CHAPTER – 10
ENVIRONMENTAL MANAGEMENT PLAN

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10.1   INTRODUCTION

Environmental Management Plan is a plan that seeks to achieve a required end state and describes how activities that have or could have an adverse impact on the environment, will be mitigated, controlled, and monitored.

Environmental impacts arising due to development activities are the key aspects on EIA study. An equally essential element of this process is to develop measures to eliminate, offset, or reduce adverse impacts to acceptable levels and enhance the beneficial ones during implementation and operation of the projects. The integration of the project planning has been done by clearly defining the environment requirements within an Environment Management Plan (EMP). The Management Action Plan aims at controlling pollution at the source of generation itself to the maximum possible extent with the available and affordable technology followed by treatment measures before they are discharged.

10.2   CATCHMENT AREA TREATMENT (CAT) PLAN

10.2.1 Need for CAT Plan

The study of erosion and sediment yield from catchment is of utmost importance as the deposition of sediment in reservoir reduces its capacity, thus affecting the water available for the designated use. The eroded sediment from catchment when deposited on streambeds and banks causes braiding of river reach. The removal of top fertile soil from catchment also adversely affects the agricultural production. Another important factor that adds to the sediment load and which contributes to soil degradation is grazing pressure.

It is a well-established fact that reservoirs formed by dams on rivers are subjected to sedimentation. The process of sedimentation embodies the sequential processes of erosion, entrainment, transportation, deposition and compaction of sediment. The study of erosion and sediment yield from catchments is of utmost importance as the deposition of sediment in reservoir reduces its capacity, and thus affect the water availability for the designated use. The eroded sediment from catchment when deposited on streambeds and banks causes braiding of river reach. The removal of top fertile soil from catchment adversely affects the agricultural production. Thus, a well-designed Catchment Area Treatment (CAT) Plan is essential to ameliorate the above- mentioned adverse cause and process of soil erosion. The catchment area treatment involves the understanding of the erosion characteristics of the terrain and suggesting remedial measures to reduce the erosion rate. For this reason, the catchment of the directly draining rivers, streams, tributaries, etc. are treated and the cost is included in the project cost.

Soil erosion may be defined as the detachment and transportation of soil. Water is the major agent responsible for this erosion. In many locations, winds, glaciers, etc. also cause soil erosion. In a hilly catchment area as in the present case, erosion due to water is a common phenomenon and the same has been studied as a part of the Catchment Area Treatment (CAT) Plan.

10.2.2 Objectives of Catchment Area Treatment Plan

Integrated watershed management plan minimizes the sedimentation of reservoir. The main aim of the Catchment Area Treatment Plan is to rejuvenate various potential and degraded ecosystems in the catchment area for longevity of the reservoir storage capacity.

The Objectives of CAT Plan has been prepared with the following objectives:

➢ Facilitate the hydrological functioning of the catchment and to augment the quality of water of the river and its tributaries.
➢ Conservate of soil cover and to arrest the soil erosion, floods and siltation of the river along with its tributaries and consequent reduction of siltation in the reservoir of the project.
➢ Demarcate of the priority of watersheds for treatment based on soil erosion intensity in the catchment area.
➢ Rehabilitate of degraded forest areas through afforestation and facilitating natural regeneration of plants.
➢ Mitigate of landslide, landslip and rock falls.
➢ Conserve soil through biological and engineering measures to reduce sediment load in river and tributaries, incidentally improving the quality of water.
➢ Conserve Ecosystem resulting from increased vegetal cover and water retaining properties of soil.
➢ Meet the fuel and fodder requirements of local people.

10.2.3   Approach for the Study

The CAT plan highlights the management techniques to control erosion in the catchment area. Life span of a reservoir in case of a seasonal storage dams is greatly reduced due to erosion in the catchment area. The catchment area considered for treatment of Ujh Multipurpose Project is 854 sq.km. The sub-watersheds in the catchment area considered for the present study are depicted in Figure-10.1.
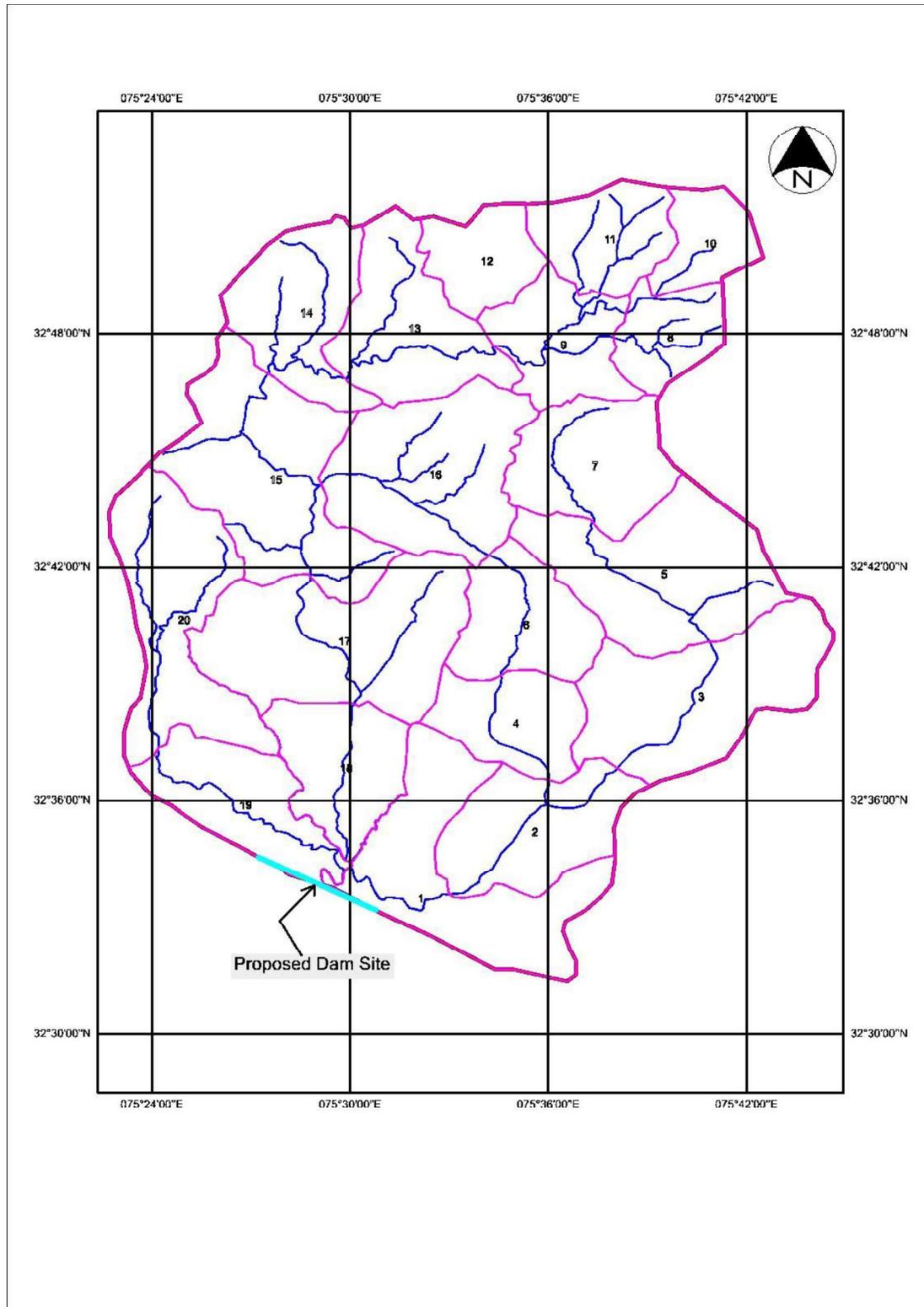
Figure-10.1: Sub Watersheds of Catchment Area of Ujh Multipurpose Project

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

Various thematic maps have been used in preparation of the CAT plan. Due to the spatial variability of site parameters such as soils, topography, land use and rainfall, not all areas contribute equally to the erosion problem. Several techniques like manual overlay of spatially index-mapped data have been used to estimate soil erosion in complex landscapes.

Geographic Information System (GIS) is a computerized resource data base system, which is referenced to some geographic coordinate system. In the present study, real coordinate system has been used. The GIS is a tool to store, analyze and display various spatial data. In addition, GIS because of its special hardware and software characteristics, has a capacity to perform numerous functions and operations on the various spatial data layers residing in the database. GIS provides the capability to analyze large amounts of data in relation to a set of established criteria.

In order to ensure that latest and accurate data is used for the analysis, satellite data has been used for deriving land use data and ground truth studies too have been conducted.

The various steps covered in the study are as follows:

- Data acquisition
- Data preparation
- Output presentation

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

Data Acquisition

The requirement of the study was first defined and the outputs expected were noted. The various data layers of the catchment area used for the study are as follows:

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

Data Preparation

The data available from various sources was collected. The ground maps, contour information, etc. were scanned, digitized and registered as per the requirement. Data was prepared depending on the level of accuracy required and any corrections required were made. All the layers were geo-referenced and brought to a common scale (real coordinates), so that overlay could be performed. A computer programme was used to estimate the soil

loss. The formats of outputs from each layer were firmed up to match the formats of inputs in the program. The grid size used was also decided to match the level of accuracy required, the data availability and the software and time limitations. The format of output was finalized. Ground truthing and data collection was also included in the procedure.

For the present study 2 Resources at-,LISS-IV imageries are used. The details are given as below:

- RSAT-2, LISS-IV Path 093, Row 047, Sub Scene C dated 27.12.2018
- RSAT-2, LISS-IV Path 093, Row 047 Sub Scene D dated 03.12.2018

The digital satellite data was used for interpretation and classification. The classified land use map of the catchment area is shown in Figure-10.2. The land use pattern of the catchment area is summarized in Table-10.1

Table-10.1: Landuse pattern of the catchment area

Category	Area (ha)	Percentage
River/ Water body	41679	2.95
Snow	534633	37.79
Agriculture Land	562027	39.73
Vegetation	151007	10.67
Barren Land	102329	7.23
Settlement	18790	1.33
Total	**85400**	**100**

Digitized contours from toposheets were used for preparation of Digital Elevation Model (DEM) of the catchment area and to prepare a slope map. The first step in generation of slope map is to create surface using the elevation values stored in the form of contours or points. After marking the catchment area, all the contours on the toposheet were digitized (100 m interval). The output of the digitization procedure was the contours as well as points contours in form of x, y & z points. (x, y location and their elevation). All this information was in real world coordinates (latitude, longitude and height in meters above sea level).

A Digital Terrain Model (DTM) of the area was then prepared, which was used to derive a slope map. The slope map is enclosed as Figure-10.3.

Various layers thus prepared were used for Modeling. Software was prepared to calculate the soil loss using input from all the layers.
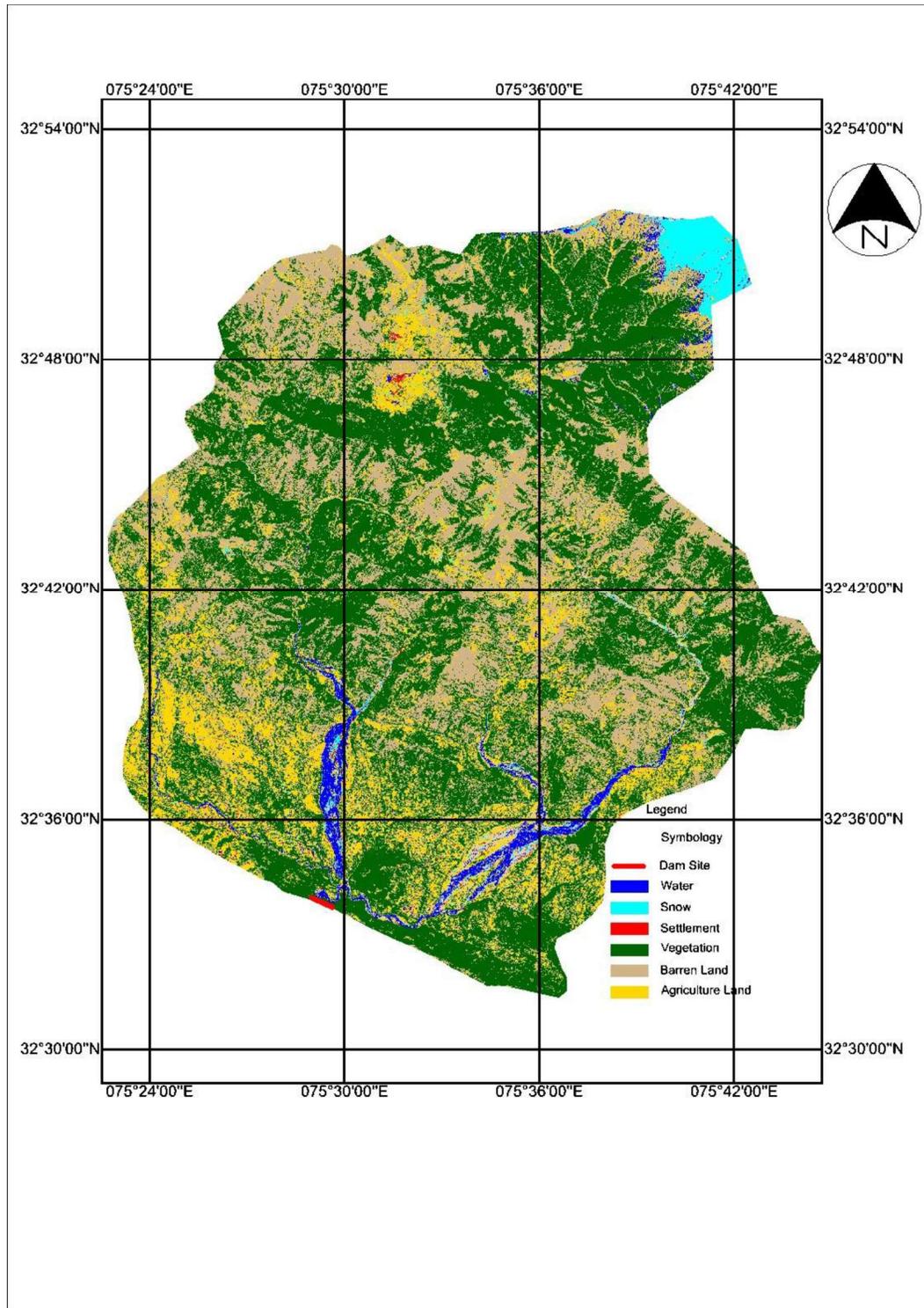
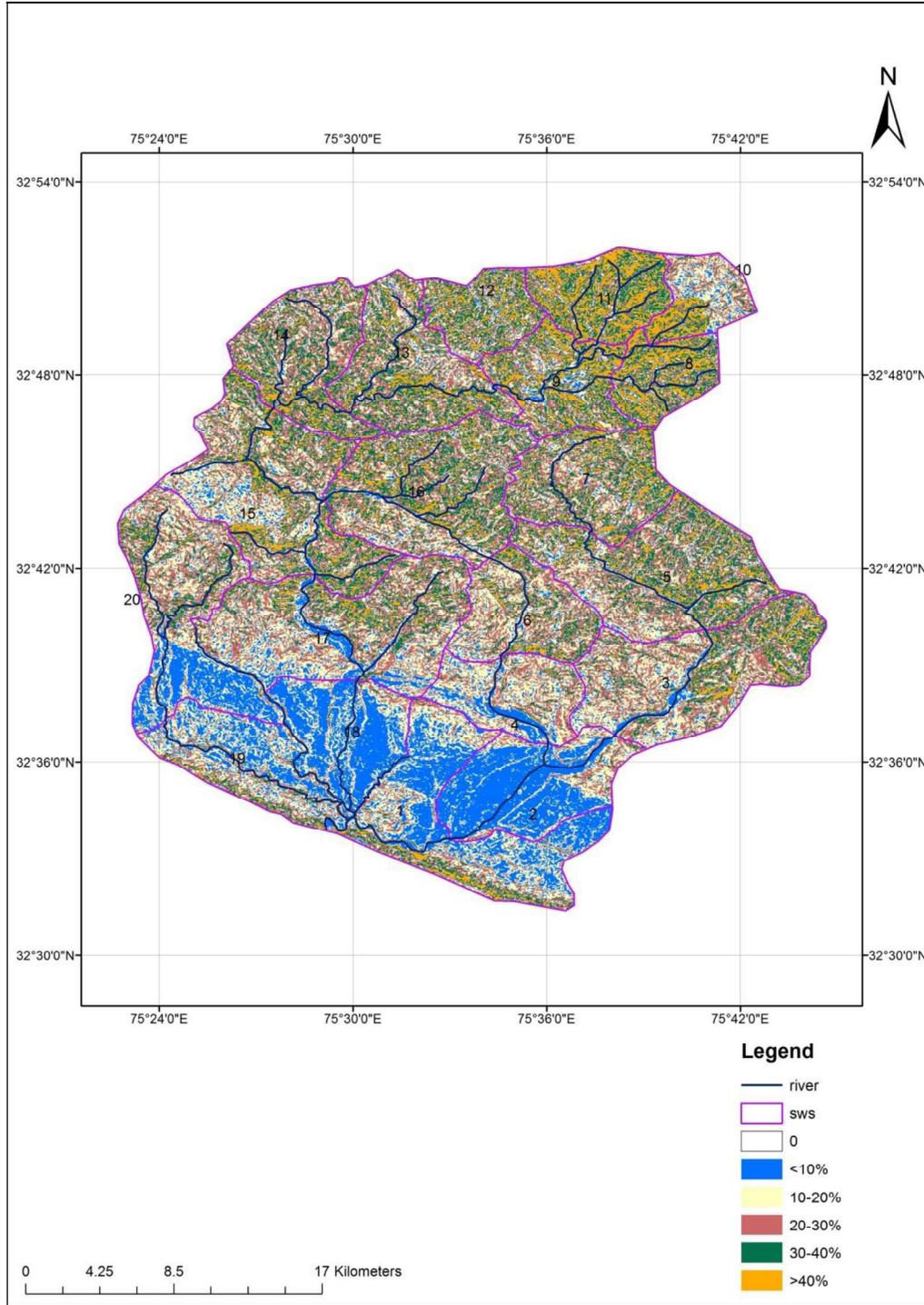**Figure-10.2: Classified Imagery of Ujh Catchment Area**

Figure-10.3 Slope Map of Ujh Catchment Area

Output Presentation

The result of the modeling was interpreted in pictorial form to identify the areas with high soil erosion rates. The primary and secondary data collected as a part of the field studies were used as an input for the model.

Estimation of Soil Loss using Silt Yield Index (SYI) Method

The Silt Yield Index Model (SYI), considering sedimentation as product of erosivity, erodibility and arial extent was conceptualized in the All India Soil and Land Use Survey (AISLUS) as early as 1969 and has been in operational use since then to meet the requirements of prioritization of smaller hydrologic units.

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

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

Silt Yield Index

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

Prioritization of Watersheds/Sub-watersheds:

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

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

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

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

The various steps involved in the application of model are:

-       Preparation of a framework of sub-watersheds through systematic delineation
-       Rapid reconnaissance surveys on 1:50,000 scale leading to the generation of a map indicating erosion-intensity mapping units.

- Assignment of weightage values to various mapping units based on relative silt-yield potential.
- Computing Silt Yield Index for individual watersheds/sub watersheds.
- Grading of watersheds/sub watersheds into very high, high medium, low and very low priority categories.

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

a.   Silt Yield Index

$$SYI = \frac{\sum (A_i \times W_i) \times 100}{A_w}; \quad \text{where } i = 1 \text{ to } n$$

Where

A_i	=	Area of ith unit (EIMU)
W_i	=	Weightage value of ith mapping unit
n	=	No. of mapping units
A_w	=	Total area of sub-watershed.

The SYI values for classification of various categories of erosion intensity rates are given in Table-10.2

Table-10.2: Criteria for erosion intensity rate

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

10.2.4   Watershed Management – Available Techniques

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

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

Following Engineering and Biological measures have been suggested for the catchment area treatment.

1.   Engineering measures

- Nallah Bunding
- Contour Bunding
- Angle iron barbed wire fencing

2.   **Biological measures**

-   Development of nurseries
-   Plantation/afforestation
-   Pasture development
-   Social forestry

The basis of site selection for different biological and engineering treatment measures under CAT are given in Table-10.3.

Table-10.3: Basis for selection of Catchment Area Treatment Measures

Treatment measure	Basis for selection
Social forestry, fuel wood and fodder grass development	Near settlements to control tree felling
Contour Bunding	Control of soil erosion from agricultural fields.
Pasture Development	Open canopy, barren land, degraded surface
Afforestation	Open canopy, degraded surface, high soil erosion, gentle to moderate slope
Barbed wire fencing	In the vicinity of afforestation work to protect it from grazing etc.
Nallah Bunding	Nala bunding work consists of constructing bunds of suitable dimensions across the nala or gullies to hold the maximum runoff water to create flooding of the upstream area temporarily for some days or weeks, with surplusing arrangements at suitable intervals to drain the water.
Nursery	Centrally located points for better supervision of proposed afforestation, minimize cost of transportation of seedling and ensure better survival.

10.2.5   Catchment Area Treatment Measures

Categorization of Watersheds

The erosion category of sub-watersheds in the catchment area as per a SYI index is given in Table-10.4. The details are shown in Figure-10.4. The area under different erosion categories are given in Table-10.5.

Table-10.4: Erosion intensity categorization as per SYI Classification

Watershed number	Area	SYI values	Category
W1	5953	1020	Low
W2	4175	1120	Medium
W3	6143	1270	High
W4	2842	1224	High
W5	6203	1160	Medium
W6	3283	1242	High
W7	3906	1262	High
W8	2024	1032	Low
W9	3073	1138	Medium
W10	1761	1160	Medium
W11	2751	1040	Low
W12	2168	1132	Medium
W13	4456	1240	High
W14	3931	1220	High

Watershed number	Area	SYI values	Category
W15	6983	1124	Medium
W16	6053	1140	Medium
W17	7139	1156	Medium
W18	3358	1230	High
W19	3571	1180	Medium
W20	5628	1236	High
Total	**85400**		

The objective of the SYI method is to prioritize sub-watershed in a catchment area for treatment. The total area under high erosion category in the catchment area is to be treated as a part of the project cost. The various measures suggested for catchment area treatment are depicted in Figure-10.5.

Table-10.5: Area under different Erosion Categories

Category	Area (ha)	Percentage
Low	245035	17.32
Medium	550097	38.88
High	619568	43.80
Total	**1414700**	**100.00**

The Catchment area Treatment Measures are categorized as under Biological Treatment Measures and Engineering Treatment Measures.

CEIA study for Ujh Multipurpose project

JKSPDC Limited

Legend

river

dam site

sws
SYI

Low

Medium

High

Proposed Dam Site

13 Kilometers

0   3.25   6.5
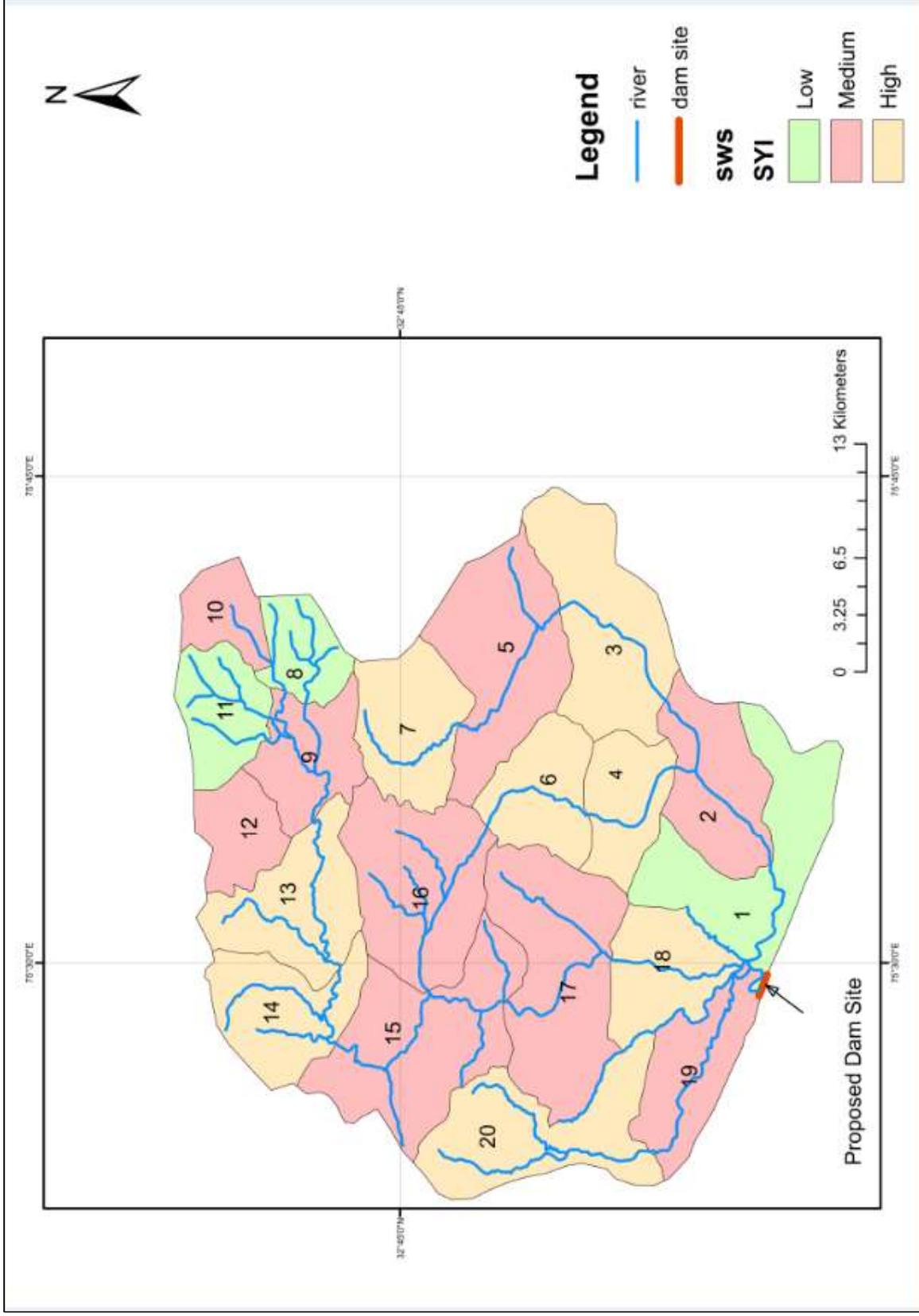
Figure-10.4: Prioritisation of Sub Watersheds for Ujh Project

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Biological Treatment Measures

As a part of biological treatment measures, following measures have been suggested:

- Afforestation
- Gap Plantation
- Pasture Development
- Social Forestry
- RIM Plantation
- Nursery Development
- Watch and Ward

The details of various biological treatment measures are given in Table-10.6.

Table-10.6: Treatment measures recommended for sub-watersheds coming under high erosion category

Sub-watershed	Afforestation (ha)	Contour Bunding (ha)	Pasture Development (ha)
W3	160	182	106
W4	100	0	30
W6	126	60	63
W7	135	0	70
W12	0	0	106
W13	150	130	50
W18	112	50	122
W20	188	200	30
Total	**971**	**622**	**577**

An amount of Rs. 2158.5 lakh has been earmarked for various afforestation measures. The details are given in Table-10.7.

Table-10.7: Cost estimate for Catchment Area Treatment of Ujh Project Biological Measures

S. No.	Item	Unit Rate (Rs.)	Unit	Target Physical	Financial (Rs. lakh)
1.	Afforestation	90,000/ha	ha	971	873.9
2.	Pasture development	33,000/ha	ha	577	291.3
3.	Nursery development	11,00,000/no.	no.	10	110.0
4.	Vegetative fencing	65,000/-	Km	50	32.5
5.	Watch and ward for 7 years @ 10 persons	12,000/man-month	Man-months	840	100.8
6.	Rim Plantation	Lumpsum			500.0
	Social Forestry	Lumpsum			250.0
	Total				**2158.5**

Engineering Treatment Measures

As a part of the CAT Plan, various engineering treatment measures have been proposed listed as below:

- Check Dams
- Contour Bunding

- Landslide control measures
- Drainage Line Treatment

Soil & Water Conservation Works

An amount of Rs. 994.3 lakh has been earmarked for various Soil & Water Conservation measures. The details are given in Table-10.8.

Table-10.8: Cost estimate for implementation of Engineering Treatment measures as a part of CAT Plan

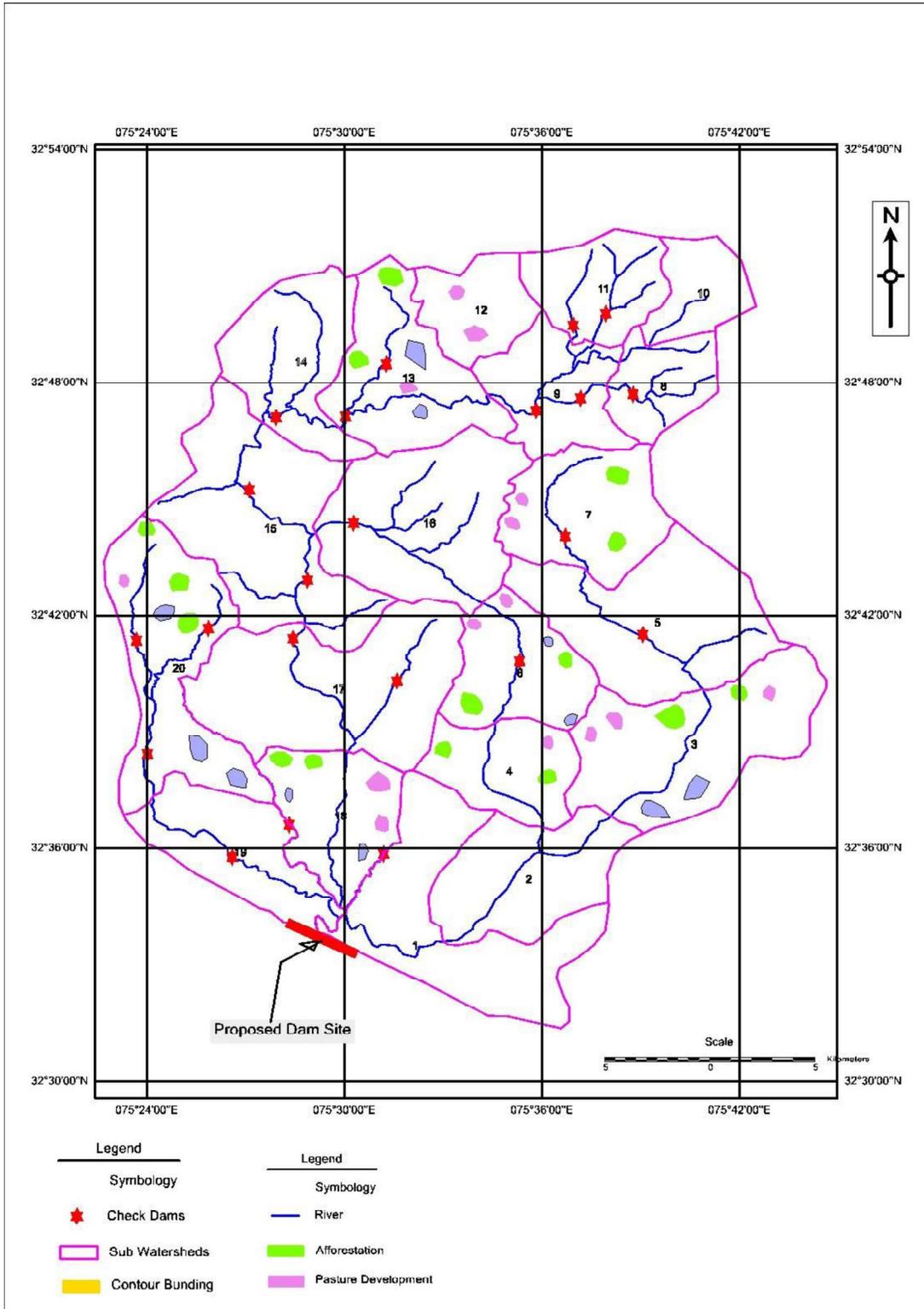| S. No.	Item	Unit Rate (Rs.)	Unit	Target	
				Physical	Financial (Rs. lakh)
1.	Check Dams	3,50,000	Nos.	22	77.0
2.	Contour Bunding	55,000		577	317.3
3.	Landslide Control Measures				250.0
4.	Drainage line treatment				350.0
	Total				**994.3**

Figure-10.5: Catchment Area Treatment Measures for Ujh Project

Other Measures

In addition to Biological and Engineering Treatment measures, other measures too have been suggested as a part of Catchment Area Treatment (CAT) Plan. These are as follows:

- Silt Observation points
- Eco-Tourism
- Training and Capacity Building
- Infrastructure Development
- Forest Protection
- Wildlife Management
- Monitoring and Evaluation
- Provision for Providing Environmental Services
- Provision for Floristic Survey and Forestry Research

Silt Observation points

Four silt observation locations for regular monitoring of silt load coming in tributaries of sub-watersheds falling under high and very high categories are proposed. This would ensure monitoring efficacy of implementation of various treatment measures proposed in CAT Plan. Monitoring would be undertaken for a period of 10 years including 5 years for CAT Plan implementation period. An amount of Rs. 616 lakh has been earmarked for this purpose. The details are given in Table-10.9.

Table-10.9: Cost earmarked for establishing Silt Observation Points

S. No.	Parameter	Cost (Rs. lakh)
1	Cost of ten laboratories – Rs 5,00,000/- for silt analysis per laboratory	50.0
2	One observation hut at each site (@ Rs 10.0 lakh/site)	100.0
3	Cost for hiring services of 5 person (Average salary- Rs 10,000/- for 10 years) considering 10% escalation per year	95.6
4	Cost for hiring services of supervisor 5 persons (Average salary Rs. 20,000/- for 10 years) considering 10% escalation per year	222.37
5	Consumables for the measurement Rs. 8.0 lacs per year for next 10 years, considering 10% escalation per year	148.0
	Total	**615.97**

Eco-Tourism

Trekking routes with camping facilities can help to boost eco-tourism in the area. Concept of "Homesteads" can be promoted. Such host families who are enterprising and having reasonable traditional accommodation in the village en-route to good eco-treks can accommodate tourists on payment basis. Such financial support to rural people can boost the activity. Involvement of local youths can provide self-employment services like guides, porters, and making arrangements for boarding and lodging of eco-tourists. The poor families can earn wages by portering or other small works. Eco- tourism societies can be formulated under the overall control of the Special Purpose Vehicle (SPV) arrangement for anchoring the eco-

tourism activities. There exists scope for eco-tourism in the area where tourists can see its wild virgin and pristine glory and catching the everlasting enthralling moments in their mind while enjoying and learning the nature. Eco-tourism activity shall feature under this component and suitable eco-tourism promotion activities shall be identified and promoted under this category. Therefore, a provision of Rs 650.00 lakh is kept for this purpose.

Training and Capacity Building

There is a need to keep all members of the existing registered Village Forest Development Committee (VFDCs) and committees to be constituted in other villages and NGOs involved in programme implementation so that they can play an active role in implementation of the CAT Plan by associating with the development work in their areas. For this purpose, people need to be trained in respect of different measures for habitat improvement by afforestation techniques, nursery development, pasture development, soil conservation and moisture retention works, horticulture development and agriculture practices in respect of land under the CAT Plan with special thrust to local technique with the use of indigenous material without deteriorating ecology of the area. The technique of river-training work needs to be explained properly so that desired results are achieved. For this purpose, a training programme has to be properly devised and carried out at range office for which a provision of Rs. 400.00 lakhc is being made.

Infrastructure Development

The total budget kept for infrastructure development for Forest department during the implementation of CAT Plan is Rs. 775 lakh. The details are given in Table-10.10.

Table-10.10: Cost summary for the Operational Support to Forest

S. No.	Component/Item	No.	Unit Rate (Rs. lakh)	Total Cost (Rs. lakh)
1	Vehicle Including operation and maintenance	20 No.	15.0	300.0
2	Office Expenditure	-	Lumpsum	150.0
3	**Office Equipment**			
	Dual Core computer with UPS & Laser Jet Printer,	15 No.	1.0	150.0
	Photocopier machine	5 No.	3.0	15.0
	Office Furniture	-	Lumpsum	100.0
4	GPS	20 No.	3.0	60.0
5.	Maintenance of Departmental buildings			200.0
6.	Maintenance of Forest roads/inspection paths			250.0
	Total			**775**

Forest Protection

An amount of Rs. 1200 lakh has been earmarked for implementation of various Forest Protection measures. The details are given in Table-10.11.

Table-10.11: Cost summary for Forest Protection Measures

S. No.	Component/Item	No.	Unit Rate (Rs. lakh)	Total Cost (Rs. lakh)
1	Fire protection measures			700.0
2	Distribution of Non-conventional Energy and Fuel Saving Devices in catchment area on a cost-sharing basis, such as, LPG, Tandoors, Pressure cookers and Solar devices	-	Lumpsum	500.0
	Total			**1200**

Wildlife Management

It is proposed to fund various components of wildlife management plan through CAT Plans that have a direct bearing on the reduction of silt load. The activities proposed for wildlife related interventions will be restricted to the project catchment area only. An amount of Rs. 900.0 lakh has been earmarked for implementation of various wildlife management measures.

Monitoring and Evaluation

The success of implementation of a CAT Plan can be fathomed by increase in vegetal cover on hill slopes and the enhancement. Various engineering and biological measures have been aimed at treating degraded and potential areas of severe to very severe soil erosion by increasing soil holding capacity and thus reducing sediment flow in the water. Therefore, for recording soil and silt data at regular intervals one small laboratory/observatory each shall be established at dam site and the barrage site on the Ujh river a where the regular discharges of the streams and silt samples shall be monitored twice a day for ten years.

A close watch on annual basis shall be maintained in respect of such areas where habitat improvement works have been carried out so as to verify the work executed on site itself and also to ascertain the rate of survival of plants and / or any damage to the new work. For monitoring of works under forestry operation, the use of remote sensing technique by using digital satellite imagery of Resourcesat-2 LISS-IV should be made obligatory. The monitoring through satellite scene should be done before commencement of works under CAT plan and in a block of two years after completion of CAT plan. The work of monitoring of various works under the CAT plan should be entrusted to an external agency which has long experience of carrying out similar work on land use data and evaluating environment impact.

M&E studies including impact evaluation studies should be scheduled for the later years of the CAT Plan implementation calendar. The indicators for monitoring impact of CAT Plan would include:

- Change in silt load.
- Survival of plantations
- Changes in land-use [private holdings]
- Changes in man-animal conflicts.
- Trend of fire incidences in vulnerable areas

A provision of Rs. 800.00 lakh is being made for monitoring and evaluation activities including the expenditure likely to be incurred on conducting meetings / seminar / workshops at the head quarter and outside. This will include payments made to the non-official members of the monitoring evaluation committee on accounts of their expenditure on traveling and boarding etc. The payment to the external agencies shall also be met out from this part.

Provision for Providing Environmental Services

A provision of Rs. 500.00 lakh is being made under this sub-head for carrying out such works which enhance the environmental status and also reduce the adverse impact on the environment and ecology. Funds for identified and approved activities for Payment for Environmental Services have also been provided under this component. The scheme inter- alia includes construction of contour trenches, incentives for fire protection on private as well as on government land/forests, provision of funds for live hedge fence on private land and Payment for Environmental Services as per approved J&K Forest Department activities and norms.

The silt contribution of private landholding is very significant. The agriculture land is not developed properly and coupled with faulty agricultural practices, like interrupting the natural drainage, contributes heavy soil erosion as compared to the other land use categories like dense forest/ open forest. Therefore, better land management shall help in reducing the sediment flow besides increasing the land productivity by way of arresting the loss of soil cover and increased soil moisture content. Accordingly, funds for the following activities on private lands will be made available:

 > Live hedge fencing of private lands - Payment shall be made as per schedule of rates of labour and works of respective Forest Circle, as applicable on the date of establishment of live hedge fence.
 > Contour trenches in private land – norms to be fixed in consultation with Agriculture Department.
 > Incentives for prevention of forest fires shall be provided village wise.

Fire management and control plan expenditure for the catchment area will be done under the PES Component. For success and survival of bio-engineering plantations, protection against the fire will also be very important. In general protection against forest fire hazards and incidents following indicative action points are proposed to manage and control fire in the catchment area:

 > Prevent and tackle fire incidences awareness campaign against the fire hazards and involvement of local people in controlling and prevention of fire incidences to be ensured.
 > Identification of sensitive hot-spots on past record and accordingly increased patrolling by deploying of appropriate manpower during fire-season.
 > Maintenance of fire-lines as per the Working Plan.
 > Winter control burning to be ensured as per the Working Plan.
 > Strengthening of communication network to ensure timely and immediate response to tackle fire incidences.
 > Enforcing fire rules and regulations especially during the fire season.

> ➢ Need based fire equipment be purchase and to be kept at appropriate places.
> ➢   Fire watch towers and fire huts to house equipment and manpower during fire season be constructed based on requirement after getting approval from the Conservator of Forests.

For nomadic tribes, who migrate along with sheep and goats across the area, necessary veterinary assistance by providing medicines and other support to maintain hygiene and health of the animal stock based on the suggestions of local veterinary office will be provided at pre-identified sites along with time schedule to be worked out as per the migration period/time. The cost of medicines and other assistance based on realistic assessment and inputs from Veterinary Office/ Department will be charged to PES.

Provision for Floristic Survey and Forestry Research

Though a provision has been made in environment monitoring plan for ecosystem monitoring including environmental studies during construction and post constructional stages respectively, an additional provision of Rs 450.0 lakh is made for carrying out floristic survey of the area after complete implementation of CAT Plan, i.e., immediately after the fifth year of maintenance.

Contingencies

An amount of Rs. 100 lakh has been earmarked for meeting any unforeseen expenditure.

10.2.6 Cost Estimates

A cost of Rs. 9543 lakh or 95.13 crore has been earmarked for implementation of CAT plan. The details are given in Table-10.12.

Table-10.12: Cost earmarked for implementation of CAT plan

S. No.	Activity	Amount (Rs. lakh)
1	Afforestation	2158.5
2	Soil & Water Conservation Works	994.0
3	Silt Observation Points	616
4	Eco-Tourism	650
5	Training and Capacity Building	400
6	Infrastructure Development	775
7	Forest Protection	1200
8	Wildlife Management	900
9	Monitoring and Evaluation	800
10	Provision for Providing Environmental Services	500
11	Provision for Floristic Survey and Forestry Research	450
12	Contingencies	100
	Total	**9543.5**

10.2.7 Schedule for Implementation of Cat Plan

It is proposed to implement the CAT Plan in 5 years. The year wise implementation of physical and financial targets is given in Table-10.13.

Table-10.13 Year wise implementation schedule for CAT Plan

S. No.	Activity	Year										Total	
		Year I		Year II		Year III		Year IV		Year V			
		Phy.	Fin. (Rs. lakh)	Phy.	Fin. (Rs. lakh)	Phy.	Fin. (Rs. lakh)	Phy.	Fin. (Rs. lakh)	Phy.	Fin. (Rs. lakh)	Phy.	Fin. (Rs. lakh)
A.	**Biological Treatment Measures**												
iii)	Afforestation	300ha	270.0	250 ha	225.0	250 ha	225.0	171.0 ha	153.9	-	-	971 ha	873.9
iv)	Pasture Development	200 ha	66.0	200 ha.	66.0	177 ha	58.41	-	-	-	-	577 ha	291.3
v)	Nursery Development	5 No.	55.0	3 No.	33.0	2 No.	22.0	-	-	-	-	10 No.	110.00
vi)	Vegetative fencing	30 km	19.5	15 km	9.75	15 km	9.75	-	-	-	-	50 km	32.5
vii)	Watch and ward	168 man-months	20.16	168 man-months	20.16	168 man-months	20.16	168 man-months	20.16	168 man-months	20.16	840 man-months	100.8
viii)	Rim Plantation	-	200.0	-	150.0	-	150.0	-	-	-	-	-	500.00
ix)	Social Forestry	-	150.0	-	100.0	-	0	-	-	-	-	-	250.00
	Sub-Total (A)		**780.66**		**603.91**		**485.32**		**174.06**		**20.16**		**2158.5**
B.	**Soil & Water Conservation Works**												
i)	Contour Bunding	200 ha	110.0	200 ha	110.0	177	93.5	-	-	-	-	577 ha	317.3
ii)	Check Dams	12	42.0	10	35.0	-	-	-	-	-	-	22	77.0
iii)	Drainage line	-	200.0	-	150	-	-	-	-	-	-	-	350.0

S. No.	Activity	Year I		Year II		Year III		Year IV		Year V		Total	
		Phy.	Fin. (Rs. lakh)	Phy.	Fin. (Rs. lakh)	Phy.	Fin. (Rs. lakh)	Phy.	Fin. (Rs. lakh)	Phy.	Fin. (Rs. lakh)	Phy.	Fin. (Rs. lakh)
iv)	Landslide Control Measures	-	150.0	-	100.0	-	-	-	-	-	-	-	250.0
	Sub-Total (B)		**502**		**395**	-	**93.5**	-	-	-	-	-	**994.3**
C	**Other Measures**												
i)	Silt observation points		300.0		175.0		140.0						615.0
ii)	Eco tourism	-	130.0	-	130.0	-	130.0	-	130.0	-	130.0		650.0
iii)	Research, Training & Capacity Building	-	80.0	-	80.0	-	80.0	-	80.0	-	80.0	-	400.0
iv)	Infrastructure Development	-	300	-	250	-	275						775.0
v)	Fire Protection Measures	-	300.0	-	300.0	-	100	-	-	-	-	-	700.0
vi)	Distribution of Non-conventional Energy and Fund Saving Devices	-	250.0	-	250.0	-	-	-	-	-	-	-	500.0
vii)	Wildlife Management	-	180.0	-	180.0	-	180.0	-	180.0	-	180.0	-	900.00
viii)	Monitoring	-	160.0	-	160.0	-	160.0	-	160.0	-	160.0		800.0

S. No.	Activity	Year Year I		Year II		Year III		Year IV		Year V		Total	
		Phy.	Fin. (Rs. lakh)	Phy.	Fin. (Rs. lakh)	Phy.	Fin. (Rs lakh)	Phy.	Fin. (Rs. lakh)	Phy.	Fin. (Rs. lakh)	Phy.	Fin. (Rs. lakh)
	and Evaluation												
ix)	Providing Environmental Services	-	100	-	100	-	100	-	100	-	100		500.0
x)	Provision for Floristic Survey and Forestry Research	-	90	-	90	-	90	-	90	-	90		450.0
xi)	Contingencies	-	20	-	20	-	20	-	20	-	20		100.0
	Sub-total(C)		1282.66		998.91		578.82		174.06		20.16		6390
	Grand Total		2565.32		1997.82		1157.64		348.12		40.32		9543.0

10.3 GREENBELT DEVELOPMENT PLAN

Although the forest loss due to reservoir submergence and other project appurtenances have been compensated as a part of compensatory afforestation. However in addition to above, it is proposed to develop greenbelt around the perimeter of various project appurtenances, selected stretches along reservoir periphery, etc. The general consideration involved while developing the greenbelt are:

- Trees growing up to 10 m or above in height with perennial foliage should be planted around various appurtenances of the proposed project.

- Planting of trees should be undertaken in appropriate encircling rows around the project site.

- Generally fast growing trees should be planted

- Since, the tree trunk area is normally devoid of foliage upto a height of 3 m, it may be useful to have shrubbery in front of the trees so as to give coverage to this portion.

The details of Greenbelt development are given as below:

- Plantation will be done along the boundaries of project colony

- Inter-connecting/approach roads of various project components, within the colonies, working sites, etc. shall be covered with avenue plantation.

- Available space within the colonies will be brought under Greenbelt for plantation of fruit, ornamental and shade trees along with shrubs, climbers etc. Fruit trees can be protected with angle iron guards.

- During the initial phase of plantation and summer seasons, watering of plants can be done. In addition, if required farm yard manure and agro-chemicals can also be applied.

- Along the road sides, 2 to 3 rows of ornamental trees can be planted.

- At the construction site and colony sites, the width of Greenbelt development can be increased depending on the quantum of land available.

- Thickness of greenbelt along reservoir periphery can be about 4 – 6 m.

- The saplings for Greenbelt can be processed from nearby nurseries of the Forest Department.

The species recommended for greenbelt development are given in Table-10.14 below:

Table-10.14: Species Recommended for Greenbelt Development for Ujh Multipurpose Project

Botanical Name	Common name	Family	Value
Annona squamosa L.	Sharifa	Annonaceae	Fruit
Artocarpus heterophyllus Lam.	Kathal	Moraceae	Fruit and soil binder
Azadirachta indica A.Juss.	Neem	Meliaceae	Medicinal
Callistemon citrinus (Curtis) Skeels	Bottle brush	Myrtaceae	Ornamental
Carica papaya L.	Papita	Caricaceae	Fruit
Citrus maxima (Burm.) Merr.	Chakotra	Rutaceae	Fruit
Cordia dichotoma G.Forst.	Lusude	Boraginaceae	Soil binder+Fruit
Dalbergia sissoo DC.	Shisham	Fabaceae	Soil binder
Diospyros kaki L.f.	Persimmon	Ebenaceae	Soil binder
Eriobotrya japonica (Thunb.) Lindl.	Logut	Rosaceae	Soil binder+fruit
Eucalyptus globulus Labill.	Safeda	Myrtaceae	Fast growth
Ficus religiosa L.	Peepal	Moraceae	Fast growth
Grewia optiva J.R.Drumm. ex Burret	Dhaman	Malvaceae	Soil binder
Litchi chinensis Sonn.	Litchi	Sapindaceae	Soil binder
Manilkara zapota (L.) P.Royen	Cheeku	Sapotaceae	Soil binder+ fruit
Morus alba L.	Shehtoot	Moraceae	Soil binder+fruit
Musa paradisiaca L.	Kela	Musaceae	Fruit
Phyllanthus emblica L.	Amla	Phyllanthaceae	Fruit
Punica granatum	Anar	Lythraceae	Fruit
Polyalthia longifolia (Sonn.) Thwaites	Ashok	Annonaceae	Fast growth+ Ornamental
Psidium guajava L.	Amrood	Myrtaceae	Fruit
Syzygium cumini (L.) Skeels	Jamun	Myrtaceae	Fruit
Terminalia chebula Retz.	Arhad	Combretaceae	Medicinal
Terminalia arjuna	Arhad	Combretaceae	Medicinal
Pyrus communis	Naspati	Rosaceae	Fruit

The cost of plantation per hectare is estimated at Rs.1,00,000. It is proposed to afforest about 50 ha of land as a part of Greenbelt Development Plan. The total cost works out to Rs.50.0 lakh. The plantation for this purpose will be carried out by Forest Department.

10.4 ENERGY CONSERVATION MEASURES

Various construction and other activities of the proposed Ujh Multipurpose project would lead to increased demand for fuel wood in the project area and its vicinity and would therefore exert pressure on forest areas located around the project. The major source of energy in the villages of the project area is fuel wood, acquirement of which is one of the main causes of ecological degradation and human drudgery. It is estimated that during the construction of the project, which would last for about 6 years, around 3,200 labourers, technical staff and their families will be working. Majority of the labour force will be outsiders and it will be very important to meet their energy requirement in an ecologically sustainable manner.

To provide an alternate for the energy requirement of the workers, contractor/s will be made responsible to provide subsidized kerosene/LPG to their workers which will in turn discourage them from illegal tree felling and removal of fuel wood and timber from the adjoining forests. Further, community kitchen facilities would also be provided to the labourers by the contractors. In addition to above, efforts would be made towards energy conservation by installing non-conventional energy sources as discussed in the subsequent paragraphs.

Energy conservation measures would be implemented to ensure that the use of non-renewable resources is minimised. A key component of achieving energy conservation would be the development of an Energy Management Action Plan. This plan would be included as part of the Construction and Operational EMPs.

The Energy Management Action Plan would be consistent with the energy conservation measures during both construction and operation phase.

10.4.1   Energy Conservation during construction phase

The following energy conservation measures would be undertaken during construction works:

- Efficient work scheduling and methods that minimize equipment idle time and double handling of material
- Throttling down and switching off construction equipment when not in use
- Switching off truck engines while they are waiting to access the site and while they are waiting to be loaded and unloaded
- Switching off site office equipment and lights and using optimum lighting intensity for security and safety purposes
- Careful design of temporary roads to reduce transportation distance
- Regular maintenance of equipment to ensure optimum operations and fuel efficiency
- The specification of energy efficient construction equipment.

10.4.2   Energy conservation during operation phase

The following energy conservation measures would be implemented during operation phase:

- Use of CFL lights up to maximum possible extent.
- Awareness about the use of CFL lights by locals.
- Development of heating, cooling and lighting use in buildings through climate-responsive design and conservation practices.
- Employing renewable energy sources such as day lighting and passive solar heating.
- Optimizing building performance and system control strategies, such as controlling lights with occupancy sensors and controlling comfort.

- Maximizing the use of solar power for signage and pedestrian lighting.
- Designing roads on site to reduce transportation distances.

An amount of Rs. 50 lakh has been earmarked for implementation of Energy Conservation Measures.

10.5   PUBLIC AWARENESS PROGRAMME

10.5.1   Objectives

The main objective is to slow down the spread of HIV/AIDS infection through creation of awareness and aiming at behavioral change. The awareness programme has the following components:

- Ensuring Blood Safety
- Control of sexually transmitted diseases
- Public awareness and community support.

i.   Ensuring blood safety

The training programe for the doctors and the blood bank staffs in consultation National or State AIDS Control Organization which includes the diagnosis of AIDS cases, mandatory licensing of blood banks and promotion of voluntary blood donation.

ii. Control of Sexually Transmitted Diseases

The main strategy for prevention and control of HIV/AIDS is to control of sexually transmitted diseases in the labour camp by the suggested measures of National or State AIDS Control Organization

iii. Public awareness and community support

A wide campaign using various media to spread awareness about the HIV/AIDS in the project area shall be taken up as Environmental management programme. This includes the use of radio, print media and folk theatre by the contractor and project proponent.

The counseling centre shall be set up in government Hospital at Tharali, which have the following objectives:

i.   To provide pre-test, post-test, follow-up, general and family counselling to general public, workers and technical staff coming to the hospital.

ii.   To provide support services and after care services for HIV positive clients.

iii. To disseminate information regarding STD, HIV/AIDS and measures suggested by National or State AIDS Control Organization.

iv. Measures for AIDS Control

The following measures are recommended for AIDS control :

-        Prevention

-        Anti-retroviral treatment

-        Primary health care

The above referred approaches for implementation in the project area are described briefly in the following paragraphs :

Prevention

- Awareness programme educating people to enable to make life saving need to be implemented.
- Intravenous drug users to be informed about the perils of sharing of needles.
- Use of various modes of media to educate people on AIDS, its nature, transmission and prevention.
- People in high risk groups to be refrained from donating blood, body organ, etc.
- All blood to be screened before transfusion.
- Strict sterilization practiced to be ensured in hospitals and dispensaries.
- Pre-sterlized or disposable syringes to be used as far as possible.

v. Anti-retroviral treatment

At present there is no vaccine or cure for treatment of HIV infection/AIDS. However, drugs that suppress the HIV infection rather than its complications can be used for prolonging the life of terminally ill patients.

vi. Primary health care

AIDS touches all aspects of primary health care, including mother and child, family planning and education. Thus, it is recommended that the AIDS control programme integrates various related issues into country's primary health care system. The AIDS control and awareness programs, developed by National Aids Control Society (NACO) need to be strictly implemented in the project area as well. In addition to primary health care, it is also recommended that the workers should be made aware not to hurt the traditional cultural and regions customs and practices.

An amount of Rs. 50.0 lakh has been earmarked for public awareness programme among the workers and technical labours about the HIV/AIDS in the project area.

10.6   ASSESSMENT OF ENVIRONMENTAL FLOWS

10.6.1 Need for Environment Flows

Environmental Flows (EF) are the flows of water in rivers that are necessary to maintain aquatic ecosystems. In other words, a flow regime in the river, capable of sustaining a complex set of aquatic habitats and ecosystem processes are referred to as environmental flow. The EF is designed to maintain or upgrade a river in desired, agreed or pre-determined status referred to as an "environmental management class" ranging from A (Negligible modification from natural condition) to F (Critically modified ecosystem).

The process for determining or estimating EF is termed as Environmental Flow Assessment (EFA) and there are more than 200 techniques suggested in literature for the same. EFA

techniques determine the volume and temporal distribution of EF. The difficulty of estimating EF values lies in the lack of understanding the relationship between river flow and the multiple components of river ecology and the scarcity of data concerned to these relationships. For example, required river flow conditions are available only for a target fish species in a given river basin and this information is very specific and not applicable under different circumstances. Different types of flows with different amount of discharge are spread through dry and wet seasons. This fact plays a very important issue in the interaction of river flow with the surrounded ecosystem. According, to flow, regime of a river can be divided into:

- *Low flows* (Base flow): this occurs throughout the year and is more in the wet season than in the dry season and defines if river flow throughout the year. The delayed flow that reaches a stream essentially as groundwater flow is also called base flow. In the annual hydrograph of a perennial stream the base flow is easily recognized as the slowly decreasing flow of the stream in rainless periods.

- *Small floods*: they are small in size, (as compared with high floods) a few number per year and they have a small period of time (days or weeks)

- *Large floods*: they are infrequently and the timing is very short (hours or days) (Refer Figure-10.6).
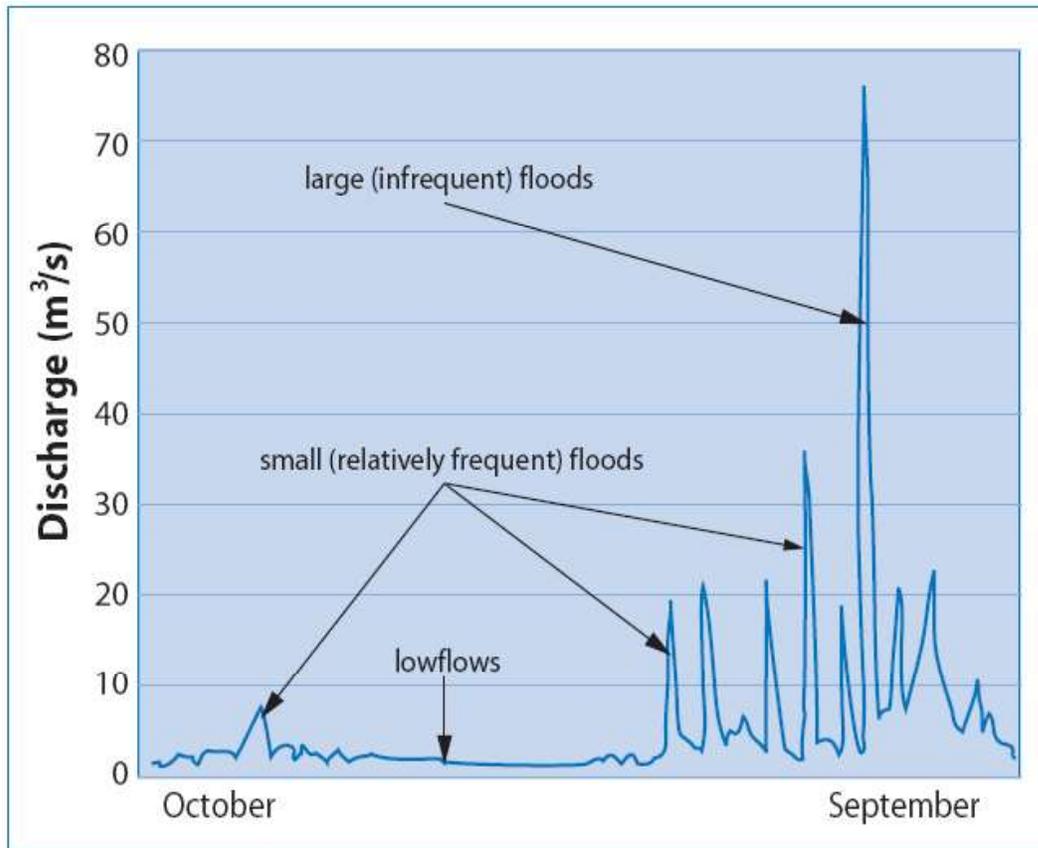
Figure-10.6: Typical Annual Hydrograph of daily flows in a river

Identification of these flow components and the understanding the ecosystem consequences of their loss or modification are one of the main objectives of Environmental Flow Assessment (EFA).

Further, flows in most of the river are being modified through impoundments such as dams and weirs, abstractions for agriculture, industrial and domestic supply, hydropower, drainage return flows and through structures for flood control. These interventions have had significant impacts, reducing the total flow of many rivers and affecting both; the seasonality of flows and the size and frequency of floods. In many cases, these modifications have adversely affected the river ecosystem, including the people living near the river banks. The river ecosystem includes both the channel and the floodplain. Regulations of river flows reduce or eliminate the linkage between the river and its floodplain margins.

With this background, it is important to recognize the importance of different flows in the river ecosystem.

According to Brown (2003), flow in rivers is generally needed for various purposes such as to:

- maintain river flow conditions like flow velocity, water depth and acceptable turbidity levels, making it possible for the river purify itself (dilution of effluents and waste water).

- maintain low flow which support livelihood of the people (people who use the river for drinking, washing, bathing, fishing, recreation and tourism, etc).

- sustain both terrestrial and aquatic ecosystem. For example, low flow provides water to wild animals, maintain soil-moisture in the banks, etc. Small floods stimulate spawning in fish and allow passage for migratory fish and germination of seeds on river banks. Large floods deposits nutrients on the banks and distribute seeds.

- recharge groundwater and aquifers by large floods, which maintain the perennial nature of rivers acting as source of water during dry season. Further, large floods flush sediments and natural obstructions in the river course and maintain a sufficient deep channel for navigation.

- preserve estuarine conditions: low flows maintain the required salt-freshwater balance and prevented the incursion of salinity. Large floods maintain links with the by scouring estuaries.

In general, flows enabling the river to play its role in the cultural and spiritual live of the people. This is very important in Indian context as some religious festivals reduce the quality and quantity of flow.

10.6.2   Requirement for Environmental Flows

The diversion of water for hydropower generation in the proposed hydroelectric projects will lead to drying or reduction of flow in river stretch upto tailrace disposal. The effect will be more pronounced in the lean season. There are no major users of water in the intervening stretches. As a result, there are no major users of water of river Ujh in the intervening stretch. Thus, no major adverse impacts are anticipated on downstream water users. However, there will be significant adverse impacts on riverine ecology, which needs to be ameliorated through the release of Environmental Flows.

The requirements of Environmental flows considered are:

- Irrigation water requirements
- Drinking water requirements
- Flow required to maintain water quality
- Flow required to sustain riverine ecology including fisheries

Irrigation and drinking water requirements

The proposed project is located in an area with low population density with no major sources of pollution. The major source of water for meeting irrigation and drinking requirements in the

project area are rivers or nallahs which flow adjacent to the habitations. The intervening stretch, i.e. between dam site and TRT disposal site, water from river Ujh is not abstracted for meeting irrigation and drinking water requirements.

Flow required for maintaining water quality

There are no sources of pollution in the area; hence, no flows are required to maintain water quality.

Flow required sustaining riverine ecology including fisheries

The river Ujh and its tributaries are typically hilly river, which has a fast water current with rich Dissolved Oxygen (DO).

The project is located in an area with elevation close to 500-600m above MSL. The dominant fish catch of the river in upper reaches in mainly comprised of *Tor* species, *Labeo* species, *Nemacheilus* species, *Barilius* species, *Schizothorax* species, *Glypthothorax* species, *Puntius* species and other cold water fishes. Whereas the lower reaches of river Ujh, comprises of Tor species, *Wallago attu*, *Mystus* species, *Labeo* species, *Bagarius* species, *Channa* species, *Heteropnesutes fossilis* , *Puntius* species etc. Amongst the migratory fish species, *Bagarius bangrius* and *Schizothorax* observed in this stretch. As a part of fisheries Management Plan, it is recommended to stock the reservoir and the river stretch upstream and downstream of dam site. The tail race tunnel will discharge water after hydropower generation at a distance of 9 km downstream of dam site. The river will remain dry for a stretch of 9 km. To sustain, the stocked fisheries, downstream of dam site, it is proposed to release Environmental Flows.

Criteria for Sustenance of Snow Trout

The minimum depth requirements are for Snow Trout are given in Table-10.15.

Table-10.15: Minimum Depth Requirements

S.No.	Season	Depth Requirement (m) for Trout
1.	Monsoon season	1.0
2.	Lean Season	0.4
3.	Non-monsoon Non-lean season	0.65 – 0.70

Source: Literature Review

Snow Trout has been considered, as the target species, which mean that if environmental flow is sufficient for their sustenance, other riverine fishes would also sustain.

Reduction in water depth and flow width should not be more than 50% of pre-project levels. Pre-project water depth and water width are assessed by reviewing the results of 100% release scenario.

Season I: This season is considered as high flow season influenced by monsoon. It covers the months from June to September. The minimum flow during this period is assumed as 30% of average flow (10 daily or monthly).

Season II: This season is considered as average flow period. It covers the month of October to November in which the proposed minimum flow is taken as 25% of average flow. This period is a transitional period between the wet and dry period.

Season III: This season is considered as low or lean or dry flow season. It covers the months from December to March. The proposed minimum flow is taken as 20% of average flow during this period.

Season IV: This season is considered as average flow period and is same as that of season II. It covers the month of April and May in which the proposed minimum flow is taken as 25% of average flow. This period is a transitional period between the dry and wet period.

10.6.3 Hydrological Modelling

Methodology

1-D mathematical model has been developed for assessing the changes in hydraulic parameters corresponding to design flood. The model is based on the solution of St. Venant's equation of continuity and momentum. US Army Corps of Engineers, Hydrologic Engineering Centre software HECRAS, which is in public domain, has been used to carry out the studies.

The HEC-RAS system contains three one-dimensional hydraulic components for:

- Steady flow surface profile computations
- Quasi-unsteady flow simulation
- Unsteady flow simulation
.

The L-section of the river stretch in the study area shall be developed based on available data. The available data on river cross-sections were used.

Out of the full year flow series (90% Dependability), three average values shall be calculated:

- Average of four leanest months (Lean season)
- Average of four monsoon months (Monsoon season)
- Average of remaining four months (Non monsoon & Non lean season)

Fish assemblages often include a range of species and reflect the integrated effects of environmental changes. Their presence is used to infer the presence of other aquatic organisms, since the adult fish occupy the top of the food chain in most aquatic systems. They also pass through most trophic levels above the primary producer stage during their development from larvae to adults. Fish can thus be regarded as reflecting the integrated environmental health of a river (Karr et **a**l., 1986). Fish species in river can guide to prepare specification of the flows necessary to meet their needs, and be useful in the monitoring and management of those flows. It is often surmised that if management of flows for fish

maintenance is successful, then flow requirements for aquatic invertebrates will also be satisfied. This is because of the larger scale of fish habitat.

Boundary Conditions

Steady Flow Simulation has been done with normal depth at the downstream section as boundary condition.

Manning's 'N' Value

Bed of main channel at the study area is granular sand and that of flood plains are consisted of silt mixed with sand. Value of Manning's 'n' has been adopted as 0.04.

Model Studies

Steady state simulation runs have been carried out with the 1-D mathematical model with Environmental flows proposed to be released in various seasons. The results of steady simulation runs for average flow in various seasons at various cross sections for 90% dependable year are given in Table-10.16.

Table-10.16: Depth of flow for the proposed Minimum Flow on the basis of average flow during 90% dependable year for Ujh Multipurpose project

Location	Profile	Q Total (m³/s)	Deepest Bed Level (m)	Water surface Elevation (m)	Depth of Flow (m)	Vel Chnl (m/s)	Flow Area (m²)	Top Width (m)
Dam axis	M(100%)	121.76	503	504.94	1.94	2.6	46.87	38.4
	M(30%)	36.53	503	504.07	1.07	1.92	19.03	25.65
	M(29%)	35.31	503	504.05	1.05	1.9	18.56	25.38
	M(28%)	34.09	503	504.03	1.03	1.88	18.09	25.11
	M(27%)	32.87	503	504.01	1.01	1.87	17.61	24.83
	M(26%)	31.66	503	503.99	0.99	1.85	17.15	24.56
	M(25%)	30.44	503	503.97	0.97	1.83	16.67	24.27
	M(24%)	29.22	503	503.95	0.95	1.81	16.18	23.97
	M(23%)	28	503	503.93	0.93	1.79	15.69	23.67
	M(22%)	26.79	503	503.91	0.91	1.76	15.19	23.36
	M(21%)	25.57	503	503.89	0.89	1.74	14.68	23.04
	M(20%)	24.35	503	503.87	0.87	1.72	14.18	22.71
	L(100%)	15.68	503	503.69	0.69	1.52	10.35	20.09
	L(20%)	3.14	503	503.28	0.28	0.92	3.4	14.13
	L(19%)	2.98	503	503.27	0.27	0.91	3.28	14.01
	L(18%)	2.82	503	503.26	0.26	0.89	3.16	13.88
	L(17%)	2.67	503	503.26	0.26	0.88	3.04	13.76
	L(16%)	2.51	503	503.25	0.25	0.86	2.92	13.62
	L(15%)	2.35	503	503.24	0.24	0.84	2.79	13.48
	NMNL(100%)	25.12	503	503.88	0.88	1.73	14.5	22.92
	NMNL(25%)	6.28	503	503.42	0.42	1.15	5.45	16.12
	NMNL(24%)	6.03	503	503.41	0.41	1.14	5.3	15.99
	NMNL(23%)	5.78	503	503.4	0.4	1.12	5.15	15.85
	NMNL(22%)	5.53	503	503.39	0.39	1.11	4.99	15.69
	NMNL(21%)	5.27	503	503.38	0.38	1.09	4.83	15.54
	NMNL(20%)	5.02	503	503.37	0.37	1.07	4.67	15.4
	NMNL(19%)	4.77	503	503.36	0.36	1.06	4.51	15.24
	NMNL(18%)	4.52	503	503.35	0.35	1.04	4.35	15.08

Location	Profile	Q Total (m³/s)	Deepest Bed Level (m)	Water surface Elevation (m)	Depth of Flow (m)	Vel Chnl (m/s)	Flow Area (m²)	Top Width (m)
	NMNL(17%)	4.27	503	503.34	0.34	1.02	4.18	14.92
	NMNL(16%)	4.02	503	503.32	0.32	1	4.01	14.75
	NMNL(15%)	3.77	503	503.31	0.31	0.98	3.83	14.57
230 m d/s of Dam axis	M(100%)	121.76	501	503.06	2.06	2.47	49.2	32.77
	M(30%)	36.53	501	502.09	1.09	1.7	21.48	24.36
	M(29%)	35.31	501	502.07	1.07	1.68	20.99	24.18
	M(28%)	34.09	501	502.05	1.05	1.66	20.5	24.01
	M(27%)	32.87	501	502.03	1.03	1.64	19.99	23.83
	M(26%)	31.66	501	502.01	1.01	1.62	19.49	23.65
	M(25%)	30.44	501	501.99	0.99	1.6	18.98	23.46
	M(24%)	29.22	501	501.97	0.97	1.58	18.47	23.27
	M(23%)	28	501	501.94	0.94	1.56	17.94	23.08
	M(22%)	26.79	501	501.92	0.92	1.54	17.41	22.88
	M(21%)	25.57	501	501.9	0.9	1.52	16.87	22.68
	M(20%)	24.35	501	501.87	0.87	1.49	16.33	22.47
	L(100%)	15.68	501	501.68	0.68	1.29	12.16	20.82
	L(20%)	3.14	501	501.27	0.27	0.73	4.29	17.28
	L(19%)	2.98	501	501.26	0.26	0.72	4.14	17.2
	L(18%)	2.82	501	501.25	0.25	0.71	4	17.13
	L(17%)	2.67	501	501.24	0.24	0.69	3.86	17.06
	L(16%)	2.51	501	501.23	0.23	0.68	3.71	16.99
	L(15%)	2.35	501	501.22	0.22	0.66	3.56	16.91
	NMNL(100%)	25.12	501	501.89	0.89	1.51	16.67	22.6
	NMNL(25%)	6.28	501	501.4	0.4	0.94	6.69	18.43
	NMNL(24%)	6.03	501	501.39	0.39	0.93	6.52	18.35
	NMNL(23%)	5.78	501	501.38	0.38	0.91	6.34	18.27
	NMNL(22%)	5.53	501	501.37	0.37	0.9	6.17	18.19
	NMNL(21%)	5.27	501	501.36	0.36	0.88	5.98	18.1
	NMNL(20%)	5.02	501	501.35	0.35	0.87	5.8	18.01
	NMNL(19%)	4.77	501	501.34	0.34	0.85	5.62	17.92
	NMNL(18%)	4.52	501	501.33	0.33	0.84	5.4	17.82
	NMNL(17%)	4.27	501	501.32	0.32	0.82	5.21	17.73
	NMNL(16%)	4.02	501	501.31	0.31	0.8	5.01	17.63
	NMNL(15%)	3.77	501	501.3	0.3	0.78	4.81	17.53
410 m d/s of Dam axis	M(100%)	121.76	500	501.8	1.8	2.84	42.88	33.7
	M(30%)	36.53	500	500.98	0.98	1.92	19.04	24.76
	M(29%)	35.31	500	500.97	0.97	1.9	18.61	24.57
	M(28%)	34.09	500	500.95	0.95	1.87	18.18	24.38
	M(27%)	32.87	500	500.93	0.93	1.85	17.75	24.19
	M(26%)	31.66	500	500.91	0.91	1.83	17.31	23.99
	M(25%)	30.44	500	500.89	0.89	1.81	16.86	23.78
	M(24%)	29.22	500	500.87	0.87	1.78	16.39	23.56
	M(23%)	28	500	500.85	0.85	1.76	15.93	23.35
	M(22%)	26.79	500	500.83	0.83	1.73	15.47	23.13
	M(21%)	25.57	500	500.81	0.81	1.7	15	22.91
	M(20%)	24.35	500	500.79	0.79	1.68	14.52	22.68
	L(100%)	15.68	500	500.63	0.63	1.44	10.89	20.85

Location	Profile	Q Total (m³/s)	Deepest Bed Level (m)	Water surface Elevation (m)	Depth of Flow (m)	Vel Chnl (m/s)	Flow Area (m²)	Top Width (m)
	L(20%)	3.14	500	500.25	0.25	0.81	3.89	16.77
	L(19%)	2.98	500	500.25	0.25	0.79	3.76	16.69
	L(18%)	2.82	500	500.24	0.24	0.77	3.64	16.61
	L(17%)	2.67	500	500.23	0.23	0.76	3.52	16.53
	L(16%)	2.51	500	500.22	0.22	0.74	3.39	16.44
	L(15%)	2.35	500	500.21	0.21	0.72	3.25	16.35
	NMNL(100%)	25.12	500	500.81	0.81	1.69	14.83	22.83
	NMNL(25%)	6.28	500	500.38	0.38	1.04	6.03	18.12
	NMNL(24%)	6.03	500	500.37	0.37	1.03	5.88	18.02
	NMNL(23%)	5.78	500	500.36	0.36	1.01	5.72	17.93
	NMNL(22%)	5.53	500	500.35	0.35	0.99	5.58	17.84
	NMNL(21%)	5.27	500	500.34	0.34	0.98	5.39	17.72
	NMNL(20%)	5.02	500	500.33	0.33	0.96	5.23	17.62
	NMNL(19%)	4.77	500	500.32	0.32	0.94	5.08	17.53
	NMNL(18%)	4.52	500	500.31	0.31	0.92	4.91	17.42
	NMNL(17%)	4.27	500	500.3	0.3	0.9	4.72	17.3
	NMNL(16%)	4.02	500	500.29	0.29	0.88	4.54	17.19
	NMNL(15%)	3.77	500	500.28	0.28	0.86	4.36	17.08
700 m d/s of Dam axis	M(100%)	121.76	498	499.36	1.36	1.84	66.26	72.55
	M(30%)	36.53	498	498.74	0.74	1.31	27.87	50.75
	M(29%)	35.31	498	498.72	0.72	1.3	27.22	50.3
	M(28%)	34.09	498	498.71	0.71	1.28	26.55	49.84
	M(27%)	32.87	498	498.7	0.7	1.27	25.89	49.37
	M(26%)	31.66	498	498.68	0.68	1.26	25.22	48.89
	M(25%)	30.44	498	498.67	0.67	1.24	24.54	48.4
	M(24%)	29.22	498	498.65	0.65	1.23	23.85	47.9
	M(23%)	28	498	498.64	0.64	1.21	23.16	47.39
	M(22%)	26.79	498	498.62	0.62	1.19	22.45	46.86
	M(21%)	25.57	498	498.61	0.61	1.18	21.73	46.33
	M(20%)	24.35	498	498.59	0.59	1.16	21.03	45.79
	L(100%)	15.68	498	498.47	0.47	1.01	15.53	41.38
	L(20%)	3.14	498	498.19	0.19	0.58	5.39	31.66
	L(19%)	2.98	498	498.18	0.18	0.57	5.18	31.43
	L(18%)	2.82	498	498.18	0.18	0.56	5.05	31.28
	L(17%)	2.67	498	498.17	0.17	0.55	4.86	31.07
	L(16%)	2.51	498	498.17	0.17	0.54	4.65	30.82
	L(15%)	2.35	498	498.16	0.16	0.53	4.45	30.6
	NMNL(100%)	25.12	498	498.6	0.6	1.17	21.48	46.14
	NMNL(25%)	6.28	498	498.28	0.28	0.74	8.44	34.87
	NMNL(24%)	6.03	498	498.28	0.28	0.73	8.23	34.65
	NMNL(23%)	5.78	498	498.27	0.27	0.72	7.97	34.4
	NMNL(22%)	5.53	498	498.26	0.26	0.71	7.79	34.21
	NMNL(21%)	5.27	498	498.26	0.26	0.7	7.54	33.96
	NMNL(20%)	5.02	498	498.25	0.25	0.69	7.31	33.72
	NMNL(19%)	4.77	498	498.24	0.24	0.67	7.07	33.47
	NMNL(18%)	4.52	498	498.23	0.23	0.66	6.81	33.2
	NMNL(17%)	4.27	498	498.23	0.23	0.65	6.54	32.91
	NMNL(16%)	4.02	498	498.22	0.22	0.64	6.3	32.65

Location	Profile	Q Total (m³/s)	Deepest Bed Level (m)	Water surface Elevation (m)	Depth of Flow (m)	Vel Chnl (m/s)	Flow Area (m²)	Top Width (m)
	NMNL(15%)	3.77	498	498.21	0.21	0.62	6.03	32.36
1064 m d/s of Dam axis	M(100%)	121.76	496	497.1	1.1	1.82	66.74	71.12
	M(30%)	36.53	496	496.54	0.54	1.23	29.77	60.75
	M(29%)	35.31	496	496.53	0.53	1.21	29.12	60.54
	M(28%)	34.09	496	496.52	0.52	1.2	28.46	60.32
	M(27%)	32.87	496	496.5	0.5	1.18	27.78	60.1
	M(26%)	31.66	496	496.49	0.49	1.17	27.11	59.87
	M(25%)	30.44	496	496.48	0.48	1.15	26.42	59.64
	M(24%)	29.22	496	496.47	0.47	1.14	25.73	59.41
	M(23%)	28	496	496.46	0.46	1.12	25.03	59.17
	M(22%)	26.79	496	496.45	0.45	1.1	24.32	58.93
	M(21%)	25.57	496	496.43	0.43	1.08	23.59	58.68
	M(20%)	24.35	496	496.42	0.42	1.07	22.86	58.43
	L(100%)	15.68	496	496.32	0.32	0.91	17.23	56.47
	L(20%)	3.14	496	496.12	0.12	0.5	6.31	52.47
	L(19%)	2.98	496	496.12	0.12	0.49	6.11	52.39
	L(18%)	2.82	496	496.12	0.12	0.48	5.92	52.31
	L(17%)	2.67	496	496.11	0.11	0.47	5.72	52.24
	L(16%)	2.51	496	496.11	0.11	0.46	5.5	52.16
	L(15%)	2.35	496	496.1	0.1	0.45	5.28	52.07
	NMNL(100%)	25.12	496	496.43	0.43	1.08	23.32	58.59
	NMNL(25%)	6.28	496	496.19	0.19	0.65	9.69	53.74
	NMNL(24%)	6.03	496	496.18	0.18	0.64	9.44	53.64
	NMNL(23%)	5.78	496	496.18	0.18	0.63	9.19	53.55
	NMNL(22%)	5.53	496	496.17	0.17	0.62	8.94	53.46
	NMNL(21%)	5.27	496	496.17	0.17	0.61	8.67	53.36
	NMNL(20%)	5.02	496	496.16	0.16	0.6	8.42	53.26
	NMNL(19%)	4.77	496	496.16	0.16	0.58	8.16	53.16
	NMNL(18%)	4.52	496	496.15	0.15	0.57	7.89	53.06
	NMNL(17%)	4.27	496	496.15	0.15	0.56	7.61	52.96
	NMNL(16%)	4.02	496	496.14	0.14	0.55	7.34	52.86
	NMNL(15%)	3.77	496	496.14	0.14	0.53	7.07	52.75
1650 m d/s of Dam axis	M(100%)	121.76	492	493.94	1.94	1.79	68.1	64.01
	M(30%)	36.53	492	493.22	1.22	1.28	28.52	44.71
	M(29%)	35.31	492	493.2	1.2	1.27	27.84	44.31
	M(28%)	34.09	492	493.18	1.18	1.26	27.15	43.89
	M(27%)	32.87	492	493.17	1.17	1.24	26.46	43.47
	M(26%)	31.66	492	493.15	1.15	1.23	25.76	43.05
	M(25%)	30.44	492	493.14	1.14	1.21	25.06	42.61
	M(24%)	29.22	492	493.12	1.12	1.2	24.34	42.16
	M(23%)	28	492	493.1	1.1	1.19	23.62	41.71
	M(22%)	26.79	492	493.08	1.08	1.17	22.9	41.24
	M(21%)	25.57	492	493.07	1.07	1.15	22.16	40.76
	M(20%)	24.35	492	493.05	1.05	1.14	21.41	40.27
	L(100%)	15.68	492	492.89	0.89	1.02	15.42	34.68
	L(20%)	3.14	492	492.48	0.48	0.69	4.57	18.89
	L(19%)	2.98	492	492.47	0.47	0.68	4.4	18.52

Location	Profile	Q Total (m³/s)	Deepest Bed Level (m)	Water surface Elevation (m)	Depth of Flow (m)	Vel Chnl (m/s)	Flow Area (m²)	Top Width (m)
	L(18%)	2.82	492	492.47	0.47	0.67	4.22	18.14
	L(17%)	2.67	492	492.46	0.46	0.66	4.05	17.77
	L(16%)	2.51	492	492.45	0.45	0.65	3.86	17.36
	L(15%)	2.35	492	492.43	0.43	0.64	3.68	16.93
	NMNL(100%)	25.12	492	493.06	1.06	1.15	21.88	40.59
	NMNL(25%)	6.28	492	492.63	0.63	0.81	7.72	24.54
	NMNL(24%)	6.03	492	492.62	0.62	0.81	7.48	24.16
	NMNL(23%)	5.78	492	492.61	0.61	0.8	7.25	23.78
	NMNL(22%)	5.53	492	492.6	0.6	0.79	7.01	23.38
	NMNL(21%)	5.27	492	492.59	0.59	0.78	6.76	22.96
	NMNL(20%)	5.02	492	492.58	0.58	0.77	6.52	22.55
	NMNL(19%)	4.77	492	492.57	0.57	0.76	6.27	22.11
	NMNL(18%)	4.52	492	492.56	0.56	0.75	6.02	21.67
	NMNL(17%)	4.27	492	492.54	0.54	0.74	5.77	21.21
	NMNL(16%)	4.02	492	492.53	0.53	0.73	5.51	20.73
	NMNL(15%)	3.77	492	492.52	0.52	0.72	5.25	20.24
2232 m d/s of Dam axis	M(100%)	121.76	489	491	2	2.01	60.49	54.2
	M(30%)	36.53	489	490.25	1.25	1.43	25.58	38.5
	M(29%)	35.31	489	490.23	1.23	1.41	24.97	38.17
	M(28%)	34.09	489	490.22	1.22	1.4	24.36	37.84
	M(27%)	32.87	489	490.2	1.2	1.38	23.75	37.5
	M(26%)	31.66	489	490.18	1.18	1.37	23.13	37.16
	M(25%)	30.44	489	490.17	1.17	1.35	22.51	36.8
	M(24%)	29.22	489	490.15	1.15	1.34	21.87	36.44
	M(23%)	28	489	490.13	1.13	1.32	21.23	36.07
	M(22%)	26.79	489	490.11	1.11	1.3	20.59	35.7
	M(21%)	25.57	489	490.1	1.1	1.28	19.93	35.32
	M(20%)	24.35	489	490.08	1.08	1.26	19.27	34.92
	L(100%)	15.68	489	489.92	0.92	1.12	13.98	30.53
	L(20%)	3.14	489	489.5	0.5	0.75	4.16	16.65
	L(19%)	2.98	489	489.49	0.49	0.74	4.01	16.35
	L(18%)	2.82	489	489.48	0.48	0.73	3.85	16.02
	L(17%)	2.67	489	489.47	0.47	0.72	3.69	15.69
	L(16%)	2.51	489	489.46	0.46	0.71	3.53	15.33
	L(15%)	2.35	489	489.45	0.45	0.7	3.35	14.95
	NMNL(100%)	25.12	489	490.09	1.09	1.28	19.69	35.17
	NMNL(25%)	6.28	489	489.65	0.65	0.9	7.02	21.63
	NMNL(24%)	6.03	489	489.64	0.64	0.89	6.81	21.3
	NMNL(23%)	5.78	489	489.63	0.63	0.88	6.59	20.96
	NMNL(22%)	5.53	489	489.62	0.62	0.87	6.37	20.61
	NMNL(21%)	5.27	489	489.61	0.61	0.86	6.15	20.25
	NMNL(20%)	5.02	489	489.6	0.6	0.84	5.96	19.93
	NMNL(19%)	4.77	489	489.59	0.59	0.84	5.7	19.5
	NMNL(18%)	4.52	489	489.57	0.57	0.83	5.48	19.11
	NMNL(17%)	4.27	489	489.56	0.56	0.81	5.25	18.71
	NMNL(16%)	4.02	489	489.55	0.55	0.8	5.01	18.28
	NMNL(15%)	3.77	489	489.54	0.54	0.79	4.78	17.86

Location	Profile	Q Total (m³/s)	Deepest Bed Level (m)	Water surface Elevation (m)	Depth of Flow (m)	Vel Chnl (m/s)	Flow Area (m²)	Top Width (m)
3263 m d/s of Dam axis	M(100%)	121.76	483	484.98	1.98	2.25	54.02	49.61
	M(30%)	36.53	483	484.25	1.25	1.58	23.11	34.99
	M(29%)	35.31	483	484.23	1.23	1.56	22.56	34.68
	M(28%)	34.09	483	484.22	1.22	1.55	22.04	34.38
	M(27%)	32.87	483	484.2	1.2	1.53	21.49	34.05
	M(26%)	31.66	483	484.19	1.19	1.51	20.93	33.72
	M(25%)	30.44	483	484.17	1.17	1.5	20.34	33.37
	M(24%)	29.22	483	484.15	1.15	1.48	19.77	33.03
	M(23%)	28	483	484.13	1.13	1.46	19.19	32.67
	M(22%)	26.79	483	484.12	1.12	1.44	18.61	32.32
	M(21%)	25.57	483	484.1	1.1	1.42	18.02	31.95
	M(20%)	24.35	483	484.08	1.08	1.4	17.42	31.57
	L(100%)	15.68	483	483.92	0.92	1.24	12.68	27.58
	L(20%)	3.14	483	483.5	0.5	0.82	3.81	15.12
	L(19%)	2.98	483	483.49	0.49	0.81	3.67	14.84
	L(18%)	2.82	483	483.49	0.49	0.8	3.53	14.55
	L(17%)	2.67	483	483.48	0.48	0.79	3.38	14.25
	L(16%)	2.51	483	483.46	0.46	0.78	3.23	13.91
	L(15%)	2.35	483	483.45	0.45	0.76	3.09	13.61
	NMNL(100%)	25.12	483	484.09	1.09	1.41	17.8	31.81
	NMNL(25%)	6.28	483	483.65	0.65	0.98	6.43	19.64
	NMNL(24%)	6.03	483	483.64	0.64	0.97	6.23	19.33
	NMNL(23%)	5.78	483	483.63	0.63	0.96	6.04	19.03
	NMNL(22%)	5.53	483	483.63	0.63	0.94	5.86	18.75
	NMNL(21%)	5.27	483	483.61	0.61	0.93	5.64	18.39
	NMNL(20%)	5.02	483	483.6	0.6	0.92	5.44	18.06
	NMNL(19%)	4.77	483	483.59	0.59	0.91	5.26	17.76
	NMNL(18%)	4.52	483	483.58	0.58	0.9	5.04	17.38
	NMNL(17%)	4.27	483	483.57	0.57	0.88	4.83	17.03
	NMNL(16%)	4.02	483	483.56	0.56	0.87	4.62	16.65
	NMNL(15%)	3.77	483	483.54	0.54	0.85	4.41	16.27
3565 m d/s of Dam axis	M(100%)	121.76	481	482.84	1.84	1.92	63.58	69.05
	M(30%)	36.53	481	482.18	1.18	1.41	25.89	44.06
	M(29%)	35.31	481	482.16	1.16	1.4	25.24	43.51
	M(28%)	34.09	481	482.15	1.15	1.39	24.59	42.94
	M(27%)	32.87	481	482.13	1.13	1.37	23.93	42.36
	M(26%)	31.66	481	482.11	1.11	1.36	23.27	41.77
	M(25%)	30.44	481	482.1	1.1	1.35	22.55	41.12
	M(24%)	29.22	481	482.08	1.08	1.34	21.87	40.5
	M(23%)	28	481	482.06	1.06	1.32	21.18	39.86
	M(22%)	26.79	481	482.05	1.05	1.31	20.49	39.2
	M(21%)	25.57	481	482.03	1.03	1.29	19.79	38.52
	M(20%)	24.35	481	482.01	1.01	1.28	19.08	37.82
	L(100%)	15.68	481	481.86	0.86	1.14	13.71	32.07
	L(20%)	3.14	481	481.47	0.47	0.76	4.12	17.57
	L(19%)	2.98	481	481.46	0.46	0.75	3.96	17.23
	L(18%)	2.82	481	481.45	0.45	0.74	3.8	16.87
	L(17%)	2.67	481	481.44	0.44	0.73	3.65	16.53

Location	Profile	Q Total (m³/s)	Deepest Bed Level (m)	Water surface Elevation (m)	Depth of Flow (m)	Vel Chnl (m/s)	Flow Area (m²)	Top Width (m)
	L(16%)	2.51	481	481.43	0.43	0.72	3.48	16.16
	L(15%)	2.35	481	481.42	0.42	0.71	3.31	15.76
	NMNL(100%)	25.12	481	482.02	1.02	1.29	19.53	38.27
	NMNL(25%)	6.28	481	481.61	0.61	0.91	6.9	22.74
	NMNL(24%)	6.03	481	481.6	0.6	0.9	6.71	22.44
	NMNL(23%)	5.78	481	481.59	0.59	0.89	6.51	22.09
	NMNL(22%)	5.53	481	481.58	0.58	0.88	6.27	21.68
	NMNL(21%)	5.27	481	481.57	0.57	0.87	6.07	21.33
	NMNL(20%)	5.02	481	481.56	0.56	0.86	5.85	20.95
	NMNL(19%)	4.77	481	481.55	0.55	0.85	5.62	20.53
	NMNL(18%)	4.52	481	481.54	0.54	0.84	5.41	20.14
	NMNL(17%)	4.27	481	481.53	0.53	0.82	5.18	19.72
	NMNL(16%)	4.02	481	481.51	0.51	0.81	4.95	19.27
	NMNL(15%)	3.77	481	481.5	0.5	0.8	4.72	18.81
4445 m d/s of Dam axis	M(100%)	121.76	476	477.22	1.22	1.81	67.3	85.76
	M(30%)	36.53	476	476.67	0.67	1.3	28.02	58.54
	M(29%)	35.31	476	476.66	0.66	1.29	27.4	58.01
	M(28%)	34.09	476	476.65	0.65	1.28	26.71	57.41
	M(27%)	32.87	476	476.64	0.64	1.26	26.03	56.82
	M(26%)	31.66	476	476.62	0.62	1.25	25.33	56.19
	M(25%)	30.44	476	476.61	0.61	1.24	24.6	55.54
	M(24%)	29.22	476	476.6	0.6	1.22	23.93	54.93
	M(23%)	28	476	476.58	0.58	1.21	23.17	54.24
	M(22%)	26.79	476	476.57	0.57	1.19	22.51	53.62
	M(21%)	25.57	476	476.56	0.56	1.18	21.73	52.9
	M(20%)	24.35	476	476.54	0.54	1.16	20.98	52.18
	L(100%)	15.68	476	476.43	0.43	1.02	15.42	46.55
	L(20%)	3.14	476	476.18	0.18	0.61	5.18	33.81
	L(19%)	2.98	476	476.17	0.17	0.6	5	33.54
	L(18%)	2.82	476	476.17	0.17	0.58	4.83	33.28
	L(17%)	2.67	476	476.16	0.16	0.58	4.62	32.97
	L(16%)	2.51	476	476.15	0.15	0.56	4.47	32.74
	L(15%)	2.35	476	476.15	0.15	0.55	4.28	32.44
	NMNL(100%)	25.12	476	476.55	0.55	1.17	21.51	52.68
	NMNL(25%)	6.28	476	476.26	0.26	0.76	8.23	38.05
	NMNL(24%)	6.03	476	476.26	0.26	0.75	8	37.74
	NMNL(23%)	5.78	476	476.25	0.25	0.74	7.79	37.47
	NMNL(22%)	5.53	476	476.24	0.24	0.73	7.55	37.14
	NMNL(21%)	5.27	476	476.24	0.24	0.72	7.3	36.81
	NMNL(20%)	5.02	476	476.23	0.23	0.71	7.07	36.5
	NMNL(19%)	4.77	476	476.22	0.22	0.7	6.83	36.17
	NMNL(18%)	4.52	476	476.22	0.22	0.68	6.6	35.85
	NMNL(17%)	4.27	476	476.21	0.21	0.67	6.35	35.5
	NMNL(16%)	4.02	476	476.2	0.2	0.66	6.08	35.12
	NMNL(15%)	3.77	476	476.2	0.2	0.64	5.86	34.79
5426 m d/s of	M(100%)	121.76	469	470.28	1.28	1.53	84.18	107.05
	M(30%)	36.53	469	469.68	0.68	1.11	32.91	62.11

Location	Profile	Q Total (m³/s)	Deepest Bed Level (m)	Water surface Elevation (m)	Depth of Flow (m)	Vel Chnl (m/s)	Flow Area (m²)	Top Width (m)
Dam axis	M(29%)	35.31	469	469.67	0.67	1.1	32.12	61.6
	M(28%)	34.09	469	469.65	0.65	1.09	31.33	61.09
	M(27%)	32.87	469	469.64	0.64	1.08	30.54	60.56
	M(26%)	31.66	469	469.63	0.63	1.06	29.74	60.03
	M(25%)	30.44	469	469.61	0.61	1.05	28.93	59.49
	M(24%)	29.22	469	469.6	0.6	1.04	28.11	58.94
	M(23%)	28	469	469.58	0.58	1.03	27.29	58.38
	M(22%)	26.79	469	469.57	0.57	1.01	26.46	57.81
	M(21%)	25.57	469	469.56	0.56	1	25.61	57.22
	M(20%)	24.35	469	469.54	0.54	0.98	24.76	56.62
	L(100%)	15.68	469	469.42	0.42	0.86	18.21	51.79
	L(20%)	3.14	469	469.16	0.16	0.5	6.24	41.53
	L(19%)	2.98	469	469.16	0.16	0.49	6.04	41.33
	L(18%)	2.82	469	469.15	0.15	0.48	5.83	41.13
	L(17%)	2.67	469	469.15	0.15	0.47	5.64	40.94
	L(16%)	2.51	469	469.14	0.14	0.46	5.41	40.72
	L(15%)	2.35	469	469.14	0.14	0.45	5.19	40.5
	NMNL(100%)	25.12	469	469.55	0.55	0.99	25.3	57
	NMNL(25%)	6.28	469	469.25	0.25	0.64	9.82	44.84
	NMNL(24%)	6.03	469	469.24	0.24	0.63	9.56	44.61
	NMNL(23%)	5.78	469	469.23	0.23	0.62	9.3	44.37
	NMNL(22%)	5.53	469	469.23	0.23	0.61	9.03	44.13
	NMNL(21%)	5.27	469	469.22	0.22	0.6	8.75	43.87
	NMNL(20%)	5.02	469	469.22	0.22	0.59	8.47	43.62
	NMNL(19%)	4.77	469	469.21	0.21	0.58	8.19	43.36
	NMNL(18%)	4.52	469	469.2	0.2	0.57	7.91	43.1
	NMNL(17%)	4.27	469	469.2	0.2	0.56	7.62	42.83
	NMNL(16%)	4.02	469	469.19	0.19	0.55	7.33	42.56
	NMNL(15%)	3.77	469	469.18	0.18	0.54	7.03	42.28
6000 m d/s of Dam axis	M(100%)	121.76	466	467.79	1.79	2.02	60.19	67.19
	M(30%)	36.53	466	467.14	1.14	1.51	24.2	42.6
	M(29%)	35.31	466	467.12	1.12	1.5	23.58	42.06
	M(28%)	34.09	466	467.11	1.11	1.48	22.97	41.5
	M(27%)	32.87	466	467.09	1.09	1.47	22.34	40.93
	M(26%)	31.66	466	467.08	1.08	1.46	21.72	40.36
	M(25%)	30.44	466	467.06	1.06	1.44	21.08	39.76
	M(24%)	29.22	466	467.04	1.04	1.43	20.44	39.15
	M(23%)	28	466	467.03	1.03	1.41	19.79	38.53
	M(22%)	26.79	466	467.01	1.01	1.4	19.14	37.89
	M(21%)	25.57	466	466.99	0.99	1.38	18.48	37.23
	M(20%)	24.35	466	466.97	0.97	1.37	17.81	36.55
	L(100%)	15.68	466	466.83	0.83	1.23	12.77	30.94
	L(20%)	3.14	466	466.45	0.45	0.83	3.81	16.89
	L(19%)	2.98	466	466.44	0.44	0.81	3.66	16.56
	L(18%)	2.82	466	466.43	0.43	0.8	3.51	16.22
	L(17%)	2.67	466	466.42	0.42	0.79	3.37	15.89
	L(16%)	2.51	466	466.41	0.41	0.78	3.21	15.52
	L(15%)	2.35	466	466.4	0.4	0.77	3.06	15.14

Location	Profile	Q Total (m³/s)	Deepest Bed Level (m)	Water surface Elevation (m)	Depth of Flow (m)	Vel Chnl (m/s)	Flow Area (m²)	Top Width (m)
	NMNL(100%)	25.12	466	466.99	0.99	1.38	18.23	36.98
	NMNL(25%)	6.28	466	466.58	0.58	0.98	6.41	21.93
	NMNL(24%)	6.03	466	466.58	0.58	0.97	6.22	21.6
	NMNL(23%)	5.78	466	466.57	0.57	0.96	6.03	21.26
	NMNL(22%)	5.53	466	466.56	0.56	0.95	5.83	20.91
	NMNL(21%)	5.27	466	466.55	0.55	0.94	5.62	20.53
	NMNL(20%)	5.02	466	466.54	0.54	0.93	5.42	20.16
	NMNL(19%)	4.77	466	466.53	0.53	0.91	5.21	19.78
	NMNL(18%)	4.52	466	466.52	0.52	0.9	5.01	19.38
	NMNL(17%)	4.27	466	466.51	0.51	0.89	4.8	18.97
	NMNL(16%)	4.02	466	466.49	0.49	0.88	4.58	18.54
	NMNL(15%)	3.77	466	466.48	0.48	0.86	4.37	18.1
6450 m d/s of Dam axis	M(100%)	121.76	463	464.45	1.45	2.02	60.34	59.84
	M(30%)	36.53	463	463.78	0.78	1.38	26.53	42.65
	M(29%)	35.31	463	463.77	0.77	1.36	25.93	42.33
	M(28%)	34.09	463	463.76	0.76	1.35	25.29	41.99
	M(27%)	32.87	463	463.74	0.74	1.33	24.68	41.66
	M(26%)	31.66	463	463.73	0.73	1.31	24.08	41.34
	M(25%)	30.44	463	463.71	0.71	1.3	23.45	40.99
	M(24%)	29.22	463	463.7	0.7	1.28	22.81	40.64
	M(23%)	28	463	463.68	0.68	1.26	22.17	40.28
	M(22%)	26.79	463	463.66	0.66	1.24	21.53	39.92
	M(21%)	25.57	463	463.65	0.65	1.23	20.87	39.55
	M(20%)	24.35	463	463.63	0.63	1.21	20.2	39.16
	L(100%)	15.68	463	463.49	0.49	1.04	15.08	36.11
	L(20%)	3.14	463	463.2	0.2	0.59	5.36	29.43
	L(19%)	2.98	463	463.19	0.19	0.58	5.17	29.28
	L(18%)	2.82	463	463.19	0.19	0.56	5.01	29.16
	L(17%)	2.67	463	463.18	0.18	0.55	4.84	29.03
	L(16%)	2.51	463	463.17	0.17	0.54	4.65	28.89
	L(15%)	2.35	463	463.17	0.17	0.53	4.46	28.74
	NMNL(100%)	25.12	463	463.64	0.64	1.22	20.62	39.41
	NMNL(25%)	6.28	463	463.29	0.29	0.76	8.31	31.61
	NMNL(24%)	6.03	463	463.29	0.29	0.74	8.15	31.49
	NMNL(23%)	5.78	463	463.28	0.28	0.73	7.9	31.31
	NMNL(22%)	5.53	463	463.27	0.27	0.72	7.69	31.16
	NMNL(21%)	5.27	463	463.27	0.27	0.71	7.42	30.97
	NMNL(20%)	5.02	463	463.26	0.26	0.69	7.24	30.83
	NMNL(19%)	4.77	463	463.25	0.25	0.69	6.96	30.63
	NMNL(18%)	4.52	463	463.24	0.24	0.67	6.76	30.49
	NMNL(17%)	4.27	463	463.24	0.24	0.66	6.5	30.29
	NMNL(16%)	4.02	463	463.23	0.23	0.64	6.26	30.11
	NMNL(15%)	3.77	463	463.22	0.22	0.63	6.01	29.93
7400 m d/s of Dam axis	M(100%)	121.76	458	459.1	1.1	1.26	96.73	196.57
	M(30%)	36.53	458	458.55	0.55	1.09	33.4	81.3
	M(29%)	35.31	458	458.54	0.54	1.08	32.55	80.51
	M(28%)	34.09	458	458.53	0.53	1.07	31.82	79.83

Location	Profile	Q Total (m³/s)	Deepest Bed Level (m)	Water surface Elevation (m)	Depth of Flow (m)	Vel Chnl (m/s)	Flow Area (m²)	Top Width (m)
	M(27%)	32.87	458	458.52	0.52	1.06	30.97	79.02
	M(26%)	31.66	458	458.51	0.51	1.05	30.19	78.29
	M(25%)	30.44	458	458.5	0.5	1.03	29.42	77.54
	M(24%)	29.22	458	458.49	0.49	1.02	28.53	76.67
	M(23%)	28	458	458.48	0.48	1.01	27.68	75.85
	M(22%)	26.79	458	458.47	0.47	0.99	26.98	75.14
	M(21%)	25.57	458	458.46	0.46	0.98	25.97	74.13
	M(20%)	24.35	458	458.44	0.44	0.97	25.08	73.23
	L(100%)	15.68	458	458.35	0.35	0.84	18.6	66.26
	L(20%)	3.14	458	458.14	0.14	0.49	6.42	50.62
	L(19%)	2.98	458	458.14	0.14	0.48	6.21	50.32
	L(18%)	2.82	458	458.13	0.13	0.47	5.99	49.98
	L(17%)	2.67	458	458.13	0.13	0.46	5.79	49.69
	L(16%)	2.51	458	458.12	0.12	0.45	5.56	49.33
	L(15%)	2.35	458	458.12	0.12	0.44	5.33	48.99
	NMNL(100%)	25.12	458	458.45	0.45	0.98	25.64	73.8
	NMNL(25%)	6.28	458	458.21	0.21	0.62	10.09	55.79
	NMNL(24%)	6.03	458	458.21	0.21	0.61	9.86	55.48
	NMNL(23%)	5.78	458	458.2	0.2	0.61	9.54	55.06
	NMNL(22%)	5.53	458	458.2	0.2	0.6	9.27	54.69
	NMNL(21%)	5.27	458	458.19	0.19	0.59	8.97	54.28
	NMNL(20%)	5.02	458	458.19	0.19	0.58	8.68	53.87
	NMNL(19%)	4.77	458	458.18	0.18	0.57	8.42	53.5
	NMNL(18%)	4.52	458	458.17	0.17	0.56	8.13	53.09
	NMNL(17%)	4.27	458	458.17	0.17	0.54	7.85	52.7
	NMNL(16%)	4.02	458	458.16	0.16	0.53	7.54	52.26
	NMNL(15%)	3.77	458	458.16	0.16	0.52	7.22	51.8
8099 m d/s of Dam axis	M(100%)	121.76	454	454.8	0.8	1.37	88.83	121.4
	M(30%)	36.53	454	454.39	0.39	0.88	41.39	110.49
	M(29%)	35.31	454	454.39	0.39	0.87	40.53	110.28
	M(28%)	34.09	454	454.38	0.38	0.86	39.66	110.07
	M(27%)	32.87	454	454.37	0.37	0.85	38.76	109.85
	M(26%)	31.66	454	454.36	0.36	0.84	37.87	109.63
	M(25%)	30.44	454	454.35	0.35	0.82	36.98	109.42
	M(24%)	29.22	454	454.34	0.34	0.81	36.04	109.19
	M(23%)	28	454	454.33	0.33	0.8	34.95	108.92
	M(22%)	26.79	454	454.33	0.33	0.78	34.18	108.73
	M(21%)	25.57	454	454.32	0.32	0.77	33.2	108.49
	M(20%)	24.35	454	454.31	0.31	0.76	32.22	108.25
	L(100%)	15.68	454	454.24	0.24	0.64	24.43	106.32
	L(20%)	3.14	454	454.09	0.09	0.34	9.13	102.41
	L(19%)	2.98	454	454.09	0.09	0.34	8.86	102.34
	L(18%)	2.82	454	454.09	0.09	0.33	8.63	102.28
	L(17%)	2.67	454	454.08	0.08	0.32	8.34	102.2
	L(16%)	2.51	454	454.08	0.08	0.31	8.03	102.12
	L(15%)	2.35	454	454.08	0.08	0.3	7.75	102.04
	NMNL(100%)	25.12	454	454.32	0.32	0.76	32.84	108.4
	NMNL(25%)	6.28	454	454.14	0.14	0.45	13.95	103.65

Location	Profile	Q Total (m³/s)	Deepest Bed Level (m)	Water surface Elevation (m)	Depth of Flow (m)	Vel Chnl (m/s)	Flow Area (m²)	Top Width (m)
	NMNL(24%)	6.03	454	454.13	0.13	0.44	13.61	103.57
	NMNL(23%)	5.78	454	454.13	0.13	0.44	13.26	103.48
	NMNL(22%)	5.53	454	454.13	0.13	0.43	12.91	103.39
	NMNL(21%)	5.27	454	454.12	0.12	0.42	12.54	103.29
	NMNL(20%)	5.02	454	454.12	0.12	0.41	12.18	103.2
	NMNL(19%)	4.77	454	454.12	0.12	0.4	11.81	103.1
	NMNL(18%)	4.52	454	454.11	0.11	0.4	11.42	103
	NMNL(17%)	4.27	454	454.11	0.11	0.39	11.04	102.9
	NMNL(16%)	4.02	454	454.11	0.11	0.38	10.65	102.8
	NMNL(15%)	3.77	454	454.1	0.1	0.37	10.19	102.68
9000 m d/s of Dam axis	M(100%)	121.76	450	450.92	0.92	1.63	74.89	97.3
	M(30%)	36.53	450	450.46	0.46	1.08	33.82	81.19
	M(29%)	35.31	450	450.45	0.45	1.07	33.08	80.87
	M(28%)	34.09	450	450.44	0.44	1.05	32.34	80.55
	M(27%)	32.87	450	450.44	0.44	1.04	31.59	80.23
	M(26%)	31.66	450	450.43	0.43	1.03	30.84	79.9
	M(25%)	30.44	450	450.42	0.42	1.01	30.07	79.56
	M(24%)	29.22	450	450.41	0.41	1	29.28	79.21
	M(23%)	28	450	450.4	0.4	0.98	28.5	78.87
	M(22%)	26.79	450	450.39	0.39	0.97	27.71	78.52
	M(21%)	25.57	450	450.38	0.38	0.95	26.89	78.15
	M(20%)	24.35	450	450.37	0.37	0.93	26.07	77.78
	L(100%)	15.68	450	450.28	0.28	0.8	19.71	74.87
	L(20%)	3.14	450	450.11	0.11	0.43	7.26	68.8
	L(19%)	2.98	450	450.11	0.11	0.42	7.03	68.68
	L(18%)	2.82	450	450.1	0.1	0.41	6.8	68.56
	L(17%)	2.67	450	450.1	0.1	0.41	6.57	68.45
	L(16%)	2.51	450	450.09	0.09	0.4	6.33	68.32
	L(15%)	2.35	450	450.09	0.09	0.39	6.08	68.2
	NMNL(100%)	25.12	450	450.37	0.37	0.94	26.59	78.01
	NMNL(25%)	6.28	450	450.16	0.16	0.56	11.13	70.74
	NMNL(24%)	6.03	450	450.16	0.16	0.56	10.85	70.6
	NMNL(23%)	5.78	450	450.16	0.16	0.55	10.57	70.46
	NMNL(22%)	5.53	450	450.15	0.15	0.54	10.29	70.32
	NMNL(21%)	5.27	450	450.15	0.15	0.53	9.98	70.17
	NMNL(20%)	5.02	450	450.14	0.14	0.52	9.69	70.02
	NMNL(19%)	4.77	450	450.14	0.14	0.51	9.39	69.87
	NMNL(18%)	4.52	450	450.13	0.13	0.5	9.08	69.72
	NMNL(17%)	4.27	450	450.13	0.13	0.49	8.77	69.56
	NMNL(16%)	4.02	450	450.13	0.13	0.48	8.45	69.4
	NMNL(15%)	3.77	450	450.12	0.12	0.46	8.12	69.24

Note:

M   –   Monsoon Season
L   –   Lean Season
NMNL   –   Non Monsoon Non Lean Season

The depth of flow for snow trout in various seasons is given in Table-10.29. The minimum depth for few months/seasons is not available even with 100% flow. Hence, in such projects, the criteria of top width & depth has been considered for assessment of Environmental Flows.

Reduction in water depth and flow width should not be more than 50% of pre-project levels. Pre-project water depth and water width are assessed by reviewing the results of 100% release scenario.

The recommended Environmental Flows for Ujh MPP is given in Table-10.17.

Table-10.17: Recommended Environmental Flows for Ujh Multi-purpose project

S. No.	Season	Percentage of Environmental Flows	Average Environmental Flows(m^3/s)
1	Monsoon *(June to September)*	26%	31.7
2	Lean Season *(October to January)*	20%	3.14
3	Non Monsoon Non Lean Season *(February to May)*	25%	6.28

10.7   COST ESTIMATES

10.7.1 Cost for Implementing Environmental Management Plan

The total amount to be spent for implementation of Environmental Management Plan (EMP) would be Rs.9693.5 crore. The details of the cost are given in Table-10.18.

Table-10.18:   Cost for Implementing Environmental Management Plan

S. No.	Item	Cost (Rs. lakh)
1.	Catchment Area Treatment Plan	9543.5
2.	Greenbelt Development Plan	50.0
3.	Energy Conservation Measures	50.0
4.	Public Awareness Programme	50.0
	Total	**9693.5**

10.8   BUDGETARY ALLOCATION FOR VARIOUS MEASURES RECOMMENDED IN CEIA REPORT

The total amount to be spent for various measures recommended in Comprehensive EIA report would be Rs.2092.00 crore. The details are given in various chapters and are summarized in Table-10.19.

Table-10.19: Cost for Implementing Various Measures Suggested as a part of Comprehensive EIA Study for Ujh Multipurpose Project

S. No.	Item	Cost (Rs. lakh)
A. Mitigation Measures		
1.	Restoration of Quarries	1410.0
2.	Stabilization of Muck Disposal Sites	710.0
3.	Solid waste Management	53.53
4.	Environmental Management in Road Construction	2400.0
5.	Control of Water Pollution	245.0

S. No.	Item	Cost (Rs. lakh)
6.	Control of Air Pollution	114.3
7.	Control for Noise Pollution	29.0
8.	Provision of Free Fuel	1084.0
9.	Compensatory Afforestation	2780.8
10.	Biodiversity Conservation Plan	256.0
11.	Wildlife protection Plan	274.07
12.	Fisheries Management Plan	146.48
13.	Public Health Delivery System	236.31
	Sub-Total (A)	**9739.49**
B. Additional Measures		
14.	Rehabilitation and Resettlement	179351.0
15.	Livelihood Plan	1119.00
16.	Corporate Environmental Responsibility	2930.0
17.	Local Area Development Plan	5850.0
18.	Monitoring and Implementation of R& R plan.	300.0
19.	Disaster Management Plan	200.0
	Sub-Total (B)	**189750.0**
C. Environmental Management Plan		
20.	Catchment Area Treatment Plan	9543.5
21.	Greenbelt Development Plan	50.0
22.	Energy Conservation Measures	50.0
23.	Public Awareness Programme	50.0
	Sub-Total (C)	**9693.5**
D. Environmental Monitoring Programme		
24.	Implementation of Environmental Monitoring Programme during construction stage	17.068
	Sub-Total (D)	**17.068**
	Grand Total (A+B+C+D)	**209200.058 lakh**