CATCHMENT AREA TREATMENT PLAN

FOR

SHAHPUR STANDALONE PUMPED STORAGE PROJECT

SUBMITTED TO

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1.0 INTRODUCTION

1.1 General

Shahpur Standalone Pumped Storage Project (PSP) with an installed capacity of 1800 MW / 10800 MWH storage capacity is located at Shahabad Tehsil, Baran District, Rajasthan. It envisages creation of upper reservoir & lower reservoir which are located away from all existing natural river systems and have negligible catchment areas. The project sites are accessible from NH-76 road close to Mahuri Khera from where Shahpur village road takes off; and is at a distance of approximately 6 Km. Nearest railhead is Baran Railway Station, about 77 kms from project site and nearest Airport is Gwalior Airport, about 200 km from project site The powerhouse is located near Shahpur village, which is in Shahabad Tehsil of Baran district.

This scheme envisages non-consumptive re-utilization of water by re-circulation. The water from the proposed lower reservoir will be pumped up and stored in the proposed upper Reservoir and will be utilized for power generation. The Geographical co-ordinates of the proposed upper reservoir are at longitude 77° 10' 55.78"E and latitude is 25° 11' 25.21"N and that of proposed lower reservoir are 25°11'40.00"N and 77° 11' 50.00"E. The project location map is enclosed as **Figure 1**.

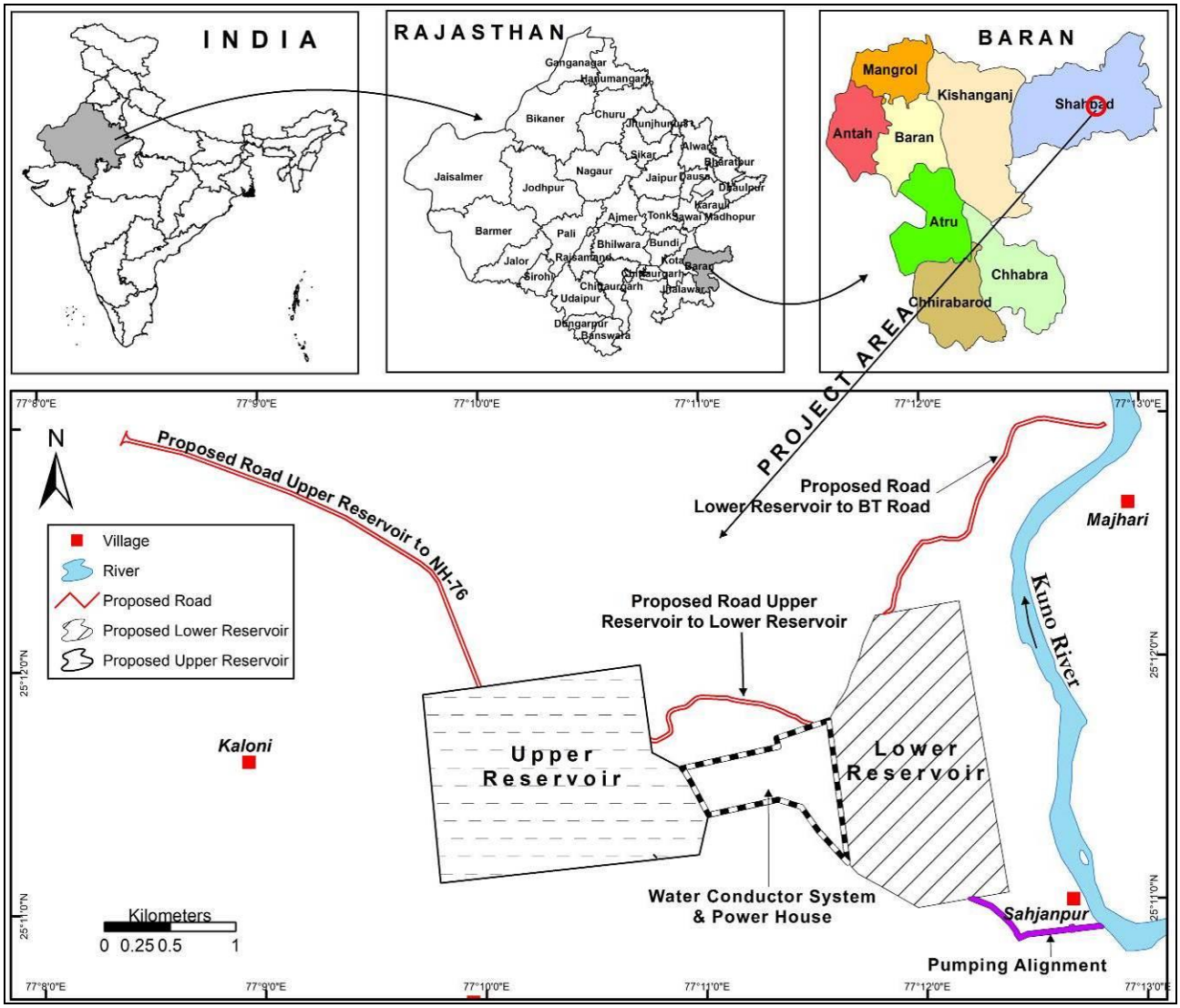

Figure 1: Location Map of Shahpur Standalone Pumped Storage Project

The Shahpur Standalone Pumped Storage Project envisages construction of both upper reservoir and lower reservoir in Baran district of Rajasthan and involves construction of rockfill embankment with avg height of 24.5 m for the length of 5309 m for creation of Shahpur PSP upper reservoir with 1.21 TMC gross capacity and construction of rockfill embankment with avg height of 26.5 m for the length of 2937 m for creation of Shahpur PSP lower reservoir with 1.05 TMC gross capacity. Total 6 numbers of Independent Head Race Pipe / Pressure Shaft with one pressure Tunnel bifurcating into two-unit pressure tunnel convey water between Lower and Upper reservoirs. Surface Power/Pump House will be located at about 830 m from the intake structure and shall be equipped with six vertical shaft reversible Francis type units composed each of a generator/motor and a turbine/pump having generating/pumping capacity of 300 & 150 MW/330 & 165MW.

1.2 Salient Features

The salient features of the proposed Shahpur Standalone Pumped Storage Project are given in **Table 1**.

Table 1: Salient Features of Shahpur Standalone Pumped Storage Project

1		Name of the Project	Shahpur Standalone Pumped Storage Project (5 x 300 MW + 2 x 150 MW)
2		**Location**	
	a	Country	India
	b	State	Rajasthan
	c	District	Baran
	d	Village near Powerhouse	Shahpur
3		**Geographical Co-Ordinates**	
	a	Shahpur Standalone PSP Upper Reservoir- (Now Proposed)	
		Latitude	25°11'25.21"N
		Longitude	77°10'55.78"E
	b	Shahpur Standalone PSP Lower Reservoir - (Now Proposed)	
		Latitude	25°11'40.00"N
		Longitude	77°11'50.00"E
4		**Access to Project Site**	
	a	Airport	Gwalior Airport – 200 km from project site
	b	Railway Station	Baran Railway Station, 77 km from project site
	c	Road	NH 76 – 6Kms
	d	Port	Kandla Port - 980 km from project site
5		**Project**	
	a	Type	Standalone Pumped Storage Project
	b	Storage Capacity	10800 MWH
	c	Rating	1800 MW
	d	Peak Operation Duration	6 hours
6		**Shahpur Standalone PSP - Upper Reservoir**	
	a	Live Storage	1.01 TMC (28.60 MCM)
	b	Dead Storage	0.20 TMC (5.66 TMC)
	c	Gross Storage	1.21 TMC (34.28 TMC)
7		**Upper Reservoir**	
	a	Full Reservoir level (FRL)	EL 507.00 m

	b	Min. Draw Down Level (MDDL)	EL 490.00 m
	c	Top Bund Level (TBL)	EL 510.00 m
	d	Type of Embankment	Asphalt Faced Rockfill Embankment
	e	Max. Height of Embankment	30 m
	f	Average Height of Embankment	24.5 m
	g	Length at the top of Embankment	5309 m
	h	Top width of the Embankment	10.0 m
	i	Type of Power Block	Gates with Concrete Breast Walls
	j	Top Level of Power Block	510.00 m
	k	Maximum Height of Power Block	38.5 m
	l	Length at the top of Power Block	162.0 m
	m	Top width of Road at Power Block	10.0 m
8		**Shahpur Standalone PSP - Lower Reservoir**	
	a	Live Storage	1.01 TMC (28.32 MCM)
	b	Dead Storage	0.05 TMC (1.42 MCM)
	c	Gross Storage	1.05 TMC (29.74 MCM)
9		**Lower Reservoir**	
	a	Full Reservoir level (FRL)	EL 349.00 m
	b	Min. Draw Down Level (MDDL)	EL 328.00 m
	c	Top Bund Level (TBL)	EL 352.00 m
	d	Type of Embankment	Asphalt Faced Rockfill Embankment
	e	Average Height of Embankment	26.5 m
	f	Length of Embankment	2937 m
10		**Intake Structure**	
	a	Type	Diffuser Type
	b	No. of Vents	3 nos.
	c	Size of Each Intake	24.00 m (W) x 11.2 m (H) including piers
	d	Length of each Intake	38.98 m (covered with RCC slab at top up to Intake Gate)
	e	Elevation of Intake center line	EL 476.30 m
	f	Elevation of Intake bottom	EL 472.55 m
	g	Design Discharge of each Intake (Turbine mode)	220.04 cumec for 300 MW Unit and 220.50 cumec for 150 MW Units
	h	Trash rack type	Vertical with inclination of 15°
	i	Size of Trash Rack	3 nos. of 7.00 m (W) x 11.60 m (Inclined Height) for each unit
	j	Numbers & Size of Intake Service Gate	6 nos. of 6.20 m (W) x 7.50 m (H)
	k	Numbers & Size of Intake Emergency Gate	1 set – 6.20 m (W) x 7.50 m (H) with Moving Gantry Crane
11		**Head Race Pipe /Pressure Shafts**	
	a	Type	Finished steel lined - circular
	b	Number of Head Race Pipe / Pressure Shaft	Total 6 No. of Independent Head Race Pipe / Pressure Shaft with one pressure Tunnel bifurcating into two unit pressure tunnel
	c	Diameter of Horizontal Pressure Tunnel	7.5 m
	d	Diameter of unit Pressure Tunnel	5.3 m
	e	Length of Head Race Pipe / Pressure Shaft	830 m (6 nos.) Length of Head Race Pipe from Intake to Vertical Pressure Shaft - 663 m Length of Vertical Pressure Shaft - 72 m Length of Horizontal Pressure Tunnel - 95 m
	f	Length of Unit Pressure Tunnel	About 50 m each

	g	Design Discharge of each Head race Pipe / Pressure Shaft	220.04 cumec for 300 MW unit and 220.50 cumec for 150 MW units
	h	Design Discharge of each unit Pressure Tunnel	110.25 cumec
	i	Maximum velocity in the Head Race Pipe / Pressure shaft	4.99 m/sec
	j	Maximum velocity in the Unit Pressure Tunnel	4.99 m/sec
12		**Powerhouse**	
	a	Type	Surface Pit Type Powerhouse
	b	Centre line of Unit	EL 298.0 m
	c	Dimensions (Excluding service bay)	196.166 m (L) x 28.5 m (W) x 61.5 m (H)
	d	Size of Service Bay	40 m (L) x 28.5 m (W)
	e	Service Bay Level	EL 313.72 m
	f	Size of Unloading Bay	25m (L) x 28.5 m (W)
	g	Unloading Bay Level	EL 336.70 m
13		**Tail Race Tunnel**	
	a	Type & Shape	Concrete Lined – Circular
	b	Number of Tunnels	7 Nos.
	c	Dia. of Tunnel for 300 MW Unit	8.50 m
	d	Dia. of Tunnel for 150 MW Unit	6.20 m
	e	Length of the Tunnel	179 m for 8.5 m dia as well as for 6.2 m dia
	f	Design Discharge for 300 MW Unit	220.04 cumec
	g	Design Discharge for 150 MW Unit	110.25 cumec
14		**Tailrace Outlet**	
	a	Type	Diffuser Type
	b	No. of Outlet	7 Nos.
	c	Size of each outlet	For 300 MW Unit - 24.00 m (W) x 12.50 m (H) including piers For 150 MW Unit - 18.00 m (W) x 9.0 m (H) including piers
	d	Length of each Outlet	31.40 m (covered with RCC slab at top up to Intake Gate)
	e	Elevation of outlet center line	For 300 MW Unit - EL + 315.30 m For 150 MW Unit - EL + 314.15 m
	f	Elevation of Outlet bottom	EL + 311.05 m for 300 MW as well as 150 MW unit
	g	Trash rack Type	Vertical with inclination of 15°
	h	Size of Trash rack	For 300 MW Unit - 3 sets of 7.0 (W) x 12.94 m (Inclined Height) for each unit For 150 MW Unit - 3 sets of 5.0 (W) x 9.32 m (Inclined Height) for each unit
	i	Tailrace outlet Service Gate	5 nos. of 6.00 m (W) x 8.50 m (H) and 2 nos. of 4.20 m (W) x 6.20 m (H)
	j	Tail Race outlet Emergency Gate	1 set - 6.00 m (W) x 8.50 m (H) 1 set - 4.20 m (W) x 6.20 m (H) with one common Gantry Crane
15		**Tailrace Channel**	
	a	Type	Trapezoidal shape with concrete lined
	b	Bed Width	140.0 m
	c	Length of channel	717 m
	d	Full Supply Depth	6.8 m
	e	Bed Slope	1:6400
	f	Side Slope	1H:6V
16		**Electro-Mechanical Equipment**	

	a	Pump Turbine	Francis type, vertical shaft reversible pump-turbine
	b	Total No of units	5 nos. (5 X 300 MW) + 2 nos. (2x150 MW)
	c	Total Design Discharge (Turbine Mode)	1320.70 cumec (5 x 220.04 cumec + 2 x 110.25 cumec)
	d	Rated Net Head in Turbine mode	154.73 m for 300 MW unit and 154.41 m for 150 MW unit
	I	**300 MW Turbines**	
	a	Total No of units	5 Units (All fixed Speed)
	b	Turbine Design Discharge	220.04 cumec
	c	Pump Capacity	330 MW
	d	Rated Pumping Head	162.56 m
	e	Rated Pump Discharge	190.96 cumec
	f	Synchronous Speed	187.50 rpm
	II	**150 MW Turbines**	
	a	Total No of units	2 Units (All Fixed Speed)
	b	Turbine Design Discharge	110.25 cumec
	c	Pump Capacity	165 MW
	d	Rated Pumping Head	163.21 m
	e	Rated Pump Discharge	95.10 cumec
	f	Synchronous Speed	250.00 rpm
	III	**Generator-Motor**	
	a	Type	Three (3) phases, alternating current synchronous generator motor semi umbrella type with vertical shaft
	b	Number of units	5 Units (5 x 300 MW) and 2 Units (2x150 MW)
	c	Rated Capacity	Generator – 300 MW & 150 MW Pump Input – 330 MW & 165 MW
	d	Rated Voltage	18.0 kV
	IV	**Main Power Transformer**	
	a	Type	Outdoor Single-Phase Power transformers with On Load Tap Changer (OLTC)
	b	Number of units	23 Nos. i.e., 3 nos. per unit & 2 no spare
	c	Rated Capacity of each unit	16 no. (3x5 Working +1 Spare) of Single Phase, 18 kV/400kV, 123 MVA and 7 no. (2 x 2 Working + 1 spare) of Single Phase, 18 kV/400kV, 62 MVA
	d	Rated Voltage	Primary – 18.0 kV; Secondary - 400 kV adjustable range of the secondary voltage: ±10% in steps of 1.25%
17		**400 KV Gas Insulated Switchgear**	
	a	Type of GIS	Indoor Type
	b	No. of GIS units	1 No.
	c	Location	Inside GIS building above ground
	d	Scheme	Double Bus Scheme with coupler and sectionalizer
18		**Power Evacuation**	
	a	Voltage Level (kV)	400 kV
	b	No. of Transmission Lines	One no. 400 kV double circuit transmission lines
	c	Conductor	Quad Moose
	d	Total Length	One 400 kV Double Circuit Transmission Line of length 75 km (approx.) from PSP will be connected to **400/765 kV PGCIL substation at New Shivpuri of Madya Pradesh State** for

			evacuation of stored power during generating mode and for supply of power during pumping mode.
19		**Estimated Cost**	
	a	Civil & Other works	4782.91
	b	E&M Works including Transmission	3096.20
	c	IDC & Others	1842.65
		Total Project Cost with IDC	9721.76

Source: Pre-Feasibility Report of Shahpur Standalone Pumped Storage Project

2.0 NEED FOR CATCHMENT AREA TREATMENT

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 steady erosion and sediment in reservoir reduce its capacity, and thus affecting 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 land productivity in the area. Thus, a well-designed Catchment Area Treatment (CAT) Plan is essential to ameliorate the above-mentioned adverse effects of soil erosion in general for normal hydroelectric projects (run of the river schemes). However, in the instant case of pumped storage project which are located away from normal river course and involves no catchment area, CAT plan is not applicable. But considering the surrounding area which are prone to soil erosion, it was felt that preparation of CAT plan will helps to mitigate soil erosion around the project area.

Soil erosion can be defined as detachment, transportation and deposition of soil particles from one place to other by means of transporting agent like air, water or animals. Soil erosion is mainly affected by rainfall intensity and runoff, slope gradient and length, soil erodibility and vegetation cover (landuse pattern). Therefore, study of erosion and sediment yield from catchments are of great importance. Soil erosion leads to:

- loss in production potential
- reduction in infiltration rates
- reduction in water-holding capacity
- loss of nutrients
- increase in tillage operation costs
- reduction in water supply

To control the rate of soil erosion in the catchment, Catchment Area Treatment (CAT) is an ineluctable part. The CAT plan pertains to preparation of a management plan for treatment of erosion prone areas through adequate preventive measures. An effective CAT plan is a key factor to make the project eco-friendly and sustainable. Thus, a well-designed Catchment Area Treatment (CAT) Plan is essential to ameliorate the above mentioned adverse process of soil erosion. CAT plan essentially consists of following steps.

1. Calculation of soil erosion using Revised Universal Soil Loss Equation (RUSLE), combined with Remote Sensing (RS) and Geographic Information System (GIS) technologies.
2. Prioritizing the areas for treatment using Silt Yield Index (SYI).
3. Planning of suitable erosion control measures.
4. Cost estimation for CAT plan.

3.0 METHODOLOGY ADOPTED FOR THE STUDY

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

- Defining study area
- Defining data requirement
- Data acquisition and preparation
- Output presentation

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

3.1 Defining Study Area

Purpose of the study is preparation of CAT plan for the Catchment Area of Shahpur Standalone Pumped Storage Project. Since the project involves construction of two different reservoirs therefore catchment area of both the reservoirs has been considered as study area. The total catchment area of both the reservoirs is **6.48 sq km**. The catchment area of both the reservoirs falls in Survey of India Toposheet No. 54G/4. In order to plan watershed management and to formulate action plans it requires subwatershed delineation, therefore, catchment area was further delineated into subwatershed. For the delineation of subwatershed, Watershed Atlas of India prepared by Soil and Land Use Survey of India (SLUSI) has been referred.

Soil and Land Use Survey of India (SLUSI) has Watershed Atlas of India under digital environment using GIS and produced a Digital Watershed Atlas (DWA) where the delineation and codification of watersheds in the country has been undertaken in GIS environment. The delineation for DWS has been done in seven stages starting with Water Resource Regions and their subsequent division and subdivisions into Basins, Catchments, Subcatchments, Watersheds, Subwatersheds and Microwatersheds in decreasing size of the delineated hydrologic unit.

As per Watershed Atlas of India, catchment areas of both the reservoirs falls in a two subwatersheds. Catchment area of lower reservoir falls in a single subwatershed, coded as 2D1B5f. Whereas, catchment area of upper reservoir falls in two subwatersheds, coded as 2D1B5f and 2D1B5c. The nomenclature of the subwatersheds forming the catchment area has been assigned as follows: Region (2) “Ganges drainage”; Basin (2D) “Chambal”; Catchment (2D1) “Chambal up to Banas confluence”; Subcatchment (2D1B); Watershed (2D1B5) “Kunu”; Subwatershed 2D1B5c and 2D1B5f **(**refer **Figure 2)**.

3.2 Defining Data Requirement

Soil loss has been calculated through RUSLE (Revised Universal Soil Loss Equation) model which is computed by the following equation:

Soil Loss (A) = R*K*LS*C*P

Wherein;

A = Soil loss (Tons/ha/year)

R is Rainfall & Runoff Erosivity Factor (MJ mm/ha-1/h-1/year-1), which depends upon the annual average rainfall in mm. Data required for R factor is rainfall intensity.

K is Soil Erodibility Factor (Tons/ha/h/ha-1/MJ-1/mm-1), which depends on the organic matter, texture permeability and profile structure of the soil. Also, it is a constant value for each soil type. Data required for K factor is soil type.
LS is Topographic Factor (dimensionless) which depends upon flow accumulation and steepness and length of slope in the area. Data required for LS factor is slope length and slope gradient.

C = Vegetation Cover and Crop Management Factor (dimensionless), which is the ratio of bare soil to vegetation and non- photosynthetic material. It is a constant value for each land use category. Data required for C factor is land use/ land cover.

P is Conservation Supporting Practice Factor (dimensionless), which takes into account specific erosion control practices like contour bunding, bench terracing etc.

3.3 Data Acquisition and Preparation

The data on various aspects was collected from different sources. Soil map of the Catchment Area was prepared from soil map of Rajasthan procured from Regional Centre of National Bureau of Soil Survey & Land Use Planning (NBSS&LUP), New Delhi. For the preparation of DEM and preparation of Slope map, Shuttle Radar Topography Mission (SRTM) 3 Arc-Second Global Digital Terrain Elevation Data (DTED) has been used. For the preparation of land use/ land cover, forest cover map prepared by Forest Survey of India, map prepared by National Remote Sensing Centre (NRSC), Indian Space Research Organisation (ISRO) of Dept. of Space with Partner Institutions viz., State Remote Sensing Application Centre, Dept. of S&T, Govt. of Rajasthan has been used. The rainfall data in the Catchment Area has been sourced from Climatic Research Unit (CRU), a component of the University of East Anglia and one of the leading institutions concerned with the study of natural and anthropogenic climate change.

3.3.1 Rainfall Erosivity (R) Factor

R factor is a function of the falling raindrop and rainfall intensity and is estimated as the product of the kinetic energy (E) of the raindrop and the maximum intensity of rainfall (I30) over duration of 30 min in a storm. The erosivity of rain is calculated for each storm, and these values are summed up for each year. In this study, the storm wise rainfall data were not available for the computation of rainfall erosivity factor (R); therefore, the relationship between seasonal value of R and average rainfall has been used. The rainfall erosivity factor has been defined as R = 81.5 + 0.38X, where, R is the average seasonal erosivity factor (MJ mm/ha^{-1}/h^{-1}/year^{-1}), and X is the annual average rainfall (mm).

For the estimation of rainfall erosivity in the Catchment Area, average rainfall of 10 years has been taken from the High-resolution gridded CRU datasets. In the absence of site specific periodic data, CRU data from the year 2011 to 2020 has been used for the calculation of R factor. In and around the Catchment Area, average rainfall of 10 years have been taken from the rain gauge station for the estimation of rainfall erosivity. The rainfall erosivity factor (R) has been calculated using equation R = 81.5 + 0.38X for annual average rainfall of observed and simulated data. The value of R i.e. 384.51 has been adopted in this study to calculate soil erosion using RUSLE.

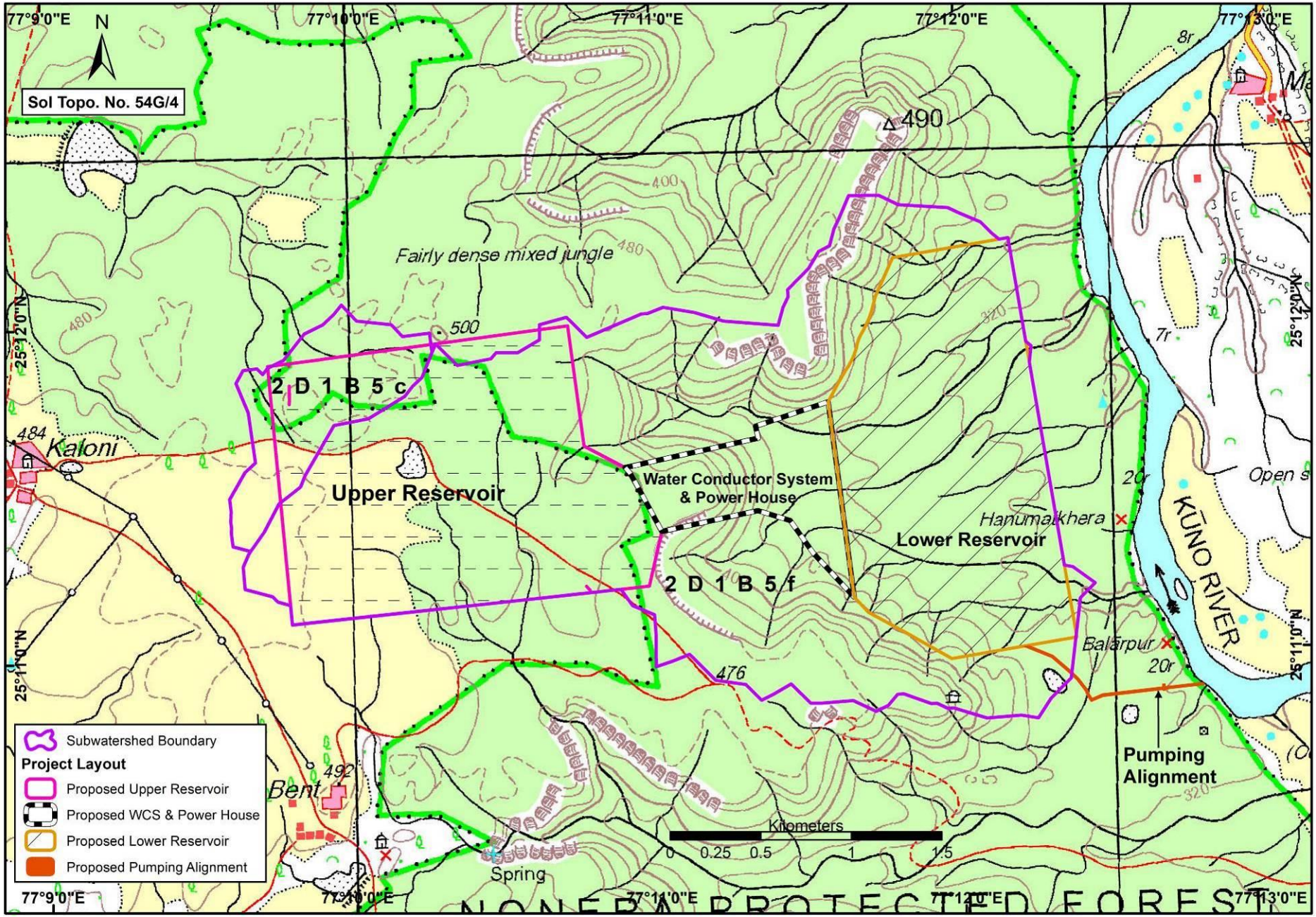

Figure 2: Catchment Area Map of Shahpur Standalone Pumped Storage Project

3.3.2 Soil Erodibility (K) Factor

The K factor is an expression of the inherent erodibility of the soil or surface material at a particular site under standard experimental conditions. It is a function of the particle-size distribution, organic-matter content, structure, and permeability of the soil or surface material. Prior to deciding the K values, soil map for the area is prerequisite. Soil map procured from NBSS&LUP, Nagpur was digitized. Mapping Unit 351, characterised by deep, moderately well drained, fine soils on very gently sloping plateau with clayey surface, slight erosion covers 71.73% of the catchment area. Rest 28.27% of the catchment area is covered by Mapping Unit 340, characterised by rock-outcrops; associated with: shallow, well drained, loamy-skeletal soil, on very gently sloping foot slopes, severely eroded. Soil map has been shown in **Figure 3**. The legend for soil mapping unit classes is given in **Table 2**. As per the soil map of the Catchment Area, the soil can be classified in two categories. Shallow with loamy skeletal texture and severe erosion have high K value i.e. 0.325, because they are less susceptible to particle detachment and they produce runoff at high rates. Deep with fine texture and slight erosion have low K value i.e. 0.15.

Table 2: Description of Soil Mapping Units in the Catchment Area

Mapping Unit	Description	Taxonomic Classification	Area (ha)	Area (%)
340	Rock-outcrops; associated with: Shallow, well drained, loamy-skeletal soil, on very gently sloping foot slopes, severely eroded.	• Rock-outcrops • Lithic Ustochrepts	183.18	28.27
351	Deep, moderately well drained, fine soils on very gently sloping plateau with clayey surface, slight erosion; associated with: Deep, well drained, fine soils, moderately eroded.	• Typic Chromusterts • Typic Chromusterts	464.82	71.73
	Total		**648.00**	**100**

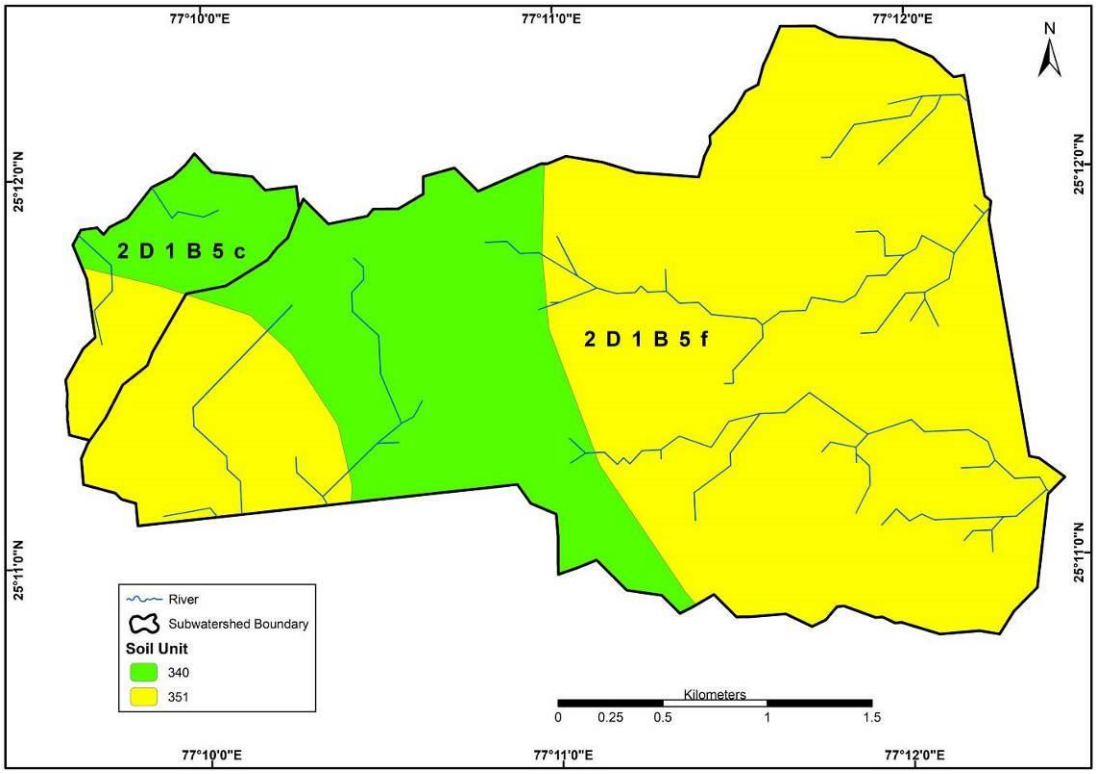

Figure 3: Soil Map of Catchment Area
(For details of Soil Unit legend refer Table 2)

3.3.3 Topographic (LS) Factor

The LS factor is an expression of the effect of topography, specifically hill slope length and steepness, on rates of soil loss at a particular site. The value of 'LS' increases as hill slope length and steepness increase, under the assumption that runoff accumulates and accelerates in the down-slope direction. Digital Elevation Model (DEM) and Slope of a particular area is prerequisite for LS factor. As already discussed, Shuttle Radar Topography Mission (SRTM) 3 Arc-Second Global Digital Terrain Elevation Data (DTED) has been used for DEM and the same DEM has been used for the preparation of slope map. The LS factor prepared for the Catchment Area is given at **Figure 4**.

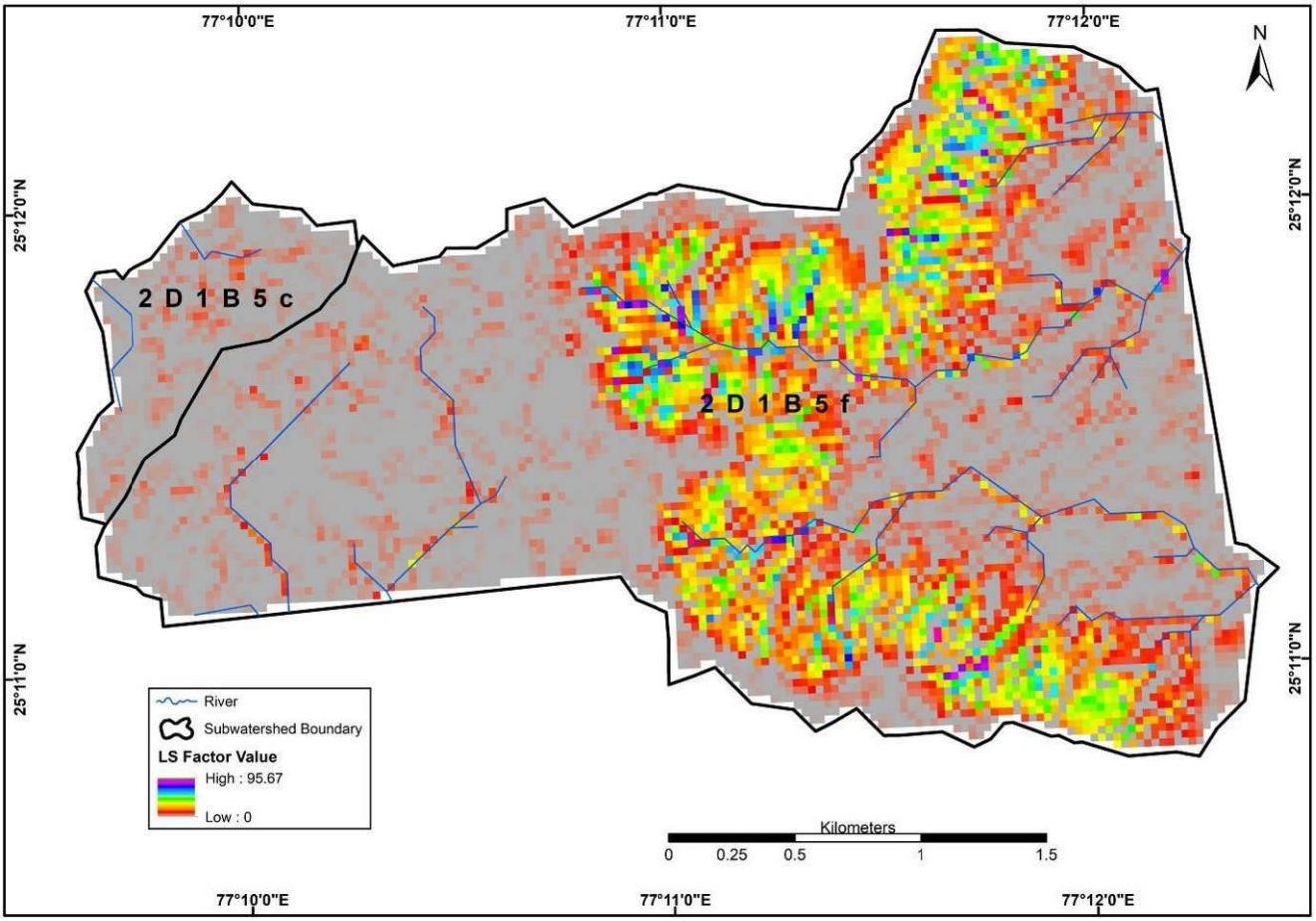

Figure 4: LS Factor Map of Catchment Area

3.3.4 Crop Management (C) Factor

The C factor is an expression of the effect of surface cover and roughness, soil biomass, and soil-disturbing activities on rates of soil loss at a particular site. The value of C decreases as surface cover and soil biomass increase, thus protecting the soil from rain splash and runoff. In the present study, forest cover map prepared by Forest Survey of India and land use/land cover map prepared by National Remote Sensing Centre (NRSC), Indian Space Research Organisation (ISRO) of Dept. of Space with Partner Institutions viz., State Remote Sensing Application Centre, Dept. of S&T, Govt. of Rajasthan has been used in the allocation of C factor for different land use classes.

The classified land use/ land cover map of the Catchment Area is shown as **Figure 5**. The land use/ land cover pattern of the Catchment Area has been given in **Table 3**. As can be seen from the map and table, the land use/ land cover pattern can be classified into six classes, out of

these, majority of the area i.e. 41.04% is covered by Open Forest, followed by Moderately Dense Forest, covering 27.38%. Fallow Land is covering 12.92% of the area. Scrub Land is covering 11.78% of the area. Agricultural Land is covering 6.84% of the area. Rest 0.04% of the area is covered by Waterbody.

Table 3: Area Falling Under Different Land Use/ Land Cover Classes

Land use/ Land cover Classes	Area (ha)	Area (%)
Moderately Dense Forest	177.43	27.38
Open Forest	265.93	41.04
Scrub Land	76.36	11.78
Agricultural Land	44.31	6.84
Fallow Land	83.70	12.92
Waterbody	0.27	0.04
Total	**648**	**100**

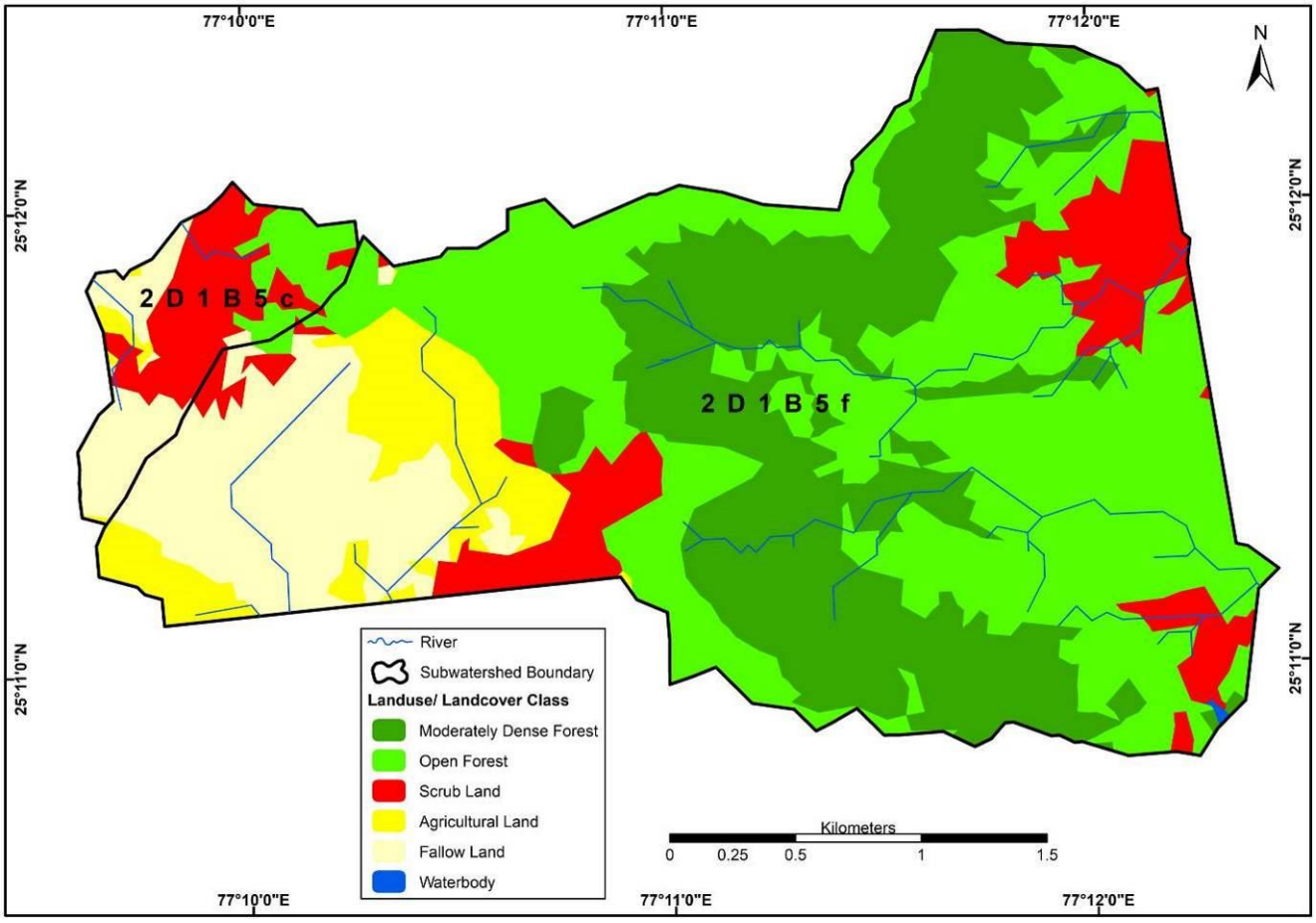

Figure 5: Land use/ Land cover Map of Catchment Area

3.3.5 Conservation Support Practice (P) Factor

The P factor is an expression of the effects of supporting conservation practices, such as contouring, buffer strips of vegetation, and terracing, on soil loss at a particular site. It is the ratio of soil loss with specific support practice to the corresponding loss with up-or down-slope cultivation. In the present study, the P factor has been considered as 1.

3.4 Output Presentation

A thematic map for soil loss of the Catchment Area has been prepared using RUSLE model mentioned in the above section. The Catchment Area was then demarcated into different soil

erosion intensity mapping units or classes based upon the extent of soil loss (see **Table 4 & Figure 6**). The Catchment Area under different Erosion Intensity categories is given in **Table 4**. As can be seen from the figure and table, around 44% of the catchment area is prone to less than 1 tons/ha/annum soil erosion, i.e. under negligible erosion intensity category and around 5% of its area is prone to Severe and Very Severe soil erosion.

Table 4: Area falling under different Erosion Intensity Categories

S. No.	Soil loss in tons/hectare/annum	Erosion Intensity Category	Area (ha)	Area (%)
1	<1	Negligible	283.58	43.76
2	1-5	Slight	120.02	18.52
3	5-10	Very Low	63.90	9.86
4	10-20	Low	72.83	11.24
5	20-40	Moderate	75.68	11.68
6	40-80	Severe	25.86	3.99
7	>80	Very Severe	6.12	0.95
Total			**648.00**	**100**

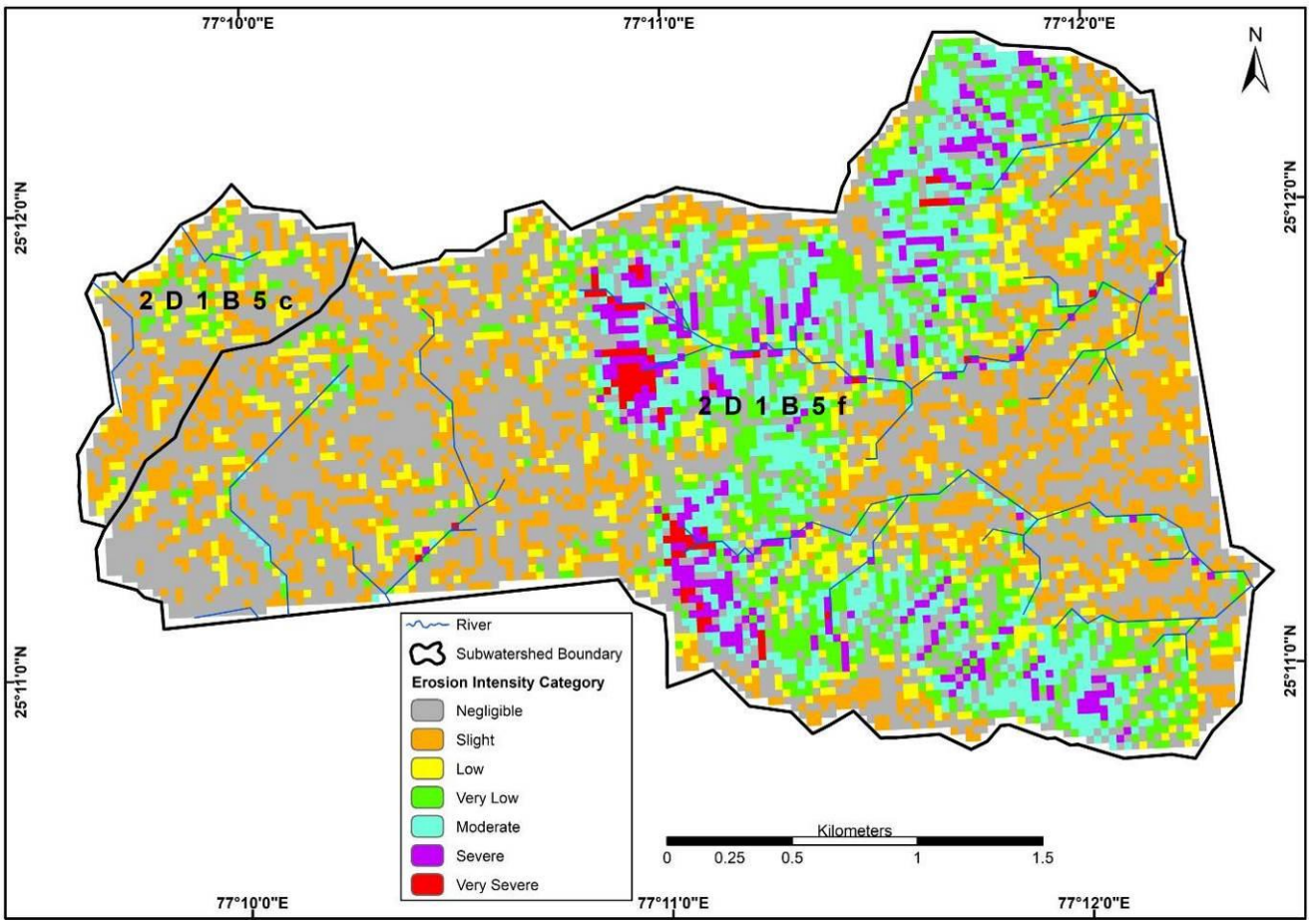

Figure 6: Erosion Intensity Map of Catchment Area

3.5 Prioritization

`Silt Yield Index' (SYI), method conceptualized by Soil and Land Use Survey of India (SLUSI) is being used for prioritization of smaller hydrologic units within river valley project areas. Since the catchment area is only 6.48 sq km and could be delineated into only two subwatersheds therefore, it is proposed to consider same priority for both the subwatersheds.

4.0 TREATMENT PLAN

4.1 Area to be taken up for Treatment

Areas under severe and very severe erosion intensity category will be taken up for treatment. To arrive at such an area, first of all areas under severe and very severe erosion intensity category were extracted, which comes out to be **31.98 ha** (refer **Table 5**). Thereafter, areas under severe and very severe erosion intensity category falling within the proposed project components such as lower reservoir, upper reservoir, water conductor system, etc. were removed as once the project is constricted this area will not be available for treatment. The area thus arrived at and considered as treatable area comes out to be 25.91 ha (or say **26** ha).

From the map given at Figure 6 it can be seen that the areas under severe and very severe erosion intensity category falls under 2D1B5f subwatershed only. Further, the landuse and landcover classes falling inside this 25.91 ha of severe and very severe erosion intensity category area are Moderately Dense Forest (18.81 ha) and Open Forest (7.10 ha).

The period for implementing Catchment Area Treatment Plan interventions including maintenance has been taken as 7 years. It is proposed to prepare micro plans, establish administrative setup and implement other entry point activities in the first year itself, followed by implementation of treatment measures in second year. Maintenance period (only for biological measures) will be for subsequent 5 years.

4.2 Treatment Measures

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.

4.2.1 Biological Measures

The biological measures would comprise of:

- Normal Afforestation
- Assisted Natural Regeneration

4.2.1.1 Normal Afforestation

A well stocked forest is the best insurance against soil loss as well as for ecological rehabilitation. It is therefore proposed to increase the vegetation cover in the tract. For this, patches of scrub forest falling under severe and very severe erosion intensity category shall be brought under afforestation. The locality factors prevalent in the area such as fires, grazing etc. are fairly adverse to the establishment of plantations. Thus, special and intensive efforts are needed to ensure the success of afforestation work. Owing to the above enumeration factors, the plantation will require higher levels of maintenance also. This will include raising of multi-tier mixed vegetation of suitable local species. 1100 plants per hectare will be

planted under this scheme. Planting will be done in pits. Earth work should be done well in advance. Plants should be healthy with strong stems. Planting should be done in June when the water supply starts. RCC fence posts with 4 strand barbed wire fencing, interlaced with thorny bushes will be done in the plantation areas. Further, it is assessed that it is essential to make provision for soil and moisture conservation measures in the areas proposed for afforestation. Provision had been made for undertaking various necessary soil and moisture conservation measures in these areas. Provision is also made for five years maintenance of afforestation undertaken as part of the Sub-watershed management. For providing the maintenance it is assumed that mortality during first year will be 25 per cent and will reduce to 20 per cent during second year and to 15 per cent during third, fourth and fifth year. The unit cost for afforestation including maintenance cost for five years is estimated to be Rs 86,380 per ha consisting of Rs 58,900 for plantation and Rs 27,480 for maintenance for five years. The detailed estimate is furnished in **Annexure-I**. The area to be brought under normal afforestation is **7 ha**. Map showing area to be brought under normal afforestation is given as **Figure 7**.

4.2.1.2 Assisted Natural Regeneration

In moderately dense forests, conditions are conducive to natural regeneration provided some sort of assistance is provided. Such area shall be taken up under this component. The areas shall be closed to reduce biotic interference. Ground surface will be cleared of slash, debris and felling refuse to afford a clean seed bed to the falling seed. At certain places some soil raking may also have to be done to facilitate germination of seeds. Where natural regeneration is found deficient. It will be supplemented by artificial planting. Patch sowing in suitable areas may also be done. 250 plants per hectare will be planted under this scheme. The plantation will be maintained for subsequent five years. Wooden fence posts with 4 strand barbed wire fencing, interlaced with thorny bushes will be done in the plantation areas. The unit cost for assisted natural regeneration including maintenance cost for five years is estimated to be Rs. 39,240 per ha consisting of Rs. 25,700 for plantation and Rs. 13,540 for maintenance for five years. The detailed estimate is furnished in **Annexure-I**. The area to be brought under assisted natural regeneration is **19 ha**. Map showing area to be brought under assisted natural regeneration is given as **Figure 7**.

4.2.2 Engineering Measures

Gullies in their upper reaches only must be treated to prevent further deepening and widening. The purpose of engineering measures is to reduce the gradient, reduce the flow velocity and protect the stream bank. The water is guided safely from a higher elevation to a lower elevation without causing erosion at the gully/nala bed and banks. The water pools behind the engineering promotes the percolation into the soils. Check dam is one such engineering measure. The other engineering measures proposed for soil & water conservation includes Gabion structures, Continuous Contour Trench (CCT), Mini Percolation Tank (MPT) etc. A lumpsum amount of **Rs. 6.50 lakh** has been kept for various engineering measures. Map showing the nalas on which check dams have been proposed and area for other engineering measures is given as **Figure 7**.

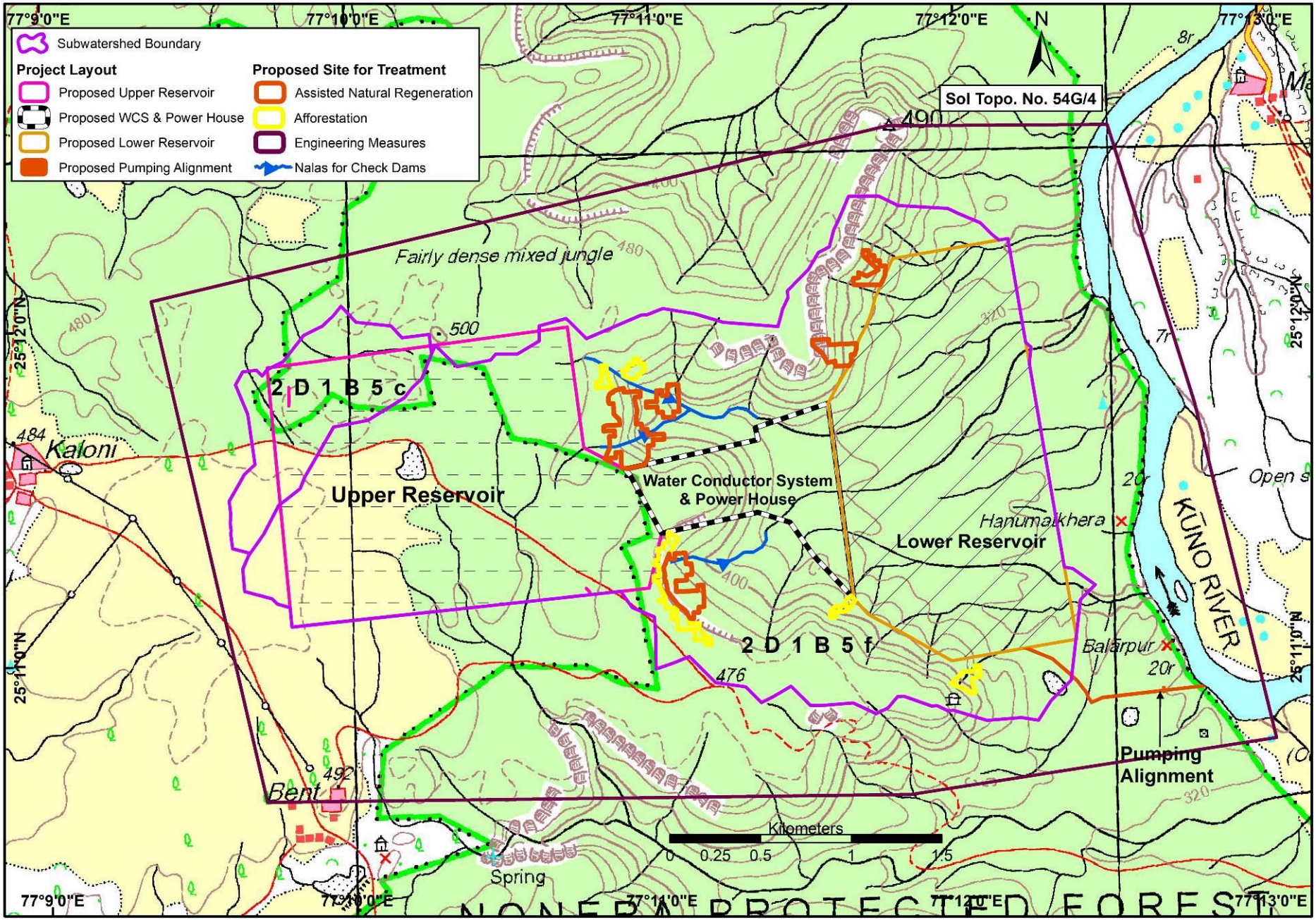

Figure 7: Map showing Areas proposed for Treatment Measures

5.0 OTHER COMPONENTS OF CAT PLAN

Apart from the biological and engineering treatment measures in the Catchment Area there are other aspects of the CAT Plan to be addressed and their cost included in the overall cost estimate of the plan. The charges for operational support, forest protection, social mobilization, documentation and publication, monitoring and evaluation and providing environmental services are some of the integral ingredients which have to be considered and included while formulating the CAT plans.

5.1 Administrative Charges

For an efficient management of forest resources, it is essential that operational support to the Forest Department is adequately developed. Similarly, in remote localities there are no places for shelter for the staff, people and trekkers. Therefore, a budgetary provision of **Rs. 1.00 lakh** has been kept as administrative charges.

5.2 Provision for Micro Planning

The year-wise areas requiring treatment measures have been suggested but have not been marked. The spatial location of specific treatment to be carried out in the catchment area would require extensive detailing during the implementation of CAT and a provision for micro-planning has been made in the total CAT financial allocation. For this purpose, a provision of **Rs. 0.40 lakh** is being made.

5.3 Socio-economic

The following measures would help in rejuvenating the ecosystem and in reducing the soil erosion in the region. It shall be carried out for local villages near the catchment area.

i. Avenue plantation using fuel wood trees with suitable fencing in the villages.
ii. Establishment of training, awareness programmes for water and soil conservation in the village areas
iii. Awareness program for conservation of natural resource.

A budgetary provision of **Rs. 1.00 lakh** has been kept under this component.

5.4 Monitoring & Evaluation

Monitoring and evaluation will be undertaken as a part of project management. A process of self-evaluation at specified intervals of time will ensure the field level verification of suggested treatment measures and efficacy of the CAT plan.

The year-wise areas requiring treatment measures have been suggested but have not been marked. The spatial location of specific treatment to be carried out in the Catchment Area would require extensive detailing during the implementation of CAT and a provision for micro-planning has been made in the total CAT financial allocation. Thereafter, annual work plan would be prepared well in advance after undertaking initial ground surveys during micro-planning, specifying physical and financial targets, sites, locations and beneficiaries of each component of the project activity. Month-wise work schedule of various items of each component for the financial year would also be prepared in advance and its timely implementation would be ensured. Monthly progress report on all activities would be

submitted by the Range Officers to Divisional Forest Officer. The monitoring committee shall be constituted at the project level for this purpose which too would monitor on a regular basis the quality and quantity of works being carried out under the CAT plan area. A provision of **Rs. 0.60 lakh** has been made for this component.

5.5 Contingencies

A provision of **Rs. 2.00 lakh** has been kept under this component for some leeway to adjust any unforeseen expenditure.

6.0 COST ESTIMATE

The estimated cost of implementation of Catchment Area Treatment Plan as defined above is **Rs. 25.00 lakh** and is given at **Table 5**. Year wise physical and financial targets are given in **Table 6**.

Table 5: Estimated Cost of Catchment Area Treatment Plan Implementation

S. No.	Item	Rate (Rs)	Unit	Target	
				Physical	Financial (Rs.)
I	**Biological Measures**				
1	Afforestation				
	i) Creation	58,900	Ha	7	4,12,300.00
	ii) Maintenance for 5 years	27,480	Ha	7	1,92,360.00
2	Assisted Natural Regeneration				
	i) Creation	25,700	Ha	19	4,88,300.00
	ii) Maintenance for 5 years	13,540	Ha	19	2,57,260.00
	Sub Total I				**13,50,220.00**
II	**Engineering Measures**				
3	Check Dams, Gabion Structures, CCT, MPT etc.	LS	LS	LS	6,50,000.00
	Sub Total II				**6,50,000.00**
A	**Treatment Cost (Sub Total I + II)**				**20,00,220.00**
III	**Administrative Measures**				
4	Administrative Charges @5% of Treatment Cost				1,00,011.00
5	Micro planning @2% of Treatment Cost				40,004.40
6	Socio-economic Cost @5% of Treatment Cost				1,00,011.00
7	Monitoring & Evaluation Cost @3% of Treatment Cost				60,006.60
8	Contingencies @10% of Treatment Cost				2,00,022.00
B	**Sub Total III**				**5,00,055.00**
	Total CAT Plan Cost (A + B)				**25,00,275.00**

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Table 6: Year Wise Phasing of Physical and Financial Targets

S. No.	Treatment Measures	Year - 1		Year - 2		Year - 3		Year - 4		Year - 5		Year - 6		Year - 7		Total	
		Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)	Phy.	Fin. (Rs)
I	**Afforestation Measures (ha)**																
1	**Normal Afforestation**			7	4,12,300											**7**	**4,12,300**
	1st Year maintenance					7	48,160									**7**	**48,160**
	2nd Year maintenance							7	41,090							**7**	**41,090**
	3rd Year maintenance									7	34,370					**7**	**34,370**
	4th Year maintenance											7	34,370			**7**	**34,370**
	5th Year maintenance													7	34,370	**7**	**34,370**
2	**Assisted Natural Regeneration**			19	4,88,300											**19**	**4,88,300**
	1st Year maintenance					19	57,000									**19**	**57,000**
	2nd Year maintenance							19	52,630							**19**	**52,630**
	3rd Year maintenance									19	49,210					**19**	**49,210**
	4th Year maintenance											19	49,210			**19**	**49,210**
	5th Year maintenance													19	49,210	**19**	**49,210**
	Sub Total I			**26**	**9,00,600**	**26**	**1,05,160**	**26**	**93,720**	**26**	**83,580**	**26**	**83,580**	**26**	**83,580**		**13,50,220**
II	**Soil & Water Conservation Measures**																
3	Check Dams, Gabion Structures, CCT, MPT etc.				6,50,000												**6,50,000**
	Sub Total II				**6,50,000**												**6,50,000**
A	**Treatment Cost (Sub Total I + II)**				15,50,600		1,05,160		93,720		83,580		83,580		83,580		**20,00,220**
III	**ADMINISTRATIVE MEASURES**																
4	Administrative Charges @5% of Treatment Cost		50,006		50,006												**1,00,011**
5	Micro planning @2% of Treatment Cost		40,004														**40,004**
6	Socio-economic Cost @5% of Treatment Cost		50,006						50,006								**1,00,011**
7	Monitoring & Evaluation Cost @3% of Treatment Cost				46,518		3,155		2,812		2,507		2,507		2,507		**60,007**
8	Contingencies @10% of Treatment Cost				1,55,060		10,516		9,372		8,358		8,358		8,358		**2,00,022**
B	**Sub Total III**		**1,40,015**		**2,51,584**		**13,671**		**62,189**		**10,865**		**10,865**		**10,865**		**5,00,055**
	Total (A and B)		**1,40,015**		**18,02,184**		**1,18,831**		**1,55,909**		**94,445**		**94,445**		**94,445**		**25,00,275**

N. Gopi Krushna

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Deputy General Manager (DGM)
Authorised Signatory
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ANNEXURE I

1. Per Hectare Cost Norm for Normal Afforestation

S. No.	Particulars of Work	Unit	Qty.	Rate (Rs.)	Amount (Rs.)
1	Survey & demarcation and preparation of map	Ha.	1	450	**450.00**
2	Bush cutting in the plantation site	Ha.	1	750	**750.00**
3	Interlacing of thorny bushes in B/wire	Rmt	180	3	**540.00**
4	Preparation of inspection path 60 cm wide	Rmt	150	15	**2250.00**
5	Layout of Pits	Ha.	1	500	**500.00**
6	Digging of pits 45x45x45 cm (40% of total)	00	4.4	1200	**5280.00**
7	Digging of pits 30x30x30 cm(60% of total)	00	6.6	900	**5940.00**
8	Filling of pits 45x45x45 cm (40% of total)	00	4.4	200	**880.00**
9	Filling of pits 30x30x30 cm (60% of total)	00	6.6	150	**990.00**
10	Carriage of naked roots plants over a distance of 0.5 km up hill	00	2	100	**200.00**
11	Carriage of plants in P/bags over a distance of 0.5 km up hill	00	3.5	150	**525.00**
12	Planting of entire Plants raised in P/bags	00	7	300	**2100.00**
13	Planting of naked root plants	00	4	200	**800.00**
14	Nursery cost of Plants	Nos	1100	9	**9900.00**
	Total				**31105.00**
15	Soil & moisture conservation works (25% of initial planting cost)		25%		**7776.25**
16	Add cost of RCC fence post and B/Wire			LS	**20000.00**
	Grand Total				**58881.25**
	Or Say				**58900.00**
I	**1st Year Maintenance - 25% Mortality**				
1	Re-digging of Pits 45x45x45 cm	00	1.1	600	**660.00**
2	Re-digging of Pits 30x30x30 cm	00	1.7	450	**742.50**
3	Filling of pits 45x45x45 cm	00	1.1	100	**110.00**
4	Filling of pits 30x30x30 cm	00	1.7	75	**123.75**
5	Planting of P/bags plants	00	1.8	300	**525.00**
6	Planting of naked root plants	00	1.0	200	**200.00**
7	Carriage of plants in P/bags over a distance of 0.5 km up hill	00	0.9	150	**131.25**
8	Carriage of naked roots plants over a distance of 0.5 km up hill	00	0.5	100	**50.00**
9	Nursery cost of Plants	No.	275	9	**2475.00**
10	Repair of fence	Rmt	180	2	**360.00**
11	Repair of Inspection path	LS			**500.00**
12	Repair of soil and moisture conservation works	LS			**1000.00**
	Total I				**6877.50**
	Or Say				**6880.00**
II	**2nd Year Maintenance - 20% Mortality**				
1	Re-digging of Pits 45x45x45 cm	00	0.9	600	**528.00**
2	Re-digging of Pits 30x30x30 cm	00	1.3	450	**594.00**
3	Filling of pits 45x45x45 cm	00	0.9	100	**88.00**
4	Filling of pits 30x30x30 cm	00	1.3	75	**99.00**
5	Planting of P/bags plants	00	1.4	300	**420.00**
6	Planting of naked root plants	00	0.8	200	**160.00**
7	Carriage of plants in P/bags over a distance of 0.5 km up hill	00	0.7	150	**105.00**
8	Carriage of naked roots plants over a distance of 0.5 km up hill	00	0.4	100	**40.00**
9	Nursery cost of Plants	No.	220	9	**1980.00**
10	Repair of fence	Rmt	180	2	**360.00**
11	Repair of Inspection path	LS			**500.00**
12	Repair of soil and moisture conservation works	LS			**1000.00**
	Total I				**5874.00**
	Or Say				**5870.00**
III	**3rd Year Maintenance - 15% Mortality**				
1	Re-digging of Pits 45x45x45 cm	00	0.7	600	**396.00**

S. No.	Particulars of Work	Unit	Qty.	Rate (Rs.)	Amount (Rs.)
2	Re-digging of Pits 30x30x30 cm	00	1.0	450	**445.50**
3	Filling of pits 45x45x45 cm	00	0.7	100	**66.00**
4	Filling of pits 30x30x30 cm	00	1.0	75	**74.25**
5	Planting of P/bags plants	00	1.1	300	**315.00**
6	Planting of naked root plants	00	0.6	200	**120.00**
7	Carriage of plants in P/bags over a distance of 0.5 km up hill	00	0.5	150	**78.75**
8	Carriage of naked roots plants over a distance of 0.5 km up hill	00	0.3	100	**30.00**
9	Nursery cost of Plants	No.	165	9	**1485.00**
10	Repair of fence	Rmt	200	2	**400.00**
11	Repair of Inspection path	LS			**500.00**
12	Repair of soil and moisture conservation works	LS			**1000.00**
	Total I				**4910.50**
	Or Say				**4910.00**
IV	**4th Year Maintenance - 15% Mortality**				
1	Re-digging of Pits 45x45x45 cm	00	0.7	600	**396.00**
2	Re-digging of Pits 30x30x30 cm	00	1.0	450	**445.50**
3	Filling of pits 45x45x45 cm	00	0.7	100	**66.00**
4	Filling of pits 30x30x30 cm	00	1.0	75	**74.25**
5	Planting of P/bags plants	00	1.1	300	**315.00**
6	Planting of naked root plants	00	0.6	200	**120.00**
7	Carriage of plants in P/bags over a distance of 0.5 km up hill	00	0.5	150	**78.75**
8	Carriage of naked roots plants over a distance of 0.5 km up hill	00	0.3	100	**30.00**
9	Nursery cost of Plants	No.	165	9	**1485.00**
10	Repair of fence	Rmt	200	2	**400.00**
11	Repair of Inspection path	LS			**500.00**
12	Repair of soil and moisture conservation works	LS			**1000.00**
	Total I				**4910.50**
	Or Say				**4910.00**
V	**5thYear Maintenance - 15% Mortality**				
1	Re-digging of Pits 45x45x45 cm	00	0.7	600	**396.00**
2	Re-digging of Pits 30x30x30 cm	00	1.0	450	**445.50**
3	Filling of pits 45x45x45 cm	00	0.7	100	**66.00**
4	Filling of pits 30x30x30 cm	00	1.0	75	**74.25**
5	Planting of P/bags plants	00	1.1	300	**315.00**
6	Planting of naked root plants	00	0.6	200	**120.00**
7	Carriage of plants in P/bags over a distance of 0.5 km up hill	00	0.5	150	**78.75**
8	Carriage of naked roots plants over a distance of 0.5 km up hill	00	0.3	100	**30.00**
9	Nursery cost of Plants	No.	165	9	**1485.00**
10	Repair of fence	Rmt	200	2	**400.00**
11	Repair of Inspection path	LS			**500.00**
12	Repair of soil and moisture conservation works	LS			**1000.00**
	Total I				**4910.50**
	Or Say				**4910.00**
	Total Maintenance Cost				**27,480.00**
	GRAND TOTAL	**Ha.**	**1**		**86,380.00**

2. Per Hectare Cost Norm for Assisted Natural Regeneration

S. No.	Particulars of Work	Unit	Qty.	Rate (Rs.)	Amount (Rs.)
1	Survey & demarcation and preparation of map	Ha.	1	450	**450.00**
2	Bush cutting in the plantation site	Ha.	1	750	**750.00**
3	Interlacing of thorny bushes in B/wire	Rmt	180	3	**540.00**
4	Preparation of inspection path 60 cm wide	Rmt	150	15	**2,250.00**
5	Layout of Pits	Ha.	1	115	**115.00**
6	Digging of pits 45x45x45 cm (40% of total)	“00	1	1200	**1,200.00**
7	Digging of pits 30x30x30 cm(60% of total)	“00	1.5	900	**1,350.00**
8	Filling of pits 45x45x45 cm (40% of total)	“00	1	200	**200.00**
9	Filling of pits 30x30x30 cm (60% of total)	“00	1.5	150	**225.00**
10	Carriage of naked roots plants over a distance of 0.5 km up hill	“00	0.5	100	**50.00**
11	Carriage of plants in P/bags over a distance of 0.5 km up hill	“00	0.75	150	**112.50**
12	Planting of entire Plants raised in P/bags	“00	1.5	300	**450.00**
13	Planting of naked root plants	“00	1	200	**200.00**
14	Nursery cost of Plants	Nos	250	9	**2,250.00**
	Total				**10,142.50**
15	Soil & moisture conservation works (25% of initial planting cost)		25%		**2535.63**
16	Add cost of RCC fence post and B/Wire			LS	**13,000.00**
	Total Plantation Cost				**25,678.13**
	Or Say				**25,700.00**
	Maintenance				
I	**1st Year - 25% Mortality**				
1	Re-digging of Pits 45x45x45 cm	“00	0.25	600	**150.00**
2	Re-digging of Pits 30x30x30 cm	“00	0.38	450	**168.75**
3	Filling of pits 45x45x45 cm	“00	0.25	100	**25.00**
4	Filling of pits 30x30x30 cm	“00	0.38	75	**28.13**
5	Planting of P/bags plants	“00	0.38	300	**112.50**
6	Planting of naked root plants	“00	0.25	200	**50.00**
7	Carriage of plants in P/bags over a distance of 0.5 km up hill	“00	0.19	150	**28.13**
8	Carriage of naked roots plants over a distance of 0.5 km up hill	“00	0.13	100	**12.50**
9	Nursery cost of Plants	No.	63	9	**567.00**
10	Repair of fence	Rmt	180	2	**360.00**
11	Repair of Inspection path	LS			**500.00**
12	Repair of soil and moisture conservation works	LS			**1,000.00**
	Total I				**3,002.00**
	Or Say				**3,000.00**
II	**2nd Year - 20% Mortality**				
1	Re-digging of Pits 45x45x45 cm	“00	0.2	600	**120.00**
2	Re-digging of Pits 30x30x30 cm	“00	0.3	450	**135.00**
3	Filling of pits 45x45x45 cm	“00	0.2	100	**20.00**
4	Filling of pits 30x30x30 cm	“00	0.3	75	**22.50**
5	Planting of P/bags plants	“00	0.3	300	**90.00**
6	Planting of naked root plants	“00	0.2	200	**40.00**
7	Carriage of plants in P/bags over a distance of 0.5 km up hill	“00	0.15	150	**22.50**
8	Carriage of naked roots plants over a distance of 0.5 km up hill	“00	0.10	100	**10.00**
9	Nursery cost of Plants	No.	50	9	**450.00**
10	Repair of fence	Rmt	180	2	**360.00**
11	Repair of Inspection path	LS			**500.00**
12	Repair of soil and moisture conservation works	LS			**1,000.00**
	Total II				**2,770.00**
	Or Say				**2,770.00**
III	**3rd Year - 15% Mortality**				

S. No.	Particulars of Work	Unit	Qty.	Rate (Rs.)	Amount (Rs.)
1	Re-digging of Pits 45x45x45 cm	“00	0.15	600	**90.00**
2	Re-digging of Pits 30x30x30 cm	“00	0.23	450	**101.25**
3	Filling of pits 45x45x45 cm	“00	0.15	100	**15.00**
4	Filling of pits 30x30x30 cm	“00	0.23	75	**16.88**
5	Planting of P/bags plants	“00	0.23	300	**67.50**
6	Planting of naked root plants	“00	0.15	200	**30.00**
7	Carriage of plants in P/bags over a distance of 0.5 km up hill	“00	0.11	150	**16.88**
8	Carriage of naked roots plants over a distance of 0.5 km up hill	“00	0.08	100	**7.50**
9	Nursery cost of Plants	No.	38	9	**342.00**
10	Repair of fence	Rmt	200	2	**400.00**
11	Repair of Inspection path	LS			**500.00**
12	Repair of soil and moisture conservation works	LS			**1,000.00**
	Total III				**2,587.00**
	Or Say				**2,590.00**
IV	**4th Year - 15% Mortality**				
1	Re-digging of Pits 45x45x45 cm	“00	0.15	600	**90.00**
2	Re-digging of Pits 30x30x30 cm	“00	0.23	450	**101.25**
3	Filling of pits 45x45x45 cm	“00	0.15	100	**15.00**
4	Filling of pits 30x30x30 cm	“00	0.23	75	**16.88**
5	Planting of P/bags plants	“00	0.23	300	**67.50**
6	Planting of naked root plants	“00	0.15	200	**30.00**
7	Carriage of plants in P/bags over a distance of 0.5 km up hill	“00	0.11	150	**16.88**
8	Carriage of naked roots plants over a distance of 0.5 km up hill	“00	0.08	100	**7.50**
9	Nursery cost of Plants	No.	38	9	**342.00**
10	Repair of fence	Rmt	200	2	**400.00**
11	Repair of Inspection path	LS			**500.00**
12	Repair of soil and moisture conservation works	LS			**1,000.00**
	Total IV				**2,587.00**
	Or Say				**2,590.00**
V	**5thYear - 15% Mortality**				
1	Re-digging of Pits 45x45x45 cm	“00	0.15	600	**90.00**
2	Re-digging of Pits 30x30x30 cm	“00	0.23	450	**101.25**
3	Filling of pits 45x45x45 cm	“00	0.15	100	**15.00**
4	Filling of pits 30x30x30 cm	“00	0.23	75	**16.88**
5	Planting of P/bags plants	“00	0.23	300	**67.50**
6	Planting of naked root plants	“00	0.15	200	**30.00**
7	Carriage of plants in P/bags over a distance of 0.5 km up hill	“00	0.11	150	**16.88**
8	Carriage of naked roots plants over a distance of 0.5 km up hill	“00	0.08	100	**7.50**
9	Nursery cost of Plants	No.	38	9	**342.00**
10	Repair of fence	Rmt	200	2	**400.00**
11	Repair of Inspection path	LS			**500.00**
12	Repair of soil and moisture conservation works	LS			**1,000.00**
	Total V				**2,587.00**
	Or Say				**2,590.00**
	Total Maintenance Cost				**13,540.00**
	GRAND TOTAL	**Ha.**	**1**		**39,240.00**