-compost. The pit will be refilled with the mixture, 10-15 gm of mycorrhizal inoculum near the root system is to be added. After this, plant saplings already inoculated with biofertilizers (Rhizobium and Azotobacter bacteria) would be planted and refilling will be done to cover the entire plant root system. The schematic technique of plantation is shown in **Figure 13.4** Turfing (sodding) and suitable shrubs will be grown at slopes. About 5 cm of thick layer external soil will be spread on the slope area. Sod patches (40 cm x 20 cm) will be grown per square meter. Before sowing, the area will be properly amended with the manure @ of 2 kg/m^2.

Figure 13.4: Schematic representation of plantation using VAM technique



1. **Excavate in spoil dump pit of size 60 cm x 60 cm x 60 cm**

2. **Mix 43.2 litres of soil, 10 kg of apple peel compost, 5 kg of farm yard manure and 2 kg of vermi-compost with excavated spoil (Soil : Spoil = 1:4)**

3. **Refill the pit with Mixture**
4. **10 –15 g of Mycorrhizae inoculum near the root system**

5. **Plantation of sapling inoculated with biofertilizers (Rhizobium + Azatobactor) and refilling**

2.2.3 Species for Plantation

14. Afforestation with suitable plant species (native plants) of high ecological and economic value and adaptable to local conditions will be undertaken at the rate of 1,000 trees per hectare in accordance with canopy cover requirement.

2.2.4 Irrigation Facility

15. Generally, afforestation programme in the vicinity is not supplemented with any irrigation modalities and depends on rains. However, in order to ascertain quick greenery and growth in the spoil tip areas, irrigation, especially during the drought period is to be provided. For this, STP discharge will be used and also water-harvesting tanks will be constructed to supplement the drip irrigation facility in the downstream for the horticultural crops. Research trenches will also act as water harvesting structures to facilitate irrigation for the cash crops.

2.2.5 Fencing

16. All the sites will be properly fenced to protect the area from human and animal interference. About 4,400 m of fence would be required at all the sites.

2.2.6 Watch and Ward

17. It is proposed that 5 guards would be deployed for protection and maintenance of sites for three years. The duties will include replacement of casualties, weeding, watering, repair of fence line etc.

3. RECOMMENDATIONS

18. Following recommendations for smooth implementation of the Muck Disposal Plan are delineated below:

- Selection of species having faster growth, and helpful in stabilizing the dump sites
- Project authorities should ensure frequent meetings with the project team to enable smooth implementation of the Plan

4. BUDGET

19. An amount of Rs. 340.0 lakh has been earmarked for stabilization of muck disposal sites. The details are given in Table 13.3.

Table 13.3: Summary of cost required for muck disposal

S.No.	Cost	Amount (Rs. lakh)
1.	Plantation on spoil tips (plain area) including bio-fertilizer cost	100.0
2.	Turfing on slopes (@ Rs. 100,000/- per ha taking into account 40% of total area of muck disposal i.e. 45 ha to be earmarked for turfing)	40.0
3.	Fencing cost for 4400 m (@ 500/- per running m)	20.0
4.	Retaining Wall (lump sum)	150.0
5.	Cost of two portable water pumps, (flow 20 cum/hr, 20m head, along with 200 m pipe, 100 mm dia, HDPE)	10.0
6.	Watch & Ward (2 persons @ Rs. 10,000/month/for 8 years considering	20.0

	10% escalation per year	
	Total Cost	**340.0**

ANNEX 14: RESTORATION PLAN FOR QUARRY AREAS

1. QUARRY SITES

1. The construction of the proposed Lower Kopili hydroelectric Project, would involve handling of large quantities of materials. The estimated quantities of principal construction materials are given in Table 14.1. The details of quarries for fine and coarse aggregates are given in Tables 14.2 and 14.3 respectively.

Table 14.1: Requirements of Coarse and Fine Aggregates in Wearing and Non-Wearing Surfaces

S. No.	Type	Wearing surface (m^3)	Non-Wearing surface (m^3)	Total
1.	Coarse Aggregate	72,000	759,000	831,000
2.	Fine Aggregate	36,000	378,000	414,000
	Total	**108,000**	**1,137,000**	**1,245,000**

Table 14.2: Quarries selected for Fine Aggregates

Quarry No.	Location	Haulage Distance	Type of Aggregate	Estimated Quantity
'A	Near Sudariang Nala Lat: $25^0$35'30" N Long: $92^0$44'30" E'	10 km u/s of dam axis	Fine Aggregate	40,500 m^3/year
'C'.	Near Langpher Nala, Panimur Lat: $25^0$42'49" N Long: $92^0$50'21" E	7 km d/s of proposed Power house	Fine Aggregate	55,000 m^3/year

Table 14.3: Quarries selected for Coarse Aggregate

Quarry No.	Location	Haulage Distance	Type of Aggregate	Estimated Quantity
'B'.	Near Kala Nala Lanka Umrangshu Lat: $25^0$41'53.56" N Long: $92^0$48'47.50 E	3 km d/s of proposed Power house	Coarse Aggregate	1,558,037 m^3

2. The quarrying would lead to following impacts:

- Creating the pits or quarries requires the removal of virtually all natural vegetation, top soil and subsoil to reach the aggregate underneath. Thus, vegetal cover is lost from quarrying sites.
- Quarrying can disrupt the existing movement of surface water and alter the natural drainage pattern. Engineering activities associated with quarrying can directly change the course of surface water. Pits or depressions created by quarrying can intercept surface water flow.
- Blasting during quarrying is another key adverse impact. Blasting may occur daily or as infrequently. Blasting noise generally increases with the amount of explosive, with specific atmospheric conditions, and with proximity to a blast. The area in front of a blast commonly receives more noise than area behind the blast.
- Earth-moving equipment along with increased vehicular movement are the pother source of noise in quarrying activities. The impacts of noise are highly

dependent on the sound source, the topography, land use, ground cover of the surrounding site, and climatic conditions. Topographic barriers or vegetated areas can shield or absorb noise.

- Opening of the quarries will cause visual impacts because they remove some part of the hills. Quarrying operations are semi-mechanized in nature. Normally, 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, the rock from the exposed face of the quarry under the action of wind and other erosion forces, get slowly weathered and after some time, they become a potential source of landslide.

2. STABILIZATION OF QUARRY SITES

3. The quarry slopes after excavation of the construction material needs to be stabilized. It is suggested that quarry slopes should be maintained at a slope 1:1. The slope should then be covered with topsoil of at least 30 cm. It is suggested that for stabilization, grass, herbs & shrubs should be grown over these slopes.

4. Afforestation with suitable plant species of high ecological and economic value along with turfing by suitable grass species can be undertaken over the two quarry sites after providing required slope and laying top soil over the slopes. Wherever required, proper engineering measures like construction of retaining wall etc. would also be constructed for proper slope stabilisation.

5. The quarries will be restored through engineering and biological measures. The budget earmarked for phyto-remediation of quarry sites is Rs. 115.0 lakh. The details are given in Table 14.4.

Table 14.4: Cost estimate for restoration of quarry sites

S. No.	Remedial measures proposed	Amount (Rs. lakhs)
1.	Plantation	30.0
2.	Turfing over 33 ha	10.0
3.	Retaining Wall	50.0
4.	Training of slopes including labor cost and laying down of top soil	15.0
5.	Fencing over quarry areas (4,000 rm)	10.0
	Total	**115.0**

ANNEX 15: GUIDELINES FOR QUARRY AREA MANAGEMENT

A. Purpose

1. Quarries generally required to provide material for road construction sites, can have significant adverse environmental effects, especially on ecologically sensitive areas. Quarries can become environmental hotspots and can significantly affect the visual appearance of an area. Special mitigation and management measures are often required to avoid or minimise the environmental and social impacts of quarries.

B. Scope

2. These guidelines for quarries cover:
   - statutory approvals
   - environmental and social impacts of quarries
   - selection of quarries
   - operation of quarries
   - rehabilitation of quarries

3. The guidelines seek to ensure that Contractors[149]:
   - comply with the regulatory requirements in force at the time
   - reasonably manage any impacts
   - reinstate and rehabilitate the land appropriately
   - consult with affected communities

C. Impacts

4. Some of the potential impacts of quarries are:
   - rock blasting causing air pollution, and noise and vibrations
   - trucks transporting materials to the site causing air pollution, and noise and vibrations
   - ponds of stagnant water forming in excavated areas giving rise to the breeding of mosquitoes and the spreading of malaria and other mosquito-borne diseases
   - natural beauty of the landscape being affected by excavations and the removal of vegetation
   - natural drainage systems in the area being affected by excavations

5. The procedure for identification and finalization of quarry site/s shall be as given below:
   - Estimating the quantity of quarry material to be collected from each quarry area
   - Only licensed quarry will be used (selected quarries are existing ones)
   - New quarry will be at least 1.5 km away from the settlement, forest and other ecologically sensitive areas and away from water body (selected quarries are existing ones)
   - Contractor shall identify alternative quarry sites along the whole corridor based on required quantity and environmental consideration as given in the following prescribed format of Quarry source identification.

[149] The EMP stipulations will be applicable even if contract use existing licensed quarry. In case contractor use the existing licensed quarry a copy of the quarry license and lease / sub-lease agreement should be submitted to the Project Proponent. Contractor shall submit a plan delineating how he shall comply with requirements stipulated in this plan and elsewhere in the EMP on quarrying activity.

- Contractor shall submit to the Engineer the detailed information / documents as prescribed in the format;
- Engineer shall undertake site inspection of alternate quarry sites and convey to Contractor on accepting a particular quarry site on environmental consideration;
- Contractor shall then take apply and obtain Quarry Lease Deed / License from the Department of Mines and Geology and provide copy of the same to the Engineer prior to operation;
- Contractor shall estimate water requirement for dust suppression at quarry sites during operation and for water spraying on kutcha (non-metal) haul road and ensure availability water by identifying sources and obtaining necessary permission;
- Contractor shall prepare quarry sites operation and redevelopment plan considering surrounding land uses, local needs and agreement with the landowner;
- Only licensed blaster i.e. short-firer certificate holder will be responsible for quarry blasting
- Permits for transportation, storage and use of explosive, as will be required, shall be obtained from the Controller of Explosive;
- Whenever so advised by the Engineer, controlled blasting e.g. using less charge, restricting depth and dia or drill holes, cut-off blasting etc., shall be undertaken.
- Quarry operation will be undertaken in stages with adequate benching

6. The procedure for environmentally sound operation and management of quarry sites is given below:

- Estimating the quantity of quarry material to be collected from each quarry area;
- Demarcating the entire quarry area by fencing and putting red-flag poles;
- Providing adequate metallic access road;
- Preserving topsoil from the quarry compound, if any, by stripping and stacking aside separately at corners;
- Carrying out blasting as per agreed operational plan complying with the requirements of MoRTH Specification (Clause 302 & 303) and MoEF&CC as given below;
- Maintaining a Quarry Material Collection Register on daily material collection for each of the quarry area, which shall be produced to Engineer's representative as and when requested;
- Redeveloping the area within 2 months (or as will be agreed upon) of completion of quarry material collection;

D. Use of Explosive for Blasting

1. General

7. Blasting shall be carried out in a manner that completes the excavation to the lines indicated in drawings, with the least disturbance to adjacent material. It shall be done only with the written permission of the Engineer. All the statutory laws, regulations, rules, etc., pertaining to the acquisition, transport, storage, handling and use of explosives shall be strictly followed.

8. The Contractor may adopt any method or methods of blasting consistent with the safety and job requirements. Prior to starting any phase of the operation the Contractor shall provide information describing pertinent blasting procedures, dimension and notes.

9. The magazine for the storage of explosives shall be built as per national / international standards and located at the approved site. No unauthorized person shall be admitted into the magazine which when not in use shall be kept securely locked. No matches or inflammable material shall be allowed in the magazine. The magazine shall have an effective lightning conductor. The following shall be displayed in the lobby of the magazine:

- A copy of the relevant rules regarding safe storage in English and Assamese (and in Hindi, if required) languages with which the workers concerned are familiar.
- A statement of up-to-date stock in the magazine.
- A certificate showing the last date of testing of the lightning conductor.
- A notice that smoking is strictly prohibited.

10. All explosives shall be stored in a secure manner in compliance with all laws and ordinances, and all such storage places shall be clearly marked. In addition to these, the Contractor shall also observe the following instructions and any further additional instructions which may be given by the Engineer and shall be responsible for damage to property and any accident which may occur to workmen or the public on account of any operations connected with the storage, handling or use of explosives and blasting. The Engineer shall frequently check the Contractor's compliance with these precautions.

2. Materials, Tools and Equipment

11. All the materials, tools and equipment used for blasting operations shall be of approved type. The Engineer may specify the type of explosives to be allowed in special cases. The fuse to be used in wet locations shall be sufficiently water-resistant as to be unaffected when immersed in water for 30 minutes. The rate of burning of the fuse shall be uniform and definitely known to permit such a length being cut as will permit sufficient time to the firer to reach safety before explosion takes place. Detonators shall be capable of giving effective blasting of the explosives. The blasting powder, explosives, detonators, fuses, etc., shall be fresh and not damaged due to dampness, moisture or any other cause. They shall be inspected before use and damaged articles shall be discarded totally and removed from the site immediately.

3. Personnel

12. The blasting operation shall remain in the charge of competent and experienced supervisor and workmen who are thoroughly acquainted with the details of handling explosives and blasting operations.

4. Blasting Operations

13. The blasting shall be carried out during fixed hours of the day preferably during the mid-day luncheon hour or at the close of the work as ordered in writing by the Engineer. The hours shall be made known to the people in the vicinity. All the charges shall be prepared by the man in charge only.

14. The Contractor shall notify each public utility company having structures in proximity to the site of the work of his intention to use explosives. Such notice shall be given sufficiently in advance to enable the companies to take such steps as they may deem necessary to protect their property from injury.

15. Red danger flags shall be displayed prominently in all directions during the blasting operations. The flags shall be planted 200m and 500m from the blasting site in all directions for blasting at work site and quarry, respectively. People, except those who actually light the fuse, shall be prohibited from entering this area, and all persons including workmen shall be excluded from the flagged area at least 10 minutes before the firing, a warning siren being sounded for the purpose.

16. The charge holes shall be drilled to required depths and at suitable places. Blasting should be as light as possible consistent with thorough breakage of the material necessary for economic loading and hauling. Any method of blasting which leads to overshooting shall be discontinued.

17. When blasting is done with powder, the fuse cut to the required length shall be inserted into the hole and the powder dropped in. The powder shall be gently tamped with copper rods with rounded ends. The explosive powder shall then be covered with tamping material which shall be tamped lightly but firmly.

18. When blasting is done with dynamite and other high explosives, dynamite cartridges shall be prepared by inserting the square cut end of a fuse into the detonator and finishing it with nippers at the open end, the detonator gently pushed into the primer leaving 1/3rd of the copper tube exposed outside. The paper of the cartridge shall then be closed up and securely bound with wire or twine. The primer shall be housed into the explosive. Boreholes shall be such size that the cartridge can easily go down. The holes shall be cleared of all debris and explosive inserted. The space of about 200 mm above the charge shall then be gently filled with dry clay, pressed home and the rest of the tamping formed of any convenient material gently packed with a wooden rammer.

19. At a time, not more than 10 such charges will be prepared and fired. The man in charge shall blow a siren in a recognised manner for cautioning the people. All the people shall then be required to move to safe distances. The charges shall be lighted by the man-in-charge only. The man-in-charge shall count the number of explosions. He shall satisfy himself that all the charges have been exploded before allowing the workmen to go back to the blasting site.

5. Misfire

20. In case of misfire, the following procedure shall be observed:

- Sufficient time shall be allowed to account for the delayed blast. The man-in-charge shall inspect all the charges and determine the missed charge.
- If it is the blasting powder charge, it shall be completely flooded with water. A new hole shall be drilled at about 450 mm from the old hole and fired. This should blast the old charge. Should it not blast the old charge, the procedure shall be repeated till the old charge is blasted.
- In case of charges of gelignite, dynamite, etc., the man-in-charge shall gently remove the tamping and the primer with the detonator. A fresh detonator and primer shall then be used to blast the charge. Alternatively, the hole may be cleared of 300 mm of tamping and the direction then ascertained by placing a stick in the hole. Another hole may then be drilled 150 mm away and parallel to it. This hole shall then be charged and fired when the misfired hole should explode at the same time. The man-in-charge shall at once report to the Contractor’s office and the Engineer all cases of misfire, the cause of the same and what steps were taken in connection therewith.

- If a misfire has been found to be due to defective detonator or dynamite, the whole quantity in the box from which defective article was taken must be sent to the authority directed by the Engineer for inspection to ascertain whether all the remaining materials in the box are also defective.

6. Account

21. A careful and day to day account of the explosive shall be maintained by the Contractor in an approved register and manner which shall be open to inspection by the Engineer at all times. During quarry operation, periodic joint inspection should be carried out by the Contractor and Engineer's representatives.

22. A typical checklist for the same is given here.

Quarry Source Identification

Construction Stage Report: Date:
Supervision Consultant: Contractor: Contract Package:
Location of Quarry (Ch. & Offset):

Sl. No.	Item / Requirement	Details as per Actual
1	Present land use (bare land with no prominent vegetation is preferred)	
2	Predominant wind direction	
3	Size and area of Quarry (m x m & Sq. m)	
4	Quantity Available (Cum)	
5	Quantity proposed to be collected (Cum)	
6	No of Trees with girth more than 0.3 m	
7	No Settlement within 1500 m of Quarry	
8	No water body within 1500 m of Quarry	
9	Width of Haul road (m)	
10	Total Length of Haul Road (km)	
11	Length of Non-metal Haul Road (km) (should be as minimum as possible)	
12	No of Settlements within 200m of Non-metal Haul Road (should be as minimum as possible)	
13	Quantity of water required for dust suppression i.e. sprinkling at borrow area and on non-metal haul road (Cum)	
14	Details of Water sources for dust suppression	
15	Availability of water required for dust suppression (Cum)	

Documents to be attached:

1) Site plan and layout plan of quarry site
2) Proposed quarry site operation and redevelopment plan
3) Written consent / lease agreement with the Department of Mines & Geology
4) Written consent from competent authority for use of water for dust suppression

Certified that the furnished information is correct and all relevant information as required is attached

Contractor's Representative:

Details to be inspected for Monitoring Quarry Area Operation & Management

Attributes	Requirements
Access road	• Only approved access road shall be used
Top soil preservation	• Top soil, if any, should be stripped and stored at designated area before start of quarry material collection; • Top soil should be re-used / re-laid as per agreed plan
Controlled blasting & safety	• Storage of explosive magazine as per threshold quantity with all the safety measures; • Handling of explosive by licensed blaster only; • Use low intensity explosive; • Check unfired explosive, if any, before drilling; • Carryout blasting at lean time only; • Cordoned the area within 500m radius with flagmen having whistle for signaling preparedness; • Using properly designed audio visual signal system i.e. siren and flagmen for blasting; • Keep ready an emergency vehicle near blasting area with first aid facility and with active emergency response system.
Damage to surrounding land	• Movement of man & machinery should be regulated to avoid damage to surrounding land.
Drainage control	• The surface drainage in and around the area should be merged with surrounding drainage;
Dust control	• Haul road should be made metallic; • Suitable dust arrester for drilling; • Water spraying at quarry complex, if required.
Covering material transport vehicle	• Material transport vehicle should be provided with tail board, and cover
Personal Protective Equipment	• Workers shall be provided with helmet, safety shoes, ear muffler and air musk and their use should be strictly enforced.
Redevelopment	• The area should be redeveloped within two months (or as agreed) on completion of material collection as per agreed plan.

ANNEX 16: PLAN FOR ENVIRONMENTAL TRAINING TO WORKERS

- All workers will complete the environmental training programs. The goal of programs will be to educate all workers on the following issues:
    i. Fire arms possession
    ii. Traffic regulations
    iii. Illegal logging & collection of non-timber forestry products
    iv. Non disturbance of resettlement communities
    v. Hunting & fishing restrictions
    vi. Waste management
    vii. Erosion control
    viii. General housekeeping, and construction health and safety trainings

- Where necessary, participants in job-specific training will be identified on the basis of their skills and capacity to undertake the training.

- All training sessions will be conducted in Assamese (and in Hindi, if required) language for local personnel and as appropriate for foreign staff. All written materials will be provided in Assamese (and in Hindi, if required) language and other languages as appropriate.

- A training register will be maintained that will contain details of the following:
    i. Name of training session
    ii. Date of training session
    iii. List of attendees and signatures
    iv. Name of trainer

- Upon completion of each relevant training course, each participant will be issued with a certificate of successful completion. A copy of the certificate will also be placed on each participant's employment file.

- The contractor will implement a rolling program of refresher courses in environmental, health and safety awareness issues through the use of 'tool-box' sessions at construction sites.

- During audits of the construction areas, workers' knowledge of environmental, health and safety issues will be examined.

- Workers who have undergone job-specific training will be examined in relation to their knowledge and skills, and are subject to re-training, if necessary. Records of examination results and any re-training will be kept as part of the training register.

- All new employees will complete relevant training prior to commencement of any activities on the construction site.

- The key messages from the training sessions will be produced in both poster and leaflet form, in Hindi/Assamese and English language. Posters will be displayed prominently in construction work camps and construction areas and leaflets will be distributed to staff on a regular basis

ANNEX 17: PLAN FOR CONSTRUCTION CAMP MANAGEMENT

1. Use of camps

- All workers who are based on the construction site will be basically accommodated by the construction camps.
- Appropriate sanitation facilities will be installed in accordance with Water Quality Management Plan.

2. Disease control, health and safety issues

- Buildings in Residence camps and sub-camps will be made 'mosquito-proof' as far as possible through ensuring adequate sealing of doors and windows, provision of suitable ventilation and as necessary, installing mosquito-nets and other prevention devices.
- Medical, sanitary and disease prevention measures for each camp will be implemented in accordance with the requirements of Project Personnel Health Program.
- Pesticide use in the camps and sub-camps will be carried out in accordance with the requirements of Project Personnel Health Program and the ADB SPS requirements regarding pesticide use.
- Waste generated at the construction camps will be managed in accordance with the requirements of the Waste Management Plan and IFC EHS Guidelines.
- Construction workers will be trained in health and safety issues relating to the camps in accordance with the requirements Annex 16: Plan for Environmental Training for Workers.

3. Camp access

- In general, access to the camps will be restricted to construction workers and visitors with an authorized access pass.

4. Potable water supply

- All potable water storage facilities will be secured, with access limited to authorized personnel. Local rivers (tributaries only) or underground water will be used as the source of the potable water supply. Regular testing (weekly) of all drinking water sources for staff shall be undertaken to ensure compliance with national water quality standards. The intake for the potable water storage will be located a 100 distance upstream of any wastewater discharge point.
- Water quality monitoring of the potable water storage in camps and sub-camps will be carried out in accordance with the requirements of environmental monitoring plan (weekly).

5. Camp rules and regulations

- A set of rules and regulations applicable to camps and sub-camps will be developed. The rules and regulations will include:

i. Prohibitions on hunting and poaching of wildlife, purchasing wildlife meat, fishing, gathering and harvesting medicinal or valued plants and trees, and possessing firearms, snares, traps and other hunting equipment

ii. Access restrictions for non-construction personnel

iii. Housecleaning and waste management requirements

iv. Measures for preserving health and the dissemination of vectors and transmissible diseases

- Residents of the camps shall be provided with written information and training on camp rules and regulations. Camp rules and regulations will be prominently displayed in the camp areas.

ANNEX 18: PROJECT PERSONNEL HEALTH PROGRAM

Following measures will be implemented to take care of project personnel health.

- The “Health and Safety Manual”, which will be in compliance with the IFC EHS Guidelines, will be distributed to the personnel attending health and safety training in the language used by the workers during trainings. It contains the following contents:

1. Health

i Anti malaria precautions
ii Precautions for HIV / AIDS and other venereal diseases
iii Diarrhea precautions
iv Symptoms of other diseases typical of the area (such as dengue fever)
v Recommendations regarding proper disposal of all wastes
vi Use of proper drinking water
vii Use of appropriate toilets

2. Safety

i Use of Personal Protective Equipment (PPE)
ii Use of specific equipment according to the safety procedures
iii Use of appropriate clothing
iv Use of appropriate ladders
v Use of appropriate slinging
vi Attention to signals of danger
vii Attention to suspended weights
viii Attention to unprotected pits
ix Attention to buried cables
x Attention to overhead power cables
xi Attention to all flammable items
xii Procedure for fire extinguishing
xiii Miscellaneous safety issues

- First aid teams will be specifically trained and assigned in groups of two to three persons to the different sites
- Medical facilities, including items such as First Aid kits and bedding for patients, should be provided.
- A doctor should be reached when an accident occurs.
- In the event of a spill of any hazardous material, actions and responses will be taken according to Emergency Plan for Hazardous Materials (Annex 27).
- Vector control of mosquitoes and other pests will be managed in the appropriate manner.
- Solid waste that might attract pests such as domestic rubbish and food waste shall be managed properly.
- The water supply and sewage system, especially in camp sites, will be maintained in good working condition through regular monitoring according to the required standards.

- The use of pesticides to control pests will be limited to only those cases deemed necessary. Use and handling of pesticides will be conducted on the appropriate manners.

ANNEX 19: LANDSCAPING AND RESTORATION OF CONSTRUCTION AREAS

1. RESTORATION OF CONSTRUCTION SITES

Due to various construction activities viz., construction of working areas, office and residential complexes, etc. will disturb the natural environment of the project area. Engineering and biological measures are suggested for the stabilization and beautification of the disturbed area. Following measures should be adopted for the restoration and landscaping of colony areas and construction sites.

- During construction phase, proper roads and lanes would be provided inside the colony area. Open area in the colony and working area would be planted with various plant species. Local native species and local ornamental plants (not invasive) and avenue plantation should be done along the roads and lanes and in open places in the colonies, offices, powerhouse area, dam area and adits.
- Patch plantation may be done at all vacant sites in and around colony area, officers, adits, working areas etc. with plantation in 2-3 or even more rows wherever possible.
- The choice of the tree species for plantation will depend on agro-climatic conditions of the area.
- Retaining walls should be built to avoid landslides and slips. Proper drainage would be provided inside colony for the outlet of the domestic/rain water.
- Parks and play grounds with all play implements will be developed in the colony areas during the construction phase and at vacant spaces after completion of the work.
- Green areas would be developed in front of offices, hospital, officers club, field hostels, guest houses etc. during the construction phase.

2. POST PROJECT CONSTRUCTION LANDSCAPING

After the completion of all the construction activity, the construction sites and other temporary settlements would be removed and area covered with the top soil to support the growth of plant species. These plant species which grow first are considered ecological pioneers and would initiate the process of succession and colonization. Areas close to colony and suitable areas will be landscaped to develop children parks, gardens, etc. The maintenance of the area will be done by the project in O&M stage for the life of the project. Rest of the area will be vegetated and restored. A lump sum provision of Rs. 30 lakh has been kept for this activity.

3. BUDGET FOR RESTORATION OF COSNTRUCTION SITES

The cost for landscaping and restoration is estimated as Rs.100.0 lakh. The details are given in Table 19.1.

Table 19.1:Cost Estimate for Restoration of Construction Areas and Landscaping Plan

S.No.	Item of Work			Amount (Rs. lakh)
A	**Colony Area, Office Complexes**			
	(i)	Engineering measures		
		(a)	Retaining Walls	20.0
		(b)	Levelling the area	10.0
	(ii)	Bio-engineering measures		
		(a)	Covering the slopes with geo-textiles	10.0
		(b)	Mulching	10.0
	(iii)	Biological measures		
		(a)	Planting of trees and shrubs	10.0
		(b)	Planting of flowering plants and other herbs	10.0
	Sub-total (A)			**70.0**
B	**Post project construction landscaping**			**30.0**
	Total			**100.0**

ANNEX 20: ENVIRONMENTAL MANAGEMENT IN ROAD CONSTRUCTION

1. INTRODUCTION

The project can be reached from Guwahati through the National Highway (NH-52) road going further to Lanka with a distance of approximately 155 km. From Lanka up to dam site area, NH-52 exists for a distance of about 33 km and from NH-52 vehicular road shall be used which runs along the project. Total length from Lanka to project site is 48 km.

PWD road Longku-Garampani shall be main access road to the project and from this access roads to the various components of the project will be constructed. In addition, about 60 km of road length from Lanka Garampani to Umrangsu shall be improved.

It is proposed to construct the access road to the various project components as given in Table 20.1. The bridges and culverts to be constructed as a part of the project are given in Table 20.2.

Table 20.1: Proposed Roads in the Project Area

S. No.	Description	Length (km)
1	Lanka Garampani road to dam site & Rehabilitation area, dyke & intake shaft top including existing road diverted	5.52
2	Explosive magazine road	0.84
3	Lanka Garampani road to powerhouse	1.21
4	Approach road to colonies	0.37
5	Road to rock Quarry area	1.19
6	Road to Dumping area	0.61
7	Road to Adit portal	1.22
8	Road to Hydro mechanical workshop	0.10
9	Road to Electro mechanical workshop	0.03
10	Road to Surge Shaft	1.85
	Road to proposed bridge	0.16
	Total	**13.04**

Table 20.2: Proposed bridges and culverts in the Project Area

Description	Number
No. of bridges	3
No. of culverts	10

One bridge (BRG 3) of span 60 m will be constructed on the PWD road on Longku nala. One more bridge (BRG 1) is proposed to be constructed on the existing road at a nala crossing for a span of 48 m. One more bridge (BRG 2) of span 11 m is also proposed to be constructed across the diversion channel to pass over upstream coffer dam

New roads of about 13.04 km length are proposed to be constructed to connect the various project components. Most of the proposed new roads will be aligned along the slope of hills, muck generated due to the road cutting and would also involve removal of vegetation and trees from slopes and re-working of the slopes in the immediate vicinity of roads. Plantation of suitable soil binding plant species needs to be carried out to stabilize the rim of the roads and for control of the landslides/ slips suitable engineering and biological measures also needs to be

framed and implemented. The construction of new roads will provide better connectivity to the villagers of the region with the main road and National Highways. Soil erosion could also increase due to construction activities, which could reduce the photosynthetic activity to some extent of the aquatic plants due to increased turbidity. Adequate measures need to be implemented as a part of EMP to ameliorate this adverse impact to the extent possible.

2. IMPACTS DUE TO CONSTRUCTION OF ROADS

The construction of roads can lead to the following impacts:

- The topography of the project area has steep slope, which descends rapidly into narrow valleys. The conditions can give rise to erosion hazards due to net downhill movement of soil aggregates.
- Removal of trees on slopes and re-working of the slopes in the immediate vicinity of roads can encourage landslides, erosion gullies, etc. With the removal of vegetal cover, erosive action of water gets pronounced and accelerates the process of soil erosion and formation of deep gullies. Consequently, the hill faces are bared of soil vegetative cover and enormous quantities of soil and rock can move down the rivers, and in some cases, the road itself may get washed out.
- Construction of new roads increases the accessibility of a hitherto undisturbed areas resulting in greater human interferences and subsequent adverse impacts on the ecosystem.
- Increased air pollution during construction phase.

3. MANAGEMENT MEASURES

The approach roads will have to be constructed as a part of providing access to the construction site. In a hilly environment, construction of roads sometime disturbs the scenic beauty of the area. In addition, landslides are often triggered due to road construction because of the loosening of rocks by water trickling from various streams.

Steeply sloping banks are liable to landslides, which can largely be controlled by provision of suitable drainage. The basic principle is to intercept and divert as much water as possible, before it arrives at a point, where it becomes a nuisance. The other erosion hazard is that of surface erosion of the bank, which is best controlled by vegetation. However, in a steeply sloping terrain, difficulty lies in growing vegetation on steeply sloping banks. Engineering solutions such as surface drainage, sub-surface drainage, toe protection and rock bolting can be used. Landslides can be stabilized by several methods-engineering or bioengineering measures alone or a combination of these. The cost required for implementation of various measures has already been incorporated in the overall budget earmarked for construction of roads.

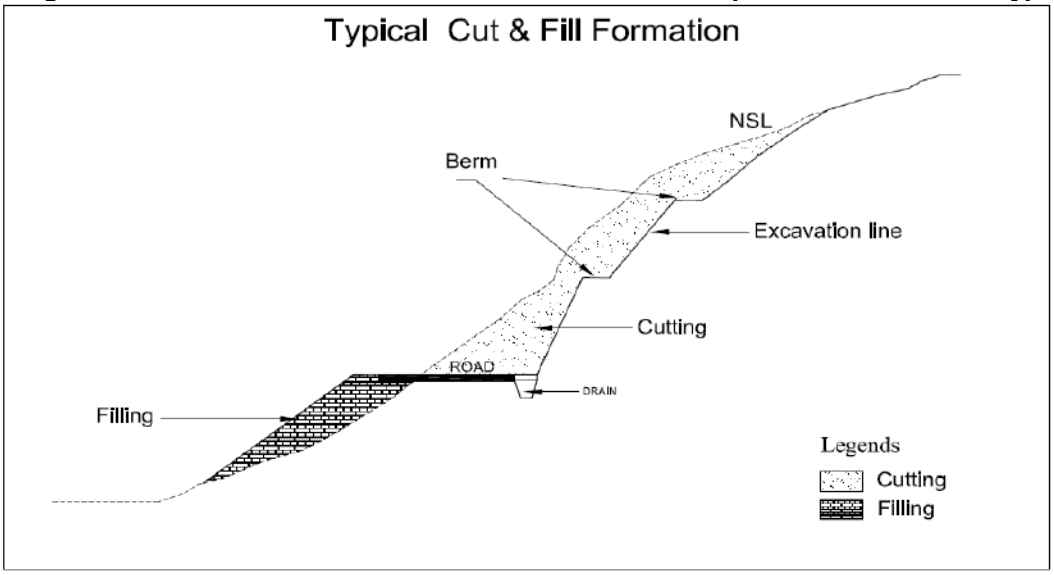
In hilly terrain, road construction often generates significant quantity of wastes (muck) due to the stripping of the rocks to make way for the roads. The stripped muck is generally cleared by dumping the material along the slopes. These dumped material finally flow down to the valleys and ultimately finds its way to the river. However, it is recommended to adopt a more systematic approach. The stripped material should be collected and dumped in the designated muck disposal area, which will have check dams to prevent the muck to flow down into the river. After disposal operation is complete at the dump site, the dump yard should be contoured and vegetated.

The various aspects to be considered while making the project roads are briefly described in the following figures and paragraphs.

Construction

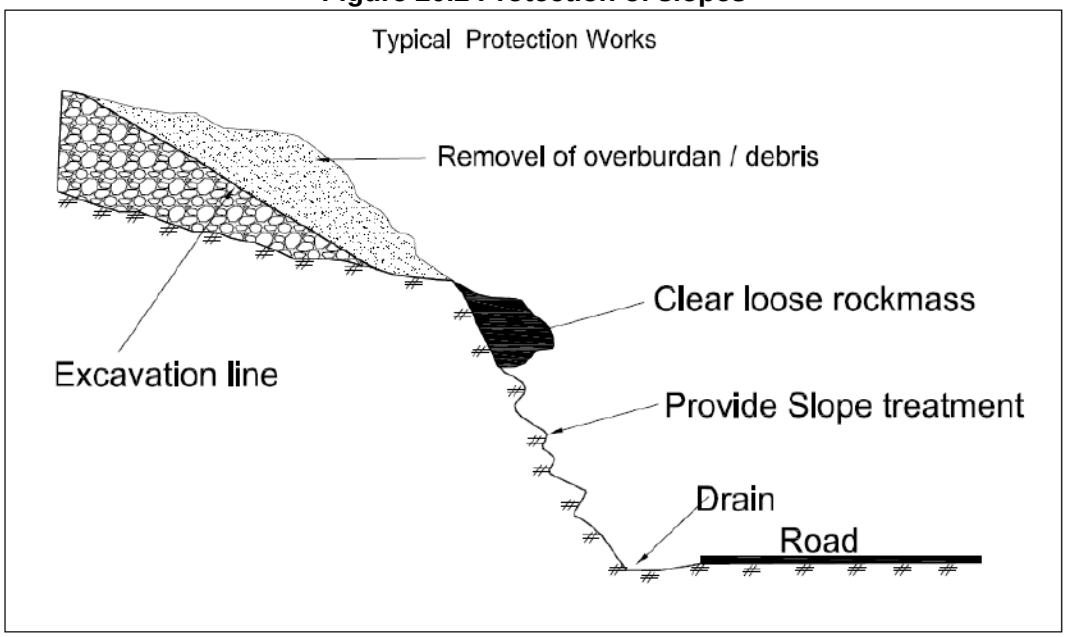
- Area for clearing shall be kept minimum subject to the technical requirements of the road. The clearing area shall be properly demarcated to save desirable trees and shrubs and to keep tree cutting to the minimum.
- Where erosion is likely to be a problem, clearing operations shall be so scheduled and performed that grading operations and permanent erosion control of features can follow immediately thereafter, if the project conditions permit; otherwise temporary erosion control measures shall be provided between successive construction stages. Under no circumstances, however, should very large surface area of erodible earth material be exposed at any one time by clearing.
- The method of balanced cut and fill formation shall be adopted to avoid large difference in cut and fill quantities. (Refer Figure 20.1).

Figure 20.1 Method of balanced cut and fill formation (for access roads only)



- The cut slopes shall be suitably protected by breast walls, provision of flat stable slopes, construction of catch water and intercepting drains, treatment of slopes and unstable areas above and underneath the road, etc. (Refer Figure 20.2).

Figure 20.2 Protection of slopes



- Landslide prone areas shall be treated with location specific engineering protection measures.
- Where rock blasting is involved, controlled blasting techniques shall be adopted to avoid over-shattering of hill faces.
- Excavated material should not be thrown haphazardly but dumped duly dressed up in a suitable form at appropriate places where it cannot get easily washed away by rain, and such spoil deposits may be duly trapped or provided with some vegetative cover.

Drainage

- Drainage of the water from hill slopes and road surface is very important. All artificial drains shall be linked with the existing natural drainage system.
- Surface drains shall have gentle slopes. Where falls in levels are to be negotiated, check dams with silting basins shall be constructed and that soil is not eroded and carried away by high velocity flows.
- Location and alignment of culverts should also be so chosen as to avoid severe erosion at outlets and siltation at inlets.

Grassing and Planting

- Tree felling for road construction/works should be kept bare minimum and strict control must be exercised in consultation with the Forest Department. Equivalent amount of new trees should be planted as integral part of the project within the available land and if necessary, separate additional land may be acquired for this purpose.
- Depending on the availability of land and other resources, afforestation of roadside land should be carried out to a sufficient distance on either side of the road.

4. BUDGET

An amount of Rs. 169.52 lakh has been earmarked for implementation of measures to mitigate adverse impacts due to construction of roads. The details are given in Table 20.3.

Table 20.3: Details of expenditure for implementation of measures for management of Impacts due to construction of roads

S.No.	Item	Cost (Rs. lakh)
1.	Clearing @ Rs.2 lakh per km for 13.04	26.08
2.	Provision of breast walls, construction of catch water and interceptor drains @Rs.5 lakh per km for 13.04 km	65.20
3.	Provision of drainage system along roads @Rs.5 lakh per km for 13.04 km	65.20
4.	Roadside plantation, Jute matting etc. @ Rs.1 lakh per km for 13.04 km	13.04
	Total	**169.52**

ANNEX 21: GREEN BELT DEVELOPMENT PLAN

1. INTRODUCTION

The forest loss due to the reservoir submergence and construction of other project appurtenances shall compensated as a part of compensatory afforestation. However, it is proposed to develop greenbelt around the perimeter of various project appurtenances, selected stretches along reservoir periphery, etc. The main objectives of creating a green belt around a reservoir are to:

- Check soil erosion around the reservoir
- Check landslides and slips around the reservoir
- Develop the habitat for wildlife particularly avi-fauna

The general consideration involved while developing the greenbelt are:

- Trees growing up to 10 m or above in height with perennial foliage should be planted around various appurtenances of the proposed project.
- Planting of trees should be undertaken in appropriate encircling rows around the project site.
- Generally fast growing species should be planted.
- Since, the tree trunk is normally devoid of foliage up to a height of 3 m, it may be useful to have shrubbery in front of the trees so as to gives coverage to this portion.

2. PLANTATION

The tree plantation will be done at a spacing of 2.5 x 2.5 m. About 1600 trees per ha will be planted. The maintenance of the plantation area will also be done by the project proponent. The treated waste water and the manure generated by composting of solid waste generated for labor camps will be used for the greenbelt development. The species shall be recommended for greenbelt development in consultation with the Forest Department.

3. BUDGET

The cost of plantation per hectare is estimated at Rs. 100,000 per ha which includes sapling cost, nursery cost, labor cost, cost of manure, weeding etc. It is proposed to afforest about 20 ha of land as a part of Greenbelt development. The total cost works out to be Rs. 20 lakh.

ANNEX 22: SOLID WASTE MANAGEMENT PLAN

1. INTRODUCTION

Residential buildings will be required to house staff working during the construction of the project and subsequently for the operational staff at both the dam site and at the powerhouse. Permanent buildings may be considered only if these are required in the post construction period also. The following tables below give the details of residential and non-residential buildings.

Other temporary facilities including Contractor's colony and Labor Colonies will be placed at respective location near to the site area. This will include temporary residential colony near to the dam complex area on the right bank at available terrace. Labor colonies will be near to the dam complex location and at adit portal location, powerhouse location.

Non-Residential buildings include project administrative building and other facilities at the location near to Powerhouse on the right bank. The details of temporary and permanent residential buildings are given in Tables 22.1 and 22.2 respectively. Likewise details of temporary and permanent non-residential buildings are given in Tables 22.3 and 22.4 respectively.

Table 22.1: Details of Residential Buildings –Temporary

S.No	Designation	Type of Quarters			
		I	II	III	IV
1	GM (Project Head)	1			
2	DGM		4		
3	AGM		8		
4	DM		20		
5	Engineer			20	
6	Assistant Engineer			26	
7	Medical Officer		1		
8	Nurses & Compounders				4
9	Security Officer		1		
10	Assistant Security Officer		1		
11	Security Assistants				20
12	Accounts Assistants			10	
13	Engineering Consultant Representative		1		
14	Laboratory Incharge			1	
15	Lab Assistants				3
16	Geologist		1		
17	Assistant Geologists			4	
18	CAD Operators			3	
19	Work Charge/Maintenance Staff				20

Table 22.2: Details of Residential Buildings – Permanent

S. No.	Designation	Type of Quarters			
		I	II	III	IV
1	GM (Project Head)	1			
2	DGM		2		
3	AGM		6		
4	DM		11		

S. No.	Designation	Type of Quarters			
		I	II	III	IV
5	Engineer			11	
6	Assistant Engineer			11	
7	Medical Officer		2		
8	Nurses & Compounders				4
9	Security Officer		1		
10	Assistant Security Officer			2	
11	Security Assistants				10
12	Accounts Officer		2		
13	Accounts Assistants			8	
14	Electrician				5
15	Foreman/Mistry			3	
16	Car Drivers				3
17	Administrative Assistants			9	
18	Peons & Messengers				10
19	CAD Operators			2	
20	Work Charge/Maintenance Staff				20
21	Store Incharge		1		
22	Store Keeper			3	
23	Store Helpers				6

Note: Type I Quarters consist of plinth area 176 m^2
Type II Quarters consist of plinth area 84 m^2
Type III Quarters consist of plinth area 54 m^2
Type IV Quarters consist of plinth area 36 m^2

Table 22.3: Details of Non-Residential Buildings – Temporary

S. No.	Description	Plinth Area (m^2)
1	Administration block & site office	1,500
2	Batching plant area	100
3	Shopping centre	1,000
4	Workshop building	500
5	Petrol pump with service station	300
6	Explosive magazine 2 nos. 20 T capacity	200
7	Sewerage treatment plant	500
8	Water pumping station	100
9	Stores	1,000
	Total	**5,200**

Table 22.4: Details of Non-Residential Buildings – Permanent

S. No.	Description	Plinth Area (m^2)
1	Administration block & site office	1,500
2	Field hostel / Guest House	500
3	Parking Area	500
4	Store	500
5	Primary school	1,000
6	Post office, Police Station & Bank	300
7	Dispensary	500
8	Club/recreation	1,000
9	Community hall with parking	500
10	Fire Station	300
11	Taxi & Bus stand	1,000
	Total	**7,600**

This Permanent/Temporary colony between dam and Powerhouse shall be developed. This colony shall have following facilities:

- Potable Water Supply arrangements.
- Sanitation and sewage disposal arrangements.
- Drainage arrangements.
- Internal roads and cross-drainage works.
- Electrical supply.
- Fencing and Security
- Dispensary
- Club
- Community Hall
- Field Hostel
- School
- Nursery
- Water Treatment Plant
- Sewage Treatment Plant

It is proposed to provide two offices complex at suitable topographic location one near Powerhouse site and other close to dam site. In addition other buildings such as Hydro Mechanical workshop, Electro Mechanical, Plant Machinery workshop and Contractor camp shall also be prepared. The total plinth area for residential buildings –Temporary works out to be 9,506 m^2.

2. QUANTITY OF SOLID WASTE GENERATION

The quantity of waste generated in Indian cities reported to be in the range of 0.2-0.6 kg/capita /day as per the “Manual on Solid Waste Management” prepared by Central Public Health & Environment Engineering Organisation (CPHEEO), Ministry of Urban Development, Govt. of India. The Waste Generation pattern is very much dependent on the living style of the population. As the major share of the population is labor force will stay in project area, the waste generation factor of 210 g/capita/day has been taken into consideration.

Solid waste generation will be the leading problem among the negative impacts assuming that huge quantity of municipal waste that would be generated from residential colony, labor camps and office buildings when the project is constructed. Huge amount of sewage will also be generated from the similar sources during the construction and operation phase of the proposed project. The major generation sources for sewage and municipal wastes would be as follows:

- Municipal waste from residential colony, labor camps, office buildings
- Sewage from residential colony, labor camps, office buildings
- Hazardous wastes (i.e. Bio-Medical wastes) from primary health centre and hospitals

It is also expected that if proper management measures for solid waste are not adopted, it will degrade the nearby environment, create hazards for labor and staff that would be posted in the project area during construction/ operation period of the project. Therefore, all the problems due to origination of solid waste require proper management facilities. The types of wastes, its

composition and major generation sources during the construction/ operation of proposed Project are indicated in Table 22.5.

Table 22.5: Expected typical composition of waste in proposed project

Waste Type	Composition of waste	Sources of waste generation
Municipal waste	Food wastes, plastics, paper, sewage, glass, vegetables waste.	From residential and labor camp areas
Construction waste	Empty cement begs, dust, debris, demolition and construction wastes, scrap, dust and ashes etc.	From construction site and crusher etc.
Bio-medical waste	Syringes, cotton, bandages, glass tubes etc.	From primary health centers

3. COMPOSITION OF MUNICIPAL SOLID WASTES

The composition of garbage in India indicates lower organic matter and high ash or dust contents. It has been estimated that recyclable content in solid waste varies from 13 to 20% and compostable materials is about 80-85%. a typical composition of municipal solid waste is given in Table 22.6.

Table 22.6:Typical composition of municipal solid wastes expected in the proposed project

Description	Percent by weight
Vegetable, leaves	40.15
Grass	3.80
Paper	0.81
Plastic	0.62
Glass/ceramics	0.44
Metal	0.64
Stones/ashes	41.81
Miscellaneous	11.73

Source: Central Pollution Control Board

Chemical composition of solid waste is another important aspect for evaluating alternative processing and energy recovery point of view. The details of typical chemical composition of municipal wastes in India are given in Table 22.7.

Table 22.7: Chemical components of municipal solid wastes expected in the proposed project

Component	C (%)	H (%)	O (%)	N (%)	S (%)	Ash (%)
Food wastes	48	6.4	37.6	2.6	0.4	5
Paper	43.5	8	44	0.3	0.2	6
Card board	44	5.9	44.6	0.3	0.2	5
Plastic	60	7.2	22.8	-	-	10
Textiles	55	6.6	31.2	4.6	0.15	2.5
Rubber	78	10	-	2	-	10
Leather	60	8.0	11.6	10	0.4	10
Garden trimming	47.8	6	38	3.4	0.3	4.5
Wood	49.5	6	42.7	0.2	0.1	1.5
Dirt, ashes, brick etc.	26.3	3	2	0.5	0.2	68

Source: Central Pollution Control Board

4. ADMINISTRATIVE SET UP

Administratively, a Solid Waste Management Committee (SWMC) comprising of the project representatives will look after the management of solid waste. The SWMC may comprise of the following:

- In-charge of civil works, at least of the rank of Senior Manager/Manager (1 No.)
- Supervisors/JEs (2 Nos.)

The SWMC will be supported by sanitary workers, sweepers etc., the number of which may be decided by the SWMC after assessing the work requirement.

5. SOLID WASTE MANAGEMENT PLAN

A solid waste management system works on four basic principles viz. segregation & primary storage at the source, collection, transportation, treatment and disposal. Report performance internally against management plan and seek improvements if needed.

5.1 Segregation at source

- Segregation of waste is one of the critical activities in the Solid Waste Management as it saves undue efforts on transportation and disposal of recyclable or inert wastes. The segregation of such wastes, before they are transported to the processing/ disposal site, should be carried out.

- Waste segregation cannot be introduced without public awareness and should be implemented in a phased manner. In order to achieve this, the following strategy may be adopted for promoting public awareness:
  i. The residents shall be educated about appropriate use of biodegradable waste like kitchen & garden wastes.
  ii. Extensive awareness campaigns have to be organized by SWMC for educating the public on the aspects related to impacts of solid waste on environment and health, ill effects of littering and burning of wastes, segregation of municipal solid wastes, proper primary storage within their house premises, etc. The awareness can be spread through posters, distribution of pamphlets etc. SWMC may involve NGOs for organizing awareness programs at project school, hospital etc.
  iii. Residents may be advised to develop the habit of segregating the biodegradable waste material like kitchen and garden waste and store in a separate bag or a bin installed at their respective houses.

- The SWMC would educate its sanitary workers about the revenue earning potential of recyclable waste and various options to earn revenue. The sanitary workers (licenced contractor) should be advised to collect such waste separately. To encourage collection of recyclables, SWMC may think of devising a plan which can provide some revenue opportunities for the sanitary workers. Market potential with respect to the forward linkages for effective disposal of recyclable waste is to be identified and exploited by the SWMC for the purpose.

- Collection and segregation of hazardous wastes from the workshops viz. used batteries, transformer oil, used oil, metal scraps etc. and selling them to CPCB registered vendors having Environmentally Sound Management (ESM) system.

- The operator of waste processing/disposal facility should be advised to carry out inspection of waste received to further segregate recyclables and sell them to recyclers. If it is not feasible to segregate recyclables on their own, the processing/disposal facility operator may allow registered scavengers to enter the premises of the waste disposal facility (existing) and pick recyclable waste. This would ensure reduction in rejects, reducing burden on processing plant as well as landfill.

- SWMC may register the names of recyclers for the recyclables such as plastics, newspapers, glass, metals etc. from residential and commercial sources and the names of registered recyclers should be published or made known to the public residing in the project / labor colonies / labor sheds.

- SWMC may associate and involve residents, shop owners, hospital & school staff and NGOs/ Voluntary Organizations of the area working in the field of waste management in increasing awareness among the people to segregate recyclable material at source and hand it over to a designated waste collector identified by SWMC.

5.2 Primary Storage of Wastes

It is recommended to segregate waste into two categories & store the segregated wastes in three different containers:

One container **(Green Coloured)** for the **"Biodegradable Waste"** or the **"Wet Waste"**

Other container **(Blue Coloured)** for the **"Non-biodegradable Wastes"** or the "**Dry Waste".**

Other suitable container **(Red Coloured)** for the **"Hazardous Waste"** or the "**Contaminated Waste".**

Wet waste (Biodegradable) includes the following:

- Kitchen waste including food waste of all kinds, cooked and uncooked, including eggshells and bones
- Flower and fruit waste including juice peels and house-plant waste
- Garden sweeping or yard waste consisting of green/dry leaves
- Green waste from vegetable & fruit vendors/shops
- Waste from food & tea stalls/shops etc.

Dry waste (Non-biodegradable) includes the following:

- Paper and plastic, all kinds
- Cardboard and cartons
- Containers of all kinds excluding those containing hazardous material
- Packaging of all kinds
- Glass of all kinds
- Metals of all kinds
- Rags, rubber
- House sweeping (dust etc.)
- Foils, wrappings, pouches, sachets and tetra packs (rinsed)
- Discarded electronic items from offices, colonies viz. cassettes, computer diskettes, printer cartridges and electronic parts.

- Discarded clothing, furniture and equipment

Contaminated waste (Hazardous) includes the following:

- Sanitary Waste
- Ashes
- Waste from first aid centre
- Other waste (hazardous)

The wet and dry wastes are to be stored in two different containers as mentioned above. As the biodegradable waste degrades and generates liquid, it is advisable to use non-corrosive container with lid for the storage of bio-degradable/wet waste.

A **Green** coloured container of 10 liters capacity for a family of about 5-6 members would generally be sufficient for wet waste. However, it is advisable that a household should keep larger container or standby container to store the additional wastes produced in 24 hours. The household may have a spare capacity of 100% to meet unforeseen delay in clearance or unforeseen extra loads.

Dry waste can be stored in another **Blue** coloured container of 10-12 litre capacity or plastic bag/Jute Bag/plastic/polymer containers.

The containers are to be procured by SWMC and provided to individual households in the project colonies & labor colonies/camps. Some containers of bigger capacity (0.5 m^3) will also be kept at public places, as community bins, like offices, workshops, shops, community centre, school, canteens/ mess, guest houses etc. The places where community bins have to be placed away from drinking water sources and preferably on elevated areas concrete surface with a bermed 110% volume where water stagnation is not there during rainy days.

For the project hospital, separate storage bins are to be arranged, the wastes of which are to be disposed of through incinerators.

To enforce successful implementation, necessary rules/by-laws should be framed by SWMC to make segregation and storage at source compulsory and also to avoid littering and burning of wastes at the project sites.

5.3 Collection of Solid Wastes

It is recommended to have a mechanism for door to door collection of waste from the staff/ labor colonies and labor sheds. The sanitary workers / sweepers) will have tricycle with containers or containerized handcarts having ringing bell and will go for waste collection from individual house at a fixed time every day. The sanitary workers would ring the bells at the time of reaching the particular area/locality, giving a signal for waste collection to the residents.

In labor colonies also, the door-to-door collection of waste would be carried out. The containerized rickshaws or handcarts would be employed for collection of wastes. The laborers should be strictly advised to store the wastes in available plastic containers of suitable size. The waste bins including community bins are to be cleaned daily by the sanitary workers at an informed timing.

During collection of wastes from the bins, care shall be taken to avoid waste spillage and it shall be the responsibility of the sanitary workers to clean & maintain hygienic conditions at the places where community bins are kept.

5.4 Waste Handling

As per Municipal Solid Waste (Solid Waste Management & Handling) Rules, 2000; the manual handling of waste has to be avoided. As per the recommended system, the waste from their source of generation is either collected by sanitary workers during door-to-door collection from the colonies or from community bins.

The sanitary workers, after primary collection, will transport the waste to the storage depots from where it will be lifted by dumper placers and transported to the processing and disposal sites. Adequate storage facilities will be made available in case of delay in the transportation.

The community bins of size 0.5 m^3 are to be lifted manually and unloaded into the containers kept in the transportation vehicles.

The sanitary workers involved in manual lifting are to be provided with gloves and proper respiratory masks and shall be instructed to use them compulsorily while handling waste. It will be the responsibility of the sanitary supervisors to monitor the proper use of personnel protective equipment by the workers.

5.5 Transportation of Solid Wastes

It is recommended to use tricycles/push carts/containerized handcarts, for primary collection of waste from the individual households, offices and other public places, as described above, up to the waste storage depots. The sufficient number of tri-cycles/push carts/containerized handcarts shall be arranged for effective door-to-door collection system. All waste leaving site must be accompanied by a waste transfer note.

The wastes collected from the street sweeping and drain cleaning is to be shifted to the waste storage depots using tricycles/handcarts.

The transportation of waste from the waste storage depots to the processing and disposal sites will be done in the covered trucks/dumpers etc. so that the waste is not exposed to the human population and there is no spillage of waste on the roads during transportation.

To take care of certain unavoidable circumstances, if it is required to lift waste from some open place, front-end loaders and tractor trolleys may be used. However, the waste in tractor trolley has to be covered with LDPE sheet during its transport.

6. DISPOSAL OF SOLID WASTE (NON-DEGRADABLE PORTION)

As per the requirements of the Municipal Solid Waste (Solid Waste Management & Handling) Rules 2000, land filling would be restricted to non-biodegradable, inert waste and other waste that are not suitable either for recycling or for biological processing. Land filling shall be done following proper norms and landfill sites shall meet the specifications as given in these rules. It will also follow IFC EHS Guidelines on Waste Management. The quantum of solid waste to be disposed for landfill is given in Table 22.8.

Table 22.8: Estimation of Quantity of waste to be disposed to landfill

S. No.	Description	Data
1.	Per capita MSW generation at present	0.21 kg per capita per day
2.	Population during construction stage of the project	2,800
3.	Total Solid Waste (SW) generation at the rate of 0.21 kg/capita/day	588 kg/day
4.	Considering the fraction of bio-degradable waste as 45 % of total SW generated, total quantity of bio-degradable waste to be generated (for vermi-composting)	265 kg/day
5.	Inorganic waste for disposal (48% of total waste) to landfill (considering that recyclable waste in form of paper, glass, metals, plastic etc. constitute 7 % of total waste)	283 kg/day
6	Hence total waste to be disposed in landfill at present	548 kg/day
7.	Waste to be disposed to landfill, annually	200 tons/year
8.	Waste to be disposed to landfill in 4 years	800 tons/year

The details of landfill site are given as below:

- Length 16 m
- Width 10 m
- Depth of fill 5 m

A provision of 15% of the total area, for accommodating infrastructure facilities has also been included while working out requirement of space (the exact location of the landfill is still being determined, but following IFC EHS guidelines). The liner system will comprise of the following layers below the waste:

- 0.30 m thick drainage layer comprising of coarse sand or gravel (stone dust with no fines)
- 0.2m thick protective layer of sandy silt
- 1.50mm thick HDPE geomembrane
- 1.0 m thick clay layer/amended soil layer, amended soil layer comprising of local soil + bentonite is to be provided).

7. TREATMENT OF SOLID WASTE (DEGRADABLE PORTION)

Considering the fraction of bio-degradable waste as 45% of total SW generated, total quantity of bio-degradable waste to be generated (for vermi-composting), which amounts to about 0.8 m^3/day. The vermi-composting the process takes around 60 days to mature. Thus the total capacity of pits required would be (60*0.8) 48 cu m.

The locations of the compost pits will be selected in compliance with IFC EHS guidelines in waste management. A pit of 2m x 1.5m x 1.3m deep (0.3m freeboard) size can take 3.0 cu m of compostable waste. Thus the no. of pits required shall be 16. The total area will be almost three times the pit area as some area in between pits will be required for transportation and stacking of waste. Hence, total area required will be 150m^2. The pits will be covered with GI sheets. Additional 80 sq. m would be kept for storage for compost plus screening and other activities.

The pits to be constructed will have around 25 cm of bottom lining consisting of about 5 cm thick stone grit over which 15 cm thick coarse sand followed by 15 cm thick earth lining will be done.

The refuse along with animal dung will have to be laid in layers of 5 to 10 cm thickness. The pit will be then watered on alternate days. Thereafter waste is laid in 5 to 10 cm thick layers twice in a week till the whole pit is filled up. Every week the waste will need to be turned up and water will have to be sprinkled every day to keep adequate moisture. The process will take around 45 to 60 days where after the composted waste from the pit is taken out and after drying it is screened with screens having 2 mm dia holes. The screened compost would be filled in plastic bags and used as good manure especially for cultivation of vegetables and flowers.

8. BUDGET

The total cost required for solid waste management is Rs. 234.84 lakh. The details are given in Table 22.9.

Table 22.9: Cost estimate for solid waste management

S. No.	Item	Cost (Rs. lakh)
1.	Cost of land for land filled vermin-composting sites	20.0
2	Reclamation and stabilization cost of landfill and vermin-composting sites	10.0
3	Two covered trucks for conveyance of solid waste to landfill and vermin-composting site @ Rs. 3 million per truck	120.0
4.	Manpower cost for 5 persons @ Rs. 10,000/ month for 4 years including 10% escalation/year	27.84
5.	03 tractors with trolleys @ Rs. 500,000/ per tractor with trolley	15.0
6.	Awareness programme	5.0
7.	Water facility & Toilet facilities at landfill and vermin-composting site	5.0
8.	Tools & Implements	10.0
9.	Yard lighting maintenance store room lighting, Monitoring station @5000/ fixture x 40'	2.0
10.	Periodical Training & Medical Checkup	20.0
	Total	**234.84**

ANNEX 23: EMERGENCY PLAN FOR HAZARDOUS MATERIALS

1. Storage of Hazardous Waste

All the fuel and hazardous material storage will be adequately bounded to prevent any spillage problem.

2. Spill Response Procedures

In the event of a spill of any hazardous material, work will be ceased in the immediate vicinity and the area will be cleared of all construction personnel except those involved in the clean-up activities, if necessary.

In the event of a spill of any hazardous material, the following response hierarchy will apply and will be used in the development of the detailed emergency response procedures:

a. First priority is to seek medical attention for any injured personnel

b. Second priority is to prevent further injury to personnel

c. Third priority is to prevent environmental damage

d. Fourth priority is to clean-upspill

e. Fifth priority is to remediate area of spill

f. Sixth priority is to complete reporting requirements

For spills of hazardous materials, appropriate treatment and disposal methods for the known range of hazardous materials will be applied by trained personnel.

3. Emergency Contact Details

At each construction site, information on emergency response procedures, emergency contact numbers and communication and reporting procedures (to be implemented in case of an emergency situation) will be clearly displayed.

4. Training of Personnel

At each construction site where hazardous materials are used and where there exists a potential for a spill, there will be at least two employees on-site at all times who are trained in appropriate emergency response procedures and communication and reporting procedures to be implemented in case of an incident (refer to Environmental Training for Workers Plan).

All construction personnel will be trained in basic emergency response procedures including communication and reporting procedures to be implemented in case of an emergency situation.

5. Emergency Incident Communication Process

In the event of an accidental release or spill of a hazardous material, the following communication processes will be implemented:

a. ESO (Environmental and Social Officer) immediately notifies ESMMU

b. ESMMU immediately notifies emergency response team

c. ESMMU immediately notifies external emergency authorities (if required)
   Communication will initially be verbal, with written communication as soon as practical.

The communication processes will include the following information in relation to accidental releases or spills:

a. Location of spill

b. Nature of material spilt

c. Amount of material spilt

d. Clean-up processes to be implemented

e. Any injuries to personnel

f. Need for emergency or external assistant

g. Any safety/evacuation requirements to be implemented on the construction site

Within 48 hours of the completion of a spill clean-up, a report will be submitted to the Owner. The report will be used to identify any required corrective or preventive actions and emergency response procedures and training programs will be modified accordingly.

6. Sulfur Hexafluoride

Fugitive emissions of SF_6 will be monitored following the requirements of Institute of Electrical and Electronics Engineers (IEEE) and International Electro-technical Commission (IEC). Annual inventory on the use of SF_6 will be conducted to monitor usage and losses. A very high grade sealing system and erection methodology will be followed to keep the loss of SF_6 within 0.1% every year. SF_6 gas handling system for evacuation and storage will always be used for the maintenance of the circuit breaker. Relevant standards from the WB EHS Guidelines for Power Transmission and Distribution 2007 and Centrol Pollution Control Board (CPCB) on handling SF_6 and other hazardous materials will be complied with.

ANNEX 24: MEASURES FOR AIR POLLUTION CONTROL

1. IMPACTS ON AIR QUALITY

In a water resources project, air pollution occurs mainly during project construction phase. The major sources of air pollution during construction phase are:

- Fuel combustion in various construction equipment, e.g. crushers, drillers, rock bolters, diesel generating vehicles, etc.
- Fugitive emissions from crusher
- Impacts due to vehicular movement

a) Pollution due to fuel combustion in various equipment

The operation of various construction equipment require combustion of fuel. Normally, diesel is used in such equipment. The major pollutant, which gets emitted as a result of diesel combustion, is SO_2. The SPM emissions are minimal. Based on past experience in similar projects, PM10, PM2.5, NOx and SO_2 are not expected to increase significantly. Thus, in the proposed project, no significant impact on ambient air quality is expected as a result of operation of various construction equipment.

b) Emissions from crusher

The operation of the crusher during the construction phase is likely to generate fugitive emissions, which can move even up to 1 km in predominant wind direction. During crushing operations, fugitive emissions comprising of the suspended particulate will be generated. There could be marginal impacts to settlements close to the sites at which crusher is commissioned. However, based on past experience, adverse impacts on this account are not anticipated. However, during finalizing the project layout, it should be ensured that the labor camps, colonies, etc. are located on the windward side (upwind) and outside the impact zone (about 1.5 to 2 km) of the crushers.

c) Impacts due to vehicular movement

During construction phase, there will be increased vehicular movement for transportation of various construction materials to the project site. Large quantity of dust is likely to be entrained due to the movement of trucks and other heavy vehicles. However, such ground level emissions do not travel for long distances. Thus, no major adverse impacts are anticipated on this account.

2. MITIGATION MEASURES

a) Control of Emissions

Minor air quality impacts will be caused by emissions from construction vehicles, equipment and DG sets, and emissions from transportation traffic. Frequent truck trips will be required during the construction period for removal of excavated material and delivery of select concrete and other equipment and materials. The following measures are recommended to control air pollution:

- The contractor will be responsible for maintaining properly functioning construction equipment to minimize exhaust.

- Construction equipment and vehicles will be turned off when not used for extended periods of time.
- Unnecessary idling of construction vehicles to be prohibited.
- Effective traffic management to be undertaken to avoid significant delays in and around the project area.
- Road damage caused by sub-project activities will be promptly attended to with proper road repair and maintenance work.

b) Air Pollution control due to DG sets

The Central Pollution Control Board (CPCB) has issued emission limits for generators up to 800 KW. The same are outlined in Table 24.1, and are recommended to be followed.

Table 24.1:Emission limits for DG sets prescribed by CPCB

Parameter	Emission limits (gm/kwhr)
NOx	9.2
HC	1.3
CO	2.5
PM	0.3
Smoke limit*	0.7

Note : * Light absorption coefficient at full load (m^{-1})

The above standards need to be followed by the contractor operating the DG sets.

The other measures are recommended as below:

- Location of DG sets and other emission generating equipment should be decided to keep in view the predominant wind direction so that emissions do not effect nearby residential areas.
- Stack height of DG sets to be kept in accordance with CPCB norms, which prescribes the minimum height of stack to be provided with each generator set to be calculated using the following formula:

  $H = h+0.2x \sqrt{KVA}$

  H = Total height of stack in metre

  h = Height of the building in metres where the generator set is installed

  KVA = Total generator capacity of the set in KVA

c) Dust Control

The project authorities will work closely with representatives from the community living in the vicinity of project area to identify areas of concern and to mitigate dust-related impacts effectively (e.g., through direct meetings, utilization of construction management and inspection program, and/or through the complaint response program). To minimize issues related to the generation of dust during the construction phase of the project, the following measures have been identified:

- Identification of construction limits (minimal area required for construction activities).
- When practical, excavated spoils will be removed as the contractor proceeds along the length of the activity.
- When necessary, stockpiling of excavated material will be covered or stacked at offsite location with muck being delivered as needed during the course of construction.

- Excessive soil on paved areas will be sprayed (wet) and/or swept and unpaved areas will be sprayed and/or mulched.
- Contractors will be required to cover stockpiled soils and trucks hauling soil, sand, and other loose materials.
- Clean the wheels of vehicles leaving the site to control the mud spread onto the public road.
- Contractor shall ensure that there is effective traffic management at site.
- Dust Suppression – The roads, construction area and vicinity (access roads, and working areas) shall be swept, sprinkled with water on daily basis to suppress dust.

3. IMPLEMENTING AGENCY

Various management measures needs to be implemented for Control of air pollution control need to be included in the Tender Document for the Contractor involved in construction activities. The same shall be monitored on a regular basis by the project proponents.

ANNEX 25: MEASURES FOR NOISE POLLUTION CONTROL

1. IMPACTS ON NOISE LEVELS

In a water resource projects, the impacts on ambient noise levels are expected only during the project construction phase, due to earth moving machinery, etc. Likewise, noise due to quarrying, blasting, vehicular movement will have some adverse impacts on the ambient noise levels in the area.

2. MITIGATION MEASURES

The contractors will be required to maintain properly functioning equipment and comply with occupational safety and health standards. The construction equipment will be required to use available noise suppression devices and properly maintained mufflers.

- Careful selection of construction methods.
- vehicles to be equipped with mufflers recommended by the vehicle manufacturer. Prohibiting works vehicles queuing on the public road.
- staging of construction equipment and unnecessary idling of equipment within noise sensitive areas to be avoided whenever possible.
- notification will be given to residents within 300 m of major noise generating activities (1km for blasting). The notification will describe the noise abatement measures that will be implemented.
- monitoring of noise levels will be conducted during the construction phase of the project. In case of exceeding of pre-determined acceptable noise levels by the machinery will require the contractor(s) to stop work and remedy the situation prior to continuing construction.

The following Noise Standards for DG sets are recommended for the running of DG sets during the construction:

- The maximum permissible sound pressure level for new diesel generator sets with rated capacity up to 1,000 KVA shall be 75 dB(A) at 1 m from the enclosure surface.
- Noise from the DG set should be controlled by providing an acoustic enclosure or by treating the enclosure acoustically.
- The Acoustic Enclosure shall be made of CRCA sheets of appropriate thickness and structural/ sheet metal base. The walls of the enclosure shall be insulated with fire retardant foam so as to comply with the 75 dB(A) at 1 m sound levels specified by CPCB, Ministry of Environment & Forests.
- The acoustic enclosure/acoustic treatment of the room shall be designed for minimum 25 dB(A) Insertion Loss or for meeting the ambient noise standards, whichever is on the higher side.
- The DG set shall also be provided with proper exhaust muffler.
- Proper efforts shall be made to bring down the noise levels due to the DG set, outside its premises, within the ambient noise requirements by proper siting and control measures.
- A proper routine and preventive maintenance procedure for the DG set shall be set and followed in consultation with the DG set manufacturer which would help prevent noise levels of the DG set from deteriorating with use.

Noise due to crusher

Based on literature review, noise generated by a crusher is in the range of 79-80 dB(A) at a distance of 250 ft or about 75 m from the crusher. Thus, noise level at a distance of 2 m from the crusher shall be of the order of 110 dB(A). The exposure to labor operating in such high noise areas shall be restricted up to 30 minutes on a daily basis. Alternatively, the workers need to be provided with PPEs (ear muffs or plugs), so as to attenuate the noise level near the crusher by at least 25 dB(A), to bring noise level down to 85 dB(A). The exposure to noise level in such a scenario to be limited up to 4 hours per day.

It is known that continuous exposure to noise levels above 85 dB(A) (IFC EHS standard) affects the hearing of the workers/operators and hence has to be avoided. Other physiological and psychological effects have also been reported in literature, but the effect on hearing acuity has been specially stressed. To prevent these effects, it has been recommended by international specialist organizations that the exposure period of affected persons be limited as specified in Table 25.1.

Table 25.1: Maximum Exposure Periods specified by OSHA (IFC guideline is 85 dB (A))

Maximum equivalent continuous noise level dB(A)	Unprotected exposure period per day for 8 hrs/day and 5 days/week
90	8
95	4
100	2
105	1
110	½
115	¼
120	No exposure permitted at or above this level

Measures to control noise due to blasting

Various measures outlined for control of noise due to blasting is given as below:

- Use of backfill cover has the potential to reduce air overpressure levels by 10 dB (A).
- Air overpressure levels may also be reduced by deck loading. In a blast with a significant vertical free face, this reduction may in some circumstances be obtained by deck loading the front row holes fired on the initial delays only, without needing to deck load all the front row holes.
- Rock excavation by blasting shall be done for all solid rock in place which cannot be removed until loosened by blasting, barring or wedging, removal of all big boulders or detached pieces of massive rock.
- Rock excavation close to the final excavated surfaces shall be performed using controlled blasting methods such as "pre-splitting", "cushion blasting" or “smooth blasting". Line-drilling shall be used to limit the over break and damage of surround rock.
- All excavations shall be performed using methods and techniques that will produce smooth and sound rock surfaces with minimum over break and fracturing beyond the lines and grades or limits of excavation. Drilling and blasting shall be done in such a manner as to ensure that the rock will break along the desired lines and grades. Rock faces and slopes shall be scaled or cleaned of loose or overhanging rock immediately after excavation.
- Blast holes shall be drilled not exceeding two-third of the depth of rock to be excavated from the elevation at which the hole is started. The holes shall not be larger than

necessary to permit easy passage of whole sticks of explosives to the bottom of the holes. As the excavation approaches its final limits, the depth of holes for blasting and the amount of charges for the holes shall be reduced progressively.

- Blasting shall be carried out with non-electric detonators only except for the cord/fuse initiation by electric detonators. A separate circuit, independent of power and light circuits, shall be used for blasting.
- Charging, tamping and firing of drilled holes shall be done by an approved licensed person under his personal direction. Proper signals by siren shall be given before each operation of blasting.
- Blasting shall be permitted only when proper precautions are taken for the protection of persons, work and property. Any damage done to the work or property by blasting shall be repaired immediately.

A trained professional shall be hired to monitor the technical specifics of the blast, such as size and depth of drilled holes, and the type and amount of explosive used.

ANNEX 26: MEASURES FOR WATER POLLUTION CONTROL

All sites have the potential to pollute watercourses, so the approach should be adopted at the earliest stage of the project.

1. CONTROL OF WATER POLLUTION DURING CONSTRUCTION PHASE

i) Sewage from labor camps/colonies

The project construction is likely to last for a period of 4 years. The peak labor strength likely to be employed during project construction phase is about 800 workers and 200 technical staff. The employment opportunities in the area are limited. Thus, during the project construction phase, some of the locals may get employment. It has been observed during construction phase of many of the projects; the major works are contracted out, who bring their own skilled labor. However, it is only in the unskilled category, that locals get employment. The construction phase, also leads to mushrooming of various allied activities to meet the demands of the migrant labor population in the project area.

The following assumptions have been made for assessing the emigrating population in the area:

- 50% of workers and 10% technical staff migrating into the area are married.
- In 50% of the family of workers both the husband and wife will work.
- In 100% of the family of technical staff, only husband will work.
- About 2% of total migrating population has been assumed as service providers and shall be with families.
- Family size has been assumed as 4.

Considering the above assumptions, the total increase in population is expected to be about 2,800. The details are given in Table 26.1.

Table 26.1: Increase in total population due to immigration of labor population during construction phase

S. No.	Description	Nos	Family Size	Population
	Peak Migrant Workers 800 Nos			
	Single	400	1	400
	Married	400	4	1,600
	Subtotal			2,000
	Peak Technical Staff 200 Nos			
	Single	180	1	180
	Married	20	4	80
	Subtotal			260
	Service Provides 60 Nos			
	Married	60	4	240
	Subtotal			240
	Total			**2,760 say 2,800**

Based on experience of similar projects and above referred assumptions, the increase in the population as a result of migration of labor population during construction phase is expected to be of the order of 2,800. Considering per capita water supply as 135 lpcd, the domestic water requirement has been estimated as 0.38 mld. Considering sewage generation as 80% of the total water supplied, quantum of sewage generation is expected to be 0.30 mld. The labor

population is proposed to be situated in existing colonies. One community toilet needs to be provided for 20 persons. The sewage from the community toilets can be treated in a Sewage Treatment Plant (STP) comprising of aerated lagoon and secondary settling tank. The treated effluent can be used for meeting irrigation requirements of areas being afforested under greenbelt development and canal bank plantation. The total cost required shall be Rs. 155.8 lakh. The details are given in Table 26.2.

Table 26.2: Cost estimate for sanitation facilities in labor camps.

Item	Unit	Number	Total cost (Rs. lakh)
Community toilet	Rs.75,000/community toilet	140 nos.	105.0
Aerated lagoon & Secondary setting tank to treat effluent to CPCB effluent discharge standards			40.0
Total			**145.0**

ii) Effluent from crushers

During construction phase, at least one crusher will be commissioned at the quarry site by the contractor involved in construction activities. It is proposed only crushed material would be brought at construction site. The capacity of the crusher shall be of the order of 500 tph. Water is required to wash the boulders and to lower the temperature of the crushing edge. About 0.1 m^3 of water is required per ton of material crushed. The effluent from the crusher would contain high-suspended solids. A total quantity of 50 m^3/hr of effluent is expected to be generated from various crushers. The effluent, if disposed without treatment, can lead to marginal increase in the turbidity levels in the receiving water bodies. The natural slope in the area is such that, the effluent from the crushers will ultimately find its way in river Kopili.

It is proposed to treat the effluent (to CPCB effluent discharge standards) from crushers in settling tank before disposal so as to ameliorate even the marginal impacts likely to accrue on this account. An amount of Rs. 10 lakh has been earmarked for this purpose.

(iii) Effluent from tunneling sites

During tunneling work the ground water flows into the tunnel along with construction water, which is used for various works like drilling, shotcreting, etc. The effluent thus generated in the tunnel contains high suspended solids. Normally, water is collected in the side drains and drained off into the nearest water body without treatment. It is recommended to construct a settling tank of adequate size to settle the suspended impurities. The effluents are expected to be generated from these locations, which shall be treated (to CPCB effluent discharge standards) prior to disposal. An amount of Rs. 10 lakh has been earmarked for this purpose. An amount of Rs. 10 lakh has been earmarked for this purpose.

(iv) Effluent from Batching Plants

During construction phase, batching plants will be commissioned for production of concrete. Effluent containing high suspended solids shall be generated during operation and cleaning of batching plants.. However, no major adverse impacts, are anticipated due to small quantity of effluent and large volume water available for dilution in river Kopili. It is proposed to treat the effluent(to CPCB effluent discharge standards) before disposal to ameliorate even the marginal

impacts likely to accrue on this account. An amount of Rs. 10 lakh has been earmarked for this purpose.

(vii) Effluent from Fabrication Units and Workshops

The fabrication units and workshops which shall be functional during construction phase will generate effluents with high suspended solids and oil and grease level. It is proposed to treat the effluent from fabrication units and workshops (to CPCB effluent discharge standards) prior to disposal. An amount of Rs. 10 lakh has been earmarked for this purpose.

2. CONTROL OF WATER POLLUTION DURING OPERATION PHASE

In the project operation phase, a plant colony with 50 quarters and nonresidential buildings is likely to be set up. It is recommended to provide a suitable Sewage Treatment Plant (STP) to treat the sewage generated from the colony. The cost required for construction of sewage STP in the project colony has already been covered in the budget earmarked for construction of the project colony. Hence, the cost for the same has not been included in the cost for implementing EMP.

3. WATER POLLUTION INCIDENT EMERGENCY RESPONSE

All site personnel should be aware of the appropriate action in case an emergency happens, e.g. the spillage of potentially polluting substances. Emergency response procedure should be developed for the site. Any pollution to surface water or groundwater should be reported. (Details refer to Annex 23)

4. BUDGET

The total expenditure required for implementation of various environmental measures for control of water pollution shall be Rs. 185.0 lakh. The details are given in Table 26.3.

Table 26.3: Expenditure required for Environmental Management in Labor Camps

S. No.	Item	Cost (Rs. lakh)
1.	Sanitation facilities	145.0
2.	Settling tank to treat effluent from crushers	10.0
3.	Settling tank to treat effluent from tunneling sites	10.0
4.	Settling tank to treat effluent from batching plants	10.0
5.	Settling tank to treat effluent from Fabrication Units and Workshops	10.0
	Total	**185.0**

ANNEX 27: ENERGY CONSERVATION MEASURES

1. INTRODUCTION

Various construction and other activities of the proposed LKHEP would lead to increased demand for fuel wood and fodder in the project area and its vicinity and would therefore exert pressure on forest areas located around the project. The major source of energy in the villages of the project area is fuel wood, acquirement of which is one of the main causes of ecological degradation and human drudgery. It is estimated that during the construction of the project, which would last for about 8 years, around 2,800 laborers (including their family members) will be working. Majority of the labor force will be outsiders and it will be very important to meet their energy requirement in an ecologically sustainable manner.

To provide an alternate for the energy requirement of the workers, contractor/s will be made responsible to provide subsidized kerosene/LPG to their workers which will in turn discourage them from illegal tree felling and removal of fuel wood and timber from the adjoining forests. Further, community kitchen facilities would also be provided to the laborers by the contractors. In addition to above, efforts would be made towards energy conservation by installing non-conventional energy sources as discussed in the subsequent paragraphs.

2. ENERGY CONSERVATION DURING CONSTRUCTION PHASE

The following energy conservation measures would be undertaken during construction works:

- Efficient work scheduling and methods that minimize equipment idle time and double handling of material
- Throttling down and switching off construction equipment when not in use
- Switching off truck engines while they are waiting to access the site and while they are waiting to be loaded and unloaded
- Switching off site office equipment and lights and using optimum lighting intensity for security and safety purposes
- Careful design of temporary roads to reduce transportation distance
- Designing roads on site to reduce transportation distances.
- Regular maintenance of equipment to ensure optimum operations and fuel efficiency
- The specification of energy efficient construction equipment.

3. ENERGY CONSERVATION DURING OPERATION PHASE

The following energy conservation measures would be implemented during operation phase:

- Use of CFL lights up to maximum possible extent.
- Awareness about the use of CFL lights by locals with appropriate waste disposal.
- Employing renewable energy sources such as day lighting and passive solar heating.

4. ENERGY SAVING MEASURES FOR POPULATION IN STUDY AREA

4.1 Distribution of Kerosene oil stoves

Conventional Kerosene oil Stoves is a good substitute for fuel wood and it is proposed that kerosene oil stoves would be distributed amongst the workers and the locals in the affected

villages. Total budget for distribution of 2000 kerosene oil stoves @ Rs.1000 per stove would be Rs.20.00 lakh.

4.2 Distribution of Pressure Cookers

The distribution of the pressure cookers may also be taken as one of the attractive option for energy saving. The energy required for food preparation in pressure cookers is less than conventional cooking in pot, therefore, to save burning of firewood, pressure cookers *w*ould be given at subsidized rates to the laborers for cooking needs. It will also help in reducing energy consumption. The total budget for distribution of 20.0 lakh.

4.3 Solar Cookers

Solar cookers utilize sunrays, one of the abundant sources of pollution free natural energy. Barring cloudy days in rainy season, it can be used in sunny days to cook and thereby conventional fuels to a significant amount. It, however, supplements the cooking fuel and cannot replace it in total. Solar energy is abundantly available in India. On clear sunny days, it is possible to cook noon meal for 4 to 5 people in a normal Box solar cooker and if one desires either full or part evening meal could also be cooked in it. Concentrating Cookers can cook food for large number of people faster than box solar cookers.

Solar cookers are available both with and without electrical back up in different sizes and features. These can be procured from manufacturers /suppliers/district and head offices of state agencies. Cooker with an electrical back up has the advantage of cooking food during non-sunshine hours/cloudy days with very nominal consumption of electricity. The cost of the cooker is of the order of Rs. 5000 depending on its size and features. A normal size family cooker is sufficient for a family of 4 to 5 members. It has a life of 15 to 20 years and pays back the cost in 3 to 4 years. Community box solar cookers are also being manufactured by some of the manufacturers, which can cook food for 20 to 25 people. The total budget for distribution of 500 solar cookers @ Rs.5000 per cooker for PAFs / locals would be Rs. 50.0 lakh.

4.3 Installation of Improved Chulhas

Improved chulhas are scientifically designed for optimal regulation of heat flow and better fuel utilization. Improved chullhas not only economies fuel wood consumption but also help in keeping the house clean, i.e. free from smoke and also help in preventing eye ailment due to smoke. Provisions may be made to make smokeless chullhas available to the villagers. Varieties of energy efficient chullhas are available such as durable fixed type chullhas with chimney, portable type and High altitude chullhas. . The total budget for distribution of 1,000 smokeless chullhas @ Rs. 1000 would be Rs. 10.0 lakh.

5. BUDGET

An amount of Rs.100.0 lakh has been earmarked for distribution of energy saving measures amongst population in the Study Area. The details are given in Table 27.1.

Table 27.1 : Estimated Cost for Energy Conservation Management Plan

S. No.	Particulars	Cost (Rs. lakh)
1.	Distribution of Kerosene oil stoves	20.0
2.	Distribution of Pressure Cookers	20.0
3.	Distribution of Solar Cookers	50.0
4.	Distribution of Improved Chullhas	10.0
Total		**100.0**

ANNEX 28: FIRE PROTECTION IN LABOUR CAMP AND STAFF COLONIES

1. INTRODUCTION

It has been envisaged that the fire protection planning in labor camps and staff colonies shall be taken up. The details are given in following sections of this chapter.

2. CONSTRUCTION OF CAMPS ETC. AND PLACEMENT OF FIRE PROTECTION EQUIPMENT

It has been planned that all facilities to be constructed shall be fully equipped with the fire protection equipments as per IS standards. The analysis of fire hazard in the construction of these camps, colonies and other facilities is given in Table 28.1.

Table 28.1: Analysis of fire hazard in the construction of camps, colonies and other facilities

S. No	Stage	Potential hazard	Remedial Measures
1.	Construction of labor camps and staff colonies	• Fire prevention and fire fighting not considered in design • Inadequate fire protection measures during construction phase	**BY PROJECT PROPONENT** • While construction of Field hostels, Guest House/office and other facilities owned by project proponent shall provide the fire protection system as per IS Standards for Fire code. • Proper housekeeping will also be ensured and maintained during these facilities to protect them from any fire related incidents. • It will be ensured that the fire fighting equipments are placed at common place also including work place preferably within 15 meters of work place. **BY CONTRACTORS** • Clear term of reference will be given to contractor at tendering stage for incorporating fire code as per IS Standard. • Fire fighting equipments will be placed at all common places (within 15 meters of work place)

3. IMPLEMENTATION OF FIRE PROTECTION SYSTEM

During construction, it has been envisaged to set up full-fledged Environment Health & Safety (EHS) department reporting directly to Head of Project. This department shall also take care of the adequacy of Fire Safety measures set up in all facilities created either owned by project proponent or any of its Contractors. The analysis of responsibility for this EHS team in respect of Fire protection system is given in Table 28.2.

Table 28.2:Responsibility for this EHS team in respect of Fire protection system

S.No.	Stage	Potential hazard	Remedial Measures
1.	During Occupation	• Fire incident due to electrical short circuit/LPG Leakage/ Improper handling of flammable liquids/lack of precaution • Improper access to and from the location • In adequate fire fighting arrangements • Lack of knowledge • Lack communication • Lack of Knowledge on fighting fire and handling fire equipment • Inadequate emergency response	• Residential complex will be constructed as per the approved design and will be checked for completeness on fire aspect before allotment to residents • Each Block Colony/ camp will be provided with rated estimated trip off circuit breaker will be installed on each block. • All residents are made aware of fire hazard by training, regular campaigns and by placing posters and signs • LPG Cylinders/Flammable liquids will be stored at designated storage area. The storage will be well protected, ventilated with adequate provision of fire equipment. • Each block of the colony will be provided with 10 kg DCP fire extinguishers. • Additionally fire point containing fire buckets, CO_2 extinguishers, DCP Extinguisher will be provided at the common place covering four residential blocks in labor camp. • Placement of written posters of preventive measures in each accommodation block • Regular EHS inspection of the camp site • Placement of placard of emergency numbers to be contacted in case of Emergency • Dedicated phone line will be provided in labor camps for effective communication. • Ensure proper access is maintained around and to the residential blocks • Identification of emergency Muster points at safe distance

4. RESPONSIBILITY

Project In charge is responsible for implementation of plan through his authorized representative on site. Site EHS Team shall monitor the implementation of plan and report non-compliance to site management.

5. TRAINING AND AWARENESS

Training of employees on fire prevention and fire fighting is important to prevent occurrence of fire incident in project area. All employees will be given brief overview of fire prevention, fire fighting procedure and response process at the time EHS Induction training. Project proponent will also carry out regular campaigns on fire prevention around the site. EHS Department is responsible for providing required training.

6. BUDGET

Implementation of this plan will be mandatory for all contractors. Requirements of this plan will be part of contract agreement. The tentative cost of the fire protection in labor camps and staff colonies is estimated about Rs. 40.0 Lakhs. The details are given in Table 28.3.

Table 28.3: Details of cost for fire protection in labor camps and staff colonies

S. No.	Provision	Estimated cost (Rs. lakhs)
1	Provision of fire extinguishers in labor camps and staff colony	
a)	Fire extinguisher DCP 5KG / 10 KG / 30 KG	10.0
b)	Fire Extinguisher CO2 10 KG	5.0
c)	Fire extinguisher Foam Type 30 KG	5.0
2	Refilling and maintenance	10.0
3	Inspection Charges	5.0
4	Training, Campaign and poster installation	5.0
	Total	**40.0**

The firefighting system in the project area will be suitably built in the contract document which would be executed by specialized vendors, cost for which will be included in the project cost.

ANNEX 29: SAFETY PRACTICES DURING CONSTRUCTION PHASE

1. INTRODUCTION

The information on following aspects pertaining to safety have been presented in this chapter:

- Personal Safety Equipment
- Rescue Team
- Illumination and Earthing
- Maintenance of Traffic and Safety on Public Roads
- Blasting
- Ventilation of Underground Works
- Control of Dust, Silica and Noxious Gases in Underground Works
- Management of Explosives
- Traffic management during construction phase
- Measures to be taken during excavation of earth
- Safety practices during construction phase
- Fire protection in labor camp and staff colonies

2. PERSONAL SAFETY EQUIPMENT

2.1 General

- All the personnel as well as the site representatives and visitors shall be equipped with appropriate personal safety equipment. 'I he use of such equipment shall be compulsory.
- Every person entering the working area in open air or in underground shall wear a protective helmet. Every person entering into underground works shall have a battery operated electric lamp. No one can enter or work underground without the confined spaces training.
- The safety-lock footwear with steel caps and sole plate shall be worn by all employees engaged in work having an inherent danger to the feel. Light footwear such as sandals, canvas or tennis shoes shall not be permitted for construction work.
- During the drilling works and in the areas where the employees are exposed to harmful noise levels, car protectors shall be made available and required to wear.
- Employees engaged in work having an inherent danger of eye or face injury1 shall be furnished and required to wear protection glasses, goggles or masks Where irritant or toxic substances may come in contact with the skin or clothing, employees shall be wearing the protective clothing or shall be required to apply a protective ointment by a competent physician.
- Employees working on sleep slopes or otherwise subject to possible falls from levels not protected by fixed guardrails or safety nets, shall be secured by safety bells and lifelines.

2.2 Requirements for Underground Works

- Emergency material shall be provided at each underground excavation heading. This equipment shall consist of the following, as a minimum:
  a) 3 stretchers
  b) 3 woolen blankets
  c) 2 appliances for artificial breathing
  d) I oxygen flask
  e) 3 explosion-pcooflamps

f) wound dressing and disinfecting material
g) pain-killing injections
h) gas masks

- At least two members of the Rescue Team as described hereinafter, properly instructed and trained in the rescue procedures, shall be in each crew working underground

3. RESCUE TEAM

- Prior to the commencement of construction, a Rescue Team shall be formed. This Rescue Team shall be capable to render help after accidents caused by flooding, fire, gas explosion, etc.
- The Rescue Team shall be organised in such a way that sufficient number of members will be ready for action at any time until the Completion of Works.
- The Rescue Team members shall be instructed and trained for their task by a qualified and experienced person. If required, an outside specialist shall be hired to perform such training. A refresher training for all members of the Rescue Team shall be conducted at least every six months.
- Each Rescue Team member shall be skilled in giving the first aid, dealing with the appliances for artificial respiration, and lire fighting equipment and shall possess a good local knowledge. Adequate equipment for reaching even the remotest working area shall be at their disposal.

4. ILLUMINATION AND EARTHING

4.1 General

- All working sites in the open, transit areas, excavation sites, access to tunnels, etc., shall be adequately illuminated during night work by electrical lights as specified in the Section "Site Installations and Services".
- Illumination of Underground Works
- Each working face shall be brightly illuminated.
- The vaults along the entire length of the tunnel adits and shaft shall be illuminated with electrical light throughout the duration of construction works. The lamps shall be located as follows;
  a) Every 25 m in unlined stretches,
  b) Every 50 m in lined stretches.
  The lamps shall be installed in a particular area immediately after the rock supporting measures have been completed.
- Electrical cables shall be well insulated, protected and firmly fixed to tunnel walls by means of adequate insulators, Lamps shall be well protected against damage.
- Lighting by flame is expressly forbidden in the underground.

4.2 Earthling, Wet Work Areas, Control of Electric Discharges

- All equipment and appliances, which are exposed to lightning, shall be earthed electrically, and the effectiveness of such earthling shall be periodically checked by the specialised personnel.
- No equipment electrically powered by more than 24 Volts shall be operated by personnel standing in water.

- Only air, battery-powered or hydraulic tools shall be permitted in the wet areas.
- Where electrical blasting will be used, equipment shall be installed to control possible electric discharges in the ground due to storms, electrical motors, etc. As soon as such discharges arc noted, electrical blasting operations shall be suspended, or the detonator type changed.

5. MAINTENANCE OF TRAFFIC AND SAFETY ON PUBLIC ROADS

- All necessary precautions for the protection of the work and the safety of the public on the roads affected by his activities shall be taken. Where the work will be carried out at the site of, or close to an existing road, the vehicular and pedestrian traffic shall be maintained safe at all times. If any operations can cause traffic hazards, the repair or fence or any such other measures shall be taken for ensuring safety.
- Roads subject to interference by the work shall be kept open or suitable detours shall be provided and maintained, and all necessary barricades, suitable and sufficient flashlights, flagmen, danger signals, and signs be provided.
- Roads, which will be closed to traffic, shall be protected by effective barricades on which acceptable warning and detour signs shall be placed. All barricades shall be kept illuminated and all lights shall be kept on from sunset to sunrise.
- The temporary passes and bridges shall be provided to give an access to the existing villages, houses, etc., to the satisfaction of the authorities concerned whenever he disturbs such existing way during the execution of the Works.

6. BLASTING

6.1 General

- All blasting shall be carried out in a workmanlike and safe manner by a competent, licensed and experienced blasting engineer or foreman. No blasting shall be done without his approval.
- Blasting will be permitted only after adequate provisions have been made for the protection of persons, the Works, and public or private property. Responsibility for the safety of persons and property shall be ensured. All claims resulting from personal injury and damage to property and equipment that may resulting from its blasting operations shall be taken care of. Any damage done to the Works or property by blasting shall be repaired.
- Blasting in the open air shall be carried out only at certain hours of (he day in accordance with a schedule. Barriers shall be erected and warning shall be given to the workers at the Site and to the public immediately before blasting, so that no person will enter the danger zone until blasting is finished.
- Upon completion of blasting, an "all clear" signal shall be given by the responsible blasting engineer after he has satisfied himself that all charges loaded have detonated and that no delay-explosions or misfiring arc to be expected.
- Such methods of blasting shall be employed that shock and vibration are minimised.
- No blasts involving charges larger than 200 kg shall be carried without at least one hour prior to the blast.
- No blasting shall be permitted within 25 m of any concrete placed within the previous 7 days, except backfill concrete behind steel ribs. After 7 days. Blasting will not be permitted within 10 m of structures or installations vulnerable to damage by blasting.

- No charging and firing will be permitted during thunderstorms and other electrical disturbances.
- Mats or rubber tires tied together with rope shall be used as protection from flying debris to cover the charges where blasting may expose persons or properly to injury or damage.

6.2 Underwater Blasting

- Only water resistant blasting caps and detonating cord shall be used in underwater blasting operations.
- Loading tubes and casings of dissimilar metals shall not be permitted because of possible electrical transient current from galvanic action.
- When more than one charge is placed underwater, a float device shall be attached to an element of each charge in such manner that it will be released by the firing.
- No drilling, digging or excavating shall be permitted until all misfires have detonated or the explosives are removed from the missed holes.

7. VENTILATION OF UNDERGROUND WORKS

7.1 General

- Installation and operation of ventilating systems for underground construction sites, shall be done. Calculations of fresh air supply volume, type of ventilation scheme, duct diameters, materials and equipment and position of ventilators and dust arrestors shall be performed. Description of the working cycle including number of persons employed, number and capacity of diesel-powered equipment working at one time at each tunneling face shall also be included.
- All parts of the Works shall be maintained in a slate which will not be injurious to the health of the personnel. The air in underground shall contain no less than 20% oxygen and shall not contain a concentration of gases, vapours or dust greater than is safe for the health of workmen.
- If requited, the ventilating system shall be kept in operation also after breakthrough in tunnels, galleries and shafts in order to maintain the fresh air volume requirements staled hereafter
- Intermediate fans attached to the main duct line shall be provided as required to ensure satisfactory removal of contaminated air. All ventilation ducts shall be maintained in an airtight condition.
- Ventilation ducts shall be firmly fixed to the vault in such position that a minimum clearance of 200 mm remains between the duct and the extremities of train or vehicular traffic employed in the underground.
- Should the volume of fresh air at the heading face not reach the required amount and quality, the whole duct system shall be pressure-and-volume tested in portions not exceeding a few hundred meters. Measuring stations shall be located not closer than 10 times the duct diameter from any fan or other flow disturbance within the duct.

7.2 Ventilating System

- The ventilating system shall be of such efficiency that the average air velocity in the largest excavated profile is not less than 0.3 m/s. In case the presence of methane gas is detected or suspected this value shall be increased to 0.5 m/s.

- Furthermore, the main ventilating system shall ensure that both of the following minimum fresh air volume requirements are satisfied at all times:
- 3.0 m^3/min for each person employed underground at one time
- 6.0 m^3/min for each metric horse power (PS) of diesel-powered equipment at work underground at one lime. This value may be reduced to 3.0 m^3/min providing the equipment is using diesel oil low in Sulphur content (max. 0.2% of Sulphur by volume).
- These fresh air volumes shall be cumulative and the design calculations for the maximum number of persons and diesel-powered equipment working in the underground at any one time. Any estimated losses, e.g. due to the leaks in the ducts, shall be added to the figures stated above.
- The ventilating system in the underground excavation performed by drilling and blasting shall consist of two parts:
  a) Main ventilating system,
  b) Secondary ventilating system.
- The main ventilating system shall be designed to allow the flow to be reversed and shall be operated as follows:
  a) Prior to the blasting, the system will be put in the exhaust mode of operation. Blasting fumes shall be extracted as close as possible to the excavation face. Exhaust air and blasting fumes shall be discharged in such a way that they can neither escape in any other working place nor be re-circulated in the fresh air supply system.
  b) Prior to the commencement of mucking and removal of material the system will be put in the forced mode of operation which will continue till termination of mucking.
- The secondary ventilating equipment of the forced type shall be installed to provide adequate ventilation of the area between the heading face and the air intake/outlet of the main system. This system shall be switched on prior to the blasting and shall be operating until the main system has been put into forced mode of operation. The air intake shall be located at a sufficient distance from the heading face to ensure that blasting fumes do not permeate into this area and cause a recycling of blasting fumes. The outlet of this duct shall be located so close to the heading face that the driving of the blasting fumes and dust away from the face into main system is ensured. The minimum capacity shall be at least 70% of the main system capacity. The end diameter of the duct shall be such that the air discharge velocity is not less than 20 m/s.
- Re-entry to the heading face and resuming of the work may not occur earlier than IS minutes following each blast.

8. CONTROL OF DUST, SILICA, AND NOXIOUS GASES IN UNDERGROUND WORKS

8.1 Dust and Silica

- To reduce the amount of dust, only wet drilling will be allowed and during mucking, muck tips shall be kept constantly damp by sprinkling with water. The use of high-pressure water jets for this purpose will not be permitted.
- The concentration of fine dust shall be measured and content of silicon dioxide (SiO_2) in all dust-producing underground operations by an approved method.
- Air samples shall be taken within 10 days of commencing underground excavation, and at 90-day intervals thereafter. Samples shall be taken from actual working areas. The sampling and testing shall be performed by a qualified person or laboratory.
- Should the concentration of fine dust exceed the limits, such necessary measures shall be undertaken and install such additional equipment which will ensure that the dust concentrations are within the specified safe hygienic limits.

8.2 Noxious Gases

- Use of internal combustion engines, other than approved mobile diesel-powered equipment will not be permitted in underground construction sites.
- Concentrations of other flammable gases shall not exceed 40% of the lower explosive limit at the heading face and 20% of the lower explosive limit in the general tunnel or shaft atmosphere.
- If concentrations of noxious gases or other flammable gases exceed the permissible limits set forth above, all operations shall be interrupted immediately and personnel shall be removed to a safe area. AH sources of ignition shall be extinguished or removed. All equipment, with the exception of ventilation equipment, shall be shut down.
- In case of need, an independent consultant experienced in gaseous tunneling shall be engaged. Re-entry and resuming of the work shall be prohibited until such measures are taken.

9. MANAGEMENT OF EXPLOSIVES

9.1 General requirements of responsible persons

- All persons charged with, responsible for or involved in the storage, transportation and handling of explosives are to have received appropriate training, are to be suitably qualified and experienced and are to be familiar with the details and guidelines of this chapter.
- Persons responsible in whatever capacity for the storage, transportation and/or handling explosives are to be in good health.
- Persons not qualified to store, transport or handle explosives may carry, load and unload dangerous material into vehicles or storage under supervision of a qualified person, provided they are verbally briefed on safety measures prior to handling explosives.
- All transportation and storage of explosives, temporarily or permanent must be recorded in a log book showing the amount of explosives transported or stored and the amount of explosives being used.

9.2 Environmental Requirements

The environmental requirements (temperature, humidity and vibration) of explosives vary, and are dependent on their intended storage conditions (including shelf life), transportation, handling and use. The performance of explosives will be unpredictable and the safety will be reduced if the manufacturers' environmental conditions are not met. In general, explosives should be:

- Kept dry and well ventilated.
- Kept as cool as possible and free from excessive or frequent changes of temperature.
- Protected from direct sunlight
- Kept free from excessive and constant vibration.

9.3 Storage Requirements

The key aspects to be considered while considering the storage site are:

- All storage facilities require adequate ventilation to prevent dampening and heating of stored explosives. Climatic conditions, size of magazine and location will determine the amount of ventilation required.

- Permanent and/or main storage facilities shall be fire-resistant, theft resistant, weather resistant and ventilated.
- Portable storage facilities, such as a skid-mounted container, trailer or semi-trailer shall be theft-resistant, fire-resistant and weather-resistant. The magazine should be constructed of steel with an interior lining of timber.
- Magazines of less than one cubic metre in size should be fixed to the ground to prevent theft of the entire magazine.
- A day box is used for the on-site storage of explosives required for daily operation and shall be:
    - Weather resistant and able to be locked.
    - Wherever possible or practical it should be of steel construction
    - but can be wooden boxes or other appropriate containers.
    - They shall contain no more than 10 kg of explosives and or (including) appropriate quantity of initiating means to fire the given quantity of explosives.
- Detonators and/or other means of initiation are to be stored and carried in a separate box from explosives.
- Vehicles are not to be left loaded with explosives at any time unless they are under continuous security guard and are not to be used as overnight storage facilities.

The following are the minimum general rules and guidelines for the storage of explosives

- Permanent and/or main storage facilities are to have ventilation, installed in such a way that it cannot be closed, blocked or allow water to penetrate.
- Permanent and/or main storage facilities are to be fitted with lightning conductors.
- Permanent and/or main storage facilities are to have separate rooms or a substantial barrier for separating explosives and detonators/blasting caps.
- In all circumstances, where possible explosives shall be stored in their original packaging.
- All boxes are to be placed at least 100mm above the floor, e.g. on wooden pallets.
- When boxes are stacked the height will not exceed 1.5 metres. The space between the top of the boxes and the ceiling will not be less than 600mm.
- When stacked on shelves boxes are to be at least 100mm away from the upper shelf, and 500mm away from the walls of the room.
- When stacking boxes the width of the base is to be bigger than the height of stacked boxes.
- Blasting caps and electric detonators may be stacked only if packed in boxes and on wooden shelves maximum two layers on a shelf. Total height of stacked boxes will not exceed 1.4 metres.
- If portable lanterns or pocket torches of any description are required they will be switched on before entering the store. The person holding the torch will not handle explosives or detonators or blasting caps.
- Materials used for packaging explosives are to be destroyed and not discarded after use.
- Fire extinguishers shall be available in storage facility.

9.4 Additional Safety Measures for Storing and Handling of Explosives

These following shall be implemented and adhered to by the contractor/ project proponent:

- A trained and qualified person is to be responsible for managing the receipt, storage, guarding and issuing explosives at all levels
- Only authorised persons are to enter any storage facility and where appropriate and relevant to be escorted at all times.

- All smoking materials, including cigarettes, matches, lighters etc. and any object or item that might cause fire are prohibited from the storage facility. At the entrance to the facility there is to be a warning sign stating 'NO SMOKING OR SMOKING MATERIALS ALLOWED BEYOND THIS POINT'**.**
- Clothing and shoes of all workers are to be in accordance with rules on storage of explosives. Shoes are to be manufactured in such a manner as not to cause sparks.
- The storage facility is not to be used for anything other than storing explosives. It should be kept free from any other tools, equipment of items and should at all times be kept as clean and tidy as is practicable.
- The facility is to be secured at all times except when it is being ventilated when it should be guarded.
- Facilities are to be constructed in such a way as to provide protection from static electricity.
- If thunderstorms are predicted all work in and around the facility is to stop and personnel are to go to a safe place.
- In the event that the facility repair, all explosives and explosive accessories are to be removed before repairs are started.

9.5 Requirements when preparing to Transport Explosives

Persons responsible for the transportation of explosives are to ensure:

- That suitable communications systems are available that will allow for communication from the vehicle to the project throughout the complete journey.
- That an appropriate communication plan (covering as a minimum a radio check prior to leaving the start location and informing on arrival at destination) is in place for the journey.
- That a route card is prepared covering the complete journey. That the driver and drivers assistant are aware of all actions to be taken covering all possible eventualities during the journey i.e. breakdown, accident, robbery, etc.
- Explosives will not be transported unless securely packed in appropriate boxes. Boxes or individual packages are to have specific identification marks on them.
- Each box is to be marked with the applicable hazardous classification code.
- Boxes are to be closed and made waterproof in order to prevent any loss or spilling and moisture ingress during transport. If the vehicle is not a covered vehicle, boxes are to be covered with a waterproof cover.
- Detonators are to be securely packed in a separate metal box from explosives. Boxes containing detonators are to be carried in a separate compartment of the vehicle from boxes containing explosives. UNDER NO CIRCUMSTANCES ARE DETONATORS TO BE CARRIED IN THE SAME BOX AS EXPLOSIVES.
- Detonators and explosives are to be loaded on to the vehicle in such a way that they do not move about during transportation.
- Boxes, pallets and other packaging for transport of explosives are to be evenly distributed over the whole deck area, and can be loaded up to the height of the sides of the truck. All individual packaging and boxes with explosives are to be loaded and fixed to prevent spillage from boxes and turning over or impact inside boxes.

9.6 Requirements of vehicles used for the Transport of Explosives

Vehicles employed to transport explosives are to be roadworthy, well maintained, and in good working order. Persons in charge of the transport of explosives will check the following prior to any movement of vehicles carrying explosives.

- The vehicle is marked appropriately.
- The driver and driver's assistant are briefed about the type of explosives to be transported as well as their destination and the route they are to take. The type and quantity of explosives and conditions of roads to be travelled on are to be considered when deciding the type of vehicle to be used.
- If vehicles carrying explosives are travelling in convoy, then the distance between vehicles is to be a minimum of 100 metres.

All vehicles that are employed for the transport of explosives should also carry the following equipment:

- At least two appropriate fire extinguishers, one for the vehicle engine and one for the load, extinguishers are to be charged with a content that will efficiently extinguish an explosives fire.
- Two hand-torches, Two warning triangles for marking the vehicle when stationary on the road.
- Vehicles transporting explosives shall be fitted with an earthing-strap to take away static electricity from the vehicle to the ground.
- No passengers are to be carried in vehicles transporting explosives.
- Vehicle crews are to consist only of a driver and a driver's assistant.
- No material that may cause a fire may be carried in vehicles transporting explosives.
- No repairs that might cause fire by sparking due to impact or violent contact may be carried out.
- No smoking is allowed in the driver's cabin or any other part of the vehicle.
- The vehicle is not to be left unattended.
- The driver will drive with care and at an appropriate speed for the roads and conditions which in all cases shall never exceed 70 KPH or 80% of the highest speed determined for the road whichever is less.
- If the explosives are stolen, the project, contractor or persons transporting the explosives are to take measures to find it and to report the incident to the person in charge of the transport and also inform the local authorities.
- Explosives and the means to initiate explosives may be transported
- together only when the quantity of explosives does not exceed 50 kg, and
- 100 detonators. This will only be allowed provided that the detonators are in their originally packed boxes, and that the explosives is packed and loaded separately from the detonators.

10. TRAFFIC MANAGEMENT DURING CONSTRUCTION PHASE

Temporary diversions will be constructed with the approval of the Engineer. Detailed Traffic Control Plans will be prepared and submitted to the Engineer for approval, at least 5 days prior to commencement of works on any section of road. The traffic control plans shall contain details of temporary diversions, details of arrangements for construction under traffic, details of traffic arrangement after cessation of work each day, safety measures for transport of hazardous material and arrangement of flagmen.

The Contractor will ensure that the diversion/detour is always maintained in running condition, particularly during the monsoon to avoid disruption to traffic flow. He shall inform local community of changes to traffic routes, conditions and pedestrian access arrangements. The temporary traffic detours will be kept free of dust by frequent application of water.

11. MEASURES TO BE TAKEN DURING EXCAVATION OF EARTH

While planning or executing excavation the contractor shall take all adequate precautions against soil erosion, water pollution etc. and take appropriate drainage measures to keep the site free of water, through use of mulches, grasses, slope drains and other devices. The contractor shall take adequate protective measures to see that excavation operations do not affect or damage adjoining structures and water bodies. The recommended measures are listed as below:

- Ensure unobstructed natural drainage through proper drainage channels/ structures.
- Dispose surplus excavated earth at identified sites. Ensure minimum hindrance to locals.
- All excavations will be done in such a manner that the suitable materials available from excavation are satisfactorily utilized as decided upon beforehand. The excavations shall conform to the lines, grades, side slopes and levels shown in the drawings or as directed by the engineer.

12. FIRE PROTECTION IN LABOUR CAMP AND STAFF COLONIES

It has been envisaged that the fire protection planning shall be taken up in the following manner:

Construction of Camps etc. and placement of fire protection equipments.

It has been planned that all facilities to be constructed shall be fully equipped with the fire protection equipments as per IS standards. The analysis of fire hazard in the construction of labor camps, colonies and other facilities along with management measures is summarized in Table 29.1.

Table 29.1: Analysis of fire hazard in the construction of labor camps, colonies and other facilities

S. No	Stage	Potential hazard	Remedial Measures
1.	Construction of Camp/colony	• Fire prevention and fire fighting not considered in design • In adequate fire protection measures during construction	**By Project authorities** • While construction of Field hostels, Guest House/office and other facilities owned by the project. • The project proponent shall provide the fire protection system as per IS Standards for Fire code. • Proper housekeeping will also be ensured and maintained during these facilities to protect them from any fire related incidents. • It will be ensured that the fire fighting equipments are placed at common place also including work place preferably within 15 meters of work place. **By Contractors** • Clear term of reference will be given to contractor at tendering stage for incorporating fire code as per IS Standard. • Fire fighting equipments will be placed at all common places (within 15 meters of work place)

b) Maintenance of fire protection equipments as the safety measures thorough dedicated EHS Team.

During construction, it has been envisaged to set up fully fledged Environment Health & Safety (EHS) department reporting directly to Head of Project. This department shall also take care of the adequacy of Fire Safety measures set up in all facilities created either owned by project or any of its Contractors. The analysis of responsibility for this EHS team in respect of Fire protection system is outlined in Table 29.2.

Table 29.2: Analysis of responsibility for this EHS team

S. No	Stage	Potential hazard	Remedial Measures
1.	During Occupation	• Fire incident due to electrical short circuit/LPG Leakage/ Improper handling of flammable liquids/lack of precaution • Improper access to and from the location • In adequate fire fighting arrangements • Lack communication • Lack of Knowledge on fighting fire and handling fire equipment • Inadequate Emergency response	• Residential complex will be constructed as per the approved design and will be checked for completeness on fire aspect before allotment to residents • Each Block Colony/ camp will be provided with rated estimated trip off circuit breaker will be installed on each block. • All residents are made aware of fire hazard by training, regular campaigns and by placing posters and signs • LPG Cylinders/Flammable liquids will be stored at designated storage area. The storage will be well protected, ventilated with adequate provision of fire equipments. • Each bloc of the colony will be provided with 10 kg DCP fire extinguishers. • Additionally fire point containing fire buckets, CO_2 extinguishers, DCP Extinguisher will be provided at the common place covering four residential blocks in labor Camp. • Placement of written posters of preventive measures in each accommodation block • Regular EHS inspection of the camp site • Placement of placard of emergency numbers to be contacted in case of Emergency • Dedicated phone line will be provided in labor camps for effective communication. • Ensure proper access is maintained around and to the residential blocks • Identification of emergency Muster points at safe distance

RESPONSIBILITY

Project In charge is responsible for implementation of plan through his authorized representative on site. Site EHS Team shall monitor the implementation of plan and report which are non-compliance to site management.

TRAINING AND AWARENESS

Training of employees on fire prevention and fire fighting is important to prevent occurrence of fire incident in project area. All employees will be given brief overview of fire prevention, fire fighting procedure and response process at the time EHS Induction training. Project proponent will also

carry out regular campaigns on fire prevention around the site. EHS Department is responsible for providing required training.

13. IMPLEMENTATION OF SAFETY PLAN

The implementation of this plan will be mandatory for all contractors involved in the projects. The requirements of this plan will be part of contract agreement, therefore no cost has been kept under this plan in the EMP.

ANNEX 30: DAM BREAK ANALYSIS AND DISASTER MANAGEMENT PLAN

A. DAM BREAK INUNDATION ANALYSIS

The objective of dam break modelling or flood routing is to simulate the movement of a dam break flood wave along a valley or indeed any area downstream that would flood as a result of dam failure. The key information required at any point of interest within this flood zone is generally:

- Travel time of flood water
- Peak water level – extent of inundation
- Peak discharge
- Duration of flooding

The nature, accuracy and format of information produced from a dam break analysis will be influenced by the end application of the data. The Dam Break Analysis for Lower Kopili hydro-electric project has been carried out to ascertain the impact of uncontrolled release of water in the downstream, in the hypothetical condition of failure of dam.

A.1 DAM BREAK MODELING PROCESS

The basic theory for dynamic routing in one dimensional analysis consists of two partial differential equations originally derived by Barre De Saint. The equations are:

i. **Conversion of mass (continuity) equation**

$$(\partial Q/\partial X) + \partial(A + Ao)/\partial t - q = 0$$

ii. **Conservation of momentum equation**

a. $(\partial Q/\partial t) + \{\partial(Q\text{^}2/A)/\partial X\} + gA((\partial h/\partial X) + Sf + Sc\ ) = 0$

b. $where Q = discharge;$

A = active flow area
A_o = inactive storage area;
h = water surface elevation;
q = lateral outflow;
X = distance along waterway;
t = time;
St = friction slope;
Sc = expansion contraction slope and
g = gravitational acceleration

A.2 HEC-RAS MODEL

HEC-RAS 4.1 system contains two one dimensional hydraulic components for: i) steady flow surface profile computations; ii) unsteady flow simulation. The steady/unsteady flow computations are capable of modeling subcritical, supercritical, and mixed flow regime water surface profiles. The basic computational procedure is based on the solution of one dimensional energy equation. Energy losses are evaluated by friction (manning's equation) and contraction/expansion (coefficient multiplied by the velocity head). The momentum equation is utilized in situations where the water surface profile is rapidly varied. The graphics include X-Y plots of the river system schematic, cross-sections, profiles, rating curves, hydrographs and many other hydraulic variables.

Model Stability during unsteady flow simulation

HEC-RAS model uses an implicit finite difference scheme. The common problem of stability in the case of unsteady flow simulation can be overcome by suitable selection of following;

- Computational time step
- Theta weighing factor for numerical solution
- Cross section spacing along the river reach
- Solution iterations
- Solution tolerance
- Weir and spillway factor for numerical solution

Computational time step

Stability and accuracy can be achieved by selecting a computational time step that satisfies the courant condition;

$C_r = V_w (\Delta t/\Delta x) \leq 1.0$

Therefore: $\Delta t \leq (\Delta x/ V_w)$

Where:

V_w= Flood wave speed

V = Average velocity of flow

Δx = Distance between the cross sections

Δt = Computational time step

For most of the rivers the flood wave speed can be calculated as:

$V_w = dQ /dA$

However, an approximate way of calculating flood wave speed is to multiply the average speed by a factor. Factors for various channel shapes are shown below.

Channel shape	**Ratio (V_w/V)**
Wide rectangular	1.67
Wide parabolic	1.44
Triangular	1.33
Natural channel	1.5

Theta weighing factor for numerical solution

Theta is a weighing factor applied to the finite difference approximations when solving the unsteady flow equations. Theoretically theta can vary from 0.5 to 1.0. Theta of 1.0 provides the most stability, while theta of 0.6 provides the most accuracy.

Cross section spacing along the river reach

The river cross sections should be placed at representative locations to describe the change in geometry. Additional cross sections should be added at locations where changes occur in discharge, slope, velocity and roughness. Bed slope plays an important role in deciding the cross section spacing. Streams having slope require cross sections at a closer spacing say 500 m or so. For larger uniform rivers with flat slope the cross section spacing can be kept from 1000m to 3000m.

Solution iterations

At each time step derivatives are estimated and the equations are solved. All the computational nodes are then checked for numerical error. If the error is greater than the allowable tolerances, the program will iterate. The default number of iterations in HEC-RAS is set to 20. Iteration will improve the solution.

Solution tolerance
Two solution tolerances can be set or changed by the user: i) water surface calculation ii) storage area elevation. Making the tolerance larger can reduce the stability problem. Making them smaller can cause the program to go to the maximum number of iterations every time.

Weir and spillway factor for numerical solution
Weirs and spillways can often be a source of instability in the solution. During each time step, the flow over a weir/spillway is assumed to be constant. One solution is to reduce the time step.

A.3 INPUT DATA AND MODEL SETUP

Understanding a dam break analysis requires following range of data in general:

- Cross sections of the river from upstream to dam site and up to location downstream of the dam to which the study is required.
- Salient features of the all hydraulic structures at the dam site
- Design flood hydrograph
- Stage-Volume relationship for the reservoir
- Manning's roughness coefficient for different reaches of the river under study
- Topographic map of the downstream area for preparation of inundation map after dam break studies.

The reservoir is normally modelled as a storage area to describe the storage characteristics by the use of storage-volume at different levels. This point will often also be the upstream boundary of the model, where inflow hydrograph may be specified. However, in case of very long and wide reservoirs the routing of the inflow floods has to be carried out and hence the reservoir itself will also have to be represented by cross sections at regular intervals. The downstream boundary will be either a stage discharge relation or time series water level as in case of tidal waves etc.

A.4 CRITICAL CONDITION FOR DAM BREAK STUDY

The critical condition for a dam break study is when the reservoir is at Full Reservoir Level (FRL) and design flood hydrograph is impinged. Accordingly, in the present study keeping the initial reservoir level at MWL El. 229.60 m the reservoir routing has been carried out by impinging the design flood hydrograph and keeping all the spillway gates fully open.

A.5 RESULTS OF DAM BREAK ANALYSIS

The simulation results are given in Table 30.1.

Table 30.1: Maximum Water Surface Profile of Dam Break Analysis

RD (km)	Discharge (m^3/s)	Min Ch Elevation (m)	W.S. Elevation (m)	Velocity (m/s)	Depth of flow (m)	Top Width (m)
0	52,185.31	170	226.69	56.69	25.21	255.04
0.65	58,497.31	163	202.9	39.90	28.34	151.41
1.65	57,770.67	157	205.67	48.67	25.18	150
2.65	27,587.22	156	204.72	48.72	27.42	150
3.65	23,269.57	150	206.69	56.69	27.95	150
4.65	52,862.23	144	204.03	60.03	28.71	150
5.70	64,297.14	127.7	150.67	22.97	29.75	159.64
7.00	61,147.68	106.38	157.88	51.50	29.84	120
8.00	57,332.24	93.45	156.65	63.00	23.05	120

9.00	53,802.18	88.9	157.43	68.13	25.90	175
10.5	47,899.96	80.67	156.19	75.52	27.99	155

B. DISASTER MANAGEMENT PLAN

B.1 Status of Emergency

The emergency planning for dam break scenario is devised on the basis of results of dam break analysis mainly the travel time of flood wave to various locations in the downstream stretch of the river. The plan is, therefore, based on such measures, which are purely preventive in nature. The degree of alertness has to enhance during high stage of river manifested with sharp increase in discharge. Though there cannot be very sharp edge demarcation between different levels of emergency yet the following flood conditions have been contemplated and the preventive measures suggested against each as given in Table 30.2.

Table 30.2: Status of Emergency

S. No.	Status of emergency	Water Level	Preventive measures
1.	Normal Flood	Below Full Reservoir Level (FRL i.e. Elevation (EL) 226.0 masl and flood discharge below 7,510 cumecs	Utmost vigil by project proponent observed in regulation of spillway gates. It will not affect downstream properties.
2.	Level –1 Emergency	Rises above EL 226.0 masl but flood discharge below 7,510 cumecs	(1) All gates fully operational (2) All the official should attend the dam site. Local officials informed and warning system be kept on alert. Downstream properties not yet affected.
3.	Level –2 Emergency	Above MWL i.e. EL 226.0 masl but below top of dam i.e. EL 229.60 and the discharge continues rising above 7,510 cumecs	Communication & public announcement system (refer B.6 below) should be put into operation and flood warning issued to people.
4.	Level –3 Emergency	Top of dam i.e. EL 232.50 masl	(1) All staff from dam site to move to safer places (2) Possibility of dam failure should be flashed to District Administration. (3) Local communities are informed about possible dam failure. (4) Evacuation plan kept on alert.
5.	Disaster	Rising above EL 232.50 masl and the breach appears in any form	District Administration and Project authorities be intimated. Life saving measures should be resorted. Warning and evacuation plan implemented on ground. The nearest riverside communities are located about 20 km downstream from the dam site.

B.2 Dam Safety and Maintenance Manual

Based on standard recommended guidelines for the safety inspection of dams, a manual should be prepared by the project proponents in respect of dam safety surveillance and monitoring aspects. This should be updated with the availability of instrumentation data and observation data with periodical review. The need for greater vigil has to be emphasized during first reservoir impoundment and first few years of operation. The manual should also delve on the routine maintenance schedule of all hydro-mechanical and electrical instruments. It should be eloquent in respect of quantum of specific construction material needed for emergency repair along with delineation of the suitable locations for its stocking and also identify the much needed machinery and equipment for executing emergency repair work and for accomplishing the evacuation plan. Dam shall be inspected on an annual basis by experts for the entire lifetime of the dam and recommendations on the report shall be implemented on a priority basis.

B.3 Emergency Action Plan

Once the Emergency situation is foreseen, the Emergency Action Plan (EAP) may be put in operation, which may include:

- In rural areas warning sirens will be used to communicate with people along with traditional communications.
- Areas likely to be evacuated with priorities to be notified (first riverside communities are located about 20 km downstream from the dam site).
- Safe routes to be used for evacuation. Such routes have to be identified, discussed and planned sufficiently in advance for proper implementation of the Plan.
- Means of transportation.
- Traffic Control.
- Shelters for evacuees.
- Procedures for evacuation of people from hospitals, public places, prisons etc.
- Procedures for care and security of property from evacuated areas from anti-social elements.
- Instructions regarding assignment of specific functions and responsibilities of various members of evacuation teams.

B.4 Emergency Action Committee

The emergency action committee may comprise of:

- District Magistrates of Karbi Anglong and Dima Hasao districts, Assam
- Concerned Chief Engineer of the Project
- Concerned Superintending Engineer of the Project
- Representative of P&T Department
- Representative of Water Resource Department
- Representative of State Transport Department
- Representative of Civil Supplies Department
- District Agricultural Officer
- District Health Officer
- District Commandant of Home Guards
- District Publicity Office
- Local MP/MLA
- Special Invitee from Local Social Organization/NGO

B.5 Public Information System

During a crisis following an accident, the affected people, public and media representatives would like to know about the situation from time to time and the response of the emergency authorities to the crisis. It is important to give timely information to the public in order to prevent panic and rumors. The emergency public information can be carried out in three phases.

(i) Before the crisis

This will include the safety procedure to be followed during an emergency through posters, talks, and mass media in local language. Leaflets containing do's/ don'ts should be circulated to educate the affected population.

(ii) During the crisis

Dissemination of information about the nature of the incident, actions taken and instructions to the public about protective measures to be taken, evacuation, etc. are the important steps during this phase.

(iii) After the crisis

Attention should be focused on information concerning restoration of essential services, movement/restrictions, etc. Various tasks of the public information system would include:

- Quick dissemination of emergency instructions to the personnel and public
- To receive all calls from public regarding emergency situations and respond meticulously
- Obtain current information from the Central Control Room
- Prepare news release
- Brief visitors/media
- Maintain contact with hospitals and get information about the casualties
- Damaged infrastructure (due to dam failure) will be rehabilitated by the project proponent

B.6 Efficient Communication System

An efficient communication system is absolutely essential to achieve a successful Emergency Preparedness Plan and this has to be finalized in consultation with local authorities and administrative setup as well involving local communities. More often the entire communication facility gets disrupted in a disaster situation. The wireless facility which is comparatively free from general encumbrances of the communication system shall be invariably a part of emergency preparedness plan. The respective department of police, who generally has this facility, must have standing instructions to convey disaster messages effectively in time. In addition, telephone facility shall be available at dam site, vulnerable points and population centers. Vehicles equipped with sirens and public address system may also be kept ready for densely populated areas (however there are no density populated areas d/w impact zone of the dam. Warning sirens may also be installed in the likely affected population to save warning time (first riverside communities are located about 20 km downstream from the dam site).

B.7 Special Preparedness before First Filling of Reservoir

Many failures of dams have reportedly occurred at the time of first filling of reservoirs. The period of first filling is a critical period in the life of a dam. Hence special vigilance and precautionary steps are necessary at the time of first filling of the dam in order to avoid failure of the dam. It is,

therefore, necessary to inspect the performance of the dam carefully during this period. The preparedness shall be carried out for the first filling of reservoir as indicated below:

- Before starting the first filling of reservoir, the EAP of the project should be completed and implemented as far as possible.
- The installation of Spillway gates including hoisting arrangement, emergency power supply etc. should be completed and trial operation of gates must be made before it becomes actually operational.
- The copy of the first filling schedule shall be sent to the District Administration, and State Dam Safety Organization, if any.
- Proper lighting facilities on and nearby the dam area shall be provided before the onset of monsoon to facilitate close vigilance of the dam behavior during the night time also. A generator and flood light shall also be provided for emergency purpose.
- The control room of the dam is to be connected with the office and residence of officers-in-charge of the dam by telephone or by wireless set. The wireless/telephone stations and telephone lines should be completely out of the flood zone.
- Sufficient amount of materials such as sand, shingle, rubble etc. should be stock piled at convenient locations near the dam site.
- Sufficient number of filled sand bags should also be kept ready for emergency purposes.
- Machineries like tippers, trucks, excavators etc. along with sufficient number of labor are to be kept ready on both the flanks of dam to start remedial measures within a very short notice.
- Access roads along the downstream of the dam as well as on the top of the dam should be established for proper movement of the machines and vehicles.

B.8 Vigilance during first year of filling of a reservoir

During the first year of filling of dam, careful vigilance needs to be kept at the dam site and in the deepest river bed portion. The dam should be inspected by the Dam Incharge in three phases.

- The first phase inspection is to be carried out just before the onset of first heavy rain.
- The second phase of the inspection will be conducted after the filling of the reservoir to half the height of the dam.
- After the second inspection, if no untoward behavior of the Barrage is observed, third inspection will be made when the reservoir would be filled up to FRL.

When the spillway starts working, the Superintending Engineer should inspect the Barrage periodically during the entire period of overflowing. If any sweat, excessive settlement, leakage, cracking or sloughing of slopes is noticed, it should be brought to the attention of the higher authorities immediately. Daily reports about stage of reservoir filling, condition and behavior of the dam must be submitted by the Engineer responsible to his immediate superior as a part of the continuous vigilance of the dam.

B.9 Actions following Discovery of Problems

A close vigilance of the dam by Executive Engineer a competent person is the basic requirement for the EAP. When some distress in the dam is noticed, the nature and potentialities of the problems are required to be identified immediately by the Executive Engineer in charge of dam. Immediately, initiative for remedial measures and further activities for involving the operation of EAP be taken.

The information of any unusual development on the dam should be immediately flashed/ conveyed by the Executive Engineer in charge of the dam to the higher officials in the Department by means of the fastest available communication facilities such as wireless message/ telephone or telegram. In the event of likely failure of dam, any person within the locality shall initiate the actions as described in notification procedure and possible construction repairs depending on the seriousness of the development. Therefore, it is necessary that the staff posted on the vigilance and maintenance of the dam be adequately trained/ experienced to handle various emergent situations.

B.10 Notification Procedures

Notification procedures are an integral part of any EAP. Separate procedures should be established for slowly and rapidly developing situations and failure. Notifications would include communication of either an alert situation or an alert situation followed by a warning situation. An alert situation would indicate that although failure or flooding is not imminent, a more serious situation could occur unless conditions improve. A warning situation would indicate that flooding is imminent as a result of an impending failure of the dam. It would normally include an order for evacuation of delineated inundation areas.

Copies of the EAP shall be displayed at prominent locations, in the rooms and locations of the personnel named in the notification chart. For a regular watch on the flood level situation, it is necessary that the flood cells be manned by two or more people so that an alternative person is always available for notification round the clock. For speedy and unhindered communication, a wireless system is a preferable mode of communication. Telephones may be kept for back up, wherever available. It is also preferred that the entire flood cells, if more than one, are tuned in the same wireless channel. It will ensure communication from the dam site to the control rooms. The communication can be established by messenger service in the absence of such modes of communication.

- Using multiple warning channels (police, radio, television, telephone, sirens, loudspeakers, mobiles etc.)
- Using official sources for warning (city civil officials, police, fire fighting etc.)
- Repeat warnings
- Ensuring that warnings are consistent and accurate
- Giving specific instructions about what actions should and should not be taken by people of the area to protect themselves
- Conveying to the affected persons, possible extent of duration of flood/danger and urgency. However, this should not be overplayed to cause panic

All departments, which are charged with the emergency preparedness, shall be identified and nodal officer in each department shall be identified from each department in advance. Such officers shall be provided residential telephone/cell phone in addition to their office telephones during the flood season. It is evident that the emergency preparedness plan is an integrated matter requiring technical expertise, specific administrative skill and spontaneous public participation (if is required) to be practical, pragmatic and successful.

B.11 Management after receding of Flood Water

The officer-in-charge of relief camp shall assist in the process of timely evacuation and rehabilitation of the persons likely to be affected, cattle and property. He shall also maintain

record of persons/families in the camp and make arrangements for essential items of daily use and ensure reasonable health, sanitation, water supply and street lighting facilities. A daily situation report shall be sent to the control room. Some of the measures which need to be implemented are listed as below:

- Provision of various food items and shelter to the evacuees.
- Provision of fuel for various evacuees.
- Provision of adequate fodder supply.
- Arrangements for potable water supply.
- Commissioning of low cost sewage treatment and sanitation facilities, and disposal of treatment sewage.
- Expeditious disposal of dead bodies human and livestock.
- Immunization programmes for prevention of outbreak of epidemics of various water related diseases.
- Adequate stocks of medicines of various diseases, especially water-related diseases.

C. COST ESTIMATES

The budget for different activities required to be carried out for mitigation and prevention of dam break hazard exclusively from the dam is Rs. 370.0 lakh as per details given in Table 30.3.

Table 30.3: Cost Estimate for Implementing DMP

S. No.	Particular	Cost (Rs. lakh)
1.	Installation of alert system in control room	30.0
2.	Setting up of communication system in various villages	50.0
3	Setting up of communication system between dam and d/s settlements	100.0
4	Public information system	30.0
5	Setting up of a seismic observatory at dam site	100.0
6	Flood Forecasting Arrangements	30.0
7	Training and miscellaneous	30.0
	Total	**370.0**

ANNEX 31: REPORT ON INITIAL ENVIRONMENTAL ASSESSMENT OF POWER EVACUATION SYSTEM

(Provided as separate Volume)

ANNEX 32: AUDIT OF EXISTING SUBSTATIONS

A. Introduction

1. The Government of India requested ADB financing for 120 MW Lower Kopili Hydroelectric Project under Tranche 3 of MFF for Assam Power Sector Investment Program. The project involved construction of 120 MW Hydropower Project at Langku village in Dima Hasao district of Assam and associated power evacuation systems. The evacuation system consists of i) a 50 km long 220 kV transmission line from LKHEP to existing 132/33 kV substation at Samkardev Nagar, and ii) a 20 km long 33 kV transmission line from LKHEP to existing 33/11 kV substation at Umrangso in Dima Hasao District of Assam. The scope also includes expansion of these two substations to accommodate necessary bays to terminate the proposed lines.

2. As required under ADB's SPS 2009 an environmental and social compliance audit has been carried out on these two substations. The audit methodology includes desk review of the existing and proposed system configuration, site inspections and discussions substation managers and nearby communities. The findings of the audit exercise are presented in herewith.

B. Sankardev Nagar (132/33 kV) Substation

3. This substation is located at Sankardev Nagar (near Lanka) of in Village Pam Gaon in Nagaon district of Assam. The GPS Coordinates of substation are 25059'16" N and 92055'30" E. This substation was first constructed in 1983 and it is currently being operated by AEGCL. Present connectivity includes i) one 132 kV D/C TL to 220/132 kV S/S at Samaguri, ii) one 132 kV S/S TL to Diphu (District Headquarters of Karbi Anglong Hill District), and one 132 kV S/C TL to M/S. Calcom Cement Industry (bulk consumer). The existing transformer capacity is 2x40 MVA, 22 MW, 2 MVA with 45% loading. The expansion of this substation will include increase in voltage level from existing 132 kV with 2 no. power transformers (capacity 2 x 25 MVA) to 220 kV with 2 no. inter-connected transformers (ICT) (capacity 2 x 160 MVA). Switchgear proposed type is Gas Insulated Substation (GIS) with 4 (four) nos. of 220 kV feeder bays at S/S.

B.1 Land requirements

4. The existing substation has a plot area of 64,681 sq. m (51 bigha) owned by AEGCL (government). The land required for establishment of proposed expansion work is about 8,695 sq. m (6 bigha). There is sufficient open space available within existing premises by substations and proposed expansion will take place at open space within the existing premises, which is enclosed with metal fencing. Therefore, no additional land acquisition is required.

B.2 Land Use

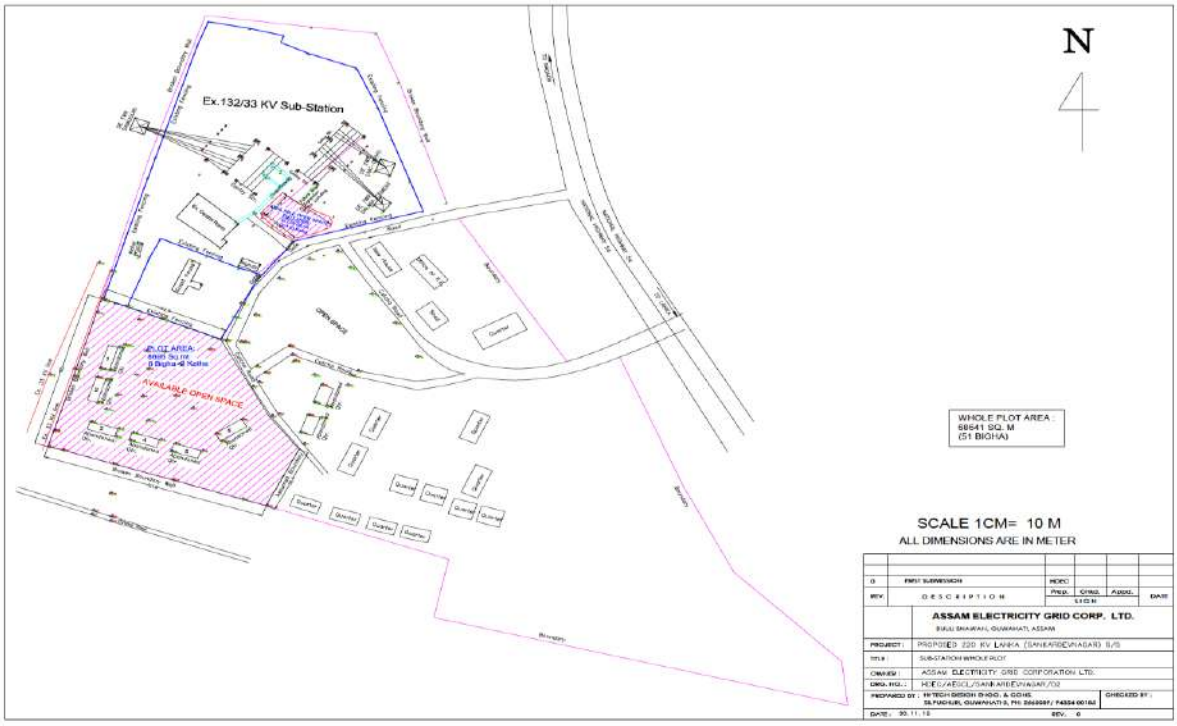
5. The land use in and around the S/S area is mainly open fields and agricultural land. There are no villages/settlements in the immediate vicinity of the existing S/S. There are patches utilized for cattle and sheep grazing. Clearing of vegetation may be required.

B.3 Forests and Ecology

6. There are no forests or environmentally protected area in the vicinity of the substation. The site clearance for proposed expansion work may require cutting of 2-3 tress and clearing of

bushes. Loss of trees will be compensated by planting additional trees @ 1:10 trees along the periphery of the substation.

Figure 32.1: Site Plan of an existing S/S at Sankardev Nagar



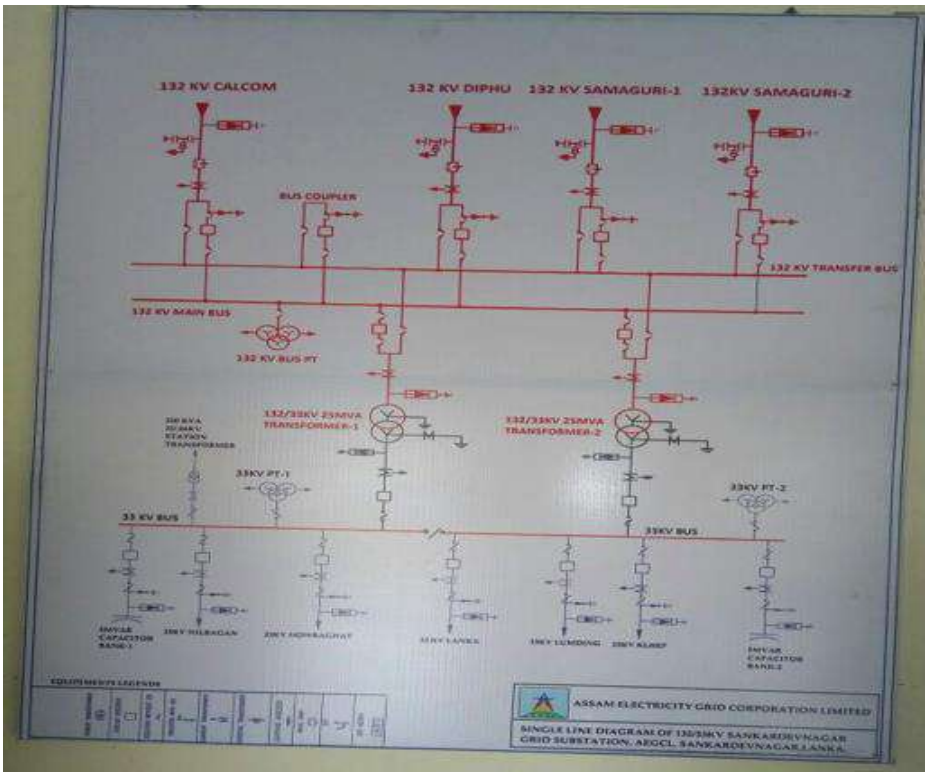


Figure 32.2: Single Line Diagram of 132/33 kV Sankardev Nagar Substation

	
Photo 1: Existing Sankardev Nagar Substation	**Photo 2: Available space within premises of existing substation**

C. Umrangso (33/11 kV) Substation

7. This substation is located at 16 Kilo (Umrangsu) in Dima Hasao district of Assam. The GPS Coordinates of substation are $25^0$30'42" N and $92^0$45'31" E. This substation was first constructed in 1987 and it is currently being operated by APDCL. Present connectivity includes 33kV voltage level with 5 nos. bays and there is one transformer. The expansion of this substation will include construction of 33kV bay.

C.1 Land requirements

8. The existing substation has a plot area of 15 bigha owned by APDCL (government). The land required for establishment of proposed expansion work is about 2 bigha). There is sufficient open space available within existing premises by substation and proposed expansion will take place at open space within the existing premises, which is enclosed with metal fencing. Therefore, no additional land acquisition is required.

C.2 Land Use

9. The land use in and around the substation area is mainly residential area with settlements.

C.3 Forests and Ecology

10. There are no forests or environmentally protected area in the vicinity of the substation. Cutting of trees is not required. However, clearing of vegetation bushes may be required.

Figure 32.3: Single Line Diagram of 33/11 kV Umrangso Substation

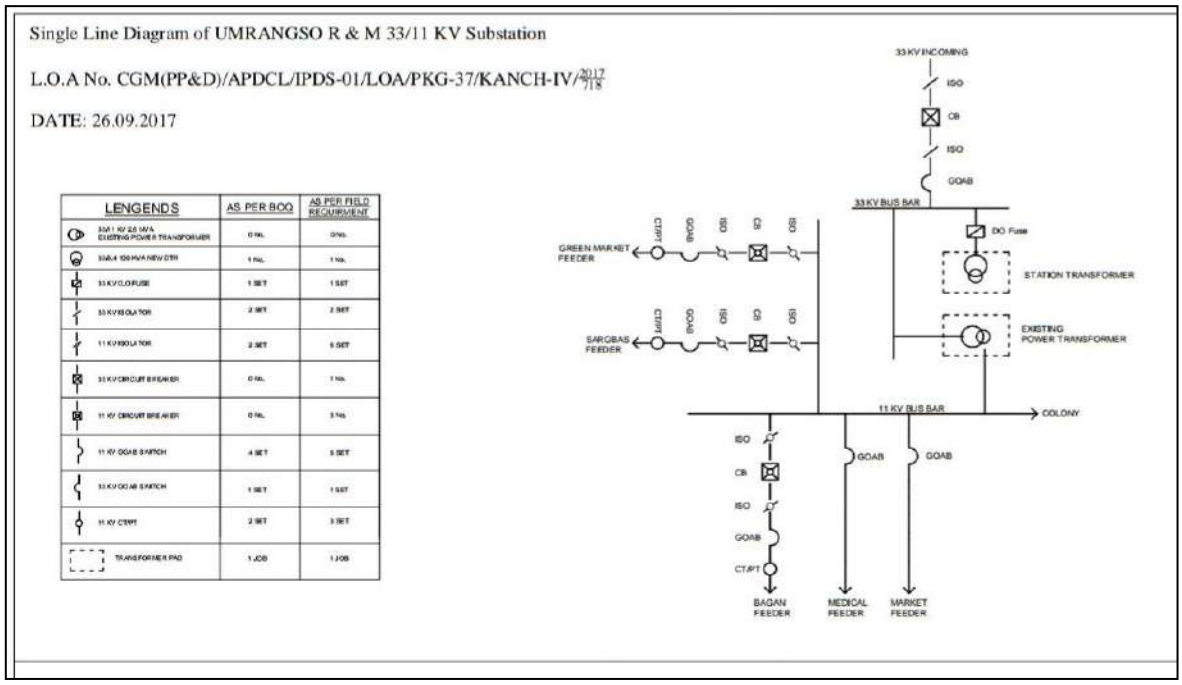


Photo 3: Existing Umrangso Substation

Photo 4: Available space within premises of existing substation

Photo 5: Existing Umrangso Substation

Photo 6: Discussion with substation Manager

D. Findings and Conclusion

11. The existing substations are constructed and are under operation and managed by AEGCL/APDCL since long time under government and state regulatory requirements. Also, there are no reported incidences of any environmental, health and safety gaps or accidents. The proposed expansion work at these substations under the LKHEP project will be carried within the existing premises and there is no additional acquisition of land or resettlement of people required for proposed work. Also, there are no impacts anticipated on local communities or on environmental setting of the area surrounding these two substations. Therefore, it can be concluded that there are no adverse environmental and social impacts anticipated from proposed expansion work.

ANNEX 33: TOR ISSUED BY MOEF&CC FOR EIA

Annex xx: Minutes of the 69th Meeting of the Expert Appraisal Committee for River Valley and Hydroelectric Projects constituted under the provisions of EIA Notification 2006, held on 11th -12th November 2013 at SCOPE Complex, New Delhi

The 69th Meeting of the Expert Appraisal Committee (EAC) for River Valley and Hydropower Projects was held during 11th– 12th November 2013 at SCOPE Convention Centre, Opposite Jawaharlal Nehru Stadium, New Delhi. The meeting was chaired by Shri. AlokPerti, Chairman. Shri C. Achalender Reddy, Member, Dr. Mathur, member EAC and S. Sathyakumar member could not attend the meeting due to pre-occupation/prior commitment. The list of EAC Members and officials/consultants associated with various projects who attended the meeting is annexed.

The following Agenda items were taken-up in that order for discussions:-

1st Day (11.11.2013)

1. **Agenda Item No.1**: Welcome by Chairman and Confirmation of Minutes of the 68th EAC Meeting held on 23rd – 24th September 2013.

The minutes of the meeting of the 68th EAC Meeting held on 11th– 12th November 2013 was confirmed. Thereafter, main agenda items were taken up for discussion.

2. **Agenda Item No.2** : Consideration of Project proposals for Scoping and Environmental Clearance.

The following project proposals were considered:

Agenda Item No. 2.14 Lower Kopili HEP (120 MW) in KarbiAnglong 7 North Cachar Hill Districts of Assam by M/s. Assam Power Generation Corporation Ltd. – For reconsideration of ToR.

The project for granting ToR was earlier considered during 26th-27th December 2012 and subsequently during 22nd – 23rd March 2013 by EAC. The project proponent has brought down the capacity from 150 MW to 120 MW factoring into dedicated release of environmental flow. Of this 120 MW, a dam toe power house of 10 MW has also been proposed with 2x2.5 m +1x5 MW combinations. The EAC during its 68th meeting sought additional information/clarification to enable its reconsideration. Accordingly, on receipt of clarification and additional information, the project was included for consideration of 69th EAC meeting.

The EAC felt that high acidity of river water was a serious threat for both capital cost and life of electro-mechanical component of the project post commissioning. The project proponent submitted their response about the viability of the project. During the presentation, response to representation received from South Asia Network on Dams, Rivers and People was also given. The key issues discussed during the meeting were:

Dam Induced Flood

The catastrophic flood on 18th July" 2004 was mainly due to high intensity of rainfall in the upper catchment of Kopili River (upstream of Khandong Dam). As per the available rainfall records, in the month of July" 2004 monthly rainfall recorded is of the highest order i.e. 2372.80

mm at Jowai (during the period from 1983 to 2005) and of the order of 729.50 mm at Garampani (during the period from 1963 to 2006). It is also evident from the flood damage data of the affected Revenue Circles of Nagaon district viz. Doboka, Hojai, Kampur and Raha from 1995-2013 that there was heavy flood during the year 2004. Water level in the Khandong reservoir went up to 727.70 m against FRL of 719.30 m. The reservoir can be filled up to M.W.L. and normally the dam is designed for this level. Moreover there is no gate installed at the Khandong Dam and flood release from the reservoir due to gate operation does not arise. Excess inflow due to heavy rainfall in the catchment is passing over the dam after the attaining M.W.L. of the reservoir. In this context, it may be mentioned that construction of another dam about 25 km downstream of the existing Khandong Dam will moderate the flood due to inflow from the undisturbed intervening catchment area of 788 sq. km between Khandong dam and proposed Lower Kopili dam and excess inflow that spilled over from the Khandong reservoir. Moreover, Lower Kopili Dam is designed for maximum flood of 11030 cumec based on IMD data of precipitation over the entire catchment area covering Khandong and Lower Kopili Dam i.e. of 1288 sq.km and 788 sq.km respectively (total area of 2076 sq.km). The design flood (PMF) for Lower Kopili H.E project of 11030 cumec was approved by C.W.C on 30.10.2012.

The downstream impact due to flood could only be averted with prior warning to the people who reside in the riverine area. During operation of gates of LKHEP.APGCL will install such system in coordination with District Administration and Local people.

As stated by SANDRP, the major tributary Myntang of river Kopilihaving a catchment area of 512 Sq. KM is included in the intervening catchment area of 788 Sq. Km of Lower Kopili Dam .As such the inflow from Myntang river already included in the design flood of 11030 Cumec for LKHEP and approved by CWC in 2012.

Inadequate Spillway Capacity at proposed Lower Kopili H.E. Project.

The design spillway capacity of the proposed LKHEP is not 16110 Cumec as mentioned. It is evaluated as 11030 Cumec which has been approved by CWC after detailed hydrological study made with H.M. data acquired from IMD Pune& New Delhi as stated in para 1 above. The Lower Kopili Dam is designed for the above capacity which is inclusive of excess water spill over from Khandong Dam and inflow from the intervening undisturbed catchment area of 788 sq. km up to Lower Kopili Dam. . Hence, the design spillway capacity of LKHEP is adequate to pass off the PMF of 11030 Cumec.

Acidity of the water in River Kopili

Water of Kopili River is acidic at the proposed LKHE project site. Therefore, special measures are to be adopted to protect the Electro mechanical and Hydro mechanical equipment and river water exposed surface of concrete of the proposed project. APGCL has taken the following decisions:-

g. i) Adopt similar measures taken by MeSEB for MyntduLeshka HEP, Meghalaya.
h. ii) Stainless steel to be provided to all H.M. and E/M equipment, reinforcement, steel liner etc.
i. iii) Concrete admixtures to be used for all water contact surface to mitigate adverse impact of acidity.
j. iv) Avail expert consultancy from CWC for tackling acidity problems.

This is the one of the reasons for enhancement of project cost. It may be stated that activity of the proposed LKHEP would not aggravate any acidity factor in the river and in its downstream during construction as well as in post construction stage. The acidity in the river is only due to open cast mining in the upper catchment areas located in the state of Meghalaya.

Similar problems have been experienced by NEEPCO as well as by MeSEB for Kopili and MyntduLeshka HEP respectively. The MeSEB has proposed to use acid resistant coated steel materials which were tested at CSMRS lab during July 2013.The test results revealed that the coated materials found suitable to resist acidic hydro environment and no major deterioration of the paint and colour. The Project Proponent also intends to adopt similar measures.

GSI NE region had done extensive detailed surface and sub-surface geotechnical investigation since 1979-80 to 1985-86 and 2008-09 to 2012-13. Locations of various components were fixed as per the guidance of Eng. Geology Division GSI, Shillong.

GSI in its Geo technical report for LKHEP has mentioned about the existence of Dhansiri- Kopili fault located near to the project site (refer Plate-III of the report, enclosed). As per available records, major Earth Quake > 5 in Ritcher Scale were occurred during the period 1901-93 within 50KM radius of the proposed project site. IIT Roorkee has considered the aforesaid report while carrying out studies for determination of site specific design Earth Quake Parameters for LKHEP (June 2012). Based on these parameters, various project components have been designed. Further, APGCL has already initiated actions to install 3-4 seismographs network at the proposed LKHEP site for MEQ studies.

APGCL presented the project before the EAC in three occasions i.e. Dec‟12, March„ 13 and latest on 24the September„ 2013. Based on the observations of EAC, APGCL has reviewed the land area to be acquired for the project.. Compensation to project affected families will be given as per the norms of NRRP-2007 of Government of India. Form-I has been revised considering observations of EAC. Area and land use pattern to be acquired have also been revised in item 1.1.of Form-I. Hence the revised Form-I submitted on 23.08.2013 should be treated as final.

APGCL is committed to address the local issues particularly project Affected Families with priority.

Reservoir submergence was shown as 620 ha in the earlier PFR. In the said PFR, a provision of 2.00 m above the MWL of 229.60 m was kept in the reservoir area of 620 Ha as a cushion for allowance of any subsidence on the reservoir periphery due to draw down effect of fluctuation of water level. In order to comply with the observation of EAC, the land area under submergence has been reassessed as 552.00 ha considering submergence in the reservoir area up-to MWL only.

The EAC recommended the TOR clearance for the project, with the following additional issues to be covered in the CEIA study:

- Cumulative impact of the operation of Kopili reservoirs of Khandong dam, Longku dam and Lower Kopili hydroelectric projects.
- The rights of Dimasa people shall be protected and the same shall be covered as a part of R&R Plan. In addition, any measure suggested by the state government of Assam, for

PAFs of Dimasa Tribe shall also form part of R&R Plan.

- The geo-morphological and neo-tectonic mapping shall be done as a part of the study. These maps along with site specific studies shall be included in the documents for appraisal by EAC for River Valley Projects of Ministry of Environment & Forest, and National Committee on Seismic Design Parameters, Central Water Commission. The recommendations of these agencies will be suitably incorporated in project design, construction as well as operation.

The EAC recommended grant of ToR with the following additional conditions:

- Downstream impact assessment study shall be conducted appropriately by project proponent.
- Impacts on hydrological regime and aquatic ecology due to peaking power operation to be assessed.
- Assessment of optimum reservoir operation to be done.
- Impacts due to tunneling and blasting to be assessed and mitigation measures proposed.
- Impacts due to mining for abstraction of construction material.
- Impacts due to backwater effect especially during monsoon.
- Impacts due to filling up of reservoir up to MWL.
- Existence of wetlands, water courses and other water bodies in the Study Area.
- Three season water quality monitoring downstream of Myntdu Leshka HEP, in Meghalaya to be carried out.
- It is to be assessed if anti-coating material will react with acidic water and adversely impact water quality.
- Environmental flow to be proposed as per existing norms i.e. 20% for lean, 25% for non-lean and non-monsoon and 30% for monsoon period.
- Bio-diversity study to be conducted by a suitable institute as per OM of MoEF&CC dated 28.05.2013.
- Cumulative impact assessment of upstream and downstream projects also to be done.
- FC application has to be submitted soon and not later than 6 months from date of issue of the ToR.

The meeting ended with a vote of thanks to the Chair.

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ANNEX 34: DERIVATION OF E-FLOW

Period			90 % dependable year	Average Monthly Q	Average Four Monthly Q
			2004	cumecs	cumecs
Jun	1	- 10	40.51	76.56	113.23
	11	- 20	113.92		
	21	- 30	75.25		
Jul	1	- 10	97.73	107.93	117.87
	11	- 20	117.99		
	21	- 31	108.06		
Aug	1	- 10	164.71	117.21	102.67
	11	- 20	109.93		
	21	- 31	76.99		
Sep	1	- 10	166.51	151.24	80.32
	11	- 20	119.99		
	21	- 30	167.22		
Oct	1	- 10	119.68	95.10	49.02
	11	- 20	101.82		
	21	- 31	63.79		
Nov	1	- 10	57.85	47.13	31.89
	11	- 20	51.27		
	21	- 30	32.26		
Dec	1	- 10	27.64	27.83	26.72
	11	- 20	27.45		
	21	- 31	28.41		
Jan	1	- 10	27.17	26.02	27.16
	11	- 20	24.21		
	21	- 31	26.69		
Feb	1	- 10	27.03	26.58	45.05
	11	- 20	25.43		
	21	- 28	27.28		
Mar	1	- 10	25.95	26.46	
	11	- 20	27.02		
	21	- 31	26.41		
Apr	1	- 10	29.55	29.59	
	11	- 20	29.45		
	21	- 30	29.78		
May	1	- 10	66.90	97.55	
	11	- 20	95.41		
	21	- 31	130.35		

As per the Environmental Appraisal Committee (EAC) of the Ministry of Environment and Forests 20% of the average flow in four consecutive leanest months in the 90% dependable year should be considered for environmental release during lean season.		
Average flow of Four consequitive leanest months (Dec to Mar)	**26.724**	cumecs
Average flow of Four consequitive monsoon months (Jun to Sept.)	**113.234**	cumecs
Average flow of Four consequitive monsoon months (Apr, May, Oct and Nov.)	**67.343**	cumecs
Environmental Release during **lean season**: (**20%** of min average flow for four months for 90% Dependable Year)	**5.345**	cumecs
Environmental Release during **monsoon season**: (**30%** of average flow for four months (June to September) for 90% Dependable Year)	**33.970**	cumecs
Environmental Release during **non-lean, non-monsoon** period season: (**25%** of average flow for four months (April, May, October and November) for 90% Dependable Year)	**16.836**	cumecs

Annex 35: EMP AND EMOP FOR ROAD COMPONENT

This EMP is applicable to Roads and Infrastructure Component of LKHEP

Table 35.1 Environmental Management Plan

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Coast	Institutional Responsibility	
							Implementation	Supervision
Pre-construction and Design Stage								
1. Alignment								
1.1 Pavement damage and inadequate drainage provisions in habitat areas	• Construction of concrete pavement in habitat areas considering alignment level and drainage. • Raise road level above the nearby areas with provision of adequate side drains to evacuate the rain water and domestic discharges (drained by habitats occasionally) to prevent damage to road and rain water entry to habitats' houses. • Provision of adequate no. of cross drainage structures based on drainage pattern around the alignment.	Design requirement	All habitat Areas throughout the alignment	Design of both cross & side drains. 9 no. of slab culverts and 33 box culverts.	Review of detail Design documents & drawings	Included in construction cost	Design Consultant	APGCL/ (CSC)
1.2 Loss of tree and vegetation (about 611 trees are likely to be cut)	• Restricting tree cutting within construction limit • Avoid tree cutting at ancillary site. • Maintain Compensatory tree plantation of 6110 trees @ 1: 10 • Alignment is passing through Mandap and Panimur reserve forest area, length 1.4 km and	Design requirement	Throughout the alignment	611 No. of tree will be cut.	Observation	Included in construction cost	Design Consultant	APGCL/ (CSC)

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Coast	Institutional Responsibility	
							Implementation	Supervision
	2.6km; respectively.							
1.3 Protection of sensitive receptors	• Careful selection of alignment to the sensitive receptor. • Timely scheduling of construction activity • Provision of noise suitable barriers	As per requirement	Location of sensitive receptors (Schools, temples, hospitals, forest areas)	Design and alignment plan	Review of design	Included in construction cost	Contractor	APGCL/ (CSC)
1.4 Safety along the proposed alignment	• Make provisions of crash barriers at accident prone areas as identified in the road safety studies. • Provision of rumble strips in habitat areas to regulate speed. • Provision of retro-reflective warning sign boards nears school, hospital, religious places and forests areas. • Provision of proper sidewalks/pedestrian zone along the road near habitat areas, school, hospital, religious places and forests. • Compliance with norms specified in IRC codes for state highway for curvature and grading • Provision of safety kerb at all bridges. • The design should attempt to equalize cut and fill. • Minimize the cutting in hill areas. Incorporate slope stabilization measures to prevent any land slide	Design requirement	Places where height of embankment is more than 3.0 m.	No. of accident & Vehicle collision	Field observation, interview of locals	Included in construction cost	Design Consultant	APGCL/ (CSC)

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Coast	Institutional Responsibility	
							Implementation	Supervision
	situation. • Incorporate Slope stabilization measures to prevent any land slide situation.							
2. Natural Hazards								
2.1 Protection for damage from Earthquake	• Design considering relevant seismic standard in the clause under IRC 6-2014 for earthquakes in bridges (three major bridges)		Throughout the stretch	Incorporation of IRC 6-2014 guidelines for earthquake in bridge design	Review of bridge design	Included in construction cost	Design Consultant	APGCL
2.2 Protection of road embankment in Flood prone Areas.	• Raise embankment height above the HFL levels in the flood prone areas. • Provision of adequate balancing culverts. • Improvement in existing culverts/ Bridges to increase their carrying capacity.	IRC:34 Recommend ations for road construction in waterlogged area and IRC: 75 and MORT&H guidelines for Design of High Embankment s	All the existing culverts/ bridges	Design of both cross & side drains, 9 no. of slab culverts and 33 no. of box culverts.		Included in construction cost	Design Consultant	APGCL
3. Shifting of utility structures								
3.1 Disruption of utility services to local community	• All telephone and electrical poles/wires and underground cables should be shifted before start of construction. • Necessary permission and payments should be made to relevant utility service agencies to allow quick shifting and restoration of utility	As per requirement	Throughout the corridor	Utility shifting plan Complaints from local people Status of local utility services	Interaction with concerned utility authorities and local public	Included in Construction cost	Contractor	APGCL/ CSC

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Coast	Institutional Responsibility	
							Implementation	Supervision
	services. • Local people must be informed through appropriate means about the time of shifting of utility structures and potential disruption of services if any							
B. Construction Stage								
1. Air Quality								
1.1 Dust Generation due to construction activities and transport, storage and handling of construction materials	• Transport, loading and unloading of loose and fine materials through covered vehicles. • Paved approach roads. • Storage areas to be located downwind of the habitation area. • Water spraying on earthworks, unpaved haulage roads and other dust prone areas.	MORT&H Specifications for Road and Bridge works Air (P and CP) Act 1981 and Central Motor and Vehicle Act 1988	Throughout corridor.	PM_{10} level measurements Dust pollution or complain of locals	Standards CPCB methods Observations Public consultation	Included in Construction cost	Contractor	APGCL/ CSC
1.2 Emission of air pollutants (HC, SO_2, NO_X, CO etc.) from vehicles due to traffic congestion and use of equipment and machinery	• Regular maintenance of machinery and equipment. • Batching, asphalt mixing plants and crushers at downwind (1km) direction from the nearest settlement. • Only crushers licensed by the PCB shall be used • DG sets with stacks of adequate height and use of low sulphur diesel as fuel. • Ambient air quality monitoring • Follow traffic management plan.	The Air (Prevention and Control of Pollution) Act, 1981(Amended 1987) and Rules1982	Asphalt mixing plants, crushers, DG sets locations	Monitoring of ambient air quality & checking PUC certificates	Standards CPCB methods	Included in Construction cost	Contractor	APGCL / CSC

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Coast	Institutional Responsibility	
							Implementation	Supervision
2. Noise								
2.1 Noise from Construction vehicle, equipment and machinery.	• All equipment to be timely serviced and properly maintained. • Bottlenecks to be removed. • Construction equipment and machinery to be fitted with silencers and maintained properly. • Only IS approved equipment shall be used for construction activities. • The regulation near residential, built up and forest area construction shall be restricted to daylight hours. • Timing of noisy construction activities shall be done during night time and weekends near schools and selected suitable times near temples when there are no visitors, concurrent noisy operations may be separated to reduce the total noise generated, and if possible re-route traffic during construction to avoid the accumulation of noise beyond standards. Else provision of temporary noise barrier at sensitive locations or near sources.	Legal requirement Noise Pollution (Regulation and Control) Rules, 2000 and amendments thereof +Clause No 501.8.6. MORT&H Specifications for Road and Bridge works. IFC Noise standards	Throughout. section especially at construction sites, residential and identified sensitive locations.	Noise levels Measurements Complaints from local people	As per Noise rule, 2000 Consultation with local people	Included in Construction cost Plantation cost is separate	Contractor	APGCL/ CSC
3. Land and Soil								

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Coast	Institutional Responsibility	
							Implementation	Supervision
3.1 Land use Change and Loss of productive/top soil	• Non-agricultural areas to be used as borrow areas to the extent possible. • If using agricultural land, top soil to be preserved and laid over either on the embankment slope for growing vegetation to protect soil erosion.	As per requirement	Throughout the section and borrow areas	Borrow pit Locations Top soil storage area	Review borrow area plan, site visits	Included in construction cost	Contractor	APGCL/ CSC
3.2 Slope failure and Soil erosion due to Construction activities, earthwork, and cut and fill, stockpiles etc.	• Bio-turfing of embankments to protect slopes. • Slope protection by providing frames, dry stone pitching, masonry retaining walls, planting of grass and trees. • The side slopes of all cut and fill areas will be graded and covered with stone pitching, grass and shrub as per design specifications. Care should be taken that the slope gradient shall not be greater than 2:1 • The earth stockpiles to be provided with gentle slopes to prevent soil erosion.	IRC: 56 - 1974 recommended practice for treatment of embankment slopes for erosion control Clause No.306 and 305.2.2 MORT&H Specifications for Road and Bridge works Guidelines IX for Soil erosion	Throughout the entire road especially along hilly areas	Occurrence of slope failure, landslides or erosion issues	Review of design documents and site observation	Included in Construction cost	Design consultant and Contractor,	APGCL/ CSC
3.3 Borrow area management	• Non-productive, barren lands, upland shall be used for borrowing earth with the necessary permissions/consents. • Depths of borrow pits to be regulated and sides	IRC Guidelines on borrow areas and for quarries(Environmental	Borrow sites location	Existence of borrow areas in inappropriate unauthorized locations.	Review of design documents and site observation	Included in Construction cost	Design consultant and Contractor,	APGCL/ CSC

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Coast	Institutional Responsibility	
							Implementation	Supervision
	not steeper than 25%. • Topsoil to be stockpiled and protected for use at the rehabilitation stage. • Transportation of earth materials through covered vehicles. • IRC recommended practice for borrow pits (IRC 10: 1961). • Borrow areas not to be dug continuously. • To the extent borrow areas shall be sited away from habituated areas. Borrow areas shall be leveled with salvaged material or other filling materials which do not pose contamination of soil. Else, it shall be converted into fishpond in consultation with fishery department and land owner/community. • Rehabilitation of the borrow areas as per Guidelines for redevelopment of Borrow Areas.	Protection Act And Rules,1986; Water Act, Air Act)+ Clause No. 305.2.2 MORT&H Specifications for Road and Bridge works Guidelines V for Borrow Areas management		Poor borrow area Management practices. Incidents of accidents. Complaints from local people.				
3.4 Quarry Operations	• Aggregates will be sourced from existing licensed quarries. • Copies of consent/ approval / rehabilitation plan for a new quarry or use of existing source will be submitted to EO, APGCL. • The contractor will	Clause No. 111.3 MORT&H Specifications for Road and Bridge works Guidelines VI for	Quarry area locations	Existence of licenses for all quarry areas from which materials are being sourced Existence of a	Review of design documents, contractor documents and site observation	Included in Construction cost	Contractor	APGCL/ CSC

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Coast	Institutional Responsibility	
							Implementation	Supervision
	develop a Quarry Redevelopment plan, as per the Mining Rules of the state and submit a copy of approval to EA.	Quarry Areas Management		Quarry redevelopment Plan				
3.5 Compaction of soil and impact on quarry haul roads due to movement of vehicles and equipment	• Construction vehicles, machinery, and equipment to be stationed in the designated ROW to avoid compaction. • Approach roads/haulage roads shall be designed along the barren and hard soil area to reduce the compaction. • Transportation of quarry material to the dumping site through heavy vehicles shall be done through existing major roads to the extent possible to restrict wear and tear to the village/minor roads. • Load of haulage trucks will be monitored to ensure they do not exceed the standard limits to avoid safety issues and excessive damage on the roads • Land taken for construction camp and other temporary facility shall be restored to its original conditions.	Design requirement	Parking areas, Haulage roads and constructio n yards.	Location of approach and haulage roads Presence of destroyed/com pacted agricultural land or land which has not be restored to its original condition	Site observation	Included in construction cost	Contractor	APGCL/ CSC
3.6 Contamination of soil due to	• Construction vehicles and equipment will be maintained and refueled	Design requirement	Fueling station, Constructio	Quality of soil near storage area	Site observation	Included in construction cost.	Contractor	APGCL/ CSC

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Coast	Institutional Responsibility	
							Implementation	Supervision
leakage/ spillage of oil, bituminous and bituminous debris generated from demolition and road construction	in such a fashion that oil/diesel spillage does not contaminate the soil. • Fuel storage and refueling sites to be kept away from drainage channels. • Unusable debris shall be dumped in ditches and low lying areas. • To avoid soil contamination Oil-Interceptors shall be provided at wash down and refueling areas. • Waste oil and oil soaked cotton/ cloth shall be stored in containers labeled 'Waste Oil' and 'Hazardous' sold off to MoEF&CC/SPCB authorized vendors • -bituminous wastes to be dumped in approved borrow pits with the concurrence of landowner and covered with a layer of topsoil conserved from opening the pit. • Bituminous wastes will be disposed off in an identified dumping site approved , appropriately designed, compliant waste management facilities (landfills).		n sites, and constructio n camps and disposal location.	Presence of spilled oil or bitumen in area				
4. Water Resources								
4.1 Sourcing of water during	• Requisite permission shall be obtained for		Throughout the section	Approval from competent	Checking of documentati	Included in construction	Contractor	APGCL/ CSC

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Coast	Institutional Responsibility	
							Implementation	Supervision
Construction	abstraction of groundwater from Central Groundwater Authority • Arrangements shall be made by contractor that the water availability and supply to nearby communities remain unaffected.	-		authority Complaints from local people on water availability	on on Talk to local people	cost		
4.2 Disposal of water during construction	• Provisions shall be made to connect road side drains with exiting nearby ponds otherwise make provision of water harvesting pits intermittently.	Clause No. 1010 EP Act 1986 MORT&H Specifications for Road and Bridge works	Throughout the section.	Design of road side drains Existence of Proper drainage system for disposal of waste water	Standards methods Site observation and review of documents	Included in construction cost	Contractor	APGCL/ CSC
4.3 Alteration in surface water hydrology due to embankment	• Existing drainage system to be maintained and further enhanced. • Provision shall be made for adequate size and number of cross drainage structures esp. in the areas where land is sloping towards road alignment. • Road level shall be raised above HFL level wherever road level is lesser than HFL.	Design requirement, Clause No 501.8.6. MORT&H Specifications	Near all drainage channels, river crossings etc. specially locations of 9 no. of slab culverts and 33 no. of box culverts.	Design of road side drains	Review of design documents Site observation	Included in construction cost	Contractor	APGCL/ CSC
4.4 Siltation in water bodies due to construction activities/	• Embankment slopes to be modified suitably to restrict the soil debris entering water bodies. • Provision of Silt fencing	Design requirement , Clause No 501.8.6. MORT&H	Near all water bodies, river embankme	Siltation of rivers, streams, ponds and other water	Field observation	Included in construction cost	Contractor	APGCL/ CSC

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Coast	Institutional Responsibility	
							Implementation	Supervision
earthwork	shall be made at water bodies. • Silt/sediment should be collected and stockpiled for possible reuse as surfacing of slopes where they have to be re-vegetated. • Earthworks and stone works to be prevented from impeding natural flow of rivers, streams and water canals or existing drainage system.	Specifications for Road and Bridge works (CP and CP) and worldwide best practices	nt slopes.	bodies in area				
4.5 Deterioration in Surface water quality due to leakage from vehicles and equipment's and waste from construction camps.	• No vehicles or equipment should be parked or refueled near water-bodies, so as to avoid contamination from fuel and lubricants. • Oil and grease traps and fueling platforms to be provided at re-fueling locations. • All chemicals and oil shall be stored away from water and concreted platform with catchment pit for spills collection. • All equipment operators, drivers, and warehouse personnel will be trained in immediate response for spill containment and eventual clean-up. Readily available, simple to understand and preferably written in the local language emergency response procedure, including	The Water (Prevention and Control of Pollution) Act, 1974 and amendments thereof.	Water bodies, refueling stations, construction camps.	Water quality of ponds, streams, rivers and other water bodies in project area. Presence of oil floating in water bodies in area	Conduction of water quality tests as per the monitoring plan Field observation	Included in construction cost	Contractor	APGCL/ CSC

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Coast	Institutional Responsibility	
							Implementation	Supervision
	reporting, will be provided by the contractors. • Construction camp to be sited away from water bodies. • Solid Wastes shall be collected, strong and taken to the approved, appropriately designed, compliant waste management facility (landfills) only. • Water quality shall be monitored periodically • All equipments operators, divers, and ware house personal will be trained in immediate response for spill containment and eventual cleanup. Readily available, simple to understand and preferably retain in the local language emergency response procedure, including reporting, will be provided by the contractor,							
5. Flora and Fauna								
5 .1 Vegetation loss due to site preparation and construction activities	• Minimize tree cutting to the extent possible. • Roadside 611 trees to be removed with prior approval of competent authority. • Compensatory plantation at 1:10 basis and	Forest Conservation Act 1980 & IRC SP: 21 and IRC SP:66	Throughout Road corridor	ROW width 611 no. trees for felling Compensatory plantation plan	Review of relevant documents – tree cutting permit, compensato	Road side Plantation cost is included in . costs.	Relevant agency specialized in afforestation	APGCL / CSC

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Coast	Institutional Responsibility	
							Implementation	Supervision
	additional plantation as per the IRC guidelines in consultation with Forest Department. • Regular maintenance of all trees planted. • Provision of LPG in construction camp as fuel source to avoid tree cutting, wherever possible. • Plantation of trees on both sides of the road. Integrate vegetation management (IVM) with the carriage way completely clear of vegetation. From the edge of the road to the boundary of ROW, vegetation structured with smaller plants near the line and larger trees further away to avoid costly and provide habitats for a wide variety of plants and animals. Additional plantation near river banks to check erosion as part of compensatory plantation. • In the event of design changes during the construction stages additional assessments including the possibility to save trees shall be made by the EA. • Road side Plantation Strategy as per IRC specifications including			6,110 no. trees replanted	ry plantation plan Field observations			

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Coast	Institutional Responsibility	
							Implementation	Supervision
	manuring.							
5.2 Wildlife/animal disturbance due to site preparation and construction activities	• Identify the locations for animal corridor crossing the alignment and provide propose passage as per site condition/geography. • Provisions of adequate signages and speed limit on road sections within forest areas to avoid accidental roadkills . • Monitoring poaching activities in workers areas and well as community areas (as per Annex 9).	Forest Conservation Act 1980 & Wildlife Protection Act, 1972	In Mandap Reserve Forest along the road Elephant crossings are reported by locals once in year (during November-December months).	Barricading the corridor for alignment crossing to guide elephant passes at one location	Physical check on conditions	Included in construction cost	Contractor	APGCL/ CSC
6. Construction Camps								
6.1 Impact associated with location	▪ All camps should maintain minimum distance from following: I. 500 m from habitation II. 500 m from forest areas where possible III. 500 m from water bodies where possible IV. 500 m from through traffic route where possible	Design Requirement	All construction camps	Location of campsites and distance from habitation, forest areas, water bodies, through traffic route and other construction camps	On site Observation Interaction with workers and local community	Included in construction cost	Contractor	APGCL/ CSC
6.2 Worker's Health in construction camp	• The location, layout and basic facility provision of each labor camp will be submitted to SQC prior to their construction. The	The Building and Other Construction workers (Regulation	All construction camps	Camp health Records Existence of	Camp Records Site	Part of the Contractors costs	Contractor	APGCL/ CSC

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Coast	Institutional Responsibility	
							Implementation	Supervision
	construction shall commence only after approval of SQC. • The contractor will maintain necessary living accommodation and ancillary facilities in functional and hygienic manner as approved by the EA. • Adequate water and sanitary latrines with septic tanks attached to soak pits shall be provided. • Preventive medical care to be provided to workers including a First-Aid kit that must be available in the camp. • Waste disposal facilities such as dust bins must be provided in the camps and regular disposal of waste must be carried out . • The Contractor will take all precautions to protect the workers from insect and pest to reduce the risk to health. This includes the use of insecticides hitch should comply with local regulations. • No alcoholic liquor or prohibited drugs will be imported to, sell, give, and barter to the workers of host community. • Awareness raising to	of Employment and Conditions of Service) Act 1996 and The Water (Prevention and Control of Pollution) Act, 1974 and amendments thereof. IFC EHS Guidelines		proper first aid kit in camp site Complaints from local people	Observation Consultation with local people living nearby			

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Coast	Institutional Responsibility	
							Implementation	Supervision
	immigrant workers/local community on communicable and sexually transmitted diseases.							
7. Management of Construction Waste/Debris								
7.1 Selection of Dumping Sites	• Unproductive/wastelands shall be selected for dumping sites. • Away from residential areas and water bodies • Dumping sites have adequate capacity equal to the amount of debris generated. • Public perception and consent from the village Panchayats has to be obtained before finalizing the location.	Design Requirement and MORT&H guidelines	At all Dumping Sites	Location of dumping sites Public complaints	Field survey and interaction with local people	Included in construction cost	Contractor	APGCL/ CSC
7.2 Reuse and disposal of construction and dismantled waste	• The existing bitumen surface shall be utilized for paving of cross roads, access roads, and paving works in construction sites and camps, temporary traffic diversions, and haulage routes. • Unusable and -bituminous debris materials should be suitably disposed off at pre-designated disposal locations, with approval of the concerned authority. The bituminous wastes shall be disposed in secure landfill sites only in environmentally	MORT&H and IFC EHS guidelines	Throughout the corridor	Percentage of reuse of existing surface material Method and location of disposal site of construction debris	Contractor Records Field Observation Interaction with local people	Included in construction cost	Contractor	APGCL/ CSC

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Coast	Institutional Responsibility	
							Implementation	Supervision
	accepted manner. For removal of debris, wastes and its disposal MOSRTH guidelines and IFC EHS guidelines should be followed. • Unusable and surplus materials, as determined by the . Engineer, will be removed and disposed off-site. • All excavated materials from roadway, shoulders, verges, drains, cross drainage will be used for backfilling embankments, filling pits, and landscaping.							
8. Traffic Management and Safety								
8.1 Management of existing traffic and safety	• Temporary traffic diversion shall be planned by the contractor and approved by the 'Engineer'. • The traffic control plans shall contain details of diversions; traffic safety arrangements during construction; safety measures for night time traffic and precautions for transportation of hazardous materials. Traffic control plans shall be prepared in line with requirements of IRC's SP 55 document'. • The Contractor will ensure that the diversion/detour is	Design requirement and IRC SP:55	Throughout the . corridor especially at intersections.	Traffic management plan Safety signs on Site Number of traffic accidents	Review traffic management plan Field observation of traffic management and safety system Interaction with people in vehicles using the road	Included in construction cost	Contractor	APGCL/ CSC

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Coast	Institutional Responsibility	
							Implementation	Supervision
	always maintained in running condition, particularly during the monsoon to avoid disruption to traffic flow. • On stretches where it is not possible to pass the traffic on the part width of existing carriageway, temporary paved diversions will be constructed. • Restriction of construction activity to only one side of the existing road. • The contractor shall inform local community of changes to traffic routes, and pedestrian access arrangements with assistance from "Engineer".							
8.2 Pedestrians, animal movement	• Temporary access and diversion, with proper drainage facilities. • Access to the schools, temples and other public places must be maintained when construction takes place near them. • Fencing wherever cattle movement is expected. • To avoid the need for cattle underpasses, some of the proposed culverts `near habitations may be widened to facilitate cattle movement.	Design requirement And IRC: SP: 27 -1612 IRC:SP: 32 - 1988 Road Safety for Children (5-12 Years Old) IRC:SP: 44 - 1994 Highway Safety Code IRC: SP: 55 -	Near habitation on both sides of schools, temples, hospitals, graveyards, construction sites, haulage roads, diversion sites.	Road signage & drainage as per IRC guideline Complaints from local people	Field observation Interaction with local people	Included in construction cost	Contractor	APGCL/ CSC

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Coast	Institutional Responsibility	
							Implementation	Supervision
		2001 Guidelines for The Building and other Construction workers Act 1996 and Cess Act of 1996 Factories Act 1948						
8.3 Safety of Workers and accident risk from construction activities	• Contractors to adopt and maintain safe working practices. • Usage of fluorescent and retroflectory signage, in local language at the construction sites • Training to workers on safety procedures and precautions. • Mandatory appointment of safety officer. • All regulations regarding safe scaffolding, ladders, working platforms, gangway, stairwells, excavations, trenches and safe means of entry and egress shall be complied with. • Provision of PPEs to workers. • Provision of a readily available first aid unit including an adequate supply of dressing		Construction sites	Availability of Safety gears to Workers Safety signage Training records on safety Number of safety related accidents	Site Observation Review records on safety training and accidents Interact with construction workers	Included in construction cost	Obligation of Contractor	APGCL/ CSC

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Coast	Institutional Responsibility	
							Implementation	Supervision
	materials. • The contractor will not employ any person below the age of 18 years for any work • Use of hazardous material should be minimized and/or restricted. • Emergency plan (to be approved by engineer) shall be prepared to respond to any accidents or emergencies. • Accident Prevention Officer must be appointed by the contractor.							
8.4 Accident risk to local community	• Restrict access to construction sites to authorized personnel. • Physical separation must be provided for movement of vehicular and human traffic. • Adequate signage must be provided for safe traffic movement		Construction sites	Safety signs and their location Incidents of Accidents Complaints from local people	Site Inspection Consultation with local people	Included in construction cost	Contractor	APGCL/ CSC
9. Site restoration and rehabilitation								
9.1 Clean-up Operations, Restoration and Rehabilitation	• Contractor will prepare site restoration plans, which will be approved by the 'Engineer'. • The clean-up and restoration operations are to be implemented by the contractor prior to demobilization. • All construction zones	As per requirement	Throughout the corridor, construction camp sites and borrow areas	Clean and restored camp sites Presence/absence of construction material/debris after	Site Observation Interaction with locals Issue completion certificate	Included in construction cost	Contractor	APGCL/ CSC

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Coast	Institutional Responsibility	
							Implementation	Supervision
	including river-beds, culverts, road-side areas, camps, hot mix plant sites, crushers, batching plant sites and any other area used/affected by the . will be left clean and tidy, at the contractor's expense, to the satisfaction of the Environmental officer. • All the opened borrow areas will be rehabilitated and 'Engineer' will certify in this regard.			completion of construction works on construction site	after restoration of all sites are found satisfactory			
C. Operation stage								
1. Air quality								
1.1 Air pollution due to due to vehicular movement	• Roadside tree plantations shall be maintained. • Regular maintenance of the road will be done to ensure good surface condition. • Vehicular air pollution will be managed and monitored. • Ambient air quality monitoring. If monitored parameters are above the prescribed limit, suitable control measures must be taken. • Technological and behavioral changes • Road signs shall be provided reminding the motorist to properly maintains their vehicles to economize on fuel	Environmental Protection Act, 1986; The Air (Prevention and Control of Pollution) Act, 1981	Throughout the Corridor	Ambient air quality (PM10, PM2.5, SOx, CO, NOx) Survival rate of trees planted	As per CPCB requirements Site inspection	Included in Operation/ Maintenance cost	Contractor	APGCL/ CSC

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Coast	Institutional Responsibility	
							Implementation	Supervision
	consumption and unprotect the environment.							
2. Noise								
2.1 Noise due to movement of traffic	• Effective traffic management and good riding conditions shall be maintained to reduce the noise level throughout the stretch and speed limitation and honking restrictions may be enforced near sensitive locations. • The effectiveness of the multilayered plantation should be monitored and if need be, solid noise barrier shall be placed. • Create awareness amongst the residents about likely noise levels from road operation at different distances, the safe ambient noise limits and easy to implement noise reduction measures while constructing a building close to the road.	Noise Pollution (Regulation and Control) Rules, 2000 and amendments thereof	Sensitive Receptors (School, Hospital, and residential areas)	Noise levels	Noise monitoring as per noise rules ,2000 Discussion with people in sensitive receptor sites	Included in Operation/ Maintenance cost	Contractor	APGCL/ CSC
3. Land and Soil								
3.1 Soil erosion at embankment during heavy rain fall.	• Periodic checking to be carried to assess the effectiveness of the stabilization measures viz. turfing, stone pitching, river training structures etc. • Necessary measures to be followed wherever	As per requirement	At bridge locations and embankment slopes and other probable	Existence of soil erosion sites Number of soil erosion sites	On site observation	Included in Construction cost	Contractor	APGCL/ CSC

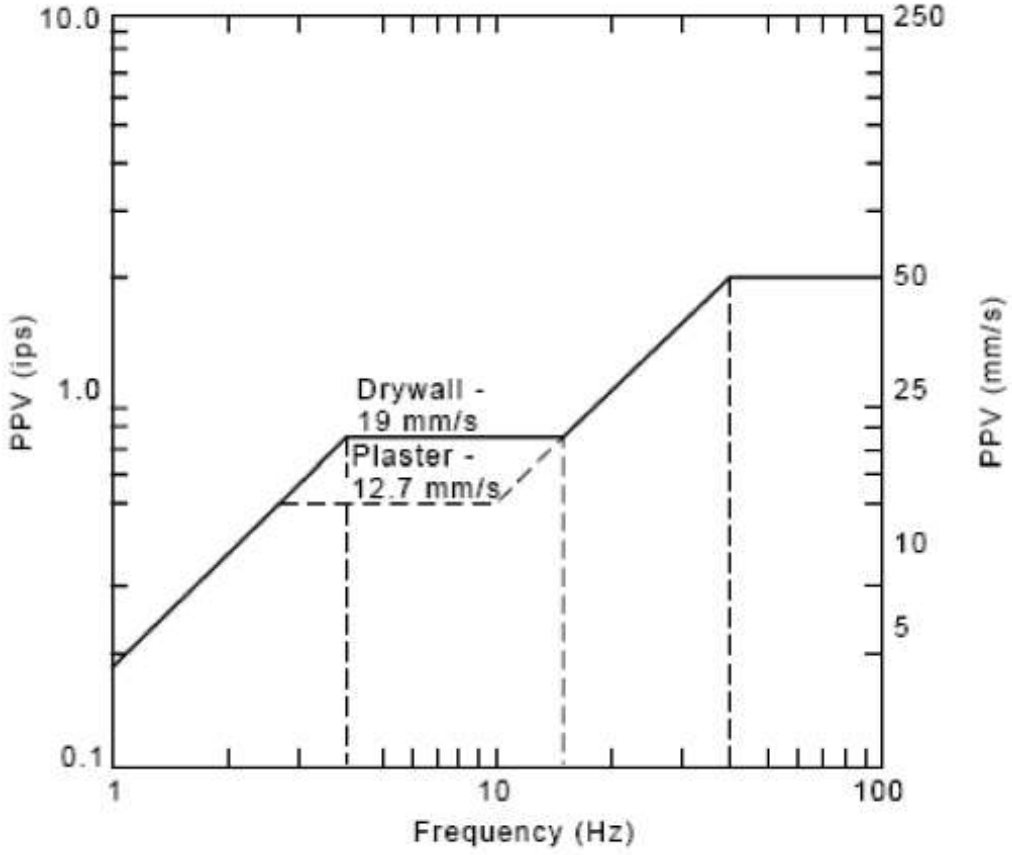
Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Coast	Institutional Responsibility	
							Implementation	Supervision
	there are failures		soil erosion areas.					
4. Water resources/Flooding and Inundation								
4.1 Siltation	• Regular checks shall be made for soil erosion and turfing conditions of river training structures for its effective maintenance.	As per requirement	Near surface Water bodies	Water quality	Site observation	Included in Operation/ Maintenance cost	Contractor	APGCL/ CSC
4.2 Water logging due to blockage of drains, culverts or streams	• Regular visual checks and cleaning of drains shall be done along the alignment to ensure that flow of water is maintained through cross drains and other channels/streams. • Monitoring of water borne diseases due to stagnant water bodies	As per requirement	Near surface Water bodies	Presence of flooded areas or areas with water stagnation	Site observation	Included in Operation/ Maintenance cost	Contractor	APGCL/ CSC
4.3 Road inundation due to choking of drainage channels	• APGCL will ensure that all drains (side drains and all cross drainages) are periodically cleared especially before monsoon season to facilitate the quick passage of rainwater and avoid flooding.	As per requirement	Flood prone sections	Incidents of flooding and road inundation with details on change	Field observation Interaction with local community	Included in Operation/ Maintenance cost	Contractor	APGCL/ CSC
5. Flora								
5.1 Vegetation	• Planted trees, shrubs, and grasses to be properly maintained. • The tree survivalist audit to be conducted at least once in a year to assess the effectiveness	Forest Conservation Act 1980	Tree Plantation sites	Minimum of 70% of tree survival	Records and fields observations	Operation and Maintenance Cost	Contractor	APGCL/ CSC
6. Maintenance of Right of Way and Safety								
6.1 Accident	• Efforts shall be made to make	As per	Throughout	Presence of	Visual	Included in	Contractor	APGCL/

Environmental Issue/ Component	Remedial Measure	Reference to laws /guidelines	Location	Monitoring indicators	Monitoring Methods	Mitigation Coast	Institutional Responsibility	
							Implementation	Supervision
Risk due to uncontrolled growth of vegetation	shoulder completely clear of vegetation. • Regular maintenance of plantation along the road side. • Invasive plant not to be planted near the road.	require ment	the route	and extent of vegetation growth on either side of road Accident data	Inspection Accident records	operation/ Maintenance cost		CSC
6.2 Accident risks associated with traffic movement.	• Traffic control measures, including speed limits, will be enforced strictly. • Further encroachment of squatters within the ROW will be prevented. • No school or hospital will be allowed to be established beyond the stipulated planning line as per relevant local law • Monitor/ensure that all safety provisions included in design and construction phase are properly maintained • Highway patrol unit(s) for round the clock patrolling. Phone booths for accidental reporting and ambulance services with minimum response time for rescue of any accident victims, if possible. • Tow-away facility for the break down vehicles if possible.	IRC:S P:55	Throughout the route	Police records on Accident Condition and existence of safety signs, rumble strips etc. on the road Presence/abse nce of sensitive receptor structures inside the stipulated planning line as per relevant local law	Review accident records Site observation	Included in operation/Mai ntenance cost	Contractor	APGCL/ CSC
6.3 Transport of Dangerous Goods	• Existence of spill prevention and control and emergency responsive system • Emergency plan for vehicles carrying hazardous material		Throughout the . stretch	Status of emergency system – whether operational or not	Review of spill prevention and emergency response system	Included in operation/ Maintenance cost.	Contractor	APGCL/ CSC

Table 35.2 Environmental Monitoring Plan

Environmental Features	Aspect to be Monitored	Time and Frequency of Monitoring	Location	Monitoring Cost (INR)	Responsible party (Implementation/ Supervision)
Construction stage					
Noise	Noise levels in dB(A)	At the start of concerned activities. At least 2 times during construction period.	At 2 locations	2,000*3*2 =12,000	EPC Contractor & PMC
Air	Emission of dust and particulate matter, NOx and SOx	At the start of concerned activities. At least 2 times during construction period.	At 2 locations	2,000*3*2 =12,000	EPC Contractor & PMC
Occupational Health and Safety	As specified in project OHS plan prepared by Contractor	Project site Weekly	Project Site	Project Cost	EPC Contractor & PMC

Annex 36: BLASTING VIBRATION LIMITS



USBM RI 8507 Safe Blasting Vibration Level Criteria

ANNEX 37: TERMS OF REFERENCE FOR EXTERNAL MONITOR

Lower Kopili Hydroelectric Project

Terms of Reference
External Monitoring for Environmental Management and Wildlife Conservation Activities

A. Introduction

1. The Government of India has applied for financial assistance from the Asian Development Bank (ADB) towards the cost of Lower Kopili Hydroelectric Project (LKHEP). The LKHEP involved construction of 120 MW hydroelectric power plant and associated 50 km long 220kV power evacuation (transmission) line in northeastern State of Assam, India.

2. The main objective of the external monitoring is to provide technical guidance and monitor implementation and effectiveness of all the environment safeguard activities including wildlife conservation related activities under the project relating to (i) construction of the 120MW power plant and transmission line, (ii) compensatory afforestation, and (iii) other habitat improvement. As per several management plans, the external monitoring agency will regularly appraise ADB and APGCL on the affectivity of the mitigation measures and practices and if inadequate recommend additional measures or studies.

3. The external monitoring services will be financed from the loan and carried out by a consulting firm recruited in accordance with ADB's Guidelines on the Use of Consultants. The consultant will be selected in accordance with ADB's Quality and Cost- Based Selection (QCBS).

B. Staffing

4. The consulting services will be implemented from 2018 to 2025 (approximately 7 years). The inputs of specialists required are summarized in Table 36.1.

Table 36.1: Summary of Consulting Services Requirement

Name of Positions	Input (Person-months)	Key qualification	Experience
International			
Biodiversity /Wildlife Specialist	19 over 7 years (3 per year during construction for 5 years, and 2 per year during operation for 2 years)	Minimum of a Master's Degree in Wildlife Conservation or Ecosystem Management and related subjects	Minimum of 15 years of working experience in biodiversity and wildlife conservation activities in critical habitat areas involving wildlife, aquatic ecosystems, and reservoir development activities
Environment Specialist	19 over 7 years (3 per year during construction for 5	Minimum of a Master's Degree in Environmental	Minimum of 15 years of working experience in preparation and implementing environment

Name of Positions	Input (Person-months)	Key qualification	Experience
	years, and 2 per year during operation for 2 years)	Engineering or Management and related EHS subjects	safeguard and related activities for hydropower and infrastructure projects
National			
Wildlife Expert	36 over 7 years (6 per year during construction for 5 years, and 3 per year during operation for 2 years)	Minimum of a Master's Degree in Wildlife Conservation or Ecosystem Management and related subjects	Minimum of 7 years of working experience in biodiversity and wildlife conservation activities in critical habitat areas involving wildlife migratory routes and reservoir development activities
Aquatic Ecological Expert	17 over 7 years (3 per year during construction for 5 years, and 1 per year during operation for 2 years)	Minimum of a Master's Degree in environment science, aquatic ecology, fisheries and related subjects	Minimum of 7 years of working experience in aquatic ecosystem, fisheries, biodiversity conservation activities in critical habitat areas involving fish management activities
Environment Specialist	36 over 7 years (6 per year during construction for 5 years, and 3 per year during operation for 2 years)	Minimum of a Master's Degree in Environmental Engineering or Management and related EHS subjects	Minimum of 7 years of working experience in preparation and implementing environment safeguard and related activities for hydropower or infrastructure projects
Subprofessional Support Staff / Field Staff: To be included under the out-of-pocket expenses, as required.			

C. Scope of Services

5. The scope of services provided by the external monitoring will include, but not be limited, to the following:

1. Biodiversity / Wildlife Specialist (International 19, National 36 person-months):

a) Review the Environmental Impact Assessment (EIA) report prepared for the project to understand the background of the conservation issues and proposed project activities
b) Based on the wildlife conservation related activities proposed in the EIA, further prepare a detailed Biodiversity Conservation and Wildlife Management Plan (BCWMP) including activities on compensatory afforestation and habitat enhancement.
c) Undertaken pre-construction biodiversity assessment, if required.
d) Provide technical guidance to the contractor for implementing the BCWMP.
e) Coordinate with the local forestry officials, wildlife officials and local Panchayat and Women self-help groups to implement the afforestation program so as to generate employment for local people, especially women to the extent possible.
f) Monitor the implementation of the BCWMP on a periodic basis and prepare quarterly monitoring reports for submission to the EA and ADB.
g) After completion of the construction works and implementation of all BCWMP activities, during the project implementation period for at least two years continue monitoring the effectiveness of the habitat enhancement activities. Based on the monitoring activities prepare annual monitoring reports during the project operation stage.
h) To facilitate easier monitoring of the effectiveness of the habitat enhancement activities, identify and procure necessary equipment such as camera traps, GPS tracking devices etc. and use them for monitoring during project operations.

2. Environment Specialist (International 19, National 36 person-months):

a) Review EIA report (including the EMP and EMoP) and all monitoring reports prepared for the project to understand the environmental issues in the project area and mitigation and monitoring requirements of the project.
b) Review the EMP for inclusion of all site specific issues and make necessary amendments if any issues are not covered.
c) Review the EMoP and ensure that the location and timing of checking/testing all environmental parameters are in accordance with the site conditions.
d) Prepare or review (if already existing) monitoring checklists for weekly or monthly checklists (as necessary) for monitoring implementation of the Environment Management Plan by the contractor.
e) Prepare or review (if already existing) reporting formats for monthly, quarterly, biannual and annual monitoring reports.
f) Monitor implementation of the EMP by the contractor on a weekly and monthly basis. In doing so complete the weekly, or monthly monitoring checklists.
g) Prepare monthly, quarterly and biannual Environmental Monitoring reports based on monitoring site visits and completed checklists for submission to the IA and ADB during project construction. The quarterly monitoring reports will be disclosed on the ADB website.
h) Include test results of environment monitoring carried out in the monitoring reports and advise/support the contractor in taking remedial actions if any of the test results are not within the required limits.

3. Aquatic Ecological Expert (National 17 person-months):

a) Review the Environmental Impact Assessment (EIA) report prepared for the project to understand the background of the conservation issues and proposed project activities
b) Based on the aquatic ecosystem conservation related activities proposed in the EIA, further prepare a detailed Fish Management.
c) Undertaken pre-construction aquatic flora and fauna assessment, if required.
d) Provide technical guidance to the contractor for implementing the Fish Management Plan.
e) Coordinate with the local forestry officials, wildlife officials and local Panchayat and Women self-help groups to implement the afforestation program so as to generate employment for local people, especially women to the extent possible.
f) Monitor the implementation of the Fish Management Plan on a periodic basis and prepare quarterly monitoring reports for submission to the EA and ADB.
g) After completion of the construction works and implementation of all Fish Management Plan activities, during the project implementation period for at least two years continue monitoring the effectiveness of the habitat enhancement activities. Based on the monitoring activities prepare annual monitoring reports during the project operation stage.