

**CATCHMENT AREA TREATMENT PLAN
OF
BHAVALI PUMPED STORAGE PROJECT (5 X 250 + 2 X 125
MW)**

**District Nasik & Thane
Maharashtra**

Section 1(c)(i) River Valley Project, Category "A"

June, 2023

Project Proponent:



JSW Energy PSP Two Limited

**JSW Centre, Bandra Kurla Complex,
Bandra East, Mumbai,
Maharashtra**

Submitted By:



EQMS GLOBAL PVT. LTD.

(Formerly EQMS India Pvt. Ltd.)

**305, 3rd Floor, Plot No. 16, Rishabh Corporate Tower,
Community Centre, Karkardooma, Delhi – 110092
Phone: 011-43062757;**

Website: www.eqmsglobal.com; E-mail – kahmad@eqmsglobal.com



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JSW Energy PSP Two Limited

Project- BHAVALI PUMPED STORAGE PROJECT (5 X 250 + 2 X 125 MW) in
Nashik & Thane Districts, Maharashtra

Catchment Area Treatment Plan

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1 CATCHMENT AREA TREATMENT PLAN

1.1 OVERVIEW OF PROJECT

The proposed Bhavali Pumped Storage Project is a self-identified, green field project by the JSW Energy PSP Two Ltd. The project, conceived as an off-stream closed loop project of installed capacity 1500 MW 12000MWH pumped storage component with 8.0 hours storage capacity for peak power shall be located in District Nashik and Thane, Maharashtra. It will encompass an upper reservoir and a lower reservoir, to be located in natural depressions near ridge separating the two districts. The upper reservoir (CA: 4.40 sq.km), proposed to be located in village Jamunde, Tehsil Igatpuri, District Nashik, shall be created by constructing 930m long rockfill dam with maximum height of 56m from NSL. It shall have gross and dead storage of 13.073MCM (0.46 TMC) and 1.654MCM (0.06 TMC) respectively by keeping FRL & MDDL at EL 737.00m & EL 711.00m respectively. The lower reservoir (CA: 7.32 sq.km), proposed to be in village Kalbhonde, Tehsil Shahpur, District Thane, shall be created by constructing 330.50 m long rockfill dam with maximum height of 70m from NSL. It shall have gross and dead storage of 12.736MCM and 1.428 MCM respectively by keeping FRL & MDDL at EL 300.00m & EL 270.00m respectively. The upper and lower reservoir are proposed with a live storage of 11.419MCM. The Project will generate 1500 MW by utilizing a design discharge of 326.42 cumecs with net head of 428.43m and 65.28 cumec with a rated head of 428.43 m respectively for larger and smaller unit. The PSP will utilize 1615 MW to pump 11.419MCM of water from lower reservoir to the upper reservoir. Layout of project is shown in **Figure 1.1**.

Water for one-time initial filling of upper reservoir shall be from the yield from the self-catchment of lower reservoir and used cyclically for energy storage and discharge. Evaporation and seepage losses will be recouped periodically from catchment of lower reservoir planned on Chornai Nala in upper catchment of Bhatsa dam.

1.2 NECESSITY FOR CATCHMENT AREA 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. A large number of cattle, sheep, and goats graze the pastures continuously throughout the year.

Catchment Area Treatment Plan has been prepared for areas with high soil erosion intensity. The CAT Plan targets towards overall improvement in the environmental conditions of the region. All the activities are aimed at treating the degraded and potential areas with very severe soil erosion. The plan provides benefits due to biological and engineering measures and its utility in maintaining the ecosystem health. The plan with objectives addresses issues such as prevention of gully erosion,





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enhancing the forest cover for increasing soil holding capacity; and arresting total sediment flow in the reservoir and flowing waters.

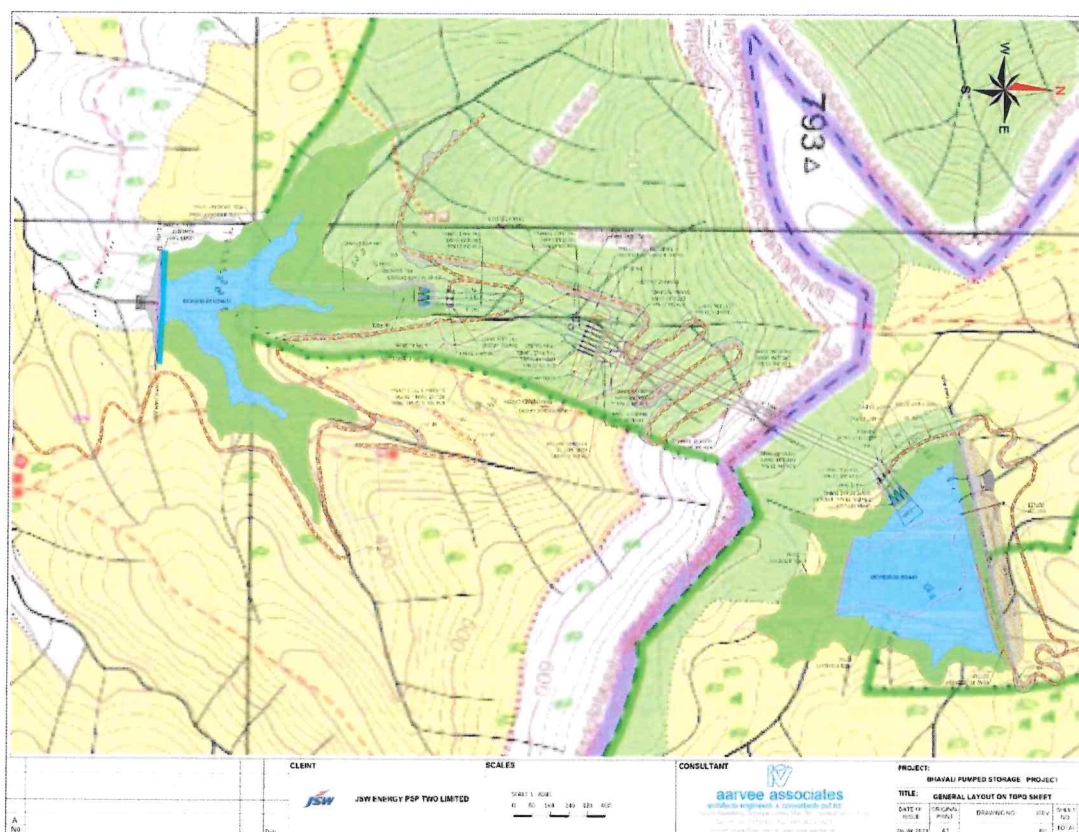


Figure 1.1 : Layout Map of Project on Toposheet

1.3 OBJECTIVES

The CAT Plan targets towards overall improvement in the environmental conditions of the region. All the activities are aimed at treating the degraded and potential areas with severe soil erosion. The plan with objectives addresses issues such as prevention of gully erosion, enhancing the forest cover for increasing soil holding capacity; and arresting total sediment flow in the reservoir and flowing waters. Catchment Area Treatment Plan has been prepared for areas with high soil erosion intensity.





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1.4 DELINEATION OF CATCHMENT AREA

The total catchment area of draining into upper and lower reservoirs is 11.72 sq.km of which intercepted catchment is nil. The area under different sub-watersheds is illustrated in **Table 1.1** and the satellite imagery of the catchment is presented in **Figure 1.2** and Sub watershed location in **Figure 1.3**.

Table 1.1: Basin Characteristics of Different Sub-watersheds

Sl. No.	Sub-watersheds	Catchment area of SWS (ha.)	Highest Elevation (masl)
1	4E8D5(1)	440	910
2	5B2B6(1)	319	793
3	5B2B6(2)	413	760
	Total	1172	-

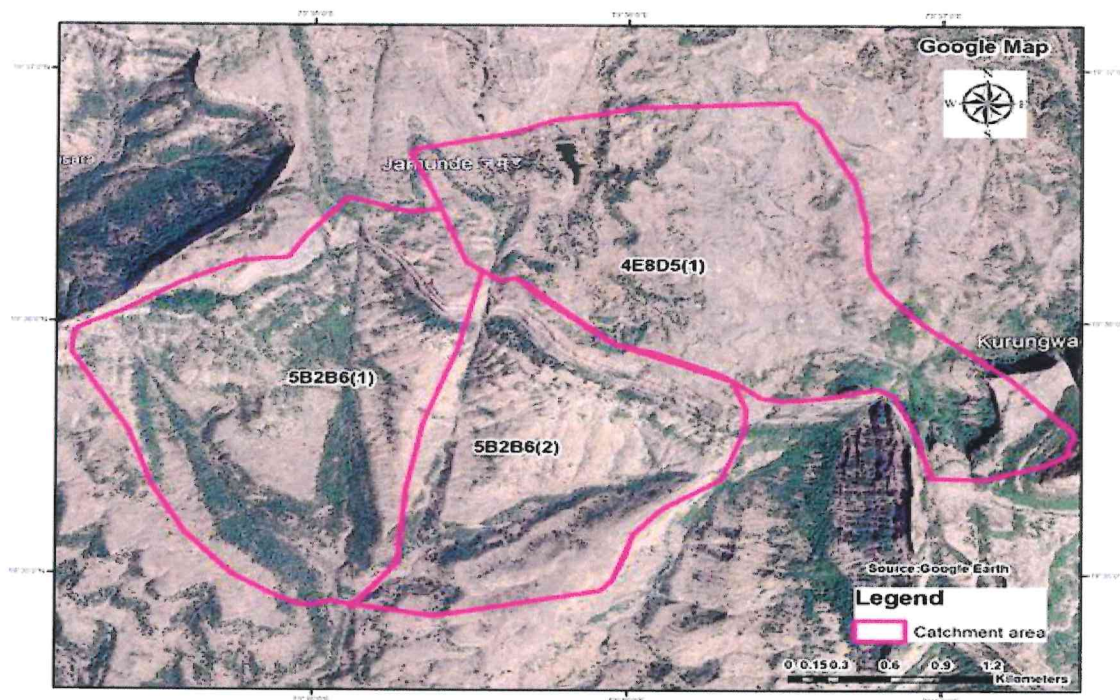


Figure 1.2 : Google Image of Catchment Area



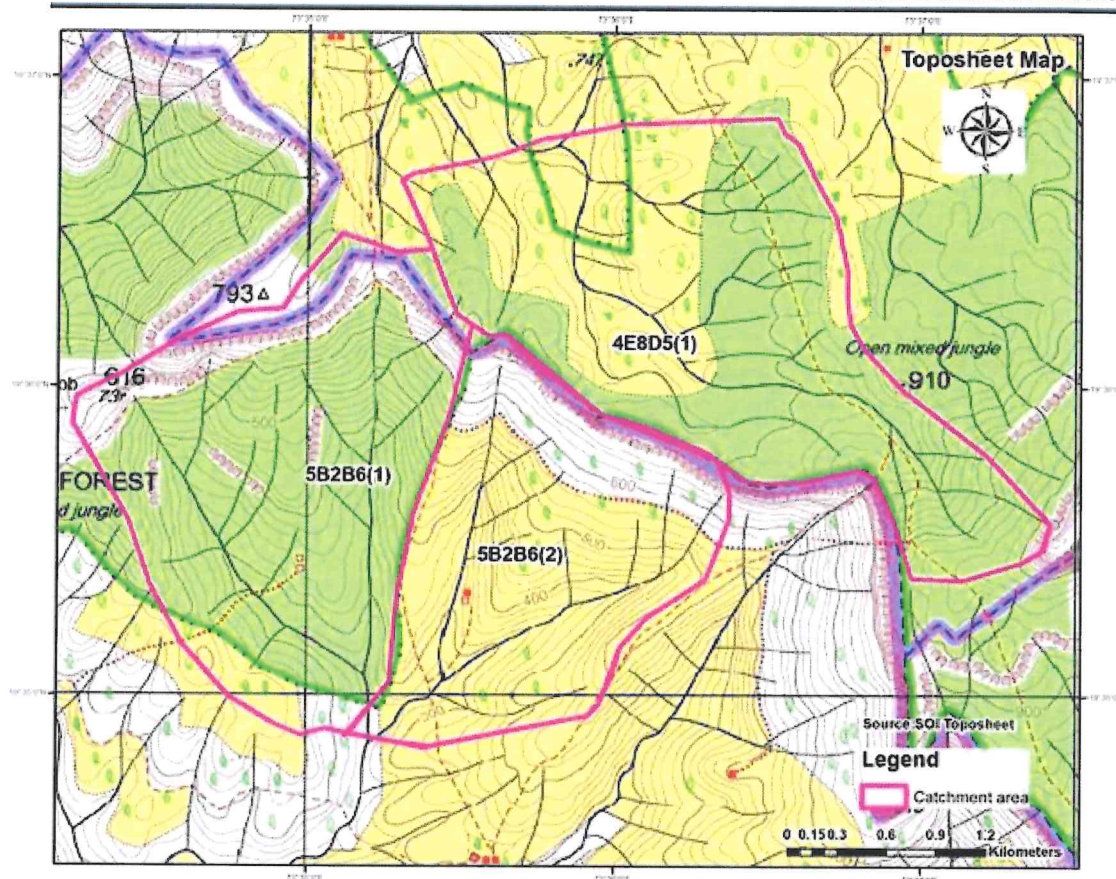


Figure 1.3 : Location of Sub-watershed

1.5 TOPOGRAPHY& BASIN CHATACTERSTICS

The project area lies in Northern Western Ghats (Sahyadri Mountain) and comprises of varied topography. The distinct physiographic units are the main system of Sahyadri hill ranges with plains of Darna River valley and Bhatsa river, tributary of the western flowing Ulhas River, separated by the hill ridge forming boundary between Nashik and Thane Districts.

The upper reservoir is receiving run off from two third order streams in the upper reaches of Darna River (Upper Godavari basin). The lower reservoir is receiving run off from two second order streams which confluence to form a third order stream within the reservoir. These streams are located in head reaches of Chorna Nadi, a tributary of Bhatsa river which in turn is a tributary of Western Flowing River (WFR) viz., Ullhas River. The catchment area of upper reservoir has hilly topography with the ground slopes from south to north. In the catchment area the ground elevation ranges between El. 700 m to El. 910 m. The catchment area of lower reservoir has hilly topography with the ground slopes from south to north. In the catchment area the ground elevation ranges between El. 300 m to El. 793 m. The





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catchment is characterized by hill ranges, escapements, cliffs. The drainage pattern of the catchment is dendritic. above msl. The hills of the catchment are part of Western Ghats.

1.6 SOIL

The soil resource maps Maharashtra have been used in the present study. The soil is predominantly loamy and is described in Table 1.2 and the soil map is presented in Figure 1.4.

Table 1.2: Soil Types and Their Description with Taxonomy

Soil Unit	Description
33	Shallow, well drained, loamy soils on moderately steeply sloping dissected hills and intervening valleys with severe erosion; associated with very shallow, well drained, loamy soils on gently sloping lands with moderate erosion.

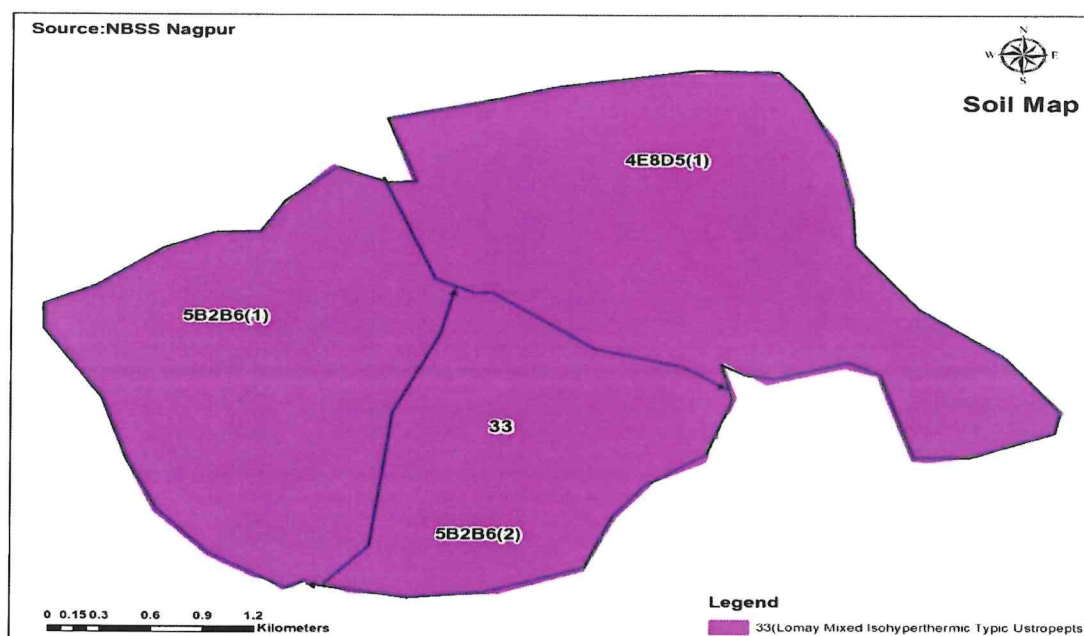


Figure 1.4 : Soil Map of Catchment Area

1.7 LAND USE

1.7.1 Land use-Land cover Classification

Based on satellite data and topo-sheets, a land-use map has been prepared. The Land use/ Land-cover map of the catchment area is presented in Figure 1.5 and its details in Table 1.3.





1.7.2 Land use Categories and Erosion

The erosion acts differently in different land-use types. It is important to understand the nature of erosion in a particular land-use class to further plan for treatment.

1.7.3 Settlement

8 ha area of the catchment constituting 0.68% of the total catchment comes under this category. Settlement area is well-planned on developed terraces and provided with storm water drainage system. The roads in settlement area are all black topped/concrete paved were seen at some places. The category needs no treatment

1.7.4 Vegetation/Forest

Around 207 ha area constituting 17.66% of the catchment area is classified under this land-use category. Enrichment or gap plantation is suggested for such land-use category. Silvi-pasture plantation and natural regeneration can also be done.

1.7.5 Open Forest Land

Under open forest category about 668 ha, constituting 57% of the total catchment area exists in the catchment. Soils have relatively good water holding capacity, humus, nutrient content and high to moderate erosion rates on steeper slopes. Afforestation is suggested so as increase the crown density by 20% in whole of the area to reduce erosion. Gullies, frequent land slips and high to extremely high erosion rates are other prominent features. Stream bank protection works followed by well-planned afforestation are suggested for such land-use category.

1.7.6 River / Water body

Around 17ha area constituting 1.45 % of the catchment area is classified under water bodies. The category needs no treatment except that the unstable bank shall be provided stream bank stabilization through protection measures whenever required.

1.7.7 Escarpment

About 80ha area constituting 6.83% of the catchment is covered under this classification.

Table 1.3: Land Use Details of Catchment (Sq.km)

Class	4E8D5(1)	5B2B6(1)	5B2B6(2)	Total	%
Agricultural Land	0.70	0.59	0.63	1.92	16.38
Open Scrub Land	2.76	2.23	1.69	6.68	57.00
Settlement	0.08	0.00	0.00	0.08	0.68
Escarpment	0.17	0.28	0.35	0.80	6.83
Water body	0.04	0.05	0.08	0.17	1.45
Vegetation	0.65	0.98	0.44	2.07	17.66
	4.40	4.13	3.19	11.72	100.00



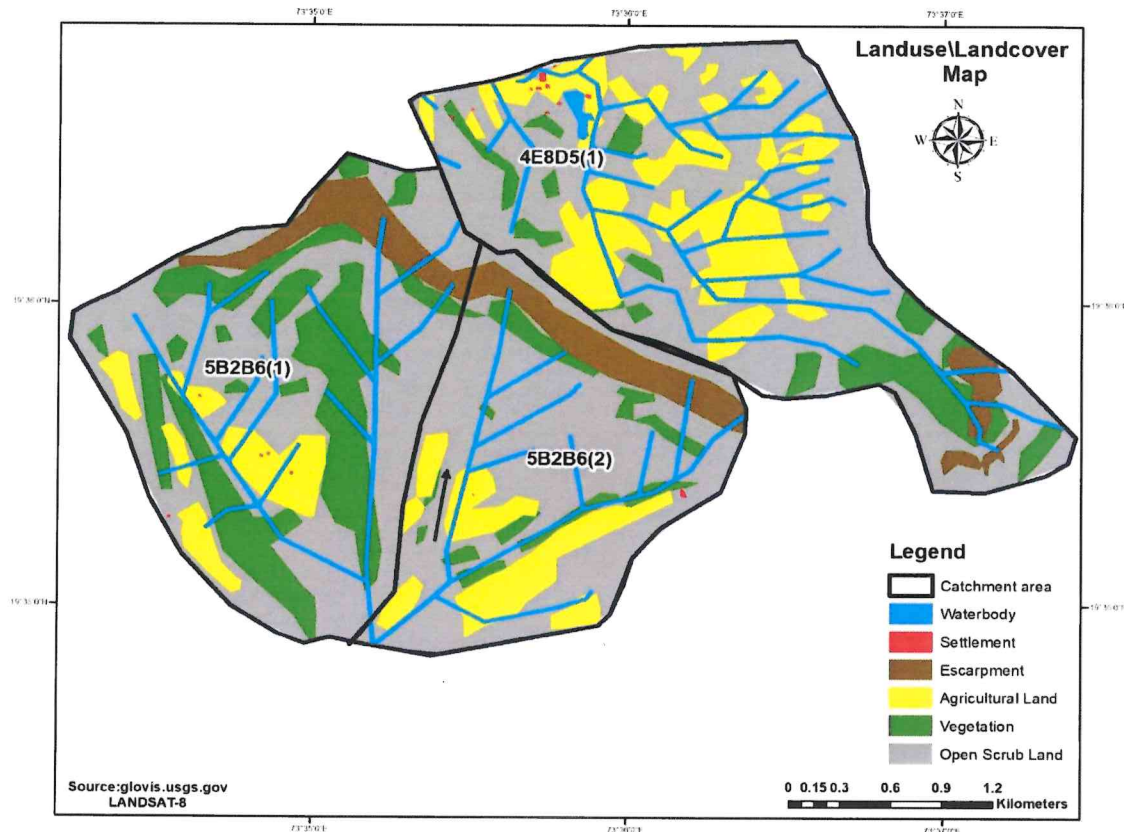


Figure 1.5 : Land use Map of Catchment Area

1.8 SLOPE

The slope of a watershed plays an important role in controlling the soil and water retention thereby affecting the land-use capability. The percentage of the slope in a watershed determines the soil erosion susceptibility and forms the basis for classifying different of the watershed into suitable classes for formulating effective soil erosion conservation measures. Broadly, the following slope classes and ranges (Table 1.4) as per norms of All India Soil & Land Use Survey were adopted to classify the slopes for the present study.

Table 1.4:Slope Ranges

Sr. No	Slope Range (Degrees)	Description
1.	0-5	Very Gently Sloping
2.	5-10	Gently Sloping
3.	10-15	Moderately Sloping
4.	15-20	Moderately Steep Slope
5.	>20	Steep Slope





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The slope map of the catchment is presented in **Figure 1.6** and slope details are as presented under **Table 1.5**. The data shows that about 53.24% area lies between very gently to gently sloping category and balance 46.76% falls from moderately to steep category.

Table 1.5: Area Under Different Slope Classes (Area in Sq.km.)

Sub-watershed	V. Gently Sloping	Gently Sloping	Moderate Sloping	Moderately Steep slope	Steep Slope	Total
4E8D5(1)	1.11	1.93	0.99	0.17	0.20	4.40
5B2B6(1)	0.88	1.05	1.13	0.60	0.47	4.13
5B2B6(2)	0.65	0.62	1.18	0.32	0.42	3.19
Total	2.64	3.60	3.3	1.09	1.09	11.72
%	22.52	30.72	28.16	9.30	9.30	100.00

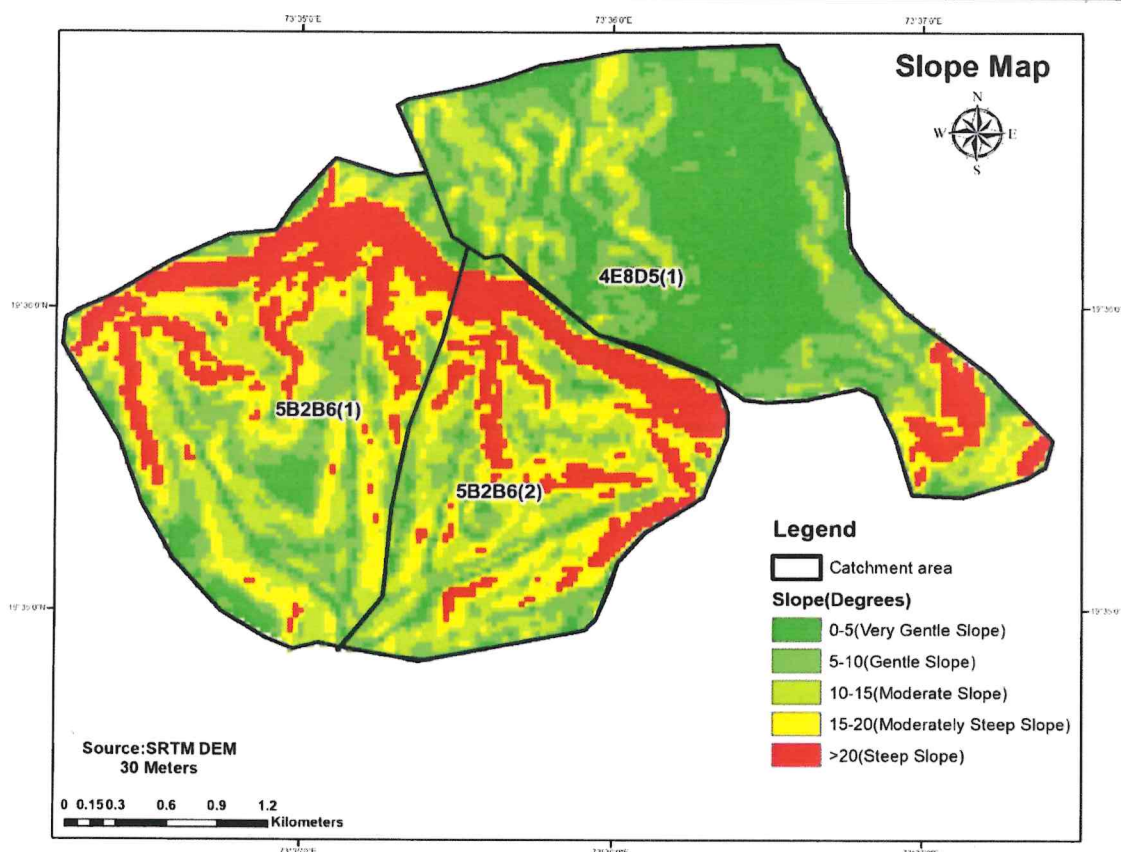


Figure 1.6 : Slope Map of Catchment Area





1.9 METHODOLOGY USED FOR STUDY

Superimposing topography, slope, soil and land use data/maps, a tentative estimation of erosion prone areas and landslides area in the catchment were made. The vulnerable and problematic areas were identified in different physiographic zones. These data sets were used for preparation of the thematic maps, calculation of sediment yield index and Erosion Intensity Units.

1.9.1 Soil Loss Using Silt Yield Index (SYI) Method

- The Silt Yield Index Model (SYI), considering sedimentation as product of erosivity, erodibility and aerial extent was conceptualized in the All-India Soil and Land Use Survey (AISLUS) as early as 1969 and has been in operational use since then to meet the requirements of prioritization of smaller hydrologic units within river valley project catchment areas.
- Methodology for the calculation of sediment yield index developed by All India Soil & Land Use Survey (Development of Agriculture, Govt. of India) was followed in this study.
- Determination of erosion intensity unit is primarily based upon the integrated information on soil characters, physiography, slope, land-use/land-cover, lithology and structure. This is achieved through super-imposition of different thematic map overlays. Based upon the field data collected during the field survey and published data, weightage value and delivery ration were assigned to each erosion intensity unit. The composite map for delineating different erosion intensity units was prepared through superimposition of the maps showing soil types, slope and land-use/land-cover. This thematic mapping of erosion intensity for entire catchment was done using the overlay and union techniques. Based on ground truth verification conducted during fieldwork and published data, weightage and delivery ratio was assigned to each erosion intensity units. The composite erosion intensity map was then superimposed on the drainage map with sub-watershed boundaries to evolve CEIU for individual sub-watershed.
- Each element of erosion intensity unit is assigned a weightage value. The cumulative weightage values of the erosion intensity units represent approximately the relative comparative erosion intensity within the watersheds. A basic factor of $K=10$ was used in determining the cumulative weightage values. The value of 10 indicated an equilibrium condition between erosion and deposition. Any value of $K (10+X)$ is suggestive of erosion intensity in an ascending order whereas the value of $K (10-X)$ is suggestive of deposition intensity in descending order.
- The delivery ratios were calculated for each composite erosion intensity unit. The delivery ration suggests the percentage of eroded material that finally finds entry into the reservoir or river/stream. Total area of different erosion intensity classes (composite erosion intensity unit) in each watershed was then calculated.
- The delivery ratio is generally governed by the type of material, soil erosion, relief length ratio, cover conditions, distance from the nearest stream, etc. However, in the present study the delivery rations to the erosion intensity units were assigned upon their distance from the nearest stream (being the most important factor responsible for delivery of the sediments) according to the following scheme. The delivery ratio criteria adopted for the study is presented in **Table 1.6**.

Table 1.6: Delivery Ratio (DR) Criteria Adopted

Nearest Stream	Delivery Ratio (DR)
0-0.9 km	1.00
1.0-2.0 km	0.90
2.1-5.0 km	0.80





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5.1-15.0 km	0.70
15.1-30.0 km	0.50

1.9.2 Sediment Yield Index & Prioritization of Sub-Watersheds

- The erosivity determinates are the climatic factors and soil and land attributes that have direct or reciprocal bearing on the units 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)

- The Silt Yield Index (SYI) is defined as the Yield per unit area and SYI value for hydrologic unit is obtained by taking the weightage arithmetic mean of the products of the weightage value and delivery ratio over the entire area of the hydrologic unit by using suitable empirical equation.
- Prioritization of smaller hydrological units within the vast catchments is based on the SYI of the smaller units. The boundary values of range of SYI values for different priority categories are arrived at by studying the frequency distribution of SYI values and locating the suitable breaking point. 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:
 - Climatic factors comprising total precipitation, its frequency and intensity
 - Geomorphic factors comprising land forms, physiography, slope and drainage characteristics
 - Surface cover factors governing the flow hydraulics
 - 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-watershed 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:

Silt Yield Index

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





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Where

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

The SYI values for classification of various categories of erosion intensity rates were taken for the present study as:

	<u>Priority Category</u>	<u>SYI Values</u>
1.	Very High	>1300
2.	High	1200-1299
3.	Medium	1100-1199
4.	Low	1000-1099
5.	Very low	<1000

The sediment Yield Index calculated for sub-watersheds is presented in **Table 1.7**.

Table 1.7: SYI and Priority Rating as per Erosion Intensity

SWS code	Erosion intensity	Area (ha)	Weightage	Area x weight-age	Delivery ratio	Gross silt yield	SYI	Priority
4E8D5(1)	Severe	21	17	357	0.8	285.6	1075	Low
	Moderate	54	15	810	0.8	648		
	Slight	361	13	4693	0.8	3754.4		
	Total	436		0		4688		
5B2B6(I)	Severe	112	17	1904	0.8	1523.2	1165	Medium
	Moderate	95	15	1425	0.8	1140		
	Slight	201	13	2613	0.8	2090.4		
	Total	408		0		4753.6		
5B2B6(2)	Severe	106	17	1802	0.8	1441.6	1210	High
	Moderate	119	15	1785	0.8	1428		
	Slight	86	13	1118	0.8	894.4		
	Total	3.11		0		3764		





1.10 CATCHMENT AREA TREATMENT PLAN

It is known that there are mainly five categories of Land uses for which a proper treatment plan should be developed. First is the Agricultural Land as this activity can never be eliminated, because the faulty practice results in heavy loss of fertile soil. Second, being open forest land for obvious conservation reasons. Third is scrub or degraded land, which contributes heavily to the silt load and possibilities exist to bring this area under pastures and other plantation to meet the local demand of fuel and fodder and thus decreasing the biotic pressure on the forests and leading to environment friendly approach of sustainable development. The fourth and most important category is Barren land because with practically no vegetal cover, the area produces huge amount of silt load. The fifth is dense forest land where in a few places soil conservation measures are required. For treatment of catchment area, the areas that require treatment have been delineated from the Composite Erosion Intensity Unit Map. The sum of weightages was reclassified as per the **Table 1.8** below to further subdivide the area as per the erosion intensity classes. The weightages for Land use, Slope & Soil were summed to get the Erosion Intensity Classes.

Table 1.8: Erosion Intensity & Weightages

Erosion Intensity Class	Sum of weightages
Very severe (E5)	12 to 14
Severe (E4)	9 to 11
Moderate (E3)	6 to 8
Low (E2)	4 to 5
Negligible (E1)	0 to 3

Considering the topographic factors, soil type, climate, land-use/land-cover in the catchment area following engineering and biological measures have been proposed to be undertaken with the aim to check the soil erosion, prevent/check siltation of reservoir and to maintain its storage capacity in the long run.

The Erosion Intensity Map of the free draining catchment has been generated on the basis of SYI data and is presented in **Figure 1.7** and the statistics are presented in **Table 1.9**.

Table 1.9: Area (ha) Under Different Erosion Intensity Categories

Sub-watershed	Very Severe	Severe	Moderate	Low	Water-bodies	Total
4E8D5 (1)	0	0.21	0.54	3.61	0.04	4.40
5B2B6 (I)	0	1.12	0.95	2.01	0.05	4.13
5B2B6(2)	0	1.06	1.19	0.86	0.08	3.19
Total	0	2.39	2.68	6.48	0.17	11.72





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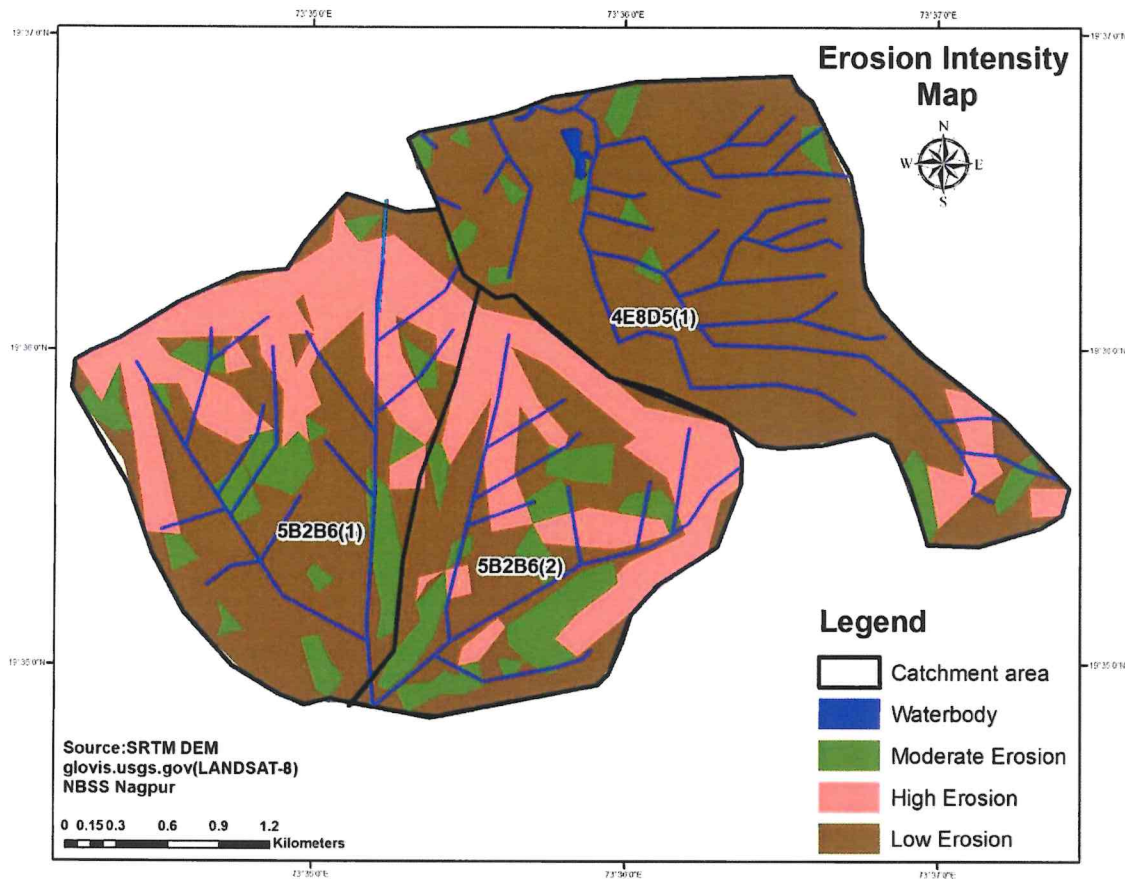


Figure 1.7 : Erosion Intensity Map of Catchment Area

1.11 TREATMENT OF INDIVIDUAL SUB-WATERSHED

Areas falling under very severe and severe erosion would be taken up for conservation treatment measures such as biological and engineering measures under CAT Plan. In the present case, an area of 20 ha has been proposed to be treated by plantation under the CAT plan. Besides this engineering measures will be undertaken.

1.11.1 Normal Afforestation

In critically degraded areas, plantation of locally useful diverse and indigenous plant species such as timber plantation species, fodder species, fuel wood species, grasses, shrubs and legumes, medicinal and aromatic plants would be undertaken. The forestation will include rising of multi-tier mixed vegetation of suitable local species in the steep and sensitive catchment areas of rivers/streams with the objective of keeping such areas under permanent vegetative cover. Furthermore, degraded areas would also be brought under vegetation cover. Suitable trees of economic value to local people shall





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be raised in the degraded forest areas near to villages with the objective of supplementing income of the villagers.

Effective fencing would also be provided for protection of saplings. Before any new area is taken up, eradication of weeds and unpalatable grass species is important. There are a few locations within forest in the catchment area where the crown density is poor and plantation can be done to increase the patch density of crop. In such areas, plantation of 1100 seedlings per hectare is likely to create dense forest.

1.11.2 Civil Structures

➤ Gully Control-Check Dams

Gullies are mainly formed because physiographic, soil type, and heavy biotic interference in an area. Different types of check dams would be required for different conditions comprising of different materials depending upon the site conditions and the easy availability of material (stones) at local level and transport accessibility. Generally, brush wood check dams are recommended to control the erosion in the first order basin/streams in upper reaches and dry random stone masonry check dam shall be provided in the lower reaches where discharge is higher. In such stream where discharge and velocity of flow are still higher gabion structure shall be provided. Lower down the sub-watershed, i.e., in the third order drainage silt retention dams in the form of gabion structure shall be provided.

➤ Stream bank Protection

Stream bank erosion is caused by variety of reasons such as destruction of vegetative cover, mass movement on unstable bank slopes, undermining of top portion of lower bank by turbulent flow and sliding of slopes when saturated with water. The Stream Bank Protection would include wire crate boulder spurs in two to three tiers depending upon the high flood level of the streams.

1.12 COST UNDER BIOLOGICAL MEASURES

Out of the total stock to be planted under normal afforestation, 20% species shall be tree species having medicinal values and 10% of fruit bearing wild species useful to wildlife shall also be planted. The cost analysis per hectare of afforestation with 1111 plants/ha is based as per Model Rate Structure for raising with cost of fencing inclusive of maintenance for ten years with 5% annual escalation. Considering that the work of raising normal plantation shall commence from year 2024-25, the rate to be adopted for plantation shall be Rs 8.45 lakh/ha in accordance with the Ready Reckoner sanctioned by PCCF(HoEF), M.S. Nagpur letter dated Desk-17/ca/Nodal Cell/CR-40/152/2019-20, Dated 4.10.2019.

Plantation under normal afforestation component shall be carried out in catchment area. Plantations will be maintained for ten years. The cost of works under normal afforestation component for 20 ha area @ Rs 8.45 lakh/ha has been assessed as **Rs. 169 lakhs** (Table 1.10)

Table 1.10: Cost Estimate for Normal Afforestation

SWS	Area Proposed for Normal Plantation (ha)	Rate (Rs lakh/ha)	Total (Rs lakh)
4E8D5 (1)	5	8.45	42.25





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5B2B6 (I)	10	8.45	84.50
5B2B6(2)	5	8.45	42.25
Total	20		169.00

1.13 ENGINEERING WORKS (SOIL & WATER CONSERVATION MEASURES)

Hard (Engineering) structures are to be constructed as landslide control and stream bank stabilization over visually active slides and eroded banks of the main nala and its tributaries falling under “Severe” and “Very Severe” erosion intensity areas to control the sediment flow and further degradation of the catchment areas. Since these measures are to be carried out by construction of individual structure such as wire crate spurs and dry random stone masonry walls/check dams and contour bunding in step slopes etc. on-site specific basis. The cost of each of such structure has been analyzed on the basis of average dimensions adopted. The analysis of rates of such structures is presented in **Table 1.11**.

Table 1.11: Cost Norms for Engineering Works

S. No.	Item	Quantity	Unit	Rate	Amount
1.	Dry Rubble Stone masonry (DRSM) Check Dam				
(a)	Excavation in foundation in all kinds of soil i/c boulders in 5.60 m x 1.80 m x 0.50 m = 5.04 cubic meter	5.04	Cum	116	584.64
(b)	Loading and unloading of rubble stone				
	I-Step 5 x 1.5 x 1.25 = 9.38				
	II – Step 7 x 1.0 x 0.75 = 5.25	23.52	Cum	297.38	6994.14
(c)	Wing Walls 2 x 3.75 x 0.6 x 1.5 = 6.75 Total 21.38 x 1.1 = 23.52				
(d)	Carriage of boulder by road from quarry site to 30 km beyond initial lead up to 1 km (146.40+10.4x25) x 1.3	23.52	cum	528.30	12425.62
(e)	Carriage of boulder by manually (head load) total lead up to 150 m @153.8x1.3	23.52	Cum	199.94	4702.59
(f)	Labour charges for dry stone masonry with outer face stone dressed i/c lead upto 1 km and all lifts @706x1.3/cum	23.52	Cum	917.80	21586.67
				Total	46293.66
				Add 2% Contingencies	925.87
				Grand Total Rs.	47219.53
				Say Rs.	47000.00
2.	Wire Crate Check Dam				
(a)	Excavation in foundation in all kinds of soil i/c boulders in 6.60 m x 2.30 m x 0.50 m = 7.59 cubic meter	7.59	Cum	116	880.44
(b)	Loading and unloading of rubble stone	35.24	Cum	297.38	10479.67





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	Foundation Step - 6.0 x 2.0 x 1.0 m = 12 cubic meters				
	I- Step - 6.0 m x 1.9m x 1.0m = 11.40 cubic meter				
	II- Step - 6.0 m x 1.8m x 0.8 m = 8.64 cubic meter				
	Total requirement of boulder = 32.04 x 1.1 = 35.24 cubic meter				
(c)	Carriage of boulder by road from quarry site to 30 km beyond initial lead up to 1 km (146.40+10.4x25) x1.3	35.24	Cum	528.30	18617.29
(d)	Carriage of boulder by manually (head load) total lead up to 150 m @153.8x1.3	35.24	Cum	199.94	7045.89
(e)	Weaving of wire netting of GI wire mesh size 15 cm x 15 cm				
	Foundation Step-2(6x2+6x1+2x1) = 40 m ²				
	I- Step-2(6x1.9+6x1+2x1) = 38.8 m ²				
	II- Step- 2(6x1.8 + 6x0.8 + 2x0.8) = 34.4 m ²				
	Total = 113.2 m ²	113.2	M ²	30	339.60
(f)	Filling of boulder and hand packing in wire crates	35.24	M ³	778.70	27441.39
(g)	Cost of GI wire	2.25	Qtl	10000	22500
(h)	Carriage of boulder by manually (head load) total lead up to 150 m	2.25	Qtl	120	450
Total Rs.					87754.28
Add 3% Contingencies					2632.63
Grand Total Rs.					90386.92
Say Rs.					90400
3	Contour Bunding	1	ha	10000	10000.00

The Break-up of works in respect of civil structures for land slide and stream bank stabilization and moisture retention operations with their costs is shown in **Table 1.12**.

Table 1.12: Cost of Engineering Measures

SWS	DRSM check dam @ Rs. 0.47 lakh each		Wire Crate Check Dam @ Rs. 0.90 lakh each		Total Cost (Rs. lakh)
	No.	Cost	No.	Cost	
4E8D5 (1)	10	4.70	4	3.60	8.30
5B2B6 (I)	30	14.10	8	7.20	21.30
5B2B6(2)	30	14.10	8	7.20	21.30
	70	32.90	20	18.00	50.90





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1.14 COST OF OTHER COMPONENTS OF CAT PLAN

Apart from the forestry works and drainage line treatment 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. Provision for micro planning and documentation are some of the integral ingredients, which have to be considered and included while formulating the CAT plans.

1.14.1 Provision for Micro Plans

Based on the ground truth reality in each of the village forest department committee or society under different sub-watersheds, comprehensive micro plan for execution of the work has to be prepared as per norms. The micro plan for each beat shall be with due regards to the environmental functions and productive potential of the forests and their carrying capacity. For this purpose, a provision of **Rs. 2.60 lakh** is being made.

1.14.2 Provision for Proper Documentation

Emphasis should be laid on the publicity of the work proposed under the plan and work carried out on annual basis so that transparency is maintained and proper documentation of the work is also carried out for future reference and testing the efficacy of the work in due course of time. On this count a provision of **Rs. 1.00 lakh** is proposed. The documentation would inter alia include implementation report, progress reports, photography, videography etc.

1.14.3 Provision for Forest Protection

The need for rigorous watch and ward of the forest covered under the catchment area becomes more imperative in view of proposed new plantation under the CAT plan and due to increased human activity in the form of labour, who shall be engaged for forestry works. Thus, fire protection measures including construction and maintenance of fire lines shall be carried out. For these a provision of **Rs. 11.50 lakh** is being earmarked.

1.14.4 Provision for 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 shall be established at dam site, where the regular discharges of the streams and silt samples shall be monitored daily for ten years by the project proponent.

A provision of **Rs. 5.00 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





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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.

1.14.5 Provision for Environmental Services

A provision of **Rs.10.00 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. The scheme inter-alia includes construction of contour trenches, incentives for fire protection on government land/forests, provision of funds for live hedge fence on private land.

1.15 SUMMARY OF COST OF WORKS

The cost of all works proposed in the CAT plan is enumerated in **Table 1.13** and yearly break-up of fund requirement in **Table 1.14**.

Table 1.13: Cost of CAT Plan

S. No.	Particulars	Amount (Rs. In Lakh)
1.	Habitat treatment works under free draining catchment	
(a)	Normal afforestation (20 ha @ Rs. 845000/ ha)	169.00
	Sub- total (1)	169.00
2.	Soil and water conservation measures	
(a)	DSRM check dam (70 no. @Rs 47000/ha each)	32.90
(b)	Wire crate check dam (20 no. @ Rs 90000/each)	18.00
	Sub- total (2)	50.90
3	Other Components of CAT Plan	
(a)	Provision for Micro Plan	2.60
(b)	Documentation	1.00
(c)	Forest Protection	11.50
(d)	Provision for Monitoring and Evaluation	5.00
(e)	Provision for Environmental Services	10.00
	Sub- total (3)	30.10
Grand Total.		250.00





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Table 1.14 : Year wise Requirement Funds for Implementing CAT Plan

Sl. No.	Component	1-Y	2-Y	3-Y	4-Y	5-Y	6-Y	7-Y	Total (Rs. Lakh)
1	Habitat treatment works								
(a)	Normal afforestation								
	i. Advance work	34.10	34.10	0.00	0.00	0.00	0.00	0.00	68.20
	ii. Plantation	0.00	27.30	27.30	0.00	0.00	0.00	0.00	54.60
	iii. Maintenance	0.00	0.00	12.80	9.40	8.00	8.00	8.00	46.20
2	Soil and water conservation measure								
(a)	DRSM check dam	0.00	11.75	11.75	9.40	0.00	0.00	0.00	32.90
(b)	Wire crate check dam	0.00	4.50	4.50	4.50	4.50	0.00	0.00	18.00
3	Other Component	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(a)	Micro plans	2.60	0.00	0.00	0.00	0.00	0.00	0.00	2.60
(b)	Documentation	0.00	0.00	0.20	0.20	0.20	0.20	0.20	1.00
(c)	Forest protection	1.00	2.50	2.50	1.50	1.50	1.50	1.00	11.50
(d)	Monitoring and Evaluation	0.00	1.00	1.00	1.00	1.00	0.50	0.50	5.00
(e)	Environmental Services	0.00	2.50	2.50	1.50	1.50	1.50	0.50	10.00
Total		37.70	83.65	62.55	27.50	16.70	11.70	10.20	250.00



(K. PRADEEPA)
Chief Conservator of Forests (T)
Thane Circle, Thane.



(NARESH ZURMURE)

Addl. Principal Chief Conservator of Forests
and Node Officer
Maharashtra State, Nagpur

(Shomita Biswas)

Principal Chief Conservator of Forest
(Head Of Forest Force)
Maharashtra State, Nagpur - 440001.



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Table 1.14 : Year wise Requirement Funds for Implementing CAT Plan

Sl. No.	Component	1-Y	2-Y	3-Y	4-Y	5-Y	6-Y	7-Y	Total (Rs. Lakh)
1	Habitat treatment works								
(a)	Normal afforestation								
	i. Advance work	34.10	34.10	0.00	0.00	0.00	0.00	0.00	68.20
	ii. Plantation	0.00	27.30	27.30	0.00	0.00	0.00	0.00	54.60
	iii. Maintenance	0.00	0.00	12.80	9.40	8.00	8.00	8.00	46.20
2	Soil and water conservation measure								
(a)	DRSM check dam	0.00	11.75	11.75	9.40	0.00	0.00	0.00	32.90
(b)	Wire crate check dam	0.00	4.50	4.50	4.50	4.50	0.00	0.00	18.00
3	Other Component	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
(a)	Micro plans	2.60	0.00	0.00	0.00	0.00	0.00	0.00	2.60
(b)	Documentation	0.00	0.00	0.20	0.20	0.20	0.20	0.20	1.00
(c)	Forest protection	1.00	2.50	2.50	1.50	1.50	1.50	1.00	11.50
(d)	Monitoring and Evaluation	0.00	1.00	1.00	1.00	1.00	0.50	0.50	5.00
(e)	Environmental Services	0.00	2.50	2.50	1.50	1.50	1.50	0.50	10.00
Total		37.70	83.65	62.55	27.50	16.70	11.70	10.20	250.00



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ACB(T) Nashik

Deputy Conservator of Forests
West Nashik

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EQMS GLOBAL PVT. LTD

(Shomita Biswas)
Principal Chief Conservator Of Forests
(Head Of Forest Force)
Maharashtra State, Nagpur - 440004



(NARESH ZURMURE)
Additional Principal Chief Conservator of Forests
and Nodal Officer
Maharashtra State, Nagpur