DAM REHABILITATION AND IMPROVEMENT PROJECT

DRIP
Dam Rehabilitation & Improvement Project

CONSTRUCTION OF ADDITIONAL SPILLWAY AT HIRAKUD DAM, IN SAMBALPUR DISTRICT, ODISHA

ENVIRONMENTAL IMPACT ASSESSMENT

Submitted

By

Department of Water Resources
Government of Odisha

January, 2018

CONTENTS

List of Tables

List of Figures

C4-17	Natural Drainage Map of the Study Area
C4-18	Hydrogeomorphology map of the Study Area
C4-19	Collection of Water Sample From Surface Water And Ground Water Sources
C4-20	Adding Chemical to Surface Water Sample For DO Fixation
C4-21	Location Map Of the Water Monitoring Stations
C4-22	Map showing Borrow Areas and Dumping Areas
C4-23	Map showing Quarry Sites
C4-24	Sediment Collection
C4-25	Photographs Of Birds
C4-26	Photographs Of Macrophytes
C4-27	Photographs Of Fish
C4-28	Degraded Lamdunguri Forest
C4-29	Eco-sensitive Map of Odisha
C4-30	Eco-sensitive Map of Odisha (part of Enlarged view around project site)
C4-31	Photographs of village amenities
C4-32	Religious Places
C4-33	Recently Built Crematoria
C4-34	Garbage dumped area in and around Bahadurpada
C4-35	Google map showing Historical Places and its distances from Hirakud Dam

List of Annexures

Annexure No.	Title of Annexure
1.1	Letter from EIC, Water Resources dated 29.04.15
1.2	Note and Action Plan on safeguards
1.3	Construction Schedule
2.1	MoEFCC Minutes of 11th Meeting of Expert Appraisal Committee- River Valley & Hydro-electric Projects
3.1	DFO Report
5.1	Water Supply Pipe Line and Bridge in Layout Map
6.1	Plantation Scheme
6.2	Plant Site Management
6.3	Borrow Areas Management Plan
6.4	Quarry Area Management Plan
6.5	Explosive Management
6.6	Risk and Disaster Management Plan
6.7	Environment Health Safety Management Plan
6.8	Construction and Labour Camps Management

6.9	National Ambient Air Quality Standard
6.10	Noise Standard
6.11	Ground Water parameters
6.12	Surface Water parameters
6.13	Muck dumping management

ACRONYMS

Ammd	Amendment
AMSL	Above Mean Sea Level
CCA	Culturable Command Area
CE&BM	Chief Engineer and basin manager
CEMC	Centre For Envotech and Management consultancy Pvt. Ltd.
CPCB	Central Pollution Control Board
CPMU	Central Project Management Unit
Cumsec	Cubic meter per second
CWC	Central Water Commission
DEA	Dept of Economic Affairs
DoWR	Department of Water Resources
DRIP	Dam Rehabilitation & Improvement Project
DSL	Dead Storage Level
DSRP	Dam Safety Review Panel
EL	Elevation Level
ESIA	Environmental & Social Impact Assessment
FRL	Full Reservoir Level
Ft	Feet
GCA	Gross Command Area
GoI	Government of India
GoO	Government of Odisha
GSI	Geological Survery of India
Ham	Hectare meter
IMD	Indian Meteorology Department
INR	Indian Rupees
LARR	Land Acquisition, Rehabilitation & Resettlement
MoEF&CC	Ministry of Environment, Forest and Climate Change
MoTA	Ministry of Tribal Affairs
MoWR	Ministry of Water Resources
MSL	Mean Sea level
MWL	Maximum Water Level
nos.	Numbers
NWDA	National Water Development Authority
OP	Operational policy
PCCF	Principal Chief Conservator of Forest
PMF	Probable Maximum Flood
PMoU	Project Monitoring Unit
PLEMC	Project Level Environmental & Social Management Committee
RAP	Resettlement of Action Plan
RCC	Reinforced Concrete Cement
SPCB	State Pollution Control Board
SPMU	State Project Management Unit
SSEMP	Site Specific Environmental Management Plan
SWRD	State Water Resources Department
ToR	Terms of Reference
U/s	Up Stream
WB	World Bank
WBG	World Bank Guidelines

EXECUTIVE SUMMRY

E.1 INTRODUCTION:

Project specific Environmental Impact Assessment study has been conducted for the proposed additional spillway at Hirakud dam in Sambalpur district of Odisha state proposed as a flood protection measures. The additional spillways have been proposed on the left bank dyke of the existing reservoir. The proposed project will include spill way with 243m long approach channel and RCC spill channel for a length of 2.14 km.

The Central Water Commission have organised to obtain consent of the World Bank for Phase-I and included the Project in the Bank aided ongoing Dam Rehabilitation and Improvement Project (DRIP).

As a pre-requisite of World Bank funding; various project interventions due upon construction of Left bank additional spillway need to be studied to ensure environmental and social compliance. This EIA/EMP is specifically prepared for implementation of additional spillway at the left bank dyke (Phase - I).

The main objective of the Environment Assessment Study is to identify the potential environmental impacts due to the proposed project as well as to formulate the measures for mitigating those environmental impacts at various stages of the project. The study report also covers the specific requirement of World Bank Policy on environment and social safeguards.

E.2 NEED OF THE PROPOSED PROJECT:

While the enormously rich water resources of Hirakud Dam continues to remain the mainstay of Odisha's agricultural prosperity & Hydropower potentiality, it has experienced growing concern since last two decades in working out alternatives for managing exceptional flood events when the reservoir is maintained at its maximum holding capacity.

The Central Water Commission (CWC), the apex technical body of ministry of water resources (MoWR) Govt. of India have conducted protracted study of the Hydrology of River Mahanadi and agreed to the revision of Probable Maximum Flood (PMF) with a peak value at 69632 m^3/sec.

The consequences of this upwards revision of PMF against the existing Release Capacity of 42450 m^3/sec through the entire existing 34 nos. of spillway gates & 64 nos of under sluice gates of Hirakud Dam, will imperatively raise grave safety concerns in negotiating the excess flood release of 24182 m^3/sec.

In this prospective, the Union Ministry as well as the State Government (GoO) have expressed urgent intentions to workout viable alternative for safe passing of the additional flood so as to restore safety of Hirakud Dam. Thus, the Central Water Commission (CWC) in consultation with experts from dam safety organisation, engineers from the State Water Resources Department (SWRD) and national level consultants have carried out protracted discussions in several sittings to work out a most feasible alternative for a safe release of the excess flood from Hirakud dam during the event of PMF.

The decision emanated from the meetings of the experts was unanimous on the strategy.

- Release of the excess flood at the events of a PMF through construction of additional spillway structures, one at the left bank dyke near Gandhi Hillock and the other on the right dyke with its spill falling into Juanjhaor nalla.
- In the process, the reservoir water level may encroach the free board by 1.om thereby the MWL may rise up to El 193.02m (i.e. FRL 192.02m +1.0m rise).

It was decided to implement the above expert committee recommendations in two phases.

Phase-I: Construction of additional spillway at the left bank dyke on the second saddle of Gandhi hillock, with releasing arrangements through 5 gates each of size 15m X 15m and releasing capacity of 9122cumsec. This phase is herein after referred to as Project.

Phase-II: Construction of additional spillway on the right dyke across Juanjhor nalla with releasing arrangements through 8 nos. gates, each of size 15m X 10m and releasing capacity of 9057 cumsec.

The State Water Resource Department (SWRD), Govt. of Odisha expressed intentions to implement the Project works expeditiously through World Bank funding assistance for Phase-I. The Phase-II will be taken up after completion of Phase-I following all the environmental and social assessment requirements.

E.3 NEED & OBJECTIVE OF EIA STUDY:

The construction activities of the proposed project will remain adjacent to the existing left dyke and within the project owned land for Hirakud dam project.

However, the project interventions will considerably impact the existing environment as well as the social infrastructure in and around the project areas. Submergence of land, construction of new spillway, dykes and spill channel etc. will cause change of landuse apart from displacement of population.

It was imperative to conduct Environmental Impact Assessment Study (EIA) and prepare Site Specific Environmental Management Plan (SSEMP) to minimise the project induced impacts.

E.4 SCOPE OF THE STUDY:

The scope of the study included the following issues.

(i) Review of the project features.

(ii) Review of the Acts, Policies and regulatory frame work.

(iii) Baseline Assessment of Environmental and Social Components.

(iv) Analysis of alternatives

(v) Mitigation Measures and Management Plan

(vi) Monitoring Mechanism & Capacity Building.

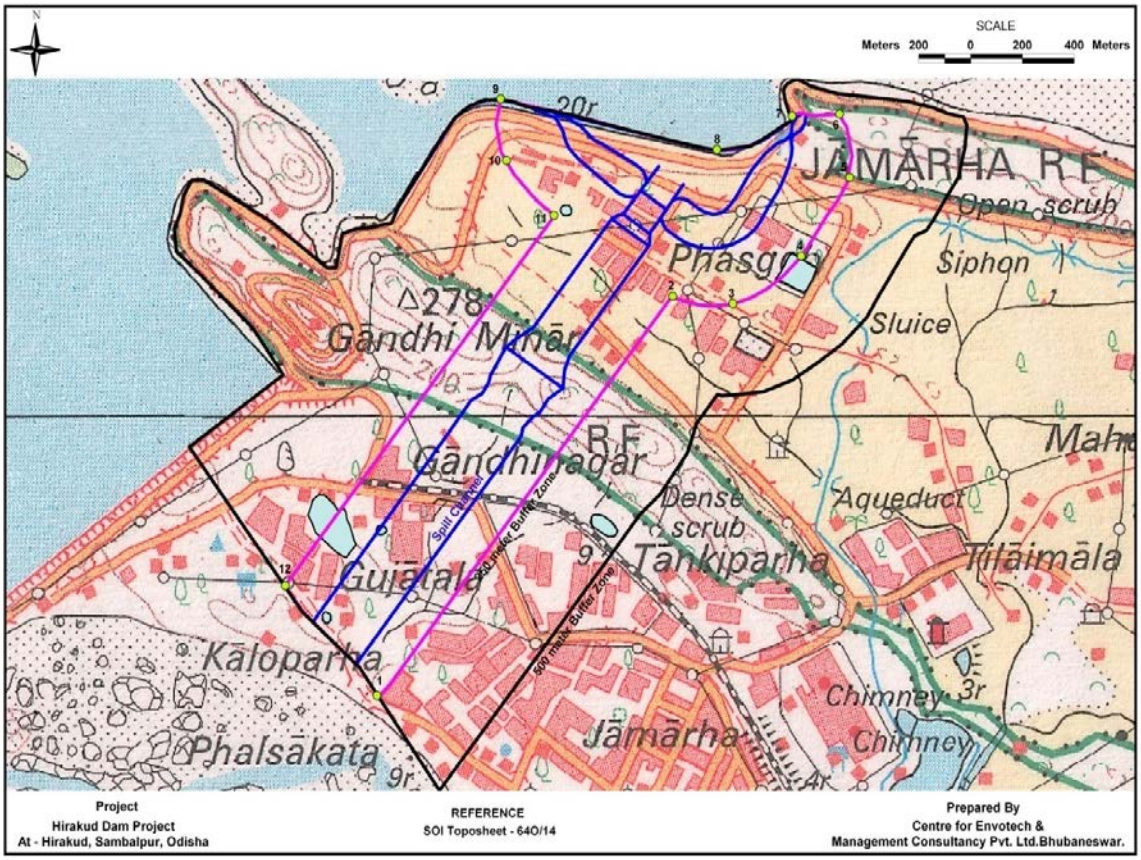
(vii) Cost analysis and Budget

E.5 DESCRIPTION OF PROJECT:

The works under this project are featured with:

- Construction of one additional spillway structure located at the left bank dyke between RD 701m (2300ft) and 1646m (5400ft) and 243m downstream of the Hirakud reservoir.
- It is proposed to cut open the left dyke for 945m length and lead the reservoir water to the spillway structure through an approach channel.
- The spread of water will be contained by two small connecting earth dams at either side of the spillway.
- The excess flood water will be released through the proposed additional spillway through its 5 No. gates each of size 15m X 15m which will be discharged to the river Mahanadi by means of a 250m wide X 2.14 km long well designed RCC spill channel.
- A bridge will be constructed across the channel for facilitating access between communities of two opposite sides of spill channel.

- The location of the project, general topography and proposed hydraulic structures are shown in following map.



E.5.1 Salient Features of Project:

The summary details of the project features in regard of its finalized location and structural components etc. are depicted below in Table E-1.

Table E-1: SALIENT FEATURES OF PROJECT

Sl. No.	Features for finalised location	
	Item/ Components	**Details**
1.	**Project Location**	
	• Location of Spillway structure	243m downstream of first gap left dyke of Hirakud Dam in Hirapur Notified Area Committee (NAC) in Sambalpur district, Odisha
	• Geo-coordinates of the present location	Latitude: 21^0 32’ 52.15” Longitude: 83^0 53’ 58.03” Latitude: 21^0 32’ 54.38” Longitude: 83^0 53’ 54.8”
	• Township & Railway station	Entire proposed project area is located in Hirakud. Nearest township Burla; Hirakud Railway Station on East Coast Railway is located about 8 km away.
2.	**Spillway**	
	• Discharge capacity	$9122m^3$/sec (3.22 lakh cusecs) 91.00m (5 nos. Bays each 15m)

Sl. No.	Features for finalised location	
	Item/ Components	**Details**
	• Length of spillway • Length of Abutments (Left/Right) • No. and Size of spillway gates • Crest elevation • Dam top elevation • Width of Spillway Bridge	52.00m/78.00m 5 nos. each @ 15m x 15m EL 177.00m EL 195.68m 7.50m
3.	**Connecting Dykes (Left / Right)** • Length of Earthen Dykes • Top elevation of Dykes • Geo-coordinates at the butting points with main Dyke.	**(Left / Right)** 640m/384m EL 195.68m/195.68m 1. Latitude: 21^0 33' 0.54" Longitude:83^0 54' 12.56" 2. Latitude: 21^0 32' 52.15" Longitude:83^0 53' 58.09" 3. Latitude: 21^0 32' 54.38" Longitude:83^0 53' 54.8" 4. Latitude: 21^0 33' 2.6" Longitude: 83^0 53' 44.4"
4.	**Approach channel** • Length of approach channel • Width of approach channel • Bed level of channel (Approx.)	243.00m 120.00m EL 167.00m
5.	**Spill Channel** • Stilling Basin Invert • Bed level of channel at the beginning • Tail water level (approx) • Length of Spill Channel/ slope • Width of Spill Channel	**Concrete lined Section** EL 147.00m EL 158.00m EL 173.00m 2.14km/ S=1:3000 120m width x 714m length /200m width (till outfall point) excluding transition length**.**
6.	**Construction of bridge over spill channel**	The bridge will be located at the existing main road.
7.	**Settlement**	Gandhinagar, Gujatal, First gap colony, Laxminagar, Re-rolling colony, Cable Colony, and Prem Nagar of Hirakud NAC.
8.	**Affected Household**	A total of 716 households settled in 7 habitation area are going to be affected
8.	**Tree Felling**	In Reserve Forest Area: 115 nos. In Non Forest Area : 3595 nos.

Sl. No.	Features for finalised location	
	Item/ Components	**Details**
		The predominant tree species are Mango, Cassia Siamea, Neem, etc. There is no Rare, Endangered or Threatened species
9.	**Forest Diversion**	9.441 ha. of forest land to be diverted In Lamdungri Reserve Forest
10.	**Affected common Property Resources**	Temples and 'Bijesthalis' - 11 "Puja Mandap" - 1 Crematoria structure - 1 Primary schools - 2 High school - 1 Anganwadi center - 4
10.	**Utility Shifting**	Water supply pipeline network to Burla and Sambalpur. Electric line Major roads - 2 nos.
11.	**Project Cost**	Cost of project is Rs. 590.00 Crores on 2016 price level.

E.6 ACTS, POLICY & INSTITUTIONAL FRAMEWORK:

Acts, policies & institutional frameworks of the Govt. of India, Govt. of Odisha as well as relevant safeguard policies of the World Bank were reviewed for preparation of the Environmental and Social Management Plan and the Resettlement Action Plan.

The relevant Acts, Policies, Legislations and Guidelines applicable to the project pertaining to the Environmental and Social safeguard are stated below in Table E-2.

Table No. E-2: Relevant Acts, Policies, Legislations and Guidelines applicable to the project

Acts, Policies and Notifications	Key requirement	Applicability	Type of permit and stage of applicability	Administrative Authority and indicative time frame for grant of permission	Responsibility
Environment Protection Act 1986	To protect and improve overall Environment.	Applicable	Environment Clearance	MoEF&CC, six months (Considering one season data as per approved TOR)	SPMU/IA (Chief Engineer and Basin Manager, Upper Mahanadi basin, Burla)
EIA Notification 14th Sep 2006 And amendment till date	To protect and improve overall Environment. Requires prior environmental clearance for new, modernization and expansion projects listed in schedule 1 of EIA Notification, 2006	Applicable	Environment Clearance required for the construction of the additional spillway	MoEF&CC, six months (Considering one season data as per approved TOR)	SPMU/IA (Chief Engineer and Basin Manager, Upper Mahanadi basin, Burla)
		Applicable	Environment Clearance at the Construction stage for borrowing earth, query for stone & sand as applicable	SEIAA /DEIAA during construction phase 3months	Contractor
Air (Prevention and Control of Pollution) Act, 1981, 1987	An act to prevent and control Air pollution	Applicable	Consent to Establish (CTE) & Consent to Operate (CTO) for Batching plant & stone crushers	SPCB Govt. of Odisha during establishment of Batching plant & stone crushers 3 to 4 months	Contractor
Water Prevention and Control of Pollution) Act, 1974, 1988	An act to prevent and control water Pollution.	Applicable	Consent to Establish &Consent to Operate. for Batching plant & stone crushers	SPCB Govt. of Odisha during establishment of Batching plant & stone crushers 3 to 4 months	Contractor
Noise Pollution (Regulation and Control Rules) 2000 and amendment till date	Ambient Noise Standards for different areas and zones	Applicable	No permits issued under this act. However the Contractor has to comply with the standard limits during construction	SPCB Govt. of Odisha	Contractor

Acts, Policies and Notifications	Key requirement	Applicability	Type of permit and stage of applicability	Administrative Authority and indicative time frame for grant of permission	Responsibility
Hazardous & Other Wastes (Management And Trans-boundary Movement) Rules, 2016	Protection to general public against Improper handling storage and disposal of hazardous Waste. The rules prescribe the management requirement of hazardous wastes from its generation to final Disposal.	Applicable	Authorization for storage and handling Hazardous waste	SPCB Odisha	Contractor
MSIHC Rules, 2000	Usage and storage of hazardous material	Applicable	No specific permit is required, however precautions defined under the material safety datasheets should be followed for use of hazardous substances (like paint solvents) listed under the schedules attached to this notification if any proposed to be used. Safety audit and other requirements should have to be complied if storage quantity exceeds the regulated threshold limit	-Do-	Contractor
Construction and Demolition Waste Management Rules, 2016	To manage the construction and demolition waste	Applicable	Approval required from local authorities, if waste generation is >20 tons in a day or 300 tons per project in month	SPCB Odisha	contractor
Plastic waste Management Rules, 2016	To manage the plastic waste generated	Applicable	No authorization to be obtained. Waste Management and Minimization to be done. Fee to be paid to local bodies, if applicable	SPCB, Odisha	Contractor
The Batteries (Management and Handling) Rules 2001	To regulate the disposal and recycling of lead acid batteries	Applicable	No specific registration Required. Compulsion to buy and sale through Registered vendor only	-Do-	-Do-

Acts, Policies and Notifications	Key requirement	Applicability	Type of permit and stage of applicability	Administrative Authority and indicative time frame for grant of permission	Responsibility
The Forest (Conservation) Act, 1980 and amendments The Forest (conservation) Rules 1981 and Amendments till date	To protect forest by restricting conversion of forested areas into non-forested areas and deforestation	Applicable	Forest Clearance / Permission for tree cutting.	Regional Office of MoEF&CC, State Forest Dept. 8 to 10 months	Chief Engineer and Basin Manager Upper Mahanadi basin, Burla
Explosive Act 1884 & Explosive Rules, 2008	Safe transportation, storage and use of explosive material, blasting site and safe distance	Applicable	Permission for storage and usage of explosive	DC , Chief Controller of Explosives, Govt. of India 2 months	-Do-
Central Motor Vehicle Act 1988 and amendment Central Motor Vehicle Rules, 1989 and amendments till date	To minimize the road accidents, penalizing the guilty, provision of compensation to victim and family and check vehicular air and noise Pollution.	Applicable	No permit issued under this Act however the contractor has to ensure proper licence PUC, permits as required	Motor Vehicle Licensing Authority of the Region.- Regional Transport Officer	-Do-
The Gas Cylinder Rules 2004	To regulate the storage of gas / possession of gas cylinder more than the exempted quantity	Applicable	License to store gas cylinder more than the regulated quantity.	Chief Controller of Explosives, Govt. of India	Contractor
Building & Other Construction workers (Regulation of Employment & Condition of Service)	To regulate the employment and condition of service of building and other construction workers and to provide for their safety, health and welfare measures	Applicable	Obtaining labourer licence	Dist. Labour Commissioner	Contractor

In addition to the above Acts and Rules, the Contractor has to comply with the various Labour Rules such as Factories Act, 1948; Employees State Insurance Act, 1948; Workmen's Compensation Act, 1923; Minimum Wages Act, 1948 The Inter-state Migrant Workmen (Regulation of Employment and Conditions of Service) Act, 1979 , etc.

Safeguard policies of the World Bank were also consulted in regard of the Environmental and social Management Considerations.

Relevant World Bank Safeguard Policies are mentioned below.

Sl.No.	WB Safeguard Policies	Objective & Purpose	Applicability
1.	**OP/BP-4.01** Environmental Assessment	The objective of this policy is to ensure that the Bank financed project is environmentally sound and sustainable.	Triggered
2.	**OP/BP-4.04** Natural Habitat	The policy prioritizes conservation of Natural Habitats for long term project sustainability. The Bank therefore expects the Borrower to suggest appropriate measures for protection maintenance and rehabilitation of Natural Habitats in the study report.	Triggered, while no endangered species are found in the project area, however, there maybe potential substantial loss of ecological functions provided by trees that will be cut during the construction process. the EMP has provision for afforestation and mitigation measures.
3.	**OP-4.36** Forestry	The policy gives importance to restoration of forest eco-system, which entails management and conservation methods of forest flora fauna and wildlife. Since a part of the RF is likely to be affected, the Bank expects that these aspects need to be included in the report along with proposal to restore forest health and welfare of the indigenous people who are dependent on forest produce.	Triggered. Since construction of Additional Spillway at Hirakud Dam will involve diversion of 9.441 hectare of forest land. It will involve removal of around 3600 trees and a EMP will include afforestation of double the number of trees.
4.	**OP/BP – 4.37** Safety of dams	The policy enforces adequate measures for ensuring safety of dams during its life cycles.	Triggered as it is additional structure of the existing dam and has been covered under dam break analysis
5.	**OP/BP – 4.12** Involuntary displacement and resettlement	The policy objective is to avoid involuntary displacement and resettlement as far as practicable by exploring viable alternatives. It also emphasizes approach to improve the living standards of the displaced people, encourages community participation in implementation of resettlement activities and provide assistance to the affected people regardless of their legal status on title of the land.	Triggered as project envisage displacement of squatters (716 households); all are non-title holders
6.	**OP 4.10** Indigenous People	The policy aims at restoring the rights and cultural dignity of the indigenous people while ensuring receipt of proper social	Triggered, Among the affected population few

Sl.No.	WB Safeguard Policies	Objective & Purpose	Applicability
		and economical benefits.	numbers of tribal have been recorded. Tribal development plan has been prepared for affected tribal group.
7.	**OP N 4.11** Cultural property	The policy emphasizes preservation of cultural property in the project area, restoration of archaeological monuments and unique environmental features.	Not Triggered, No archaeological site or unique environmental features is located in the project area. However 11 nos. of temples, 1 crematoria building will be affected.
8.	**OP 4.09**	The policy helps manage the effect of pests on agriculture and health and provides support to strategies which promote the use of biological or environmental control methods and reduces reliance on synthetic chemical pesticides.	Triggered. It is envisaged that no pesticide will be procured under the project and only chemical treatment which is a practice during forest management in India will be carried out. However, in the interest to ensure no pesticide is use, the policy is triggered.

E.7 BASELINE ASSESSMENT OF ENVIRONMENTAL COMPONENTS:

Baseline survey was carried out in the study area of the sub-project to establish the existing environmental and social status. This included the study of Physical, Biological and Socio-economic environment in and around the project study area. It also included collection of Secondary data such as Topography, Geology, Meteorology, Seismicity and Flora, Fauna status. In the process of Data collection and compilation, DoWR records were consulted, information obtained from Dam Safety Organisation, Hirakud Dam Authorities, some credible Organisations of the State and Central Government and Literature Consultations.

E.7.1 The Study Area: The study area covers core zone and zone of influence.

The core zone covers the area involved for construction of dykes, spill way and spill channel which is confined to 170m on either side from the centre line of the proposed alignment of the spillway, approach channel and spill channel. The influence zone of the project for monitoring of environmental parameters such as air, water soil, etc is described with River Mahanadi flowing West to East direction forming the southern boundary while the Hirakud dam forms the western and northern boundary and the eastern boundary is demarcated by a line 500m from centre of the spill channel, whereas for the wildlife sanctuary the zone of influence is considered 10km from the centre of the spillway.

The study included analysis of physical, ecological and socio-economic environment to establish the baseline environmental conditions in and around the project area and the likely impacts on these components due to the projects.

E.7.2 Summary of Baseline Data:

Some of the baseline information / data considered for environmental and social impact assessment are summarised below.

LAND ENVIRONMENT:		
1.	Physiography	The topography of the study area exhibits undulating features; the highest elevation is around 278m AMSL over hill ranges and gradually sloping to the minimum at 160m AMSL.
2.	Seismicity	The project area comes under seismic zone III which implies influences as moderate damage risk zone.
3.	Land use	The study area exhibits 19.76% of land as settlement, 60.87% as agricultural land, 12.06% as forest cover, 5.07% as plantation area and 2.22% area exhibits small water bodies.
4.	Soil quality	Soil sampling was done at Gandhi Nagar and Bahadurpada. The soil type is slightly acidic, pH varying from 6.1 to 6.4 with moisture content 13-14%. The conductivity ranges between 114.6 to 169.7micro mho/cm. The N, P, K contents remain at healthy standards.
5.	Land erosion	There is moderate to low land erosion seen around the denudated hill ranges of Gandhi hillock.
6.	Meteorology	Rainfall: Normal Annual Rainfall is 1415.1mm. The maximum rainfall recorded in year 2012 as 1964.7 mm. Temperature: The observed maximum temperature during the study period was 44^0C (2016) and minimum 25^0C. The average maximum temperate is 45^0C in May and average minimum temperate is 10^0C in Dec. & January. Relative humidity: The observed maximum relative humidity was 68% and the minimum is 35%.
7.	Hydrology	The study area features two streams which becomes responsible for draining the area effectively. The major stream is river Mahanadi across which the dam is constructed. The area in the south of the Gandhi Hillock is found to be well drained with S-W slope leading to Mahanadi River. The probable maximum flood of Hirakud dam with peak value is estimated to be 69632 m^3/sec
AIR QUALITY		
8.	Air Quality	Ambient Air Quality was monitored with respect to PM10, PM2.5, SOx, NOx, CO & HC at 4 locations around the core zone to assess the existing status of air quality in the area during the month of May - June, 2016.
		The particulate matter PM10 ranges between 71.22 $\mu g/m^3$ to 94.7 $\mu g/m^3$, PM2.5 ranges between 35.6 $\mu g/m^3$ to 54.9 $\mu g/m^3$, SO_2 concentration ranged from 4.7 $\mu g/m^3$ to 11.1 $\mu g/m^3$, NO_X ranged between <9 $\mu g/m^3$ to

LAND ENVIRONMENT:		
		14.1 μg/m^3. All the parameters are within the maximum permissible limit.
NOISE LEVEL		
9.	Noise Level	Noise level monitoring was done at 4 locations, near the Air Monitoring stations. These monitoring stations are located in residential areas. the day time noise limit varies from 42.1 dB (A) to 51.4 dB (A) and the night time limit ranges between 35.2 dB (A) to 45.3 dB (A).
		The observed noise levels are well within the prescribed ambient noise level standards.
WATER ENVIRONMENT		
10.	Surface Water quality	Surface water samples were taken from 5 locations; of which 3 no. are from Ponds and one from Reservoir on upstream and one at downstream of the Mahanadi river (proposed spillway).
		Chemical analysis of surface water conducted for 22 parameters which are furnished in Table No. C4-19 reveal that the water quality conforms to the tolerance limit under IS:2296 and considered as "Class C" of Use based classification.
11.	Ground Water quality	Two nos. of groundwater samples were analysed i.e., one hand pump near Nilakantha Temple and the other near the office campus.
		Chemical analysis of groundwater was conducted for 28 parameters which is furnished in Table No. C4-18. The result reveal that water quality conforms to IS:10500-2012 at desirable limit.
12.	Groundwater level	The pre-monsoon ground water level in the project area was found to be 3.15m BGL.
13.	Sediment Quality	To determine sources of heavy metals and pesticides in sediment sample was collected from the periphery of the reservoir and was analysed. The test results revealed that the sediments carry negligible amount of heavy metals and pesticides.
14.	Drainage pattern	The major River is Mahanadi across which the dam is constructed. The study area features two local seasonal streams which becomes responsible for draining the area effectively. The area in the south of the Gandhi Hillock is found to be well drained with S-W slope leading to Mahanadi River.

BIOLOGICAL ENVIRONMENT		
1.	Forest cover and Biodiversity	The proposed spill channel pass through Lamdungri Reserved Forest is located on the hill having an area of 490 Ha. This is a scrub and degraded forest with scanty vegetation. The predominant tree species are Mango, Neem, Chakunda, etc The project will require diversion of 9.441ha of forest area from this Reserved Forest located in Sambalpur Forest Division.
		The floral population in the project alignment does not include any endangered or threaten tree species.

		No Schedule-1 species of wild animals found in the area. However, snake, monitor lizard, mongoos, etc are observed.
		About 23 bird species were noticed during the study. List furnished in Table No. C4-28. These are all local species and none of them attract the Schedule-1 category. No migratory birds are reported in the proposed area.
		Common fish species like Kau, Balia, Magura, Todi, etc are observed in local ponds.
2.	Location of eco-sensitive areas	There is no wildlife sanctuary or Biosphere Reserve in the study area. The nearest wildlife sanctuary is Debrigarh Sanctuary, which is located at 13.0km away from the project at its western direction. There bis no migratory route of wild animals located in the project area.
SOCIAL ENVIRONMENT		
1.	Affected families	A total of 716 households settled in 7 habitations of Hirakud are going to be affected which are Gandhinagar, Gujatal, First gap colony, Laxminagar, Re-rolling colony, Cable Colony and Prem Nagar. Demography profile of these PAPs, as assessed during survey, has been summarised in para 4.5.1 of Chapter 4 of the EIA report.
2.	Archaeological monuments	There are no Archaeological monuments or historical importance places found within 10 kms from Hirakud dam.
3.	Cultural features	There exist one or more temples in almost every village. There are about 11 temples and 'bijesthalis', 5 holy grooves and a "puja mandap" located in the study area. One Crematoria is recently built from benevolent fund alongside of river embankment towards the Mahanadi river. This structure is falling within the proposed alignment of spill channel near confluence point of proposed spill channel and river and will require relocation. There are 2 primary schools, 1 high school and 4 numbers of Anganwadi centers located within the study area which will be affected due to the project
4.	Infrastructure	Two major road connections from the nearby habitations to approach the Dam proper will be cut off by the proposed spill channel. A water treatment plant is located at about 150 m towards right hand side of the proposed spill channel in Taranagar which is connected with drinking water supply network for Hirakud/ Burla and Sambalpur Towns. This pipeline network may get affected due to this project implantation.
5.	Livelihood	Agriculture is the main source of livelihood for the affected population. 14 Households depend on Agriculture who use to

		cultivate vegetables and sale in nearby urban area. Though the proposed project displacement area is situated in a very close proximity of the Dam, still no household is going to be affected of fisherman category who use to depend on fishing for their livelihood.

E.8 STAKEHOLDERS AND PUBLIC CONSULTATION:

- During the process of baseline assessment, formal and informal discussions were held with Govt. officials and individuals of the project affected locality, including women and tribal inhabitants.

- **Stake holders for EIA study were identified and indicated in the Table below.**

Stake-Holders		
Central Government Organisation [GoI]	**State Government Organisation [GoO]**	**Local Public**
• Central Water Commission(CWC) [for CPMU/MoWR] • Dam Safety & Rehabilitation of Projects (MoWR) • Designated consultants of CPMU (EGIS)	• Water Resources Department(SWRD) • Dam Safety Organisation • Forest and Wildlife Department • Public Health Department • Revenue Department(District Collector, RRO and Tahsildar) • Local Municipality authorities • Local village committees,	• Inhabitants of project influence area around proposed project • Project affected persons • NGOs & Nagarik committee • Fisheries cooperative society

E.8.1 Issue Discussed:

Some significant issues linked to the project were discussed with stakeholders in several meetings. Issues which have environmental and social concern are mentioned below.

- Intensity of rainfall and recording mechanism of inflow in to Hirakud reservoir.
- Downstream flooding problems during release of excess flood from Hirakud dam.
- Locational as well as structural aspects of the proposed left bank additional spillway.
- Reservoir operation and alarm system
- Environmentally sensitive features in the vicinity
- Local issues arising out of submergence
- Resettlement of displaced people
- Tourism development prospects
- Construction related issues

Sl.	Issues Raised	Stakeholder consulted	Issues Raised/Suggestions	Addressal
1.	Disruption of utility services	Project authority, Public Health Engineering Organisation and water users.	Disruption of utilities and services as the Proposed channel will intersect the supply line Relocation of water supply pipeline and other utilities	The existing pipeline and electric poles will be relocated at project cost. The Dam Authority will deposit the estimated amount to the line department for relocation and will provide all necessary support in facilitating the relocation process.
2.	Damage to the existing road network and closure of the area on the other side of the channel	Project authority, local people and consultant.	Re-linking of approach road to Gandhi Minar disrupted by Spill Channel.	Agreed to construct a bridge across spill channel prior to cutting of the road and construction of channel in the affected location.
3.	Impact on Temples and Crematoria	Project authority, consultant and local inhabitant	Local residents raised the issue of impact on temples and crematoria and requested to shift this structure in the adjacent land before construction of channel to avoid interference with rituals and inconvenience to the user community.	Project authority agreed to shift all the affected temples and crematory to the adjacent area beyond proposed channel in consultation with the local people/user community
4.	Fishery in dam	Fishing community, Representative of Fishery Co-operative society, Chief Engineer, SE, representatives from WB, EGIS and CEMC	The Fishery Cooperative Society representative informed that there are 10 Fishery Cooperative Society involve in fishing from Hirakud Reservoir, but they do not have facility such as pond for fingerling development. They requested for provision of ponds for development of fingerlings in project land along the dam. They Society people gave their consent that they will maintain the pond if they are allotted the same It was also informed by the Fishery Department and the Fishermen Society the no fishing is done on the reservoir	The Chief Engineer, Hirakud Dam assured that they will explore the possibility to provide additional area for pond development within the Dam area.

Sl.	Issues Raised	Stakeholder consulted	Issues Raised/Suggestions	Addressal
			towards left dyke, near proposed area.	
5.	Disruption in Electricity supply	Junior Manager from electricity dept., Chief Engineer, SE, representatives from WB, Egis and CEMC	The department has to draw 11kv line along the bridge or supply electricity from Burla side supply to Gujatala, Gandhinagar etc. If supply from the Burla side then a transformer will be needed. So as alternate arrangement they can provide electric supply to villages from both sides.	
6.	Wildlife movement The excess of earth material and top soil after utilization	DFO, Sambalpur, Chief Engineer, SE, representatives from WB, Egis and CEMC	No wildlife from Debrigarh sanctuary approaches Hirakud Dam. The dug up earth from spill-way should not be dumped on forest land. The excess of earth material and top soil after utilization by project can be dumped at nearby places of degraded forest in consultation with forest department, so that the earth material can be utilized by forest department at a lesser cost for plantation purpose in the degraded forest. Forest dept. expressed their interest to take top soil for thier use in plantation	The Dam Authority agreed to provide surplus top soil if the Forest Department is interested to take the soil for development of the degraded forest area in the Lamdungri Reserve Forest area. The site for dumping of the top soil will be given by the Reserved forest for the quantity they intent to use.
7.	Compensation for the house, structure and property	Affected person of the area	They were interested to know the compensation package and the project authority describe that the package will be disclosed after finalization of the package by the state govt.	All the affected persons are squatters and fall under Non-titleholder Category. The Project Authority informed the people that they have already appointed Consultant for SIA study and preparation of R&R Policy which will require approval of the State Government. The affected persons will be compensated according to the R&R Policy.
8.	Pollution	Affected person of the area, Project authority and	The local people express their concern about the dust generation and	Periodical water sprinkling will be carried out in and around the proposed project alignment to curb the dust generation. This aspect has already

Sl.	Issues Raised	Stakeholder consulted	Issues Raised/Suggestions	Addressal
		consultant	deterioration of air quality in the area. They also inform that sometime they face air pollution problem in the area due to HINDALCO Factory. Dust generation during excavation, demolition and construction of spill channel	addressed in the EMP adequately.
9.	Public Safety/ Inconvenience during construction	Affected person of the area, Project authority and consultant	Issues raised by public regarding safety issues during construction activities. the project authority assured that all safety measures will be taken during construction and will be strictly monitored. Disruption of Public moment during construction as the alignment will cross the road. The project authority informed that a bridge will be constructed across the spill channel prior to the excavation activities in the road network to ensure uninterrupted traffic movement.	All safety arrangements such as hard barricading, delineators, Caution signboards, lighting etc, will be provided along the construction zone near habitation area. This has been addressed in the EMP and will be responsibility of the Contractor. The same will be strictly monitored. The public may complain to the Dam Authority if they find any incidence of lapsed through grievance redressal mechanism.

E.8.2 The Second Level Public Consultation:

The second Level Public Consultation meeting on Environmental Impact Assessment, Social Impact Assessment Reports and R&R issues of Proposed Additional Spillway Project of Hirakud Dam, Sambalpur was held on 26th September, 2017 at 10.00 A.M. in-front of Nehru Udyan, Gandhinagar as per the notification no. 550, dated. 11.09.2017 issued by office of the District Collector, Sambalpur. The meeting was chaired by Sri Trilochan Majhi, Additional District Magistrate, Sambalpur and representatives from various organizations such as District Administration, Department of Water Resources, Hirakud Dam Project, State Pollution Control Board, Police Department, Sambalpur Municipal Corporation, Public Works Department, EGIS Expert Consultant, Odisha Construction Corporation Limited, Centre for Envotech and Management Consultancy Pvt. Ltd. were participated along with Public representatives/ Local leaders, Project Affected Persons and media representatives.

The meeting was started by the welcome address of Chief Engineer and Basin Manager and he briefed about the need of the project with its technical aspects. ADM, Sambalpur, described the audience about the purpose of the Public Consultation. This is followed by explanation regarding World Bank's policy, requirement by Dr.Surjit Singh Dipak, Egis. The representatives from CEMC Pvt. Ltd. explained about the Environmental and Social Impact due to the project. The R&R package for project affected persons was explained by special LAO, Sambalpur.

The Project Affected Persons were given a chance to raise their doubts and queries after detailed deliberation by administration. Some of the issues raised by the public are related to technical matter where as rest are of social nature. The issues were clarified by Chief Engineer and officials from district administration.

The proceeding of consultation meeting and list of the members present in the meeting are given in the Annexure -6.2.

E.9 ANTICIPATED IMPACTS ON VARIOUS ENVIRONMENTAL COMPONENTS:

Environmental impacts due to various project components were predicted concerning three important phases of project cycle; namely the pre-construction phase, construction phase and operation phase. Some significant impacts predicted in each of those phases are briefed below.

Components	Location / Activities	Anticipated Impacts	Mitigation Measures
PRE-CONSTRUCTION PHASE			
Land acquisition (Forest land)	Lamdungri RF across the spill channel alignment	• Change of landuse • Landscape degradation • Loss of forest, flora, fauna	• To Carryout plantation on Non forest open land as per approved C.A. Plan
Land acquisition (Govt. land)	Land for other project requirements such as Borrow area, Dumping yard, Approach road and labour colony	• Landscape degradation • Affects natural drainage • Contamination Water of existing surface water and groundwater sources	• Ensure implementation of the approved RAP/payment of compensation • Removal of debris through contract agencies • Avoid effluent discharge as well as solid waste disposal from the work site either to the reservoir water body or to Downstream of river. • Cement Slurry, lubricants, oils contained in the wash water (Curing) should be

Components	Location / Activities	Anticipated Impacts	Mitigation Measures
			primarily led to a sedimentation pond before leading it to the water body.
Resettlement and rehabilitation	Shifting of habitations (Parts) adjacent to left side of Hirakud Dam, affected due to submergence and construction activities.	• Displacement of population • Loss of property-livelihood • Dismantling of private, Govt. and religious structures, public utilities etc. • Socio-economic disturbance of indigenous community, vulnerable people.	• Float Notices to Owner agencies well ahead of dismantling action • Ensure evacuation of occupants and shifting • Involve district administration for maintaining law & order situation • Compensation and payment and other benefits will be made as per RAP
Utility Shifting	Social infrastructure • Temple • Cremation structure • Water works	• Affects religious and cultural rights of people • Disruption in potable water supply, electricity	• Moderate social Impacts (till relocation) • disruption of services like water supply, traffic movement, electricity, • Hirkund water supply line will be realigned before start of construction to ensure continued water supply
CONSTRUCTION PHASE:			
Excavation: Blasting Quarrying Borrowing of earth	For new spillway, spill channel and earth dam structures	• May affect air quality and noise level for a temporary period during construction • Generation of solid waste (Muck) and safe muck disposal • Land erosion- land degradation • Increased traffic intensity • Public health and safety concern.	• Air pollution control measures to be followed • Ensure use of PUC vehicles • Dust generated during operation of heavy excavators should be curbed by water sprinkling • Other plants, machineries & Equipments are to be maintained properly to prevent high noise level • Demarcate the 'No Entry' boundary by flagging so as to avoid any likely accidents • Displays Signboard / Warnings • Strictly adhere to the recommendation blasting time (i.e. before sunrise and after sunset) so as to avoid public inconvenience • Organise awareness programme on blasting effects precaution measures and environmental resource management. • Organise periodic health camps • Ensure supervision of

Components	Location / Activities	Anticipated Impacts	Mitigation Measures
			blasting activities by experts. • Approved Quarry area should be operated only after obtaining appropriate authority. • : blasting wherever required shall be controlled blasting, Blasting timing will be pre notified to the public. Area will be cordoned off before blasting to ensure safety of people and workers. • Borrow areas will be rehabilitated after use. Prior Environmental clearances shall be obtained its before use. •
Use of • Heavy machineries • Heavy pumps • Concrete mixers • Batching Plant	Work site - Plant Site	• Air pollution (dust generation) • Noise pollution (Running period) • Surface water quality • Soil pollution.	• Adopt Air Pollution Control measures like water sprinkling • Limit hours of quarry activities to prevent public inconvenience • Use barriers & signals to reduce public exposure to blasting (if any) • Plants, Machineries & Equipments should be handled properly to minimize dust generations high noise • Green belt development around quarry and crusher site • Deploy PUC vehicles • Ensure providing safety gadgets to workers & Safe working environment • Organise health camps at periodic intervals.
Transport of materials and haulage of machinery	Work site - Use of vehicles and machineries	• Increased traffic intensity • Air pollution (Dust) • Workers and local people exposure	• Dust generated during operation of heavy machineries should be curbed by water sprinkling • Machineries & Equipments are to be maintained properly to prevent high noise level • Avoid plying trucks on village roads / populated areas. • Install speed breakers on road • Trucks may be covered with

Components	Location / Activities	Anticipated Impacts	Mitigation Measures
			tarpaulin during the carriage. • Ensure routine maintenance of transport vehicles
Material handling and storage	Stacking yards Storage godowns	• Landscape degradation • Soil pollution • Pollution of water quality • Obstruction to land drainage	• Dust generated during material handling should be curbed by water sprinkling • Use separate storage stacks / Bins for different construction materials like sand, metal, chips & steels etc. • Provide lined drains between the stacks to collect rainwater which are to be connected to a sedimentation pond before released to natural drains.
Hot mix plants	Batching plant for concrete mix	• Affect air quality and noise level • Soil pollution • Workers and local people exposure	• Locate the Plant at higher elevation & away from movement of labour force, operational staff • Limit the hours of operation to minimize exposure • Prevent spreading of plant washouts on land • Effluents should be collected in still ponds; treated & then recycled for road sprinkling purpose • Prior consent shall be obtained from SPCB
Debris disposal	Dumping yards Stacking areas	• Landscape degradation • Obstruction to land drainage • Water quality pollution	• Dust generated during operation of heavy excavators should be curbed by water sprinkling • Other plants, machineries & Equipments are to be maintained properly to prevent high noise level • Ensure Air Quality monitoring • Dump Solid wastes in specified dumping areas to minimize Contamination of water. • Provide drainage for waste water through collection ponds. • Project all ground water extraction well if located nearly • Avoid plying trucks on village roads / populated areas. • Install speed breakers on road • Trucks may be covered with

Components	Location / Activities	Anticipated Impacts	Mitigation Measures
			tarpaulin during the carriage. • Ensure routine maintenance of transport vehicles • Backfilling of construction areas to be taken up after construction is over • The waste disposal area is to be levelled / graded • Plantation may be taken up • Select separate disposal sites for useful stones • All disposal will be made as per Construction and demolition debris waste management rule 2018
Labour camps Contractor's camps	Demarcated area for housing of the labour force and contractor camp	• Likely loss of green cover • Affects local ecology • Sanitation problems • Worker's health • water pollution	• Select location of camping sites away from the worksite as well as from the existing villages / Townships. • The contractor should maintain the labour camps properly by sheltering outstation labourers & their families; each camp to host around 50 (fifty) families to facilitate safe living. • Minimum requirement of Living by this imported labour force should be provided by the contractor so as to prevent conflicting issues with the neighbouring population/villagers. • The project authority, through the designated contractor, should ensure fulfilling the following requirements. (i) HEALTH FACILITY - Free medical check up - Supply of medicines, - Ambulance for shifting (ii) SANITATION FACILITY /CLEANER ENVIRONMENT - Provide temporary toilets. - Arrange for proper sanitation facilities, (iii) DRINKING WATER SUPPLY - Provide potable drinking water (iv) Supply of Electricity - Provide free electric supply for Minimum domestic use (v) SUPPLY OF FREE FUEL - Ensure supply of free fuel to each labourer family - Prevent collection of fuel

Components	Location / Activities	Anticipated Impacts	Mitigation Measures
			wood for cooking (vi) ENFORCING USE OF SAFETY GADGETS - Motivate the labourers to use protective footwear, Head gear, Ear Plugs and goggles etc while on duty during construction period. - Setup First-Aid Centre at the worksite
OPERATION PHASE:			
Monitoring of pollution	• Water quality • Sediment quality • Groundwater level in the region	---	• Consistent monitoring, review of the constraint areas and resource management renders the implementation process safe and successful.
Maintaining safe operational mechanism	• Gate operation for excess flood release • Warning system	• Likely disaster due to downstream flooding • Loss of lives and property due to improper warning system.	• Improved mechanism to alert the D/S localities against likely flooding will help people to stay prepared. • Dam authorities (SWRD) will take steps for advance warning signals.

- **No direct impact is anticipates on aquatic flora and fauna of the river.**

E.10 ANALYTICAL FINDINGS FROM IMPACT ASSESSMENT:

- Environmental Impacts sectorized in Land Environment, Water Environment, Biological Environment were studied broadly for the implementation phase and Post Implementation Phases of this project.
- In the Implementation phase, most of the negative environmental impacts are site specific and relate to construction phase environmental components. Negative impacts of low severity such as soil erosion and soil pollution; Air Noise and water pollution; Drainage and water logging; Generation of construction spoils and their disposal; Transportation and traffic congestion; location of labour camps and Health problem etc. are viewed as Direct-short term-low impacts which are mostly Reversible in nature and does not severely affect the livelihood of the people.
- On the other hand; Impact on Flora, Loss of habitats and landscape degradation are viewed as short term but irreversible impacts of low severity.
- All the above components responsible for causing moderate social and environmental impacts are categorised as “Category-B” which can be mitigated easily with precautionary measures and standard mitigative methods.
- Environmental and Social components like Acquisition of forest land & Private land for project use, Displacement of population marked with loss of property loss of livelihood and Socio cultural bonding etc have long term, irreversible impacts which are of low serving in the instant case. These two components are categorized as “Category-A” whose impacts required specific management plan (such as Forest Diversion Plan & Resettlement Action Plan) and close monitoring of mitigation measures, proposed there in.

- Landscaping, tourism development and prospects of Fishery Development are positive impacts of the post-implementation phase besides the priority objective i.e. safety of Hirakud Dam.

E.11 MITIGATION MEASURES:

It has been established in the analytical review of components and their included impacts as in the previous paragraph that most of them are short termed, reversible and Low severity impacts, reasonably categorised as B-Category. These can be addressed through appropriate mitigation methods and precautionary procedure.

Such mitigation measures proposed for environmental and social impacts both for the implementation phase as well as for the post-implementation (Operation) phase are described in chapter-5 of this EIA report.

The various mitigation measures for air, water and soil pollution, as well as for other issues such as landscape degradation, increase in plying of vehicles and machineries, health safety are described in detail in chapter 5.

E.12 ANALYSIS OF ALTERNATIVES:

In the event of negotiating the PMF 69,632 cumsec, there would be urgent necessity to release the excess routed flood @ 27,182 cumsec through additional spillways to be constructed over and above the existing spillways and sluices of Hirakud Dam.

Without the project the safety is compromised at the time of flooding. So risk will rise if we don't give additional spill way. We have studied 2 alternatives for additional spill way; one is on top of Gandhi Hill Rock and the other is at the downstream of the hill, near existing left dyke.

- It is revealed from the Exploratory Drilling Operations conducted by GSI, that competent foundation strata are not available at the first identified location on the saddle, on Lamdungri forest.
- Suggested shifting of the spillway location 700 meters further upstream of the original spillway axis where suitability of foundation confirmed.

E.13 ENVIRONMENTAL MANAGEMENT PLAN [EMP]:

The Environmental Management Plan [EMP] has been framed on the basis of baseline data, components of the project activities and relevant mitigation measures. While it emphasizes effectiveness of managing the recommended mitigative measures it was necessary to identify credible organizations/agencies which could be made responsible to implement them properly. Budgetary support has been made intrinsic with the management items. Adopted mitigation measures against some significant environmental issues have been broadly discussed in chapter 7 of this EIA document. The EMP will be part of the Tender Document for contractors.

E.13.1 Environmental Monitoring Plan [EMOP]:

Monitoring being an effective tool for ensuring environmental quality in the project implementation, the EMF delineates Environmental & Social monitoring Plan [EMoP] as essential requirement.

Monitoring activities are proposed for (i) Construction phase and (ii) Operation phase till defect liability periods.

It is proposed to constitute one monitoring evaluation cell which would carry periodical monitoring of implementation of environmental safe guards. The cell will be headed by chief Engineer /Executive Engineer of implementing agency under whom the team leader an Environment Officer of PMC and EHS experts of the contractors will be working as the members of the cell. The contractor will be directly responsible for implementation of EMP at the site where as the PMC and the IA will be supervisory.

A summary table for EMoAP has been prepared showing Environmental indicators; frequency of monitoring; Responsible organisation and individuals which have been furnished in **Table No. C7-5** of Chapter 7 in this EIA report. The table may serve as a ready reckoner for the project management unit to facilitate decision making.

However the Monitoring format may further be improved, upgraded and modified by the Project Management Unit to suit the site specific requirements.

E.13.2 Environment Grievance Redressal Mechanism:

Effective environmental grievance redressal mechanism has been developed to receive the grievances from the concern public or other stake holders at the site during construction and to address the issue raised by different agency. The proposed mechanism on grievance redressal on environmental issues is described in Chapter 7.

E.13.3 Institutional Arrangement, Training & Capacity Building:

An environmentally complied sustainable project needs to have a competent organisation & Institutions support having trained personnel in the background. In this EIA study necessity for Training & Awareness programmes for capacity building has been emphasized. Although the State Water Resources Department (SWRD) is already positioned with efficient, experienced & skilled technical personnel; the state government may consider to impart adequate training for a screened group to be deployed for management of this specifically important Dam safety project of Hirakud Dam. A training module with monitoring Budget has been suggested with most probable time frame, contained in chapter 7 of this EIA document. The State Management Unit may improve or upgrade this as per site specific requirements.

E.13.4 Budgetary Support:

A cost estimate for amelioration of environment has been suggested with most approximate quantification and component wise expenditure. This estimate has also taken into consideration the probable expenditure on monitoring and capacity Building.

A budgetary provision of **Rs**. **600.667** lakhs or 60.06 Mn rupees has been made for implementation of environmental safeguards as stipulated in the EMP for different stages of the project.

CHAPTER-1
PROJECT DESCRIPTION

1.0 INTRODUCTION:

River Mahanadi, the sixth largest river in the peninsular river systems of India graciously flows 494 km in the North-Eastern part of Odisha state measured from its total traverse of 851 km from its origin to the outfall point at Bay of Bengal. In its basin area of 65,628 sq km in Odisha State, the river influences development scenario of 23 districts, 7 nos. in full and 16 nos. in part. The River Mahanadi being the lifeline of the state carries sacred feelings for the people of Odisha.

1.1 HIRAKUD DAM ON RIVER MAHANADI:

In the early fifties of twentieth century the Union Government has taken a giant stride to construct the Hirakud Dam Project across river Mahanadi in Sambalpur district of Odisha state. Aligned with multipurpose objectives this huge river valley project has headed the development achievement of the Country in the early years of post independence. Hirakud Dam, the largest ever earth dam in Asian sub-continent thus became operative in 1957 and was dedicated to the people on 13th January by Pandit Jawaharlal Nehru, the then Prime Minister of India.

Despite delivering the multipurpose benefits since last 58 years of its operation; the Dam is not free from safety apprehensions considering a situation when the reservoir at FRL suddenly gets stressed with sudden flood impinge from its upper catchment due to an unwarranted post monsoon storm rainfall. It was a long felt need to implement appropriate safeguard measure.

To understand such a critical occurrence, it would be rational to broadly discuss the Basin features of Mahanadi Basin, Reservoir operation procedure and approach for releasing a worst Probable Maximum Flood (PMF).

1.1.1 Mahanadi Basin in Brief:

Basin features

- River Mahanadi, an east flowing river originates at an average elevation of 442m (above MSL) in Bastar Plateau near Pharasiya village of Raipur district in Chhatishgarh state.
- Mahanadi Basin, is encompassed within geographical co-ordinates 80^0 30’ to 86^0 50’ (East) longitude and 19^0 20’ to 20^0 35’ (North) latitude. It is physically bounded by central hills in the North, Eastern Ghats in the South, Maikala Hill range in the west and Bay of Bengal in the East.
- The River traverses a total distance of 851 kms and outfalls into Bay of Bengal. It covers a distance of 357 km in Raipur & Bilaspur districts of Chhatishgarh state and balance 494 km in the State of Odisha.
- During its long traverse, it drains large areas of Chattishgarh, Odisha and comparatively small areas of state of Bihar and Maharastra. Thus it makes the river basin an Inter-State System.
- The State-wise watershed area and percentage interception are shown below.

State-wise coverage of drainage area*

Sl. No.	State	Area in Sq. km.	% total Basin
1	Chhattishgarh	75,136	53.24
2	Odisha	65,628	46.50
3	Maharashtra	238	0.17
4	Jharkhand	132	0.09
	Total	1,41,134	100

* * *Source 3rd spiral study Report of Mahanadi Basin*

- Mahanadi Basin in Odisha accounts for 65,628 sq km i.e. 46% of the total basin area & 42.14% of total Geographical area of Odisha.
- The Geographical Co-ordinates are 82^0 03’ 54” to 86^0 48’ 56” (East) Longitude and 19^0 15’ 57” to 22^0 31’ 46” (North) Latitude.

- The Basin spreads over 23 districts out of 30 districts of Odisha.
- Out of the 14 nos. major tributaries of River Mahanadi; 3 nos. lies in Odisha state namely Ong & Tel on its right and IB on its left directly outfalls into Hirakud reservoir.

Surface water potential of the Basin

- Out of the total catchment of 141134 Sq Km; the catchment area up to Delta Head is 1,32,100 Sq Km where as the balance 9034 Sq km lies in Deltaic Plane.
- Computation of Run-off upstream of Hirakud Dam has been made by using weighted Rainfall data and runoff details in the standard computer modelling.
- Virgin flow of entire Mahanadi up to Delta head is 75833 Mm^3 as annual average and 60475 Mm^3 as 75% dependability. These are further moderated according to utilization factors.
- Inflow to the Hirakud reservoir is gradually reducing every year due to multi sectional utilisation in the upstream by the ever increasing development projects by Chhatisgarh state.
- As assessed by NWDA (2000), the present water availability to Hirakud reservoir from the upper catchment has been reduced to 40,586.87 Mm^3 at 75% dependability.

Flood and Drainage:

- Mahanadi basin is mostly subjected to Cyclonic storms moving from Bay of Bengal to NW direction i.e. opposite to the direction of river flow. As such the river often experiences high to very high floods beyond rational estimation.
- Flood management in the Mahanadi Basin has since being considered in two distinct reaches namely Upper Mahanadi and Mahanadi Delta having intercepting catchments 1,32,100 sq. km. and 9034 sq. km. respectively. Flood problems are not significant in the Upper Mahanadi reaches.
- Considering devastating effects of several historical flood events in Mahanadi River; the Union Government have planned construction of Hirakud Dam in 1948 with its principal objective as flood absorption followed by controlled release.

1.1.2 Salient Features of Hirakud Dam:

(A) Location:

- Geographical co-ordinates (at midpoint of Axis) — Latitude 21^0 32' 00" (North), Longitude 83^0 52' 00" (East)
- Locality : In Hirakud NAC, about 15 km west from Sambalpur Town.

(B) The Hirakud Dam:

- Catchment intercepted by Hirakud Dam = 83,400 km^2
- Maximum Annual Run off = 9.09 M. Ham (yr 1961)
- Minimum Annual Run off = 1.133 M. Ham (yr 2000)
- Length of Dam = 4800m+Dykes = 24,896m [i.e. 9337m (L)+10,759m(R)]
- FRL = MWL = EL 192.024m
- Top width of Dam = 9.14m
- Dam top Elevation =El 195.68m
- Height above Deepest foundation level = 60.96m

- **Reservoir Capacity & water Spread:**

Storage	Elevation (In m/ft)	Capacity (In M. m^3)	Water Spread area (in sq km)
Gross storage	FRL/MWL/192.024m/ 630ft	8136 Mm^3(yr 1957) 5896 Mm^3 (yr 2000)	743 sq km
Dead storage	DSL 179.83m/590ft	2318 Mm^3 (yr 1957) 1073 Mm^3 (yr 2000)	274 sq km

Live Storage	FRL 192.024m	5814 Mm^3(yr 1957) 4823 Mm^3(yr 2000)	743 sq km

- **Existing Spillway & sluice gate details:**
  Type: Solid Gravity type with Ogee profile & sky-jump bucket
  Discharge capacity : 42450 cumsec (15 lakh cusecs)
  Crest elevation of Spillway : EL 185.298m (RL 610 ft)
  No. of crest gates : 34 Nos. (Each 15.54m x 6.10m)
  No. of Sluice gates : 64 Nos. (Each 3.658m x 6.20m)
- **Canal System:**
  No. of head Regulators provided in the Dam = 3 Nos.
  Bargarh Main Canal (L) Design Discharge Q = 108.16 m^3/sec
  Sason Main Canal (L) Q = 17.82 m^3/sec
  Sambalpur Distributary (L) Q = 3.59 m^3/sec

C. Construction Background:

Dam construction undertaken by : Govt. of India
Starting date of Construction : 12th April 1948
Completion date : 13th January 1957
Period of Construction : 9yrs 8 months
Name of Design agency : CWC/MoWR (Govt. of India)
Date of first full impoundment : 15th Oct, 1958.
Major accidental Events : No records of Major accidental events [As per DOWR records]

D. Ownership:

Overall Ownership - Department of Water Resources (DoWR), Govt. of Odisha
Operation & Maintenance - Department of Water Resources (DoWR), Govt. of Odisha
Safety of Dam - Department of Water Resources (DoWR), Govt. of Odisha CE Dam safety Organisation (DoWR).

1.1.3 Designed Multipurpose Benefits:

Some of the key benefits envisaged at the planning stage are mentioned below.

i) Irrigation: (Designed Potential)

Gross command Area (GCA) = 1,81,376 ha
Culturable Command Area (CCA) = 1,59,106 ha
Annual Irrigation Potential = 2,67,491 ha
[Kharif 1,59,106 ha + Rabi 1,08,385 ha]

ii) Hydropower Generation:

Power Dam Location : Below Right abutment of Dam
Penstocks (7 nos.) : 5 Nos. each 7.6m dia and 2 Nos. each 6.1m dia
Power house location : Located at the toe of the Power Dam at the right flank
Generation of Power : Installed capacity 347.86 MW

iii) Domestic/Municipal/Industrial water supply:

Annual Quantum of water (U/s reservation) = 11.414 Mm^3
Benefited population = 2,72,200 Nos.

iv) Flood Protection:

Flood protected Area (up to Mundali, Cuttack District) = 9,50,000 ha

v) Tourism & Recreation facilities provided:

Gandhi Minar (Left) Jawahar Minar (Right),
Jawahar Udyan & Hirakud Reservoir itself with panoramic excellence.

1.2 JUSTIFICATION OF THE PRESENT PROPOSAL:

Hirakud Dam project made operative since 1957 has been successfully delivering benefits according to its multipurpose objectives. In these preceding 58 years span, the engineers of the Dam Management unit have effectively manoeuvred the river floods during the monsoon as well as during many unwarranted storm rainfall events in the upper catchment. The operative tool used to control the reservoir levels is the reservoir working table/Rule curve designed by the Central Water Commission (CWC).

The spillway gates and the sluice gates were operated in such a way that the maximum outflow from the reservoir does not cause severe flood havoc in the deltaic plains downstream of the river.

But over these years of effective flood control management there were several occasions of safety concern when due to heavy post monsoon precipitations in the upper catchment, the Hirakud Reservoir got stressed with sudden impinge of huge floods while it stood at its maximum designed water level (MWL at 630 ft).

To this effect, there was necessity to review the inflow design flood initially worked out at the planning stage for Hirakud Dam Project.

1.2.1 Review of Design Flood:

In 1952, a returned period of 500years, PMF was computed by CWC at 15.00lakh cusecs for Hirakud, which was adopted for designing the spillway capacity.

Later, In 1997, the Central Water Commission (CWC) with the help of Dam Safety Review Panel (DSRP) and engineers from the State Government have rationally considered all the past major storm events and adopted latest techniques to compute the PMF for Hirakud Dam.

The peak of the computed flood hydrograph read 69632 m^3/sec (i.e. 24.60 lakh Cusec) with corresponding volume of release as 16800 Mm^3 (13.59 Million Acre feet). This PMF value at 69632 cumsec was recommended by the DSRP as the Revised Design Flood for Hirakud. **Annexure-1.1**

1.2.2 Revised Hydrology & its Consequences:

The design flood has been subsequently revised and a Project Maximum Flood (PMF) with a peak value of 69632m^3/sec was accepted by the CWC. The consequence of a revised PMF of 69632m^3/sec appeared to be alarming, considering the existing spillway discharging capacity.

Table 1.1: Discharge Quantity through different gates of Hirakud

Particulars of Release	Discharge Quantity
Discharge through 64 Nos under sluices of the dam	26,885m^3/sec
Discharge through 34 Nos spillway radial gates	15,565m^3/sec
Total Discharging capacity	42,450m^3/sec
Anticipated PMF value	69,632m^3/sec
Negotiable additional discharge	27,182 m^3/sec

- It is felt very much essential to work out solutions to provide for management of this additional flood discharge to ensure safety of Hirakud Dam.

Probable solution rested with exercises to locate additional spillways to pass part of the excess discharge through these additional spillways while absorbing a part of it in the reservoir in the modified flood moderation technique.

(A) Findings:

The above table implies that in the event of negotiating the PMF 69632 cumsec, there would be urgent necessity to release the excess routed flood @ 27182 cumsec through additional spillways to be constructed over and above the existing spillways and sluices of Hirakud Dam.

(B) Recommended solutions:

After considering several alternatives the experts and technical authorities of central and state government have recommended the following action points.

(1) In regard of Reservoir Operation:

- Pre-depletion of the Reservoir before the Flood event is to be avoided.
- The Freeboard may be encroached by 1.0 m over FRL. In that case the MWL will reach EL 193.02m [i.e. FRL 192.02m+1.00m Rise]

(2) To address Release of excess routed flood:

- Proposal for construction of additional spillways is acceptable at two locations; i.e. one at the left bank near Gandhi Hillock & other in the Right Dyke with spill falling in to existing nallah 'Jhaunjhor'.

1.3 NEED OF THE PROPOSED PROJECT:

While the enormously rich water resources of Hirakud Dam continues to remain the mainstay of Odisha's agricultural prosperity & Hydropower potentiality, it has experienced growing concern since last two decades in working out alternatives for managing exceptional flood events when the reservoir is maintained at its maximum holding capacity.

The Central Water Commission (CWC), the apex technical body of ministry of water resources (MoWR) Govt. of India have conducted protracted study of the Hydrology of River Mahanadi and agreed to the revision of Probable Maximum Flood (PMF) with a peak value at 69632 m^3/sec.

The consequences of this upwards revision of PMF against the existing Release Capacity of 42450 m^3/sec through the entire existing 34 nos. of spillway gates & 64 nos of under sluice gates of Hirakud Dam, will imperatively raise grave safety concerns in negotiating the excess flood release of 24182 m^3/sec.

In this prospective, the Union Ministry as well as the State Government (GoO) have expressed urgent intentions to workout viable alternative for safe passing of the additional flood so as to restore safety of Hirakud Dam. Thus, the Central Water Commission (CWC) in consultation with experts from dam safety organisation, engineers from the State Water Resources Department (SWRD) and national level consultants have carried out protracted discussions in several sittings to work out a most feasible alternative for a safe release of the excess flood from Hirakud dam during the event of PMF.

The decision emanated from the meetings of the experts was unanimous on the strategy.

- Release of the excess flood at the events of a PMF through construction of additional spillway structures, one at the left bank dyke near Gandhi Hillock and the other on the right dyke with its spill falling into Juanjhaor nalla.
- In the process, the reservoir water level may encroach the free board by 1.om thereby the MWL may rise up to El 193.02m (i.e. FRL 192.02m +1.0m rise).

It was decided to implement the above expert committee recommendations in two phases.

Phase-I: Construction of additional spillway at the left bank dyke on the second saddle of Gandhi hillock, with releasing arrangements through 5 gates each of size 15m X 15m and releasing capacity of 9122cumsec. This phase is herein after referred to as Project.

Phase-II: Construction of additional spillway on the right dyke across Juanjhor nalla with releasing arrangements through 8 nos. gates, each of size 15m X 10m and releasing capacity of 9057 cumsec.

The State Water Resource Department (SWRD), Govt. of Odisha expressed intentions to implement the Project works expeditiously through World Bank funding assistance for Phase-I. The Phase-II will be taken up after completion of Phase-I following all the environmental and social assessment requirements.

1.4 ANALYSIS OF ALTERNATIVES:

In the Environmental & Social Impact Assessment (ESIA) study, several alternatives, arising due to uncertainties existed with the project components need to be examined for project sustainability. Analysis of those alternatives in regard of their complex inter-relationships, future implications, benefits, Risks and Economic viability, becomes a feasible approach for decision making.

Alternatives are sorted out in two distinct areas of the project implementation. These are critically analysed for decision making on the basis of most feasible alternative. Two such areas considered for analysis of alternatives are:

1. Pre-Project Development Alternatives
2. Project Implementation (Environmental and Social) Alternatives.

1.4.1 Pre-project Development Alternatives:

In the present context, the Expert/Decision makers in due recognition of the project objectives have carried out extensive exercises for identification of feasible alternatives in Planning, Design & Location stages.

- Keeping the focussed objective in the perspective as well as the key impact areas such as hugeness of the reservoir, importance of the Dam and very large settlements downstream of the Dam, it was urgently necessary to find out feasible solution for effective release of additional discharges through analysis of alternatives.

- In view of the above; the Planning & Design experts of the country i.e. CWC; DSRP authorities from the GOI, Dam Safety Organisation (DSO) & Hirakud Dam authorities under State WRD (SWRD) and other reputed consultants have interacted through several meetings between 2013 and 2014, revealed some feasible alternatives for consideration.

Several structural and Non-Structural alternatives were conceived in support of passing the additional discharges. Of these the following few alternative proposals accrued consideration which were later analysed through review, model study and field reconnaissance etc.

Table 1-2: Analysis of Alternatives Related to Planning, Design & Location (Pre-project)

Sl. No.	ALTERNATE OPTIONS	IMPLICATIONS	REMARKS
1	Raising the height of the existing Dam i.e. both concrete dam and earthen dam.	• Impact on existing dam structure due to vibration while carrying out dismantling of concrete by mechanical breakers and scrapping/removal of top layer of machinery. • Constraints of reconstruction, refixing of gates and raising structures by scaffolding and concreting etc as per the design. • Slope protection works for a very long earthen dam and dyke portion. • Depletion of the reservoir water level may be necessary during the construction period. • Insufficient time available for construction which may involve the following risks. ➢ Loss of irrigation and power potential likely for the interim period. ➢ Grave risks on Safety of existing Dam and spillway structures. ➢ Safety of downstream Embankments structures is questionable. ➢ High risks due to downstream flooding posing grevious risks which may affect populated townships and villages. ➢ Huge Loss of life, property and crop is expected.	This option is not feasible and was Scored off.
2	Lowering the spillway crest level with a corresponding increase in the height of the Spillway Crest gates.		This option was scored off from the list as Not feasible
3	Additional Spillway on the Left of the Left Spillway replacing part of the existing earth dam.		This option was not feasible
4	Additional Spillway on the Right Dyke area involving spill channels joining the		This option was not feasible

Sl. No.	ALTERNATE OPTIONS	IMPLICATIONS	REMARKS
	existing kuliani jhor Nalla		
5	Prior to the event of PMF the reservoir level can be lowered from EL 630 ft to EL 625 ft to accommodate excess flood.	• Reduction of discharging capacity by 13.36 % with reference to model study results. • Change of Rule Curve may be necessary. • Precission in of reservoir operation necessary. • Meteorological uncertainties may lead to more risks. • Risk of affecting the designed project benefits i.e., loss of power potential irrigation and flood control.	Proposal was Not acceptable as FRL/MWL to be maintained at EL 630 ft as per rule curve.
6	Additional spillway between Gandhi hillock and adjacent hillock on the left bank with construction of additional dyke.	• Safety of dam can be ensured. • Loss of forest due to additional land requirement • Loss of Property – Displacement & Resettlement • Competent foundation strata were questionable. Required further explorative data.	This option was not feasible due to non-availability of foundation strata.
7	Additional spillway 700m upstream of original spillway axis planned between Gandhi hillock and adjacent hillock on the left bank with additional dyke.	• Safety of dam can be ensured. • Competent foundation rock available. • Less length of connecting dykes and less quantity of borrow earth. • Reduction of approach channel length. • Involves less land submergence and hence less displacement. • Potential environmental and social impacts can be minimised such as ➢ Loss of flora can be compensated by Afforestation programme. ➢ Loss of Property and Displacement can be addressed by Resettlement and Rehabilitation Action Plan (RAP).	**Feasible option** as ratified by the expert committee (CPMU).
8	Additional Spillway on the Right Dyke area involving spill channels joining juanjhar Nalla (About 100 m wide and 6 km long)	• Discharging capacity of nalla is more due to wider channel. • Comparatively less length of spill channel may be required. • May affect populated villages not acquired by the project authorities. • Geo technical investigation yet to be completed.	Feasibility of this option shall be reviewed only after Geo technical investigation.

1.4.1.1 Selection of Alternative:

The above mentioned development alternatives along with some survey finding were discussed in the meeting held on 12th March 2015, by the Chairman, Central water commission, other experts from the central and state Dam Safety Organisations, EIC WRD of Odisha and consultants. Final decision followed the sequences mentioned below.

(i) Technical Decisions Taken:

- Avoid Pre-depletion of the reservoir level before the Flood event.
- Freeboard may be encroached by 1 m i.e. (192.02+1.00) up to EL 193.00 m.
- Adopt combination of additional spillways at both left and Right sides of the Hirakud dam. However, construction of left side additional spillway was to be taken up in the first phase.

(ii) Alternative Location finalised for Left additional spillway:

- It is revealed from the Exploratory Drilling Operations conducted by GSI, that competent foundation strata are not available at the identified location on the saddle.
- Suggested shifting of the spillway location 700 meters further upstream of the original spillway axis where suitability of foundation confirmed.

- CWC have worked on the recommendations and relocated the spillway site nearer to the earthen dyke; followed with redesign of the structure, connected dykes approach channel and Spill channel etc. shown in the **Fig C1-2**
- It entailed comparatively less excavation, lesser submergence of land and reduction of length of connecting earthen dykes.

1.4.2 Environmental Alternative Scenario of Implementation & Post Implementation Phases:

The most feasible option picked up from consideration of development alternatives is judged from environment and social sustainability. Environmental & Social implications of some selected sub-project activities are considered for alternative study inter-alia supporting the decision making mechanism. These are analysed for sub project activities in construction phase and operation phases.

Alternatives Considered for Construction Phase:

Sl. No	Project Activities / Components	No Project Scenario	With Project Scenario
1	**Land Acquisition** • Forest land (Deforestation/Construction) • Govt Land (Construction/ Material handling waste disposal / Borrowing)	All activities and components are associated with some environmental and Social impacts of varying degrees. These impacts will be avoided if components are not implemented. But dam safety will suffer.	Dam safety aspects will be achieved. Environmental impact may be minimised through mitigation measures where as social impacts will be addressed through Resettlement and rehabilitation plan and implementation of RAP. Afforestation or plantation of 35950 plant species on non-forest govt. land. Degraded forest land may be developed by the Forest Dept. By using the excess spoil earth and plantation method.
2	**Excavation and Desilting of Reservoir** • Excavation for foundation. • Desilting for approach channel. • Disposal of waste etc	The Safety aspects of Hirakud Dam will suffer with much greater implications of social and Environmental Risks without implementation of components. Implications are: 1. Disaster due to dam failure. 2. Flooding of Downstream and submergence involving loss of property, risks of lives at downstream habitations. 3. Agricultural land may be sandcasted with heavy loss of crops.	Dam safety aspects will improve. Environmental issues like Air, Water, Noise and Soil Pollution will be reduced by implementing mitigation measures and management plans.
3	**Construction of Structures** • Additional Spillway • Connecting Earth Dam / Dykes • Approach Channel • Spill Channel		Project objectives will be achieved. Environmental impacts such as Air, Water Noise and Soil pollution impacts may be reduced by effective mitigation measures.

Sl. No	Project Activities / Components	No Project Scenario	With Project Scenario
4	**Approach Road** • Construction of approach road improvement of existing road • Dam top road to be realigned- improved	There would be no new road communication in the area. Dam inspection may not be properly attended.	• Land acquisition problems may be minimum. • Impact on Air, Noise and Vegetation covers may be addressed by proper mitigation measures. • Create convenience for Dam inspection as well as Tourism Development.
5	**Drainage** • Ensuring Dam drainage • Restoration of natural drains	Dam Safety aspect may suffer	• Dam Safety aspect will improve. • Risks of Water pools, Soil & water pollution will be minimised by implementation of mitigating measures. • Natural flow will be restored.
6	**Solid Waste Disposal** • Disposal of wastes from borrow area • Disposal of Construction debris	• Landscape and Vegetation cover will not be affected	• Dam toe areas will remain clean and attractive due to some beautification effects which attract tourists. • Excess unused soil will be handed over to Forest dept. to use in degraded forest.
7	**Machinery & Equipment Handling**	Air, Water and Noise pollution will not appear but dam safety aspect will suffer without the proposed works requiring Machinery & Equipment.	• Proper maintenance will improve the efficiency of Machineries and Equipments • Impact during the construction period will be increased. But, mitigation measures will reduce the Pollution impacts.
8	**Labour Camps** • Housing for the construction labourers in Camps • Staff Colony for Workers	No adverse impacts and no social problems will appear. But dam safety aspect will suffer without implementation of the project works involving the labour force.	• Water pollution, waste disposal, Health and Sanitation problems likely to appear in labour camps/staff colony. • But the impacts will be addressed through safeguard and mitigation measures. • Improve efficiency of construction activities
9	**Displacement of Population** • Resettlement and Rehabilitation	• No displacement of population • No-Social impact and no resettlement plan would be necessary. • But the Dam Safety aspect gets seriously affected.	• Social impacts will be mitigated with improper implementation of RAP. • The strategic steps contemplated are: ➢ Govt. Land at three locations are available for rehabilitating the project affected families. ➢ All social issues economic sustainability and Resettlement in project offered R & R

Sl. No	Project Activities / Components	No Project Scenario	With Project Scenario
			colony will be undertaken by the project authority.

1.4.3 Alternatives Considered for Operation (Post-Implementation) Phase:

SL NO	Project Activities / Components	No Project Scenario	With Project Scenario
1	Maintenance of Spillway gates for improving ability to release additional flood	Serious Safety implications during Flood (PMF) Management due to improper operation of gates. Does not attract serious Environmental issues; But Dam safety will be at stake if not implemented.	Ensures Smooth operation of Gates in response to urgent need of excess flood release.
2	Improving Lighting for external areas of new construction including the entire length of spill channel	No environmental damage envisaged but involves serious risks for public.	• Insignificant impact on environment. • Safer spillway operation and dam inspection • Positive effect on aesthetics. • Entails safe operation and proper inspection. • Beautification of the area will be achieved.
3	**Tourism Development** In addition to existing tourism facilities.	• Potential Environmental degradation may be avoided. • Social benefit in terms of service and income may not be available to the local people.	• There may be pollution due to solid waste as well as waste water generation. • Air and Noise pollution due to increase in vehicular traffic. • Safeguard measures and proper mitigation measures will be adopted to reduce adverse impacts.
4	**Improving the Communication Network.** i.e. Real time assessment • Between upstream Gauge Stations • U/s release from Dams (Upper Catchment Dams of Chhatisgarh) • Civil Authorities in flood plains D/S of Hirakud Dam	• May not attribute to serious environment damage but the dam safety will suffer considering any incompetent communication network.	Will improve reservoir operation techniques. Minor short term environment impact may appear but Risk factor will be reduced by better flood management.
5	**Improving the monitoring mechanism** Includes monitoring • For environmental Components	Environmental Impacts existent with the project components would render the project unsustainable	All negative impacts are minimized / annulled by appropriate mitigation measures. Consistent monitoring, review of the constraint areas and resource management renders in the operation phase shall be successful.

1.4.4 Finalisation of Most Feasible Alternative:

Various alternatives in regard of Planning, Design and Location of the project have been discussed in the previous paragraph 2.4.1. The final outcome from the analysis of alternatives is outlined below.

- **From Planning perspective**
  - In the event of PMF with peak value 69632 m^3/sec, the release of additional discharge @ 27,000 m^3/sec will be carried out through construction of 2 additional set of spillways on either side of the main Hirakud Dam and to function simultaneously.
  - It is agreed that, during the process the freeboard may be encroached by 1.0 metre i.e. up to EL 193.00 m

- **From Design Considerations**

Design Parameters	Left Spillway
• Number and Size of Gates	-5 nos. Radial CG @ 15m x 15m each
• Crest level of spillway	- EL 177.024 - 91.00 m
• Length of Spillway	- 111.00 m
• Length of Control Structure	- 9122 m^3/sec
• Discharge	- 1.8km /120m up to 0.7km and 200m for balance 1.1km
• Length / Width of Spill Channel	
• Length of Connecting earthen dykes L/R	- 684m / 340m
• Estimated Cost	- 590 Crores (2016 price level)

- **Finalised Locations:**
  The final location details are mentioned below.

Left Additional Spillway:
Location: Down Stream of the Left dyke on 1st Gap (between RD 2300' & RD 5400')

Spillway Location Co-ordinates- Latitude: 21^0 32' 52.15"
Longitude: 83^0 53' 58.03"

Latitude: 21^0 32' 54.38"
Longitude: 83^0 53' 54.8"

Connecting Dykes Co-ordinates:

1. Latitude: 21^0 33' 0.54"
   Longitude: 83^0 54' 12.56"
2. Latitude: 21^0 32' 52.15"
   Longitude: 83^0 53' 58.09"
3. Latitude: 21^0 32' 54.38"
   Longitude: 83^0 53' 54.8"
4. Latitude: 21^0 33' 2.6"
   Longitude: 83^0 53' 44.4"

- **Implementation Strategy.**
  - It is agreed that the construction of additional spillways may be phased.
  - The left spillway will be implemented at the first instance as additional component of DRIP already on going through World Bank Funding.

1.5 DoWR APPROACH FOR IMPLEMENTATION OF PROJECT:

- DoWR, Govt. of Odisha in broad consensus of the above finalised recommendation, have approached the World Bank authorities to consider funding for the construction of Left additional spillway project under DRIP.

- It was agreed by the Central Project Management Unit (CPMU) i.e. Central Water Commission (CWC) and the State Project Management Unit (SPMU) i.e. the DoWR of Odisha Government.

1.6 NECESSITY OF PROJECT:

The project; basically a safety assurance scheme of Hirakud Dam, envisages construction of additional spillways to negotiate excess routed flood in extreme cases of Probable Maximum Flood [PMF at 69632 m^3/sec] impinging the reservoir while it stands at its FRL.

Project Frame:

- It entails combination of two additional spillways structures to be constructed at both flanks of the existing spillways on left and Right Dykes.
- The present project deals with Construction of Additional Spillway near the left bank dyke over the Gandhi Hillock at an investment of Rs.590 Crores (INR).
- These works are considered as parts of Dam Rehabilitation and Improvement Project [DRIP] already under Implementation through WB assistance.

Implementation strategy:

- The World Bank has agreed in principle to include project estimated at Rs.590 Crores as additionally to the ongoing Dam Safety Rehabilitation and Improvement Project (DRIP).
- The State Government has concurred the proposal for seeking additional World Bank funding assistance accounting to Rs.590 Crores for implementing project i.e. construction of Left Bank additional spillway.
- DoWR has engaged consultants of different discipline to assist the project authorities in fulfilling the statutory document requirement of the World Bank.

Design of project structure

- The Spillway Structure, connecting Dykes at both ends, approach Channel, Stilling Basin and Spill channels have been designed by CWC and drawings forwarded to the project authority for necessary implementing action.
- The location Map is furnished below in the Fig.1-2.
- The structural details are furnished in Fig. 1-2, Fig.1-3, Fig.1-4 and Fig. 1-5.

1.7 SALIENT FEATURES OF PROJECT (LEFT SIDE ADDITIONAL SPILLWAY):

The salient features of the additional spillway are given below**:**

Sl. No.	Features for finalised location		Remark
	Item/ Components	Data	
1.	**Location** • Location of Spillway structure • Geo-coordinates of the present location • Township & Railway station	243m downstream of first gap left dyke. Latitude: 21^0 32’ 52.15” Longitude: 83^0 53’ 58.03” Latitude: 21^0 32’ 54.38” Longitude: 83^0 53’ 54.8” Nearest township Burla and Hirakud Railway Station on East Coast Railway is located about 8 km away.	Details shown in Fig. 1-2
2.	• **Spillway** • Discharge capacity • Length of spillway • Length of Abutments (Left/Right) • No. and Size of spillway gates • Crest elevation • Dam top elevation	 9122m^3/sec (3.22 lakh cusecs) 91.00m (5 nos. Bays each 15m) 52.00m/78.00m 5 nos. each @ 15m x 15m EL 177.00m EL 195.68m 7.50m	Details shown in Fig.1-4

3.	**Connecting Dykes (Left / Right)** • Length of Earthen Dykes • Top elevation of Dykes • Geo-coordinates at the butting points with main Dyke.	**(Left / Right)** 640m / 380m EL 195.68m/195.68m 5. Latitude: 21^0 33' 0.54" Longitude:83^0 54' 12.56" 6. Latitude: 21^0 32' 52.15" Longitude:83^0 53' 58.09" 7. Latitude: 21^0 32' 54.38" Longitude:83^0 53' 54.8" 8. Latitude: 21^0 33' 2.6" Longitude: 83^0 53' 44.4"	Shown in Fig.1-3
4.	**Approach channel** • Length of approach channel • Width of approach channel • Bed level of channel (Approx.)	 243.00m 120.00m EL 167.00m	Shown in Fig.1-2
5.	**Spill Channel** • Stilling Basin Invert • Bed level of channel at the beginning • Tail water level (approx) • Length of Spill Channel/ slope • Width of Spill Channel	**Concrete lined Section** EL 147.00m EL 158.00m EL 173.00m 1800m / S=1:3000 120m width x 714m length /200m width (till outfall point) excluding transition length**.**	Shown in Fig.1-5
6.	Earth required for new dykes	9,72,000 cum.	
7.	Rock materials to be used for Rip rap, rock toe	56700 cum.	
8.	Proposed method of excavation	Mechanic method by use of excavator, loader and transportation by dumper.	
9.	Quantity of excavation= (All kind of soil, DI, Hard rock)	22,11,000 cum.	
10.	Useful rock for reuse in construction	8,52,600 cum	
11.	Construction Methodology	The construction activities like excavation, embankment construction and concrete laying are to be carried out by mechanised method with involvement of labour to the minimum possible extent.	
12.	Time for construction	30 months.	
13.	Project Cost	Cost of project is Rs. 590.00crores at 2016 price level.	
14.	Submergence area	Reservoir area increase around 12 ha.	
15.	Land acquisition	Land acquisition is not required for construction of different components of the project as 61.598 Ha land belongs to Water Resources Dept. And acquired 63.64 Ha land from Industry dept. and 9.441Ha from Forest Dept. However, compensation package to squatters is dealt in RAP	
16.	Tree felling	Reserve Forest Area: 115 nos. Non Forest Area : 3595 nos.	
17.	Utility shifting – temple, structures, cremation, school	Temples and 'Bijesthalis' - 12 "Puja Mandap" -1 Cremation structure - 1	

		Major roads - 2 The water supply pipeline network. primary schools - 2 high school - 1 and Anganwadi center _ 4	
18.	Other features proposed	Temples, school construction, tree plantation, fisheries promotion,	
19.	Traffic management & road net work	Restore road communication link/existing approach roads to Gandhi Minar and Dam Top Road. Provide crossing structures / Bridge over the spill channel with adequate safeguard measures.	
20.	Environmental Enhancement measures	10 Fish pond, Bio-toilet at tourist places	
21.	Bridge	The bridge will be located at the existing main road.	

1.7.1 Input in Project based on EIA recommendations:

Following the EIA study and Stakeholder consultations the mitigation measures have been included in the project:

(i) Bridge Across Spill Channel:

A bridge has been proposed across the spill channel on the existing road to Gandhi Tower for maintaining the connectivity on eitherside of the spill channel. The population will move on other side of the channel after the spillway channel construction. There is no bridge at present. The need of new bridge arises due to proposed construction of the spill channel and maintaining connectivity to Hirakund dam from this side as well. The bridge design and detailing is in progress. The bridge is expected to be about 120m long.

(ii) Resettlement Sites:

Initially three resettlement sites were identified by the Dam Authority one at Basantpur and another at Rengalipalli village which were around 20 Km away and one at Larbanga 8 Km away from the proposed site. During public consultation Most of the PAFs expressed an interest in having sites nearer to their present settlement as they feared livelihoods being affected. In response, the GoO identified further three resettlement sites at Solpali, Solband and Garmuda (within Sambalpur Municipal Corporation area) which is 3 km away from the original habitations. The resettlement sites will be firmed up after taking into account preferences by all the households. Subsequently the identified area will be developed with necessary amenities such as road, water source, electricity, health facilities etc., prior to handing over plots to the affected families. It is agreed that no disturbance(s) will be made to the existing living unless the relocation site are complete in all aspects.

(iii) Enhancement Measures:

Following enhancement measures have been proposed in the project

Fishery Ponds:

The Dam Authority has made a provision of 10 fishery pond within the dam area for fingerlings development as an enhancement measures on the advise of Fishery Department and the Fishermen Cooperative Society **d**uring stakeholder consultation, as presently there is no facility for fingerling development and management.

Supply to Soil for Forest Development:

The forest department expressed their interest to take the excavated surplus soil after utilization by project for plantation purpose in the degraded forest. The adjacent reserved

forests is entirely degraded. The reason of degradation is non-availability of fertile top soil in the entire reserved forest area. The surplus soil can be fully utilised for rejuvenating this degraded forests. Thus the project will help in conservation of forest area. The excess of earth material and top soil can be dumped at nearby places of degraded forest in consultation with forest department, so that the earth material can be utilized.

The scheduling of construction is incorporated in **Annexure -1.3.**

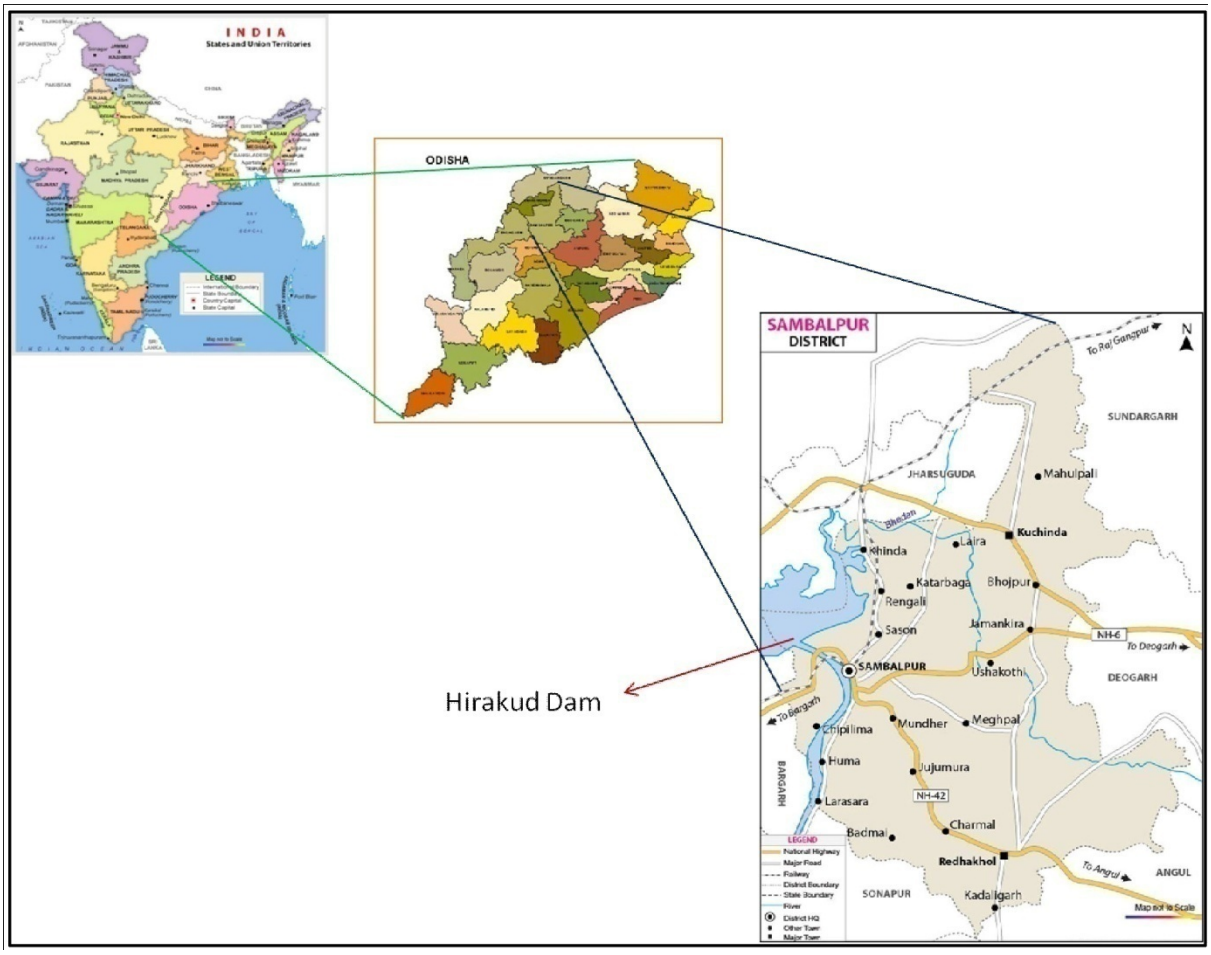
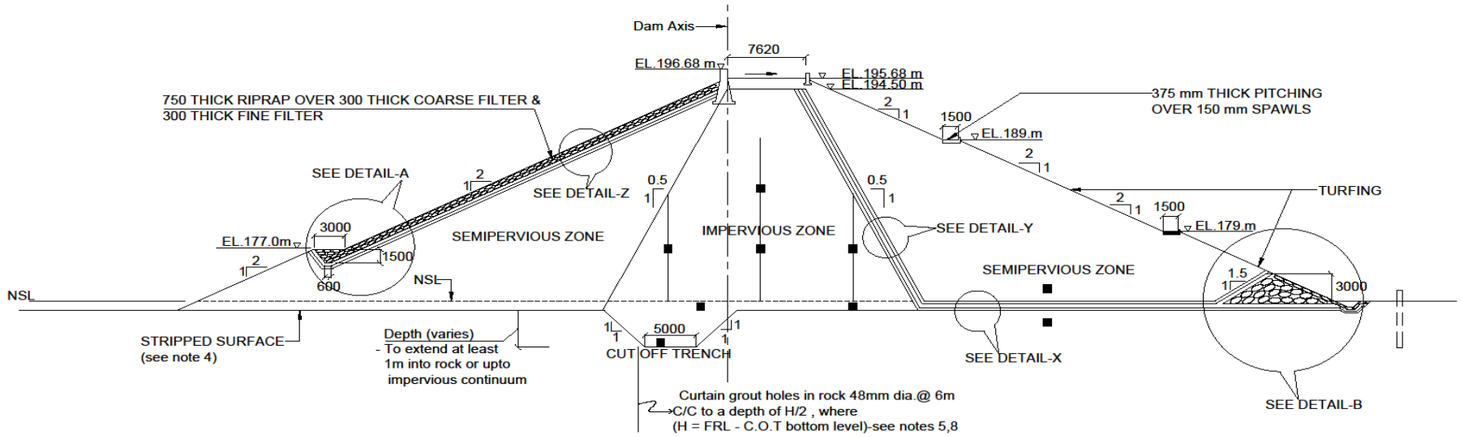
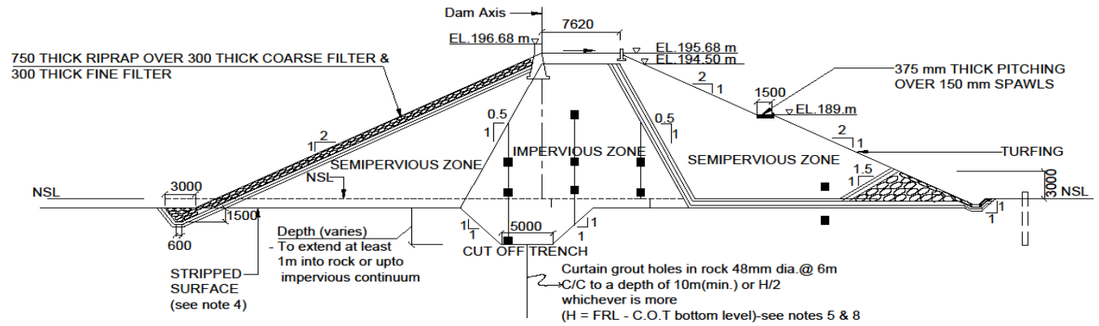


Fig. 1-1: Index Map of Project site

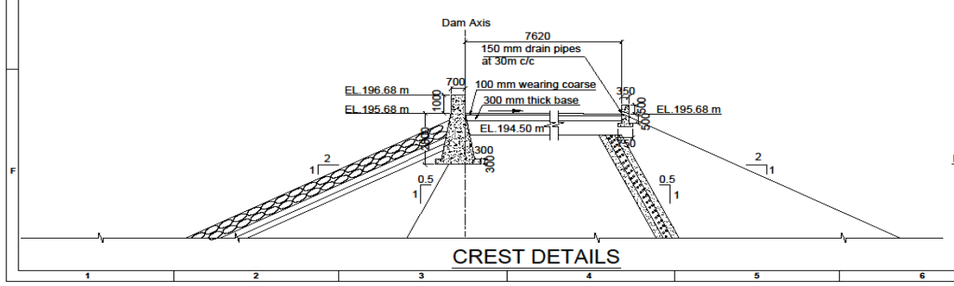
Fig. 1-2: Location Map of Additional Spillway and Spill Channel



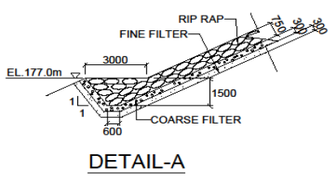
TYPICAL SECTION B-B



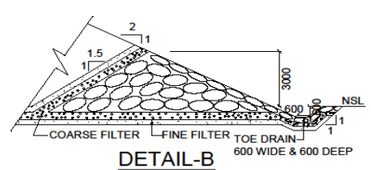
TYPICAL SECTION C-C



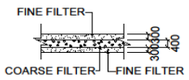
CREST DETAILS



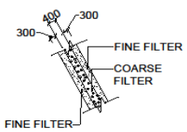
DETAIL-A



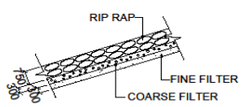
DETAIL-B



DETAIL-X



DETAIL-Y



DETAIL-Z

Legend :-

■	Vibrating Wire Piezometers	20 Nos.
= =	Porous Tube Piezometers	10 Nos. (Along dam length at suitable location)

Notes : -

1. All dimensions are in millimeters & elevations are in meters unless otherwise specified.
2. Elevations indicated are exclusive of settlement allowances.
3. Filter material shall conform to standard filter criteria.
4. Stripping shall be carried out to remove the top soil and other objectionable material to the required depths as per direction of the engineer in charge. Particular care is to be taken to exclude all organic matter & vegetation growth.
5. The depth of the cut-off trench shall be determined as excavation progresses. It shall extend at last 1m into fresh rock or upto impervious continuum.
6. The detailed cross-sections shall be provided in construction drawings during construction stage. The latest soil testing reports are to be considered for the purpose.
7. Construction is to be carried out as per standard earth dam specifications
8. The curtain grouting details will be detailed by the contractor in construction drawings during construction stage in consultation with an experienced site Geologist.
9. The dimensions are not be scaled.

NOT FOR CONSTRUCTION

CLIENT	DEPARTMENT OF WATER RESOURCES GOVERNMENT OF ODISHA
PROJECT	HIRAKUD DAM–ADDITIONAL SPILLWAY ON LEFT OF GANDHI HILLOCK AT NEW LOCATION
TITLE	EARTHEN DYKES–CROSS SECTIONS (Including Instrumentation Details)
CONSULTANT	CENTRAL PROJECT MANAGEMENT UNIT (DRIP) CENTRAL WATER COMMISSION

Sd/- Drawn	Sd/- Designed	Sd/- Checked	Sd/- Recommended

Date : MAY - 2016 | DRAWING NO. HDNS-NS-131 | Sheet 2 OF 2

Fig. 1-3: Cross Section of Earthen Dyke at B-B and C-C

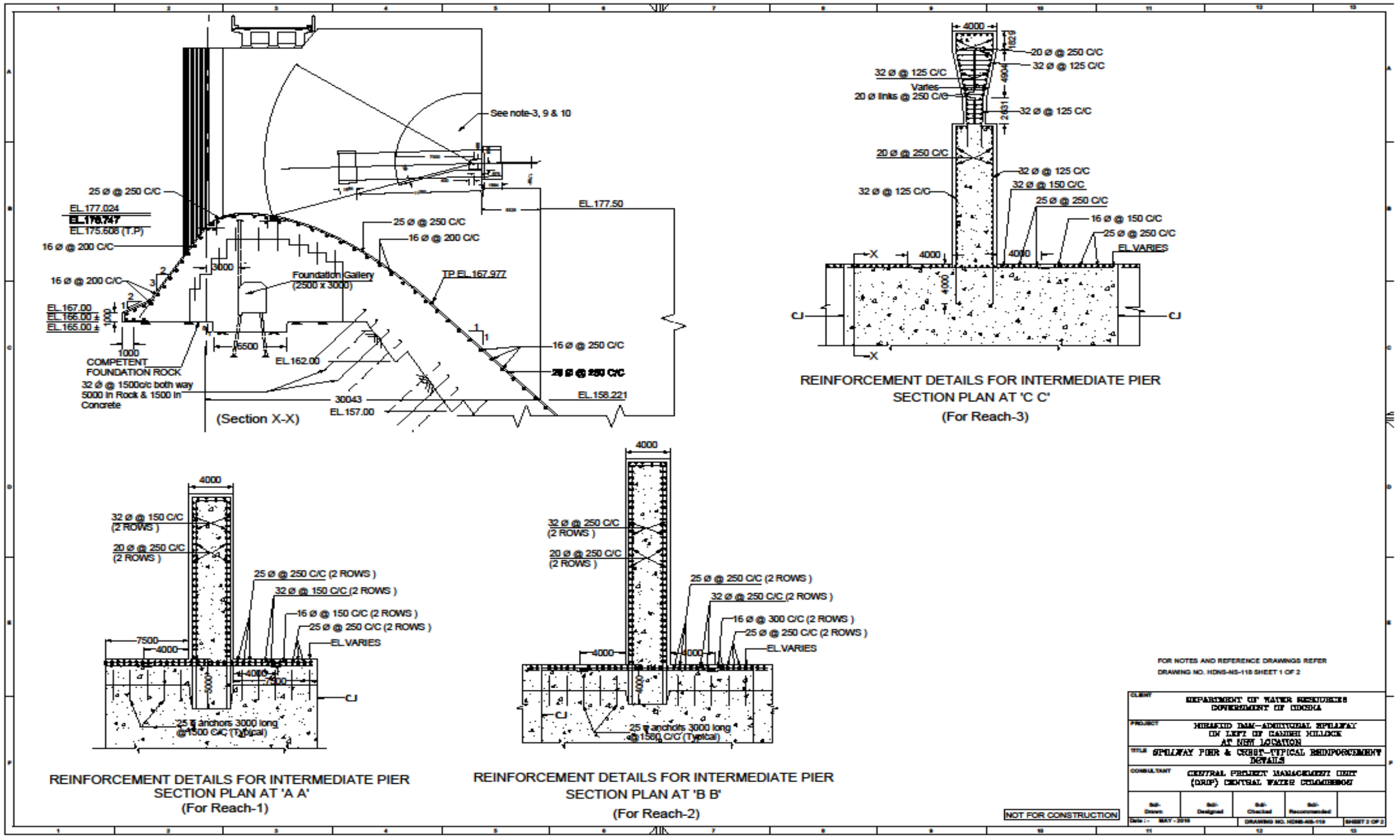
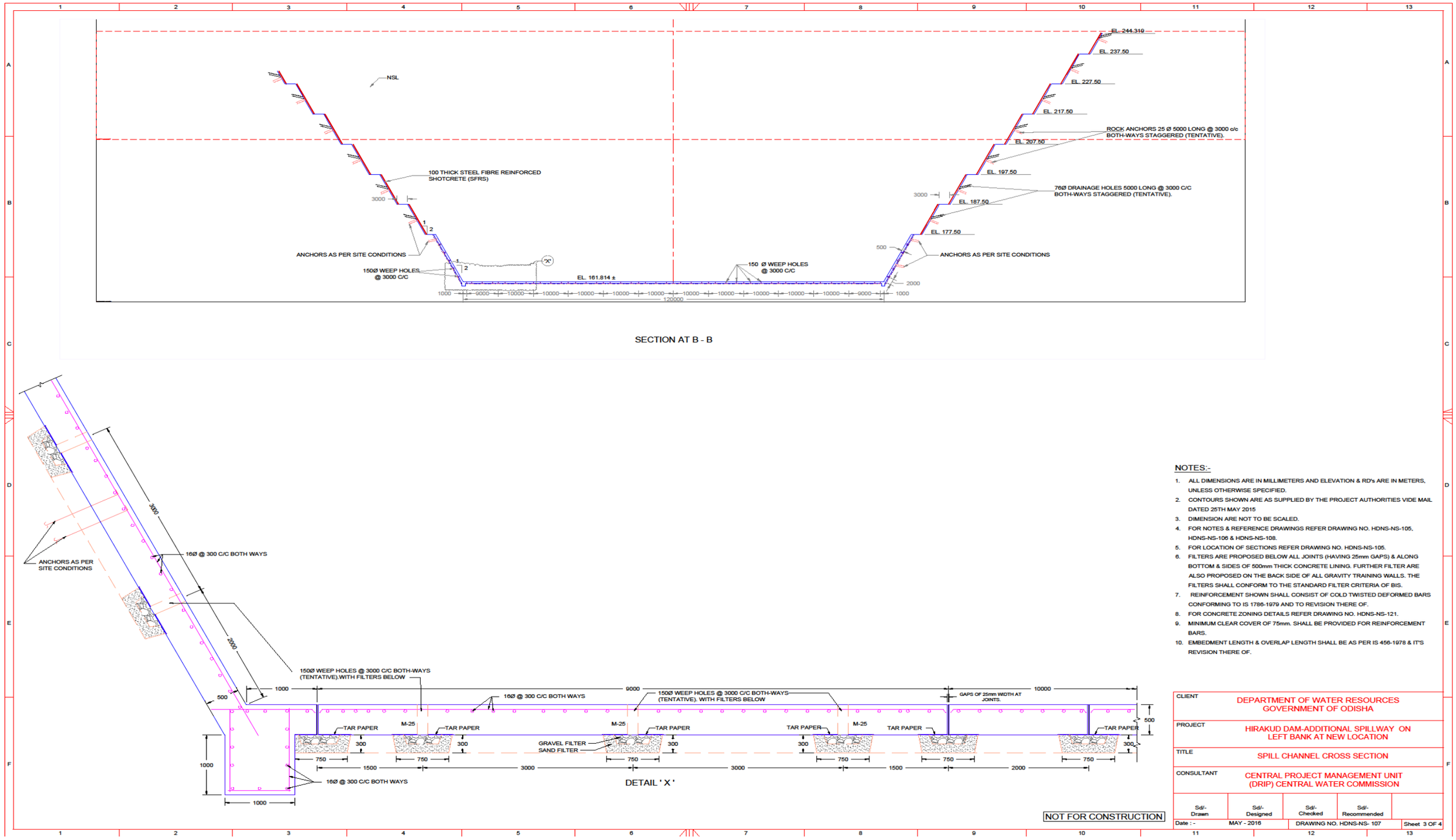


Fig. 1-4: REINFORCEMENT DETAILS SECTION PLAN



NOTES:-

1. ALL DIMENSIONS ARE IN MILLIMETERS AND ELEVATION & RD's ARE IN METERS, UNLESS OTHERWISE SPECIFIED.
2. CONTOURS SHOWN ARE AS SUPPLIED BY THE PROJECT AUTHORITIES VIDE MAIL DATED 25TH MAY 2015
3. DIMENSION ARE NOT TO BE SCALED.
4. FOR NOTES & REFERENCE DRAWINGS REFER DRAWING NO. HDNS-NS-105, HDNS-NS-106 & HDNS-NS-108.
5. FOR LOCATION OF SECTIONS REFER DRAWING NO. HDNS-NS-105.
6. FILTERS ARE PROPOSED BELOW ALL JOINTS (HAVING 25mm GAPS) & ALONG BOTTOM & SIDES OF 500mm THICK CONCRETE LINING. FURTHER FILTER ARE ALSO PROPOSED ON THE BACK SIDE OF ALL GRAVITY TRAINING WALLS. THE FILTERS SHALL CONFORM TO THE STANDARD FILTER CRITERIA OF BIS.
7. REINFORCEMENT SHOWN SHALL CONSIST OF COLD TWISTED DEFORMED BARS CONFORMING TO IS 1786-1979 AND TO REVISION THERE OF.
8. FOR CONCRETE ZONING DETAILS REFER DRAWING NO. HDNS-NS-121.
9. MINIMUM CLEAR COVER OF 75mm. SHALL BE PROVIDED FOR REINFORCEMENT BARS.
10. EMBEDMENT LENGTH & OVERLAP LENGTH SHALL BE AS PER IS 456-1978 & IT'S REVISION THERE OF.

CLIENT	DEPARTMENT OF WATER RESOURCES GOVERNMENT OF ODISHA
PROJECT	HIRAKUD DAM-ADDITIONAL SPILLWAY ON LEFT BANK AT NEW LOCATION
TITLE	SPILL CHANNEL CROSS SECTION
CONSULTANT	CENTRAL PROJECT MANAGEMENT UNIT (DRIP) CENTRAL WATER COMMISSION

Sd/- Drawn	Sd/- Designed	Sd/- Checked	Sd/- Recommended	
Date : -	MAY - 2016	DRAWING NO. HDNS-NS- 107		Sheet 3 OF 4

Fig. 1-5: SPILL CHANNEL CROSS SECTION

CHAPTER-2
LEGAL & REGULATORY COMPLIANCE

2.0 INTRODUCTION:

Most development projects have marched to success when their implementation process adequately confirmed to country's prevailing legal, policy and regulatory framework. In the process, organizational support and institutional framework were emphasized during all phases of project construction maintenance and operational efficiency.

In the present context the pre-project "scope of study" with issues and requirements need to be correctly accentuated.

2.1 POLICY, LEGAL AND REGULATORY COMPLIANCE:

This section explains the legal & regularity requirements under different acts / rules and policies for training to environment safeguards. it also identified the requirement of permits /licenses in the project under different rules /regulation as different stages of the period.

2.2 STATUTORY CLEARANCE APPROVAL & PERMISSIONS:

Implementation of the Project necessitates prior clearances from the Regulatory Authorities, Approval from the Government and Donor Agency (WB) and permission from the District Administration / Designated Officers.

Safeguard policies of the World Bank were also consulted in regard of the Environmental and social Management Considerations.

Relevant World Bank Safeguard Policies are mentioned below.

Table 2.1 : Relevant World Bank Safeguard Policies

Sl.No.	WB Safeguard Policies	Objective & Purpose	Applicability
1.	**OP/BP-4.01** Environmental Assessment	The objective of this policy is to ensure that the Bank financed project is environmentally sound and sustainable.	Triggered
2.	**OP/BP-4.04** Natural Habitat	The policy prioritizes conservation of Natural Habitats for long term project sustainability. The Bank therefore expects the Borrower to suggest appropriate measures for protection maintenance and rehabilitation of Natural Habitats in the study report.	Triggered, while no endangered species are found in the project area, however, there maybe potential substantial loss of ecological functions provided by trees that will be cut during the construction process. the EMP has provision for afforestation and mitigation measures.
3.	**OP-4.36** Forestry	The policy gives importance to restoration of forest eco-system, which entails management and conservation methods of forest flora fauna and wildlife. Since a part of the RF is likely to be affected, the Bank expects that these aspects need to be included in the report along with	Triggered. Since construction of Additional Spillway at Hirakud Dam will involve diversion of 9.441 hectare of forest land. It will involve removal of around

Sl.No.	WB Safeguard Policies	Objective & Purpose	Applicability
		proposal to restore forest health and welfare of the indigenous people who are dependent on forest produce.	3600 trees and a EMP will include afforestation of double the number of trees.
4.	**OP/BP – 4.37** Safety of dams	The policy enforces adequate measures for ensuring safety of dams during its life cycles.	Triggered as it is additional structure of the existing dam and has been covered under dam break analysis
5.	**OP/BP – 4.12** Involuntary displacement and resettlement	The policy objective is to avoid involuntary displacement and resettlement as far as practicable by exploring viable alternatives. It also emphasizes approach to improve the living standards of the displaced people, encourages community participation in implementation of resettlement activities and provide assistance to the affected people regardless of their legal status on title of the land.	Triggered as project envisage displacement of squatters (716 households); all are non-title holders
6.	**OP 4.10** Indigenous People	The policy aims at restoring the rights and cultural dignity of the indigenous people while ensuring receipt of proper social and economical benefits.	Triggered, Among the affected population few numbers of tribal have been recorded. Tribal development plan has been prepared for affected tribal group.
7.	**OP N 4.11** Cultural property	The policy emphasizes preservation of cultural property in the project area, restoration of archaeological monuments and unique environmental features.	Not Triggered, No archaeological site or unique environmental features is located in the project area. However 11 nos. of temples, 1 crematoria building will be affected.
8.	**OP 4.09**	The policy helps manage the effect of pests on agriculture and health and provides support to strategies which promote the use of biological or environmental control methods and reduces reliance on synthetic chemical pesticides.	Triggered. It is envisaged that no pesticide will be procured under the project and only chemical treatment which is a practice during forest management in India will be carried out. However, in the interest to ensure no pesticide is use, the policy is triggered.

On safety and occupational health aspects related to the project , the World Bank Group's General Environmental .Health and Safety Guidelines(EHS)will be followed.

Table 2-2: Relevant Acts, Policies, Legislations and Guidelines applicable to the Project

Acts, Policies and Notifications	Key requirement	Applicability	Type of permit and stage of applicability	Administrative Authority and indicative time frame for grant of permission	Responsibility
Environment Protection Act 1986	To protect and improve overall Environment.	Applicable			
EIA Notification 14th Sep 2006 And amendment till date	To protect and improve overall Environment. Requires prior environmental clearance for new, modernization and expansion projects listed in schedule 1 of EIA Notification, 2006	Applicable	Environment Clearance required for the construction of the additional spillway. **	MoEF&CC , six months (Considering one season data as per approved TOR)	SPMU/IA (Chief Engineer and Basin Manager, Upper Mahanadi basin, Burla)
		Applicable	Environment Clearance at the Construction stage for borrowing earth, query for stone & sand as applicable.	SEIAA /DEIAA during construction phase 3months	Contractor
Air (Prevention and Control of Pollution) Act, 1981, 1987	An act to prevent and control Air pollution	Applicable	Consent to Establish (CTE) & Consent to Operate (CTO) for Batching plant & stone crushers	SPCB Govt. of Odisha during establishment of Batching plant & stone crushers 3 to 4 months	Contractor
Water Prevention and Control of Pollution) Act, 1974, 1988	An act to prevent and control water Pollution.	Applicable	Consent to Establish & Consent to Operate for Batching plant & stone crushers	SPCB Govt. of Odisha during establishment of Batching plant & stone crushers 3 to 4 months	Contractor
Noise Pollution (Regulation and Control Rules) 2000 and amendment till date	Ambient Noise Standards for different areas and zones	Applicable	No permits issued under this act. However the Contractor has to comply with the standard limits during construction	SPCB Govt. of Odisha	Contractor

Acts, Policies and Notifications	Key requirement	Applicability	Type of permit and stage of applicability	Administrative Authority and indicative time frame for grant of permission	Responsibility
Plastic waste Management Rules, 2016	To manage the plastic waste generated	Applicable	No authorization to be obtained. Waste Management and Minimization to be done. Fee to be paid to local bodies, if applicable	SPCB, Odisha	Contractor
The Batteries (Management and Handling) Rules 2001	To regulate the disposal and recycling of lead acid batteries	Applicable	No specific registration Required. Compulsion to buy and sale through Registered vendor only	-Do-	-Do-
Coastal Zone Management Act 2011 as Amended IN 2016	To regulate development activities within the 500m of high tide line in coastal zone and 100 m of tidal influence rivers.	Not Applicable	CRZ Clearance	--	--
The Forest (Conservation) Act, 1980 and amendments The Forest (conservation) Rules 1981 and Amendments till date	To protect forest by restricting conversion of forested areas into non-forested areas and deforestation	Applicable	Forest Clearance / Permission for tree cutting.	Regional Office of MoEF & CC, State forest dept. 8 to 10 months	Chief Engineer and Basin Manager Upper Mahanadi basin, Burla
+Biological Diversity Act, 2002	Conservation of biological diversity, sustainable use of its components and fair and equitable sharing of the benefits arising out of the use of biological resources, knowledge and for matters connected therewith or incidental thereto	Not Applicable	No permit issued under this Act	--	---
Wild Life Protection Act, 1972, 1993	To protect wildlife through notifying National Parks and Sanctuaries and buffer areas around these zones	Not Applicable	Wild life Clearance	--	--
Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996	Requirement of preparation of onsite and offsite Disaster Management Plans for Accident prone areas.	Not Applicable	No permits issued under this act	--	--

Acts, Policies and Notifications	Key requirement	Applicability	Type of permit and stage of applicability	Administrative Authority and indicative time frame for grant of permission	Responsibility
Public Liability and Insurance Act 1991	Protection from liability arising due to accidents from handling of hazardous chemicals.	Applicable	No permits issued under this act. Owner of project should take out Insurance policies providing for contracts of insurance so as he is insured against liability to give relief, before handling any such hazardous material	Dist. Collector 1 month	Chief Engineer and Basin Manager Upper Mahanadi Basin, Burla
Explosive Act 1884 & Explosive Rules, 2008	Safe transportation, storage and use of explosive material, blasting site and safe distance	Applicable	Permission for storage and usage of explosive	DC, Chief Controller of Explosives, Govt. of India	Contractor
Petroleum Rules, 2002	Use and Storage of Petroleum products	Not Applicable	License to store petroleum beyond prescribed Quantity.	Dist. Collector	Chief Engineer and Basin Manager Upper Mahanadi Basin, Burla
Central Motor Vehicle Act 1988 and amendment Central Motor Vehicle Rules, 1989 and amendments till date	To minimize the road accidents, penalizing the guilty, provision of compensation to victim and family and check vehicular air and noise Pollution.	Applicable	No permit issued under this Act however the contractor has to ensure proper license PUC, permits as required	Motor Vehicle Licensing Authority of the Region.- Regional Transport Officer	-Do-
The Gas Cylinder Rules 2004	To regulate the storage of gas / possession of gas cylinder more than the exempted quantity	Applicable	License to store gas cylinder more than the regulated quantity	Chief Controller of Explosives, Govt. of India	Contractor
Ancient Monuments and Archaeological Sites and Remains Act, 1958	Conservation of cultural and historical remains found in India. According to this Act, area within the radii of 100m and 300m from the "protected Property" are designated as "protected area" and "controlled area" Respectively. No development activity (including building, mining, excavating, blasting) is permitted in the "protected area" and development activities likely to damage the protected property is not permitted in the "controlled area" without prior permission of the Archaeological Survey of India (ASI).	Not Applicable	No objection certificate	Archeological Survey Of India. (ASI) Govt. Of India	-Do-
Solid Waste Management Rule 2016	To manage solid waste in the applicable area.	Not Applicable	Obtaining authorization under solid waste management rules for processing/recycling/treatment and	CPCB, Govt. of India and SPCB, Odisha	contractor

Acts, Policies and Notifications	Key requirement	Applicability	Type of permit and stage of applicability	Administrative Authority and indicative time frame for grant of permission	Responsibility
			disposal of solid waste however handling and disposal of waste generated to be ensured by the contractor.		
River Board Act	To control the regulation and development of interstate and river valleys	Not Applicable	--	--	--
The Merchant Shipping Act, 1958	The Merchant Shipping Act regulates and controls the discharge of oil or oil mixture by an Indian tanker or ship within any of the prohibited zones or by a foreign tanker or other ship within the prohibited zone adjoining the territories of India. Further, there is a prohibition for discharging any oil anywhere at sea from an Indian ship.	Not Applicable	--	--	--
Building & Other Construction workers (Regulation of Employment & Condition of Service)	To regulate the employment and condition of service of building and other construction workers and to provide for their safety, health and welfare measures	Applicable	Obtaining laborer license	Dist. Labour Commissioner	Contractor
R & R Clearance	Providing rehabilitation And resettlement	Applicable	RPDC, Govt. of Odisha	Approval from Govt. of Odisha	Chief Engineer and Basin Manager Upper Mahanadi basin, Burla
Tree Felling in Non Forest Area		Applicable		DFO, Sambalpur Division	Chief Engineer and Basin Manager Upper Mahanadi basin, Burla

In addition to the above Acts and Rules, the Contractor has to comply with the various Labour Rules such as Factories Act, 1948; Employees State Insurance Act, 1948; Workmen's Compensation Act, 1923; Minimum Wages Act, 1948 The Inter-state Migrant Workmen (Regulation of Employment and Conditions of Service) Act, 1979 , etc.

**** -- Applicability of EIA Notification, 2006 and amendment thereafter**: The Point No.2 of EIA Notification Dt.14.09.2006 of MoEF&CC defines the requirements of prior Environmental clearance for different projects which is as below:

"POINT NO.2. Requirements of prior Environmental clearance (EC) – The following Projects or activities shall require prior Environmental clearance from the concerned Regulatory Authority, which shall herein after referred to be as the Central Govt. in the Ministry of Environmental & Forests for matters falling under category 'A' in the Schedule and at State level the State Environment Impact Assessment Authority (SEIA) for the matters falling under category 'B' in the Schedule, before any construction work or preparation of land by the Project Management except for securing the land, is started on the Project or activity.

(i) All new Projects or activities listed in the Schedule to this Notification.

(ii) Expansion and modernization of existing Projects or activities listed in the Schedule to this Notification with addition of capacity beyond the limits specified for the concerned sector, i.e. Projects or activities which cross the threshold limits given in the schedule after expansion or modernisation.

(iii) Any change in product-mix in an existing manufacturing unit included in Schedule beyond the specified range."

The present proposal of "Construction of Additional spillway of Hirakud dam Safety" does not fall in any category listed in Schedule of EIA Notification, 2006. Since, the Hirakud dam was constructed for flood control, irrigation and power generation, this project can be compared with the Category of "River Valley project" which is listed at Sl. 1(c) of the Schedule of the EIA Notification, 2006. So the applicability of environmental clearance for the proposed project has been analysed based on the conditions stipulated under the schedule. The conditions requiring environmental clearance for river valley projects under different category have been mentioned in the Schedule of EIA Notification is as follows:

Schedule
List of Projects or activities requiring prior Environmental Clearance.

Project or activity	**Category with threshold limit**		**Conditions, if any**
	A	B	
1(c) River Valley projects	(i) ≥ 50 MW Hydro electric Power Generation. (ii) ≥ 10,000 ha of Culturable Command Area	(i) < 50 MW ≥ 25 MW Hydro electric Power Generation, (ii) < 10,000 ha of Culturable Command Area	General Conditions shall apply

The proposed additional spillway project will neither alter the present culturable command area nor the capacity of existing hydro electric power generation. However, as per advice of the World Bank, the project proponent approached the MoEF&CC for clarification on applicability of environmental clearance under EIA Notification. The Expert Appraisal Committee of the MoEF&CC classified the project as "Category-A" project and issued Terms of Reference (TOR) for EIA study. Following the appraisal of the EIA study, Expert Appraisal committee of MOEF&CC has recommended the case for granting of the environment clearance for this project as indicated in the Minutes of the Meeting enclosed as **ANNEXURE-2.1.**

The forests clearance for diversion of forest land also is granted in two stages. Stage I clearance has already been granted to the project. The stage II forests clearance process is going on. The formal forests clearance letter is also likely to be issued soon.

CHAPTER – 3
ENVIRONMENTAL & SOCIAL BASELINE

The objective of conducting baseline survey of the existing environmental and social status in the study area is to provide a data base for predicting the likely changes that are expected in implementation of the project. Simultaneously, it would provide a reliable platform for monitoring such changes in the operation phase. This chapter deals with the approach for data collection, Environmental scoping / identification of Environmental attributes and baseline survey details.

3.1 STUDY AREA:

The study area covers core zone and zone of influence.

CORE ZONE: The core zone is 340m wide stretch of land covering the area involved for construction of dykes, spill way and spill channel which is confined to 170m on either side from the centre line of spill channel.

ZONE OF INFLUENCE:

The influence zone of the project for environmental parameters such as air, water etc is described with River Mahanadi flowing West to East direction forming the southern boundary while the Hirakud dam forms the western and northern boundary and the eastern boundary is demarketed by a line 500m from centre of the spill channel, whereas for the wildlife sanctuary and aquatic flora and fauna it is considered 10km from the centre of the spill way.

3.2 APPROACH FOR DATA COLLECTION:

Collection of baseline data was done according to the terms of reference (ToR) during the period from May to June 2016.

The consultant's team of experts have adhered to a standard approach for collection of baseline data through sight recognisation and sampling, interaction with local people and discussion with project authority, stake holder consultation, collection of data from relevant project records performance overview of the completed phases, collected data from secondary sources and analysis.

The studied parameters include land, water, air, noise, soil, sediment and biological environment as well as the pre-project Socio–economic status of the people of study area.

I. Secondary Baseline Data

Secondary data of the project area were collected from secondary sources like publishes literatures from various government agencies, or institutions on physical, biological and social components of environment. The data were reviewed and verified for establishing existing environmental and ecological status within the project area. Following documents from different sources were consulted for collection of baseline environmental data.

Table 3-1: Sources of Secondary Data

Sl. No.	Information	Source
1.	Toposheets, District Planning Maps	Survey of India, Govt. of India
2.	Meteorological data	Indian Meteorological Department, Govt. of India
3.	Geological data	Geological Survey of India, Directorate of Mines and Geology, Government of Odisha
4.	Sesmic zonation	Odisha Disaster Management Authority
5.	Reserve Forests, Protected Forests and Wildlife Sanctuaries	Department of Forests, Govt. of Odisha
6.	Landuse Pattern	Department of Economics & Statistics, Government of Uttar Pradesh,
7.	Forests Statistics	Department of Forests, Govt. of Odisha
8.	Wildlife Sanctuary/ National Parks/Tiger Reserves	Wildlife Department/ Forest department, Odisha

Sl. No.	Information	Source
9.	Demographic Profile	District Census Handbook, Govt. of India,
10.	Archeological Monuments/Sites	Archaeological Survey of India
11.	Legislative Acts and Rules	Department of Economics & Statistics, Government of Odisha, Ministry of Environment and Forest, Govt. of India
12	Census Data of 2011	Census of India, Government of India

Fig. 3-1: Consultation with project officials

Fig.3-2: Consultation with villagers

II. Primary Baseline data

The primary baseline information on different environmental components were collected through field survey. . Field survey were carried out to collect information on the major environmental features such as settlement facilities, drainage pattern of the area, forest, trees within RoW of the alignment, waterbodies, river crossing, sensitive receptors, air, water, noise and soil quality etc. Further primary samples surveys for the environmental components, such as air, surface water, noise and soil characteristics that are critical in the context of the project were carried out during the study period.

Sampling stations were strategically located. Soil & Water samples were collected as per recommended procedure. Suitable equipments are used to record Air quality and Noise level at site.

Literature and authentic records were consulted to study the Environment & Socio–Economic status concerning the study areas.

Table 3-2: Field Survey and Sampling Period

Sl	Items	Period
1.	Water quality	25th & 26th May 2016
2.	Soil quality	25th & 26th May 2016
3.	Ambient Air Quality	25th May 2016 to 7th june 2016
4.	Noise level	25th & 26th May 2016
6.	Natural Environment (Flora & Fauna)	30th October to 10th November 2016

Status of preproject environmental conditions in the study area was considered in three noticeable sectors, i.e.

A. Physical environment
B. Biological environment
C. Social environment

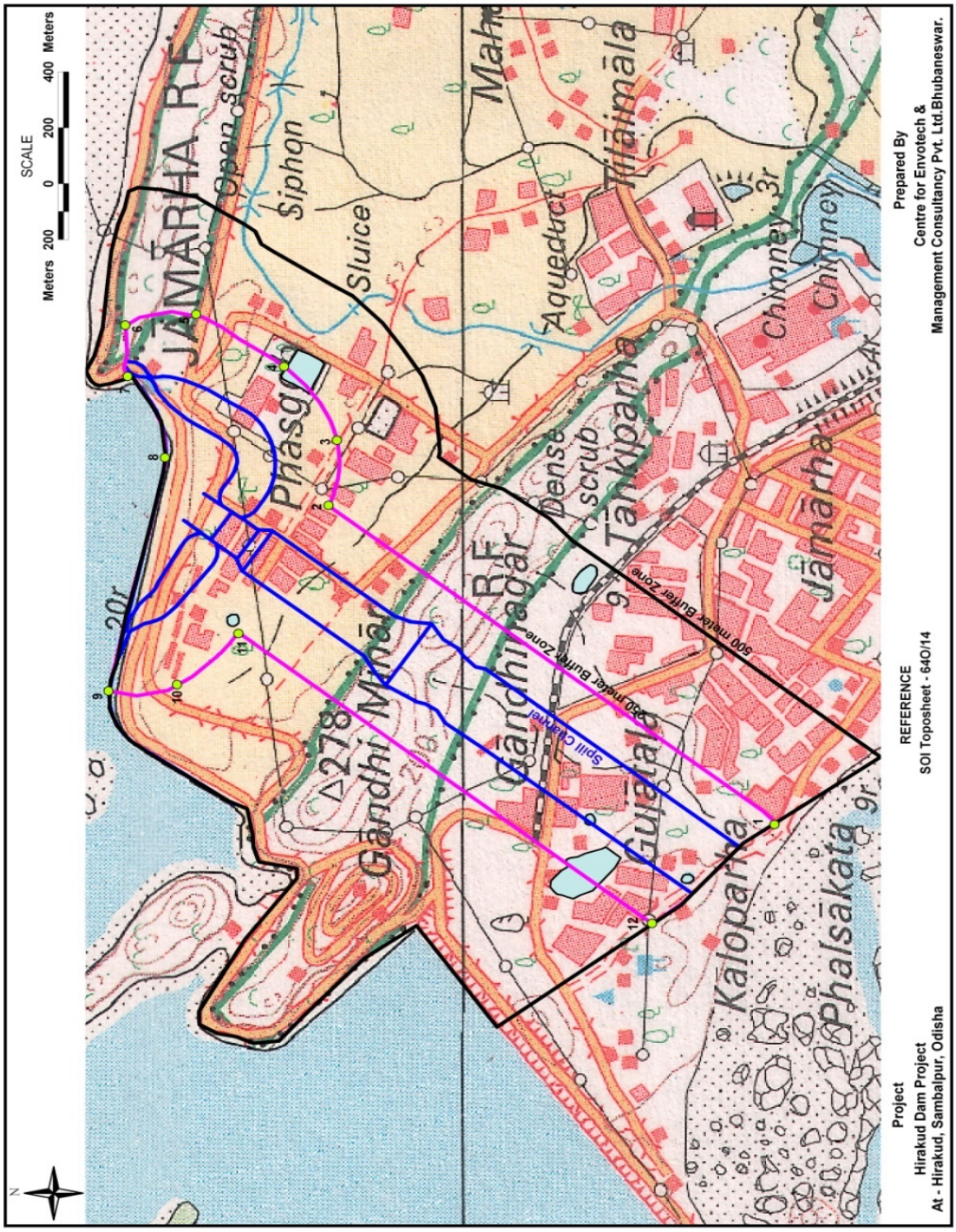


Fig. 3-3: Map of the Study area

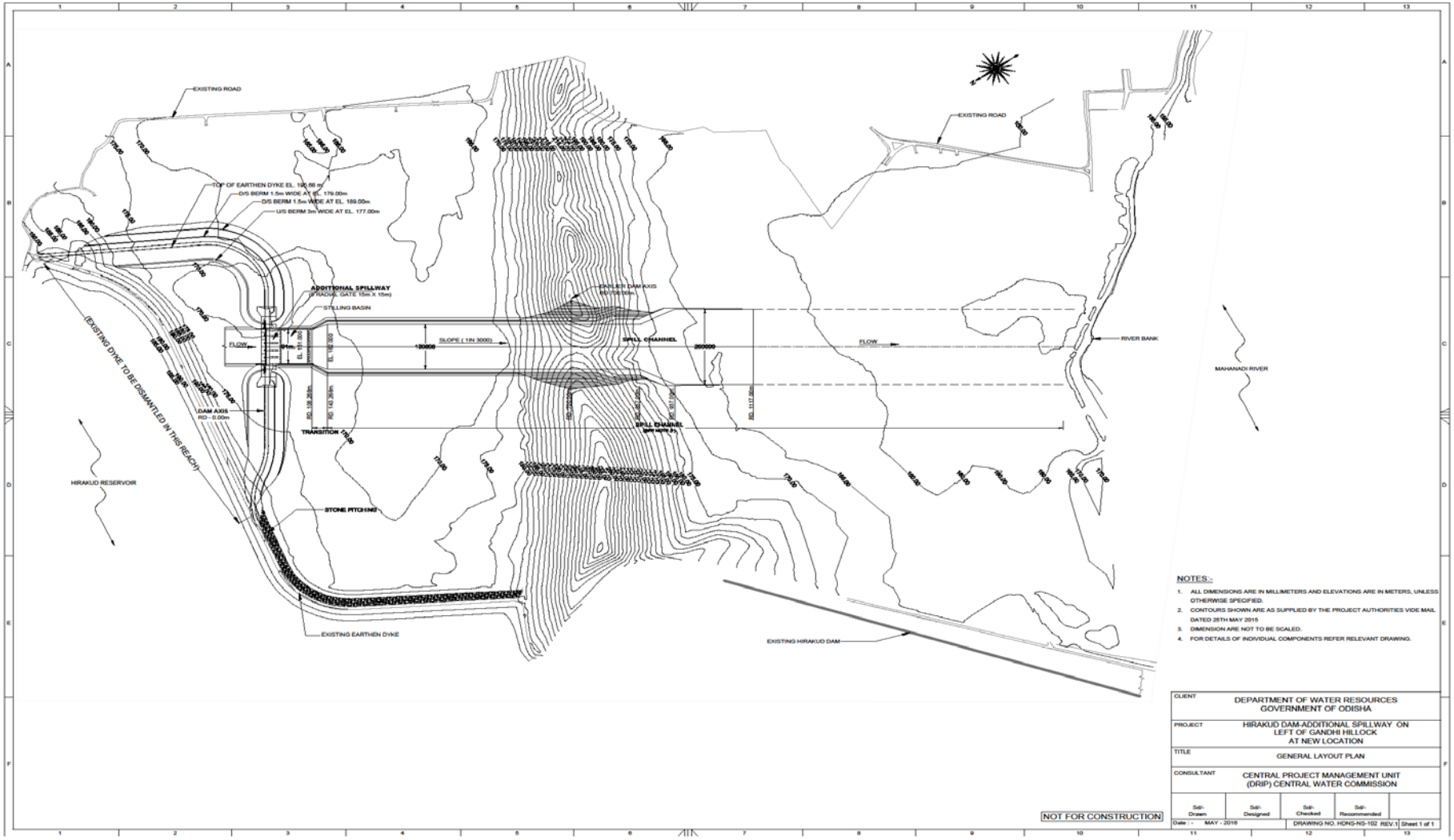


Fig. 3-4: Additional spillway structure of Hirakud Dam

3.3 PHYSICAL ENVIRONMENT:

Baseline environmental parameters for physical environment include survey for preproject status of land, air, water and climatic conditions of the study area.

3.3.1 LAND ENVIRONMENT:

Baseline assessment included field survey, sampling, laboratory tests, consultations and literature review of significant Environmental issues which were identified during the process of environmental reconnaissance (ER) and review of earlier studies undertaken for similar activities.

Baseline assessment of land Environment comprises of Physiography, Geology, Seismology and soil characteristics of the study area. The relevant information's and data mostly relates to literature review, thematic interpretation and consultation of statistical records. Field sampling and laboratory testing methods for soil quality parameters were adopted.

3.3.1.1 Physiography:

The study area mostly comprises of hills, valleys and plains. The topography is highly undulating in the hilly regions and gentle sloping in at the foot hills. In the central part of the study area large hill ranges are present extending in the WNW-ESE direction. This hill range is coming under Lamdungri Reserve Forest and appears at about 700 m away from the additional spillway in sw direction. The highest elevation of these hills in the study area is 278m Above Mean Sea Level (AMSL) whereas the lowest elevation in the study area is 160m Above Mean Sea Level (AMSL), which is shown in shaded relief map in **Fig 3-5**. These hill ranges divide the study area into two parts, one to the northern and the other in the southern part. In general; slope of the study area in the southern region is towards south and in northern region at NE. Major Drainage of this area is Mahanadi River which lies in the southern part of the study area flowing south westerly.

3.3.1.2 Geology:

The study area comprises of varied lithology ranging from Archaean to recent age. The area is underlained by Archaean crystallines mainly of granites and granite gneisses. The occurrence of alluvium is of recent to sub-recent period. The general geology of the area as envisaged from the geo-technical report of the spill channel area is that it is a nearly flat surface with top surface covered with greyish silty soil. Some outcrops of gray granite gneisses are exposed at a few locations. Along 300m upstream of old spill way axis, completely weathered, decomposed rock mass of granitic gneiss is exposed along the foothills. Intensely fractured ferruginous quartzites covered with soil forms the NW-SE trending ridge.

Granite and granite gneiss: These are the major litho units occupying vast areas of the study area and limited to central part of the study area.

Alluvium: This is the youngest geologic unit of recent age. It consists of gravel, sand, silt and clay. It is developed in the flood plains of the major river i.e. Mahanadi and its tributaries.

Erosion situation:

Rocks usually do not stay as it is forever. Forces like wind and water break down rocks through the processes of weathering and erosion. As a matter of fact, topsoil of the area has been completely washed away resulting in exposure of rocks at places in general and the top of the hill. Lamdungri RF includes a series of hillocks with less of flat land at the toe.The area is more succeptable to erosion and project authority has provided garland drains around the project area. Some part of Tara nagar on the hill slop erosion has been taken place due to excavation activity of the local people.

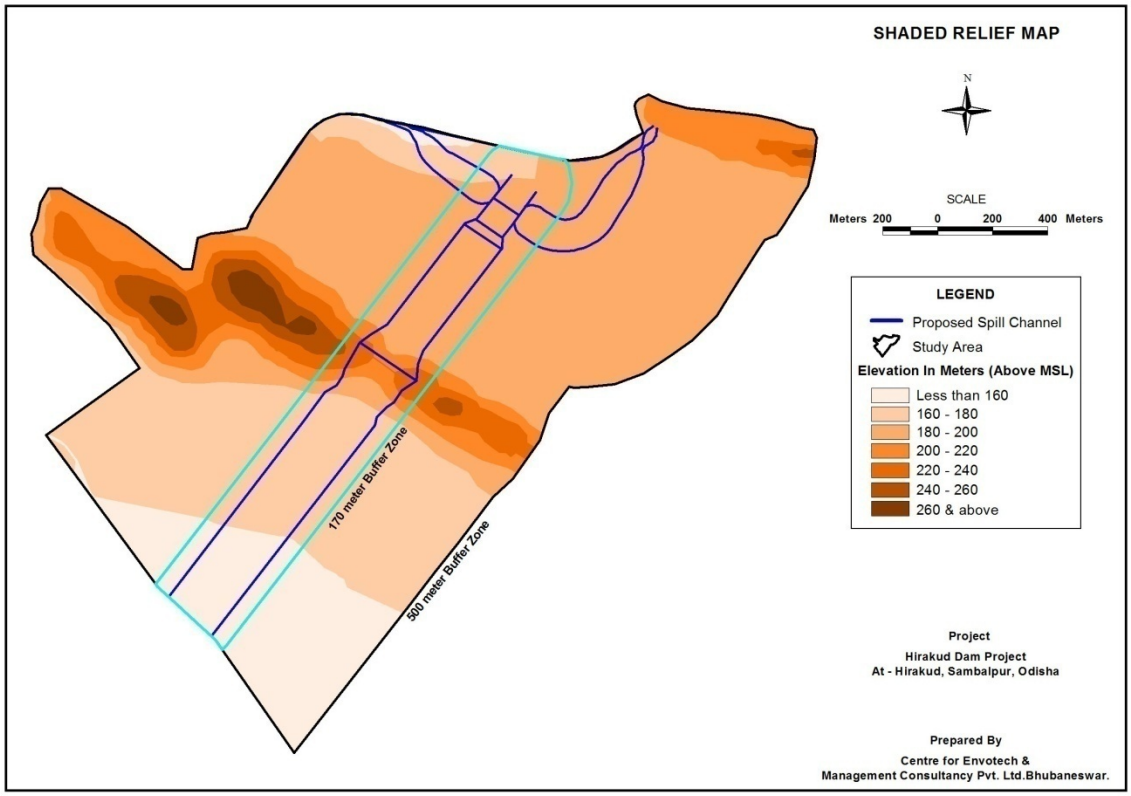


Fig. 3-5: Shaded Releif Map of Study Area

Fig. 3-6: Environmental features in and around the proposed Additional Spillway

3.3.1.3 Seismology:

Seismic zone:

Initially the entire Indian landmass, was broadly been divided into 5 different seismic zones namely, zone-I, zone—II, zone-III, Zone-IV and zone-V basing on different levels of earthquake hazard. Subsequently the revision of the seismic zone map given earlier in the vulnerability atlas of India 1997, the seismic zone-I has been merged into seismic zone-II and renamed as zone-II. Recently the **Medvedev–Sponheuer–Karnik scale**, also known as the **MSK** or *MSK-64*, is a macro-seismic intensity scale used to evaluate the severity of ground shaking on the basis of observed effects in an area of the earthquake occurrence. **The project area comes under zone-III.**

In zone-II, the probable seismic intensity is MSK VI or less. This zone is referred as low damage risk zone and in zone-III the associated intensity is MSK VII. This is termed as moderate damage risk zone. Seismic Zone map describing seismicity of Odisha is given in **Fig 3-7. The moderate damage risk zone would thus require that design of the structure be such that it can withstand earthquakes of magnitude of upto 7 on the richter scale.**

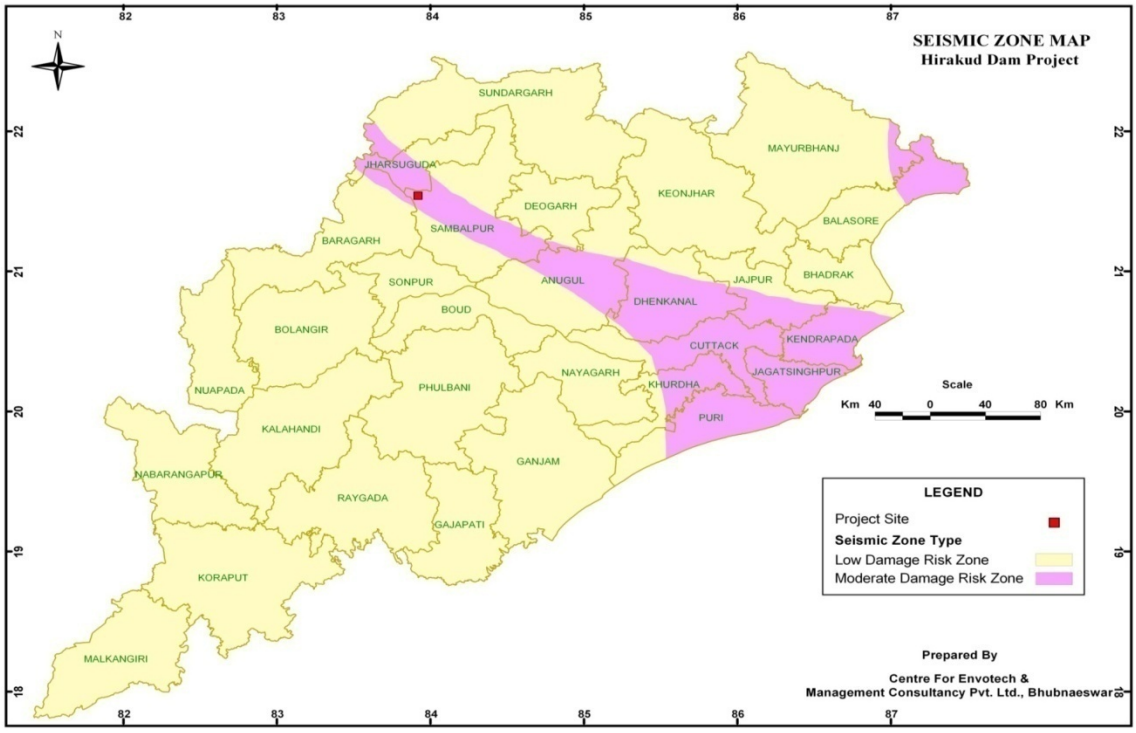


Fig. 3-7: Seismic Zoning Map of Odisha (Source: Odisha Disaster Management Authority).

3.3.2 Meteorology:

Meteorology of the study area plays an important role in air pollution studies. The prevailing meteorological conditions at the Project site will regulate the dispersion and the dilution of air pollutants in the atmosphere. The predominant wind speed at the project site will decide the direction and distance of the most affected area from the proposed activity.

The critical weather elements that influence air pollution are wind speed, wind direction, temperature, which together determines atmosphere stability.

To study the meteorological parameters of the study area data obtained from the nearest IMD stations located at Hirakud.

The parameters observed from these IMD stations are Temperature, Barometric pressure, Relative Humidity, Rainfall, Wind Speed and Wind Direction which are reflected in **Table 3-3.**

As per the data (1961-1990), obtained from the nearest IMD station Hirakud,. Hot summer is felt from March to June and the maximum temperature has been recorded as high as 45^0C in the month of May.

July onwards the area experiences the monsoons. The project area gets rainfall from South Western monsoon. The usual rainfall occurs for a period of four months during monsoon. The total rainy days

during this four month period are around 55 – 60 days. The South-West monsoon lasts from mid June to mid September and the area receives more than 80% of the annual rainfall during the period. The normal annaul rain fall in this area is 1415.1 mm

Winters season extends between the months of October to February. These months experience a maximum temperature of 35°C and and minimum temperature of 100C. During study period the predominant wind direction is SW. Detailed wind rose diagram is given below:

The 30 years average meteorological data of Hirakud observatory of IMD is represented in **Table3-3 and Fig.3-8 & Fig.3-9** respectively**.**

Table 3-3: Meteorological data of Hirakud for the period from 1961 to 1990

HIRAKUD (Climatological Normals-1961-1990)									
Month	**Temperature**		**Relative Humidity**		**Wind Speed**	**Predominant Wind Direction (Wind from)**	**Rainfall**	**Station Level Pressure**	
	Max	**Min**	**Max**	**Min**	**Avg.**	**%**	**mm**	**Max**	**Min**
JAN	31	10	66	47	2.7	N	11.5	999	995
FEB	35	12	60	39	3.1	N	27.3	997	992
MAR	39	16	50	32	3.3	NW	22.7	994	989
APR	42	20	48	29	4.5	SW	19.3	991	985
MAY	45	23	50	30	5.3	SW	32.4	987	982
JUN	43	23	68	56	6.4	SW	202.3	983	979
JUL	35	24	84	78	5.8	SW	396.4	983	980
AUG	35	23	85	80	5.5	W	408.8	984	981
SEP	34	24	80	74	4.6	W	229.1	988	984
OCT	34	19	71	60	3.7	E	54.2	994	990
NOV	32	14	65	53	3.1	NE	6.2	997	994
DEC	30	10	66	51	2.6	N	4.9	999	995

Source: IMD, Climatological Normals (1961 - 1990)

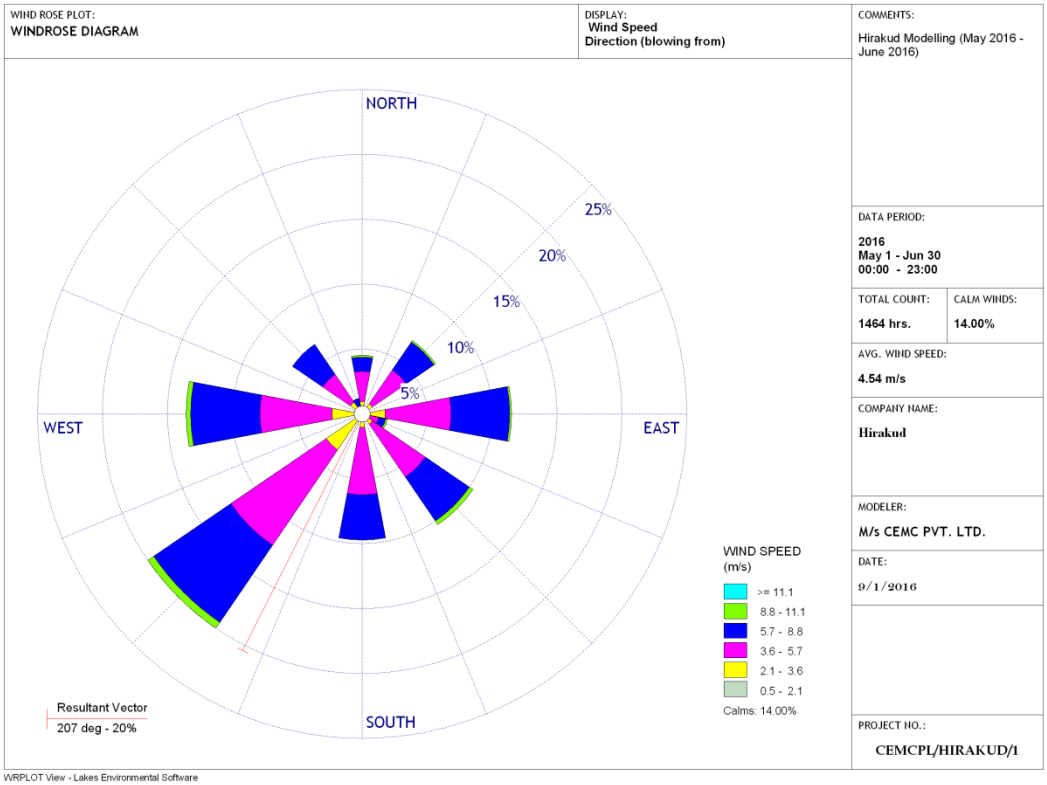


Fig. 3-8: Wind Rose Diagram of Hirakud (May 2016 - June 2016)

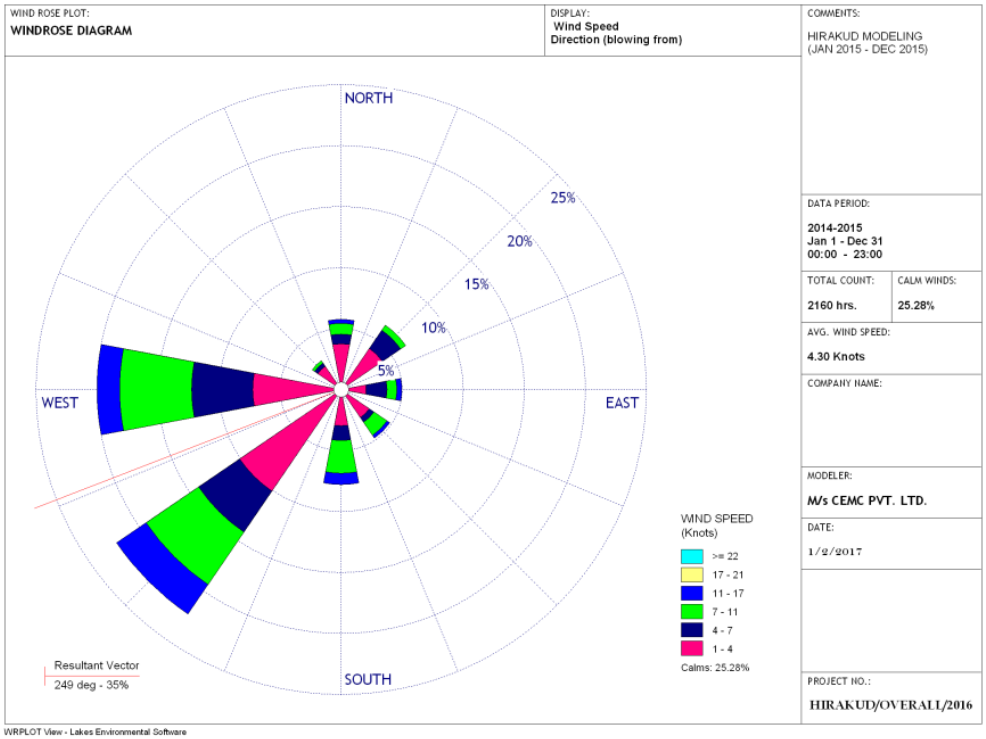


Fig. 3-9: Yearly Wind Rose Diagram

Monthly rainfall data of Sambalpur district for last 5 years period i.e. from 2011-2015 have obtained from Hydro-met Division, IMD and furnished in **Table 3-4,** and also graphically presented below**.**

Table 3-4: Comparison of monthly Rainfall of Sambalpur District for the period 2011 to 2015.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2011	0	11	1.3	39.9	51.6	200.6	310.4	295.7	534.6	28.1	0	0	1473.2
2012	102	11	0	13.7	3.2	235.8	429.6	743.8	282.9	94.3	46.2	2.2	1964.7
2013	7.1	10.7	1.9	31.5	14.2	191.8	495.5	254.8	155.1	248.1	0	0	1410.7
2014	0	25.6	13.3	0.8	28.3	65	419.8	634.4	329.7	46.2	0	1.5	1564.6
2015	5.8	3.6	7.4	52.6	2.5	248.8	463.3	331.6	136.6	5.5	0	14.7	1272.4
Monthly Average	22.98	12.38	4.78	27.7	19.96	188.4	423.72	452.06	287078	84.44	9.24	3.68	

Source: Customised Rainfall Information System (CRIS), Hydromet Division, IMD, Ministry of Earth Science.

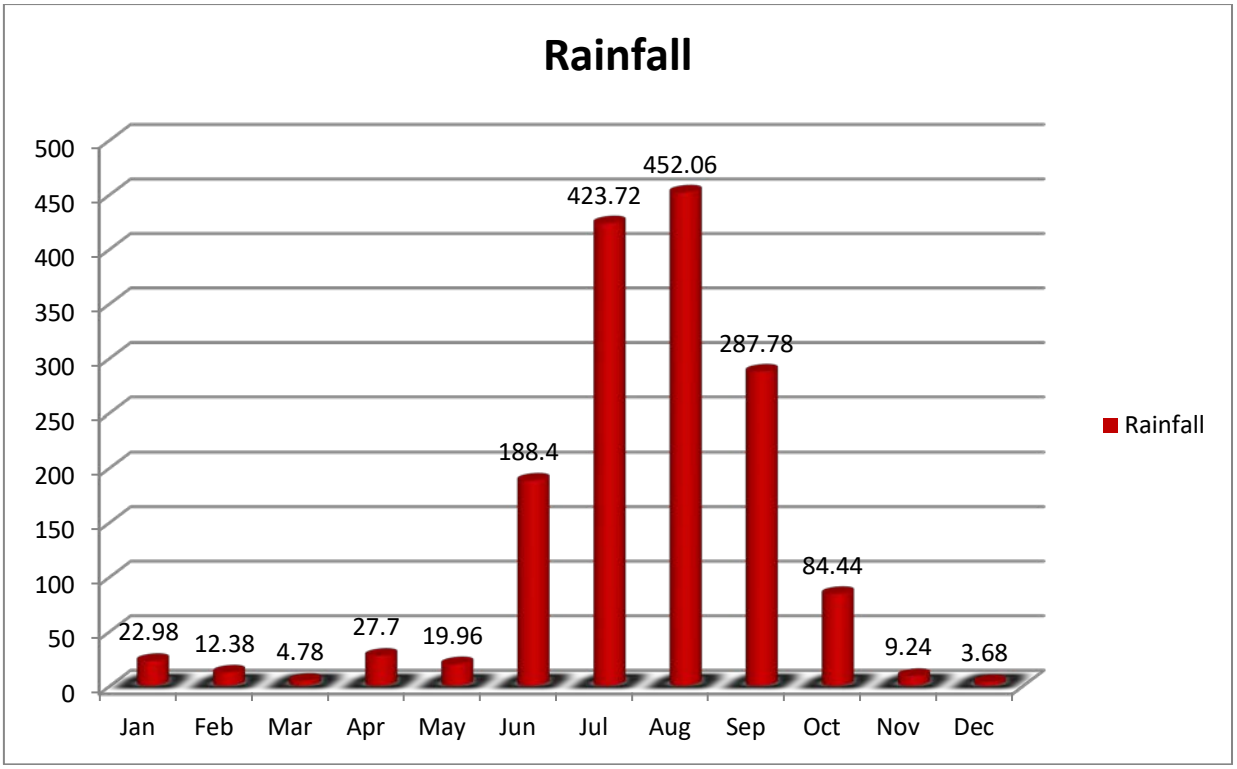


Fig. 3-10: Monthly Average Rainfall of last five years

Flood:

Mahanadi is the sixth biggest river system in India having the largest basin area in the state of Odisha. It has a catchment area 48700 sq km in the entire deltaic region beyond Munduli Barrage, which gets affected by medium to severe flood almost often causing immense loss to life and property. The problem starts when the flood at delta head of Mahanadi (Munduli) exceeds the safe limit of 24600 cumecs. In 1957 Hirakud dam was build up on the Mahanadi at Sambalpur to cater the irrigation, hydroelectricity generation mainly. Along with these purposes, it acted as a major check point for flood control in the downstream. If we see the past records, before the construction of Hirakud dam the delta area had witnessed 27 years of flooding during 90 years (1868-1957). But in the post-construction period during the last 53 years (1959-2011), the floods in the delta have been reported in only 9 years. Even though the frequency of floods in Mahanadi downstream has been decreased substantially by Hirakud dam, there are lot of peripheral activities and climatological factors emerging day by day to concern the flood possibility.

3.3.3 Land Use & Land Cover Pattern:

As Land use refers to "man's activity and the various uses which are carried on land" and Land cover refers to "natural vegetation, water bodies, rock/soil, artificial cover and others resulting due to land transformation", the study area also consists of different types of lands. The Land use/Land cover map of the study area is prepared based on the satellite imagery as well as secondary information along with limited field survey. The satellite imagery map showing the present Land use and Land cover in the study area is furnished in **Fig. 3-11.**

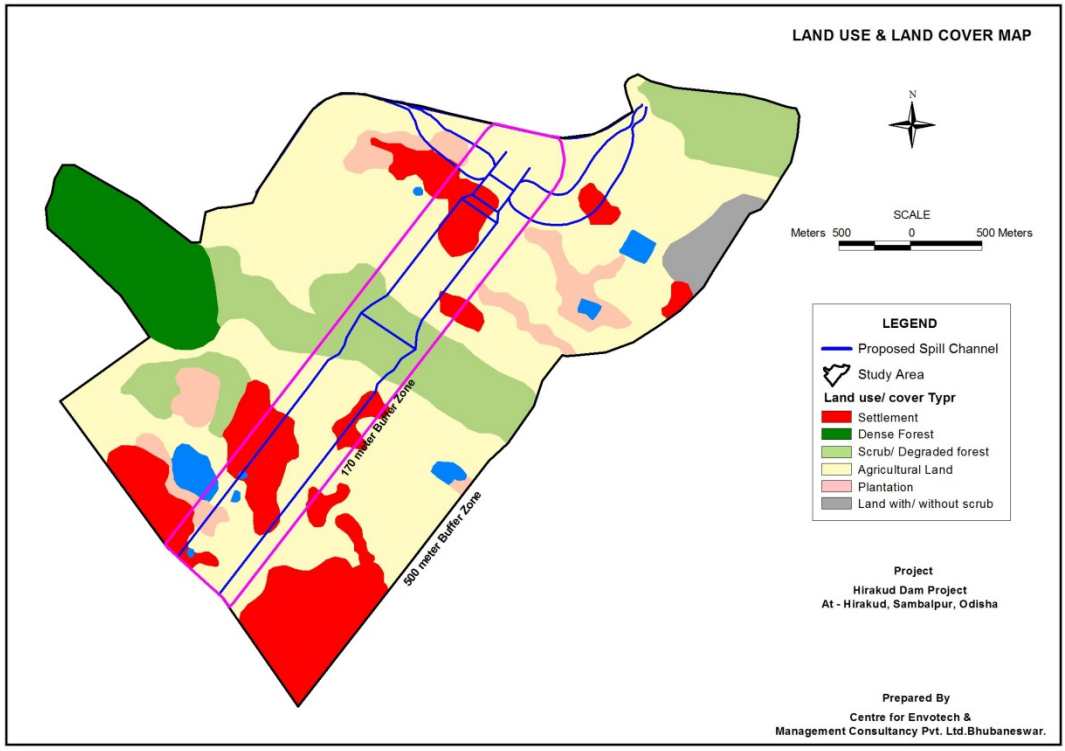


Fig. 3-11: Land Use Map of the study area

Table 3-5: Land Use / Land Cover Pattern of the Study Area

Land use Pattern	Area in ha	Percentage
Settlement	47.74	15.34
Scrub/Degraded Forest	49.18	15.80
Plantation	16.95	5.45
Agricultural Land	165.8	53.28
Water body	3.46	1.11
Dense Forest	22.48	7.22
Land with/without Scrub	5.60	1.80
Total	**311.21**	**100**

It reveals from the analysis that about 53% of the total land is agricultural land. Approximately 15% land covered by settlement, 15.8% by Scrub/ degraded forest and other rest land is combination of dense forest, water bodies and plantation. In the central and north-eastern part of the study area some forest patches are found. Maximum no. of habitations is found in the southern part of the project area. The details about the land categories are given below.

Settlement: It is defined as an area of human habitation developed due to non-agricultural use and that which has a cover of buildings, transport and communication, utilities in association with water, vegetation and vacant lands. The rural settlements are mostly associated with vegetation cover and smaller in size.

Scrub/Degraded forest: Forest lands with poor tree growth mainly of small or stunted trees having density less than 10%.

Plantation: These are the areas associated with degraded forest land where plantation has been made to regenerate the forest or areas where orchards/horticulture has been developed. These areas are characterized by regular shape.

Agricultural Land: It is defined as the land primarily used for farming and for production of food, fiber, and other commercial and horticultural crops.

Water Bodies: These are natural or artificial occurrences of water in form of river, ponds and reservoirs. They may be perennial or non-perennial in nature.

3.3.4 SOIL QUALITY:

Soil is the most important medium for supporting agricultural development. Its properties influence fertility, water retention capacity, gas exchange ability and physical support capacity of plant roots, determination of various other chemical constituent parameters in the study area. The following activities will have to be undertaken for assessment of soil quality / soil properties.

3.3.4.1 Methodology:

For studying the soil profile of the region two soil sampling stations were selected to assess the existing soil conditions in and around the project area. Soil samples were collected during the study period and its physical and chemical properties were analyzed.

Soil samples were collected during 25th & 26th May 2016 from selected locations in the study area to assess the existing soil conditions in and around the study area. This will establish the baseline characteristics and will facilitate in the identification of the incremental concentrations from the proposed activities at a later stage. The baseline characteristics which are analyzed now takes into consideration the effect on soil due to the existing agricultural activities and other anthropogenic activities in the study area.

There will be no flushing or sediment removal from the dam area as part of the spillway development plan. Sedmient flushing is not being undertaken by the dam authorities. There is alsono industrial activity in the project area which may discharge its waste to contaminate the land/soil of its vicinity. . Therefore, there is no sediment contaminationenvisaged in the project area.

Thus the sampling locations are decided based on one or more criteria listed below:

- To determine the existing soil characteristics of the study area.
- To determine the impact on soil characteristics due to the various activities in the study area.
- To determine the impact on agricultural productivity of soil.

3.3.4.2 Soil Sampling Locations:

For studying the existing soil quality status of the study area two soil sampling locations (Ghandhi Nagar and Bahadurpada, the proposed resettlement colony) were selected in and around the project area. Details of the soil sampling locations are presented in **Fig.No.C3-12** and **Table No.C3-6**. Soil samples were collected from each of the sampling locations to analyse the physico-chemical properties.

Table 3-6: Details of Soil Sample Monitoring Locations

Code	Location	Direction	Distance	Latitude	Longitude	Type of Area
		from centre of the spill way				
S1	Gandhi Nagar	South-West	1.10 km	21^0 32’21.60” N	83^0 53’32.53” E	Unirrigated
S2	Bahadurpada	East	0. 65 km	21^0 32’48.51” N	83^0 54’15.98” E	Barren

3.3.4.3 Soil sampling:

From each location soil samples were collected at a depth of 15 cm using a 2.5 cm diameter soil auger. Soil samples were mixed and homogenized. After removing recognizable stones, plant and animal debris, samples were air-dried and sieved through a 2 mm mesh sieve before analysis and kept in sealed containers at 4°C before analysis following Fang (2007). Then, soils were subjected to physical and chemical analyses

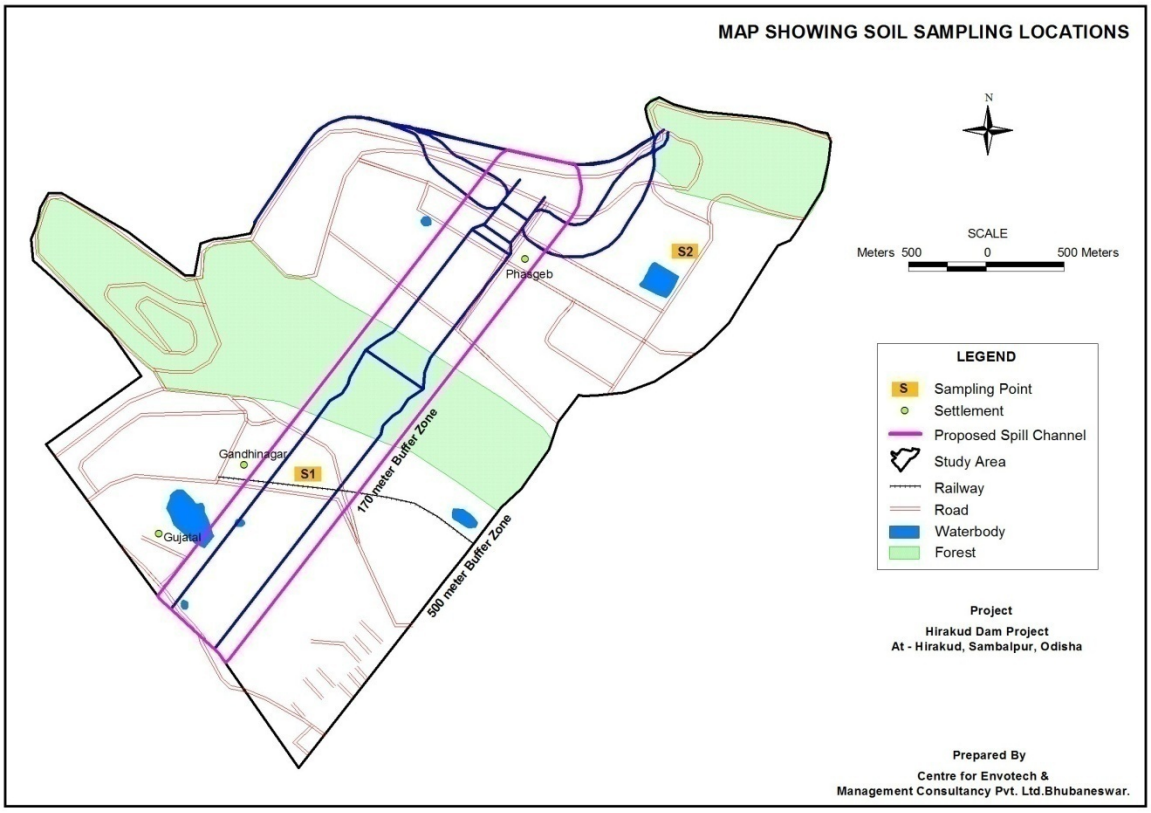


Fig. 3-12: Soil Sampling Location Map

Fig. 3-13: Collection of soil sample from Bahadurpada

3.3.4.4 Soil Characteristics:

Various physico-chemical parameters of soil samples collected from different locations of the study area were analyzed to determine the soil nutrient status. pH was measured with a pH meter. Electrical conductivity (EC) (μmho/cm) at 25ºC was determined in soil extract by using EC- meter (Hesse, 1972). Organic matter and total nitrogen were estimated using Walkely and Black and Micro-kjeldahl methods, respectively as mentioned in Rowell (1996). Estimation of available phosphorus was done according to the Olsen's method, Calcium and Magnesium by Versene method. Flame photometer was used for estimation of sodium and potassium (Rowell, 1996). The moisture content of soil was determined on dry weight basis as per Hoque et al. (2008) and bulk density of soil samples was determined as per Misra (1968).

Table 3-7: Analytical results of soil quality of the study area

Parameters	LOCATIONS	
	Gandhi Nagar	**Bahadurpada**
Colour	Yellowish brown	Yellowish brown
Type of Soil	Acidic	Acidic
pH value at 25^0C(1:10)	6.1	6.4
Texture	Sandy Clay	Sandy Clay
Sand (%)	36.2	39.5
Silt (%)	15.7	19.2
Clay (%)	47.9	41.1
Bulk Density (g/cm^3)	1.36	1.52
Porosity (%)	28.65	33.87
Moisture content (%)	13	14
Chloride (mg/kg)	200	308
Sulfate (mg/kg)	50	95
Available Phosphorus (mg/kg)	25.2	28.9
Available Potassium (mg/kg)	4	12.1
Available Sodium (mg/kg)	12	22.8
Iron (%)	0.01	0.021
Available Organic Carbon (%)	1.2	1.9
Available Nitrogen (mg/kg)	28	32
Conductivity (Micro mho/cm)	114.6	169.7

3.3.4.5 Discussion:

Plants are capable of absorbing and assimilating as many as forty or fifty different chemical elements. Sixteen of these chemical elements have been found to be essential to the growth of most plants. Knowledge of the physical and chemical characteristics of soil is essential to the successful growth of all plant life. Thus soils are tested to determine if essential plant nutrients are present in it or not for raising the desired plants.

Bulk density:

Bulk density is an indicator of soil compaction and soil health. It affects infiltration, rooting depth, available water capacity, soil porosity, plant nutrient availability, and soil microorganism activity. It also influences key soil processes and productivity. It is generally the weight of dry soil per unit of volume typically expressed in g/cm^3. The higher the bulk density the less pore space a soil has. Typical bulk density values depend on the soil materials and conditions. As Bulk density reaches 1.55 to 1.6 g/cm^3, restriction of root growth starts and at about 1.8 g/cm^3 root penetration is inhibited. In the present study, the bulk density of soil samples collected from different locations are between 1.36 and 1.52 g/cm^3 and hence considered ideal for growth of plant roots (**Table 3-7**).

Moisture content:
The percentage of moisture content of different locations of the study area ranged from 13 to 14 (**Table 3-8)**. Soil moisture content is having a major contribution towards maintaining the soil nutrient status and also one of the important factors affecting nitrification. In water logged areas soil suppresses the process of nitrification because of deficient oxygen. Range of moisture content as 13% to 14% noticed in the present investigation period at different locations of the study area is suitable for the activity of soil microbes and in the process of nitrification.

pH:
The pH indicates the acidity or alkalinity (basic) of the soil. Different plants have differing optimum soil pH requirements. The majority of plants prefer a pH of around 6, which is very slightly acidic. The soil pH is important in determining the availability of soil minerals. At pH extremes some minerals are "locked up" and cannot be used by the plants, whilst other minerals may become toxic. Soil pH can have an effect on microbial activity in the soil. As for example, the *Rhizobium* bacteria that are associated with the nodulation of legume plants do not survive well in acidic soils. Further pH of soil mainly depends on the soil water ratio. The pH of the soil samples in the study area ranged from 6.1 to 6.4 (**Table 3-9**) which clearly indicate that soil pH of the study sites is mildly acidic in nature.

Electrical Conductivity:
Electrical conductivity, as the measure of current carrying capacity, gives a clear picture of the amount of soluble salts present in the soil. It plays a major role in the salinity of soils. There is a relation between electrical conductivity and salinity. Lesser the EC value low will be the salinity value of soil and vice-versa. Conductivity of the soil samples of study area varied from 114.6 to 169.7 µmho/cm (**Table 3-10**). Electrical conductivity values within 250 µmho/cm are considered as normal nature of soil. EC values of soil between 250 and 750 µmho/cm are considered as moderately tolerant for agricultural practices and 750 to 2250 µmho/cm are considered critical for tolerant crops, while EC values more than 2250 µmho/cm are not considered safe for most of the crops. In the present study, both the soil samples were found to be suitable for agriculture.

Organic Carbon:
The term Soil Organic Matter (SOM) has been used in different ways to describe the organic constituents of soil. SOM as all organic materials found in soils irrespective of their origin or state of decomposition (Baldock and Skjemstad, 1999). It has long been recognized as one of the most important components in maintaining soil fertility, soil quality, and agricultural sustainability. Since SOM consists of C, H, O, N, P and S, it is difficult to directly measure the SOM content. Most analytical methods of organic matter generally measure only organic compounds or carbon and estimate SOM through a conversion factor. Therefore it is only an approximation of the level of once-living or decomposed matter. Soil organic matter is often viewed as the thread that links the biological, chemical and physical properties of a soil. It has been associated with numerous soil functions like nutrient cycling, water retention and drainage, erosion control, disease suppression and pollution remediation, etc. In the present study it was observed that the organic carbon varied between 1.2% and 1.9% which is suitable for agricultural practices.

Availabe Nitrogen:
The nitrogen in terms of percentage in different locations of study area ranged between 28 to 32 mg/kg (**Table 3-11**). Nitrogen is one among the four primary elements essential for the plant tissues. It is the major component of proteins, nucleic acids and chlorophyll. The atmospheric nitrogen gets trapped in the soil during electro and photo-chemical fixation and also by the action of microorganisms. Soil nitrogen is made available to various groups of plants through a process of mineralization. The total nitrogen in soil exists in both organic and inorganic forms. Organic form of nitrogen content present in the soil is decayed by microbial activity. During this process all the organic nitrogen gets converted to ammonium, nitrates and nitrites. Such forms of nitrogen are easily taken up by the plants for their various metabolic processes. It also plays a major role in maintaining the fertility of the soil.

Available Phosphorous:
Phosphorus is essential for plant growth. It is a component of adenosine diphosphate (ADP) and adenosine triphosphate (ATP). These two compounds are involved in most significant energy transformation processes in plants. The available phosphorous content of soil in different locations of the study area varied between 25.2 to 28.9 mg/kg (**Table 3-12**).

In connection to macronutrient required by plants, phosphorus is the second most important macronutrient available in the soil to be used by various plant life forms for different metabolic activities. It is a major component of nucleic acids, phospholipids and many phosphorylated compounds. Similarly, it is also a second most limiting factor often affecting plant growth. Chemically, phosphorus exists in the

soil in the form of both organic and inorganic forms. Generally plants are dependent on inorganic phosphorus especially in the form of phosphate ions, whereas organic phosphates are also important sources of phosphorus in almost all types of soils. In comparison to other macronutrients phosphorus is required in small quantities, but it may be the most likely limiting element in productivity of the plant. Therefore ecologically it is very much significant.

Potassium:
The exchangeable Potassium (K) values were found to be in a wide range - ranging between 4 to 12.1 mg/kg (**Table 3-13**). Potassium plays many essential roles in plants. It is an activator of many enzymes responsible for various metabolic activities like starch synthesis, nitrate reduction, and sugar degradation. Potassium is extremely mobile within the plant and helps regulate the opening and closing of stomata in the leaves and uptake of water by root cells.

Potassium is also essential for photosynthesis, protein synthesis, starch formation and for the translocation of sugars. All root crops generally respond to application of potassium. As with phosphorus, if it may be present in large quantities in the soil and yet exert no harmful effect on the crop. Potassium increases crop resistance to certain diseases and by encouraging strong root and stem systems, helps to prevent the undesirable growth of plants that is sometimes caused by excessive nitrogen. Potassium delays maturity, thereby working against undue ripening influences phosphorous can exert. In general way, potassium exerts a balancing effect on the effects of both nitrogen and phosphorous. Hence it is one of the important macronutrient acts as a multi-nutrient fertilizer.

Sodium:
The sodium content in the study area ranged between 12 to 22.8 mg/kg (**Table 3-14**). The sodium content in soil identifies the degree to which the exchange complex is saturated with it. It is important to note that sodium has been found partially to take the place of potassium in the nutrition of certain plants.

However, if any cultivation/plantation will be done in the particular sampling area then depending upon the cultivation/plantation the manure will be supplied to the soil for development of the soil fertility.

3.3.5 AIR QUALITY:

The objective of the study is to analyze the existing ambient air quality within the study area and compare it with the standards specified by CPCB/SPCB to know about the pollution status of air in and around the study area. To quantify the impact of the construction activities on the ambient air quality at the study area and its surrounding area, it is necessary to evaluate the existing ambient air quality in those areas.

3.3.5.1 Frequency & Duration of Sampling:

The existing ambient air quality of the study area was measured during 25th May, 2016 to 7th June, 2016 and analysed in terms of Particulate Matter (PM_{10}), Particulate Matter ($PM_{2.5}$), Sulphur-dioxide (SO_2), Oxides of Nitrogen (NOx), Carbon Monoxide (CO) and Hydrocarbon (HC). The causes of air pollution in the area will be due to construction activities i.e. excavation, construction and allied work, vehicular movement, dust arising from unpaved village roads and domestic fuel burning. The critical weather elements that influence air pollution are wind speed, wind direction, temperature, which together determines atmospheric stability.

The National Ambient Air Quality Standard as per MoEF Notification of 16 Nov., 2009 is furnished in table below.

Table 3-8: National Ambient Air Quality Standard (as per MoEF Notification of 16 Nov., 2009)

Sl. No.	Pollutant	Time Weighted Average	Concentration in Ambient Air		
			Industrial, residential, Rural and Other Area	Ecologically Sensitive Area	Methods of Measurement
1	Sulphur Dioxide (SO_2), µg/m^3	Annual * 24 hours **	50 80	20 80	- Improved West and Gaeke - Ultraviolet fluorescence
2	Nitrogen Dioxide (NO_2), µg/m^3	Annual * 24 hours **	40 80	30 80	- Modified Jacob & Hochheiser (Na-Arsenite) - Chemiluminescence
3	Particulate Matter (size < 10µm or PM_{10}) µg/m^3	Annual * 24 hours **	60 100	60 100	- Gravimetric - TOEM - Beta attenuation

Sl. No.	Pollutant	Time Weighted Average	Concentration in Ambient Air		
			Industrial, residential, Rural and Other Area	Ecologically Sensitive Area	Methods of Measurement
4	Particulate Matter (size < 2.5µm) or $PM_{2.5}$ µg/m^3	Annual * 24 hours **	40 60	40 60	- Gravimetric - TOEM - Beta attenuation
5	Ozone (O_3) µg/m^3	8 hours ** 1 hour **	100 180	100 180	- UV photometric - Chemilminescence - Chemical Method
6	Lead (Pb) µg/m^3	Annual * 24 hours **	0.50 1.0	0.50 1.0	- AAS/ICP method after sampling on EPM 2000 or equivalent filter paper - ED-XRF using Teflon filter
7	Carbon monoxide (CO), mg/m^3	8 hours ** 1 hour **	02 04	02 04	- Non dispersive Infra Red (NDIR) spectroscopy
8	Ammonia (NH_3) µg/m^3	Annual * 24 hours **	100 400	100 400	- Chemiluminescence - Indophenol blue method
9	Benzene (C_6H_6) µg/m^3	Annual *	05	05	- Gas chromatography based continuous analyzer - Adsorption followed by GC analysis
10	Benzo(a) Pyrene (BaP)–particulate phase only, ng/m^3	Annual *	01	01	- Solvent extraction followed by HPLC/GC analysis
11	Arsenic (As), ng/m^3	Annual *	06	06	- AAS/ ICP method after sampling on EMP 2000 or equivalent filter paper
12	Nickel (Ni), ng/m^3	Annual *	20	20	- AAS/ ICP method after sampling on EMP 2000 or equivalent filter paper

* Site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 08 hourly or 01 hourly mentioned 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.

3.3.5.2 Location of Air Quality Monitoring Stations:

The baseline status of the ambient air quality has been established through a scientifically designed ambient air quality monitoring network and was based on following considerations:

- Meteorological condition on synoptic scale.
- Topography of the study area.
- Representatives of regional background air quality for obtaining baseline status.
- Location of residential areas representing different activities.

To assess the ambient air quality level, four monitoring stations were set up in the study area and their details are presented in **Table 3-9**. The montoring locations are shown in **Fig. 3-14**.

Table 3-9: Ambient Air Quality (AAQ) Monitoring Stations

Sl. No	Station Code	Distance	Direction	Location	Latitude	Longitude	Type of Area
		From centre of spillway					
1	A1	0.24 km	West	Near First gap	$21^0$32’53.90” N	$83^0$53’44.30” E	Residential
2	A2	1.09 km	South-west	Near Nehru Udyan	$21^0$32’31.41” N	$83^0$53’25.47” E	Residential
3	A3	1.52 km	South	Near Mechanical Division	$21^0$32’05.67” N	$83^0$53’41.86” E	Commercial/ Industrial area

4	A4	0.72 km	East	Bahadurpada	$21^0$32’46.88” N	$83^0$54’18.67” E	Residential

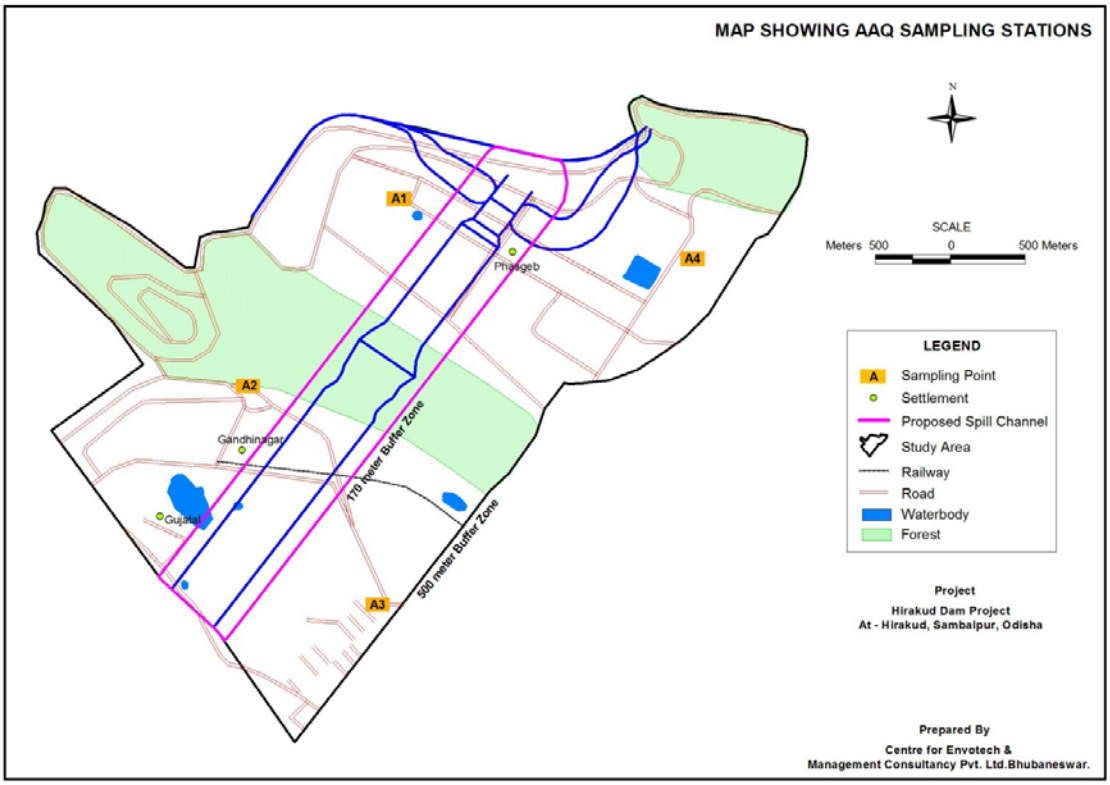


Fig. 3-14: AAQ Monitoring Location Map

3.3.5.3 Methodology:

Respirable Dust Samplers have been used for monitoring PM10 (<10 microns) and for gaseous pollutants like SO_2 and NOx whereas Fine Particulate Air Sampler is used to measure PM2.5 (<2.5 microns).

The monitoring was carried out twice a week for 2weeks at each sampling location. The methods of sample collection, equipment used and analytical procedure adopted are presented in **Table 3-10**.

Table 3-10: Methodology of Sampling & Analysis and Equipment used

Sl.	Parameters	Instrument / Apparatus used	Method followed
1.	Fine Particulate matter: $PM_{2.5}$ (size <2.5 micrometer)	Fine Particulate Sampler, Teflon membrane Filter Paper, Balance	Gravimetric methods
2.	Particulate matter PM_{10} (size <10 micrometer)	Respirable Dust Sampler (RDS), Filter Paper Whatman Glass Fiber GF/A, Balance	Gravimetric methods
3.	Nitrogen Oxides (NOx)	RDS with gaseous attachments, Spectrophotometer	Jacobs & Hochheiser modified (Na-Arsenite) methods
4.	Sulphur dioxide (SO_2)	RDS with gaseous attachments, Spectrophotometer	Improved west & Gaeke method
5.	Carbon Monoxide (CO)	CO Analyser	Non dispersive infrared spectroscopy
6.	Hydro Carbon (HC)	Gas Chromatograph	FID detector

Table 3-11: Sampling Location wise AAQ Data (Concentration in µg/m^3 for $PM_{2.5}$, PM_{10}, SO_2, NO_X & HC and mg/m^3 for CO)

	Near First Gap (A1)						Near Nehru Udyan (A2)					
Date	**PM10**	**PM2.5**	**SO2**	**NOx**	**CO**	**HC**	**PM10**	**PM2.5**	**SO2**	**NOx**	**CO**	**HC**
25-26/05/2016	79.6	44.6	5.2	< 9	< 0.1	< 0.1	78.5	40.4	6.7	< 9	< 0.1	< 0.1
26-27/05/2016	85.4	40.3	4.9	9.1	< 0.1	< 0.1	71.2	36.3	6.2	< 9	< 0.1	< 0.1
1-2/06/2016	86.7	46.8	5.6	9.8	< 0.1	< 0.1	76.8	35.6	5.6	< 9	< 0.1	< 0.1
2-3/06/2016	83.9	45.1	4.7	< 9	0.11	< 0.1	73.9	38.1	5.9	9.2	< 0.1	< 0.1
98th Percentile	86.622	46.698	5.576	9.758	0.1088	<0.1	78.398	40.262	6.67	9.176	< 0.1	< 0.1
	Near Mechanical Division (A3)						**Bahadurpada (A4)**					
Date	**PM10**	**PM2.5**	**SO2**	**NOx**	**CO**	**HC**	**PM10**	**PM2.5**	**SO2**	**NOx**	**CO**	**HC**
28-29/05/2016	94.7	54.9	11.1	13	0.12	< 0.1	84.2	43.3	7.6	10.2	< 0.1	< 0.1
29-30/05/2016	89.6	49.9	9.6	13.6	0.15	< 0.1	82.8	41.6	7.4	9.1	< 0.1	< 0.1
4-5/06/2016	91.3	52.5	10.1	14.1	0.14	< 0.1	79.2	38.5	6.8	9.6	0.11	< 0.1
5-6/06/2016	87.2	53.9	10.8	13.7	0.16	< 0.1	81	40.7	7	9.1	< 0.1	< 0.1
98th Percentile	94.496	54.84	11.082	14.076	0.1594	< 0.1	84.116	43.198	7.588	10.164	0.1088	< 0.1

Table 3-12: Summarized ambient air quality analysis data

Location	PM_{10} (µg/m^3)			$PM_{2.5}$ (µg/m^3)			SO_2 (µg/m^3)			NO_X (µg/m^3)			CO (mg/m^3)			Hydrocarbon (µg/m^3)
	Max.	**Min.**	**Avg.**	**Max.**	**Min.**	**Avg.**	**Max.**	**Min.**	**Avg.**	**Max.**	**Min.**	**Avg.**	**Max.**	**Min.**	**Avg.**	
Near First gap (A1)	86.7	79.6	83.9	45.8	39.3	44.2	5.6	**4.7**	5.1	9.8	<9	<9	0.11	<0.1	<0.1	<0.1
Near Nehru Udyan (A2)	78.5	**71.2**	75.1	40.4	**35.6**	37.6	6.7	5.6	6.1	9.2	<9	<9	< 0.1	<0.1	<0.1	<0.1
Near Mechanical Division (A3)	**94.7**	87.2	90.7	**54.9**	49.9	52.7	**11.1**	9.6	10.4	**14.1**	13	13.6	**0. 2**	<0.1	0.2	<0.1
Bahadurpada (A4)	83.2	76.5	79.85	43.3	37.9	40	7.5	6.7	7.1	10.2	**<9**	<9	0. 18	**<0.1**	0.14	<0.1
Range Value	**71.2-94.7**			**35.6-54.9**			**4.7-11.1**			**<9- 14.1**			**<0.1-0.2**			
NAAQS STANDARD	**100**			**60**			**80**			**80**			**< 4.0**			
Testing Method	**IS: 5182 (Part-23)**			**Gravimetric Method**			**IS: 5182 (Part-2)**			**IS: 5182 (Part-6)**			**IS: 5182, (Part-10)**			**GC with FID**

Near Mechanical division

Bahadurpada
Nehru Udyan

First gap

Fig. 3-15: photographs of AAQ monitoring

3.3.5.4 Observations:

Particulate Matter (PM_{10}):

The values of PM_{10} at all the measured locations remain below the NAAQ permissible standard as per CPCB norms for rural, residential and other areas during the moniotoring period.. The average concentration of PM_{10} was recorded in the range of minimum 75.1 $\mu g/m^3$ at Nehru Udyan to maximum of 90.7 $\mu g/m^3$ at Mechanical Division. This higher concentration of PM10 at the mechanical division of irrigation department may be attributed to the impact of emission from HINDALCO Industries Ltd.

Particulate Matter ($PM_{2.5}$):
The concentration of $PM_{2.5}$ at different locations varied between 35.6µg/m^3 - 54.9 µg/m^3. The maximum concentration was recorded at monitoring station A3 sampling station at mechanical division, and the minimum concentration was recorded at A2 sampling station. The mean values at all the locations remain below the NAAQ permissible standard as per CPCB norms for rural, residential and other areas.

Sulphur Dioxide (SO_2):
The SO_2 analysis data shows, that SO_2 concentration of AAQ ranged from 4.7 µg/m^3 to 11.1 µg/m^3. Maximum SO_2 concentration was exhibited at site A3 and minimum at A1. In general the range of SO_2 concentration in the AAQ of the study area is within the specified norms of CPCB.

Nitrogen Oxides (NO_x):
The maximum and minimum concentration of NO_X ranged between <9 µg/m^3 – 14.1 µg/m^3. In all the sampling locations the value of NOx was well within the permissible standard of CPCB.

Carbon Monoxide (CO):
Maximum time the carbon monoxide value remained below the detectable level of 0.1 mg/m^3. The maximum CO value was recorded 0.2 mg/m^3 at mechanical division.

It is inferred from the result that there is a higher concentration in all the analysed parameters at A3 station i.e. near Mechanical Division which comes under commercial or industrial area. However, the values are within the range of NAAQ standard.

3.3.6 Noise Environment:

The physical description of sound concerns its loudness as a function of frequency. Noise in general is an unwanted sound, which is composed of many frequency components of various types of loudness level distributed over the audible frequency range. Sound Pressure Levels (SPL's) are measured in decibels on the A-weighted scale, dB (A), where the A-weighting scheme accounts for the sensitivities of the human ear over the audio spectrum.

3.3.6.1 Noise Levels in the Study Area:

Baseline noise levels have been monitored at different points during 25th & 26th May 2016 within the study area using a noise level meter. Four noise monitoring stations, close to the air monitoring stations, were identified for the assessment of the existing noise levels keeping in view the nature of the monitoring location i.e. residential areas in villages, schools etc. The noise monitoring locations with reference to the Project is given in the **Fig. 3-16.**

Table 3-13: Details of Noise Level Monitoring Locations

Station Code	Distance	Direction	Location	Latitude	Longitude	Type of Area
	From centre of spill way					
N1	0.24 km	West	Near First gap dyke	21^{0}32'53.90" N	83^{0}53'44.30" E	Residential
N2	1.09 km	South-west	Near Nehru Udyan	21^{0}32'31.41" N	83^{0}53'25.47" E	Residential
N3	1.52 km	South	Near Mechanical Division	21^{0}32'05.67" N	83^{0}53'41.86" E	Commercial/Industrial area
N4	0.72 km	East	ahadurpada	21^{0}32'46.88" N	83^{0}54'18.67" E	Residential

Noise Level monitoring was carried out to measure the sound pressure level in the surrounding settlement areas of the study area on hourly basis to study the impact of the noise on the local environment. The day levels have been monitored between 6.00 A.M and 10.00 P.M and the night levels have been monitored between 10.00 P.M and 6.00 A.M. The monitoring results are represented in L_{eq}[dB(A)] and furnished below in **Table 3-14.**

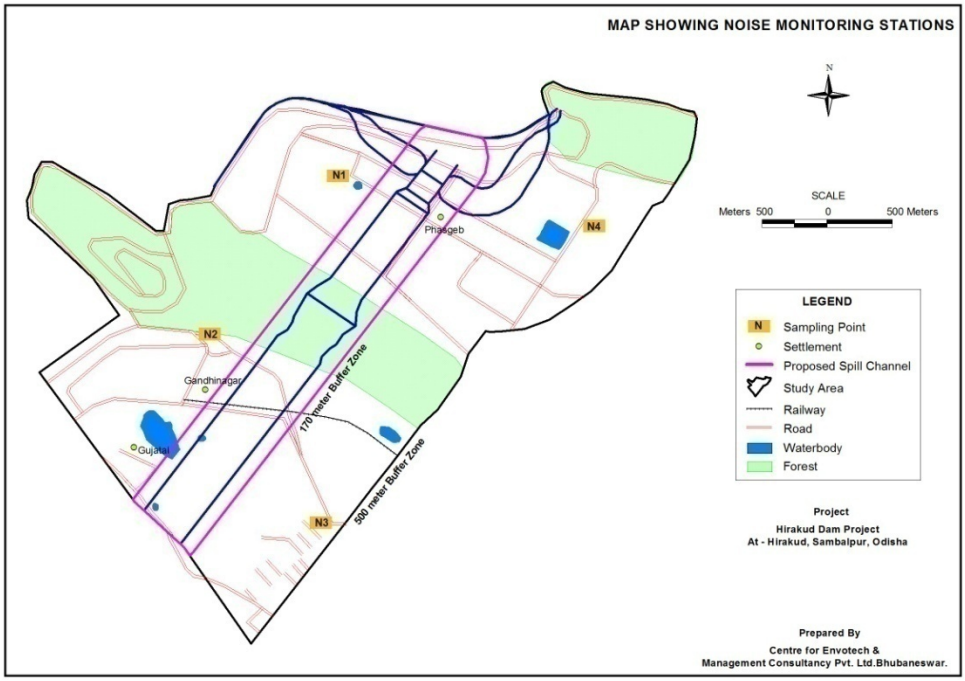


Fig. 3-16: Location map of the Noise monitoring stations

Table 3-14: Noise Level in the Study Area

Code	Location	Area Category	L_{eq}[dB(A)]	
			Day	Night
N-1	Near First gap	Residential	46.2	37.1
N-2	Near Nehru Udyan	Residential	49.5	41.2
N-3	Near Mechanical Division	Residential	42.1	35.2
N-4	Bahadurpada (Road)	Residential	51.4	45.3

Table 3-15: Ambient noise quality standards

Area Category	Limits in dB(A)L_{eq}	
	Day Time (6.00 AM to 10.00 P.M)	Night Time (10.00PM to 6.00 AM)
Industrial	75	70
Commercial	65	55
Residential	55	45
Silence Zone	50	40

3.3.6.2 Observations:

The day time maximum equivalent noise level (51.4) was observed at Bahadurpada, near the Taranagar road, whereas minimum day time equivalent noise level (42.1)observed near Mechanical Division during the study period. Night time equivalent noise level was observed between 37.1 **L_{eq}[dB(A)]** and 45.3 **L_{eq}[dB(A)]**. All the monitoring locations at all time the noise level was found within permissible limit for residencial area as per ambient noise quality standards mentioned in **Table No.C3-15**.

3.3.7 WATER ENVIRONMENT:

The study of water Environment basically consists of water resources and its quality. The baseline study determines quality of parameters to ascertain best use against water pollution.

Water Bodies:

Some non perennial first order streams are noticed within the study area, which carries rainwater during the rainy season for only a brief period. The study area also includes existence of four ponds of medium to small sizes. These are depicted in the Google Map furnished below in **Fig. 3-6**.

The largest Pond is located about 460 m from the toe of the Hirakud Dam having locational co-ordinates between Latitude 21º 32' 22.31" N and Longitude 83º 53' 18.91" E and Latitude 21º 32' 15.48" N and Longitude 83º 53' 21.06" E. The pond is seen holding sufficient water in summer months (May & June). Some local fish species were observed in this pond. From local enquiry it was ascertained that there has been no domestic use of this pond water.

The other 2 ponds are located near the Hira Cable Colony and the other one near the Rolling Mill Colony. The locations are:

- Hira Cable Colony Pond: Latitude 21° 32' 37.25" N & Longitude 83° 54' 8.06" E
- Rolling Mill Pond: Latitude 21° 32' 45.99" N & Longitude 83° 54' 14.69" E

The pond water is stated to have not used for any purpose. With this prospect in the background, water quality tests have been carried out for water samples of these ponds.

The fourth pond is located in Gandhi Nagar Colony which is very small in size. The pond water is also not used for drinking purpose.

3.3.7.1 Study of Drainage Pattern:

The broad drainage pattern of the study area was drawn by using the remote sensing imagery maps and toposheet. The drainage map is furnished in **Fig. 3-17.** The study area features two streams which becomes responsible for draining the area effectively. The major stream is river Mahanadi across which the dam is constructed. One stream is present on north and NE part of the hill range draining the water from NW corner of the areas. This stream will be cut by the spill channel. Similarly, another first order stream originating from the hill ranges in southern part will also be intercepted by the spill channel.

However, the area in the south of the Gandhi Hillock is found to be well drained with S-W slope leading to Mahanadi River. In the study region, the land drainage is also intercepted by small water bodies (ponds) in the valley. Some of these ponds are described under the physiography heading (Para 3.3.1).

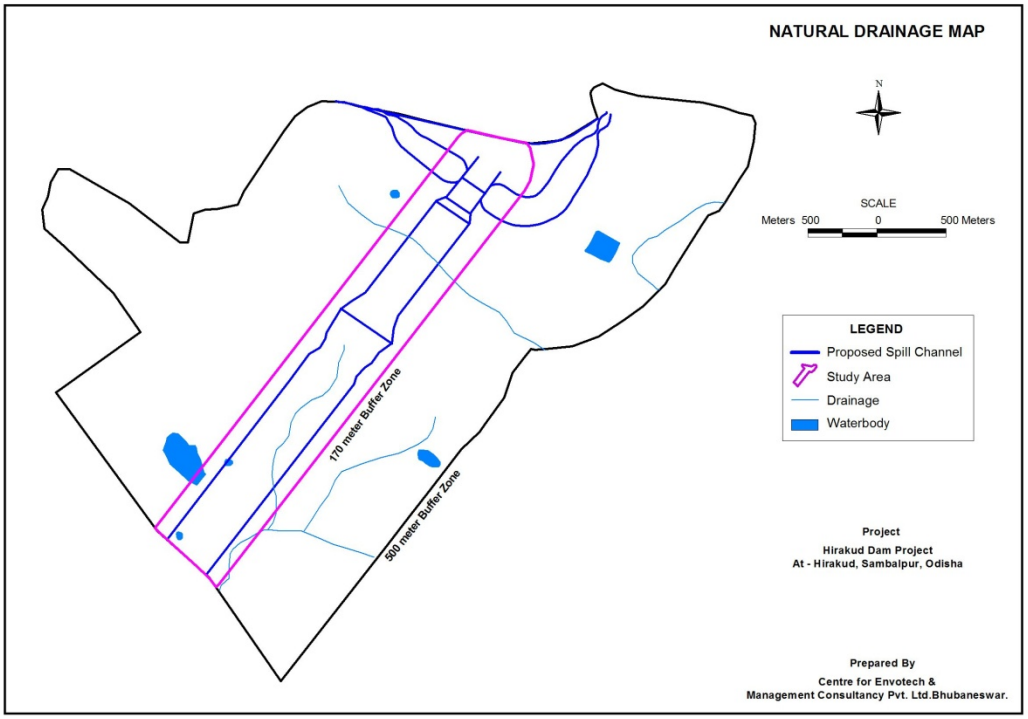


Fig. 3-17: Natural drainage map of the study area.

3.3.7.2 Hydrogeomorphology:

The project area comprises of different hydrogeomorphic features like hills, ridges and valley plains etc. Major part of the project area is covered by Pediments. The lineaer ridge is found in the central part of the project area. Pediments are found around the hills which is very large in quantity in comparison to the total area. Small patch of pediplain is found in the eastern part of the study area. The other details are as follows. The hydrogeomorphic features are shown in **Fig.3-18.**

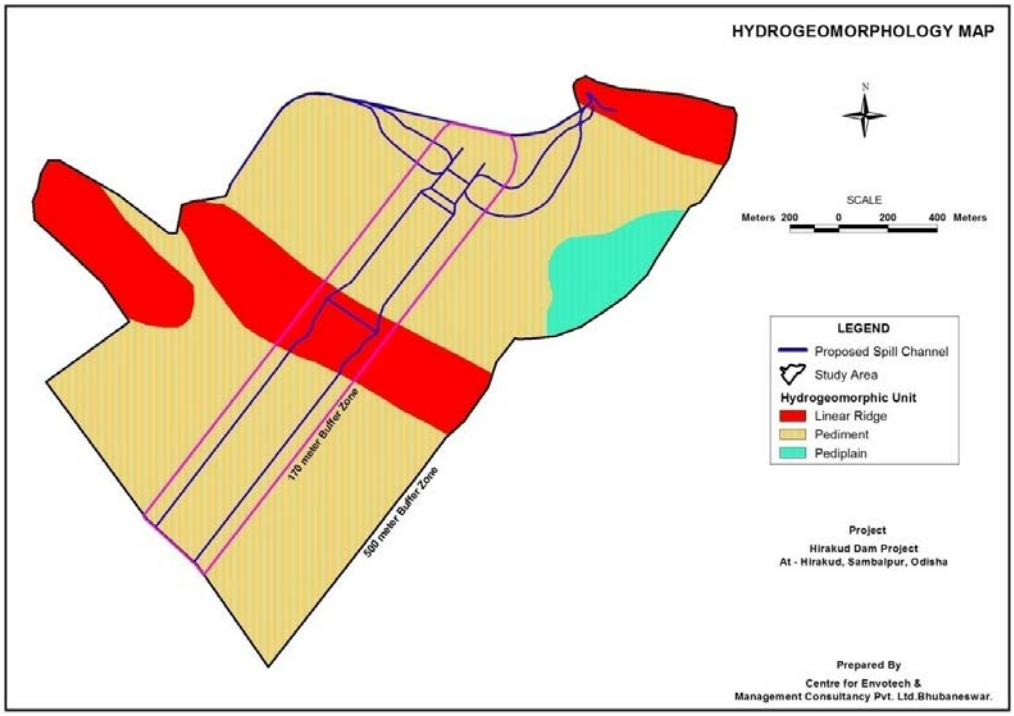


Fig.3-18: Hydrogeomorphology map of the study area

Pediments: These are gently sloping smooth erosional surface between hills and plains. This unit is found bordering the hilly terrain. Ground water potential in these units is poor to moderate.

Linear Ridge: These are linear, narrow, low lying relief generally barren and the ground water potential is poor in these areas.

Pediplain: These are large areas marked by coalescence of pediments.

3.3.7.3 Water Quality:

Water is available in the study area in the form of surface water & ground water.. For assessing the existing quality of surface water and ground water within and around the project area both surface and ground water samples were collected for analysis of various parameters on 25th and 26th of May 2016. All the sampling locations of the project area from which water samples were collected are shown in **Fig.3-21** and indicated in the table below**.**

Table 3-16: Water Quality Monitoring Locations of the Study Area (Pre Monsoon)

Sl. No.	Station Code	Distance From the centre of spill	Direction	Location	Latitude & Longitude	Type of Source
A. Surface Water						
1	SW1	0.24 km	South-East	Hira cable colony pond	21^0 32’ 37.25” N	Pond
2	SW2	1.09 km	East	Rolling mill pond	21^0 32’ 45.99” N	Pond
3	SW3	1.52 km	South- West	Hirakud reservoir near	21^0 32’ 36.56” N	Reservoir water
4	SW4	0.72 km	South- West	Downstream water	21^0 30’ 32.88” N	Hirakud Canal
5	SW5	1.82 km	South- West	Park Pond Water		Pond
B. Ground Water						

Sl. No.	Station Code	Distance From the centre of spill	Direction	Location	Latitude & Longitude	Type of Source
6	GW1	-	-	Near Office Campus	-	Dug well
7	GW2	0.38 km	South-East	Near Nilakantha Temple	21^0 32’ 46.41” N	Tube well

water
water
water

Fig.No.C3-19: Collection of sample surface and ground sources

Fig. 3-20: Adding Chemical to surface water sample for DO fixation

3.3.7.3.1 Methodology for Sampling Procedure:

Sampling is done as per APHA guideline. Proper procedure was followed during sample collection and carefully stored to avoid contamination prior to analysis.

Table 3-17: Method of Parameter Testing

Sl. No.	Parameter	Method
1.	Turbidity	APHA 2130 B
2.	pH value	APHA 4500 (B)
3.	Colour	APHA 2120 (B)
4.	Total dissolved solids	APHA 2540 (C)
5.	Total Suspended Solids	APHA 2540 (D)
6.	Total Hardness	APHA 2340 (C)
7.	Calcium	APHA 3500 Ca (B)
8.	Magnesium	APHA 3500 Mg (B)
9.	Total Alkalinity	APHA 2320 (B)
10.	Chloride	APHA 4500 Cl (B)
11.	Dissolved Oxygen	APHA 4500(B)
12.	Biochemical Oxygen Demand (3 Days, 27°C)	APHA 5210(B)
13.	Chemical Oxygen Demand	APHA 5220(B)

Sl. No.	Parameter	Method
14.	Phosphorus, Phosphate	APHA 4500 (D)
15.	Odour	APHA 2150 (B)
16.	Iron	APHA 3500 (B)
17.	Electrical Conductivity	APHA 2510 (B)
18.	Sulphate	APHA 4500 SO_4 (E)
19.	Nitrate	APHA 4500 NO_3(B)
20.	Fluoride	APHA 4500 F^- (D)
21.	Sodium	APHA 3500 Na (B)
22.	Potassium	APHA 3500 K (B)
23.	Cyanide	APHA 4500CN^- (D)
24.	Salinity	Calculation
25.	Total Coliform	APHA 9221(B)
26.	*E-Coli*	APHA 9221(F)
27.	Cadmium	APHA 3500 Cd
28.	Lead	APHA 3500 Pb
29.	SAR	Calculation
30.	Boron	APHA 3500 (B)
31.	Hexa Chromium	APHA 3500 Cr(B)
32.	Feacal Coliform	APHA 9222(D)

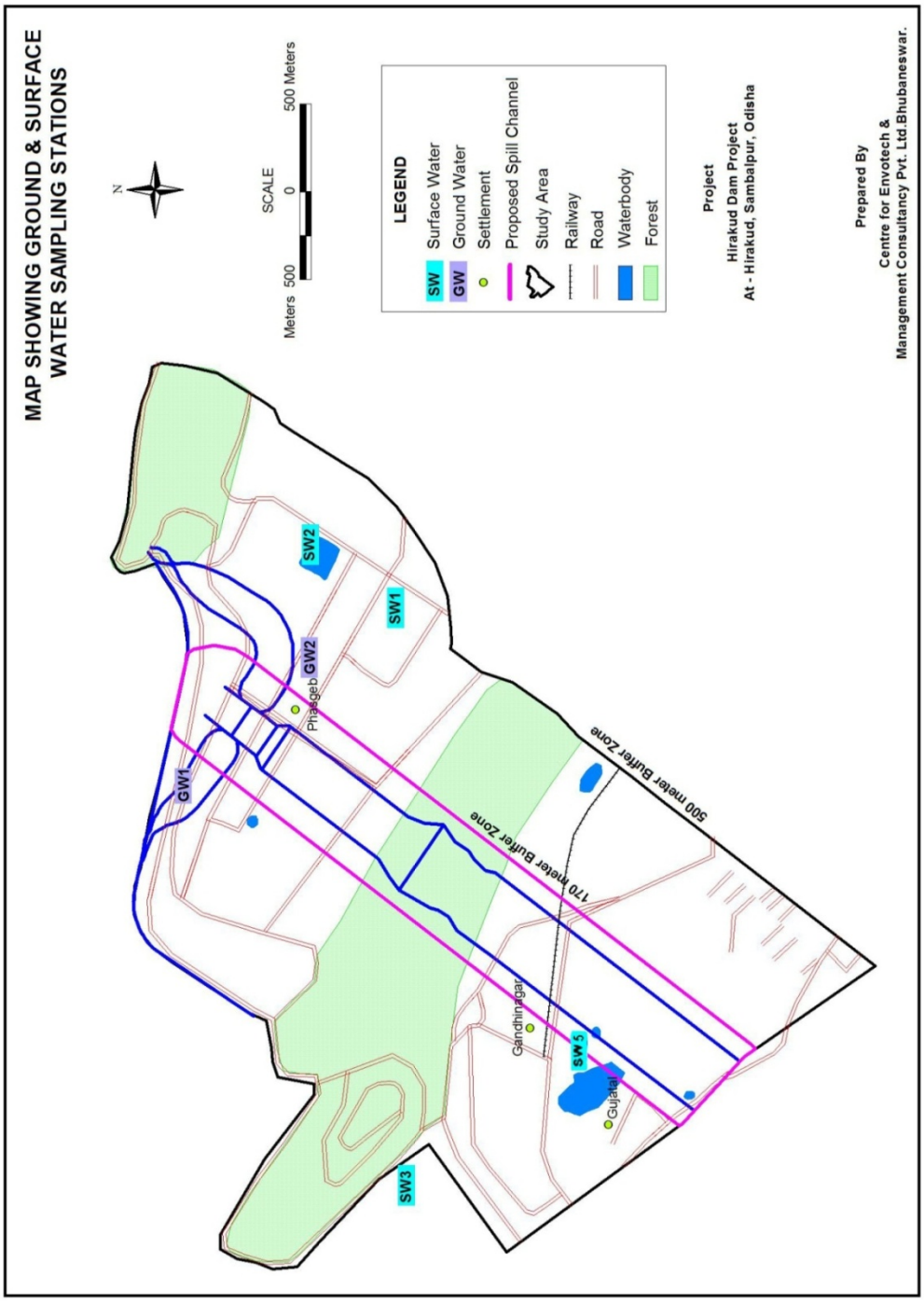

MAP SHOWING GROUND & SURFACE WATER SAMPLING STATIONS
N
SCALE
Meters 500 0 500 Meters
LEGEND
SW Surface Water
GW Ground Water
Settlement
Proposed Spill Channel
Study Area
Railway
Road
Waterbody
Forest
Project
Hirakud Dam Project
At - Hirakud, Sambalpur, Odisha
Prepared By
Centre for Envotech &
Management Consultancy Pvt. Ltd.Bhubaneswar.
SW2
SW1
GW2
Phageb
GW1
500 meter Buffer Zone
170 meter Buffer Zone
Gandhinagar
SW 5
Gujata
SW3

Fig.3-21: Location map of the water monitoring stations

Table 3-18: PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

Sl. No.	Test parameters	Unit	Norms as per IS: 10500-2012		Office Dug Well (GW1)	Nilakantha temple (GW2)
			Acceptable Limit	Permissible Limit		
1	Colour	Hazen	5	15	CL	CL
2	Odour	$	AL	AL	AL	AL
3	Taste	$	AL	--	AL	AL
4	Turbidity	NTU	1	5	<0.05	<0.05
5	pH Value @ 25°C	$	6.5-8.5	No Relaxation	7.5	7.2
6	Total Hardness (as $CaCO_3$)	mg/l	200	600	40	73
7	Iron (as Fe)	mg/l	0.3	No Relaxation	0.24	0.21
8	Chloride (as Cl)	mg/l	250	1000	9	14
9	Total Dissolved Solids	mg/l	500	2000	232.6	308.2
10	Calcium (as Ca)	mg/l	75	200	8.4	15.7
11	Magnesium (as Mg)	mg/l	30	100	4.6	8.2
12	Copper (as Cu)	mg/l	0.05	1.5	<0.03	<0.03
13	Manganese (as Mn)	mg/l	0.1	0.3	<0.05	<0.05
14	Sulphate (as SO_4)	mg/l	200	400	11.0	13.3
15	Nitrate (as NO_3)	mg/l	45	No Relaxation	<0.05	<0.05
16	Fluoride (as F)	mg/l	1.0	1.5	<0.05	<0.05
17	Phenolic Compounds (as C_6H_5OH)	mg/l	0.001	0.002	<0.001	<0.001
18	Mercury (as Hg)	mg/l	0.001	No Relaxation	<0.001	<0.001
19	Cadmium (as Cd)	mg/l	0.003	No Relaxation	<0.01	<0.01
20	Selenium (as Se)	mg/l	0.01	No Relaxation	<0.001	<0.001
21	Arsenic (as As)	mg/l	0.01	0.005	<0.001	<0.001
22	Cyanide (as CN)	mg/l	0.05	No Relaxation	ND	ND
23	Lead (as Pb)	mg/l	0.01	No Relaxation	<0.01	<0.01
24	Zinc (as Zn)	mg/l	5	15.0	1.2	1.6
25	Total Chromium (as Cr)	mg/l	0.05	No Relaxation	<0.05	<0.05
26	Total Alkalinity as ($CaCO_3$)	mg/l	200	600	190	165
27	Aluminium (as Al)	mg/l	0.03	0.2	<0.01	<0.01
28	Boron (as B)	mg/l	0.5	1.0	<0.2	<0.2

NB: ND- Not Detectable, CL-Colourless, AL-Agreeable

Table 3-19: PHYSICO-CHEMICAL CHARACTERISTICS OF SURFACE WATER SAMPLES

Sl. No.	Test Parameters	Unit	Max. Tolerance Limit as per IS 2296 : Class C	Hira Cable Colony Pond (SW1)	Rolling Mill Pond (SW2)	Hirakud reservoir (SW3)
1	Colour, Max.	Hazen	300	2	1	3
2	pH value @ 25^0C	$	6.5 to 8.5	7.4	7.7	7.8
3	Iron as Fe, Max.	mg/l	50	0.8	1.0	0.93
4	Chloride as Cl, Max.	mg/l	600	8	10	9
5	Total Dissolved Solids, Max.	mg/l	1500	449.8	375.1	317.6
6	Dissolved Oxygen, Min.	mg/l	4	5.8	6.1	6.9
7	BOD for 3 days at 27^0C, Max.	mg/l	3	2.8	2.4	2.1
8	Oil & Grease, Max.	mg/l	0.1	ND	ND	ND
9	Copper as Cu, Max.	mg/l	1.5	<0.03	<0.03	<0.03
10	Sulphate as SO_4, Max.	mg/l	400	17.2	42.5	15.7
11	Nitrate as NO_3, Max.	mg/l	50	0.3	0.4	0.06
12	Fluoride as F, Max.	mg/l	1.5	0.9	0.4	0.12
13	Anionic detergent	mg/l	1	<1	<1	<1
14	Cadmium as Cd, Max.	mg/l	0.01	<0.01	<0.01	<0.01

Sl. No.	Test Parameters	Unit	Max. Tolerance Limit as per IS 2296 : Class C	Hira Cable Colony Pond (SW1)	Rolling Mill Pond (SW2)	Hirakud reservoir (SW3)
15	Selenium as Se, Max.	mg/l	0.05	<0.001	<0.001	<0.001
16	Arsenic as As, Max.	mg/l	0.2	<0.001	<0.001	<0.001
17	Cyanide as CN, Max.	mg/l	0.05	ND	ND	ND
18	Phenolic compound as C_6H_5OH, Max.	mg/l	0.005	<0.001	<0.001	<0.001
19	Lead as Pb, Max.	mg/l	0.1	<0.01	<0.01	<0.01
20	Zinc as Zn, Max.	mg/l	15	3.2	3.6	4.8
21	Hexavalent Chromium as Cr^{+6}, Max.	mg/l	0.05	<0.05	<0.05	<0.05
22	Total Coliform, Max.	MPN/ 100ml	5000	1760	1440	<1.8

NB: ND- Not Detected

Table 3-20: PHYSICO-CHEMICAL CHARACTERISTICS OF SURFACE WATER SAMPLES

Sl. No.	Test Parameters	Unit	Max. Tolerance Limit as per IS 2296 : Class C	Down Stream Water (SW4)	Pond (SW5)
1	Colour, Max.	Hazen	300	2	9
2	pH value @ 25^0C	$	6.5 to 8.5	7.6	7.9
3	Iron as Fe, Max.	mg/l	50	0.1	0.24
4	Chloride as Cl, Max.	mg/l	600	7	19.9
5	Total Dissolved Solids, Max.	mg/l	1500	232.6	258.3
6	Dissolved Oxygen, Min.	mg/l	4	7.7	5.6
7	BOD for 3 days at 27^0C, Max.	mg/l	3	2.0	3.2
8	Oil & Grease, Max.	mg/l	0.1	ND	ND
9	Copper as Cu, Max.	mg/l	1.5	<0.03	<0.03
10	Sulphate as SO_4, Max.	mg/l	400	13.9	22.8
11	Nitrate as NO_3, Max.	mg/l	50	<0.05	<0.05
12	Fluoride as F, Max.	mg/l	1.5	0.3	0.46
13	Anionic detergent	mg/l	1	<1	<1
14	Cadmium as Cd, Max.	mg/l	0.01	<0.01	<0.01
15	Selenium as Se, Max.	mg/l	0.05	<0.001	<0.001
16	Arsenic as As, Max.	mg/l	0.2	<0.001	<0.001
17	Cyanide as CN, Max.	mg/l	0.05	ND	ND
18	Phenolic compound as C_6H_5OH, Max.	mg/l	0.005	<0.001	<0.001
19	Lead as Pb, Max.	mg/l	0.1	<0.01	<0.01
20	Zinc as Zn, Max.	mg/l	15	4.3	5.2
21	Hexavalent Chromium as Cr^{+6}, Max.	mg/l	0.05	<0.05	<0.05
22	Total Coliform, Max.	MPN/ 100ml	5000	<1.8	<1.8

NB: ND- Not Detected

3.3.7.3.2 Discussion:

To assess the surface and ground water quality of the study area, five surface water and two groundwater sampling locations were selected. The analysis result shows that Colour of the water at different locations ranges between colourless to 9 Hazen, pH value indicated that at all sampling locations the water was slightly basic in nature. The DO value is found between 5.6 to 7.7 mg/l. Thus in respect of DO, the water quality remain quite satisfactory at all points. All the heavy metals content of water at different locations are well within the limit.

The analytical results of surface water samples at different locations for various parameters reveal that all the parameters comply with IS:2296 (Class 'C') standards indicating their suitability for drinking and other purposes after conventional treatment followed by disinfection. Similarly the analysis results of groundwater samples showed all the parameters are within the prescribed limits as per IS: 10500 standards for drinking water.

3.3.7.4 DEPTH TO WATER LEVEL (DWL):

The Depth to Water Level measurements were taken up on 26th may, 2016 in the Pre monsoon period i.e. during peak summer. Only one well with little water found in First gap area. The water level of this well was measured and found to be 3.15m BGL.

3.3.7.4.1 POSSIBILITIES OF WATERLOGGING:

As per the recommendation of Central Ground water Board CGWB, the areas having the following DWL Criteria may develop waterlogging conditions.

Table 3-21: Water logging classification

Ground water level	Waterlogging Classification
Between 0-2m bgl	Severe water logging Capability
Between 2-4m bgl	Prone to water logging
Between 4-6m bgl	Less chance of water logging

The average ground water level recorded in Pre-monsoon @3.15m bgl suggests that the area is prone to water logging. The inference may however be confirmed later with further field data.

3.3.8 EROSION, SILTATION AND SEDIMENT QUALITY:

3.3.8.1 Soil Erosion & Siltation:

Soil erosion is a significant factor which could create additional environmental problems that may affect the project sustainability. Natural land cover may be considerably affected by erosion effect due to construction activities of the project. Baseline assessment of such project activities includes identification of areas prone to soil erosion, siltation and sedimentation. These included locating

I) Proposed Borrow areas
II) Proposed Quarry sites
III) Proposed spoil/Dumping sites
IV) Temporary settlements i.e Labour Camps
V) Areas of ecologic disturbance due to Dam/Spillway construction activities

3.3.8.1.1 Borrow Areas:

The project authority have identified different pockets of borrow area within the dam area along the reservoir around proposed project area. The potential borrow areas has been shown in the map **Fig.3-22.** All the borrow areas form the part of Hirakud Dam area and are located long the exiting reservoir boundary at its periphery adjacent to the left dyke. The area is devoid of any significant environmental features. The prposed area hs general slope towards the main reservoir. There is no any significant vegetation within the proposed borrow area.

Information from DoWR records reveal that the earth material below the superlaying silt layer has been tested for suitability of new earth dam Dyke construction. In case of shortfall of the required quantity; some other suitable areas after quality confirmation will be selected for borrowing earth.

However, this identified borrow area will not exhibit critical soil erosion as an after effect as because it forms a part of the reservoir. But it may attract two important environmental as well as safety issues, such as

- Disposal criteria of the top silt layer (Base Stripping), carrying sediment deposing which may be rich with heavy metal concentration. However sediment quality has been assessed in the following paragraphs to confirm if the removed sediment load will be detrimental to the area, where it would be disposed of.
- Slopes of the borrow pit adjacent to the existing dyke structure may exhibit erosion/slips at the 'Drawdown' condition. Such criteria may however be addressed by part backfilling & slope pitching.

3.3.8.1.2 Quarry Areas:

Location of suitable Quarries for construction materials would normally attract environmental implication like land erosion, land degradation and public exposure.

In the instant case; the project authorities have prudently located quarry sites far away from the study area which are already licenced and approved for quarrying activities by the owners.

The enclosed Quarry Map obtained from DoWR records reflected in **Fig. 3-23** shows different locations for Quarrying Stone, Rock products, Moorum and Sand etc.

Although these areas are away from the construction site; appropriate mitigation measures are required to be implemented against likely soil erosion in future and consequent land degradation.

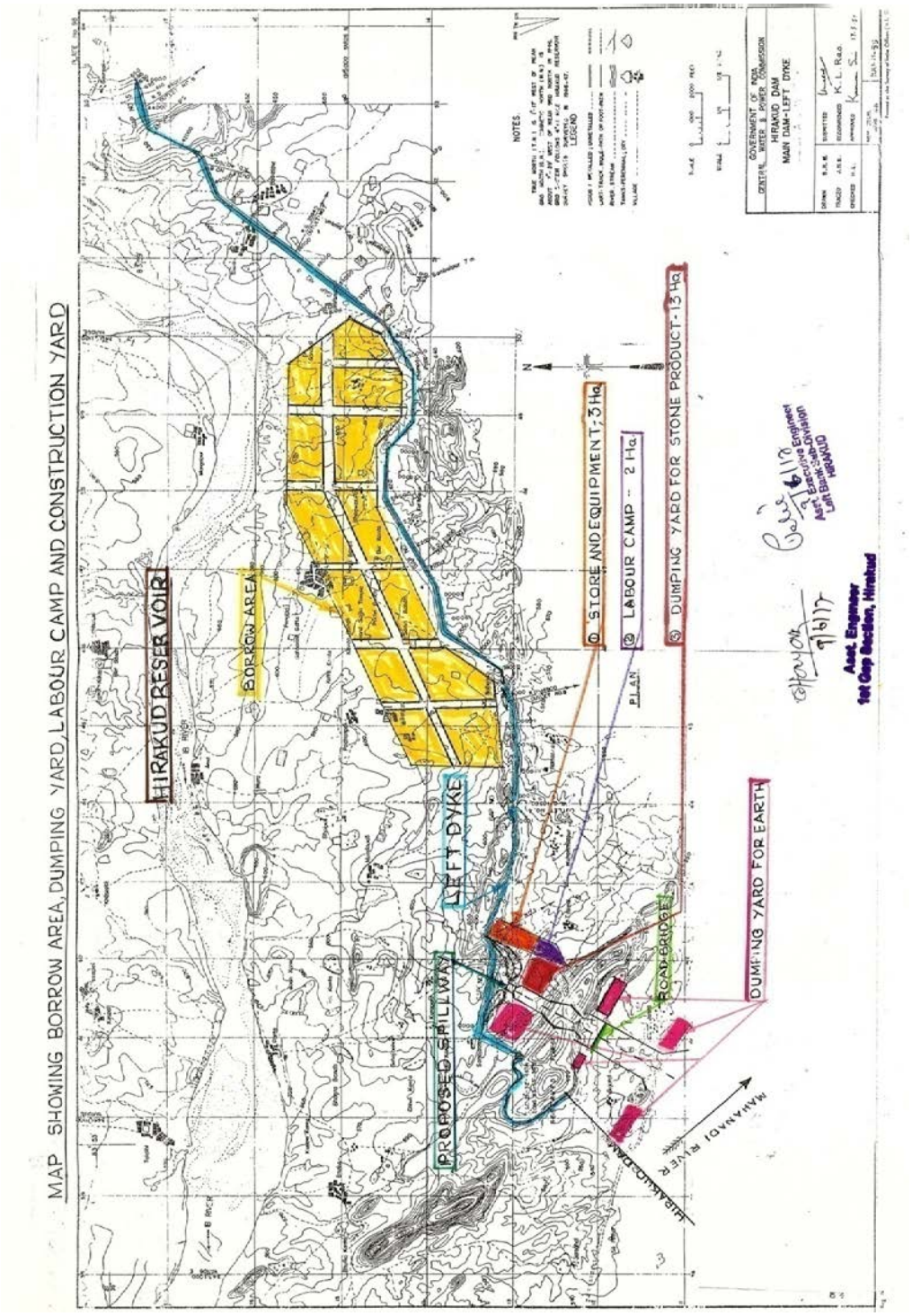
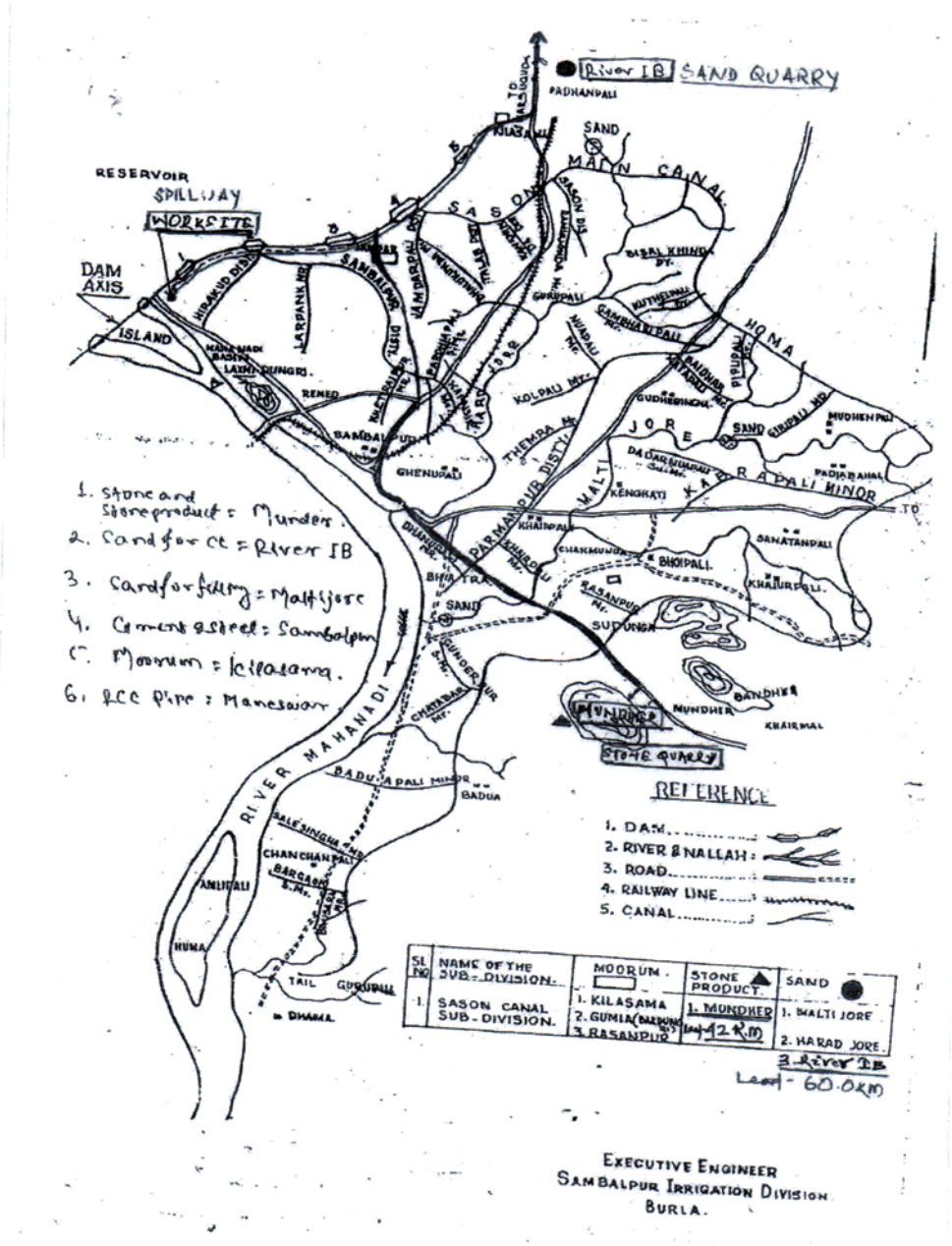

MAP SHOWING BORROW AREA, DUMPING YARD, LABOUR CAMP AND CONSTRUCTION YARD
HIRAKUD RESERVOIR
BORROW AREA
PROPOSED SPILLWAY
LEFT DYKE
STORE AND EQUIPMENT-3 Ha
LABOUR CAMP - 2 Ha
DUMPING YARD FOR STONE PRODUCT-13 Ha
DUMPING YARD FOR EARTH
ROAD BRIDGE
MAHANADI RIVER
HIRAKUD DAM
NOTES
LEGEND
GOVERNMENT OF INDIA
CENTRAL WATER & POWER COMMISSION
HIRAKUD DAM
MAIN DAM-LEFT DYKE
Asst. Engineer
1st Circ Section, Hirakud

Fig. 3-22: Map showing Borrow Areas and Dumping Areas



General Locations of Quarries for Fine & Coarse aggregates.

Fig. C3-23: Map showing Quarry sites

3.3.8.1.3 Dumping Yards:

Locating the dumping yards properly around the study area constitutes other important project interventions against environmental safeguard. Erosion becomes predominant in these areas.

The project authorities have identified three probable areas to be used as spoil dumping sites. These sites are shown in the **Fig. 3-22**. All the proposed dumping area is located in the dam area near toe of the hills and is devoid of any significant environmental features.

3.3.8.2 SEDIMENT QUALITY:

3.3.8.2.1 Sources of Heavy Metal in sediments:

Normally when a river flows in undisturbed regions unaffected by human activities, the concentration of most of the metals in water mass, remain very low, the traces being derived from the mineralogy and

weathering of the water shed. However, apart from the natural sources, the anthropogenic sources contribute largely to the building up of heavy metals in river water. The anthropogenic sources include run off from mining, disposal of untreated or partially treated industrial effluents drainage from agricultural crop land having residual pesticide and fertilizers, sewages from different settlements or urban areas, release of metal chelates from different industry, etc.

Dams / barrages built across the river bed form reservoirs for storage of huge quantities of water and as such facilitate building up of sediments on the river bed. Heavy metals discharged into aquatic systems may be immobilized within the stream sediments by main process such as adsorption, flocculation and co-precipitation. Therefore sediments in aquatic environment serve as a pool that can retain metals or release metals to the water column by various process of re-mobilization. Therefore, the heavy metals are highly concentrated in sediments than in water since the sediments act as reservoir for all contaminants and dead organic matter descending from the eco-system. Similarly the agricultural runoff during rainy season brings down the pesticide content to the river and finally deposited in the sediment.

3.3.8.2.2 Sample Collection, Preparation & Analysis:

The Grab sediment samples surrounding the root systems of different species wise collected using vertical layer, transferred to clean polythene bags and shade dried to constant weight. Sample containers should be placed in clear plastic bags to minimize soiling of the shipping container and to protect laboratory personnel. Glass containers should be protected from breakage. All sediment samples were chilled and stored in coolers. Sediments were ground and sieved through mesh (size 0.5 mm). The samples of sediments so prepared were put in plastic vials with labels and kept in Ice Box. Accurately 1 gm of dry powder of each sample was weighed and digested with conc. HNO_3, H_2SO_4 and H_2O_2 (2:6:6) as prescribed by Saison *et.al* (2004). Towards the end of digestion the beakers were brought to near dryness. The solution was made up to 100 ml each in volumetric flask with HPLC grade distilled water and examined for heavy metals by Atomic Absorption Spectrophotometer (Thermo Fisher Scietific make). Mean value of triplicate of each samples of the sediment was calculated and considered.

Table 3-22: Sediment quality guideline values for trace elements by US-EPA and TEL/PEL (Long et.al 1991)

	Level of pollution	Cd.	Cr.	Cu.	Pb	Zn.
SQG	Non-Polluted	-	<25	<25	<40	<90
SQG	Moderate Polluted	>6	>75	>50	>60	>200
SQG	Heavily Polluted	>6	>75	>50	>60	>200
TEL *		0.68	52.3	18.7	30.2	124
PEL *		4.2	160.4	108.2	112.2	271

* TEL – Threshold Effect Level is the value below which adverse biological effects would be infrequently expect.
* PEL – Probable Effect Level i.e. the values above which adverse biological affected would frequency occur.

3.3.8.2.3 Sampling Method and Laboratory Testing:

Sediment samples were collected from the periphery of Hirakud reservoir near the 2nd saddle of left dyke where an borrow area is proposed or identified. The samples was taken from 10 to 15 cm below the water surface using acid washed plastic container to avoid unpredictable changes in characteristics as per standard procedures, concentration of heavy metals in water samples was determined with an Atomic Absorption Spectrophotometer (AAS) and the pesticide values were determined using the Gas Chromatography with ECD.

3.3.8.2.4 Analysis:

Sediment parameters were analyzed and analytical results furnished in table below.

Table 3-23: Analysis Result of Sediment Sample

Sl. No.	Parameter	Units	U/s	Near N.U.
1	Moisture	%	23.8	29.6
2	pH (1:10) @ 25ºC	--	6.2	7.9
3	Electrical Conductivity@ 25ºC	µS/cm	716	1172
4	Chloride as Cl	%	0.018	0.022
5	Sulphate as SO_4	%	0.0084	0.01
6	Organic Carbon	%	0.9	1.2
7	Iron as Fe	%	0.04	0.06
8	Calcium as Ca	%	0.02	0.05
9	Sodium as Na	%	1.98	2.33
10	Potassium as K	%	0.018	0.026
11	Copper as Cu	mg/kg	<0.6	<0.6
12	Lead as Pb	mg/kg	< 0.2	< 0.2
13	Cadmium as Cd	mg/kg	<0.2	<0.2
14	Total Chromium as Cr	mg/kg	< 1	< 1
15	Total Nitrogen as N	%	0.8	0.6
16	Phosphate as PO_4	%	0.08	0.07
17	Pesticide	mg/kg	0.01	0.02

Fig. 3-24: Sediment collection

3.4 BIOLOGICAL ENVIRONMENT:

3.4.1 Biodiversity:

The project area of the additional spill way of Hirakud dam covers a portion of Lamdungri RF of Sambalpur Forest Division. As per the approved working plan of Sambalpur Division (2007-08 to 2016-17), this RF has been allocated to Rehabilitation Working Circle over 490.4612 ha. Out of this, around 9.5 ha of forest land will be diverted for construction.

Forest type of Lamdungari RF comes under 5B/C2 (Northern Tropical Dry Deciduous Forest), as per Champion & Seth (1968). In this forest species like *Cleistanthus collinus* (Karada), *Anogeissus latifolia* (Dhaura), *Azadirachta indica* (Neem), *Cassia siamea* (Bada chakunda), etc constitute a unique representation. Representation of Sal in this type of forest is less, which Constitute rarely upto 10% of the total Flora.

Lamdungiri RF covering an area of 490.4612 ha has been badly degraded due to relentless biotic interference like illicit felling, repeated fire, grazing etc. These adverse practices reslts into poor soil quality, the topsoil of the area has been completely washed away resulting in exposure of rocks at places in general and the top of the hill. This RF includes a series of hillocks with less of flat land at the toe. As one travels from Gandhiminar (278 RL) to Gujatala, trees at sparse can be noticed which gives a source of information about the indigenous species available there.

Methodology:

Assessment of Flora:

Enumeration of the plant wealth was done by surveying the area through walking along the gradients of hillocks and valleys followed by collection and identification of plant specimens. The enumeration has covered all trees having GBH (girth at breast height) greater than 10 cm. The height and conditions (i.e. Normal or Defective) of the trees were estimated by visual impression during the survey periods.

Assessment of Fauna:

The following components were studied in order to assess the status of wildlife biodiversity within the project area;

a) Wildlife survey (Mammal/ reptiles/ amphibians)
b) Migratory paths of major wildlife species
c) Distribution of birds
d) Fish fauna
e) Rare & Endangered species flora of fauna

Equipments & materials are used during the survey are Global Positioning System (G.P.S.) with an accuracy of ± 10m, Binoculars (8×40 capacity) for good viewing, a compass to guide the route & direction, maps, etc. Both direct and indirect observation methods were used to survey the fauna in the study area. Visual encounter along with indirect evidence method were employed to record vertebrate species, to prepar the checklist of avifauna the visual encounter method was employed. In addition the following methods were adopted to monitor the the faunal diversity of the proposed project area.

a. Point Survey Method: While walking on the transect observations were made in selected sites for 15 min duration.
b. Transect Method: In the study area several transecst were laid down and each transect was visited by walking on foot for detection of species.
c. Pellet and track Counts: during walking on transect all the pellets found were identified and recorded (South Wood, 1978).

Table 3-24: Trees with IUCN status in the affected (non-forest) area

Sl. No.	Local Name	Scientific Name	IUCN	No. of Trees
1.	Achu	*Morinda tinctoria*	-	7
2.	Agasti	*Sesbania egyptica*	-	2
3.	Acacia	*Acacia auriculiformis*	LC	56
4.	Mango	*Mangifera indica*	DD	227
5.	Ambada	*Spondias magnifera*	-	4
6.	Papaya	*Carica papaya*	DD	34
7.	Amla	*Emblica officinalis*	-	11
8.	Arjun, kaha	*Terminalia arjuna*	-	7
9.	Asan	*Terminalia tomentosa*	-	9
10.	Wood apple	*Annona squamosa*	-	6
11.	Babul	*Acacia nilotica*	-	42
12.	Dhoben	*Dalbergia paniculata*	-	4
13.	Bahada	*Terminalia belerica*	-	1
14.	Bara	*Ficus bengalensis*	-	76
15.	Bara koli	*Ziyphus jujuba*	-	32
16.	Baula	*Mimusops elengii*	-	8
17.	Bela	*Aegle marmelos*	-	73
18.	Bhalia	*Semicarpus anacardium*	-	11

Sl. No.	Local Name	Scientific Name	IUCN	No. of Trees
19.	Bhersunga	*Murrya coingii*	-	85
20.	Bheru	*Chloroxvlon swietenia*	-	9
21.	Chakunda	*Cassia siamea*	-	17
22.	Champa	*Michelia champaka*	-	62
23.	Chara	*Buchanania lanzan*	-	3
24.	Chauli	*Eleodendron glaucum*	-	251
25.	Dalimba	*Punica garnitum*	-	8
26.	Debadaru	*Polyalthis longifolia*	-	46
27.	Dhala sirris	*Albizzia procera*	-	3
28.	Dhaura	*Anogeissus latifolia*	-	11
29.	Dimiri	*Ficus glomerata*	-	39
30.	Eucalyptus	*Eucalyptus globalus*	-	2
31.	Gambhari	*Gmelina arborea*	-	34
32.	Gandhapalas	*Milius velutina*	-	3
33.	Ganga siuli	*Nyctanthes arbor-tristis*	-	8
34.	Genduli	*Sterculia urens*	-	9
35.	Gua	*Areca catechu*	-	1
36.	Harida	*Terminalia chebula*	-	2
37.	Jamun	*Syzyzium cumini*	-	111
38.	Banana	*Musa sapientum*	-	3
39.	Kadamba	*Anthocephalus kadamba*	-	17
40.	Lemon	*Citrus aurantifolia*	-	86
41.	Kalchua	*Glochidion lanceolarium*	-	1
42.	Kalicha	*Diospyrus sylvatica*	-	1
43.	Kamala	*Citrus medica*	-	6
44.	Kanchan, Kuller	*Bauhinia varigeta*	-	54
45.	Kaniara	*Cascabela thevetia*	-	16
46.	Kanta baunsa	*Bambusa bambos*	-	56
47.	Karamanga	*Averrhoa carambola*	-	11
48.	Karanja	*Pongamia glabra*	LC	32
49.	Kasi	*Bridelia retusa*	-	4
50.	Katha champa	*Plumeria rubra*	-	2
51.	Moi	*Garuga pinnata*	-	5
52.	Kendu	*Diospyros melanoxylon*	-	1
53.	Khajuri	*Phoenix sylvestris*	-	5
54.	Khakada	*Casearia elliptica*	-	40
55.	Kochila	*Strychnus nux-vomica*	-	6
56.	Krushnachuda	*Delonix regia*	-	33
57.	Kurei	*Hollarrhena pubescens*	-	33
58.	Kurum	*Adina cordifolia*	-	3
59.	Katranga	*Gardenia latifolia*	-	2
60.	Cashew	*Anacardium occidentale*	-	4
61.	Lembu	*Cutrus medica*	-	20
62.	Lichu	*Nyphelium litchi*	-	1
63.	Mausumi	*Citrus sinensis*	-	1
64.	Mohul	*Madhuca indica*	-	12
65.	Moi	*Lannea coromandelica*	-	48

Sl. No.	Local Name	Scientific Name	IUCN	No. of Trees
66.	Mundi	*Mitragyna parviflora*	-	7
67.	Coconut	*Cocos nucifera*	-	94
68.	Narkoli	*Phyllanthus acidus*	-	4
69.	Nima	*Azadirachta indica*	-	392
70.	Osta, Pipal	*Ficus religiosa*	-	76
71.	Palasa	*Butea monosperma*	-	80
72.	Paldhua	*Erythrina suberosa*	-	64
73.	Jackfruit	*Artocarpus heterophyllus*	-	123
74.	Pesta badam	*Pistacia vera*	NT	9
75.	Guava	*Psidium guajava*	-	197
76.	Radhachuda	*Peltoferrum ferrugenium*	-	70
77.	Ramphala	*Anona reticulata*	-	7
78.	Ritha	*Sapindus trifoliata*	-	5
79.	Saguan	*Tectona grandis*	-	47
80.	Muninga	*Moringa oleifera*	-	33
81.	Sal	*Shorea robusta*	LC	1
82.	Salia Bamboo	*Dendrocalamus strictus*	-	7
83.	Sena, Sidha	*Lagerstroemia parviflora*	-	6
84.	Siali	*Bauhiia valii*	-	59
85.	Sima kaina	*Pithecolobium dulcee*	LC	52
86.	Simili	*Bombax ceiba*	-	33
87.	Siris	*Albizzia lebek*	-	132
88.	Sissoo	*Dalbergia sissoo*	-	41
89.	Sunari	*Cassia fistula*	-	2
90.	Tala	*Borassus flabellifer*	-	30
91.	Tentuli	*Tamarindus indica*	-	16
92.	Akasmali	*Millingtonia hortnensis*	-	78
93.	Bandhan	*Ougeinia oogeinensis*	-	1
94.	Bija	*Pterocarpus marsupium*	-	39
95.	Chandan	*Santalum album*	-	1
96.	Chhatian	*Alstonia scholaris*	-	4
97.	Cashew	*Anacardium occidentale*	-	4
98.	Karada	*Cleistanthus collinus*	-	1
99.	Khair	*Acacia catechu*	-	2
100.	Kususm	*Schleichera oleosa*	-	1
101.	Kataranga	*Gardenia latifolia*	-	1
102.	Mahanim	*Melia composita*	-	3
103.	Muchukunda	*Pterospermum acerifolium*	-	3
104.	Nirgundi	*Vitex negundo*	-	16
105.	Oau	*Ougeinia indica*	-	4
106.	Eucalyptus	*Eucaliptus territicornis*	-	24
107.	Rohini	*Soymedia febrifuja*	-	8
108.	Tagar	*Taberna montona cornia*	-	1
		Total		**3595**

N.B. DD - Data Deficient, LC – Least Concern/ Lower Risk, VU- Vulnereble,
EN – Endangered, NT- Near Threatened, (-) – This taxon has not yet been assessed for the IUCN Red List **(IUCN Red List of Threatened Species, 2016)**

Table 3-25: List of Shrubs within the affected area

Sl. No.	Local Name	Scientific Name	IUCN Status
1	Arakha	*Calotropis gigantea*	-
2	Basanga	*Adhatoda vasica*	--
3	Begunia	*Vitex negundo*	-
4	Jada	Recinus communis	-
5	Jajangi	*Breynia vitis-idaea*	-

N.B. DD - Data Deficient, LC – Least Concern/ Lower Risk, VU- Vulnereble,
EN – Endangered, NT- Near Threatened, (-) – This taxon has not yet been assessed for the IUCN Red List **(IUCN Red List of Threatened Species, 2016)**

Table 3-26: List of Trees within the forest area of the project

Sl. No.	Local Name	Scientific Name	IUCN Status	No. of trees
1	Neem	*Azadirachta indica*	-	38
2	Chakunda	*Cassia siamea*	-	46
3	Teak	*Tectona grandis*	-	16
4	Girdhini	Sterculia urens	-	6
5	Chara	*Buchanania lanzan*	-	1
6	Palasa	*Butea monosperma*	-	5
7	Sisoo	*Dalbergiaa sosssoo*	-	1
8	kuruma	*Adina cordifolia*	-	2
Total				**115**

N.B. DD - Data Deficient, LC – Least Concern/ Lower Risk, VU- Vulnereble,
EN – Endangered, NT- Near Threatened, (-) – This taxon has not yet been assessed for the IUCN Red List **(IUCN Red List of Threatened Species, 2016)**

Rare/ Endangered/ Threatened (RET) Flora:
As per the IUCN Red Data book 2016 most of the plant species in the study area are not yet been evaluated for IUCN Status. In case of evaluated species most of the species in the study area are in least concern (LC) category except a single species *Pistacia vera* which belongs to near threatened (NT) category.

Table 3-27: List of fauna observed.

Sl. No.	Local name	Scientific name	Schedule	IUCN Status
1	Godhi	*Varanus flavescerps*	II	-
2	Pahadi endua	*Cyrtodactylus nebulosus*	IV	LC
3	Neula	*Harpestes ouropunetatus*	II	-
4	Musa	*Rattus rattus*	IV	LC
5	Endua	*Hemidactylus maculatus*	IV	LC
6	Champeineula	*Mabuya bibroni*	IV	LC

N.B. DD - Data Deficient, LC – Least Concern/ Lower Risk, VU- Vulnereble, EN – Endangered, NT- Near Threatened, (-) – This taxon has not yet been assessed for the IUCN Red List **(IUCN Red List of Threatened Species, 2016)**

Table 3-28: List of avifaunal species noticed in and around proposed Project area

Sl. No.	Local name	*Scientific name*	Schedule	IUCN Status
1	Bani	*Acridotheres tristis*	IV	LC
2	Bhadabhadalia	*Coracias benghalensis*	IV	LC
3	Chitra Kapta	*Streptopelia chinensis*	IV	-
4	Gai Baga	*Bubulcus ibis*	IV	LC
5	Gharchatia	*Passer domesticus*	IV	LC

Sl. No.	Local name	*Scientific name*	Schedule	IUCN Status
6	Ghumura Para	*Columba livia*	III	LC
7	Gobara	*Pycnonotus cafer*	IV	LC
8	Gunduri	*Coturnix coturnix.*	IV	LC
9	Kajalpati	*Dierurus macrocercus*	IV	-
10	Kanti Baga	*Ardeola grayii*	IV	LC
11	Kilchia Baga	*Egretta garzetta*	IV	LC
12	Koili	*Eudynamys scolopacea*	IV	LC
13	Kumbhatua	*Centropus sinensis*	IV	LC
14	Machha Ranka	*Halcyon smyrnensis*	IV	LC
15	Matia Chila	*Milvus migrans*	IV	LC
16	Nahaka Sua	*Psittacula eupatria*	IV	-
17	Sat Bhauni	*Turdoidep caudatus*	IV	-
18	Sindurmundi	*Megalaima haemaccphala*	IV	-
19	Sua	*Psittacula krameri*	IV	-
20	Crow	*Corvus macrorhynchos*	V	
21	Kumbhatua	*Dendrocitta vagabunda*	IV	LC
22	Pegion	*Treron bicincta*	IV	LC
23	Lora	*Aegithina tiphia*	IV	LC

N.B. DD - Data Deficient, LC – Least Concern/ Lower Risk, VU- Vulnereble,
EN – Endangered, NT- Near Threatened, (-) – This taxon has not yet been assessed for the IUCN Red List **(IUCN Red List of Threatened Species, 2016)**
Rare/ Endangered/ Threatened (RET) Fauna:

Similar to the flora as per the IUCN Red Data Book 2016 most of the fauna species observed in the study area were belongs to Least Concern category and no Rare/ Endangered/ Threatened species were observed in the study area.

Fig. 3-25: PHOTOGRAPHS OF BIRDS

Acridotheres tristis

Coracias benghalensis

Streptopelia chinensis

Bubulcus ibis

Passer domesticus

Columba livia

MACROPHYTES (Aquatic Flora):

To prepare the check list of Macrophytes the present study was carried out at the Hirakud reservoir, its down flow area and its near by lentic water bodies which are present in the proposed project area. Identification of macrophytes were made in the field with help local people followed by the field guide. In case of difficulties the unidentified samples from the study sites were collected and brought to the laboratory for identification. In the laboratory the species were identified on the basis of their significant characteristicsand with help of flora of Orissa (Sexena and Brahman 1994-96) and the standard literature (Fasset, 1998; Cook, 1990; Mishra, 1974).

Table 3-29: List of Macrophytes observed

Sl. No.	Local name	Scientific name	Family	IUCN Status
Submerged				
1	Chingudia Dala	*Hydrilla verticillata*	Hydrocharitaceae	LC
2		*Vallisneria natans*	Hydrocharitaceae	LC
Floating				
3	Azola	*Azolla pinnata*	Azollaceae	LC
4	Bilatidala	*Eichhornia crassipes*	Pontederiaceae	-
5		*Hygroryza aristata*	Poaceae	-
6	Kalama Saga	*Ipomoea aquatica*	Convolvulaceae	LC
7		*Lemna perposilla*	Lemnaceae	-
8		*Salvinia cucullata*	Salviniaceae	LC
Emergent				
9		*Alloteropis cimicina*	Poaceae	-
10	Madaranga	*Alternanthera sessilis*	Amranthaceae	
11		*Ampelopyteris prolifera*	Thelypteridaceae	-
12	Bena	*Chrysopogon zizanioides*	Poaceae	-
13	Bedhuan	*Cyperus sp.*	Cyperaceae	-
14	Koelekha	*Hygrophila sp.*	Acanthaceae	-
15	Jagal	*Ludwigia adscendens*	Onagraceae	-
16		*Ludwigia octovalvis*	Onagraceae	LC
17		*Trianthum crystalline*	Aizoaceae	-

Fig.3-26: PHOTOGRAPHS OF MACROPHYTES

Ludwigia adscendens

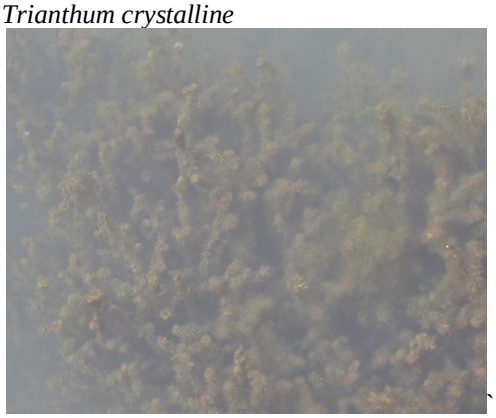
Ludwigia octovalvis

Alternanthera sessilis

Ampelopteris prolifera

Trianthum crystalline

Cyperus sp.



Hydrilla Sp.

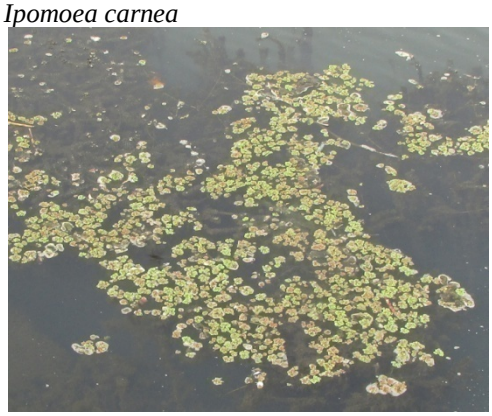
Hydrilla Sp. (Close View)

Vallisneria natans

Vallisneria natans (Close View)

Ipomoea carnea

Ipomea aquatica



Azolla pinnata

Azolla pinnata

Lemna perposilla

Ehhornia crassipes

FISH FAUNA:

The list of fish fauna of Hirakud reservoir were collected from the local fishermans followed by the research publications on Hirakud reservoir (Singh *et al.*, 2015). The list of the fishes found is listed below.

Table 3-30: Fish Fauna found in Hirakud Reservior

Sl. No.	*Local Name*	Family	Scientific Name	IUCN Status
1	*Lal Chandi*	Ambassidae	*Parambassis lala*	NT
2	*Kau*	Anabantidae	*Anabas testudineus*	-
3	*Khasia*	Anabantidae	*Colisa fasciatus*	-
4	*Cartkana*	Centropomidae	*Chanda nama*	LC
5	*Chandi*	Centropomidae	*Chanda ranga*	LC
6	*Chenga*	Channidae	*Channa orientalis*	-
7	*Salo*	Channidae	*Channa marulius*	LC
8	*Gadisa*	Channidae	*Channa punctatus*	-
9	*Seula*	Channidae	*Channa striatus*	-
10	*Ghesra*	Gobiidae	*Glossogobius giuris*	LC
11	*Bodosi*	Nandidae	*Nandus nandus*	LC
12	*Gongituri*	Belonidae	*Xenentodon cancila*	LC
13	*Gudua*	Clupeidae	*Gudusia chapra*	LC
14	*Kondaturi*	Cobitidae	*Lepidocephalichthys guntea*	LC
15	*Moraru*	Cyprinidae	*Amblypharyngodon mola*	LC
16	*Bhakura*	Cyprinidae	*Catla catla*	-
17	*Mirikali*	Cyprinidae	*Cirrhinus mrigala*	LC
18	*Purha*	Cyprinidae	*Cirrhinus reba*	LC
19	*Ballandhu*	Cyprinidae	*Danio aquipinnatus*	-
20	*Bankuaso*	Cyprinidae	*Danio devario*	
21	*Poncha Geraldi*	Cyprinidae	*Danio rerio*	LC
22	*Jhai*	Cyprinidae	*Esomus danrica*	LC
23	*Bata*	Cyprinidae	*Labeo bata*	LC
24	*Kala Bainsi*	Cyprinidae	*Labeo calbasu*	LC
25	*Pudusi*	Cyprinidae	*Labeo fimbriatus*	LC
26	*Kursha*	Cyprinidae	*Labeo gonius*	LC
27	*Rohu*	Cyprinidae	*Labeo rohita*	LC
28	*Gharuch*	Cyprinidae	*Labeo dyocheilus*	LC
29	*Kerandi*	Cyprinidae	*Puntius sarana*	LC
30	*Patia Kerandi*	Cyprinidae	*Puntius sophore*	LC
31	*Kudgi Kerandi*	Cyprinidae	*Puntius ticto*	LC
32	*Jellahri*	Cyprinidae	*Salmostoma bacaila*	LC
33	*Singla*	Bagridae	*Mystus aor*	LC
34	*Tengara*	Bagridae	*Mystus tengara*	LC
35	*Kontia*	Bagridae	*Mystus gulio*	LC
36	*Kuntiah*	Bagridae	*Mystus vitatus*	LC
37	*Pabtah*	Siluridae	*Ompok bimaculatus*	-
38	*Balia*	Siluridae	*Wallgo attu*	NT
39	*Singi*	Saccobranchide	*Heteropneustes fossilis*	LC
40	*Magura*	Claridae	*Clarias batrachus*	LC
41	*Puttuli*	Schilbeidae	*Ailia coila*	LC
42	*Punia Bachua*	Schilbeidae	*Clupisoma garua*	LC

Sl. No.	*Local Name*	**Family**	**Scientific Name**	**IUCN Status**
43	*Butchua*	Schilbeidae	*Eutropiichthys vacha*	LC
44	*Pulli*	Notopteridae	*Notopterus chitala*	LC
45	*Pholia*	Notopteridae	*Notopterus notopterus*	LC
46	*Todi*	.Mastacembeliae	*Macrognathus aculeatus*	-
47	*Baira*	Mastacembeliae	*Mastacembelus puncalus*	-

Fig. 3-27: PHOTOGRAPHS OF FISH

Mastacembelus puncalus

Mystus vitatus

Chanda Sp.

Labeo rohita

Fish Landed on the River bank

3.4.2 Findings:

Lamdunguri comprises of three hillocks in contiguity. The biotic interference exerted by the adjoining squatters of Gandhi Nagar, Cable colony, Re-rolling colony, Gujatala and first gap etc. have degraded the vegetation to the extent that only a few species are existing with thin canopy and not strong enough to withstand the wind velocity of Hirakud reservoir. There is no soil cover in the hillocks and mostly weathered rocks have been exposed.

Due to dearth of perching place, escape cover and non-existence of prey; no migratory birds visit this area although it is adjacent to Hirakud reservoir. This area does not cover any migratory route of birds visiting Hirakud during winter or for any other wild animals.

There was no endangered & threatened tree species found in the study area as per Wildlife Protection Act and IUCN list. But this forest area needs immediate attention to arrest the process of degradation. Lamdungri has 40% rooted waste. So far, in our study we did not notice any endemic plant species within the study area.

Twenty three bird species are observed in the study area. No wild animal or Schedule–I species is found in the study area. There are about 5777 trees found within affected area.

As confirmed by the DFO, Sambalpur Forest Division, there is neither any report of availability of rare and endangered species in the area nor the specified area is important from eco-social point of view. The concerned Site Inspection Report of the DFO, Sambalpur Forest Division is attached as **Annexure-3.1**.

Fig. 3-28: Degraded Lamdunguri forest

3.4.3 Sensitive areas – locational distance & discussions:

The proposed project site and its buffer zone covering 10km around it does not form part of any National park, Wildlife Sanctuary, Biosphere Reserve, Tiger Reserve and Elephant Corridor. The nearest Wildlife Sanctuary is Debrigarh Wildlife Sanctuary (HWS) which is located about 13.0 km away from western part to the Project Site.

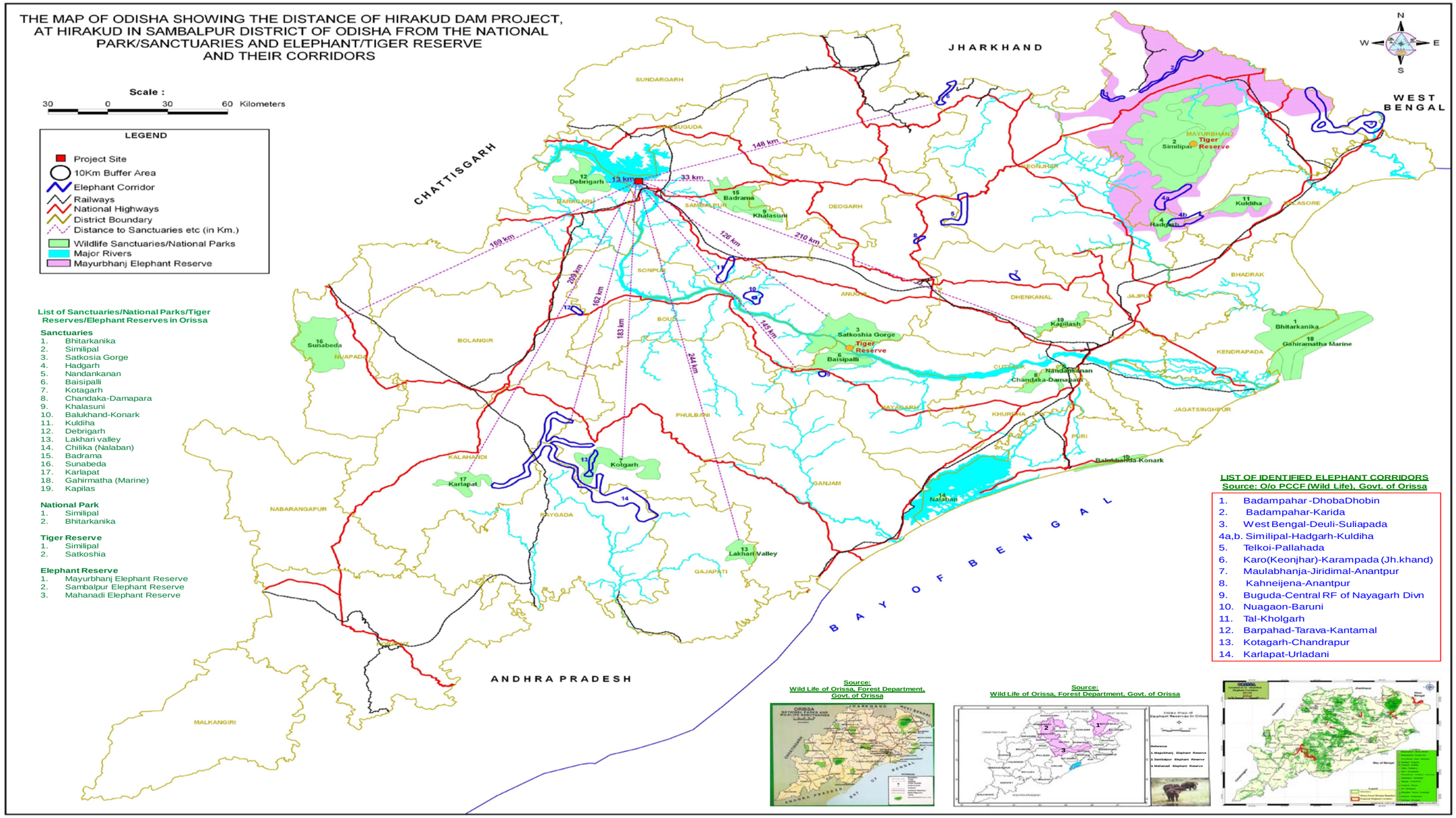


Fig.3-29: Eco-sensitive Map of Odisha

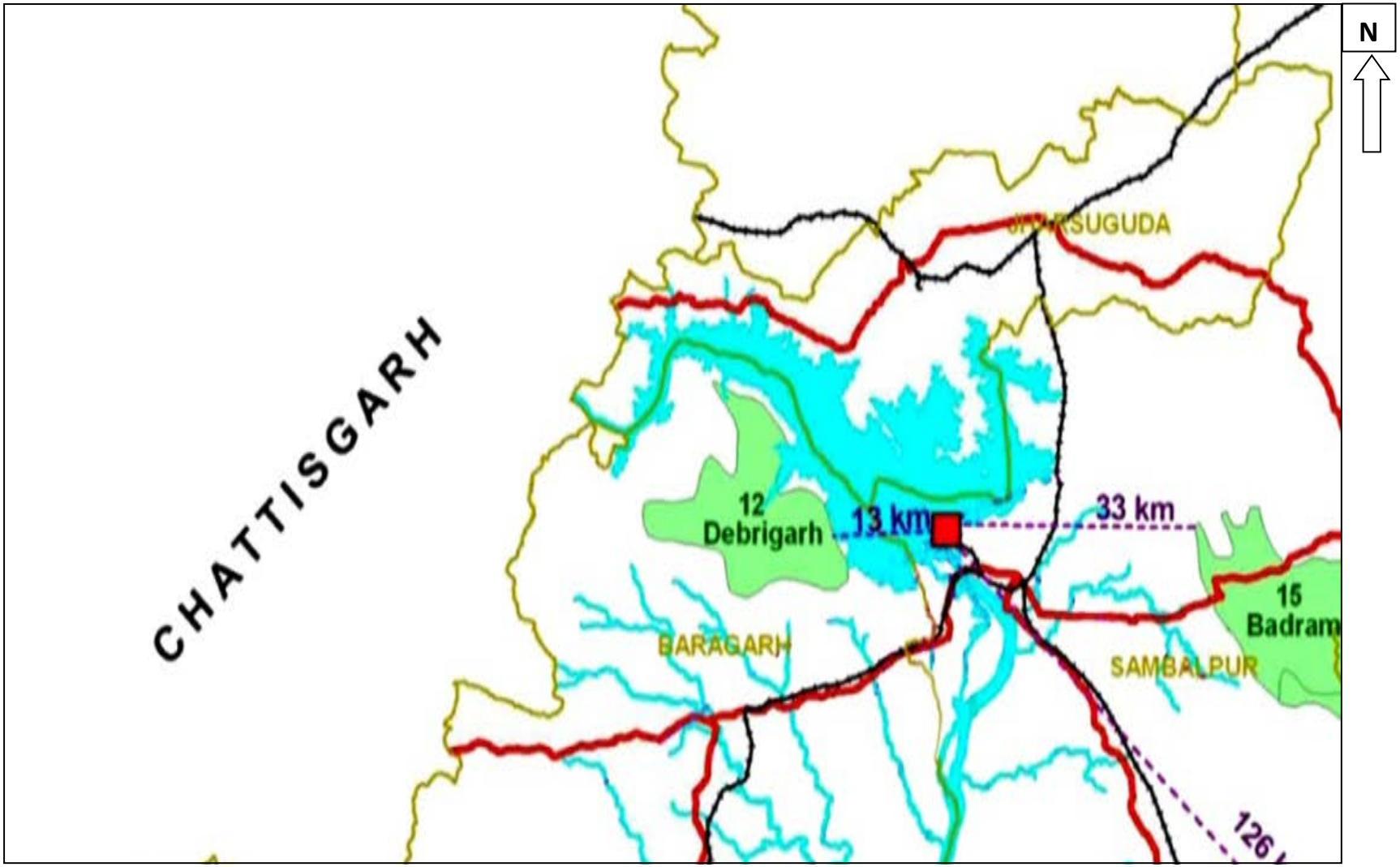


Fig.3-30: Eco-sensitive Map of Odisha (part of Enlarged view around project site)

3.5 SOCIAL ENVIRONMENT:

Execution of the Dam Rehabilitation Improvement Project (DRIP) involves land acquisition with displacement possibilities. Here is a study conducted by Center for Envotech & Management Consultancy Services Pvt. Ltd. to ascertain the concern against possible displacement. It entailed conducting a social baseline survey/ Social Impact Assessment (SIA) studies followed by preparation of Resettlement Action Plan (RAP). However a summarised data is furnished below as part of this chapter and the details are given in Social Impact Assessment (SIA) report.

The objective of the present study is to assess the impact of land acquisition/alienation for the proposed Spillway and Spill Channel on the left side of Hirakud Dam. A detailed survey was conducted in order to collect necessary information and to draw neutral assumptions based on the facts and figures for a better planning towards resettlement and rehabilitation of the affected population.

Settlements:

Human habitations have grown up on the project acquired Land occurring beyond the downstream toe of the left dyke. Some of the displaced persons of Hirakud dam have settled themselves in this area forming several colonies. Development activities related to the adjoining Industrial setups have also grown up with Houses, Roads, Railway sidings and other Public Utility facilities.

It is to be noted from the very beginning that a total of 716 households settled in 7 habitations are going to be affected in the wake of above project. Among the affected, majority of the families i.e. 407 households are found in Gandhinagar and 102 in Gujatal. Other affected families include 98 households are in Firstgap colony and 52 in Laxminagar, 17 in Re-rolling colony, 26 households in the Cable Colony, and 14 in prem Nagar. The habitationwise affected families are illustrated in table below.

Table 3-31: Quantification of Project Affected Households

Sl. No.	Name of the Hamlet/ Village	Total Number of Project Affected Households	Percentage (%)
1	First Gap	98	13.69
2	Cable Colony	26	3.63
3	Rerolling Colony	17	2.37
4	Premnagar	14	1.96
5	Laxminagar	52	7.26
6	Gujatal	102	14.25
7	Gandhinagar	407	56.84
Total (in Nos.):		**716**	**100.00**

During survey it was observed that the entire affected families are squatters who have been settling there since long and around 17% of them are earlier displaced by Hirakud Dam Project.

It can be said that majority of the families in Firstgap colony are earlier displaced households have settled there following the displacement. The list of families with prior displacement experience is given in the SIA report.

3.5.1 Demography:

A total of 3022 populations are going to be affected with this project. The total population to be affected from all the villages are tabulated below in Table 3-32.

Table 3-32: Demographic composition

Sl. No.	Name of the Hamlet/ Colony	Total House holds	Total Population	Male	(%) out of Total Poulation	Female	(%) out of total population
1	First Gap	98	431	211	6.98	220	7.28
2	Cable Colony	26	105	49	1.62	56	1.85
3	Rerolling Colony	17	82	39	1.29	43	1.42
4	Premnagar	14	72	33	1.09	39	1.29

Sl. No.	Name of the Hamlet/ Colony	Total House holds	Total Population	Male	(%) out of Total Poulation	Female	(%) out of total population
5	Laxminagar	52	231	109	3.61	122	4.04
6	Gujatal	102	418	212	7.02	206	6.82
7	Gandhinagar	407	1683	839	27.76	844	27.93
Total (in Nos.):		**716**	**3022**	**1492**	**49.37**	**1530**	**50.63**

3.5.2 Occupation of the Affected Household:

In all 7 hamlets/ colonies people pursue varied occupation in search of livelihood. Only 66 persons of the total population are in Government jobs having some sorts of direct or primary occupation. This being an urban location most people are in private jobs and non agricultural labours with low payments. The occupations which strengthen the socio-economic life of the people seem less rewarding contributing towards lesser economic growth. There are other occupations like selling of fire wood, collecting and selling of forest produces, shops, barber shop, fishing bamboo work, vegetable vending, tailoring etc in negligible numbers. The detailed Occupation of People in Affected Habitation is furnished in **Table 3-33.**

Table 3-33: Main & Subsidary Occupation of People in Affected Habitation

Particulars	Number of PAPs have these Main Occupation	Percentage (%) out of Total Population	Number of PAPs have Subsidiary Occupation	Percentage (%) out of Total Population
Govt. Service	66	2.18	00	0.00
Private Job	273	9.03	06	0.20
All type of Pension (Retirement, Old age, Physically Handicap, Widow pension etc.)	136	4.50	14	0.46
Contract job	10	0.33	00	0.00
Contractor	02	0.07	01	0.03
Anganwadi Cooker	01	0.03	00	0.00
Advocate	01	0.03	00	0.00
Business	11	0.36	02	0.07
Trading	17	0.56	00	0.00
LIC Agent	01	0.03	00	0.00
Driver	26	0.86	01	0.03
Dealership	01	0.03	00	0.00
Shop	12	0.40	11	0.36
Green Grossery Shop	01	0.03	00	0.00
Vegetable Shop	01	0.03	01	0.03
Betel Shop	04	0.13	01	0.03
Tea Stall	02	0.07	00	0.00
Agriculture	14	0.46	08	0.26
Agricultural labour	337	11.15	10	0.33
Non Agril/ Contract labour	166	5.49	06	0.20
Selling Firewood	02	0.07	00	0.00
Cook	03	0.10	02	0.07
Electrician (Pvt.)	01	0.03	00	0.00
Fitter (Pvt.)	01	0.03	00	0.00
Goldsmith	01	0.03	00	0.00

Particulars	Number of PAPs have these Main Occupation	Percentage (%) out of Total Population	Number of PAPs have Subsidiary Occupation	Percentage (%) out of Total Population
Blackshith	00	0.00	01	0.03
Painter	01	0.03	00	0.00
Carpentry	01	0.03	00	0.00
Barber	01	0.03	00	0.00
Sweeper	03	0.10	00	0.00
Priest	03	0.10	00	0.00
Mason	05	0.17	00	0.00
Washerman	00	0.0	01	0.03
Bamboo work	01	0.03	00	0.00
Bidi Making	19	0.63	00	0.00
Fishing	00	0.00	00	0.00
Tailoring	03	0.10	00	0.00
NTFP collection and selling	00	0.00	00	0.00
Milk Selling	02	0.07	00	0.00
Grazing cattle	01	0.03	00	0.00
Forest Produce collection	03	0.10	00	0.00
House Rent	00	0.0	01	0.03
Other type of work (Not disclosed)	08	0.26	01	0.03
Total Earning Persons:	1141	37.75%	67	2.22%
Non earning group Consists of: Depended Persons/ House wife/ House work/ Student/ Old Age/ Child/ Disable (Physically Handicap)/ Unemployed	1881	62.25	00	0.00
Total Persons/ Population	**3022**	**100.00**	**67** are involved in Subsidiary occupation out of total population	**2.22%** out of total population

3.5.3 Annual Income Level of Affected Households:

This indicates a poor income level of majority of the household and population in the surveyed location with a higher dependant population. If the whole earning population will be taken together, then 474 households out of 716 earn below 100000 rupees in a year. All above facts substantiate a poor economic profile with regard to annual income of the population who are to be affected under the project. The details of habitation specific level of income are illustrated in the following table.

Table 3-34: Castewise Annual Income of Project Affected Households

Sl.	Hamlet/ Colony Name	Less than 50000	50000 < 100000	100000 < 200000	200000 < 300000	300000 < 400000	400000 and above	Total House holds
1	First Gap	23	45	21	5	2	2	98
2	Cable Colony	0	14	7	2	2	1	26
3	Rerolling Colony	3	9	2	0	1	2	17
4	Premnagar	2	6	3	0	0	3	14
5	Laxminagar	11	28	7	5	1	0	52
6	Gujatal	24	43	21	7	5	2	102
7	Gandhinagar	91	175	80	35	12	14	407
Total		**154**	**320**	**141**	**54**	**23**	**24**	**716**

Sl.	Hamlet/ Colony Name	Less than 50000	50000 < 100000	100000 < 200000	200000 < 300000	300000 < 400000	400000 and above	Total House holds
Percentage (%)		21.5	44.69	19.69	7.54	3.21	3.35	100

3.5.4 Education Status of the PAPs:

The educational analysis has been done considering the entire population of all habitations. Only 243 (8.0%) persons found illiterate in the survey. Sparing child population of 236 (7.8%), not answered 95 (3.1%) and the illiterates as mentioned the remaining 2448 (81.1%) population are literate with varying academic achievements.

Educational achievement at present indicates high at Primary level and secondary level. This indicates a good motivation among current generation towards education having more enrolment and continuation. As far as higher education is concerned there are 439 (14.5%) matriculates, 181 (6%) intermediates, 107 (3.5%) graduates and 53 (1.8%) post graduates. There are 146 (4.8%) persons who have gone for technical education. The resettlement must take into consideration for the continuation of the education of the children who are studying now with different schools. The detail scenario on education is given in **Table No.C3-35**.

Table 3-35: Education Status of project affected people

Sl. No.	Village name	Primary	Secondary/ Middle	Matric	Intermediate	Graduate	Post graduate	Technical	Illiterate	Child	Not Answered	Total Population
1	First Gap	139	130	45	15	5	0	6	57	34	0	431
2	Cable Colony	29	28	34	13	3	16	2	3	6	0	134
3	Rerolling Colony	13	19	19	11	8	3	6	2	1	1	83
4	Premnagar	12	12	6	10	3	12	5	1	10	1	72
5	Laxminagar	81	38	46	22	8	3	12	10	11	1	232
6	Gujatal	107	93	61	27	8	7	28	47	30	11	419
7	Gandhinagar	420	401	228	83	72	12	87	123	144	81	1651
	Grand Total	**801**	**721**	**439**	**181**	**107**	**53**	**146**	**243**	**236**	**95**	**3022**
	%	26.5	23.9	14.5	6.0	3.5	1.8	4.8	8.0	7.8	3.1	100.0

Fig. 3-31:Photographs of village amenities

School, Anganwadi Centre, house

Water sources

3.5.5 SOCIO CULTURAL FUNCTIONS:

The project affected families found to be rich with tribal population. Socio cultural activities are influenced partly by the tribal heritage and mostly by the religious rituals of the region. As per the local enquiry, some religious activities are listed below.

Since all colonies are part of the Hirakud urban area so the cultural traditions are observed with much pomp and gaiety in all colonies. All bow down and respect "Maa Samalai" as their principal deity.
"Nuakhai" is the most important social festival of Sambalpur. Generally it takes place during the month of August and September. Preliminary preparation of the festival starts 15 days before the occasion. The first grains of the paddy crop, cooked into various dishes are offered to the deities. There after the eldest member of the family distributes new rice to other members of the family. People observe and practice much serenity during this festival.
The ***Bhai-juntia*** festival is celebrated on the Mahastami Day of Durga Puja. It is a total fasting undertaken by women without water for the whole day and night to seek Goddess Durga's blessing for the long life of their brothers.
The ***Puo-juntia*** festival is observed by mothers to invoke the grace of Lord Dutibahana for the long life and prosperity of their sons by staying fasting the whole day.
Chaitra Punei is another festival which is celebrated by the Khadia people of Firstgap colony. In that festival people are offering animal sacrifices *(Pasu Bali)* to their almighty god to full fill their desire. Karma puja is also celebrated by the Khadia community. They consume homemade brewery called as "Handia".
At the age seven the every member of Khadia community will have ear piercing s to wear silver and gold ring.

Dushahara is also another attraction oh Hirakud town, which is celebrated for seven days with big mela. "***Manabasa"*** is also celebrated by the affected people in the months of November to December worship the Maa Laxmi for wealth.

3.6 OTHER INFRASTRUCTURES/PUBLIC STRUCTURES OF ENVIRONMENTAL AND SOCIAL CONCERN:

3.6.1 Existence of Physical Structures:

An attempt has been taken to identify locations of some of the structures having religious significance in the study area.

Clutral Features:
Religious Places: There exist one or more temples in almost every village. There are about 11 temples and 'bijesthalis', 5 holygroves and a "puja mandap" located in the study area. Of these temples, one will be completely affected and one will not be affected at all. Rest of the temples will be partially affected due to construction of spill channel. The detailed list of the temples is given in SIA report. Some of the photographs of these temples are given below.

Fig. 3- 32: Religious Places

RADHA KRUSHNA TEMPLE, GANDHNAGAR

NILAKANTHESWAR TEMPLE, REROLLING COLONY

SRI SRI MUKTESWAR TEMPLE, IDC COLONY, GANDHINAGAR

SAMALEI TEMPLE, FIRST GAP

Crematoria:

A Crematoria is recently built from benevolent fund alongside of river embankment within the river. This structure is located just at the confluence point of spill channel and river.

This structure will be affected due to construction of spill channel.

Fig. 3- 33: Recently built Crematoria

Communication Links (Roads):

Two major road connections from the nearby habitations to approach the Dam proper will be cut off by the proposed spill channel. One of the roads is connected to the 'Gandhi Minar' which is the most attracting place of the dam and the same road is also leading to a park (garden), a place for recreation.

3.6.2 Educational Institutes:

The Baseline survey reveals that there are 2 primary school, 1 highschool, and 4 numbers of Anganwadi center are going to be affected situated within the peripheeri of proposed project displacement area.

3.6.3 Agriculture:

Few of the female members of Women headed households and other category use to cultivate in nearby land. They use to yield green vegetables. It has been revealed from the survey that 14 Households depend on Agriculture who use to cultivate vegetables and sale in nearby urban area.

3.6.4 Fishery:

Though the proposed project displacement area is situated in a very close proximity of the Dam, still no household is going to be affected of fisherman category who use to depend on fishing for their livelihood.

3.6.5 Water Supply:

On the right side of the proposed spill channel in Gujatala, there is a water treatment plant at a distance of 150m from right bank of proposed channel. From the treatment plant the water is supplied to Hirakud and Burla town through separate water pipe line. This pipeline network may get affected due to this project implantation.

3.6.6 Garbage Dumping Yard:

In Bahadurpada, some municipal waste has been recorded during the public consultation. This is not a regular dumping site and in past the Municipality dump randomly at the site, which was stopedp when objection was raised by the Dam Authority.

Fig. 3- 34: Garbage dumped area in and around Bahadurpada

3.6.7 Communication Links (Roads):

Two major road connections from the nearby habitations to approach the Dam proper will be cut off by the proposed spill channel. One of the roads is connected to the 'Gandhi Minar' which is the most attracting place of the dam and the same road is also leading to a park (garden), a place for recreation.

3.6.8 Structures with Archaeological and Historical Importance:

Table 3-36: Archaeological Monument/ Historical Places around the Hirakud Dam

Sl. No.	Archaeological Monuments/ Historical Places	Location	Distance from the Hirakud dam
1	Goddess Kali Temple at Patneswari	Sambalpur	11.11 km
2	Samaleswari Temple	Sambalpur	11.37 km
3	Ghanteswari Temple	Chipilima	20.3 km
4	The Leaning Temple	Huma	28.29 km
5	Vikramkhol Rock Inscription	Sambalpur	13.64 km

The above table implies that Archaeological or Historical importance monuments do not exist within 10kms radius of core zone.

Tourist Spots:

'Gandhi Minar' and 'Nehru Udyan' are the two well recognised tourist sports located in this region. It supports income oriented activities for the local population. Tourists from nearby places and different corners of the district visit these places.

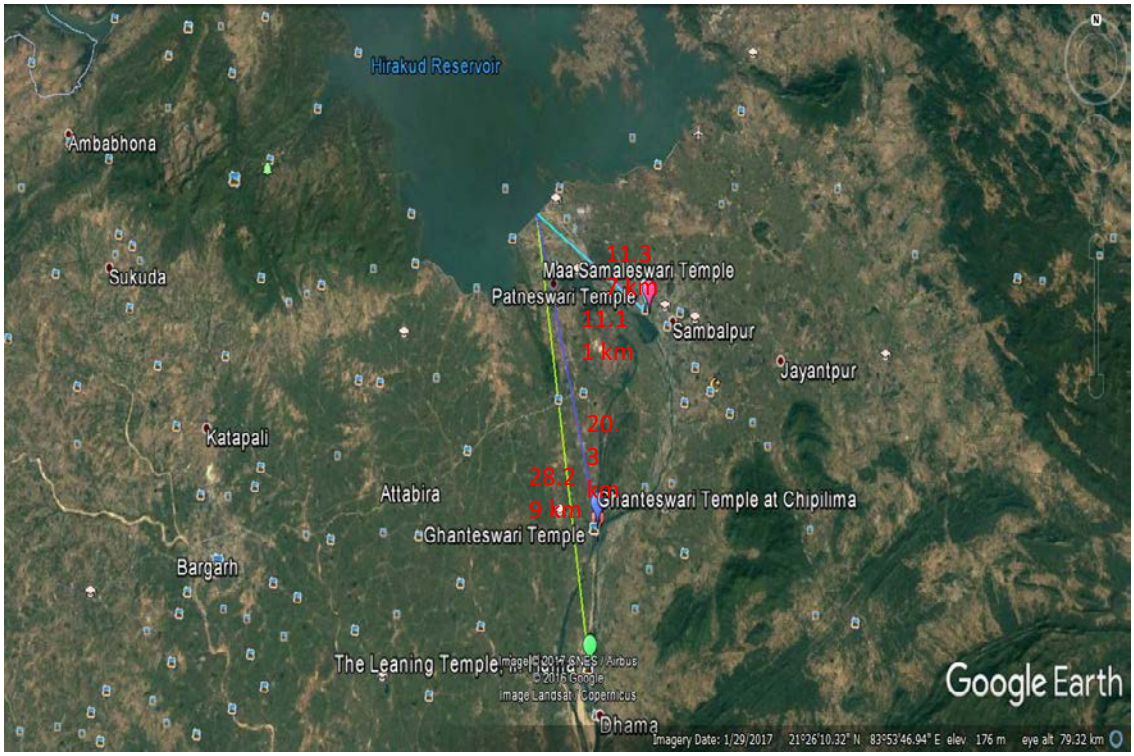


Fig. 3- 35: Google map showing Historical Places and its distances from Hirakud Dam

3.6.9 Sensitive Receptor: No sensitive receptors other than social structres (11 temples, 5 holygroves, 1 relegious splace (pooja sthal) 2 primary school, 1 high school, and 4 anganbadis) coming within 500m radius of core zone.

CHAPTER-4
POTENTIAL ENVIRONMENT IMPACTS AND MITIGATION

4.0 INTRODUCTION:

Environmental Impact Assessment [EIA] study is a process to forecast the future environmental and social conditions of the project area that might be expected to occur because of implementation of the sub-project.

Amongst several techniques suggested for prediction of impacts due to various project activities spread throughout the project cycle, the present EIA study refers to a combination "overlays of activities and impact evaluation checklist method".

4.1 APPROACH AND METHODOLOGY:

The basic approach is adopted for conducting the environmental impact study for the proposed project to assess the existing environmental scenario in and around the project area, components and activities of the project having potential environmental impacts, analyse the project proposals with respect to prevailing institutional and legislative setup of the Government of India (GoI) and World Bank Safeguard Policies on this subject.

The main approaches for the study are:

- Identification, appraisal and division between positive and negative impacts, direct and indirect impacts, and instant and long-term impacts likely to result from identification of unavoidable or irreversible impacts;
- Identification of feasible and cost effective mitigation measures to minimize negative impacts and enhance positive impacts by incorporating in the preliminary engineering design.
- Exploration towards the opportunities for environmental enhancement;
- Preparation ofEnvironmental Management Plan for effective implementation of environmental mitigation measures at different stages of the project.

4.1.1 Criteria for determining degree of Importance of Impacts:

As because many social and environment components cannot be reliably quantified due to inherent association of complex inter-relationships, most impacts have been predicated qualitatively. Significance of impacts regulated by the degree of importance of impacts covering the areas is (i) Area of Impact, (ii) Duration, (iii) Intensity and (iv) Reversibility factors.

4.2 ENVIRONMENTAL SCREENING:

Screening exercises were carried out according to the existing ESMF to delineate the potential environmental & social impacts due to the project components and their associated activities and defining the scope for further analysis depending upon the significance and extent of the impacts. Screening of impacts is presently considered for pre-construction, construction & operation stages. The steps followed for screening are detailed below.

4.2.1 Categorization of Components:

Categorization of components is necessary to assist determining the environmental and Social Consequences in regards of their severity, significance and duration. It ultimately entails convenient approach for deciding appropriate mitigation measures or a long-term management intervention.

The World Bank Safeguard Policy OP/BP 4:01 has set up guidelines for categorization of Components.

Table 4-1: Categorization Criteria

Category A	Components which have major Social & Environmental Impacts require specific management plan and close monitoring of mitigation measures.
Category B	Components which have moderate social and environmental impacts, which can be mitigated with certain precautionary measures.
Category C	Components which have 'Negligible' or 'Nil' social & environmental impacts and does not require any mitigation measures.

The identified components in **Table 4-2** are rationally categorised as below.

Table 4-2: Categorization of Components:

Sl. No.	CATEGORY A	Sl. No.	CATEGORY B	Sl. No.	CATEGORY C
1.	Acquisition of forest land	1.	Operation of Heavy machinery	1.	Safeguard measures at work sites
2.	Displacement of Communities	2.	Running of Batching plant	2.	Small Tools & Plants & Safe up keeping
3.	Blasting Operations	3.	Running of Concrete Mixer & Heavy pumps		
4.	Construction of above ground Structures	4.	Material Handling & Storage		
5.	Borrowing of earth for Dam construction.	5.	Transport of materials &machinery		
		6.	Decommissioning- Treefelling and disposal		
		7.	Establishing Construction Workers Camps		
		8.	Excavation and disposal of Wastes, Construction Spoils & Debris		

4.2.2 Screening of Environmental & Social Impacts:

An essential step in Environmental & Social Impact Assessment (EIA) is to identify all potential environmental impacts and then examine critically to find out the major impacts (both beneficial and adverse), which are then analyzed in detail. Based on description of present environmental settings of the project area as described in Chapter-2 and the proposed project components and activities described in this chapter, a scientific evaluation on various impacts that are likely to influence the environment is furnished in this chapter. To overcome the various environmental problems, possible mitigation measures have been suggested in the Environmental Management Plan.

In the present study, likely impact and its extent on various environmental parameters viz. topography and drainage, land, water, noise, air, ecological and socio-economic conditions were studied by assessing the baseline environmental status of the area and estimations were made as how this will change with commencement of project activity. The mitigation measures have been worked out with a view to bring down the levels of impacts within limits. In each of the areas of impact, measures have to be taken to mitigate adverse impacts and where these are beneficial in nature such impacts are to be enhanced. The potential environmental impacts due to the project has been studied for different stages of the project, viz

- Design and Pre-construction stage
- Construction stage
- Operation stage

Table 4-3: Screening of Environmental & Social Impacts

ON-SITE IMPACTS					
Sl No	**Activities**	**Purpose**	**Impact**	**Type of Impact (+ve / -ve)& Categorisation**	**Remarks / Significance**
A. Pre Construction Phase					
1.	Land Acquisition (i) Forest Land	Acquisition of about 9.441 ha of Lamdungri R.F is required for Spill Channel crossing across the saddle	- Change in land use - Landscape Degradation - Impact on Flora - Disturbance to Fauna	Negative/ (A)	Felling of 115 trees in forest area - Direct Impact - Long term, Irreversible in nature - Moderate severity - Minor Social Impact
	(ii) Other Land [Govt]	Land for; - Borrow area - Quarry and Dumping Sites	- Landscape degradation - Affects Natural Drainage, Water Quality	Negative/ (B)	- Indirect Impact - Long term duration, - Short term duration (For Quarry & dumping) - Low Severity
	Felling of non forest Trees Within the project core area other than forest land	For constructional activities of project components	- Change in landscape - Change in microclimate	Negative/ (B)	Felling of 3595 trees outside forest area - Direct Impact - Long term, Irreversible in nature - Moderate severity
2.	Displacement of Community Area about 5 sq km further D/s of Left dyke - Existing habitations will be affected due to Construction and submergence of area /land	- For constructional activities of project components	- Loss of property & livelihood - Displacement of population - Socio economic imbalance - Impacts cultural living style of tribal community	Negative/ (A)	- Direct Long term impact - Transcends region boundary - Irreversible with low intensity - to use management plan

ON-SITE IMPACTS					
Sl No	**Activities**	**Purpose**	**Impact**	**Type of Impact (+ve / -ve)& Categorisation**	**Remarks / Significance**
B. Construction Phase					
1.	Blasting	- Excavation and Hill cutting for foundation of structures at spillway & Spill Channel area	- Enhanced Noise level & Vibration - Temporary Air Pollution - Disposal of generated solid - Transportation / Traffic - Public Health & Safety concerns - Land erosion - Land degradation at Quarry areas	Negative/ (A)	- Direct short term impact - Reversible - Moderate severity - Low Social Impact - Mitigation measures as per explosive guidelines Chapter 3 of notification by Ministry of Commerce and Industry, Gazette 2008.
2	Borrowing of earthfrom identified burrow area	- For construction of dykes and embankments	- Soil erosion & soil pollution - Air pollution - Use of Heavy Machinery - Transportation & Traffic - Water pollution	Negative/ (A)	- Direct, short term impact - Low severity - Mitigation measures proves adequate
3.	Operation of Heavy Machinery	Laying, compaction hoisting activities for - Construction of earth dam - Spillway – gate erection	- Air pollution due to dust generation - Increased Noise Level causing Noise pollution	Negative/ (B)	- Direct, short term impact - Low severity - Mitigation measure to minimize impact
4.	Running of Concrete Mixer and Heavy Pumps	- Construction of Spillway, Bucket Approach and Spill Channels. - Pumps for dewatering and water supply for earth dam Construction	- Air Pollution - Waste water affects water quality - Soil pollution	Negative/ (B)	- Direct, short term impact - Low severity - Negligible social impact - Minimize impact through mitigation measures
5.	Transport of Materials	- Transport of Construction materials to site of work	- Increased Traffic - Air pollution, Noise pollution	Negative/ (B)	- Direct, short term impact

ON-SITE IMPACTS					
Sl No	**Activities**	**Purpose**	**Impact**	**Type of Impact (+ve / -ve)& Categorisation**	**Remarks / Significance**
	& Machinery	- Haulage of machinery	- Workers & Local people exposure		- Addressed by mitigation measures
6.	Material Handling and Storage	- Stacking ofdifferent construction materials - Sheds for small tools equipments & Cement etc	- Affects Landscape - Soil pollution - Obstruction of natural drains - Water quality pollution	Negative/ (B)	- Direct, short term impact - Insignificant impact for the locality - Addressed by appropriate mitigation measures
7.	Running of Batching Plants	- for concrete mix	- Air Quality Pollution - Affect Noise level - Soil pollution	Negative/ (B)	- Direct & Short term Impact - Low severity - Impact addressed by mitigation measure
8.	Excavation and disposal of Wastes, Construction Spoils & Debris	- Base striping, foundation of structures, Borrow of earth, Quarry and construction sites	- Affects Land environment - Landscape degradation - Pollution of water quality	Negative/ (B)	- Direct, short term impact - Low severity - Curbed through suitable mitigation measures
9.	Establishing Construction Workers Camps	- for Outstation labour force by contract agencies - Supervisory staff housing	- Loss of green cover for search of fuel wood - Lack of sanitation leading to endemic health problems - Erratic method of Solid waste & Liquid domestic disposal - Non-Acceptance of host population	Negative/ (B)	- Direct, short term impact - Low severity - Reversible Impacts - Needs Management intervention & safeguard action plan - Moderate social Impacts
10	Disruption or demolition of Social infrastructure • Temple • Cremation structure	For construction of project components	Affects religious and cultural rights of people	Negative/(A)	- Direct, short term impact - Low severity - Reversible Impacts - Needs Management intervention & safeguard action plan - Moderate social Impacts (till relocation)

ON-SITE IMPACTS					
Sl No	**Activities**	**Purpose**	**Impact**	**Type of Impact (+ve / -ve)& Categorisation**	**Remarks / Significance**
	• Water works		Disruption in potable water supply		
C. Operation Phase:					
1.	Operational Safety measures	• Reservoir operation and timely flood release mechanism • Functioning of warning system • Preventing disaster in downstream side	• Disaster due to over flooding of areas at downstream locations • Local population exposure • Impact transcends region & State as a whole • Human health & safety of workers	Negative/ (B)	• Direct short term impact • High severity • Irreversible • Require effective management plan and safeguard action plan
2.	• Tourism development by Area beautification, plantation and improved road communication	• Tourism prospects	• Landscape improvement • Beautification of above ground structures • Add to livelihood prospects of local people & Resettled population	Positive	• Indirect long term positive impact • Encourage peoples participation involving the local administration • Enhanced social impact

OFF-SITE IMPACT					
Sl No	**Activities**	**Purpose**	**Impact**	**Type of Impact (+ve / -ve)& Categorisation**	**Remarks / Significance**
1.	Quarrying (Area/ Construction Materials) • Stones and stone products - at Munder, 42 km away • Sand- from river IB 60km away.	• For construction of structural activities	- Dust nuisance – Air pollution, Noise pollution - Workers & Local people exposure	Negative / (A)	• Direct short term • Occupational health
2.	Transport of construction material by trucks/ dumpers	• For project activities	- Increased Traffic - Dust nuisance – Air pollution, Noise pollution - Workers & Local people exposure	Negative/ (B)	- Direct, short term impact - Addressed by mitigation measures
3.	Handling and disposal of Wastes, Construction Spoils & Debris by trucks/ dumpers at identified locations	• Waste disposal, site cleaning and safe disposal	- Increased Traffic - Dust nuisance – Air pollution, Noise pollution - Workers & Local people exposure - Affects Land environment - Landscape degradation - Pollution of water quality	Negative / (B)	- Direct, short term impact - Low severity - Curbed through suitable mitigation measures

4.2.3 Evaluation of Impacts:

In the previous table **(Table 4-3)**the impacts of project activities have been broadly predicated according to the environmental components while every attempt is generally made to forecast future environmental conditions quantitatively, most of them are assessed qualitatively for the best reason that many variables are associated with complexities and complex inter-relationships.

4.2.4 Summary Statement of Screened Project Activities :

- Phased activities are summarized below:

Table 4-4: Project Activities

Implementation Phase		**Post Implementation Phase**
Preconstruction Phase	**Construction Phase**	**Operation Phase**
• Land acquisition & Connected issues • Forest Land Acquisition and connected issues • Decommissioning Issues	• Construction of various Hydraulic Structures • Labour Camps • Heavy Machineries Haulage & Maintenance • Transport of materials • Material Handling and Storage • Decommissioning / De-Siltation & Disposal	• Tourism Development • Gate Operation Mechanism • Flood release management strategy at PMF • Monitoring Mechanism & Quality assurance • Safety Considerations against Hazards & Accidents

Table 4-5: Impact areas within the project Cycle

IMPACT AREAS OF THE PROJECT CYCLE			
Natural Environment	**Biological Environment**	**Pollution Control**	**Social Environment**
• Forests areas (RFs) • Changes in Topography • Hydrological Changes • Landscape degradation & Soil Erosion • Drainage • Climate Change & Global Warming	• Flora, Fauna and Biodiversity • Loss of Green Cover-Vegetation (Tree Felling) • Environmental and Social Safeguard measures	• Air Pollution due to increased Traffic Volume • Water Pollution (Both Surface & Ground Water) • Soil pollution (Including Sediment) • Noise Pollution (Vibration Effect) Waste disposal linked pollution	• Resettlement • Temporary labour Camps • Social Institutions and public utilities • Religious & cultural Properties • Indigenous and ethnic people, Gender equity issues • Local economy & employment • Occupational Health and Safety • Risks & Accidents

4.2.5 Analytical Finding:

In the above impact evaluation process, the severity of impacts are assigned to each activity on a most rational basis and are denoted by alphabets A, B & C corresponding to serious impacts, moderate impacts and no impacts / negligible impacts respectively.

- The proposal involves acquisition of forest land from Lamdunguri R.F. and the total area for diversion is 9.441 ha. The project is likely to displaced large number of people, trigger cutting of about 4000 trees though largely from non forest area. . The environmental impacts on above aspects is considered significant and rated as A category.
- In the instant case, displacement of community is one of the most significant adverse impact considered in the screening matrix. Even though the project activities remain within the project acquired land (Hirakud Dam Authority), the existing settlements mostly viewed unauthorised occupations. Since more than two decades; occupants are affected with Chronic Multiple Adverse Impacts. The significance of impact is thus rated as 'A' category.
- Since huge quantity of earth will be required for embankment of both dykes of the spill way, the burrowing of earth is considered as A Category .

Rests of the assessed impacts are either 'B' or 'C' category which is common attributes of the construction phase. All 'B' category impacts i.e. moderate impacts will be addressed through Mitigation Measures.

4.3 ASSESSMENT OF ANTICIPATED ENVIRONMENTAL IMPACTS:

During the environmental screening, the components and activities having potential environmental impacts have been identified and analysed for the significance of impacts. The Environmental Screening provides basis for defining the scope of further study and analysis for the anticipated impacts on all the sensitive environmental components and activities identified during screening. The present section assesses the likely environmental impacts during different stages of the projects, viz Design & Preconstruction stage; Construction Stage and Post Construction/Operation stage.

4.3.1 Impacts during Design & Pre-constructional Phase:

4.3.1.1 Impact on Topography & Land use:

The proposed proposal includes 91 m wide spillway, 243m long concrete lined approach channel, 2.14km long concrete lines spill channel and connecting earthen of total 1020 m length.. The proposed alignment of approach channel and the spillway is located on flat terrain but part of the proposed spill channel passes through hilly terrain of Lamdungri forests. The cutting of this hill will cause loss of forests area and permanent change in area topograpghy.

A new earthen dyke will be built near the existing left dyke in the first gap which will lead to submergence of addition 12 ha area which is unavoidable. The proposed dyke and hill cutting area is situated entirely in the dam area, there will not be any change in surrounding land beyond dam area due to this change in topography. The baseline study reflects that there is degraded reserved forest area spread over the entire hill with scanty vegetation. For the proposed spill channel there will be requirement of diversion of about 9.441 ha of reserved forest area, so there is change in land use in this stretch for non forest use, i.e. spillway channel.

The project will also involve acquisition of around 716 residential structures. The useful materials generated from demolition will be utilised for construction of houses of displaced person at their own cost.

The alignment of spill channel will be mainly located in dam area except for a small length passing through the government land of Odisha Industrial Infrastructure Development Corporation. In this stretch acquisition of 63.642 Ha land is required from OIIDC. Thus, there is change in land use, this stretch from existing forests and residential area.

Mitigation Measures:

- The alignment has been restricted to the minimum to avoid widespread impacts.
- The diversion of reserved forest and tree felling in forest area will attract the provision of Forest Conservation Act, 1980 and accordingly Forest Clearance will be required. Application for diversion of required forest area has already been made and pending with the state government.
- The forest department will carry out compensatory afforestation in the degraded forest area in twice the area to be diverted which will not only compensate the forest loss but will also help in overall enhancement in the environmental conditions in and around the area of compensatory afforestation.
- Additional plantation will be carried out by the dam authority in the area along the channel which will help in enhancement of the environment in the area adjacent to the project area.
- All the affected people will be compensated for the loss as per R & R Policy of the project before commencement of Construction works.
- Balance surplus material from demolition site will be carefully disposed in dumping area which will be in close vicinity of project areas in the low lying areas which is about 20% of demolition muck.

4.3.1.2 Impact on People due to Acquisition of Properties:

Although the project doesnot require acquisition of private land, habitation has been recorded in the project area during baseline survey. The project envisages acquisition of various commercial and residential structures and displacement of Non titleholders (NTH). Altogether 716 households are likely to be affected due to the project. These impacts have been described in detail under Resettlement and Rehabilitation Action Plan Report.

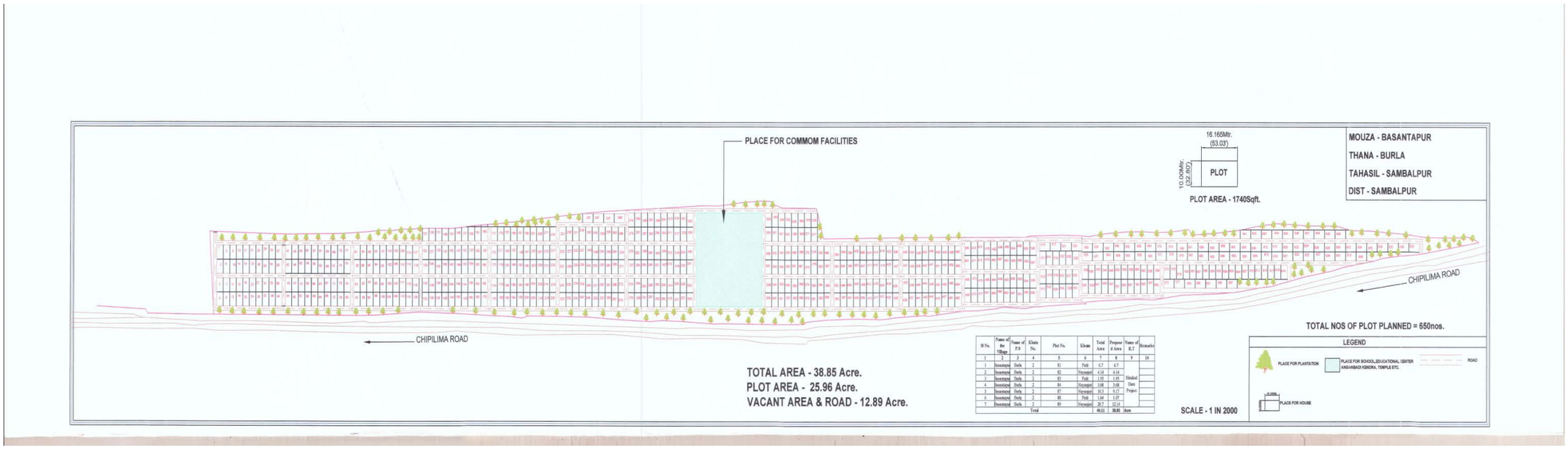
Mitigation Measures:

- The acquisition of private properties will be carried out in accordance with the RAP and entitlement framework for the project.
- Early identification of affected persons for compensation and advance planning of Resettlement and Rehabilitation Action Plan to Compensate the Losses.
- All the affected people will be compensated for the loss as per R & R Policy of the project before commencement of Construction works
- The Dam Authority has to ascertain that any additional environmental impacts resulting from acquisition of properties are addressed and integrated into the EMP and other relevant documents.
- Entitlement against loss of property will be decided by the district level compensation advisory committee as per LARR Act 2013-DCAC
- Payment to each DFs will be made by the collector of the district through his designated officers.
- Other Benefits/ Entitlements as would be prescribed in the approved RAP will be extended to the DFs.
- Three separate locations mainly govt. land were identified by the Project Authority in and around the Hirakud dam for resettlement purpose of the families to be displaced. These three sites are located at Basantapur, Rengalipalli and Larbanga respectively. A brief description of each site is given below.
- **Basantapur**:

This site is located parallel to the main road on the way to Chipilima. It is about 22kms away from the dam site and 8 kms from Chipilima. NH-53 is at a distance of 2km from this site. This area is a plain and gently undulating land, without having any structures and trees except a few shrubs. The area measures about land is 38.85 acres. In this site 650 families can be accommodated. This land is owned by Dept. of Water Resources, Govt. of Odisha. [Shown in Map No.1 Resettlement planning at Basantapur Mouza]

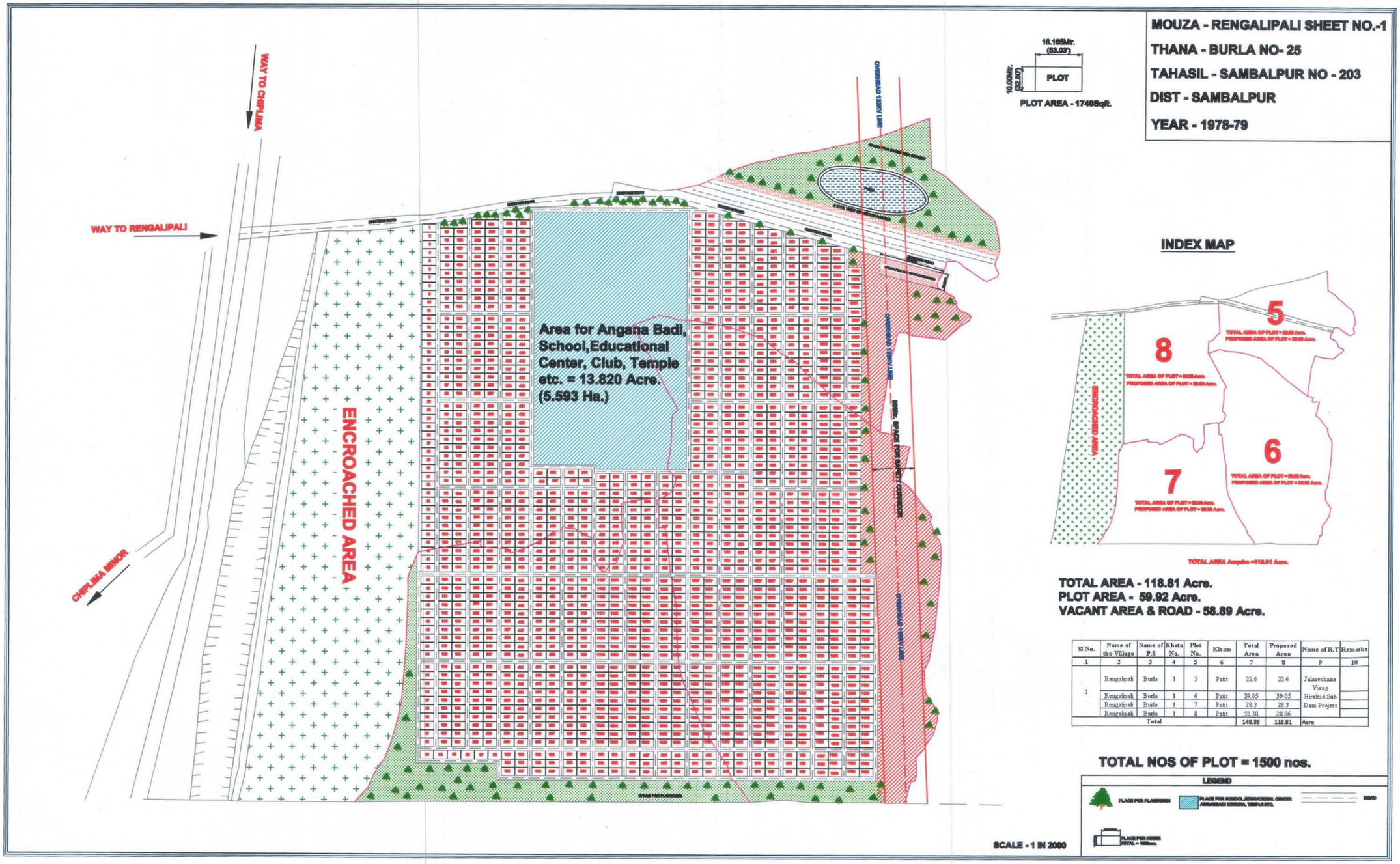
- **Rengalipalli:**
  This site is located 1km right of the Hirakud - Chipilima main road and very near to Chipilima power house which is about 30 kms away from the dam site. There exists a metal road to the identified site from the main road. This area is a plain and gently undulating land, without having any structures and trees except a few shrubs. The area of the land is 118.81 acres. In this site 1500 families can be accommodated. Amenities like school, market and Public Health Centre exist at Chiplima within a radius of 1km from this site. This land is owned by Dept. of Water Resources, Govt. of Odisha. [Shown in Map No.2 Resettlement planning at Rengalipalli Mouza]

- **Larbanga:**
  Two patches of land adjacent to each other were identified in this Larbanga Mouza to accommodate the families likely to be displaced due to project implementation. This site is located about 8 kms from the dam site on the dam road in eastern direction. This is a gently sloped land. At present this area is commonly occupied with trees, shrubs, herbs and bushes. Majority of these trees may not require felling in case the site is selected for rehabilitating the identified families to be displaced. Since this land is very near to the revenue village Larbanga most of the service facilities are available very close to the site. However, this land belongs to Revenue Dept., Govt. of Odisha. 850 families will be accomodated in this land. The area of the land is 48.03 acres. [Shown in Map No.3 Resettlement planning at Larbanga Mouza]



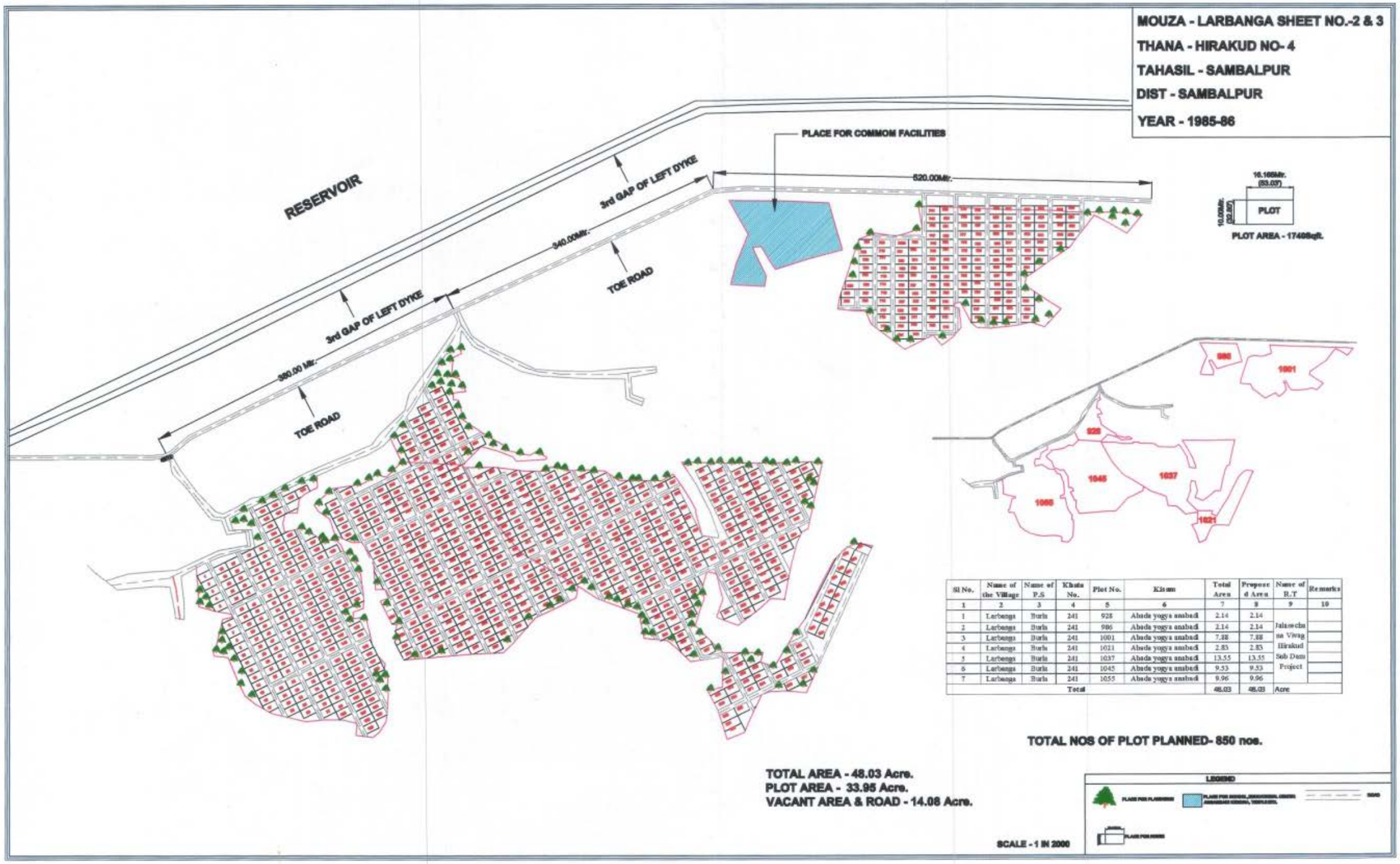
Sl No.	Name of the Village	Name of P.S	Khata No.	Plot No.	Kisam	Total Area	Proposed Area	Name of R.T	Remarks
1	2	3	4	5	6	7	8	9	10
1	Basantapur	Burla	2	81	Patit	6.7	6.7	Hirakud Dam Project	
2	Basantapur	Burla	2	82	Nawapatit	4.14	4.14		
3	Basantapur	Burla	2	83	Patit	1.95	1.95		
4	Basantapur	Burla	2	84	Nawapatit	3.68	3.68		
5	Basantapur	Burla	2	87	Nawapatit	10.3	9.17		
6	Basantapur	Burla	2	88	Patit	1.04	1.07		
7	Basantapur	Burla	2	89	Nawapatit	20.7	12.14		
Total						48.51	38.85	Acre	

Map No.1 Resettlement planning at Basantapur Mouza



Sl No.	Name of the Village	Name of P.S	Khata No.	Plot No.	Kisam	Total Area	Proposed Area	Name of R.T	Remarks
1	2	3	4	5	6	7	8	9	10
1	Rengalipali	Burla	1	5	Patit	22.6	22.6	Jalasechana Vivag	
	Rengalipali	Burla	1	6	Patit	39.05	39.05	Hirakud Sub	
	Rengalipali	Burla	1	7	Patit	28.3	28.3	Dam Project	
	Rengalipali	Burla	1	8	Patit	55.38	28.86		
Total						145.33	118.81	Acre	

Map No.2 Resettlement planning at Rengalipalli Mouza



Sl No.	Name of the Village	Name of P.S	Khata No.	Plot No.	Kisam	Total Area	Proposed Area	Name of R.T	Remarks
1	2	3	4	5	6	7	8	9	10
1	Larbanga	Burla	241	928	Abada yogya anabadi	2.14	2.14		
2	Larbanga	Burla	241	986	Abada yogya anabadi	2.14	2.14	Jalasechana Virag Hirakud Sub Dam Project	
3	Larbanga	Burla	241	1001	Abada yogya anabadi	7.88	7.88		
4	Larbanga	Burla	241	1021	Abada yogya anabadi	2.83	2.83		
5	Larbanga	Burla	241	1037	Abada yogya anabadi	13.55	13.55		
6	Larbanga	Burla	241	1045	Abada yogya anabadi	9.53	9.53		
7	Larbanga	Burla	241	1055	Abada yogya anabadi	9.96	9.96		
			Total			48.03	48.03	Acre	

Map No.3 Resettlement planning at Larbanga Mouza

4.3.1.3 Impacts on Other Assets:

i) Impact on Ponds and Drainage Pattern

Baseline study reflects that there are 4 ponds located in the project influence zone. Out of these 4 ponds, 2 ponds will be affected due to the project. 1 pond will be affected completely and the second pond will have partial impact.The baseline study reflects that these ponds are not utilised by the local community. The ponds have been created by the dam authority as a part landscaping.

Mitigation Measures:

In future landscaping has been planned by the Dam authority which will also include development of recreational ponds and will be implemented at a later stage.

ii) Impact on Utilities & Infrastructure:

The baseline study has revealed that utility services such as water supply pipeline to Hirakud, Burla and Sambalpur towns, electric supply line and telephone lines are located in the area. These utilities falling within the project alignment will need to be relocated from their present position due to the proposed alignment. Such type of impacts due to the project is inevitable. Around the project area there is road network connecting dam area with the industrial area and main town of Burla. The construction of spill channel will intersect the area which will result into disconnection of the area located on the right side of the spill channel after the hill area. Also the connectivity of the Gandhi tower, which is a tourist spot, will be broken due to proposed spill channel.

After the construction of additional spillway and spill channel the area between the D/s toe of the Hirakud Dam Gandhi Hillock the spill channel will be separated out from the existing colony & Infrastructure.

This large patch of land likely to be isolated includes parts of Gandhi Nagar and Gujatala Villages having several House structures. These are accessed through all weather road communications.

Similarly a comparatively small patch of land appearing after the Gandhi Minar & bounded by D/s toe of the Dyke, Gandhi Hillock and the spill channel will be affected. The project authorities would evacuate the people from this area. The existing approach road leading to Gandhi Minar will be cut off during the construction.

In addition to the above features, 11 number of temples,1 cremotoria 2 primary schools, 1 high school and 4 Anganwadi centres will be affected due to the project.

Mitigation Measures:

- A bridge across the spill channel will be provided on the main road to Gandhi Tower for maintaining the connectivity.
- Utility duct will be provided at bridge across the spill channel for diverting water pipeline and other lines to cross the spill channel.
- All the Utilities and community structures will be relocated at suitable locations before commencement of construction activities.
- The scheduling of the construction works will be shared with the line department (Public Health Department and Electricity Department) for ensuring uninterrupted services during construction
- The required mitigation measures would be to instruct in advance the relevant owners of these utilities to shift those before construction starts to avoid disruption of local services.

- It will be judicious for the IA to assist the owners to get space for new locations.
- Since spill channel construction is site specific, relocation and reconstruction support will be provided under the project for all affected social infrastructure.

4.3.1.4 Impact on Forest:

The project envisages acquisition of reserved forest area of about 9.441 Ha for the project from the pockets of Lamdungri Reserve Forest as the alignment of spill channel is passing through this forest area. The total area of the reserve forest is 490.46 Ha so the total affected area of this forest is only 1.9 percent. The baseline study showed that this forest is actually degraded forest and is devoid of any significant vegetation. No wild animals have been reported. of the forest has occurred mainly due to relentless biotic interference like illicit felling, repeated fire, grazing etc. The soil quality over the hill is poor in quality. As a matter of fact, topsoil of the area has been completely washed away resulting in exposure of rocks at places in general and the top of the hill. The spill channel in the forest section will split the forest area in two parts, one towards Gandhi Minar on right side of the channel and other towards Hirakud town. There will be need of felling of **115 trees** of different species from this forest area falling within the project alignment which is unavoidable. The predominant affected tree species in the forest are *Neem* (*Azadirachta indica*), *Chakunda* (*Cassia siamea*) and Teak (*Tectona grandis*). There is no endangered or threatened species found in project influence area hence there is no impact on any such tree species.

Mitigation Measures

- The diversion of reserved forest and tree felling in forest area will attract the provision of Forest Conservation Act, 1980 and accordingly Forest Clearance will be required. Application for diversion of required forest area has already been made and pending with the state government.
- The forest department will carry out compensatory afforestation in the degraded forest area in twice the area to be diverted which will not only compensate the forest loss but will also help in overall enhancement in the environmental conditions in and around the area of compensatory afforestation.
- The Dam authority will bear all the cost for compensatory affoerstation and pay compensation for the loss of forests land.
- The Dam Authority will comply with all the conditions stipulated by the forest department during forest clearance.
- Additional plantation will be carried out by the dam authority in the area along the channel which will help in enhancement of the environment in the area adjacent to the project area.
- The degraded Reserved forest area and some area along the channel has been identied and is available for the purpose of afforestation and compensatory tree plantation. Thus there is no need for the identification of additional land. If additional land is still required, dam authorities have agreed with the forest department to plant the trees in other available degraded areas.
- Th compensatory land (twice the area dierceted forests land) will also be identified and allocated by forests department. The forests clearance is granted in two stages. Stage I has already been cleared. Stage II is in the process and according to the clearance letter

forests department will allocate this land. The dam authority will comply to all condition of forest clearance clearance.

4.3.1.5 Impact on Non-Forest Trees:

In addition to the forest area, number of trees has been recorded in the project influence area. These trees have been planted either by the local people residing in the dam area or by the irrigation department/ Dam Authority. As per estimate about **3595** trees falling within the project alignment and in submergence area will be required to be felled. This impact is viewed critical due to the duration required for its reversal and sometimes it is irreversible. The trees not only provide a healthy aesthetics to the local populace but also provide shade and protect the neighbouring inhabitants from harmful effects of contaminants by absorbing them through vegetation canopy. The Major impacts associated with loss of vegetation are landscape degradation, disturbance to Fauna living on trees and change in micro climate. The flora around the Buffer Zone is not likely to be affected much because of the very limited floral diversity. The baseline studies showed that there is no any endangered or rare tree species located within the project area. The predominant tree species are Mango (*Mangifera indica*), *Neem* (*Azadirachta indica*), *Chakunda* (*Cassia siamea*), *Chauli* (*Eleodendron gaucum*), etc. The list of affected trees has been provided in Chapter-4 of this report.

Mitigation Measures:

- Permission of tree cutting will be obtained from the line department, i.e. Forest Department.
- All efforts will be made to preserve trees by restricting tree cutting within the formation width. Special attention will be given for protecting giant trees, and locally important trees (having cultural importance)
- Transplantation of big trees will be explored in consultation with the forest department and is proposed to be made in the nearby degraded forests area.
- Compensatory plantation will be carried out by the dam authority in the ratio of 1:10 in the dam area and in forest area in consultation with the forest department
- Other than compensatory afforestation, avenue plantation, embankment plantation, green belt development around the project, plantation on waste dumps etc are to be taken up. Effort will be made to minimise the tree felling by restricting tree felling within the formation width only.

4.3.1.6 Impact on National Parks/Wildlife Sanctuary:

The analysis of baseline study reflects that there is no ecological protected area such as National Park, Wildlife Sanctuary, notified eco-sensitive area located within 10 km of project influence area, so any impact on such feature due to the project is ruled out.

4.3.1.7 Impact on Fauna:

There is no natural habitat of any wild animals located in the project area. There is no any migratory route situated in and around the project area. So no impact on population of wild animals is anticipated due to the project.

4.3.2 IMPACTS DURING CONSTRUCTION PHASE:

Most of the adverse environmental impacts are related to construction works which are inevitable but are manageable through certain environmental friendly practices. Thenegative environmental effects can be taken care of at an early stage through proper engineering design and through the contract during construction practices.

The construction works will involve are site clearance, excavation, filling of earth materials, concreting, laying of bituminous mixtures, handling of hazardous materials like bitumen, diesel, etc, dumping of unusable debris materials, transportation of materials from production site to construction site, and other constructional activities and associated works like mobilization of constructional

equipments, setting up of different construction plants, setting up of workforce camps, quarrying, material storage etc. These activities have certain impacts of various magnitudes on different components of environment. The anticipated impacts due to all these activities have been described below:

4.3.2.1 Impact on Land Resources:

Clearing, grubbing and excavation of the land within the extent of formation width of the proposed alignment as well as the proposed spillway are the primary activity to prepare the bed for foundation works and construction of embankments. The excavation activity will lead into generation of excavated materials which would mainly soil mixed with pebbles, rock boulders in the project area. The soft and hard rock cutting is involved for spillway, spill channel and dyke. All the suitable materials will be re-used as fill materials, aggregates, embankment, stone pitching, etc to minimize the disposable quantity. The unsuitable excavated material will need to be disposed off due to non-suitability for use. The disposal of debris materials in haphazard manner will not only hamper the aesthetic look of the area but at the same time they are potential contaminant for the surrounding land.

Following table depicts the estimated quantity of excavated materials to be generated due to excavation and cutting of hills and existing earthen dyke. The type of material to be generated due to excavation and cutting will be mainly soil and rocks. The total quantity of excavated materials including all kind of soil and rocks has been estimated as 3755050 Cum. Out of this quantity about **1641830** CuM will be utilized for construction and allied activities. 1963220 Cum of the excavated materials will be utilised for landscaping along the spill channel to raise the ground level matching with the embankment to avoid water logging. The balance unutilised quantity of about 150000 cum will require to be dumped at suitable dumping area.

Table 4-6: Estimated Quantity of Excavated Materials and their utilisation and disposal plan

Sl. No.	Item	Quantity (Cum)
A.	**Material generation due to Excavation and cutting Main Dam, Stilling Basin, Spill Chanel & Hillock**	
a.	Generation of excavated soil	1416690
b.	Generation of disintegrated Rock due to excavation and hill cutting	700510
c.	Generation of hard rock	1237850
2	Quantity of Earth / Soil from the dismantling of exiting Dyke After Completion of Additional Spillway Works	400000
	Total Excavated materials Generated	**3755050**
B.	**Utilisation of Excavated & Cutting Materials**	
(a)	For Left and Right embankments along spill channel downstream of hillock	870000
(b)	For Embankment dams on left & right side of Additional Spillway	771830
(c)	Quantity to be used for landscaping along Spillway channel (Raising and leveling of ground)	1963220
	Total quantity to be utilised for construction and landscaping	**3605050**
C.	**Balance quantity for Disposal into dumping area**	**150000**

The area for landscaping along with their capacity is indicated in Fig. No 4.1. The potential muck disposal areas have also been identified which is earmarked Fig. 3-22 of Chapter 4.

It is estimated that additional earth quantity will be required for spillway and dyke construction. About 972000 Cum earth will be required from different borrow areas. A number of borrow areas are

available within the dam area for required quantity. The location of identified borrow area in the dam area is presented in **Fig. 3-22** of Chapter 3. Excavation of borrow area can lead into disfiguration of topography of the area. Water stagnation in the borrow pit provides ideal breeding sites for mosquitoes and thereby can spread malaria and dengue if borrow pit is not properly managed. Pits near settlements can pose health risk.

Further haphazard cutting near water courses will result into soil erosion and siltation to the nearby water bodies.

Mitigation Measures :

- No Borrow area and quarry will be operated without written agreement of the land owner
- **No haphazard cutting near water body shall be permittable.**

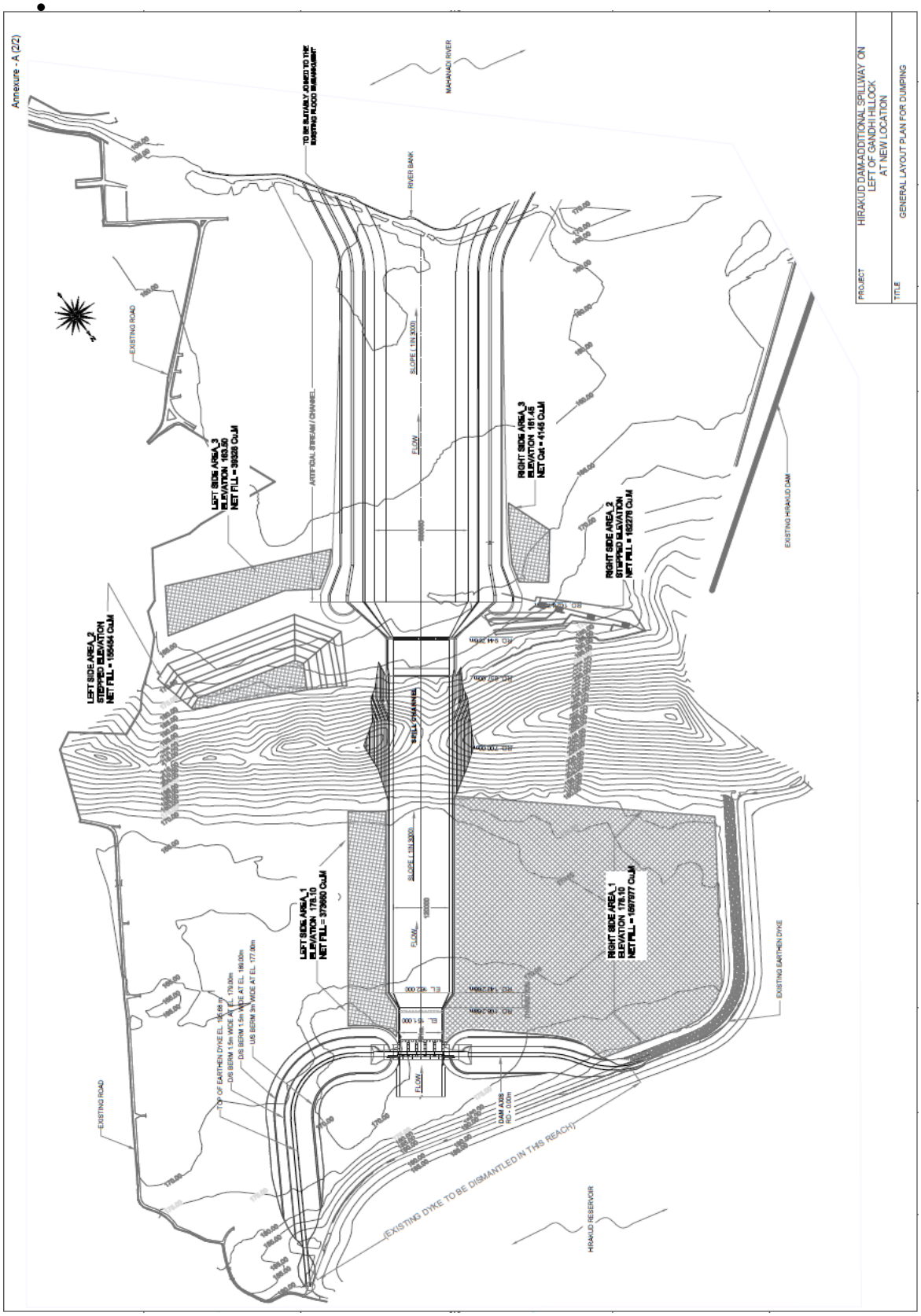


Fig. 4-1: Dumping Plan for Excavated & Cutting Materials

- The Contractor will obtain environmental clearance for the borrow area and quarry (if new quarry site is proposed) as per MoEF&CC circular on environmental clearance for minor minerals and the conditions stipulated under the environmental clearance will be binding on the contractor. The Contractor will submit the copy of clearance letter to the Engineer and Implementing Agency before commencement of material extraction.
- The earth material generated due to excavation will be used to optimum quantity to reduce impact on land resources.
- The Construction camps will be located preferably on barren land and sufficiently away from settlements and water bodies.
- The Construction camp will be provided with necessary sanitation arrangements and basic facilities.
- After dismantling of Camp the natural condition of the land will be restored.
- No scare will be left unattended after excavation activity.
- The Borrow pits will not be dug within 800 m of town or village settlement or within 1 km from any forest area.
- After excavation is over, the borrow area will be rehabilitated suitably.
- Cut face of the pit will be merged with the slope of the adjoining terrain.
- Bottom of the pits will be graded towards natural outfalls to prevent water accumulation.
- Quarrying of stones will be done only at licensed quarry and the area will be suitable rehabilitated after quarrying is over.
- The borrow areas and stone quarry site should be operated and managed as per guidelines provided EMP.

4.3.2.2 Impact on Soil:

(i) Loss of top soil: The site clearance process includes excavation and vegetation clearance which ultimately induces vegetation loss as well as loss of top soil. Since vegetation clearance shall be confined to the minimum area required for construction channels and spillway, the area affected would be very less. The activities associated with the site preparation and excavation plus movement of vehicles and equipments can disturb the surrounding lands. At the borrow area, temporary camp site or stockyards, workshops, and other ancillary sites there is chance of loss to soil fertility due to various activities.

Mitigation Measures:

- In order to minimize the impact on soil fertility the top soil will be preserved separately and will be reused for landscaping, grass turfing and site restoration work.
- The top soil will be stripped to a specified depth of 150 mm and stored in stockpiles of height not exceeding 2m away from water ways and the heap of the top soil will be covered with tarpaulin cover of turfed to cease washing out of soil especially during rains
- The stored topsoil will be spread back to maintain the soil physico-chemical and biological activity. The preserved top soil will be used for restoration of sites, in landscaping and avenue plantation.
- The preserved top soil should be used for plantation as soon as possible to prevent loss of quality and quantity.

(ii) Soil Erosion:

The problem of soil erosion is a common features associated with excavation, cutting and extraction of earthe. The area especially along the slopes at foothill is susceptible to soil erosion. The excavation activities may aggravate the erosion problem in the area if not addressed properly. The earthen

embankment may suffer with soil erosion problem if it is not properly compacted. The runoff water may enhance the erosion problem if it is not regulated properly. The area of excavation of borrow area will also face the problem of erosion.

Mitigation Measures:

- The earthen embankments will be provided with chutes and drains to minimize soil erosion.
- Stone pitching and retaining walls will be made at embankments in critical areas.
- Turfing and plantation of grasses and shrubs will be done for slope stabilization.
- All excavated pits are to be backfilled & levelled to avoid land erosion, simultaneously to improve aesthetics of structure.
- The cut slopes of the Hillock should be properly benched (with berms).
- These excavated slopes should be lined with concrete to prevent erosion of the Hills.
- The u/s slopes of the Dyke will have Rip Raps as per design.
- The D/s slopes of the Dyke will have Rock toe & Drains where as upper slopes are to be secured with Grass Cover (Turffing).
- In borrow pits, the depth of the pit will be regulated that the sides of the excavation will have a slope not steeper than 1: 2, from the edge of the final section of bank

(iii) Contamination of Soil:

Contamination of soil during construction stage is primarily due to construction and allied activities. The sites where construction vehicles are parked and serviced are likely to be contaminated because of leakage or spillage of fuel and lubricants. Pollution of soil can also occur due to spillage of asphalt or bitumen. Refuse and solid waste from labour camps can also contaminate the soil. Contamination of soil during construction might be a major long-term residual negative impact. Unwarranted disposal of construction spoil and debris will add to soil contamination. This contamination is likely to be carried over to water bodies in case of dumping being done near water body locations. However, by following mitigation measures such as maintenance of vehicles and machines and fuel refilling is carried out in a confined area can avoid contamination of soil to a great extend.

Mitigation Measures :

- The provision for oil interception chamber is suggested in EMP for treating the waste water generated from vehicle washing, refilling and maintenance areas.
- Fuel storage and refilling sites should be kept away from cross drainage structures and important water bodies.
- The petroleum products will be stored in drums kept in raised impervious platform with catch drains around the platform to contain the spilled quantity.
- All spoils shall be disposed off as desired and the site shall be fully cleaned before handing over.

(iv) Compaction of Soil:

Compaction of soil may be anticipated due to the movement of construction vehicles and heavy machines. Thus regulation of movement of heavy equipments and vehicles shall be essential to prevent this.

Mitigation Measures:

- The excavation activities and vegetation clearance will strictly be limited to formation width only.
- All the usable excavated materials will be re-used as fill materials and aggregates.
- The movement of construction vehicles and equipments will be restricted to only designated route.
- Designated storage site for fill materials and adequate stockpiling to prevent erosion and runoff related problem.

4.3.2.3 Impact on Water Resources:

i) Water Requirement for Construction:

The water demands for the construction work may pose severe stress on the public water supply if the water for construction and allied activities are taken from the same source, as water supply sources are limited in the project area.

Mitigation Measures:

- The main source of water for construction and other related activities will be from existing reservoir by pumping. However, groundwater may be used by installing bore wells at different locations such at camp sites and plant sites. Separate water supply arrangement for construction and allied works will be made in from ground water/surface water source away from public water supply source so that there is no interfere with the normal public water supply.
- The baseline study indicate that the water table along the project area is shallow ranging from 3 m -3.5m BGL and falls under safe zones in terms of ground water availability, usage and water balance and recharging capacity. Mostly surface water will be utilized for construction purpose whereas limited water from borewell will be used exclusively for domestic use in camp, so any major impact on water table in the project area is not anticipated.

ii) Impact on Water Quality:

No permanent impact is anticipated on water quality due to the project. Construction activity may temporarily deteriorate surface water quality near the alignment and borrow areas through increase in turbidity as well as in oil and grease. Waste water from the construction area charged with cement slurry, Grease and oils etc are likely to flow to the nearest water body causing contamination of water. The water contamination may be caused due to waste discharge from construction camps and labour camps. The water logging is another issue associated with construction activities. However, these impacts can be handled through following proposed mitigation measures.

Mitigation measures:

- The Contractor will take all precautionary measures to prevent the wastewater generated during construction works from entering into water bodies during monsoon.
- Clearing of all the natural drainage before onset of monsoon in order to keep all drainage unblocked.
- Re-sectioning may be adopted wherever possible. These channels are to be functional without clogging at any point.
- Earth, stones, wastes and spoils will be properly disposed off so as to avoid blockage of any drainage channel.
- The camp sites, plant site, stockyards and servicing centres will be established sufficiently away from water body/ water ways and will be provided with proper drainage system to regulate water flow from such sites
- All water and liquid wastes arising from construction activities will be properly disposed off and will not be discharged into reservoir, downstream water way or pond around project area without adequate treatment.
- All work site washouts be collected in a sedimentation pond where treatment may be imparted before releasing flow to the main drain.
- No construction materials/ spoils will be stored along the water bodies and adequate provision will be made for preventing spillage of materials into these water bodies.
- Ensure that all construction vehicle parking location, fuels/lubricants storage sites, vehicles, machinery and equipment maintenance sites are located at least 100m away from any water body. And also ensure that spillage of fuels and lubricants do not contaminate the ground.

- The slopes of embankment leading to water bodies will be modified and re channelized so that contaminants do not enter the water body.
- Provide oil & grease trap in the drains to extract the oil and grease from the runoff water to prevent contamination of water.
- Collect and store oily wastes and hand over the same to the authorised agent of hazardous waste collector.
- Deposit the excavated material only at the specified site without disturbing the natural drainage.
- Natural drainage of the entrapped area should be restored with construction of some connecting drains and crossing culverts.
- Water quality to be monitored periodically as per Environmental Monitoring Plan.

4.3.2.4 Impact on Ambient Air Quality:

Deterioration of air quality due to various construction activities along the project site is the most common impact. However, such impacts associated with construction activities are mainly localised and temporary in nature. cause of air pollutions construction phase are excavation, hill cutting, other construction activity, Blasting, borrow area and quarry operations, and disposal of Wastes, Construction Spoils & Debris vehicle moment, operation of heavy machinery, running of batching plant, mixing plant and dismantling of existing structures. These activities are expected to generate airborne fugitive dusts. It is observed during air quality monitoring that, the dust generations are short term and settle quickly within close ranges. There is very less scope of spreading of dust particles to the nearby residential areas. It is found that, the effect is localized and is mostly due to fugitive emission of dust particles. The construction activities may result into temporary deterioration of air quality in the habitation areas near the proposed channel and will have impact on human health. It requires special attention action to curb dust in those stretches.

Mitigation measures:

- Water will be sprayed frequently during construction phase, in earth handling sites, asphalt mixing sites and other excavation areas for suppressing fugitive dust. Special attention will be given when working near settlement areas, educational institutions and health centers.
- Take every precaution to control dust nuisance at all the construction zones and allied sites where works are under progress.
- The crushers and the batching plants will be sited at least 1km in the downwind direction from the nearest human settlement (Boundary of town/village).
- Every equipments and machinery will be fitted with dust suppression devices such as water sprinklers, dust bags, cyclone etc. as appropriate
- All vehicles, equipment and machinery used for construction will be regularly maintained to ensure that pollution emission levels comply to the relevant requirements of SPCB norms.
- PUC certificates will be mandatory for all vehicles/ equipment/machinery used for the project.
- Transporting of loose earth, sand and other construction materials with tarpaulin cover during the construction stage.
- Workers at mixing sites will be provided with good quality personal protective equipments (PPE) reduce the chances of ill effect of emission.
- At all the construction zones and unpaved lead roads, earthen temporary diversions and plant premises periodical water sprinkling will be carried out to suppress dust.
- At all the construction zones and unpaved lead roads, earthen temporary diversions and plant premises periodical water sprinkling will be carried out to suppress dust.Dust emission from stockpiles of excavated material will be controlled either by covering the stockpiled or by water spraying over it.
- As soon as construction is over all the surplus earth will be utilized properly all loose earth will be removed from the site.

- Workers at mixing sites will be provided with good quality personal protective equipments (PPE) reduce the chances of ill effect of emission.
- Periodical monitoring of fine Particulate Matters (PM_{10} and $PM_{2.5}$) will be carried out as per Environmental Monitoring Plan.

4.3.2.5 Impacts on Ambient Noise Level:

Operation of heavy machineries; movement of heavy vehicles, stone crushing aggregate mixing activities, operation of DG Set and blasting activities generates high noise increasing the ambient noise level in the surrounding. However most of the construction activities will be confined in gthe dam area away from habitation area the likely impact on noise pollution in the surrounding area will not be significant. Howeverworkers working near the noise generating equipments and plants are likely to be exposed to high noise level. The acceptable limits (for 8 hour duration) of the equivalent noise level exposure during one shift is 90 dB(A). Hence, noise generated due to various activities in the construction camps may affect health of the workers if they are continuously exposed to high noise level. For reasons of occupational safety, exposure to impulses or impact noise should not exceed 140 dB(A) (peak acoustic pressure). Exposure to 10,000 impulses of 120 dB(A) are permissible in one day. The noise likely to be generated during excavation, loading and transportation of material will be in the range of 90 to 105 dB (A) and this will occur only when all the equipment operate together and simultaneously. This is however, is a remote possibility. The workers in general are likely to be exposed to an equivalent noise level of 80 to 90 dB (A) in an 8-hour shift, for which all statutory precautions should be taken into consideration. However, careful planning of machinery selection, operations and scheduling of operations can reduce these levels.

The noise pollution generated due to different construction activities is a temporary affair. Each type of activity can generate different type and levels of noise that continue for a short period during the operations of those activities.

Implementing proper mitigation measures can reduce a lot of problem associated with noise pollution due to construction activities.

Mitigation Measures:

- All plants and equipments used in construction shall strictly conform to the MoEF/CPCB noise standards.
- All noise generating equipments will be installed sufficiently away from settlement areas.
- All the construction sites within 150m of the nearest habitation, noisy construction work such as crushing, concrete mixing will be stopped during the night time between 10.00 pm to 6.00 am.
- No noisy construction activities will be permitted around educational institutions/health centers (silence zones) up to a distance of 100 m from the sensitive receptors.
- The main stationary noise producing sources such as generator sets shall be provided with noise shields around them. The noise shields can either be a brick masonry structure or any other physical barrier which is effective in adequate attenuation of noise levels. A three meter high enclosure made up of brick and mud with internal plastering of a non-reflecting surface will be very effective in these regards.
- Vehicles and equipments used will be fitted with silencer and maintained accordingly.
- Only controlled blasting will be permitted during off period only. No night time blasting will be permitted.
- Ensure effective warning system before blasting and supervision of blasting activities by experts.
- Create awareness among local population against noise pollution and accident hazards.

- Noise standards of industrial enterprises will be strictly enforced to protect construction workers from severe noise impacts.
- All the workers working very close to the noise generating machinery shall be provided Earplugs to avoid any ill impacts on their health.
- An awareness programme will be organized for drivers and equipment operators to make them aware of the consequences of noise and to act properly at site.
- Noise levels to be monitored as per monitoring plan and if the noise level at any time found to be higher than immediate measure to reduce noise in that area will be ensured.

4.3.2.6 Impact on Ecological Resources:

The baseline study within the project area did not show any endangered or significant flora or fauna within the corridor of impact.Therefore, any potential direct impact on biological environmental characteristics such as loss of rare or endangered species, habitat fragmentation and wild life migrations is not envisaged.The temporary impact may be in the visual appearance of the trees and shrubs as construction activity may lead to deposition of dust cover over the leaves and foliage. This is limited to construction period and gets washed away with the first monsoon shower.

However in area of activities like borrow area, stockyard, dumping area, camp site, there may be possible that few numbers of trees may be encountered and may be damaged during different activities in such areas if proper precautionary measures are not taken during works. To avoid such risk following mitigation measures may be taken:

Mitigation Measures:

- All efforts shall be made to save the trees. No extra tree shall be cut otherthan the essentially required.
- All the trees located in camp site, stockyards, borrow areas, disposal area and other allied sites will be preserved.
- .
- In case of felling of trees by the Contractor, beyond the marked trees for cut with approval from line department, the Contractor will plant trees in the ratio of 1:10 at his own cost and submit the compliance to the Engineer for verification.
- Efforts shall be made to avoid any harm to stray animals.
- Construction workers will be directed not to harm any fauna.
- Construction vehicles will run along specified access to avoid accidents to cattle.
- Plying of Vehicles in the night time should be prohibited.

4.3.2.7 Impact on Social Environment:

i) Impairment of access to the properties:

During construction of road, cross water and side drain temporary blockage of access or interference with the access to the properties located along the proposed construction area, causing inconvenience to the users and enhances the accident risk if not managed properly.

Mitigation measures:

- Such impact can be avoided through proper planning of works and good engineering practices.
- Safe and convenient passage for vehicles, pedestrians at work site and property accesses shall be ensured by providing temporary access.
- Adequate signage and barricades shall be raised at the expected bottlenecks for safe movement of people. The Contractor shall provide early information to the affected people.
- On completion of the works, all-temporary obstructions to access shall be cleared away, all rubbish and piles of debris that obstruct access should be cleared.

ii) Aesthetics:

Disturbance of landscapeaesthetics due to excavation of borrow pits, extensive quarrying, disposal site of spoils, is expected during the constructional phase. However, it is only temporary one and it can be restored with proper management plans within a short period such as landscape development and avenue plantation, etc. During operational phase this will be enhanced with the activities associated with the maintenance of landscape, plantation programme, development of recreation site and other amenities, parks etc.

Mitigation Measures:

- The site will be cleaned immediately after the construction activity is over.
- The debris materials will be disposed off only at identified area for disposal and proper levelling will be done after disposing the materials and shall be covered with top soil and some plantation will be done at the disposal site.
- The borrow area will be rehabilitated as per site condition. It can either be developed as ponds, backfilled and levelled matching with the surrounding terrain.

4.3.2.8 Occupational Health and Safety:

Health and safety are of major concern during the construction phase. The impact on health and safety can be envisaged for both workers working near different work sites. The project will comply with the requirements of the EHS Guidelines of the World Bank Group and the conditions stipulated under Labour Rules, such as Building and Other Construction Workers (Regulation of Employment and conditions of Service) Act, 1996 and Factory Act, 1948.

Emission of gaseous pollutants and dusts are major result of various processes like material treatment, operation of batching plant, hot mix plant, stone crushing, DG sets etc. This emission effect is only for short term till the construction work is over but the effect may be significant from the point of view that the workers are directly exposed to these emissions. Apart from this, safety risks to workers, primarily in the areas of storage and handling of dangerous materials, and in operation of heavy machinery, concreting works, working on height and in trenches also involved during the construction works.

The dust and gaseous pollutant generation during the construction works near habitation area will adversely affect the health of people residing in the close proximity. The vehicles and equipment operation increase the chances of collision with vehicles, pedestrians and livestock. The poor sanitation and poorly manages dispose off the waste may cause increase in communicable diseases.

Mitigation Measures:

- **Contractor's Safety Manual:**
  The Contractor will alongwith their Quality Assurance Plan, submit their own Safety manual on Occupational Health and Safety for safety of all personnel working under the project and will be in line with the General Rules and Regulations on Occupational Health and Safety (OHS) in Building and Other Construction Workers (Regulation of Employment and Condition of Service) Act, 1996 and World Bank EHS guidelines on health and safety.

- The Occupational Health and Safety program will aim to ensure that the workplace is safe and healthy by addressing the hazards and risks at the workplace; outlining the procedures and responsibilities for preventing, eliminating and minimizing the effects of those hazards and risks; identifying the emergency management plans for the workplace or workplaces; and, specifying how consultation, training and information are to be provided to employees at various workplaces.

- Some of the risks/hazards associated with workplaces are due to working close to or at blasting Sites, excavation area, excavation of trenches for spill and approach channels, hill cutting, construction of spillway and associated with the various project construction activities. Other risks associated with the project construction phase include risk of increase of vector borne and other different diseases.

- **Provision of Personal Protective Equipment (PPEs)**

  Risks to the health and safety of workers can be prevented by provision of Personal Protective Equipment (PPEs) to all workers. This will be included in the construction cost for the Contractor. Depending on the nature of work and the risks involved, contractors must provide without any cost to the workers, the following protective equipment:

  - ✓ Helmet shall be provided to all workers, or visitors visiting the site, for protection of the head against impact or penetration of falling or flying objects.
  - ✓ Safety belt shall be provided to workers working at heights (more than 20 ft) such as roofing, painting, and plastering.
  - ✓ Safety boots shall be provided to all workers for protection of feet from impact or penetration of falling objects on feet.
  - ✓ Ear protecting devices shall be provided to all workers and will be used during the occurrence of extensive noise.
  - ✓ Eye and face protection equipment shall be provided to all welders to protect against sparks.
  - ✓ Respiratory protection devices shall be provided to all workers during occurrence of fumes, dusts, or toxic gas/vapor.
  - ✓ Safety nets shall be provided when workplaces are more than 25 feet (7.5 m) above the ground or other surfaces where the use of ladders, scaffolds, catch platforms, temporary floors or safety belts is impractical.

The specific PPE requirements for each type of work are summarized below.

Table 4-7: PPE Requirement List

Type of Works	Type of PPEs requirement
Elevated work	Safety helmet, safety belt (height greater than 20 ft), footwear for elevated work.
Handling work safety	Helmet, leather safety shoes, work gloves.
Welding and cutting work	Eye protectors, shield and helmet, protective gloves.
Grinding work	Dust respirator, earplugs, eye protectors.
Work involving handling of chemical substances	Dust respirator, gas mask, chemical-proof gloves. Chemical proof Clothing, air-lined mask, eye protectors.
Wood working	Hard hat, eye protectors, hearing protection, safety footwear, leather gloves and dust respirator.
Blasting	Hard hat, Safety Shoes, eye and hearing protection
Concrete and masonry work	Hard hat, eye protectors, hearing protection, safety footwear, leather gloves and dust respirator.
Excavation, heavy equipment, motor graders, and bulldozer operation	Hard hat, safety boots, gloves, hearing protection.
Quarries and Borrow area operations	Hard hat, eye protectors, hearing protection, safety footwear, leather gloves and dust respirator.

- **Safety for electrocution Risk**
  - The electrical equipments will be checked regularly
  - No Material will be so stacked or placed below the overhead supply mains so as to prevent danger or inconvenience to any person or the public.
  - Necessary fencing and lights will be provided to protect the public to enter the construction zones.
  - Protect electric sub-stations, high tension towers and other areas from electrocution risk by providing security fencing and light, warning signs and security patrols.

- **Other Safety Measures at Site:**
  - All the construction equipments and vehicles will conform to the emission standards stipulated by the CPCB.
  - Safe working techniques will be followed up and all the workers will be trained.
  - The Contractor will ensure at all time safe access to the work site and safe working platform for workers and other supervisory staff.
  - An Emergency Response system in case of any incidence will be developed and implemented.
  - Well equipped First Aid Box with all essential first aid items will be kept and maintained at the work site.
  - The Contractor will have arrangement with nearby doctor/ health centre for attending injured person due to accident
  - Peridical health chackups will be conducted for the workers
  - The Contractor will conduct awareness programme on HIV/AIDS and other sexually transmitted diseases for workers at least once in a quater and the record of such programme must be recorded.

4.3.2.9 Public Health and Safety:

Health and safety of local public residing in gthe project vicinity are of major concern during the construction as well as operational phases.

Emission of gaseous pollutants and dusts are major result of various processes like material treatment, operation of batching plant, hot mix plant, stone crushing, DG sets etc.. The dust and gaseous pollutant generation during the construction works near habitation area will adversely affect the health of people residing in the close proximity. The vehicles and equipment operation increase the chances of collision with local traffic vehicles, pedestrians and livestock. The poor sanitation and poorly manages dispose off the waste may cause increase in communicable diseases. Public safety is also an issue assocated with construction activities. Excavation of trenches and operations of heavy equipments and machineries near to the habitation area and roads create potential risk for public accident. Blasting activities are also have potential for accidents unless precautionary measures are not taken

Mitigation Measures:

- To ensure safe construction in the temporary accesses during construction, lighting devices and safety sign boards will be installed.
- At blasting sites, the blasting time, signal and guarding will be regulated. Prior to blasting the site will be thoroughly inspected. Blasting will not be carried out during rush hours.
- Safety of workers undertaking The plants and equipments will be installed sufficiently away from the settlement.
- All the construction equipments and vehicles will conform to the emission standards stipulated by the CPCB.

- Proper caution signage, barricading, delineators. lightings etc. will be installed at Construction zone and temporary diversions.
- Hard barricading will be provided at construction zone near habitation area and public roads
- Safe access to the properties of neighbouring area will be mainatied by the contractor at all time till completion of works in those areas
- Proper traffic management will be ensured at the Construction zone near roads.The contractor will prepare a traffic management plan and will submit it to dam authorities and the World Bank, prior to start of construction work.
- Blasting activities will be performed only during off hours and daytime so as to avoid inconvenience to the public. The blasting will be undertaked strictly as per schedule.
- The blasting schedules will be widely publicised through local news papers, television or by other means.
- The Contractor will organise awareness programme for local public on blasting effects, schedule and precautionary measures
- Road safety education will be imparted to drivers running construction vehicles. In case of negligent driving, suitable action will be taken.
- Traffic rules and regulations will be strictly adhered to.
- Adequate signage, barriers and persons with flags during construction to control the traffic will be provided.
- Speed restrictions shall be imposed on project vehicles.
- The general public/local residents shall not be allowed in high-risk areas, e.g, excavation sites and areas where heavy equipment is in operation and the spill channel.
- All lifting tools will be periodically checked & certified.
- An Emergency Response system in case of any incidence will be developed and implemented.

4.3.2.10 Other Environmental Concerns of Construction Phase:

Various other environmental impacts during construction stage include:

i) Diversion of Traffic:

Short term impact associated with the project will be traffic diversion and management during construction phase. Construction activities will cause hindrance to the existing traffic flow. There is possibility of accident hazards during construction phase of the widening project. There will be requirement for diversion of existing traffic at various construction sites during construction phase. It needs to be mentioned that though there are no direct impacts on the natural environment due to disruption/diversion of such services, but diversion can also lead to adverse impacts if not planned properly. Rapid restoration of diverted services can help in minimizing the severity of impacts arising out due to diversions of existing services.

The project authorities would explore alternative of restoring the road communication either allowing the approach over the spillway bridge or through a separate well guarded bridge over the spill channel near Gujatala or both options at a time. The project authorities will consider to

- Restore road communication link/existing approach roads to Gandhi Minar and Dam Top Road.
- Provide crossing structures / Bridge over the spill channel with adequate safeguard measures.
- Restrict unauthorised use of these approach roads and bridge crossings

Mitigation Measures:

- Proper preventive measures will be taken during the construction activities at the construction sites.

- Reduce speed through construction zones.
- Construction of bridges/culverts will be carried out prior to construction of new carriageway at the first stage.
- Proper warning signs will be displayed at construction sites.

ii) Equipment Servicing and Fuelling:

Construction equipment generates large amount of waste oil, and its proper handling is critical, since improper storage and leakage can result in the contamination of land and water bodies. Even the spillage can affect surface water bodies.

Mitigation Measures:

- The vehicle and equipment service centers will be established away from any water body or agricultural land.
- Proper bunding with appropriate Containment will be provided at the equipment and vehicle servicing centers. The spent wash from the service center will be put in separate soak pits and sand pits
- All the fuel and chemical storage will be sited on an impervious base within an embankment and secured by fencing. The storage area will be located away from water course or wetland.

iii) Construction of Workers' Camps:

Construction workers are a very neglected group in the country. Unless the workers are provided proper amenities to live at the construction site the environmental issues of road construction cannot be properly met. Apart from labour camps, separate construction Camps also established where various plants and equipments as well as offices and residential units for technical and non technical staff are located and often labour camps are also provided in the same premises. Location of the Construction camp also has certain impacts on surrounding environment if not properly managed.

At labour and construction camps lot of wastes are generated. These wastes are refuge from the plants, and equipments, waste water and other domestic waste. These wastes are solid as well as liquid waste mainly refuse water and kitchen waste. The disposal of such waste material to the surrounding land can potentially damage the land and would generate health risk to not only surrounding area but within the premises itself. Improper drainages system within the premises also creates insanitation condition thereby enhancing health risk.

Mitigation Measures:

- The Construction/labour camps will be established only on area approved by PMC.
- The worker's/labour camp will be located away from water bodies, schools and residential areas. The camp will be constructed with proper accommodation facilities.
- The workers camp will be provided with drinking water supply system so that local water sources are not disturbed.
- The camp should be provided with fuel for cooking like kerosene and /or LPG to avoid any cutting of trees for fuel wood.
- All camps will be provided with proper sanitation facilities, separate toilets and bathrooms for female and male workers, septic tanks with soak pits of sufficient size, dust bins etc.
- Waste water from domestic uses and solid wastes will be disposed of without violating environmental norms. The measures will be site specific.

- Provision of segregated garbage bins in the camps and ensure that these are regularly emptied and disposed off in a hygienic manner as per the Comprehensive Solid Waste Management Plan approved by the Environmental Expert of PMU.
- The labour camps will be provided with crèche, first aid facilities, etc as required under Factory Act.
- After completion of construction, the contractor will dismantle the camp and restore it to the original condition of the area before handing over the site to the land owner.

iv) Disruption of Services and damage to the public and private properties:

Local services, including water supply lines, irrigation line, drainage, streets are commonly cut during excavation. These activities are required by the local people for crop production, drinking water supply and access, and have the potential to damage road work too. These services are often either inadequately reconnected or not reinstate at all. During construction activities there may be damage to the utilities such as telephone cables, electric supply line, OFC line, structures, water pipelines, etc.

Mitigation Measures:

- The Contractor will arrange their own source to cater for their water requirement for construction and other activities and will not interfere with the local water supply system
- All irrigation canals, water supply lines and stand pipes, drainage and streets will be maintained during construction or if necessary, temporary services shall be arranged of the owner/ user's permission for temporary cessation will be gained.
- In the event of damage to the public utilities, and structures during construction activities the contractor will immediately restore them to the satisfaction of the owner at their own risk and cost.
- All the Services will be progressively reinstalled as soon as excavation is completed.
-

v) Impact on Historical Archaeological or Heritage Site:

The baseline study reflects that there is no any historical monument of Archaeological site located within the project influence area of 10 Km radius. So any impact on there may be chance to discover some artefacts or articles of archaeological interest during excavation. In case any valuable or invaluable articles such as fabrics, coins, artefacts, structures, or other archaeological relics are discovered, the Contractor will stop excavation activities and immediately report such findings to the Engineer and the Dam Authority who will subsequently report to the Archaeology Department, Odisha. And wait for their direction for further action.

4.3.3 IMPACTS DURING POST CONSTRUCTION/OPERATIONAL PHASE:

The project provides the opportunities of the restoration of vegetation around the vicinity of the worksite and roads by implementing the compensatory plantation programme, which will not only enhance the aesthetic view but can also help in reclamation of soil. During operational phase this will be enhanced with the activities associated with the maintenance of landscape such as plantation programme, by providing landscaping, parks and other tourist facilities, etc.

Various impacts during operation phase are discussed below:

4.3.3.1 Water Quality and Maintenance of drainage:

During the operation phase, the possibility of degradation of water quality is very remote. The impact on the surface water quality during operation can be expected due to soil erosion in the project vicinity which may increase siltation problem in the reservoir.Since the area along hill slope is prone to erosion and if proper drainage is not maintained then the problem of erosion of embankment slopes and hillside

slope may be aggravated. It should be ensure by the project authority to maintain the drain network every year before monsoon to facilitate the quick passage of rain water and avert flooding.

4.3.3.2 Impact on Air Quality:

Being restricted area, there is no change of development of any significant air polluting activities in the project vicinity. Due to development of tourism, increase in vehicular movement may occur which may lead to slight increase in vehicular emission. Now a days, low sulphur fuel and strict regulation of vehicular pollution norms at manufacturing level, such rise in air pollution may not be significant.

4.3.3.3 Impact on Noise Quality:

No impact on noise level is anticipated due to operation of the project. However during opening of the gates may lead to momentary rise in noise level due to flow of water from spillway which will be normalized after closure of the gate. There will not be any habitation near the spillway so no impact on human beings is anticipated.

4.3.3.4 Human Use Values:

Both land use and aesthetics are in fact, likely to improve due to afforestation and proper landscaping. Proper engineering design like raising of embankment, provision of parks, recreation site, etc will ensure enhancement of overall environmental condition around the project area.

4.3.3.5 Accident Hazard & Safety:

During operation stage the following safety measures may be adopted to avoid accidental risk-

- Provision of elaborate system of sign boards and road markings along the whole stretch
- Provision of suitable lighting arrangement at required locations
- Development of Emergency Response and Contingency Plan for accidents

4.3.3.6 Reservoir operation management

During flood situation, the gates of the spillway will be opened to dischanrge and excess water from reservoir to avoid risk of dam break. Without proper information system there is risk of flooding of the area in downstream around the spill channel. In case of failure of the system, the downstream population may suffer from floods. The CWC has already conducted dam break analysis and prepared disaster management plan for emergency situation. The same must be followed and implemented by the dam authority under such situation. An awareness programme may be conducted on periodic basis informing the public about the emergency situation and the alarm system.

Flood Management: Safety of Dam / Reservoir operation and effective flood release during the PMF events being the prime objective of the project, the project authorities (SPMU) will consult the central water commission (CWC of CPMU), Dam safety Organisation and Prepare a Competent Action Plan for Safe Flood release.

During PMF events Safety against flooding of Down Stream areas: The DoWR will set up a coordination committee comprising of CEBM UMB; OSDMA and District collectors etc. to chart out Disaster management and emergency action plan to negotiate the flood management during severe flood event. This committee will also ensure implementation of this action plan whenever it is required.

4.3.3.7 Induced Impact:

The entire project is located in the Dam area which is restricted area, so any development in the project area as a induced impact is not anticipated. However, at the resettlement site there will be additional opportunity for the resettled population, which will actually induce positive impoacts in terms of better living conditions and livelihood opportunity in the area.

4.3.3.8 Cumulative Impacts:

As steated in the earlier sections, being the restricted area, any additional dvelopement in the area is limited. In the Dam area around the proposed spillway tourism development has been planned by the Dam Authority which will come in future. Except for tourism development, no activities are permitted in the dam area, so any cumulative impacts due to other development is not significant.

4.3.4 Impact due to the Global Warming and Climate Change:

Global warming and its consequent effect on climate change propagate a gloomy picture on the survival of human beings and other forms of Biodiversity on the earth. It has thus become an important agenda of the international community to curb the excess carbon emissions grossly responsible for global warming. Climate change is occurring due to the increase in the level of Green House Gas [GHG]. The main contributors to GHG are Carbon Dioxide, Methane, Nitrous Oxide and some fluorinated gases. Environmental scientists have revealed that the excess warming of the planet is closely linked with the built-up in the atmospheric concentrations the above mentioned gases, mostly originated from burning of fossil fuels, land use and agriculture.

Excessive Precipitation and Flooding

India's country level data does not show any significant trends but regional moosoon variations have been recorded. Eastern parts and central India (Chattisgarh, eastern Madhya Pardesh , Bihar) and Kerla showed decreased trends in monsoon rainfall while west coast of India (north of Kerla) and interior of Karnatka and Maharashtra states showed increasing trends in seasonal monsoon rainfall. The Indian Institute of of tropical Meterology suggests that summer moosoon intensity may increase beginning from 2040 and will increase by 10 percent by 2100 under A2[1] scenerio of IPCC. The temperatrure is expected to increase in the range of 3 to 5-degree celcius in the A2 scenerio. The Hirakud project is located in the eastern part of the country and is unlikely to face extreme precipitation or flood situations in near 50-year project term.

Greenhouse Gas Emission from Machineries During Construction-stage

The additional spillway of Hirakud Dam, under World Bank Aided DRIP is a small spillway construction project which will involve various activities like Transportation of material, excavation of earth construction etc. For carrying out these activities number of on-road transportation vehicles as well as number of off-road construction equipments would be used. Such vehicles, gasoline /diesel equipment would use fossil fuels, combustion of which will generate green house goes like CO_2. For projecting emission of greenhouse going to the atmosphere the following three approaches can be utilized.

- Type and Amount of fuel used and the respective fuel emission factor.

[1]As per Intergovernmental panel on climate chnage A2 equates to regionalisation. Regionally oriented economic development. Temperature ranging 2.0 – 5.4.

- Type of equipment and the emission from each type of equipment per hour and the number of hours the equipment is in operation.
- The volume of material to be transported or handled by the equipment and specific energy needed for such quantity.

For this project the second method i.e. Type of equipment/vehicle and emission from each type has been taken as the basis the CO_2 gas emission for various on-road vehicle and off-road construction equipments are given.

Table 4-8: CO_2 emission from various types of on-road vehicles

Sl. No.	Type of vehicle	CO_2 emission in kg per 100 mile of run	CO_2 emission in kg, per 100 km of road
1	Conventional gasoline car	36	22
2	Conventional light duly gasoline truck	47	29
3	Conventional medium duly gasoline truck	147	90
4	Conventional heavy duty gasoline truck	29	18
5	Conventional Diesel car	39	24
6	Conventional light duly diesel truck	88	54
7	Conventional medium duly diesel truck	78	48
8	Conventional heavy duty diesel truck	103	63

Table 4-9: CO_2 emission from various off-road construction equipment kg/100 hours of run

Equipment type	Most common engine/fuel type	Kg CO_2
Air compressors	Gas – 4 stroke	777
Bore/Drill rigs	Gas – 4 stroke	326
Crawler tractor	Diesel	27,030
Crushing/processing equipment	Gas – 4 stroke	935
Dumper/Trenchers	Gas – 4 stroke	467
Excavators	Diesel	5,774
Graders	Diesel	6,585
Off-Highway tractor	Diesel	27,030
Off-Highway trucks	Diesel	27,078
Other construction equipment	Diesel	10,190
Pavers	Diesel	3810
Paving equipment	Gas – 4 stroke	655
Plate compactors	Gas – 4 stroke	367
Pumps	Gas – 4 stroke	621
Rubber Tyred Dozers	Diesel	7,815
Rubber Tyred Loaders	Diesel	7,815
Scrapers	Diesel	12,412

Equipment type	**Most common engine/fuel type**	**Kg CO_2**
Tractors /loaders	Diesel	1,342
Water trucks	Diesel	27,078
Welders	Diesel	619

[Source:"Greenhouse gas mitigation measures for transportation, construction and maintenance" Prepared by ICF International, 620, 7olson street, 2nd floor, San Francisco, USA on request from American Association of State Highways and Transportation officials standing committee on the Environment.]

The construction activities will be going on at the selected areas, certain activities may be continuous/discontinuous depending on situation, facilities available and several other factors. Therefore it is not practical to calculate the absolute quantity of emission for the entire project activities in precise term.

MITIGATION MEASURES:

1. Reducing Fuel Use or Improving Fuel Economy can help reduce green house gas emission. This can be possible through the following methods

- **Reducing Idling:**
  Unnecessary idling occurs when trucks wait for extended periods of time to load or unload; or when equipment that is not being used is left on reduced idling reduces fuel consumption and the associated green house gas emission.
- **Equipment Maintenance:**
  Proper maintenance often results in fuel savings, although the magnitude of savings varies by equipment type and condition. Maintenance may include systematic equipment inspection, detection of potential failure and prompt correction. For example improperly inflated tires and poor wheel alignment can adversely affect the fuel efficiency of a small truck by 3-4%. Under inflated tires increases the tires rolling resistance, require more fuel to move the vehicle.
- **Driver Training:** Training the drivers for efficiently operating the vehicle/construction equipment can same fuel.
- **Properly sized Equipment:** Identifying the proper size equipment for a task can also provide fuel savings and associated reduction in green house gas emission.
- **Alternatives to Diesel Generators:** Diesel generators may consume as much fuel as a piece of construction equipment per hour and are generally operated over a longer period of time. Instead electrically powered equipments may be preferred as an alternative.

CHAPTER – 5
PUBLIC CONSULTATION

5.0 PUBLIC CONSULTATION:

Public participation and community consultation has been taken up as an integral part of social and environmental assessment process of the project. Public participation has been viewed as a continuous two way process, involving promotion of public understanding of the process and mechanism through which developmental problems and needs are investigated and solved. This also helps in identification of different environmental and social issues within the project area and public perception and such issues. In this connection both informal and structured stakeholder consultations were carried out during the pre-project survey, planning and design stage.

5.1 CONSULTATION MEETING WITH THE PROJECT AFFECTED PEOPLE:

During the site visits the project authorities along with consultant have interacted with the local people (both male and female) for obtaining response of the affected and influence area persons.

Informal Discussion

5.2 FOCUSED GROUP DISCUSSION(FGD):

A number of focused group Discussions (FGD) were held with Project Affected and influence area People during the social and environmental survey stage. Local people are being adequately consulted as part of the project preparation. Focused group discussions as well as informal discussion with local people as well as project implementation authorities were conducted at different points of time as part of the Environmental Impact Assessment of the project. Environmental and social implications of the project were discussed in those meetings.

5.3 SUMMARY OF FGD AT FIRST GAP COLONY:

The members participated in FGD at First gap colony have proposed the following measures that will help the community to cope with the situation that would emerge due to the project.

- Dust generation due to construction activity.
- Felling of trees
- Site plan of resettlement colony, the space they will provide the pattern of housing etc.
- Immediate compensation towards livelihood sustenance till they are settled properly.

- Provide employment to the local people at the time of construction of the spill way project.
- To ensure the existing facilities of the present colony in a new resettlement colony.
- Govt. should declare the R&R package to the people and the mechanism of providing the same much before the displacement takes place.
- The resettlement colony should be provided with large no. of local trees of fruit bearing species etc.

Meeting at Firstgap colony by Mr. S.S. Barik (Team leader)

5.4 FGD AT LAXMI NAGAR:

The colony members put forth their views as follows;

- They should be provided accommodation facilities first
- Re-linking of approach road to Gandhi Minar disrupted by Spill Channel.
- Air pollution due to construction activity.
- Public safety and inconvenience during construction
- Their livelihood should be restored at the new location
- Their common property resources should be ensured at new location
- Land should be provided for cultivation purpose and should be free from soil erosion.
- Plantation should be done in and around the colony.

5.5 CONSULTATIONS WITH STAKE HOLDERS:

The need of the hour, congruent upon policy guidelines thus envisages participation of the various stakeholders described above to provide input for a complete and environmentally complied development plan while clearly defining the steps to resolve socio-economic environmental safeguard issues.

The Stakeholders for the instant case project identified are:

- Central Water commission (CWC)
- Department of Water Resources (DoWR)
- District Administration
- Department of Energy (Line Dept. - GoO)
- Department of Public Health (Line Dept.- GoO)
- Department of Forest & Environment (Line Dept.- GoO)
- Hirakud NAC Authority

5.6 CONSULTATION MEETING WITH VARIOUS GOVT. DEPARTMENTS:

The following consultation meetings were done along with representatives from World Bank, Egis, CEMC, Chief Engineer & Basin Manager, Burla and Superintending Engineer etc. on 01.6.2017

MEMBERS PRESENT:

1. Mr. Harmohan Pradhan, CEBM, UMB
2. Mr. Saroj Kumar Panda, SE
3. Mr. S.K.Jain, consultant - Environment Specialist (World Bank)
4. Mr. Surjit Singh Deepak - Egis
5. Mr. S.K.Mohanty - CEMC
6. Mr. Ashutosh Kanungo -CEMC

5.6.1 Consultation Meeting With Divisional Forest Officer (Sambalpur).

A meeting was held with DFO, Sambalpur on 01.06.2017 to discuss various issues regarding status of diversion of degraded reserved forests land for construction of spill channel.

a) Forests Department expressed their full support for the project and informed that Forests Diversion Proposal has already been forwarded by them to Nodal officer with their site visit report and recommendations. Dam authorities need to follow it further with the Forest Department and Regional Office of MoEF&CC as required.

b) The tree cutting permission will be granted by DFO office. Dam authorities need to apply them in advance since DFO would like to seek concurrence from the Nodal officer as well due to very large number of trees involved. Joint inspection will be done before tree cutting.

c) The compensatory tree plantation will be made for cutting of estimated 3595 trees. The compensatory tree plantation is to be carried out on 1:10 basis. The compensatory tree plantation may be carried out by project proponent themselves or Orissa Forests Development Corporation. The plantation on C A land will be maintained for ten years.

d) Type of plants to be planted will be decided by Forest Department. Regarding translocation of trees, Mr. Mohanty said trees with coppicing vigour can be translocated but such technique has not yet been practised in Odisha.

e) The forest of Lamdungri has been degraded due to biotic interference and hills are devoid of productive soil. It was therefore agreed that dam authority may support for rejuvenation of part of this degraded forests section on either side of spill way alignment. Chief Engineer Hirakud agreed in principle to support this enhancement measure. He agreed that extra mud available from spillway channel construction can be given to Forests Department for rejuvenation of degraded forests hills. The excess of earth material and top soil

after utilization by project can be dumped at nearby places of degraded forest in consultation with forest department, so that the earth material can be utilized by forest department at a lesser cost for plantation purpose in the degraded forest.

f) Answering to the question regarding department's expectation from project, DFO said that if requested, DFO will prepare a scheme for undertaking plantation in vacant area at the Project cost.

g) In the forest land no schedule I fauna is noticed. No wildlife from adjacent Debrigarh sanctuary approaches Hirakud Dam.

h) Maximum possible compensatory tree plantation will also be carried out in this area with the help of Forests Department. Part of compensatory tree plantation can also be made on other degraded forest area in consultation with DFO.

Dam authority confirmed to WB team that they are in agreement of enhancement measures suggested by the team and agreed by DFO. Also, that they will plant the required 35950 compensatory trees at 70 Acres land available with them along the dam boundary which is free from any encroachment.

5.6.2 Consultation Meeting With Water Supply Dept. of Govt. of Odisha.

The consultation meeting with water supply dept. of govt. of Odisha was carried out with Er. Tapan Kumar Pradhan, Assistant Executive Engineer, Public Health Engineering Organisation and other member of his office on 01.6.2017 at Hirakud. The AEE informed that water supply pipe lines of different diameter are passing below the ground surface near the confluence point of spill channel and river bank of Mahanadi. Water supply to Hirakud Township and nearby town Sambalpur is done through these pipelines. Construction of spill channel will disrupt the water supply system if the pipe lines are not shifted. Providing a solution to this problem, the Chief Engineer & Basin Manager, Upper Mahanadi Basin, Burla said that will it be possible to align the pipelines along the bridge across the spill channel, if arrangement can be made. The AEE (PHEO) agreed with the proposal but asked for the spill channel drawing showing the bridge location. The Chief Engineer & Basin Manager has given his consent to provide the drawing and asked for the estimate so that he can include the same in the budget. Also it was agreed that pipelines will not be disrupted until alternate water supply is completed. The alignment of new pipeline will be done immediately after construction of bridge over the spill channel. The existing and proposed pipe lines are demarcated in

Annexure-5.1. There are no sewer lines in the area. All sewages are disposed through septic tank constructed at individual level.

5.6.3 Consultation Meeting With District Fishery Officer.

In the meeting, Dr. Abdul Rashid, the District Fishery Officer, Sambalpur, said that large fishery community is depending on dam which is spread in three districts. Usually no activity is done between 15th June and end of August because of spawning and breeding period. He also updated that fish (Mostly Indian major carp) productivity is reducing due to illegal fishing. The current productivity level can be enhanced with the development of nursery pond for production of fingerlings. There are no spawning and breeding ground near the dam. All such grounds are located u/s of the dam. He suggested dam authorities to support establishing of pond fisheries for increasing fish productivity.

The entire Hirakud reservoir is divided into ten sectors and is allotted to ten Primary Fishery Cooperative Societies (PFCS). Each sector is allotted with lease value and royalty @ Rs.20/- hectare/year. But at present the societies are not functioning because of court case.

It was also possible to have a discussion with President Mr. Narendra Kumar Das and a few members of Budharaja Primary Fisherman Cooperative Society on the same day. They informed that there are about 10 societies around the entire reservoir and 2500 fisherman are dependents on these societies. They requested for the support for the development of the pond fisheries. Each pond requires approximately rupees five lakh investment for development of each pond. They conveyed that they are capable of maintaining the pond once developed. About 7000 fingerlings will be allowed to develop in each pond with survival rate of 50%. They will get around 7000kg fish per year if they do pisciculture twice a year and the present selling price fish is approximately Rs.120/- per kg.

The Chief Engineer has shown his interest to add this concept in project proposal agreed to support the establishment of pond fisheries. They agreed for development of one pond for each society i.e. 10 such ponds which will support the livelihood of 2500 fishermen. But the ponds if created will be handed over to Fishery Department and Fishery Department will lease the ponds to registered societies.

5.6.4 Consultation Meeting Electricity Dept.

Discussion was made with Mr. Swaraj Sharma, Junior Manager on 01.06.2017regarding alternate arrangement for supplying electricity to the affected villages of “Additional Spill Way Project” during construction period as well as operation period. He informed that they will cross the spillway channel for

power distribution line through the proposed road bridge for the spillway channel. The department has to draw power line along the bridge or supply electricity from Burla side supply to Gujatala, Gandhinagar etc. If supply will be from the Burla side then a transformer will be needed. So as alternate arrangement they can provide electric supply to villages from both sides. He also informed that contactors will also be supplied power for construction by them. However, contactors have to comply with all electrical safety requirements.

5.7 Summary of Views and comments

Views and comments expressed in the stakeholders meetings were recorded for taking corrective measures to improve the environmental quality as well as to ensure social well being of the affected population.

Table 5-1: Summary of Public Consultation in the first week of June 2017

Sl.	Issues discussed	Stakeholder consulted	Outcome
1.	Dust generation & Air Pollution due to proposed construction activity	Project authority, Dist. Authority, representative of affected people, Env. Consultant	Water sprinkling arrangement will be made on road, construction site, plants, etc
2.	Tree felling	Forest Dept., Dist. Authority, representative of affected people, Env. Consultant	10 times plantation shall be done in the vacant space around the project area apart from compensatory afforestation by forest dept.
3.	Resentment against social survey activity	District Collector, ADM, Tahasildar, Project authority, representative of affected people	Intervention of District Collector streamlined the issue.
4.	Relocation of water supply pipeline	Project authority, Public Health Engineering Organisation and water users.	The pipeline will be re-aligned at project cost.
5.	Re-linking of approach road to Gandhi Minar disrupted by Spill Channel.	Project authority, local people and consultant.	Agreed to construct a bridge over spill channel.
6.	Shifting of crematoria and temples	Project authority and consultant.	Project authority agreed to shift the crematoria and temples to the adjacent area beyond proposed channel.
7.	Fishery in dam	Fishing community, Representative of Fishery Co-operative society, Chief Engineer, SE, representatives from WB, EGIS and CEMC	Request for provision of ponds for development of fingerlings in project land along the dam. No fishing is done on the reservoir towards left dyke, near proposed area.

Sl.	Issues discussed	Stakeholder consulted	Outcome
8.	Disruption in Electricity supply	Junior Manager from electricity dept., Chief Engineer, SE, representatives from WB, Egis and CEMC	The department has to draw 11kv line along the bridge or supply electricity from Burla side supply to Gujatala, Gandhinagar etc. If supply from the Burla side then a transformer will be needed. So as alternate arrangement they can provide electric supply to villages from both sides.
9.	Wildlife movement The excess of earth material and top soil after utilization	DFO, Sambalpur, Chief Engineer, SE, representatives from WB, Egis and CEMC	No wildlife from adjacent Debrigarh sanctuary approaches Hirakud Dam. The dug up earth from spill-way should not be dumped on forest land. The excess of earth material and top soil after utilization by project can be dumped at nearby places of degraded forest in consultation with forest department, so that the earth material can be utilized by forest department at a lesser cost for plantation purpose in the degraded forest. Forest dept. expressed their interest to take top soil for their use in plantation
10.	Compensation for the house, structure and property	Affected person of the area	They are interested to know the compensation package and the project authority describe that the package will be disclosed after finalization of the package by the state govt.
11.	Compensation of salary, PF	Affected person of Rerolling mill, Cable Colony	In compliance to court order (Misc case No. 20758 of 2016) in regard of disputed 157.26 decimal land in village Taranagar the DoWR has processed payment of compensation amount Rs. 10.04 crore to take possession of land and building. Disbursement to be made by Labour Commissioner, Sambalpur.
12.	Public Safety/ Inconvenience during construction	Affected person of the area, Project authority and consultant	Issues raised by public regarding safety issues during construction activities. The project authority assured that all safety measures will be taken during construction and will be strictly monitored. Disruption of Public moment during

Sl.	Issues discussed	Stakeholder consulted	Outcome
			construction as the alignment will cross the road. The project authority informed that a bridge will be constructed across the spill channel prior to the excavation activities in the road network to ensure uninterrupted traffic movement.

5.8 THE SECOND LEVEL PUBLIC CONSULTATION:

The second Level Public Consultation meeting on Environmental Impact Assessment, Social Impact Assessment Reports and R&R issues of Proposed Additional Spillway Project of Hirakud Dam, Sambalpur was held on 26th September, 2017 at 10.00 A.M. in-front of Nehru Udyan, Gandhinagar as per the notification no. 550, dated. 11.09.2017 issued by office of the District Collector, Sambalpur. The meeting was chaired by Sri Trilochan Majhi, Additional District Magistrate, Sambalpur and representatives from various organizations such as District Administration, Department of Water Resources, Hirakud Dam Project, State Pollution Control Board, Police Department, Sambalpur Municipal Corporation, Public Works Department, EGIS Expert Consultant, Odisha Construction Corporation Limited, Centre for Envotech and Management Consultancy Pvt. Ltd. were participated along with Public representatives/ Local leaders, Project Affected Persons and media representatives.

The meeting was started by the welcome address of Chief Engineer and Basin Manager and he briefed about the need of the project with its technical aspects. ADM, Sambalpur, described the audience about the purpose of the Public Consultation. This is followed by explanation regarding World Bank's policy, requirement by Dr.Surjit Singh Dipak, Egis. The representatives from CEMC Pvt. Ltd. explained about the Environmental and Social Impact due to the project. The R&R package for project affected persons was explained by special LAO, Sambalpur.

The Project Affected Persons were given a chance to raise their doubts and queries after detailed deliberation by administration. Some of the issues raised by the public are related to technical matter where as rest are of social nature. The issues were clarified by Chief Engineer and officials from district administration.

The proceeding of consultation meeting and list of the members present in the meeting are given in the Annexure -5.2.

Table 5-2: Summary of 2nd Level Public Consultation

Sl.	Issues discussed	Issues/ Suggestions	Outcome/Addressal in the Project
1.	Resettlement Sites	The identified resettlement sites at Basantpur, Rengalipalli and Larbanga are located far away from present affected settlement area. The Dam Authority should identify resettlement	New alternate resettlement sites have been identified at Solpali, Solband and Garmuda (within Sambalpur Municipal Corporation area) which are about , 3 km away from the original habitations

Sl.	Issues discussed	Issues/ Suggestions	Outcome/Addressal in the Project
		sites in the nearby area in consultation with local people so that their livelihood/ employment is not affected.	
2.	Inclusion of Local People in Core Committee for Implementation of RAP	In the Core Committee for Implementation of RAP, the representatives from affected settlement of the area should be included.	The District Administration Agreed to include the local representatives from each affected area for implementation of RAP in Core Committee. The constitution of Core Committee by the District Authority is in progress and the names of local representatives have been invited.
3.	Additional support for vulnerable groups	The Famale headed families/widows should be given additional support for their R&R	Additional provision for skill development and additional assistance to the women headed families has been included in RAP.
4.	Public Utilities and amenities at new resettlement site	At the resettlement site all the public utilities and amenities to be provided in advance	The Dam Authority will develop the social infrastructure including internal road network, connecting roads to the resettlement site, drainage, water supply line, electric supply networks, sanitation arrangements, primary health centres, playground etc. prior to displacement and is included in RAP.

CHAPTER-6

ENVIRONMENTAL MANAGEMENT PLAN

6.0 INTRODUCTION:

Safety of Hirakud Dam remaining as the prioritized objective of the project, the State Government while implementing the project intend to establish an equitable balance between the project activities, maintenance of good environmental quality consistent with social compatibility.

Environmental Management Plan (EMP) in this study document thus equips the project proponents [CWC/GoI and SWRD/GoO] to effectively address the environmental concerns of the project spread throughout the project cycle i.e. planning, execution and operational phases. The ESMF tool for DRIP has been used for incorporation of environmental and social safeguards in the present project documents, followed along with the Resource management, Engineering and Institutional interventions.

For better effectiveness of the project Management, a well developed Environmental Management Plan [EMP] has been prepared after adequately strengthened by a carefully structured Environmental Monitoring Action Plan [EMoAP]. The plan formulation, associated approach and methodology as well as implementation strategy etc are described in the following paragraphs.

6.1 OBJECTIVE OF THE ENVIRONMENTAL PLAN [EMP]:

The objective of the Environmental Management Plan [EMP] is to minimise the stress on the existing eco-system while ensuring the Socio-Economic living standards of the people especially the poor & vulnerable groups.

In the present context, a site specific management plan has been prepared not only to improve the environmental conditions but also to mitigate the adverse impacts on quality of life of affected families. Thus the EMP is designed by taking Design stage, Construction Stage and Operation Stage into consideration. Those considerations at each stage are given below;

Design Stage

- To keep land acquisition and building demolition at a minimum
- To provide maximum safety to the communities
- To develop a design that incorporates environmental safeguards and
- To provide mitigation measures to all expected environmental degradation

Construction Stage

- To prevent and reduce the negative environmental impacts of the project by implementable mitigation measures, to be carried out by the Contractor.
- To ensure that the provisions of the EMP are strictly followed and implemented by strengthening implementation arrangements.

Operation Stage

- To prevent deterioration of environment components of air, water, soil, noise etc.

Environmental Management Plan (EMP) thus comprises of two distinct components/parts.

- Formulation of EMP
- Implementation of EMP

6.1.1 FORMULATION OF EMP:

This part takes care of the following initiatives/activities.

1. Preparation of the Management Plan:

- The engaged team of experts from Environmental disciplines have acted to transcribe Baseline information's into positive and negative impacts, followed with appropriate mitigation measures.
- Care has been taken to chart out the management methods in due compliance with the policy, Acts and Local legislation of the state as well as policy guidelines of the World Bank.
- Most management methods, especially against critically impacted areas are quantitatively enumerated as far as practicable with frequency of occurrence and estimated cost.
- The project authorities are required to rationally incorporate the environmental and social management costs in the project cost estimate and ensure budgetary provision/annual outlay for subsequent implementation action.
- In the process, all management interventions are to be scrupulously integrated with the items of work inter-alia execution of works either through contractor agency or departmentally.

The critical environmental components of the project were identified on the basis of the assessment of the potential impacts due to the proposed project and activities. These issues need to be addressed carefully in the Environmental Management Plan.

2. Components Considered in the EMP:

Based on the Identification of Environmental Impacts during EIA study and their mitigations measures a site specific Environmental Management Plan has been developed.

In the process the management interventions are considered for three recognised phases of the project cycle; i.e.

- EMP for Design and preconstruction Phase
- EMP for Construction Phase
- EMP for Post-construction/Operation Phase

[A] EMP Components Design and Preconstruction Phase:

- Acquisition of Reserved Forest Land and felling of forest trees
- Tree felling in non forest area
- Resettlement and Rehabilitation of Affected People Relocation of utility services, religious /cultural properties and Common Property Resources
- Establishment of construction workers camp
- Establishment & Operation of Concrete Batching plants, hotmix plant, Stone crushers, etc.

[B] EMP Components of Implementation/ Construction Phase:

- Borrow area operations
- Quarry operations
- Land Contamination
- Soil erosion, Loss and contamination of Top Soil
- Management of Water Environment
- Management of Air Environment
- Management of Noise Pollution
- Monitoring of Environmental Attributes
- Waste Management (Solid Waste & Effluent from site)
- Management of Ecology
- Risks, Accidents & Safety Management
- Occupational Health & Safety Management

- Camp site management
- Restoration of impacted public utility services

[C]EMP Components of Post Implementation/ Operation Phase

- Performance Monitoring
- Tourism Management
- Safety during Project Operations
- Reservoir operation management
- Effective communication network

6.1.2 Implementation of EMP:

Implementation part of the management Plan includes the following considerations.

- Organisational Support
- Implementation Strategy

6.1.2.1 Organisational Support:

Conforming to the Policy Guidelines, the project authorities (SWRD) are required to consult the line departments of state for preparation of the management plan.

Some such instances of associations are:

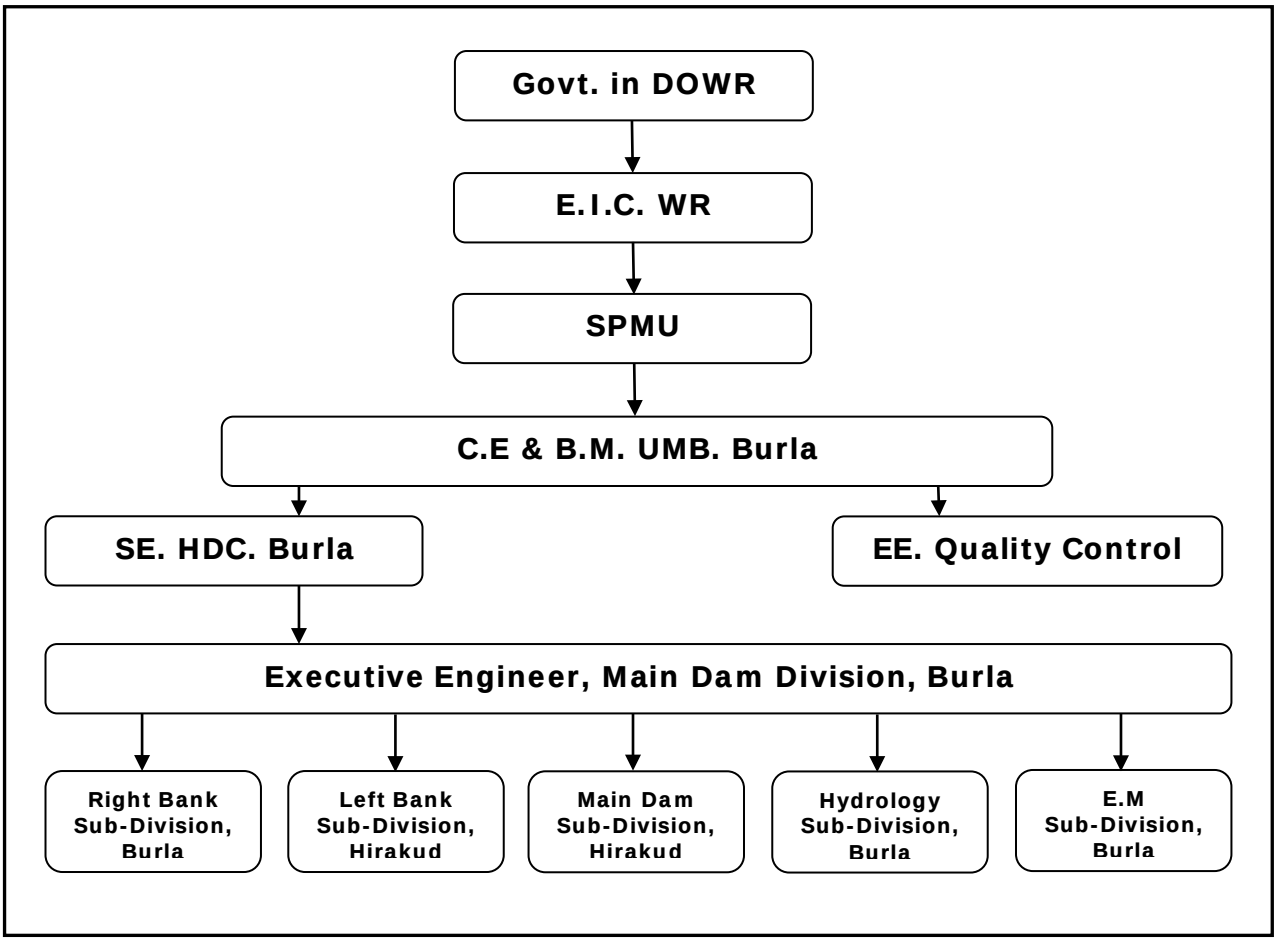
Issues	Line Departments
• For impact on Forest Land, involving - Forest Diversion Proposal, - Conservation of Flora, Fauna and Bio-diversity - Compensatory Afforestation Plan (CAP) and plantation programme. - Wildlife Conservation Plan.	State Forest and Environment Department - DFO of the district & PCCF (Forests). - PCCF and Chief wild life warden of the State.
• For Land Acquisition matters associated with ESMP	- The District Collector/RRO as well as other District Law & Order Authorities.
• For pollution control issues	- State Pollution Control Board.

6.1.2.1.1 Institutional Arrangement for Implementation of EMP

The project will be implemented by world Bank funding assistance under DRIP, comprising of Central Water Commission (CWC) and its designated environmental and social consultants (at present the EGIS) as well as a robust organisational setup of the State Project Management Unit (SPMU) comprising of the administrative authorities of State Water Resources Department (SWRD) and Technical experts – Engineer in Chief (EIC) and Engineers of Hirakud Dam Project, Dam Safety Organisation (DSO).

6.1.2.1.2 Organogram of the Project Authority

The present Organisational structure of SPMU related to Hirakud Dam Project is furnished below.



FORMATION OF PROJECT LEVEL MONITORING UNIT:

The present organisation structure will be strengthened by formation of Project Management Unit for construction of Additional spillway by way of inducting one independent consultant for Design review, construction supervision MIS, etc.

In the event of implementation of project the present SPMU organogram may be further strengthened with new addition of Divisional Engineers and staff to Monitor Environmental Management Plan & Pursue the Resettlement Action Plan (RAP).

6.1.2.1.3 Environment and Social Management Cell (ESMC)

For the implementation of the EMP/ RP, Environmental and Social Management Cell (ESMDC) will be established within the SPMU. The cell may headed by an Executive Engineer. He/She will overall be responsible for EMP Implementation, coordinating and liaisoning with government organization as well as the World Bank with respect to different forest and environmental issues. He/She will also responsible for progress monitoring of Environmental safeguards during project execution and submission of quarterly/ annual report on EMP compliance to the funding Agency. The ESMC will have the following members in the team:

1. Executive engineer (head of the cell) to report tp Nodlal officer at SMPU and engineer – in charge at site.

2. One Environmental and one Social safeguard officers to support executive engineer.

3. Site engineer (to support executive engineer and Environmental and Social safeguard specialists)

The Dam Authority will appoint Engineer-in-charge who will supervise the Contractors activities, compliances and monitor the overall progress of work. There is provision of Environmental Specialist in the team of Engineer-In-Charge who will be responsible for providing technical guidance to the Contractor for implementation of the EMP and preparation of checklists/formats/reports, etc. for implementing each of the activities as per the EMP. He will conduct regular monitoring of the implementation of the EMP by the Contractor and will prepare monthly or quarterly and annual monitoring reports on EMP implementation and compliance with environmental clauses of Contract Agreement. He shall be responsible for record keeping, providing instructions to the field representatives for corrective actions, ensuring compliance of various statutory and legislative requirements.

The Contractor will have one Environmental cum Safety Officer, who will be directly responsible for implementation of environmental safeguards at its different locations of construction. He will be ensuring compliance of the instructions given by the Engineer-In-Charge through executive engineer /ESMC. He will maintain close interaction with Engineer-In-Charge and his Field Representative and seek instructions and guidance from Environmental Expert of Engineer-In-Charge on any issue related to implementation of environment and safety measures. He shall be responsible for record keeping, and reporting to the Engineer-In-Charge through PM on actions taken. He will also give in-house training to the workers on environment and safety. He will maintain the record of day to day monitoring of environmental and safety issues at site.

The Roles and responsibility of implementation and Supervision Agencies at different levels have been defined in **Table 6-1.**

Table 6-1: Roles and Responsibility of Implementing Agency /Organisations

SPMU	IA, Hirakud Dam Authority at Site	Engineer-In-Charge	Contractor
• Overall project coordination and management through the Implementing Agency (IA) supported by Environmental Nodal officer deputed at SPMU and Engineer-In-Charge (designated specially for project) • Interaction and	• Headed by Engineer -in-Charge • Obtain statutory clearances. • Liasoning with different regulatory authorities • Joint verification to be carried out by IA, Engineer-In-Charge, Contractor Env. Officer. • Overall Supervision of implementation of EMP	• • Engineer-In charge will deliver the below task with the help of his/her deputy executive engineer and ESMC (headed by executive engineer and comprising of Environmental and social officers as). Assist and advise the	• Joint Verification Exercise including, SPMU/IA Engineer-In-Charge /ESMC for review of EMP • Interaction with ESMC, PIU and Engineer-In-Charge • Contractor's Environment cum Safety officer will be primarily responsible for

SPMU	IA, Hirakud Dam Authority at Site	Engineer-In-Charge	Contractor
Reporting to World Bank • Effective implementation of EMP and Monitoring of EMP through project specific ESMC • Compilation of Data relating to implementation of Environment Management Plan. • Advising and suggesting corrective measures to adhere to time schedule for implementation of EMP. • Carry out verification Exercise for implementation of EMP with respect to modification (if required) for enhancement measures.	• Review of all the records and keeping records of all consents/ permits/ licenses obtained by contractor. • Compilation of Data relating to implementation of EMP. • Filling of Summary Sheets and reporting to SPMU. • Approval of plans prepared by contractor	SPMU/IA in matters relating to environment and social matters. • Environmental monitoring through ESMC through approved Laboratory. • Part of Joint Verification Exercise to be carried out by SPMU, Third Party Auditing, IA and Contractor for review of EMP for modification in enhancement measures (if required) • Supervise implementation of EMP by contractor • Develop Good Practices construction guidelines to assist contractor in implementation of EMP • Conduct Consultations programs with the stakeholders on regular basis to get first hand information on the inconvenience caused to contractor's activities such as noise, debris disposal etc. • Maintain Environmental reporting system	implementation of EMP • Filling of Reporting Format and submitting to Engineer-In-Charge • Monitoring through approved agency. • Preparation of various plans for effective implementation of EMP as detailed out in EMP and submitting it for approval to Engineer-In-Charge • Identification of Sites for Labour camps, Hot mix Plant, Batch Mix Plant, debris disposal etc • Obtaining statutory licenses and clearances for opening of Borrow areas, Quarry areas, and Labour camp • Day to day implementation of Environmental Safeguards

The role and responsibilities of Environmental personnel at different levels will be as follows:

Table 6-2: Roles and Responsibilities of Environmental personnel at different level

Position	Roles & Responsibilities
SPMU's Environmental and Social Nodal Officer	• Finalize the EIA and EMP for individual sub-project with inputs from Engineer-In-Charge • Confirm integration of EMP provision related to works in the contract documents • Provide guidance on environmental issues to PIUs Environmental and Social officers as requested • Coordinate with regulatory agencies like Forest Departments, and at request of Engineer-In-Charge and/or Contractor, State Pollution Control Board • Prepare regular reports on progress on EMP implementation across the project with inputs from the environmental specialist • Document experiences of developing and implementing environmental mitigation measures an convert it into training material for internal and external capacity building • Facilitate interaction between environmental teams of different sub-projects to allow cross-fertilization of ideas, successes and learnings
Executive Engineer and ESMC headed by him	• Coordinate with Engineer-In-Charge to monitor and report on progress on EMP implementation as part of works contracts to SPMU • Participate in and facilitate consultations with stakeholders • Participate in project meetings and report on the issues related to environmental management to provide for any mid-course corrections that may be required based on situation on the ground • Coordinate on the training and capacity building initiatives • Addressal of environmental grievances received from public or other stakeholder
Environmental officer part of ESMC	• Lead the development of the sub-project specific EIA and EMP for the entire project • Review contract documents to ensure that EMP provisions related to works are included in the contract documents • Assist the Environmental Specialist in the PMU to follow-up with state government departments • Oversee and report to the executive engineer/SPMU on implementation of EMP provisions included in the works contract for each sub-project • Act as a resource person in trainings based on experience on implementing this project and previous relevant work
Contractors' Environmental cum Safety Officer	• Lead the implementation of EMP measures included in the Contract • Report on progress and shortcomings of the measures implemented to Environmental Specialist of Engineer-In-Charge

6.1.2.2 Implementation Strategy:

It is already stated that, implementation of Environmental Management Plan against environmental degradation and disaster risks are to be integrated with the sustainable development frame work and to be carried out conjunctively. Besides the organisational preparedness, the approach technique prioritises the following few aspects:

- Availing of approval / clearances from competent authorities.
- Ensuring smooth fund flow with adequate budgetary support.
- People's participation in the management proceedings and training programmes.

- Public consultation (PAPs and stakeholders).

(i) Obtaining approval/clearances from Competent Authorities:

In conformity with Acts Rules & Regulations, prior permission/clearance from the appropriate / competent authorities is necessary before commencement of the construction activities. Some of the important items are mentioned below in **Table 6-3**:

Table 6-3: Statutory permissions and clearance on Environmental Issues applicable in the project

SL No	Activities / Issues	Clearance/Permits/ Licenses Required	Regulatory Authority	Responsibility
1.	Environmental Clearance	Environmental clearance	MoEF&CC	IA (CEBM,UMB)
2.	Acquisition of Reserved Forest area, Tree cutting & disposal	Forest Diversion Proposal to be approved	Nodal officer, PCCF, GoO and MoEF &CC GoI	Executive Engineer of the Project (SWRD)
3.	Borrow area operation	• Environmental Clearance under EIA Notification, 2006	• DEIAA/ SEIAA, MoEF&CC	Contractor
4.	Identification of Govt. Land for Solid waste disposal	• Land alienation • Authority from local administration	• Tahasildar of the Locality • State pollution control Board	Contractor
5.	Land required for some project activities like approach Road Haul road etc.	• Acquisition of land as per standard procedure	Revenue Authority (Collector) of the district	Contractor
6.	Controlled Blasting operations for foundation excavation	• Blasting permission • Approved for portable magazine	District Administration (ADM)	Contractor
7.	Establishment of Batching Plant	• NOC (Consent to Establish and Consent to Operate)	State pollution control Board	Contractor
	Engagement of Labours	Labour License	District Labour Commissioner	Contractor

6.2 ENVIRONMENTAL MANAGEMENT ACTION PLAN:

This section describes the Environmental Management Action Plan during different stages of project. The Environmental mitigation measures have been incorporated at all the stages of the project right from Designing phase to Construction and Operational Phase. All care has been taken to provide mitigation measures for all expected environmental degradation at different stages. The Environmental Management action plan has been formulated for the present project for mitigation/management/avoidance of potential adverse impacts and the enhancement of the various

environmental components along with its location, timeframe of implementation, and overseeing/supervising responsibilities. The safeguard measures identified for different phases are tabulated in **Table 6-4**

Table 6-4: Environmental Management Action Plan

Environmental issues/ Activities	Mitigation Measures	Location	Timeframe	Institutional responsibility	
				Implementation	**Supervision**
A. DESIGN / PRE-CONSTRUCTION STAGE					
A.1. Acquisition of Reserved Forest Area and felling of forest trees	• Forest clearance for affected 9.441 Ha of land of Lamdungri Reserved Forest area is required to be obtained under Forest (Conservation) Act, 1980 before commencement of works. • The payment of NPV and compensatory afforestation will be made to the Forest Department by the Project Proponent, i.e. Dam Authority. • Compensatory afforestation to be taken up by the State Forest Department in the double the area of forest diversion.	Lamdungri Reserved forest on hill section In identified land by the forest department	Pre-construction stage	IA State Forest Department through their own contractor	SPMU/IA, Hirakud Dam Authority State Forest Department/ IA
A.2. Trees Felling in Non Forest Area	• The statutory permission for felling of about 3595 nos. of affected trees falling within the project alignment and in submergence area will be obtained prior to cutting of trees. • Effort will be made to minimize the tree felling by restricting tree felling within the formation width only. Special attention will be given for protecting giant trees, and locally important trees (having cultural importance) • Transplantation of big trees will be explored in consultation with the forest department • Compensatory plantation will be carried out by the dam authority in the ratio of	In and around the project area	Pre-Construction Stage	Contractor	IA, Hirakud Dam Authority

	1:10 in the dam area and in forest area in consultation with the forest department • A general guideline for tree plantation will be followed as per Tree Plantation Strategy given in **Annexure-6.1.**				
A.3. Resettlement and rehabilitation of affected people	• Carryout R&R survey and prepare RAP. • A separate R&R policy has been framed after identification of different categories of affected persons to address the issues pertaining to the Project Affected People and their rehabilitation & resettlement. • The acquisition of private properties will be carried out in accordance with the RAP and entitlement framework for the project. • Early identification of affected persons for compensation and advance planning of Resettlement and Rehabilitation Action Plan to Compensate the Losses. • All the affected people will be compensated for the loss as per R & R Policy of the project before commencement of Construction works • The Dam Authority has to ascertain that any additional environmental impacts resulting from acquisition of properties are addressed and integrated into the EMP and other relevant documents. • Entitlement against loss of property will be decided by the district level compensation advisory committee as per R&R Policy, GoO, 2006 and subsequent revisions	Habitations appearing in the Affected Areas	Pre-Construction Stage Prior to construction activities	• RRO of DoWR	• District collector IA, Hirakud Dam Authority

	• Payment to each DFs will be made by the collector of the district through his designated officers. • Other Benefits/ Entitlements as would be prescribed in the approved RAP will be extended to the DFs. • The three resettlement sites identified by the Project Authority involve insignificant environmental issues in regard of location, infrastructure facilities and public health. The sites exhibit favorable topography with plain and gently undulated land, well drained and having a few common tree species and shrubs etc.. Any one or all of them in small parts may be selected for habitation purpose. • After finalization of site during second round of consultation, the area will be developed and necessary plotting will be done along with land for amenities such as road, water source, electricity, health facilities etc. before handing over plots to the affected families. Detailed rehabilitation plan is covered in RAP. The rehabilitation process will be completed prior to implementation of project.				
A.4. Relocation of Community Utilities, Religious/ Cultural Properties and Common Property Resources	• Essential community utilities like water supply, electricity and religious structures etc are to be relocated before start of construction activity. • The IA will relocate these properties in consultation with the community. • Environmental considerations with suitable/required actions including health and hygiene aspects will be kept in mind	In and around the project area	Pre-Construction Stage	IA, Hirakud Dam Authority	IA, Hirakud Dam Authority District collector

	while relocating all community utilities and resources. • Preference of the local community using the structure will be addressed during relocation/ renovation of such affected features. • All precaution like providing safe access to these site during relocation or during construction, barricading, dust curtain shall be provided to minimize impact to religious structures.				
A.5. Establishment of Construction / Workers Camp	• The locations of construction camp to be identified by the agency preferably within the Dam Area. • The Contract will establish their camp in the Dam area with prior approval from the Dam Authority. And submit the proposed layout of the camp for approval of Engineer • If the Contractor identifies private land for establishing their camp then the legal agreement/ written Consent letter shall be obtained from the owner of the land for using for specific purpose along with its rehabilitation plan as agreed by the owner prior to construction of the camp and the copy of the same will be submitted to the Engineer-In-Charge • Construction camps will not be proposed within 500 m from the nearest settlements and cultural property to avoid conflicts and stress over the infrastructure facilities with the local community. • It will be ensured that the site is properly restored to the satisfaction of the land	At a safe distance from the work site& material storage site	Pre-Construction Stage	Contractor	Engineer-In-Charge / IA, Hirakud Dam Authority

	owner prior to handling over to the owner. • Construction camps site will be identified at least 100m from water sources / and 10 Km from Wildlife Sanctuary boundary. • The Camp site should be provided with all the necessary facilities as per norms.				
A.6. Establishment & Operation of Concrete Batching plants, hot mix plant, Stone crushers, etc.	• The Stone crushers, hot mix plant or Concrete Batching plants should be sited at least 1km away from settlements, agricultural operations and any commercial establishments. • It will be ensured by the Contractor that the siting and operation requirements of these plants conform to the Environmental (Protection) Rules, 1986. • All plants should be fitted with adequate dust suppression and emission control equipments and facilities. • Specifications of crushers and Batching plants will comply with the requirements of the relevant current emission control legislations. • The plants shall not operate till the required legal clearance are obtained and submitted. • A general guidelines on Plant site Management is given in **Annexure-6.2**	Plant Site	Pre-Construction Stage	Contractor	Engineer-In-Charge / IA, Hirakud Dam Authority
A.7 Contractor's Environmental and Safety Officer	• The Contractor has to appoint one Environmental and one Safety Officer having requisite qualification and has sufficient experience in implementation of Environmental safeguards in		Pre-Construction Stage	Contractor	Engineer-In-Charge / IA, Hirakud Dam Authority

	construction/dam projects.				
A.8. Contractor's Environmental and Safety Manual indicating action Plan	• The Contractor along with their Quality Assurance Plan, will submit their Action plan and work schedule on implementation of Environmental safeguards as stipulated in EMP and their Safety Manual for approval from the Engineers. • They are supposed to include various formats on safety data and status on implementation of environmental safeguards during different construction activities	-	At the beginning of the project immediately after mobilisation at site	Contractor	Engineer-In-Charge / IA, Hirakud Dam Authority
B. CONSTRUCTION STAGE					
B.1. Borrow area operations	• Finalizing borrow areas for borrowing earth and all logistic arrangements as well as compliance to environmental requirements as applicable will be the sole responsibility of the Contractor. • The Contractor will preferably use borrow area from already identifies site by the Dam Authority within the dam area. If the Contractor intends to open new borrow area in private land then no borrow area will be operated without written agreement with the land owner. • All the borrow areas should be approved by the Engineer, based on both material suitability and environmental considerations. • The Contractor will obtain environmental clearance for the borrow area as per MoEF circular and the conditions stipulated under the environmental clearance will be binding on the contractor. The Contractor will submit the	Inside of the reservoir periphery upon establishing material suitability Outside the reservoir on selected locations (if required)	Pre-Construction and Construction Stage	Contractor	Engineer-In-Charge / IA, Hirakud Dam Authority

	copy of clearance letter to the Engineer and PIU before commencement of material extraction. • All borrow areas will be operated in accordance with MoEF&CC guidelines. • Non-productive, barren lands, raised lands, river beds, waste lands are recommended for borrowing earth. • Extract earth from identified borrow area (to be pegged) after getting permission from project authority. • The unpaved surfaces used for the haulage of borrow materials will be maintained properly • To avoid any embankment slippages, the borrow areas will not be dug continuously, and the size and shape of borrow pits will be decided by the Engineer. • Each borrow area should be rehabilitated within one month after completion of extraction of materials to the satisfactions of the land owner and the Engineer. • A general Guidelines for Borrow area identification and operation is given in **Annexure-6.3**				
B.2. Quarry operations	• The stones generated due to hill cutting and excavation will be reutilized for construction based on the suitability of materials. • All the quarries will be approved by the Engineer, based on both material and environmental considerations.	recommended Quarry sites	During construction	Contractor	Engineer-In-Charge / IA, Hirakud Dam Authority

	• The quarry material will be obtained from licensed sites only, which operate with proper environmental clearances. • The quarry operations will be undertaken within the rules and regulations in force. All safety and environmental concerns will be addresses adequately during quarry operations and transportation of materials as per prevailing rules. • If the Contractor wants to open a new Quarry, then he has to obtain necessary environmental clearance from MoEF & CC and lease license from Directorate of Geology and Mines. • Only controlled blasting shall be carried out, if necessary for extraction of stone materials, in strict compliance with the statutory norms and specification. • A general Guideline for Quarry area identification and operation as enclosed as **Annexure-6.4** to be followed.				
B.3. Impact on Land Resource					
B.3.1. Contamination of land from construction wastes and spoils and demolition mucks	• Clear the debris from construction and demolition sites. • Debris's are to be carried by trucks/dumpers to the identified dumping yards. • The solid wastes as far as possible are to be backfilled in layers with top earth cover as far as practicable. • Suitable plantation will be taken up over the backfilled area to prevent soil erosion. • Ensure proper drainage from these areas	All construction sites, camps.	During construction stage	Contractor	Engineer-In-Charge / IA, Hirakud Dam Authority

	such that no water body nearby is affected • Benching, Grading, Plantation on the dump will enhance Landscape view. • Adhere to solid waste disposal regulations. • Muck dumping and its management is provided in **Annexure-6.13** to be followed.				
B.3.2. Environmental degradation due to improper Material Handling, Stacking and location of Service units	• Material Stacking should be regulated with convenient heaps of Geometric size & slopes. • Drainage to be provided all around the stockyard to restore soil quality. • Similarly, Service units and workshops should be located on slightly elevated grounds, such that washouts/effluents are led to the treatment pond before discharging to river.	Nearest higher ground around the construction site.	During construction phase	Contractor	Engineer-In-Charge / IA, Hirakud Dam Authority
B.4. Impact on Soil					
B.4.1. Soil Erosion	• Embankments will be provided with chutes and drains to minimize soil erosion. • Stone pitching and retaining walls will be made at embankments in critical areas. • Turfing and plantation of grasses and shrubs will be done for slope stabilization. • All excavated pits are to be backfilled & levelled to avoid land erosion, simultaneously to improve aesthetics of structure. • The cut slopes of the Hillock should be properly benched (with berms).	Embankment locations	During construction	Contractor	Engineer-In-Charge / IA, Hirakud Dam Authority

	• These excavated slopes should be lined with concrete to prevent erosion of the Hills. • The u/s slopes of the Dyke will have Rip Raps as per design. • The D/s slopes of the Dyke will have Rock toe & Drains where as upper slopes are to be secured with Grass Cover (Turffing). • In borrow pits, the depth of the pit will be regulated that the sides of the excavation will have a slope not steeper than 1: 2, from the edge of the final section of bank.	Slopes of the hillock where spill channel crosses the hill, Both side slopes of the earthen dam, and borrow pits			
B.4.2. Loss of topsoil	• In order to minimize the impact on soil fertility the top soil will be preserved separately and the top soil will be reused for landscaping, grass turfing and site restoration work. • The top soil will be stripped to a specified depth of 150 mm and stored in stockpiles of height not exceeding 2m away from water ways and the heap of the top soil will be covered with tarpaulin cover of turfed to cease washing out of soil especially during rains • The stored topsoil will be spread back to maintain the soil physico-chemical and biological activity. The preserved top soil will be used for restoration of sites, in landscaping and avenue plantation. • The preserved top soil should be used for plantation as soon as possible to prevent loss of quality and quantity.	Excavation and cutting area, embankment slopes and allied sites such as borrow area, camp sites site, stockyards etc,	During construction	Contractor	Engineer-In-Charge / IA, Hirakud Dam Authority
B.4.3. Contamination of Soil	• The provision for oil interception	Construction Camp,	During Construction	Contractor	Engineer-In-Charge /

and land from fuel and lubricants	chamber is suggested in EMP for treating the waste water generated from vehicle washing, refilling and maintenance areas. • Impervious platform and oil and grease trap will be appropriately provided at construction camp, servicing area and liquid fuel and lubricant storage areas for collection of spillage from construction equipment vehicle maintenance platform. • Fuel storage and refilling sites should be kept away from cross drainage structures and important water bodies. • The petroleum products will be stored in drums kept in raised impervious platform with catch drains around the platform to contain the spilled quantity. • All spoils shall be disposed off as desired and the site shall be fully cleaned before handing over.	Vehicle and Equipment Servicing Centre and Construction site	stage		IA, Hirakud Dam Authority
B.4.4. Compaction of Soil:	• The excavation activities and vegetation clearance will strictly be limited to formation width only. • All the usable excavated materials will be re-used as fill materials and aggregates. • The movement of construction vehicles and equipments will be restricted to only designated route. • Designated storage site for fill materials and adequate stockpiling to prevent erosion and runoff related problem.	Construction Camp, Vehicle and Equipment Servicing Centre and Construction site	During Construction stage	Contractor	Engineer-In-Charge / IA, Hirakud Dam Authority
B.5. Impact on Water Resources					
B.5.1. Siltation of the Natural drains	• Clear all the natural drainage before onset of monsoon in order to keep all drainage	At locations of CD structures	During construction	Contractor	Engineer-In-Charge / IA, Hirakud Dam

	unblocked. • Adopt re-sectioning wherever possible. These channels are to be functional without clogging at any point. • Earth, stones, wastes and spoils will be properly disposed off so as to avoid blockage of any drainage channel.	Existing natural drains inside the construction area			Authority
B.5.2. Water Pollution	• The Contractor will take all precautionary measures to prevent the wastewater generated during construction works from entering into water bodies during monsoon. • All water and liquid wastes arising from construction activities will be properly disposed off and will not be discharged into reservoir, downstream water way or pond around project area without adequate treatment. • All work site washouts be collected in a sedimentation pond where treatment may be imparted before releasing flow to the main drain. • No construction materials/ spoils will be stored along the water bodies and adequate provision will be made for preventing spillage of materials into these water bodies. • Ensure that all construction vehicle parking location, fuels/lubricants storage sites, vehicles, machinery and equipment maintenance sites are located at least 100m away from any water body. And also ensure that spillage of fuels and lubricants do not contaminate the ground. • The slopes of embankment leading to	Water bodies in and around the construction site	Construction Stage	Contractor	Engineer-In-Charge / IA, Hirakud Dam Authority

	water bodies will be modified and re channelized so that contaminants do not enter the water body. • Provide oil & grease trap in the drains to extract the oil and grease from the runoff water to prevent contamination of water. • Collect and store oily wastes and hand over the same to the authorized agent of hazardous waste collector. • Water quality to be monitored periodically as per Environmental Monitoring Plan.				
B.5.3. Sanitation and waste disposal in construction camps	• Garbage tanks, Bio toilets and other sanitation facilities will be provided at camps & construction site to avoid epidemics. • The construction camps will be located away from water sources. • The workplace will have proper medical approval by local medical, health or municipal authorities.	At Construction camp locations, wherever located along the Project corridor	During construction phase	Contractor	Engineer-In-Charge / IA, Hirakud Dam Authority
B.5.4. Sluggish Land Drainage Water Logging	• Deposit the excavated material only at the specified site without disturbing the natural drainage. • Natural drainage of the entrapped area should be restored with construction of some connecting drains and crossing culverts.	• Area bounded by the Hirakud Dam and proposed spill channel	During construction phase	Contractor	Engineer-In-Charge / IA, Hirakud Dam Authority
B.6. Impact on Air Environment					
B.6.1. Air Pollution (construction, vehicles and machinery)	• All vehicles, equipment and machinery used for construction will be regularly maintained to ensure that pollution emission levels comply to the relevant requirements of SPCB norms. • PUC certificates will be mandatory for all	Throughout Project area i.e. at construction sites, concrete batching plant and the equipments and vehicles at sites	During construction	Contractor	Engineer-In-Charge / IA, Hirakud Dam Authority

	vehicles/ equipment/ machinery used for the project. • Transportation of loose earth, sand will be done in covered vehicles. • Take every precaution to control dust nuisance at all the construction zones and allied sites where works are under progress. • The crushers and the batching plants will be sited at least 1km in the downwind direction from the nearest human settlement (Boundary of town/village). • Every equipments and machinery will be fitted with dust suppression devices such as water sprinklers, dust bags, cyclone etc. as appropriate. • At all the construction zones and unpaved lead roads, earthen temporary diversions and plant premises periodical water sprinkling will be carried out to suppress dust. • Workers at mixing sites will be provided with good quality personal protective equipments (PPE) reduce the chances of ill effect of emission. • Periodical monitoring of fine Particulate Matters (PM_{10} and $PM_{2.5}$) will be carried out as per Environmental Monitoring Plan.			Through Approved Monitoring Agency	
B.7. Impact on Noise Environment					
B.7.1. Noise from vehicles and equipments	• All plants and equipments used in construction shall strictly conform to the MoEF/CPCB noise standards.	Throughout Project area i.e. at construction sites, concrete batching	During the construction, till closure of such sites.	Contractor	Engineer-In-Charge / IA, Hirakud Dam Authority

	• All vehicles and equipment used in construction will be fitted with exhaust silencers. • Servicing of all construction vehicles and machinery will be done for exhaust silences and will be checked and if found defective will be replaced. • All the construction sites within 150m of the nearest habitation, noisy construction work such as crushing, concrete mixing will be stopped during the night time between 10.00 pm to 6.00 am. • No noisy construction activities will be permitted around educational institutions/ health centers (silence zones) up to a distance of 100 m from the sensitive receptors. • Monitoring shall be carried out at the construction sites as per the monitoring schedule and results will be submitted to Engineer-In-Charge.	plants etc.			
B.8 Monitoring of Air, Water & Noise Quality Pollution	• The periodic monitoring of the ambient air quality, noise level, water (both ground and surface water) quality, soil pollution/ contamination in the selected locations as suggested in environmental monitoring plan. • Engineer-In-Charge will appoint MoEF&CC/SPCB approved pollution monitoring agency for this purpose.	As per Environmental Monitoring Plan (Construction /Camp Sites)	During Construction	Approved laboratory	Engineer-In-Charge / IA, Hirakud Dam Authority
B.9. Impact on Ecology					
B.9.1. Loss or damage to vegetation	• Trees identified under the project will be cut only after receiving clearance from	Identified project location	During preconstruction	Contractor	Engineer-In-Charge / IA, Hirakud Dam

	the Forest Department and after the receipt of written permission from Engineer-In-Charge /IA. • Vegetation will be removed from the construction zone before commencement of construction. All works will be carried out such that there is no damage or disruption to trees other than those identified for cutting. • All the trees located in camp site, stockyards, borrow areas, disposal area and other allied sites will be preserved. • The construction materials or excavated materials will be staked at a safe distance from tree located in such areas to avoid any damage to the trees • The Contractor will submit the record of trees located in such areas to the Engineer-In-Charge and should be verified by the Engineer-In-Charge. These trees will be inspected periodically to check any damage and appropriate corrective action will be taken to preserve the tree. • In case of felling of trees by the Contractor, beyond the marked trees for cut with approval from line department, the Contractor will plant trees in the ratio of 1:10 at his own cost and submit the compliance to the Engineer for verification • Compensatory plantation will be taken up on identified Non-forest Government Land.		phase		Authority
B.9.2. Disposal of Root	• The DFO of the district may be consulted	Construction Area	Prior to	Contractor	Engineer-In-Charge /

Zones of Felled Trees	for disposal of root zones of trees. However, during the excavation / construction activities such uprooted stumps should be stacked separately for inspection/ advice of the DFO before disposal.		commencement of construction activities		IA, Hirakud Dam Authority
B.9.3. Landscape degradation	• Care should be taken to restore the vegetative cover in and around the construction site. Ensure that no trees are cut or disturbed outside the identified area. • The project authorities should initiate proposal with the District Administration & Tourism Department • Beautification of the area with Plantation of Flowering species. • Conversion of existing ponds to water sport areas for Tourists attraction. • Road Crossing structure over Nallahs / Drains may be beautified with coloured posts & Electrification.	Construction Site	After Construction Period	- Contractor	Engineer-In-Charge / IA, Hirakud Dam Authority
B.9.4. Loss, damage or disruption to fauna	• Construction workers will be directed not to harm any fauna. • Construction vehicles will run along specified access to avoid accidents to cattle. • Plying of Vehicles in the night time should be prohibited	Throughout Project area	During construction	Contractor	Engineer-In-Charge &IA, Hirakud Dam Authority
B.10. Safety Measures against Risks & Hazards					
B.10.1. Accident risks from construction activities	• To ensure safe construction in the temporary accesses during construction, lighting devices and safety sign boards will be installed. • At blasting sites, the blasting time, signal and guarding will be regulated. Prior to	Construction site and adjoining area	During construction	Contractor	Engineer-In-Charge / IA, Hirakud Dam Authority

	blasting the site will be thoroughly inspected. Blasting will not be carried out during rush hours. • For Blasting operation a general Guidelines have been provided in **Annexure- 6.5.** • A general guidelines related to Risk and Disaster Management for responding to emergency situation is given in **Annexure-6.6** • Safety of workers undertaking various operations during construction will be ensured by providing helmets, masks, safety goggles, etc • At every camp site, a readily available first aid unit including an adequate supply of dressing materials, a mode of transport (ambulance), para medical staff and an attending doctor will be provided. • Road safety education will be imparted to drivers running construction vehicles. In case of negligent driving, suitable action will be taken. • Traffic rules and regulations will be strictly adhered to. • Adequate signage, barriers and persons with flags during construction to control the traffic will be provided. • Speed restrictions shall be imposed on project vehicles. • Speed Breakers and Signboards should be displayed. • Barriers (e.g. Pillars with fencing) shall				

	be installed at construction areas to prevent pedestrian access to the freight corridor except at designated crossing points. • The general public/local residents shall not be allowed in high-risk areas, e.g., excavation sites and areas where heavy equipment is in operation and the spill channel. • All lifting tools will be periodically checked & certified.				
B.10.2. Risk from electrical equipments	• The electrical equipments will be checked regularly • No Material will be so stacked or placed below the overhead supply mains so as to prevent danger or inconvenience to any person or the public. • Necessary fencing and lights will be provided to protect the public to enter the construction zones. • Protect electric sub-stations, high tension towers and other areas from electrocution risk by providing security fencing and light, warning signs and security patrols.	Construction site	During construction	Contractor	Engineer-In-Charge / IA, Hirakud Dam Authority
B.10.3. Occupational Health & Safety of Workers	• Comply with the requirements of the Environmental, Health and Safety (EHS), Guidelines of the World Bank, April, 2007[1] and the statutory norms of safety during construction.	Workers Camp Site and Construction site	During construction	Contractor	Engineer-In-Charge / IA, Hirakud Dam Authority

[1] *Reference*: http://www.ifc.org/wps/wcm/connect/554e8d80488658e4b76af76a6515bb18/Final%2B-%2BGeneral%2BEHS%2BGuidelines.pdf?MOD=AJPERES

	• A general guideline of EHS aspects given in **Annexure- 6.7** to be followed during construction activities. • Provide adequate good quality Personal Protective Equipments (PPE) to all the workers working at construction zones and Plant sites and will ensure that these PPEs are used by workers at all time during works. • Adequate drainage, sanitation and waste disposal will be provided at workplaces. • Proper drainage will be maintained around sites to avoid water logging leading to various diseases • Adequate sanitation and waste disposal facilities will be provided at construction camps by means of septic tanks, soakage pits etc. • A health care system will be maintained at construction camp for routine check-up of workers and avoidance of spread of any communicable disease • Readily available First Aid kit will be provided at all the work sites and should be regularly maintained. • Organize awareness program on HIV aids and sexually transmitted diseases (STDs) for workers on periodic basis at least once in a quarter • Welders will be provided with eye shields and gloves. • Ear plugs will be provided for workers working in high noise zones.				

	• Workers shall be provided with potable water supply at site. • Provision of distinguishing clothing or reflective devices or otherwise conspicuously visible material when there is regular exposure of workers to danger from moving vehicles. • Monitoring and control of the working environmental and planning of safety and health precautions should be performed as prescribed by national laws and regulations.				
B.10.4. Public Safety	• To ensure safe construction in the temporary accesses during construction, lighting devices and safety sign boards will be installed. • At blasting sites, the blasting time, signal and guarding will be regulated. Prior to blasting the site will be thoroughly inspected. Blasting will not be carried out during rush hours. • Safety of workers undertaking The plants and equipments will be installed sufficiently away from the settlement. • All the construction equipments and vehicles will conform to the emission standards stipulated by the CPCB. • Proper caution signage, barricading, delineators. lightings etc. will be installed at Construction zone and temporary diversions • The Excavation area shall be securely barricaded and provided with proper caution signs, conspicuously displayed	Construction site and adjoining area	During construction	Contractor	Engineer-In-Charge / IA, Hirakud Dam Authority

	during the day and properly illuminated with red lights and/or written using fluorescent reflective paint as directed by engineer in charge during the night to avoid accident. • Hard barricading will be provided at construction zone along deep excavation all along the alignment and near habitation area and public roads and the same will be maintained throughout the construction period. • The contractor shall provide hard barricading with suitably painted single row of about 1 m wide G.I. Sheets nailed or bolted with wooden poles spaced 2 to 3 metre apart and each pole 1.6 m to 2 m long 8 cm. to 10 cm. dia. The poles will be embedded suitably framed below the ground for giving stable support as per direction of the Engineer-in-charge. All management (including watch and ward, maintenance, repair/replacement of damaged boards & parts) of barricades shall be the full responsibility of the contractor. The barricades shall be removed only after completion of the work, part work or section wise. • Safe access to the properties of neighbouring area will be maintained by the contractor at all time till completion of works in those areas • Proper traffic management will be ensured at the Construction zone near roads. • Blasting activities will be performed only during off hours and daytime so as to				

	avoid inconvenience to the public. The blasting will be undertaken strictly as per schedule. • The blasting schedules will be widely publicised through local news papers, television or by other means. • The Contractor will organise awareness programme for local public on blasting effects, schedule and precautionary measures • Road safety education will be imparted to drivers running construction vehicles. In case of negligent driving, suitable action will be taken. • Traffic rules and regulations will be strictly adhered to. • Adequate signage, barriers and persons with flags during construction to control the traffic will be provided. • Speed restrictions shall be imposed on project vehicles. • The general public/local residents shall not be allowed in high-risk areas, e.g, excavation sites and areas where heavy equipment is in operation and the spill channel. • All lifting tools will be periodically checked & certified. • An Emergency Response system in case of any incidence will be developed and implemented.				
B.10.5. Accessibility	• Provide safe and convenient passage for vehicles, pedestrians and livestock to and	Construction sites and Along	During construction	Contractor	Engineer-In-Charge / IA, Hirakud Dam

	from roadsides and property access as connecting the project	settlements			Authority
B.11. Camp Site Management					
B.11.1. Labour Camp facility	• The Contractor will comply with the requirements of World Bank Guidelines on labour standards and worker's accommodation[2] referred below • The Contractor will abide by the norms stipulated in The Building and Other Construction Workers (Regulations of Employment and Conditions of Service) Act, 1996 for construction and maintenance of labour camp. • A general Guidelines on Construction and Campsite Management (**Annexure-6.8**) required to be followed. The location, layout and basic facility provision of each labour camp will be submitted to the Engineer prior to their construction. • The construction will commence only upon the written approval of the Engineer. • Maintain necessary living accommodation and ancillary facilities in functional and hygienic manner and as approved by the Engineer. • Labour force are adapt to destroying the trees & bushes in search of their fuel wood. To prevent such unscrupulous activities Free Fuel will be supplied by the Contractor. • Proper sanitation will be ensured in the	Suitable location on Govt. land nearest to the construction site	Construction period	Contractor	Engineer-In-Charge / IA, Hirakud Dam Authority

[2] *Reference:*
http://www.ifc.org/wps/wcm/connect/9839db00488557d1bdfcff6a6515bb18/workers_accomodation.pdf?MOD=AJPERES&CACHEID=9839db00488557d1bdfcff6a6515bb18

	labour camp by the contractor. • Free periodical Health check up will be ensured by the contractor. • Preventive measures will be undertaken against spread of malaria and other occupational diseases, free of cost				
B.11.2. Potable Water	• Supply of sufficient quantity of potable water (as per IS) in every workplace/labour camp at suitable and easily accessible places and regular maintenance of such facilities. • If any water storage tank is provided, the bottom of the tank will be kept at least 1mt. above from the surrounding ground level. • If water is drawn from any existing well, which is within 30mt. proximity of any toilet, drain or other source of pollution, the well will be disinfected before water is used for drinking. • A reliable pump will be fitted to each covered well. The trap door will be kept locked and opened only for cleaning or inspection, which will be done at least once in a month.	Camp site and work zones	Construction Stage	Contractor	Engineer-In-Charge / IA, Hirakud Dam Authority
B.11.3. Sanitation and Sewage system	• The sewage system for the camp will be designed, built and operated in such a fashion that it should not pollute the ground water or nearby surface water. • Separate toilets/bathrooms, will be arranged for men and women. The number of toilet and bathroom units shall be in accordance with the norms (minimum 1 toilet/ bathroom for 20	Camp Site	Construction Stage	Contractor	Engineer-In-Charge / IA, Hirakud Dam Authority

	labours) • Adequate water, electric supply and permanent, pucca, safe access is to be provided in all toilets and urinals • All toilets and drainage system in workplaces will be provided with septic tank and soak pit dry-earth system (receptacles) which are to be cleaned and kept in a strict sanitary condition.				
B.11.4. Waste disposal	• Provide segregated garbage bins in the camps and ensure that these are regularly emptied and disposed off in a hygienic manner as per the Comprehensive Solid Waste Management Plan approved by the Environmental Expert of Engineer-In-Charge.	Camp site	Construction Stage	Contractor	Engineer-In-Charge / IA, Hirakud Dam Authority
B.11.5 HIV/AIDS Awareness Programmes	• The Contractor will conduct quarterly HIV/AIDS awareness Programme and testing on site for not less than 90% of all workers including migrant and local labours employed by the main contractor or sub-contractors as well as willing persons from local community. • The Contractor will engage approved specialised agency (NGO/Clubs/ Government Centre) with approval from Engineer-In-Charge for conducting such programme. • The Awareness programmes will generally include: (i) Awareness talk on HIV/AIDS by specialized person. (ii) Distribution of Condoms (iii) Provide and maintain condom	Camp site/ Work Site	Construction Stage	Contractor	Engineer-In-Charge / IA, Hirakud Dam Authority

	dispenser at base camp and labour camp, (iv) Provide and maintain HIV/AIDS awareness posters, etc, (v) Diagnostic tests on HIV/AIDS & STD alongwith health check-ups • The Contractor will submit their Schedule of conducting Awareness Programme to the Engineer for approval • The Contractor will commence the Awareness camp as soon as a construction workers camp is established and populated or, • where no such camp is established, within two weeks of the commencement of a significant portion of the works • The Contractor will arrange for, provide a suitable venue, and instruct all construction workers to attend the HIV/AIDS Awareness Programme and notify the Employer's Representative/ Engineer of the date, time and venue whenever a session with construction workers is conducted. • Reporting: The contractor shall prepare and submit his report on such awareness program giving date and venue of awareness training, details of the training Agency, list of participated construction workers as well as local community, photographic records and maintenance list of awarenss posters and condom dispenser.				
B.12. Site Restoration and Rehabilitation					

B.12. 1. Disruption of Services and damage to the public and private properties	• The Contractor will arrange their own source to cater for their water requirement for construction and other activities and will not interfere with the local water supply system • All irrigation canals, water supply lines and stand pipes, drainage and streets will be maintained during construction or if necessary, temporary services shall be arranged of the owner/ user's permission for temporary cessation will be gained. • In the event of damage to the public utilities, and structures during construction activities the contractor will immediately restore them to the satisfaction of the owner at their own risk and cost. • All the Services will be progressively reinstalled as soon as excavation is completed.	Construction zones, and associated sites of works including Camp, borrow area, quarry sites, haul roads etc.	During construction	Contractor	Engineer-In-Charge / IA, Hirakud Dam Authority
B.12. 2. Clean up operations, Restoration and Rehabilitation	• Site restoration plans to be prepared by the Contractor and approved by the Engineer. • The cleanup and restoration operations are to be implemented prior to demobilization. • Clear all the debris material at site, temporary structures; dispose all garbage, night soils waste as per Comprehensive Waste Management Engineer-In-Charge. • All disposal pits or trenches will be filled in and effectively sealed off. Residual topsoil, if any, will be distributed on adjoining/ proximate barren land or areas identified by the Engineer-In-Charge in	Construction zones, Camp, Plant Site and other area used for temporary services and other adjoining areas.	After Completion of Construction and before demobilization of Construction Team	Contractor	Engineer-In-Charge / IA, Hirakud Dam Authority

	a layer of thickness of 75 mm-l50 mm.				
B.13 Other Issues					
B.13.1 Impact on Historical Archaeological or Heritage Site	• In case any valuable or invaluable articles such as fabrics, coins, artefacts, structures, or other archaeological relics are discovered, the Contractor will stop excavation activities and immediately report such findings to the Engineer and the Dam Authority who will subsequently report to the Archaeology Department, Odisha. And wait for their direction for further action.	All excavation area	During construction	Contractor	Engineer-In-Charge / IA, Hirakud Dam Authority
B.3.2 Grievance Redressal	• A grievance redressal mechanism for receiving the public complain related to environmental safeguards issues and for handling such issues in effective manner. • In case any public complains are received the same will be recorded in Grievance Redressal Register in IA office. • The Engineer-In-Charge will examine the complain and accordingly issue instruction to the Contractor for resolving the issue and then report to the IA for further action. • After resolution of the complain the IA will close the register and record it appropriately.	-	During Construction Phase	Contractor/ Engineer-In-Charge	Engineer-In-Charge / IA, Hirakud Dam Authority
C. OPERATION STAGE					
C.1. Monitoring of Performance indicators during Operation					
C.1.1. Tree survival	• The PMU will monitor the operational performance of the various mitigation measures carried out as a part of the project. • The indicators selected for monitoring include the survival rate of trees; utility of	At locations where activities were done	Operation period	Contractor till defect liability period/ PIU-	Engineer-In-Charge / IA, Hirakud Dam Authority

	enhancement provision for relocated utilities, hand pumps and other relocated structures if any; status of rehabilitation of borrow areas; and noise barriers, which are proposed at different locations.				
C.1.2. Maintenance of Drainage	• PMU will ensure that all drains (side drains, cross drains etc.) are periodically cleared especially before monsoon season to facilitate the quick passage of rainwater and avoid flooding.	All drains	Operation period	Contractor till defect liability period	Engineer-In-Charge till defect liability period then IA, Hirakud Dam Authority
C.1.3. Pollution Monitoring	• The periodic monitoring of the ambient air quality, noise level, water (both ground and surface water) quality, soil pollution/ contamination in the selected locations as suggested in environmental monitoring plan will be the responsibility of Contractor. • PMU will appoint MoEFCC/SPCB approved pollution monitoring agency/Laboratory for this purpose.	As per Environmental Monitoring Plan	Operation stage	Contractor/ Engineer In Charge through approved laboratory till defect liability period	Engineer-In-Charge / IA, Hirakud Dam Authority
C.2. Tourist Facilities					
C.2. 1. Tourism Development	• Tourism development will be income oriented programme for the Displaced Families as well as others residing in the adjoining locality. • The project authority will consult the collector of the district and state Tourism Development Department to promote Tourism in the new project area.	New Project Site	Operation period	Tourism Development Department of GoO and IA, Hirakud Dam Authority	District Collector and IA, Hirakud Dam Authority
C.2.2. Landscaping & Aesthetics	• The project authorities will also ensure maintaining aesthetics of Structure, Area Lighting and Landscape development		Operation period	• Contractor	IA, Hirakud Dam Authority
C.3. Safety during Project Operations					
C.3.1. Accident Hazard and	• Provision of elaborate system of sign	Along the project	Operation Stage	Contractor,	IA, Hirakud Dam

Safety	boards and road markings along the whole stretch • Provision of suitable lighting arrangement at required locations • Development of Emergency Response and Contingency Plan for accidents	site		Engineer-In-Charge/PIU-	Authority
C.4. Reservoir operation management					
C.4.1. Flood Management during PMF events	• Safety of Dam / Reservoir operation and effective flood release during the PMF events being the prime objective of the project, the project authorities (SPMU) will consult the central water commission (CWC of CPMU), Dam safety Organisation and Prepare a Competent Action Plan for Safe Flood release.		Operational Phase of the Project	• CE&BM UMB • CE/Director Dam safety Organisation	State level monitoring unit
C.4.2. Safety against flooding of Down Stream areas **-Disaster management**	• The DoWR may set up one coordination committee comprising of CEBM UMB; OSDMA and District collectors etc to Chart out Disaster management and emergency action plan to negotiate the flood management during severe flood event.	Sambalpur Township and many other districts in the lower Mahanadi region	Operation Stage	District collector and IA, Hirakud Dam Authority	-do-
C.4.3. Effectivity of Communication Network.	• The DoWR would liaison with Chhatisgarh state to ensure timely communication of information in regard of flood releases. • DoWR to establish new gauge station in the upper catchment, if necessary. • Improve Communication network by using satellite information links and electronic system application. • Conduct training & Work Shops on flood management at periodic intervals.		Operation Stage	IA, Hirakud Dam Authority and CWC	-do-

6.3 ENVIRONMENTAL ENHANCEMENT:

6.3.1 Fish Ponds

The Hirakud reservoir is being used by fisherman community for fishing. The entire reservoir is divided into different sectors and the sectors are allotted to different fisherman community on lease basis by the Dam Authority. During public consultation, the representatives of Fishermen Cooperative Society requested for developing ponds for fingerlings as presently such facilities are not available for them around the reservoir. They want only pond the the maintenance of ponds and developments of fingerlings shall be responsibility of the Fishermen Cooperative Society. There are 10 such society is working for fishing in the reservoir. These ponds require half acre of land along the reservoir side in the project area. This facility can be considered for the economic development of fisherman families of displaced group. The Dam Authority has planned for development of at least one pond for each Society. In total 10 ponds will be constructed for which Rs. 50 Lakhs will be required to keep in the budget.

6.3.2 Revival of Degraded forest:

Around the project area Lamdungri RF is located on hillock. This forest is a degraded forest. The forest has been degraded due to biotic interference and hills are devoid of productive soil. It has been proposed to support for rejuvenation of part of this degraded forests section on either side of spill way alignment by providing excess earth material and top soil generated due to excavation, cutting of hills, cutting area of existing earthen dyke and borrow areas. As per estimation 150000 Cum earth material including soil will require to be disposed off. These earth materials are suitable for converting the degraded land into plantation area. Being RF area the outside agency will not be allowed to do any work inside forest area.

As requested by the DFO, these excess of earth material and top soil after utilization by project can be dumped at nearby places of degraded forest in consultation with forest department. The forest dept will then utilise this material as per their plantation programme within this reserve forest.

Chief Engineer Hirakud agreed in principle to support this enhancement measure. He agreed that extra mud available from spillway channel construction can be given to Forests Department for rejuvenation of degraded forests hills.

6.3.3 Toilets for Tourist spots:

In operation phase of the project many tourists will be attracted due to development of beautification around the project site. There is possibility of increase in unsanitary condition around the tourist spot. The tourist spots should be provided with Bio-toilets to overcome these issues. The advantage of such toilets is that the sludge obtained from these toilets is free from pungent odour and the sludge can be directly used as manure. It will not contaminate the surrounding area.

6.3.4 Environmental Monitoring Programme:

Environmental monitoring provides an essential tool to make necessary recommendations and adopt suitable control strategies so that menace of rising environmental degradation could be minimized and a relief be extended to the people including labours in case of any damage caused under occupational health hazards. The monitoring is necessary for the following reasons:

- To see what impacts have occurred;
- To evaluate the performance of mitigation measures proposed in the EMP;
- To ensure that the conditions of approval are adhered to;
- To suggest improvements in management plan, if required;

- To see that benefits expected from the EA are achieved as the project proceeds; and
- To satisfy the legal and community obligations.

6.4 ENVIRONMENTAL MONITORING PLAN:

6.4.1 Performance Indicators (PIS)

The physical, biological and social components, which are significant in affecting the environment at critical locations, have been suggested as Performance Indicators. The following specific environmental parameters can be qualitatively and quantitatively measured and compared over a period of time and therefore selected as Performance Indicators for monitoring due to their regulatory importance and the availability of standardized procedures and relevant expertise.

- Air quality
- Water quality
- Noise levels around sensitive locations
- Soil Quality
- Re-plantation success /survival rate
- Restoration of borrow pits
- Construction camp management
- Sedimentation in the ponds and Reservoir
- Safety at Work
- Waste Management & Debris Removal
- Gender participation in works
- Site Restoration
- Awareness programme on HIV/AIDS

6.4.2 Monitoring of Performance Indicators

Ambient Air Quality (AAQ) Monitoring

Ambient air quality parameters which are recommended for monitoring of widening and strengthening of state highway are PM_{10} (Particulate Matter having less than 10 micron size) or $PM_{2.5}$ (Particulate Matter having less than 2.5 micron size), Sulphur Dioxide (SO_2), Oxides of Nitrogen (NOx) and Carbon Monoxide (CO) and Hydrocarbon (HC). These parameters are to be monitored at selected locations such as plant and machinery sites, crusher sites, excavation works, etc. starting from the commencement of construction activity. Data should be generated once in a season at the selected monitoring locations in accordance with National Ambient Air Quality (NAAQ) Standards 2009. **(ANNEXURE-6.9)**.

Ambient Noise Monitoring

The measurement for monitoring the noise levels to be carried out at sensitive locations and at construction sites along the project road in accordance to the Ambient Noise Standards formulated by Central Pollution Control Board (CPCB) (**ANNEXURE - ENV10)**. Sound pressure level would be monitored on twenty-four hourly basis. Noise shall be recorded at "A" weighted frequency using digitized noise monitoring instrument.

Water Quality

Water quality of local water resources that is used by local community shall be monitored. The

physical and chemical parameters recommended for analysis of water quality relevant to road project are pH, total solids, total suspended solids, total dissolved solids, COD, BOD, DO, Oil and Grease, Chloride, Iron, etc. The monitoring of the water quality will be carried out at all locations identified along the project road during construction and operation phase. Monitoring parameters will be as per IS-10500 (**ANNEXURE- 6.11**) for ground water quality and for surface water quality as per CPCB Guidelines for used based surface water classification (**ANNEXURE- 6.12)**

Soil Quality

The soil quality of the surround fields close to the construction site and plant site will be monitored to understand the impact of soil quality. The physic-chemical parameters recommended for analysis are physical Parameter: Texture, Grain Size, Gravel, Sand, Silt and Clay and Chemical Parameter: pH, Conductivity, Calcium, Magnesium, Sodium, Nitrogen and Absorption Ratio.

Tree Survival Rate

To ensure the proper maintenance and monitoring of the compensatory plantation, a regular maintenance and monitoring of the survival rate of the planted trees is being proposed up to a period of 5 years after plantation operation of the project. Visual observation of the tree survival will be recorded at every quarter. This will be monitored by the Engineer-In-Charge till their demobilization and then by implementing agency with the help of Forest Department.

Restoration of Borrow Pits

Visual inspection of completed borrow area will be carried out to check the status of restoration of borrow area and the effectiveness of the restoration works will be verified by the Engineer-In-Charge in accordance with the guidelines provided in EMP and MoEF&CC. All the borrow area must be restored after operation.

Construction camp management:

The visual inspection of site will be done every month to check the labour standards and facilities provided in the camp.

Safety at Works

Monthly Auditing of safety at works including supply and use of PPEs, Safe working conditions, first Aid facilities, incidence report, safety trainings, etc will be carried out by the Engineer-In-Charge to check the effectiveness of safety measures at site.

Waste Management and Debris Removal:

Visual observation on management of waste and debris at different site will be made on regular basis by the Engineer-In-Charge.

Gender Participation in works:

A genuine integration of gender and their participation into projects activities needs to be done at each stage of the project cycle, i.e. from participatory planning, to implementation, monitoring and evaluation.

The project authority should explore the approach taken at getting involvement of women in different activities. Furthermore, the project authority should observe that women were under represented or over represented in various activities and what constrains or facilitates their participation by the agency?

Verification of Labour records followed by random checking at site will be conducted to analyse the gender participation mainly with respect to female workers.

Site Restoration:

Visual observation will be made to verify the site restoration activities after completion of works by Engineer-In-Charge before recommending completion of works.

HIV/AIDS Awareness Programme

The records of conducted programme as per agreed schedule by the Contractor and list of participants will be checked. The representative of Engineer-In-Charge must witness each programme and maintain the records of it.

6.4.3 Environmental Monitoring Action Plan (EMoAP):

An Environmental Monitoring Plan (EMoAP) has been framed for both implementation and post-implementation phases covering monitoring of major pollution parameters, frequency, methods, indicators and institutional arrangements pertinent to the above EMoAP is furnished in Table No. C7-5 below.

Table 6-5: Summary table for Environmental Monitoring Action Plan (EMoAP)

Sl. No.	Performance Indicators	Monitoring Parameters	Standards	Location (s)	Frequency	Monitoring method	Action Plan in case parameters exceeds the standard limit or adverse impact observed	Responsible organisation	
								Implementation	Supervision
A. During Construction stage									
1.	**Air quality**	PM_{10}, $PM_{2.5}$, SO_2, NO_X and CO.	National Ambient Air Quality Standard (CPCB, 18th Nov, 2009)	• Construction site, • Approach roads • Sensitive receptors. • Plant and machinery sites • Crusher sites • excavation works	Continuous Ambient Air Quality Monitoring through establishment of Computerised Continuous Ambient Air Quality Monitoring System with 4 Nos. of monitoring locations , throughout the construction period of 3 years	Analysis Reports Visual Observation	Check and modify dust control device like bag filter/cyclones of hot mix plant, covers and water sprinklers	Contractor through establishment on Continuous Ambient Air Quality Monitoring System/NABL approved Environmental Laboratory	Engineer-In-Charge / Dam Authority/ IA
2.	**Surface Water quality**	pH, Temperature, DO, BOD, COD, Oil & Grease, Total Suspended Solid, turbidity, Total Hardness, Chlorine, Iron, etc. Total Coliform	Tolerance Limit as per IS 2296 : Class C	• Ponds near construction site. • River Mahanadi at D/s of dam	Grab sampling once in 3 months excluding the monsoon construction period	Analysis Reports Visual Observation	Check and modify Oil interceptors, silt fencing devices	Contractor through NABL approved Environmental Laboratory	Engineer-In-Charge / Dam Authority/ IA
3.	**Ground Water quality**	pH, Temperature, TSS, TDS, Total hardness, Chlorine, Iron, Sulphate, Nitrate, heavy metals, etc.	Ground Water Quality Standard as per IS: 10500, 1991	• Near habitations • D/s of dam	Grab sampling once in 3 months excluding the monsoon construction period	Analysis Reports Visual Observation	Check and modify Oil interceptors, silt fencing devices	Contractor through NABL approved Environmental Laboratory	Engineer-In-Charge / Dam Authority/ IA
4.	**Noise level**.	Leq dB (A) (Day and Night) Average and Peak values	Ambient Noise Standard (CPCB,	- At construction site. - At sensitive receptors	24 hourly recording of Leq once in 3 months till construction period	Analysis Reports Visual	Check and modify equipment and devices used to protect noise level	Contractor through NABL approved Environmental Laboratory	Engineer-In-Charge / Dam Authority/ IA

Sl. No.	Performance Indicators	Monitoring Parameters	Standards	Location (s)	Frequency	Monitoring method	Action Plan in case parameters exceeds the standard limit or adverse impact observed	Responsible organisation	
								Implementation	Supervision
			2000)	- At nearby habitations		Observation			
5.	**Soil quality**	Physical Parameter: Texture, Grain Size, Gravel, Sand, Silt, Clay; Chemical Parameter: pH, Conductivity, Calcium, Magnesium, Sodium, Nitrogen, Absorption Ratio, heavy metals		- In and around construction site. - Near the dumping yards. - Location near habitations.	Twice a year, once in pre-monsoon and other during post-monsoon till construction period	Analysis Reports Visual Observation	Check and modify the arrangement of containment of oil, drainage to protect soil quality	Contractor through NABL approved Environmental Laboratory	Engineer-In-Charge / Dam Authority/ IA
6.	**Safety at Works**	Use of PPE, Health conditions, First aid and ambulance, Training Awareness programme on HIV/AIDS	100% compliance with worker Safety	- Work site - Labour colony	Daily observations for PPEs and Safe access nad working platform, and first Aid Kits. during construction period. Quarterly for health, safety training, HIV/AIDS awareness programme training	Purchase records Daily safety records Issue records Visual observation	Immediate supply of adequate numbers of PPEs, enforcement of use of PPEs by workers during works, repair of damaged access & working platforms and replacement of first aid kits	Contractor	Engineer-In-Charge & Dam Authority/IA
7	**Survival rate of plants**	Growth rate with respect to time.	90% Survival Rate	- Alongside spill channel and degraded areas	Quarterly till 5 years Quarter.	Analysis Reports Visual Observation	Replacement of dead tree with healthy saplings of same species, repairing of tree guards, fencing etc.	Contractor & Engineer-In-Charge till Defect liability Period then IA	Engineer-In-Charge / Dam Authority/ IA
8.	**Public & Traffic**	No. and type of	-	- Approach roads,	Monthly during	Record	Vehicle having valid	Contractor's safety officer	Engineer-In-

Sl. No.	Performance Indicators	Monitoring Parameters	Standards	Location (s)	Frequency	Monitoring method	Action Plan in case parameters exceeds the standard limit or adverse impact observed	Responsible organisation	
								Implementation	Supervision
	safety arrangement	vehicles, PUC Certificates Vehicles Fitness certificates - Driving licences, - Safety Signages, Barricading		- Village roads adjacent to project site and near habitation area	construction period.	checking Safety/ caution signboards, barricading around work zones, Public complaints	permits and PUC to ply on road. Replacement of all damaged signboards and barricading		Charge & Dam Authority
9.	**Debris clearance**	Volume and type of solid wastes	Periodical removal of debris and other waste	- Work site	Weekly during construction period.	Vehicle log book Direct observation	Removal of Debris to disposal sites	Contractor's safety officer and Engineer-In-Charge	Engineer-In-Charge / Dam Authority/ IA
10.	**Labour & Gender participation**	Involvement of women worker	--	- Work site	Monthly	Muster roll & Wages Register Labour Statement	Wages as per Minimum Wages Act	Contractor's safety officer and Engineer-In-Charge	Dam Authority
11.	**Labour Standards**	Basic Facility at labour camp and general hygienic conditions	As per BOCW Act, 1996	Labour Camp	Monthly	Visual observation	Restoration of labour facilities at labour camp	Contractor	Engineer-In-Charge & Dam Authority
12.	**Site Restoration**	Restoration of all temporary sites to original or better conditions and as per approved plan		Borrow area, quarry site, Plant site, camp site and other associated sites	Once after completion of activities at site	Visual observation, Record checking	Restoration to be completed for all the sites before completion certificate	Contractor & Engineer-In-Charge	Dam Authority
13.	**HIV/AIDS Awareness Programme**	Awareness programme	As per Schedule	Project site	Once in 3 months	Visual observation Record		Contractor	Engineer-In-Charge / Dam Authority

Sl. No.	Performance Indicators	Monitoring Parameters	Standards	Location (s)	Frequency	Monitoring method	Action Plan in case parameters exceeds the standard limit or adverse impact observed	Responsible organisation	
								Implementation	Supervision
						checking			
B.	**Post Construction/ Operation Stage**								
1.	**Surface Water quality**	pH, Temperature, DO, BOD, COD, Oil & Grease, Total Suspended Solid, turbidity, Total Hardness, Chlorine, Iron, Total Coliform	Tolerance Limit as per IS 2296 : Class C	Ponds/ water bodies in and around construction site.	Twice a year, once in pre-monsoon and other in post-monsoon.	Analysis Reports Visual Observation	Clearing of all drains and vents. Regulating the water flow into the ponds/ reservoir	Contractor through NABL approved Environmental Laboratory till defect liability period after that IA till 1 years	Engineer-In-Charge/ Dam Authority
2.	**Ground Water quality**	pH, Temperature, TSS, TDS, Total hardness, Chlorine, Iron, Sulphate, Nitrate, heavy metals, etc.	Ground Water Quality Standard as per IS: 10500, 1991	Wells/ tubewells in and around construction site and nearby habitations.	Twice a year, once in pre-monsoon and other in post-monsoon.	Analysis Reports Visual Observation	Removal of water logging conditions.	Contractor through NABL approved Environmental Laboratory till defect liability period after that IA till 1 years	Engineer-In-Charge/ Dam Authority
3.	**Water logging and drainage**	Visual inspection as well as measurement of groundwater level.	-	- construction site - near Ponds - Waste disposal areas.	Once pre-monsoon and once post-monsoon	Visual observations Photographic record of drain cleaning Water level record	Removal of water logging conditions.	Contractor and Engineer-In-Charge till defect liability period after that IA till 1 years	Engineer-In-Charge/ Dam Authority
4.	**Survival of plantations**	Visual inspection	90%	- Greenbelt plantation area - Avenue plantation	At least one year of gestation period	Survival Record	Replacement of dead plants with healthy plants, investigation for diseases and accordingly application of pesticides or medicines will be done	Contractor and Engineer-In-Charge till defect liability period after that IA till 1 years	Engineer-In-Charge/ Dam Authority

6.4.4 Environmental Monitoring Budget:

In the pre-implementation/ planning stage, a monitoring has to be drawn up considering various environmental and social components. The estimate should include expenditure on account of manpower engaged, sampling, laboratory testing and supervision of environmental and social parameters. A sample estimate is indicated below.

Table 6-6: Environmental Monitoring Budget

Sl. No.	Parameter	Items to be monitored	No. of locations	Frequency per annum	Rate per location/ Sample (Rs.)	Amount (Rs.) per annum
A.	**Construction Phase**					
i.	Air quality	Parameters as per Monitoring Plan	4	9 (24 hourly sample once in a month except for rainy season)	8000	2,88,000
ii.	Surface water quality	Parameters as per Table No.C4-19	2	3 (Once in 3 months except rainy season)	7500	45000
iii.	Ground water quality and level	Water quality Parameters as per Table No.C4-18	2	3 (Once in 3 months except rainy season)	7500	45,000
iv.	Noise level	Noise level	4	12 (24 hours recording Once in a month)	2500	1,20,000
v.	Soil quality	Parameters as per Table No.C4-7	2	2	7500	30,000
2.	**Other** Performance Indicators	• Survival rate of plants • Traffic safety arrangement • Debris clearance • Safety arrangement for workers • Gender participation			240000 lump sum	2,40,000
					Total	**7,68,000**
3.	**Post-Implementation Phase**					
(i)	Surface water quality	Parameters as per Table No.C4-19	2	2	7500	30,000
(ii)	Soil quality	Parameters as per Table No.C4-7	2	2	6000	30,000
(ii)	Ground water quality and level	Water quality Parameters as per Table No.C4-18	2	2	6000	30,000
					Total	**90,000**

Note: In post implementation phase the air quality monitoring has not been considered because of its insignificant effect. The water quality and soil quality monitoring may be continued for at least two to three years to ascertain change of quality. In case pollution is noticed at any time during this period then necessary remedial measures may be taken up.

6.5 REPORTING SYSTEM OF ENVIRONMENTAL MONITORING:

Monitoring and evaluation are important activities in implementation of all projects. Monitoring involves periodic checking to ascertain whether activities are going according to the plans. It provides the necessary feedback for project management to keep the programme on schedule.

The Contractor will prepare report of environmental safeguards and safety data along with monthly progress report. The PMC Environmental Expert will prepare quarterly and annual environmental monitoring reports for onwards submission to SPMU and CWC for onwards submission to the World Bank results of various environmental issues during the implementation/ construction phase and post-implementation/operation phases shall be recorded in standard format for convenience of review.

The reporting system will operate linearly from Environment & Safety Officer to the Contractor, who will report to the PMC. The PMC then submit the report to the Implementing Agency (Dam Authority), Main Dam Division Burla. The IA will then forward the reports to the SPMU and CWC.

6.6 ENVIRONMENTAL TRAINING AND CAPACITY BUILDING:

Effective implementation of the project with social and environmental compliance would largely depend on the Institutional/Organisational capacity building as well as Training of the engineers and associated resource personnel for skill development. In this score, cultural sensitivity, Group dynamics, conflict resolution skill and ability to work with the user population are as important as the engineering proficiency already held by the state officials.

In this respect, the State Water Resources Department (SWRD) needs to associate other line departments, institutions and some social, environmental specialists.

Awareness development and training of personnel involved in the project implementation thus would ensure capacity building, an essential component of the management plan.

6.6.1 Awareness Programmes:

The engineering personnel of the water Resources Department, associated staff of the Line Departments, stakeholders of the project as well as the elected representatives needs to be sensitized regarding the importance of social and environmental issues.

The State Government in the Department of Water Resources should arrange number of workshops to propagate urgency and awareness of the project requirements. It should be linked with site visit and deliberations by Social and environmental specialists from recognized institutions/ credible organisations. Such programme would eradicate doubts of the people ease out stringent attitude of project affected people and ensure better co-operations.

Systematic training initiative is the key input for capacity building. Engineering personal and staff to be deployed for the project implementation need to undergo training for upgrading their knowledge and technical skills for performance innovation. Simultaneously effective training programmes should be opted for organisation motivation.

Approach:

- It thus entails a training module that comprises;
  - Training of the DoWR field staff
  - Training of the existing administrative personnel
  - Training of the Contractor and PMC staff
- DoWR to organise Training Programmes in the existing training centres of the State i.e. WALMI or Gopabandhu Institute for Administration and reputed Naba Krishna Chowdhury Centre for Social Development or Engineering Staff College, Hyderabad
- The trained officials would arrange number of training programme for junior level field officers and staff at the Divisional level.

- Expenditure for conducting Awareness and Training programme would be incorporated in the appropriate subhead of Project cost estimate.

6.6.2 Strategy for Capacity Building

- The training and capacity building strategy should form as integral part of the management procedure.
- Such activities should commence from the planning stage and evenly spread during the implementation phase.
- A schedule for capacity building activities should be drawn to facilitate effective implementation.

However, a sample schedule is proposed below for different official involve in project implementation

Table 6-7: Schedule for Training & Capacity Building Strategy:

Module	Title	Objectives	Time of Training	Duration (Day)	Level	Participants	Budgetory Provision (Rs.)
1	Concept of Environmental and Social Management Framework	• Brief up Bank's safeguard policies and requirements • Brief up latest on environmental legislations • Implementation, Supervision and Monitoring Mechanism • Provision made in Contract Documents	Before awarding contracts	2	State	SPMU and IA	250000
2	Orientation Workshop on ESMF Implementation	• ESMF requirements • Implementation, Supervision and Monitoring Mechanism • Roles and Responsibilities of Contractors, PMC and Engineers of Dam Authority • Identificati,on of Environmental and social issues • Addressing environmental and social impacts • Preparing mitigation plans	Pre-construction stage (when contractors are substantially mobilized)	2	State	SPMU & Dam Authority (Executive Engg. /AEE/AE, PMC, Contractors and Third Party Monitoring Agency	250000
3	Focused Training on Specific Issue/s	• Analyzing problems, referring stipulations in Contract and GEMP and agreed to feasible solution within specified timeframe • Procedure for implementation of EMP provisions during	During construction, as and when needed.	1	Hirakud Dam Basin Department	Dam Authority, PMC, Contractors and Third Party Monitoring Agency	150000

Module	Title	Objectives	Time of Training	Duration (Day)	Level	Participants	Budgetory Provision (Rs.)
		construction stage • Procedures for record keeping and reporting on status of EMP compliance • Issues relating to wage parity, child labor, etc.					
4	EMP Implementation during construction stage	To understand the requirement of EMP and its implementation during construction stage of the project road. Good and bad practice of EMP during construction stage of the project	During Construction stage	1	Project	Contractor and their staffs.	100000

6.7 ENVIRONMENT GRIEVANCE REDRESSAL MECHANISM:

Grievance Redress Mechanism is part and parcel of the machinery of any administration. No administration can claim to be accountable, responsive and user-friendly unless it has established an efficient and effective grievance redress mechanism. In fact, the grievance redress mechanism of an organization is the gauge to measure its efficiency and effectiveness as it provides important feedback on the working of the administration.

Effective environmental grievance redressal mechanism gives an opportunity to the organization to implement a set of specific measures to ensure good governance accountability and transparency in managing and mitigation of environmental issue. This consists of defining the process for recording/receiving complaints and their redressal in respect of environmental matters.

A Grievances Cell shall be constituted to attend to the complaints of public regarding environmental problems. On receipt of the petition, a Registration Number will be allotted and entered in the Register. This number will be immediately communicated to the Petitioner and the Petitioner will be assured that the grievance will be redressed.

The proposed two level structures are described below:-

I. Two tier method at Field Level

Sl.	Activity	Duration	Action by
1	Receipt of complaint in assignee unique identification number (Format at Annexure-A).	D (date of receipt of complaint)	Env. & Safety Officer
2	Scrutiny of complaint for action in terms of available Law/Act	D+3	Env. & Safety Officer
3	Verification of authenticity of complaint by site visits and If within his purview, initiate action for remedial measures and intimate the compliant	D+7	Env. & Safety Officer
4	In case the redressal of complaint is not within the purview of Env. & Safety Officer, the complaint to be forwarded to next tier i.e. Contractor of the Project.	D+8	Contractor
5	If within purview, initiate action in consultation with supporting staff to redress the complaint.	D+14	Contractor
6	Furnish information to complainant about the action being taken as a consequence of his/her complaint within 15 days of the complaint received. If the complainant is not satisfied with the action taken by the first tier, he may further report the matter to next tier Govt. level.	D+15	Contractor
7.	If the problem cannot be solved at contractor level, he can send it to the Executive Engineer	D+15	Contractor
8	Executive Engineer will resolve and if he can not resolve it than it shall be escalated to Engineer-in-Charge than to SPMU level.. Resolution shall be communicated to concerned within 30 days.	D+16 to D+30	Executive engineer/ESMC/Engineer-in-charge/SPMU in order of sequence

II. Three Tier method at DoWR Govt. level

It, the complaint is not redressed by contractor then it will be dealt at DoWR, Govt. of Odisha

Sl.	Activity	Duration	Action by
1	Receipt of complaint	D(date of receipt of complaint)+3	Executive Engineer
2	Executive Engineer will scrutinize the complaint and decide the action to be initiated to redress the complaint based on available Law/Act.	D+8	Executive Engineer
3	In case the redressal of complaint is not within the purview of Executive Engineer, the complaint to be forwarded to next tier i.e. Superintending Engineer, HDC, Burla else solve the problem and intimate the complaint.	D+10	Superintending Engineer
4	If the complaint is not fit to be redressed/does not require any action, the Superintending Engineer will dispose the complaint by replying to the complainant within 12 days of the complaint.	D+12	Superintending Engineer
5	Furnish information to complainant about the action being taken as a consequence of his/her complaint within 25 days of the complaint forwarded to him.	D+15	Superintending Engineer
6	In case the redressal of complaint is not within the purview of Superintending Engineer, the complaint to be forwarded to next tier i.e. Chief Engineer & Basin Manager, Upper Mahanadi Basin, Burla.	D+18	Chief Engineer
7.	Furnish information to complainant about the action being taken as a consequence of his/her complaint within 25 days of the complaint forwarded to him from first tier.	D+25	Chief Engineer
8.	Send monthly status report of all complaint from field level and Division level to CE&BM, UMB (Annexure-B)	28th of every month	Chief Engineer

ANNEXURE-A

Format for Grievance Redressal Mechanism Register:

Sl. No.	Name of the Complainant	Unique complaint number	Address & Contact No.	Gist of the Complaint	Forwarded to whom	Whether grievance redressed or not	If yes, Gist of disposal	If rejected, gist of reasons	If not attended reasons

ANNEXURE-B

Monthly status Report:-

Sl. No.	Name of the unit	No. of pending complaints at the end of previous month	No. of complaint received during the month	Action initiated during the month	Completed during the month	No. of complaints pending at end of month	No. of grievance redressed	No. of dismissal	Total	Remarks

6.8 EMP Budgeting

In implementing the project the centre and State Government authorities have taken prudent decision to integrate the project with the ongoing world Bank aided Dam Rehabilitation and Improvement Project [DRIP] for prioritizing safety assurance of Hirakud Dam.

As mentioned earlier; Impacts due to most of the social and environmental factors cannot be reliably quantified because of the uncertainties associated with the prediction of many variables & inherent complexities. As such, prediction of Impacts and mitigation measures were mostly qualitative in approach.

In this chapter attempt has been taken to estimate environmental costs based on the mitigation measures proposed. In the process; expenditure assigned to each activities of environmental and social compliance are rationally worked out.

Table 6-8: Proposed EMP cost

Sl. No.	Component	Item	Unit	Estimated Quantity	Rate (Rupees)	Amount (In Lakh Rupees)
A.	**Pre-Construction Stage**					
A.1	Forest Clearance	Diversion of 9.441 Ha of Lamdungri Reserved Forest land for non forest activities; compensatory afforestation and NPV Cost The final cost will be provided by the forest department after joint verification, preparation of compensatory afforestation scheme and maintenance cost which is required to be deposited by the Dam Authority) Forest Clearance is waited	Hect	9.441	25 Lakh	236.025
A.2	Compensatory Plantation against felling of non forest trees	Compensatory Plantation of 35950 of trees in lieu of cutting of 3595 trees in non forest area within Dam area	No.	35950		88.14
A.3	Relocation of Cultural and Religious structures	Relocation of 13 temples and on crematoria	No.			Covered in RAP
A.4	Utility shifting	Shifting of electric poles, water supply pipelines				Covered on Engineering cost
					Total EMP cost (Rupees) during Pre-Construction Phase	**324.165**

Sl. No.	Component	Item	Unit	Estimated Quantity	Rate (Rupees)	Amount (In Lakh Rupees)
B.	**CONSTRUCTION STAGE**					
B.1	Management at labour camp	Maintaining sanitation in camps & providing Toilets septic tanks and drainage system with safe sewerage disposal arrangement	L.S. No.	16	1,915	**5.00**
B.2	Borrow area rehabilitation	Rehabilitation of completed borrow areas	No.		L.S.	**5.0**
B.3	Restoration of Natural Drains ensuring effective land drainage.	Construction of new drains 2km	Km	2	3.00	6.0
		Cross Structure	L.S.			12.00
		Total				**18.00**
B.4	Management of Dumping sites for Muck / waste disposal	Disposal of excavated material to identified dumping site	Sq M			Covered in Civil Cost
B.5	Relocation of disrupted public road due to project activities.	Construction of 4.5 Km of diverted road	Km			Covered in Civil Cost
B.6	Environmental Monitoring	(a) Continuous Ambient Air Quality monitoring through Continuous Ambient Air Quality Monitoring System as per Monitoring Plan for 3	Month	36	300000	108.00
		(b) Ambient Noise level monitoring as per Monitoring Plan (once in a month at 4 locations for 3 Years)	No.	144	2500	3.60
		(c) Water Quality monitoring of surface water as per Monitoring Plan (2 locations in the interval of 3 months for 3 Years excluding monsoon season)	No.	18	7500	1.35
		(e) Ground Water Quality monitoring (2 locations in the interval of 3 months for 3 Years excluding monsoon season)	No.	18	7,5000	1.35
		(d) Soil Quality monitoring of Agricultural lands as per Monitoring Plan (once in 6 months at 2 locations in for 3 Years)	No.	12	7,500	0.90

Sl. No.	Component	Item	Unit	Estimated Quantity	Rate (Rupees)	Amount (In Lakh Rupees)
B.7	Monitoring of other Performance Indicators	• Safety arrangement for workers • Debris clearance • Survival rate of plants • Traffic safety arrangement for 3 years	L.S.		L.S.	7.5
B.8	HIV/AIDS Awareness	HIV/AIDS Awareness and health check up programmes to be organized by the Contractors for their staff including labours and local population. (Once in every 3 months till 3 years)	No.	12	50000	6.0
B.9	Environmental Training and Capacity Building	EMP Orientation at Sate Level and at construction site	Lump Sum			7.5
B.10	Environmental enhancement	Nursery pond for development of fingerlings	No.	10	5	50.00
Total EMP cost (Rupees) during Construction Phase						**214.20**
C.	**OPERATION STAGE**					
C.1	Environmental Monitoring	(a) Surface Water Quality monitoring along the project road (2 locations in the interval of 6 months for 3 Years)	No.	6	7,500	0.90
		(b) Ground Water Quality monitoring along the project road (2 locations in the interval of 6 months for 3 Years)	No.	6	7,500	0.90
		(d) Soil Quality monitoring around project area at 2 locations in the interval of 6 months for 3 Year)	No.	6	7,500	0.90
C.2	Tree plantation monitoring	Along the project corridor for 2 years	Lump Sum			5.0
Total EMP cost during Operation Phase						**7.70**
Total Cost (A+B+C)						**546.925**
Contingency (10%)						**54.602**
Total EMP Cost (Lakh Rupees)						**600.667**