

# **CATCHMENT AREA TREATMENT PLAN**

**For**

## **“MAA RATANGARH MULTIPURPOSE PROJECT” DISTRICT DATIA, MADHYA PRADESH**

**Project Proponent:  
WATER RESOURCE DIVISION,  
DISTRICT GWALIOR, MADHYA PRADESH**

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## **WATER RESOURCES DEPARTMENT, MADHYA PRADESH**

**Project: Environmental Management Plan for Maa Ratangarh Multipurpose Project, District Datia, Madhya Pradesh**

### **FINAL EMP REPORT**

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	<p>Catchment Area Treatment (CAT) Plan should be prepared micro-watershed wise. Identification of free draining/ directly draining catchment based upon Remote Sensing and Geographical Information System (GIS) methodology and Sediment Yield Index (SYI) Method of AISLUS, Dept. of Agriculture, Govt. of India coupled with ground survey. Areas or watersheds falling under 'very severe' and 'severe' erosion categories should be provided and required to be treated. Both biological as well as engineering measures should be proposed in consultation with State Forest Department for areas requiring treatment. Year-wise schedule of work and monetary allocation should be provided. Mitigation measures to check shifting cultivation in the catchment area with provision for alternative and better agricultural practices should be included.</p>	Chapter-1 (EMP)



## **1 CATCHMENT AREA TREATMENT PLAN**

### **1.1 Introduction**

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 crucial factor that adds to the sediment load and which contributes to soil degradation is grazing pressure. Many cattle, sheep, and goats graze the pastures continuously for about six months in the region.

The lack of proper vegetal cover is a factor to cause degradation and thereby results in severe runoff/soil erosion, and subsequently premature siltation of the reservoir. 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.

The pre-requisite for a watershed management is the collection of multipronged data e.g., geology, geomorphology, topography, soil, land use/land cover, climate, hydrology, drainage pattern, etc. The multi-pronged data generated from various published sources and actual data collected from these watersheds on the above-mentioned parameters forms the basis of the Action Plan for Catchment Area Treatment is presented here.

Catchment Area Treatment (CAT) plans for the free draining catchment area of the proposed project 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 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, enhancing the forest cover for increasing soil holding capacity; and arresting total sediment flow in the reservoir and flowing waters.

### **1.2 Objectives**

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. For this purpose, the action plan has been prepared with the following objectives:

1. To facilitate the hydrological functioning of the catchment and to augment the quality of water of the river and its tributaries.
2. Conservation 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.

3. Demarcation of the priority of watersheds for treatment based on soil erosion intensity in the catchment area.
4. Rehabilitation of degraded forest areas through afforestation and facilitating natural regeneration of plants.
5. Mitigation of landslide, landslip and rock falls.
6. Soil conservation through biological and engineering measures to reduce sediment load in river and tributaries, incidentally improving the quality of water.
7. Ecosystem conservation resulting from increased vegetal cover and water retaining properties of soil.
8. To meet the fuel and fodder requirements of local people.
9. Promotion of non-conventional energy device to reduce pressure on forest.
10. Employment generation through community participation and conservation.

### **1.3 Catchment Area**

The Sindh basin, situated in the northern part of Madhya Pradesh is an important basin in the state. The river Sindh has its origin at village Gopi Talai in Lateri, Tehsil of Vidsha district in Madhya Pradesh at an elevation of 533.40m above M.S.L. Sindh a tributary of Yamuna flows mostly through M.P. in the district of Vidisha, Guna, Ashoknagar, Shivpuri, Gwalior, Datia and Bhind. It then joins river Yamuna near village Jagammanpur in Jalaun District of Uttar Pradesh. The total length of the river from its origin to its confluence with Yamuna is 500 km. The river flows through Malwa Plateau in Vidisha and Guna district. In Shivpuri it flows through a thick forest and hilly stretch and enters the plains after the town Narwar in Shivpuri district. The total drainage area up to the confluence with Yamuna River is 17413 sq.km. and catchment area upto Dam site is 12739 Sq Km.

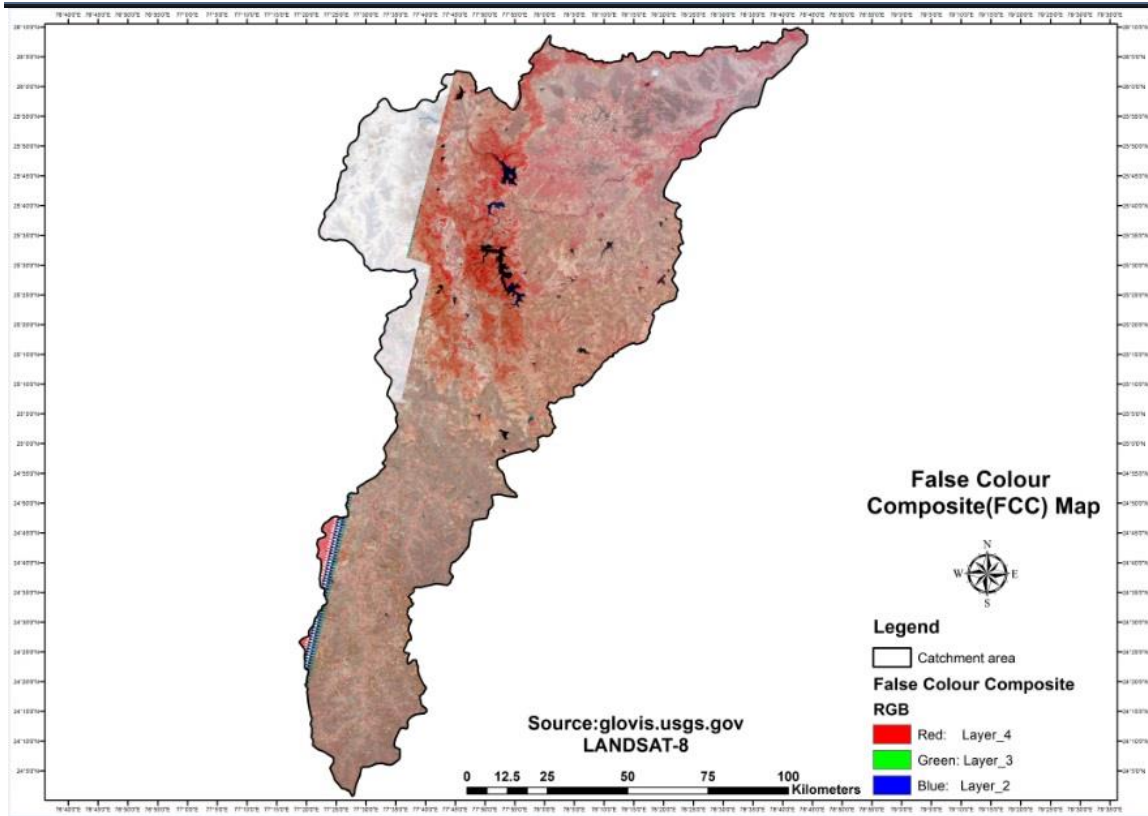
#### **1.3.1 Free Draining Catchment**

The total catchment area of Sindh up to the proposed site is 12739 sq. km with intercepted catchment area as 5915 Sq Km. Since the catchment is not intercepted by any other major or medium water resource project on upstream, the Catchment Area Treatment Plan shall be formulated for entire catchment (12739 sq. km).

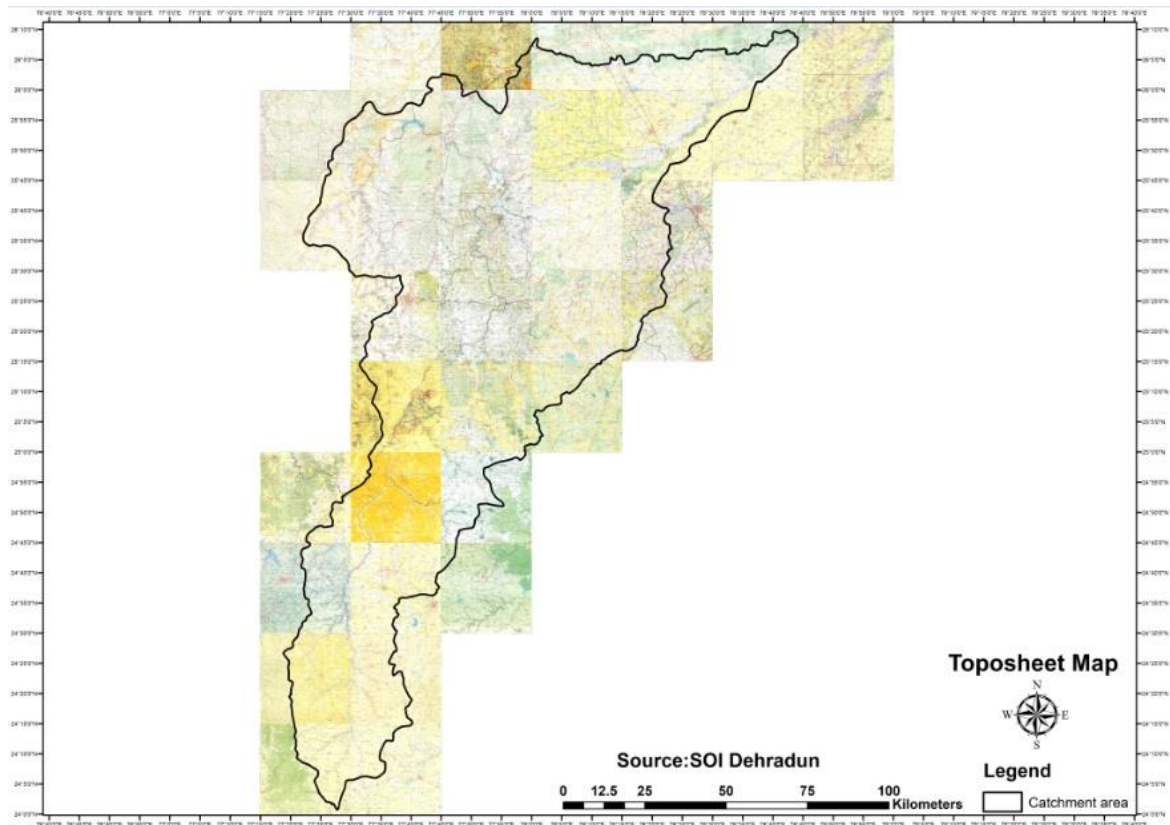
The basin characteristics of catchment are illustrated in **Table 1.1**, the satellite imagery of the free draining catchment is presented in **Figure 1.1**, and the mosaic map of watershed location is shown in **Figure 1.2**.

**Table 1.1: Basin Characteristics of watershed**

Sl. No.	watershed	Total catchment area of MWS (Sq.km.)	Altitude of the highest point in WS (mamsl)
	Name		
1	Catchment of Maa Ratangarh	12739	539



**Figure 1.1: FCC Map of Catchment Area**

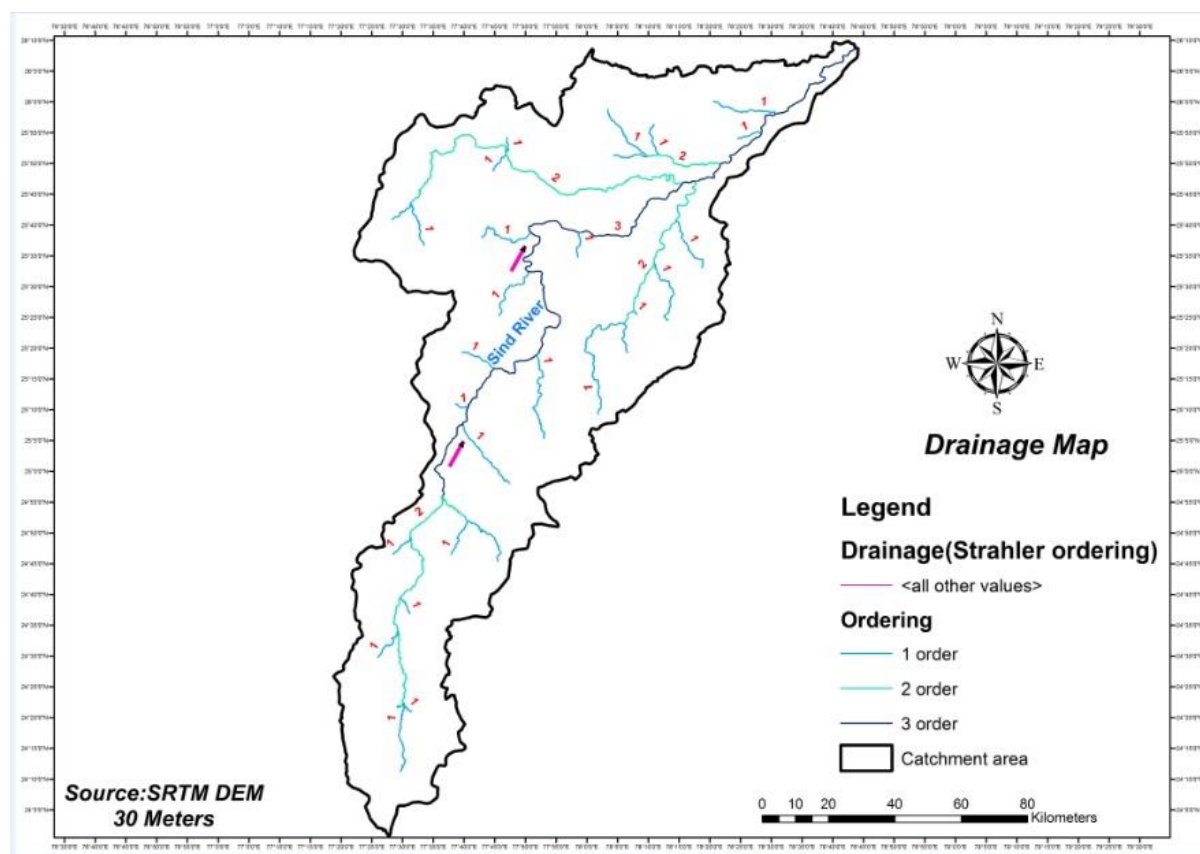


**Figure 1.2: Mosaic Map Showing Location of watershed**



## 1.4 Topography

The catchment is largely hilly terrain and has undulated topography and tracts of agriculture land and dry deciduous forest. The highest altitude in the basin is 539 mamsl, The Datia district comes under the Gangetic drainage system and is drained by the Sind, the Pahuj, the Mahuar and the Betwa. The former two, however form the drainage system of the main body of the district. The rivers are almost seasonal and have heavy run off only during the peak period of July and August in the rainy season. During the dry season most of the streams become dry and water is available only in some channels of the main stream. The drainage map of the catchment is shown in **Figure 1.3**.



**Figure 1.3: Drainage map of the catchment.**

## 1.5 Soil

The soil resource map of Madhya Pradesh (NBSS Publication No 59) has been used in the present study. The soil is predominantly sandy clay loam to clay soil. The soil map is presented in **Figure 1.4**.

Soil map unit 341-

- The soil type belongs to Shallow, well drained, loamy skeletal soils on moderately slopping plateau with moderate erosion and slightly stony, associated with: shallow, well drained loamy skeletal soils on gently sloping with serve erosion and slightly stony.





**Soil map unit 350**

The soil type belongs to Deep, moderately well drained, calcareous, clayey soils on very gentle sloping interveinal plateau with moderate erosion, associated with: Deep, moderately well drained, calcareous, clayey soils on very gentle sloping with moderate erosion.

**Soil map unit 351**

The soil type belongs to Deep, well drained, loamy soils on gently sloping interveinal plateau with severe erosion and moderately stony, associated with: Deep, moderately well drained, clayey soils on gently sloping with severe erosion and slightly stony.

**Soil map unit 374**

The soil type belongs to Deep, moderately well drained, calcareous, clayey soils on gently sloping plain with moderate erosion, associated with: Deep, moderately well drained, calcareous, clayey soils on very gentle sloping with moderate erosion.

**Soil map unit 375**

The soil type belongs to deep, moderately well drained, calcareous, clayey soils on very gently sloping plain land with moderate erosion, associated with: Deep, moderately well drained, clayey soils on very gentle sloping with moderate erosion.

**Soil map unit 383**

The soil type belongs to deep, moderately well drained, clayey soils on very gently sloping undulating plain with moderate erosion, associated with: Slightly deep, well drained, calcareous, clayey soils on gently sloping plain with moderate erosion

**Soil map unit 488**

The soil type belongs to very shallow, well drained, loamy soil on moderately sloping residual hills with isolated hillocks with severe erosion, associated with: shallow, well drained, loamy soils on gently sloping with severe erosion and slightly stony.

**Soil map unit 493**

The soil type belongs to slightly deep, well drained, loamy soil on gently sloping undulating upland with mounds with moderate erosion, associated with: shallow, somewhat excessively drained, loamy soils on gently sloping with severe erosion.

**Soil map unit 509**

The soil type belongs to slightly deep, well drained, loamy soils on gently sloping plain land with moderate erosion, associated: moderately deep, somewhat excessively drained, sandy soils on moderately sloping with severe erosion.



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Soil map unit 446

The soil type belongs to Very shallow, somewhat excessively drained, loamy soils on gently sloping undulating plateau with severe erosion and moderately stony, associated with: shallow, well drained, loamy-skeletal soils on moderately sloping with severe erosion and moderately stony.

Soil map unit 492-

The soil type belongs to Very shallow, somewhat excessively drained, loamy soils on gently sloping undulating plateau with severe erosion and moderately stony, associated with: shallow, excessively drained, loamy- soils on moderately steep sloping with severe erosion and moderately stony.

Soil map unit 427-

The soil type belongs to Very shallow, somewhat excessively drained, loamy soils on moderately steep sloping hills with escarpments with severe erosion and strongly stony, associated with: slightly deep, somewhat excessively drained, loamy soils on moderately sloping with severe erosion and slightly stony.

Soil map unit 573-

The soil type belongs to deep, moderately well drained, calcareous, clayey soils on very gently sloping plain land with moderate erosion, associated with: Deep, well drained calcareous, loamy soils on moderate steep sloping with severe erosion.

Soil map unit 452-

The soil type belongs to slightly deep, well drained, loamy soils on moderately undulating plateau (slightly dissected) with severe erosion and moderately stony, associated with: very shallow, somewhat excessively drained loamy soils on gently sloping with severe erosion and moderately stony.

Soil map unit 425-

The soil type belongs to Very shallow, excessively drained, loamy soils on moderately steep sloping hill with escarpments with severe erosion and strongly stony associated with: Very shallow, excessively drained, loamy skeletal soils on moderately sloping with severe erosion and strongly stony.

Soil map unit 432-

The soil type belongs to Very shallow, somewhat excessively drained, loamy soils on moderately hill with pediments with severe erosion and slight stony, associated with: Deep well moderately drained, calcareous, coarse-loamy soils on gently sloping with moderate erosion.

Soil map unit 447-



The soil type belongs to Very shallow, somewhat excessively drained, loamy-skeletal soils on gently sloping undulating plateau with severe erosion and moderately stony, associated with: Very shallow, well drained loamy soils on very gently sloping with moderate erosion and moderately stony.

Soil map unit 454-

The soil type belongs to Deep, well drained, loamy soils on moderately sloping undulating plateau with (slight dissected) moderate erosion, associated with: Very shallow, well drained loamy soils very gently sloping with moderate erosion

Soil map unit 533-

The soil type belongs to Deep, well drained, loamy soils on gently sloping plateau with moderate erosion, associated with: Slightly deep, well drained, loamy soil on very gently sloping with moderate erosion and slightly stony.

Soil map unit 535-

The soil type belongs to Shallow, somewhat excessively drained, loamy soils on moderately sloping plateau with severer erosion, associated with: Very shallow, somewhat excessively drained, loamy soils on moderately sloping with severe erosion.

Soil map unit 548-

The soil type belongs to moderately deep, moderately well drained calcareous, loamy soils on very gently sloping undulating plain with mounds with moderate erosion, associated with: Moderately well drained loamy soils on very gently sloping with moderate erosion.

Soil map unit 555-

The soil type belongs to Deep Moderately well drained calcareous clayey soils on gently sloping plain with hummocks (slightly dissected) with moderate erosion, associated with: Moderately deep moderately well drained calcareous clayey soils on gently sloping plain with slight erosion.

Soil map Units- 558-

The soil type belongs to Deep, well drained, loamy soils on gently sloping plain land with valleys with slight erosion, associated with: Moderately well drained, calcareous, loamy soils on very gently sloping with moderate erosion.

Soil map Units- 562 –

The soil type belongs to Moderately deep, well drained, loamy soils on very gently sloping flood plain (mode-rately dissected) with moderate erosion, associated with; Deep, well drained, calcareous clayey soils on gently sloping with moderate erosion.

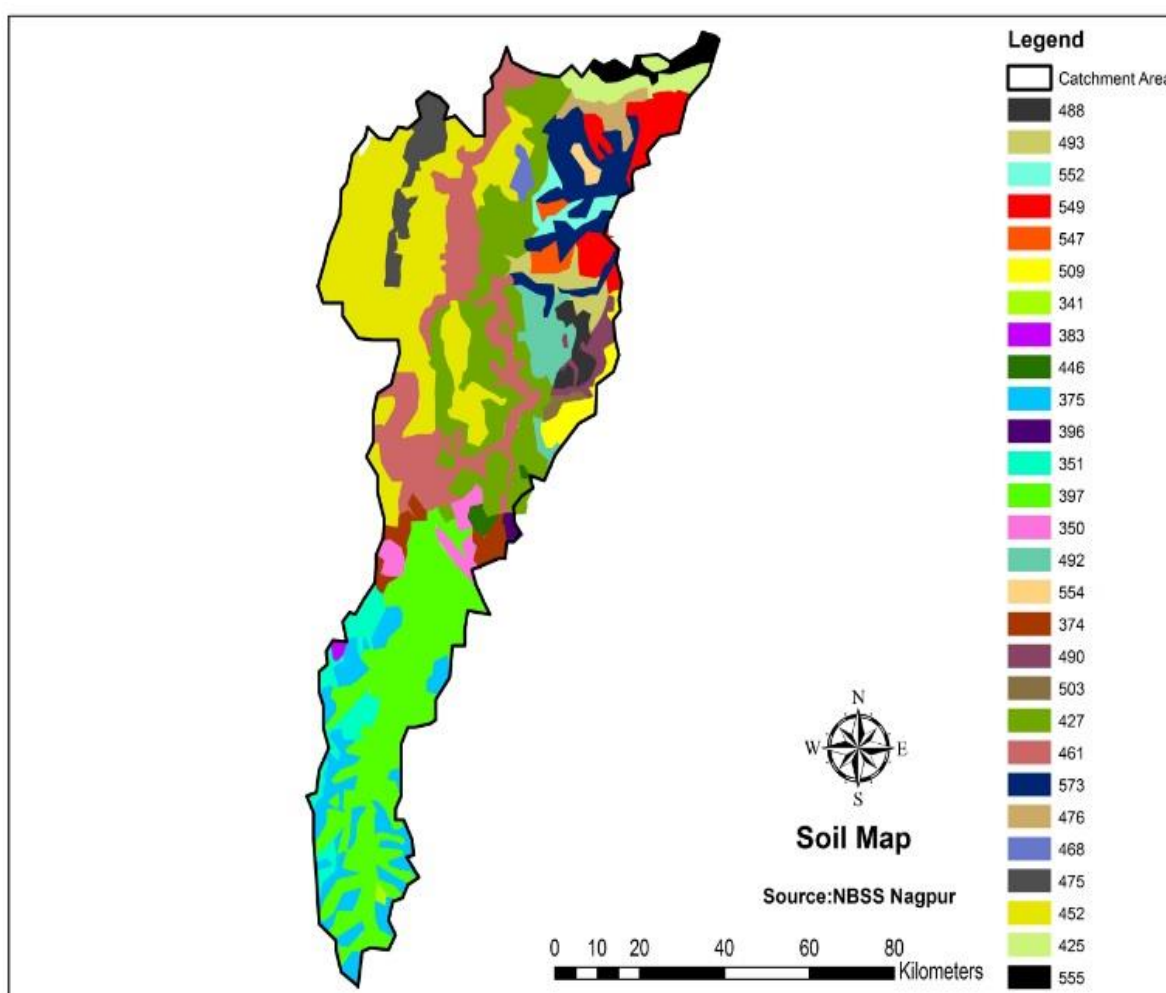
Soil map Units- 567-



The soil type belongs to Deep, moderately well drained calcareous clayey soils on Moderately sloping ravenous land (slightly dissected) with very severe erosion, associated with; Deep, well drained, calcareous, loamy soils on moderately sloping with slight erosion.

Soil map Units- 572-

The soil type belongs to Deep, somewhat excessively drained, calcareous, loamy soils on moderately sloping ravenous land (highly dissected) with very severe erosion, associated with; Deep, well excessively drained calcareous, loamy soils on moderately steep sloping with severe erosion.



**Figure 1.4: Soil Map of Catchment**

## **1.6 Land use**

### **1.6.1 Land use-Land Cover Classification**

Based on satellite data and topo-sheets, a land-use map has been prepared and verified in detail



during ground surveys i.e. crosschecked with ground truths. The Land use/ Land-cover map of the catchment area is presented in **Figure 1.5** and its details are presented in **Table 1.2**.

### **1.6.2 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 land-use class to further plan for treatment.

#### **1.6.2.1 Agricultural Land**

Around 8769.12 sq. km area of the catchment constituting 68.84 % of the total catchment comes under this category. Plain to Well-planned and developed terraces were seen at some places. In general, at places the sheet and rill type of soil erosion predominates with few gullies in early stage of its development. Very few or no measures are taken to conserve soil and tendency exists to interrupt the natural drainage due to faulty agricultural practices. Runoff often exceeds the safe velocity on long slope lengths. It is suggested to repair and better design the agricultural terraces, which follows the faulty agricultural practices.

Temporary and semi-permanent soil conservation structures like brushing dams, wiring woven and gabion check dams etc. shall be made for effective adaptive management.

#### **1.6.2.2 Settlement**

Under settlement category about 368.34 sq. km area of catchment constituting 2.89 % of the total catchment is present.

#### **1.6.2.3 Open Forest Land**

Under open forest category about 2310.7 sq. km constituting 18.13% of the total catchment, is present. Forest crown density ranges from 0-40% or on average 20% crown density can be assumed present in the area. Soils have relatively good water holding capacity, humus, nutrient content and moderate to slight erosion rates on steeper slopes. Therefore, rill erosion predominates which in due course leads to scrub land formation with gullies. Afforestation is suggested so as increase the crown density by 20% in whole of the area to reduce erosion.

#### **1.6.2.4 Dense Forest**

Dense forest covers about 1146.2 sq. km area constituting 8.99% of the catchment with the forest crown density above 40%. Soils are very good in water holding capacity, humus and nutrients with no erosion but due to steeper slopes, some area requires soil conservation measures.

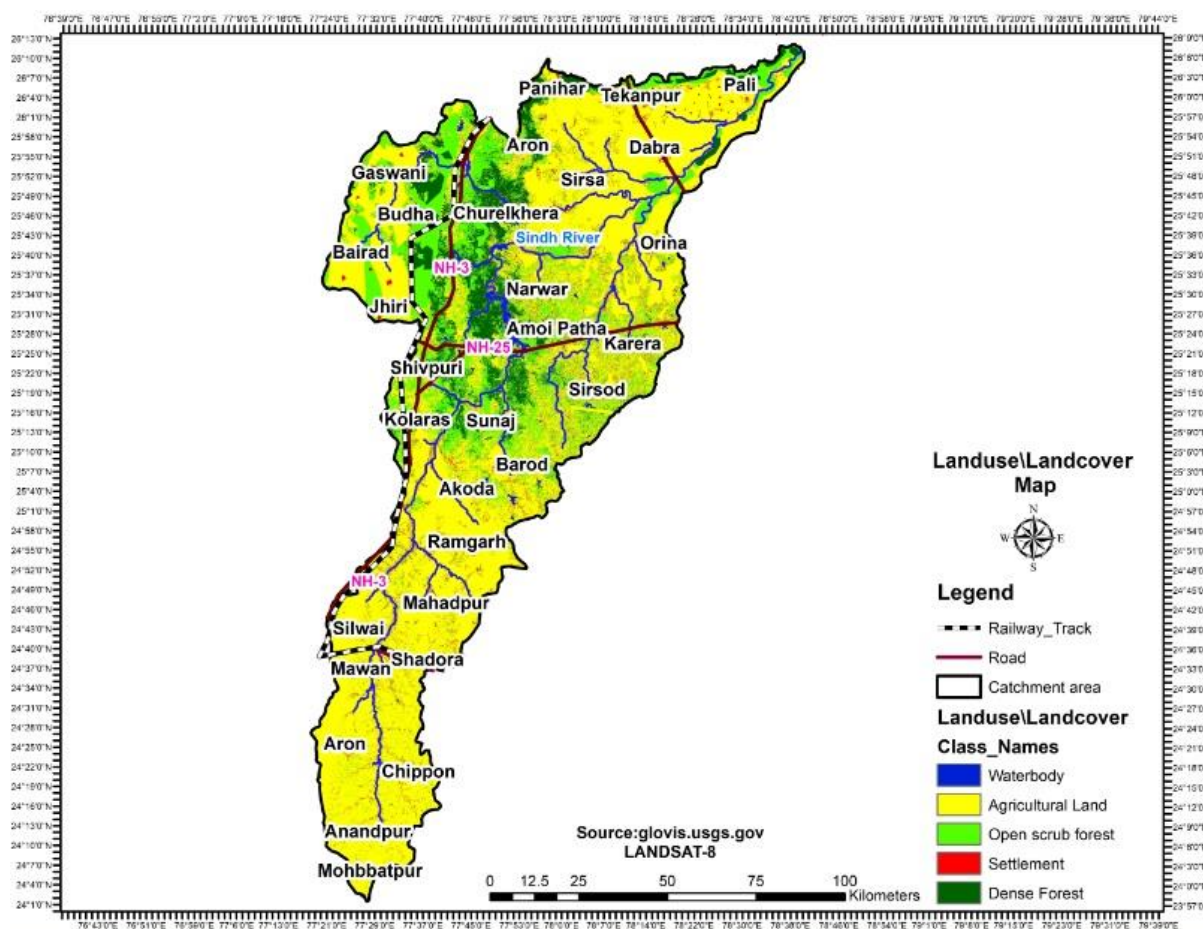
#### **1.6.2.5 River / Water body**

Around 144.70 sq. km area constituting 1.13% 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.



**Table 1.2: Land use Details of watershed in the Catchment**

watershed	Land Use Category						Area (sq. km)
	Dense Forest	Open Forest	Scrub	Agriculture	Settlement	Water body	
Maa Ratangarh	1146.2	2310.7	-	8769.1	368.3	144.70	12739
Percentage	8.99	18.13	-	68.84	2.89	1.15	100



**Figure 1.5: Land use Map of Catchment Area**



## 1.7 Slope

The slope of a watershed plays a key 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 1.3**) as per norms of All India Soil & Land Use Survey were adopted to classify the slopes for the present study.

**Table 1.3: Slope Ranges showing the intensity of catchment area**

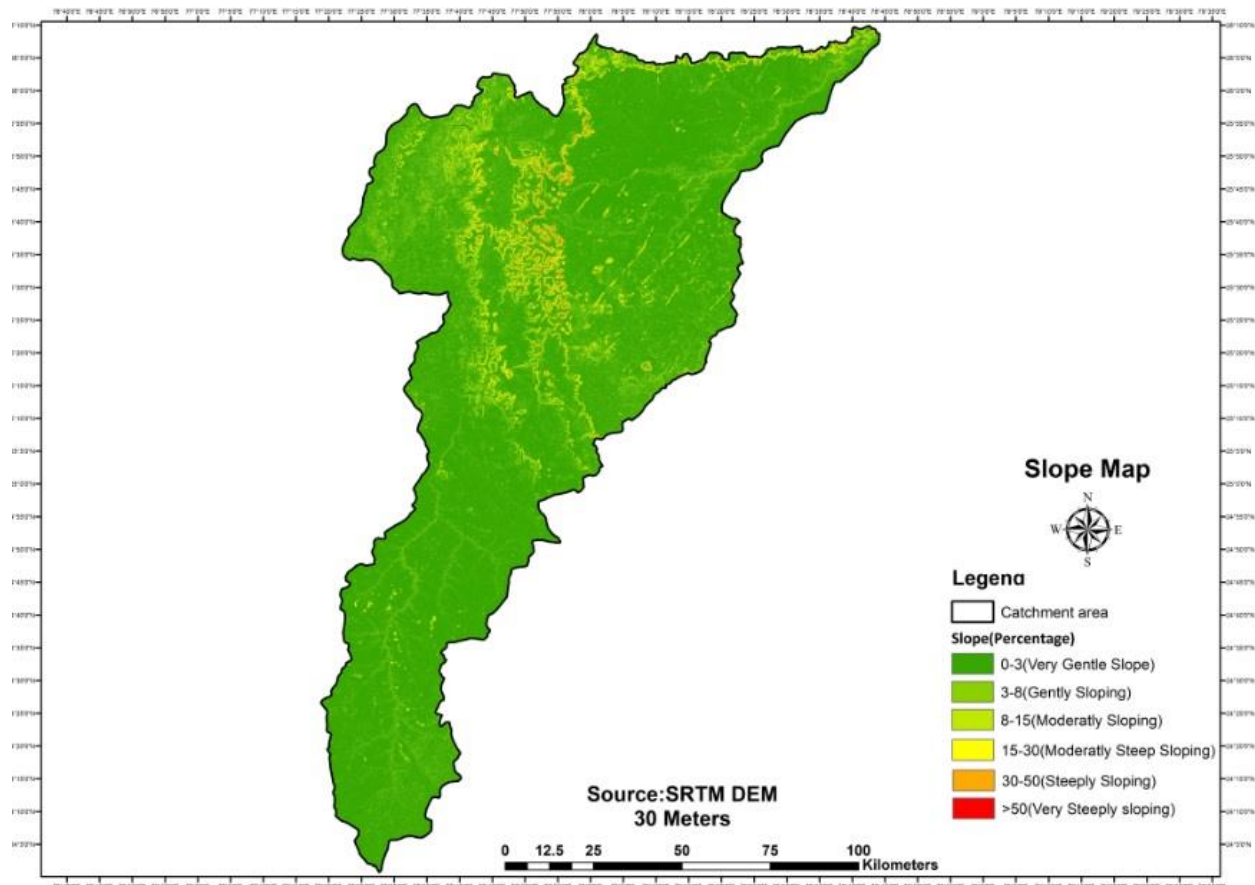
Sr. No	Slope Range (Degrees)	Description
1	0-5	Very Gentle Slope
2	5-10	Gentle Slope
3	10-15	Moderate Slope
4	15-25	Moderately Steep Slope
5	25-35	Steep Slope
6	>35	Very Steep Slope

The Slope map of the free draining catchment is presented in **Figure 1.6** and slope details are as presented under **Table 1.4**. The data shows that about 78.09% area lies between very gentle to gentle slope category of slope and balance 21.91% falls from moderate slope to moderately steep slope category.

**Table 1.4: Area under Different Slope Classes**

Sr. No	Description	Area (sq. km)	Area (%)
1	0 - 5(Very Gently Sloping)	9537.02	74.86
2	5- 10(Gently Sloping)	2356.37	18.49
3	10 - 15(Moderately Sloping)	457.09	3.58
4	15-25(Moderately Steep Sloping)	279.87	2.2
5	25-35(Steeply Sloping)	78.05	0.62
6	>35 (Very Steeply Sloping)	30.89	0.25
<b>Total</b>		<b>12739</b>	<b>100</b>





**Figure 1.6: Slope Map of Catchment**

## **1.8 Methodology Used for the 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.

### **1.8.1 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.

#### **Erosion Intensity and Delivery Ratio**

- Determination of erosion intensity unit is primarily based upon the integrated information on soil characters, physiography, slope, land-use/land-cover, litho logy 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 crucial factor responsible for delivery of the sediments) per the following scheme. The delivery ratio criteria adopted for the study is presented in **Table 1.5**.

**Table 1.5: Delivery Ratio (DR) Criteria**

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
5.1-15.0 km	0.70
15.1-30.0 km	0.50

**(ii) 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 is 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 various 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**

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

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 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

Accordingly, the sediment Yield Index has been calculated for watershed. The computation of SYI for water shed is presented in **Table 1.6**.

**Table 1.6: SYI and Priority Rating as per Erosion Intensity**

Sub-watershed code	Erosion intensity	Area (ha)	Weightage	Area x weightage	Delivery ratio	Gross silt yield	Sediment yield index	Priority
2C1B7(1)	V. Severe	0.00	18	0.0	0.80	0.0	1043	Low
	Severe	42890	16	686240	0.80	43.0		
	Moderate	310058	14	4340812	0.90	306.0		
	Slight	920952	12	11051424	0.80	694.0		
	Negligible	0.00	10	0.0	0.80	0.0		
Total		1273900				1043		

### 1.9 Catchment Area Treatment Plan

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 forestland 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 forestland 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 1.7** 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 1.7: Erosion Intensity & Weightages**

Erosion Intensity Class	Sum of weightages
Very severe (E5)	12 to 14
Severe (E4)	9 to 11



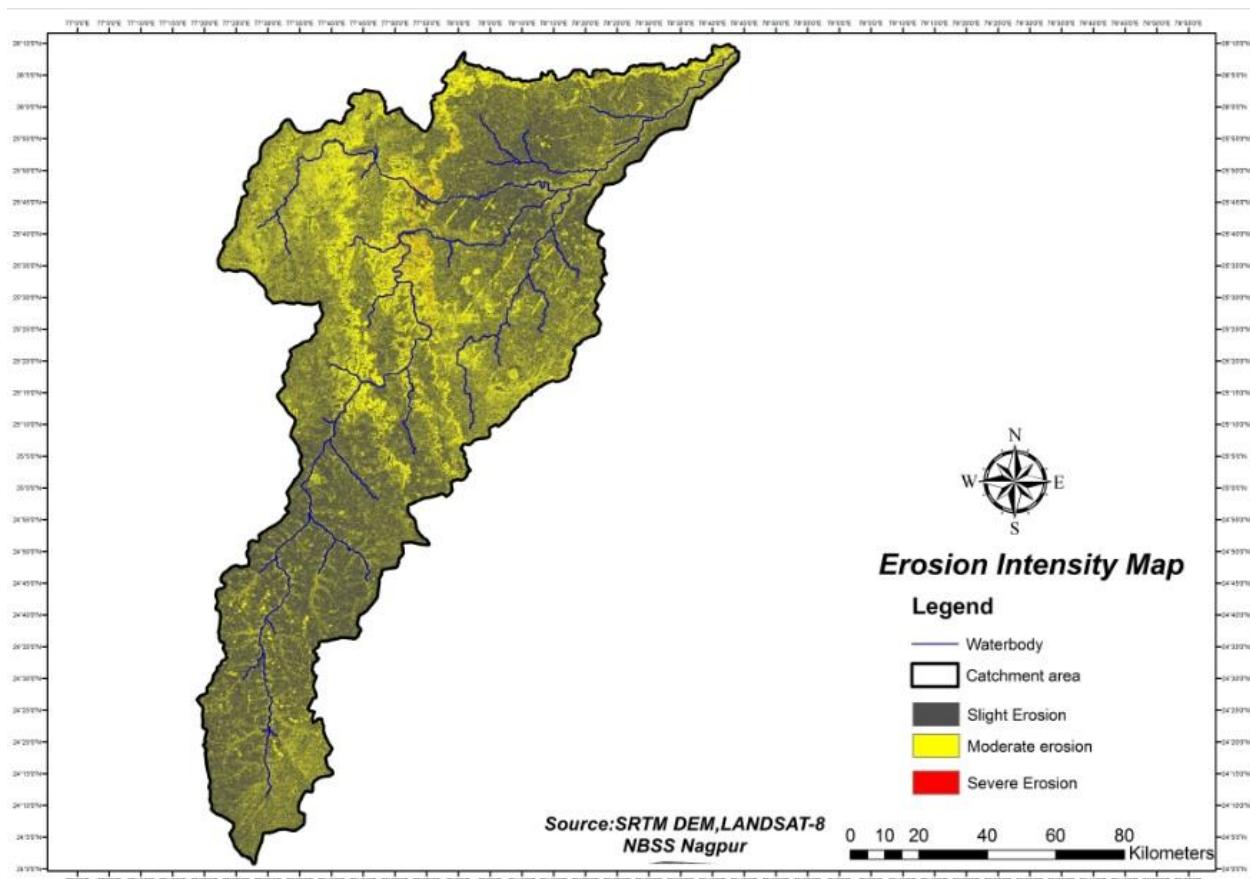
Moderate (E3)	6 to 8
Slight (E2)	4 to 5
Negligible (E1)	0 to 3

After exclusion of rocks and inaccessible terrain, only those areas which fall under very severe and severe erosion intensity category would be taken up for conservation treatment measures in very high priority category micro-watersheds, whereas in the rest of micro-watersheds belonging to other priority categories, the area falling under very severe erosion intensity class shall be taken for treatment with biological and engineering measures under the CAT Plan.

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 based on SYI data and is presented in **Figure 1.7** and the statistics are presented in **Table 1.8**.

**Table 1.8: Erosion Intensity Categories in Sub-Watersheds (sq. km)**

Sr. No	water- shed	Very Severe	Severe	Moderate	Slight	Negligible	Total
1	Maa ratangarh	0.00	505	3050	9184	0.00	12739



**Figure 1.7: Erosion Intensity Map of Free Draining Catchment Area**



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### **1.10 Treatment of Individual Sub-Watershed**

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. And, agriculture activities, if faulty, result in heavy loss of fertile soil. Second, is open forest land for conservation reasons Third is scrub or degraded land, which contributes heavily to silt load. Possibilities exist to bring this area under pastures and plantation to meet local demand of fuel and fodder and thus decreasing the biotic pressure on the forests 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 a few places soil conservation measures are required.

Areas falling under very severe and severe erosion intensity category would be taken up for conservation treatment measures after excluding the percentage of area above 25<sup>0</sup> slopes from the area coming under very severe and severe erosion intensity class falling under rocks and inaccessible terrain where no treatment is feasible, the rest of area of very severe and severe categories is to be treated with biological, bio-engineering and engineering measures under CAT Plan. Considering the topographic factors, soil type, climate, land-use/land-cover in the catchment area following measures have been proposed to be undertaken with aim to check soil erosion, prevent/check siltation of reservoir and to maintain its storage capacity in the long run.

#### **1.10.1 Activities to be undertaken**

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

With a view to conserve and augment the state's rich medicinal plant resources in its natural habitat through adaptive and participatory management of the local people, cultivation of high priority medicinal plant species shall be undertaken. Thrust shall be given to organic cultivation of medicinal plants.

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. It is, therefore, recommended that some parts of the pasture should be closed for seeding purpose only.

##### **1.10.1.2 Enrichment Plantation**

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 500 seedlings per hectare is likely to create dense forest.



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#### **1.10.1.3 High Density Energy Plantation**

In order to reduce the biotic pressure on the forest areas near the villages, high-density energy plantation in forest areas and barren areas under the village can help in long way to solve the ever-increasing problem of scarcity of fodder and fuel wood in hilly areas. To overcome the problem of scarce availability of fodder and fuel it is proposed to bring substantial area by planting 1600 trees/ha with suitable fast-growing species.

#### **1.10.1.4 Treatment of Pasture**

The restoration and management of degraded pasture is a vital objective, both to provide sufficient habitat for spatial movement of the spill over species outside and within catchment area and to provide biological resources to the local populace. The pastures have their own unique significance in the geophysical, environmental and socio-economic set-up of the region. They are the prime and continual source of herbage for the wild herbivores which are prey base for carnivores, cattle, sheep and goats. These pastures are extensively grazed by the live stocks of the local people. The large scale and indiscriminate grazing of these pasture over a prolong time has left these pastures ominously degraded. The palatable grasses are no more than a few inches tall and the other related pasture species have also started showing signs of stress. Because of continuous and heavy pressure of grazing, barren patches have developed over vast areas and soil erosion is rampant in these pastures. There is an imperative need to address this abysmal and alarming situation immediately before these pastures are brought to such a condition, where, their rejuvenation becomes impossible. Owing to traditional rights of the grazers, it is difficult to restrict the number of animals grazing there. Thus, the only alternative left is to increase the productivity of these pastures to cope with the grazing pressures. The situation warrants for a realistic survey and allied research in context of entire grazing issues and formulation of an action plan for corrective measures within the gambit of the state policy on the subject matter. Till such time the following recommendations are made for the management of pastures.

- Assessment of the carrying capacity of the pastures through surveys to ascertain allowable size of live stocks.
- Periodical field checking of the size of the herds mentioned in the permits to avoid misuse by some permit holders.
- Public awareness.
- Periodical closure of areas in pastures for the proliferation of seeds of desirable grass species.
- Implementation of rotational deferred grazing system to derive the advantage of early nutritive growth and rest period during the growing season.
- Interaction with the local people and so that a sort of social fencing could be achieved.

#### **1.10.1.5 Nursery Support**

In order to meet the huge requirement of saplings required under biological / bio-engineering measures and reservoir rim treatment new nursery has to be developed along with support to the existing nurseries which shall also augment the supply of saplings for the works proposed.



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#### **1.10.1.6 Soil Bioengineering**

Soil bio-engineering is state-of-the-art using the living vegetation, either alone or in conjunction with non-living plant material and civil engineering structures, to stabilize slopes and/or reduce erosion. Such measures utilize live plants and plant parts, either alone or in conjunction with non-living plant material and hard measures usually referred to as civil engineering structures, where they provide additional mechanical support to soil, present barriers to earth movement, function as hydraulic drains, and act as hydraulic pumps. Soil bio-engineering system use live plant cuttings, rooted plants, and plant stems that are placed in the ground, or in earthen or other structures that commonly incorporate inert materials such as rock, wood, geo-synthetics, geo-composites or other products.

Control of severe landslide or gully erosion usually requires engineering structures to avoid slope failure and gully cutting. However, such measures involve exorbitant investment and a high degree of technology. It has been experienced that lack of timely and adequate maintenance has resulted in spectacular failure of measure under taken and the resultant erosion is more serious than before the treatment.

The exclusive use of vegetative measures for control of major land slide and severe gully erosion often results in failure. However, when vegetative measures are combined with engineering measures, i.e. bio-engineering, the result can be effective stabilization of the area from mass movement and gully cutting, and dramatic reduction of surface erosion, at relatively low cost and high sustainability and with added benefit of fodder and fuel wood production for local people.

The successful results of bio-engineering techniques have been observed in gully control, waste land reclamation and slope stabilization. By for these have been observed to be economically desirable and most-effective for erosion control in degraded area.

Soil bio-engineering measures shall be adopted in landslide zones and area degraded due to road excavation. The work shall involve fixing of brush wood check dams, spraying of grass and legume seeds, plantation of shrubs @ 500 /ha and trees @ 150 /ha, fencing of the area and maintenance for three years. The most common method of hill and slope stabilization is the seeding of grass and herb mixture.

Dry Seeding is an easy method where seed (5 g/sq.) and organic fertilize (100 g/sq.) are scattered by hand or machine. It can be applied on flat slopes with rough surfaces. It is also possible to use hay-flowers instead of common seeds.

On steeper slopes where it is necessary to cover the soil quality, a cover crop seeding is used. Special types of rye (in fall) and barley (in spring) are spread in a mixture of 5 gm/sq. and covered with soil. On the surface, normal seed (5 g/sq.) are spread.

On less steep slope with rough surface and no erosion problems tree and shrub seeding can be spread. Seeds of trees and shrubs are mixed with sand in a ratio of 1:3 and spread as broadcast, pit or row seeding.





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#### **1.10.1.7 Civil Structures**

##### **Brush wood Check Dams and Retaining Walls**

Brushes wood check dams are useful in arresting further erosion of depressions, channels, and gullies on the denuded landslides. In addition, retaining walls of stone masonry and RCC would be constructed to provide support at the base of threatened slopes.

##### **Slope Modification by Stepping or Terracing**

The slope stability increases considerably by grading it. The construction of steps or terraces to reduce the slope gradient is one of the measures.

##### **Bench Terracing**

The area under moderately steep slope i.e. between  $10^0$ - $15^0$  slopes would be subjected to bench terracing. The local people would be convinced to follow this type of terracing for comparatively better yield and with minimum threat to erosion. Moreover, in several habitations in the catchment such practices are already visible. While making bench terraces, care must be taken not to disturb the topsoil by spreading earth from the lower terraces to higher terraces. The vertical intervals between terraces will not be more than 1.5m and cutting depth may be kept at 50 cm. The minimum average width of the terrace would be kept from 4 to 5 m to enable usage of prolong hinge. The shoulder bunds of 30 x 15 cm would also be provided. Staggered channels will drain off the excess water from the terraces.

##### **Gully Control-Check Dams**

Gullies are mainly formed because physiographic, soil type, and heavy biotic interference in an area. The scouring of streams at their peak flows and sediment-laden run-off cause gullies. The gullies would be required to be treated with engineering/mechanical as well as vegetative methods. Check dams would be constructed in some of the areas to promote growth of vegetation that will consequently lead to the stabilization of slopes/area and prevention of further deepening of gullies and erosion. Diverse 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.



**Contour Staggered Trenches**

Contour staggered trenches are mainly provided to trap the silt and runoff. This is also done to prepare a fertile base for plantation, in moderately steep to very, very steep slopes.

**Landslide Control**

Rainfall pattern of the area and water seepage coupled with geological formation results in landslides. Water plays an important role in triggering of landslides and mass wasting processes along with other factors such as slope and nature of soil/land-cover/land-use. However, most of the landslides are caused by human negligence. Road construction, overgrazing of hill slopes, felling of trees for timber, fuel, and fodder and upslope extension of cultivation are some of main causes of landslides. Gabion structures shall be provided at the base of the land slide zones to control the toe erosion by water.

**Catch-water Drains**

Among the most effective, practical and least expensive measures of landslide hazard management is construction of catch-water drains for run-off and surface waters in the identified hazard-prone zone so that little or no water can infiltrate into the ground. All the streams and minor watercourses would be diverted around the crown of the slide or the potentially hazardous area through catch water drains with an adequate gradient. The catch water drains when provided avoid runoff to pass over such vulnerable areas and water is guided through these drains provided on foothill or along the kuccha/pucca roads. The ground surface of threatened area is leveled out to eliminate all depressions where water can accumulate.

**1.11 Cost Analysis of Different Works under Biological Measures****1.11.1 Afforestation**

Out of the total stock to be planted under 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 1100 plants/ha, with five strands barbed wire fencing stretched across RCC fence posts inclusive of maintenance for five years has been worked out as Rs. 1.84 lakh/ha as shown in **Table-1.9**. The rate analysis is as per labor wage of Rs 289/day with 10% annual enhancement as per sanctioned schedule of CF for forestry works and for other works as per PWD schedule of rate. The cost of materials has been adopted as per prevalent market rates.

Plantation under normal afforestation component shall be carried through identified user groups in catchment area. Plantations will be maintained for five years.

**Table 1.9: Per Ha. Cost Norms for Model Plantation Works**

Sl. No.	Particular of Work	Quantity	Rate/ Man days per unit	Total Man days	Total Amount
<b>First year preparation year</b>					
<b>A. Labour Oriented Works</b>					
1	Survey and demarcation of plantation area	1 ha	0.45 man-days /ha	0.45	130.05
2	Weeding of obnoxious weeds	1 ha	4 man-days/ha	4	1156



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	except lantana				
3	Dag Belling with line for siting pits	1100	2.5 man-days/1000 no.	2.75	794.75
4	Digging pits 45x45x45 cm	1100	5 man-days/100 no.	55	15895
5	Filling pits with FYM mix with soil and Pesticides	1100	1.5 man-days/100 no.	16.5	4768.5
6	Preparation of Path	240m	30 man-days/km	7.2	2080.8
	<b>Total Labour cost (A)</b>				<b>24825.1</b>
<b>B. Material Component</b>					
1	Cost of FYM including carriage @ 10% of volume of pit i.e. 1100(0.45x0.45x0.45) x0.1	10.03 m3	1200 / m3	0	12036
2	Providing fertile soil including carriage @ 10% of volume of pit i.e. 1100(0.45x0.45x0.45) x0.1	10.03 m3	500 Rs/m3	0	5016
3	Applying cost of Neem Cake @ 30g/pit	33 Kg	55 Rs/ Kg	0	1815
4	Cost of plant	1210 No.	11 Rs/Plant	0	13310
5	Cost of Service Pipe	100 RM	55 Rs/m	0	5500
6	Proportionate cost for providing irrigation implements like tank, pipe fittings & electric motor etc.	1 job	L.S.	0	4200
7	Proportionate cost for providing chowkidar hut	1 job	L.S.	0	2000
	<b>Total Material cost (B)</b>				<b>43877</b>
<b>C. Chain Link Fencing Work</b>					
1(a)	Cost of 2m high RCC pole @ 2.5m c/c (140x1.1)/2.5=62	62	296.3/no.	0	18370.60
1(b)	<u>GST @18%</u>	Rs 18370.6	0.18	0	3306.70
2(a)	Cost of barbed wire in five strands (141x5)/7=100	100 Kg	90 Rs /kg	0	9000.00
2(b)	<u>GST @18%</u>	9000	0.18	0	1620.00
3(a)	Cost of U-nails	10 Kg	90 Rs /kg	0	900.00
3(b)	<u>GST @18%</u>	900	0.18	0	162.00
4(a)	Cost of GI wire	3 Kg	100 Rs /kg	0	300.00
4(b)	<u>GST @18%</u>	300	0.18	0	54.00
5	Cost of labour for stretching & fixing barbed wire and other miscellaneous work	141	0.16 Man days / RM	6.56	1521.90
6	Excavation of pit for poles	62	2.5 man-days/100 No.	1.55	359.60
7	Cost of fixing poles in pit with PCC 1:3:6 mix	2.32 m3	3643/m3	0	8451.80
8	Erection of poles	62	Rs 80/ Pole	0	4960.00
	<b>Total Fencing cost (C)</b>				<b>49006.60</b>
	<b>Total Cost First year</b>				<b>117708.70</b>



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Sl. No.	Particular of Work	Quantity	Rate/ Man days per unit	Total Man days	Total Amount
<b>Second Year - Plantation Work</b>					
<b>A. Labour Oriented Works</b>					
1	Carriage of plant raised in nursery over a distance of 45 Km	1210 No.	170/100 No.	0	2057
2	Carriage of plants from road side to plantation site by manual labour up to 2 Km	1100	0.4Mandays/100 No	4.4	1399.2
3	Planting saplings in pits	1100	1.8 Man days/100 No	19.8	6296.4
4	Carrying out first weeding, nirai operations and application of fertilizer and pesticides including replacing of dead plants of previous year	1100	1.25 man-days/100 No.	13.75	4372.5
5	Carrying out second weeding, nirai operations and application of fertilizer and pesticides including replacing of dead plants of previous year	1100	1 man-days/100 No.	11	3498
6	Spraying pesticides and insecticides	1100	0.6 man-days/100 No.	6.6	2098.8
7	Applying Irrigation	1 job	L.S.	0	1600
8	Clearing of Fire lines	180 RM	2.25 man-days/Km	0.41	128.8
	<b>Total Labour oriented Works cost (A)</b>				<b>21450.7</b>
<b>B. Material Component</b>					
1	Cost of fertilizer (DAP/Urea) and Pesticides @ 40g and 10g / plant respectively	55 Kg	24 Rs/kg	0	1320
2	Cost of Diesel for Irrigation	1 Job	L.S.	0	1000
3	Contingency	1 Job	L.S.	0	200
	<b>Total Material Component Cost (B)</b>				<b>2520</b>
	<b>Total Second Year</b>				<b>23970.7</b>
<b>Third Year - Maintenance</b>					
<b>A. Labour Oriented Works</b>					
1	Repair of fencing	1 ha.	2 man-days/ha.	2	700
2	Cost of replacing of dead plants (10% mortality)	110	Rs 15 /No.	0	1650
3	Carriage of plant raised in nursery over a distance of 45 Km	110 No.	170/100 No.	0	187
4	Carriage of plants from road side to plantation site by manual labour up to 2 Km	110	0.4Mandays/100 No	0.44	154
5	Carrying out first weeding, nirai operations and application of fertilizer and pesticides including replacing of dead plants of previous	1100	1.25 man-days/100 No.	13.75	4812.5



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Sl. No.	Particular of Work	Quantity	Rate/ Man days per unit	Total Man days	Total Amount
	year				
6	Carrying out second weeding, nirai operations and application of fertilizer and pesticides including replacing of dead plants of previous year	1100	1 man-days/100 No.	11	3850
7	Spraying pesticides and insecticides	1100	0.6 man-days/100 No.	6.6	2310
8	Applying Irrigation	1 job	L.S.	0	1600
9	Clearing of Fire lines	180 RM	2.25 man-days/Km	0.41	143.5
	<b>Total Labour oriented Works cost (A)</b>				<b>15407</b>
<b>B. Material Component</b>					
1	Cost of fertilizer (DAP/Urea) and Pesticides @ 40g and 10g / plant respectively	55 Kg	24 Rs/kg	0	1320
2	Cost of Diesel for Irrigation	1 Job	L.S.	0	1000
3	Contingency	1 Job	L.S.	0	200
	<b>Total Material Component Cost (B)</b>				<b>2520</b>
	<b>Total Third Year</b>				<b>17927</b>
<b>Fourth Year - Second year of Maintenance</b>					
<b>A. Labour oriented works</b>					
1	Carrying out first weeding, nirai operations and application of fertilizer and pesticides including replacing of dead plants of previous year	1100	1.25 man-days/100 No.	13.75	5293.75
2	Applying Irrigation	1 job	L.S.	0	1950
3	Watch and ward	1 job	L.S.	0	3000
	<b>Total Labour oriented Works cost (A)</b>				<b>10243.75</b>
<b>B. Material Component</b>					
1	Cost of Diesel for Irrigation	1 Job	L.S.	0	1100
2	Contingency	1 Job	L.S.	0	200
	<b>Total Material Component (B)</b>				<b>1300</b>
	<b>Total Fourth Year</b>				<b>11543.75</b>
<b>Fifth Year - Third year of Maintenance</b>					
<b>A. Labour oriented works</b>					
1	Fencing repair	1 ha.	2 man-days/ha.	2	848
2	Watch and ward	1 job	L.S.	0	3300
	<b>Total Labour oriented Works cost (A)</b>				<b>4148</b>
<b>B. Material Component</b>					
1	Contingency	1 Job	L.S.	0	220
	<b>Total Material Component Cost (B)</b>				<b>220</b>
	<b>Total Fifth Year</b>				<b>4368</b>



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Sl. No.	Particular of Work	Quantity	Rate/ Man days per unit	Total Man days	Total Amount
<b>Sixth Year - Fourth year of Maintenance</b>					
<b>A. Labour oriented works</b>					
1	Watch and ward	1 job	L.S.	0	3600
	<b>Total Labour oriented Works cost (A)</b>				<b>3600</b>
<b>B. Material Component</b>					
1	Contingency	1 Job	L.S.	0	240
	<b>Total Material Component Cost (B)</b>				<b>240</b>
	<b>Total Sixth Year</b>				<b>3840</b>
<b>Seventh Year - Fifth year of Maintenance</b>					
<b>A. Labour oriented works</b>					
1	Watch and ward	1 job	L.S.	0	4000
	<b>Total Labour oriented Works cost (A)</b>				<b>4000</b>
<b>B. Material Component</b>					
1	Contingency	1 Job	L.S.	0	300
	<b>Total Material Component (B)</b>				<b>300</b>
	<b>Total Seventh Year</b>				<b>4300</b>
<b>Abstract of Cost of Plantation and Maintenance</b>					
First year-preparation					117708.70
Second Year-Plantation					23970.70
Third year-First year of Maintenance					17927
Fourth year-Second year of Maintenance					11543.75
Fifth year-Third year of Maintenance					4368.00
Sixth year-Fourth year of Maintenance					3840.00
Seventh year-Fifth year of Maintenance					4300.00
<b>Total Cost</b>					<b>183658.2</b>
<b>Say Rs 1.84 Lakh/ha.</b>					

## 1.11.2 Enrichment Plantation

The cost analysis of enrichment plantation per hectare with 500 plants and protection of thorny bushes / twigs for individual plant, with maintenance cost has been assessed as Rs. 1.32 lakh/ha as shown in Table-1.10.

**Table 1.10 Cost Analysis per ha. of Enrichment Plantation**

Sl. No	Particular of Work	Quantity	Rate/ Man days per unit	Total Man days	Total Amount (Rs)
<b>First year preparation year</b>					
<b>A. Labour oriented works</b>					
1	Survey and demarcation of plantation area	1 ha	0.45 man-days /ha	0.45	130.05
2	Weeding of obnoxious weeds except lantana	1 ha	4 man-days/ha	4	1156
3	Dag Belling with line for siting pits	500	2.5 man-days/	1.25	361.25



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Sl. No	Particular of Work	Quantity	Rate/ Man days per unit	Total Man days	Total Amount (Rs)
			1000 no.		
4	Digging pits 45x45x45 cm	500	5 man-days/100 no.	25	7225
5	Filling pits with FYM mix with soil and Pesticides	500	1.5 man-days/100 no.	7.5	2167.5
6	Preparation of Path	240m	30 man-days/km	7.2	2080.8
	<b>Total Labour cost (A)</b>				<b>13120.6</b>
<b>B. Material Component</b>					
1	Cost of FYM including carriage @ 10% of volume of pit i.e. 500(0.45x0.45x0.45) x0.1	4.56 m3	1200 / m3	0	5472
2	Providing fertile soil including carriage @ 10% of volume of pit i.e. 500(0.45x0.45x0.45) x0.1	4.56 m3	500 Rs/m3	0	2280
3	Applying cost of Neem Cake @ 30g/pit	15 Kg	55 Rs/ Kg	0	825
4	Cost of plant	550 No.	11 Rs/Plant	0	6050
5	Cost of Service Pipe	100 RM	55 Rs/m	0	5500
6	Proportionate cost for providing irrigation implements like tank, pipe fittings & electric motor etc.	1 job	L.S.	0	4200
7	Proportionate cost for providing chowkidar hut	1 job	L.S.	0	2000
	<b>Total Material cost (B)</b>				<b>26327</b>
<b>C. Chain Link Fencing Work</b>					
1(a)	Cost of 2m high RCC pole @ 2.5m c/c (140x1.1)/2.5=62	62	296.3/no.	0	18370.60
1(b)	<u>GST@18%</u>	Rs 18370.6	0.18	0	3306.70
2(a)	Cost of barbed wire in five strands (141x5)/7=100	100 Kg	90 Rs /kg	0	9000.00
2(b)	<u>GST@18%</u>	9000	0.18	0	1620.00
3(a)	Cost of U-nails	10 Kg	90 Rs /kg	0	900.00
3(b)	<u>GST@18%</u>	900	0.18	0	162.00
4(a)	Cost of GI wire	3 Kg	100 Rs /kg	0	300.00
4(b)	<u>GST@18%</u>	300	0.18	0	54.00
5	Cost of labour for stretching & fixing barbed wire and other miscellaneous work	141	0.16 Man days / RM	6.56	1521.90



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Sl. No	Particular of Work	Quantity	Rate/ Man days per unit	Total Man days	Total Amount (Rs)
6	Excavation of pit for poles	62	2.5 man-days/100 No.	1.55	359.60
7	Cost of fixing poles in pit with PCC 1:3:6 mix	2.32 m3	3643/m3	0	8451.80
8	Erection of poles	62	Rs 80/ Pole	0	4960.00
	<b>Total Fencing cost (C)</b>				<b>49006.60</b>
	<b>Total Cost First year</b>				<b>88454.20</b>
<b>Second Year - Plantation Work</b>					
<b>A. Labour oriented works</b>					
1	Carriage of plant raised in nursery over a distance of 45 Km	550 No.	170/100 No.	0	935
2	Carriage of plants from road side to plantation site by manual labour up to 2 Km	500	0.4Mandays/100 No	2	636
3	Planting saplings in pits	500	1.8 Man days/100 No	9	2862
4	Carrying out first weeding, nirai operations and application of fertilizer and pesticides including replacing of dead plants of previous year	500	1.25 man-days/100 No.	6.25	1987.5
5	Carrying out second weeding, nirai operations and application of fertilizer and pesticides including replacing of dead plants of previous year	500	1 man-days/100 No.	5	1590
6	Spraying pesticides and insecticides	500	0.6 man-days/100 No.	3	954
7	Applying Irrigation	1 job	L.S.	0	1600
8	Clearing of Fire lines	180 RM	2.25 man-days/Km	0.41	128.8
	<b>Total Labour oriented Works cost (A)</b>				<b>10693.3</b>
<b>B. Material Component</b>					
1	Cost of fertilizer (DAP/Urea) and Pesticides @ 40g and 10g / plant respectively	25 Kg	24 Rs/kg	0	600
2	Cost of Diesel for Irrigation	1 Job	L.S.	0	1000
3	Contingency	1 Job	L.S.	0	200



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Sl. No	Particular of Work	Quantity	Rate/ Man days per unit	Total Man days	Total Amount (Rs)
	<b>Total Material Component Cost (B)</b>				<b>1800</b>
	<b>Total Second Year</b>				<b>12493.3</b>
<b>Third Year - Maintenance</b>					
<b>A. Labour oriented works</b>					
1	Repair of fencing	1 ha.	2 man-days/ha.	2	700
2	Cost of replacing of dead plants (10% motility)	50	Rs 15 /No.	0	750
3	Carriage of plant raised in nursery over a distance of 45 Km	50 No.	170/100 No.	0	85
4	Carriage of plants from road side to plantation site by manual labour up to 2 Km	50	0.4Mandays/100 No	0.2	70
5	Carrying out first weeding, nirai operations and application of fertilizer and pesticides including replacing of dead plants of previous year	500	1.25 man-days/100 No.	6.25	2187.5
6	Carrying out second weeding, nirai operations and application of fertilizer and pesticides including replacing of dead plants of previous year	500	1 man-days/100 No.	5	1750
7	Spraying pesticides and insecticides	500	0.6 man-days/100 No.	3	1050
8	Applying Irrigation	1 job	L.S.	0	1600
9	Clearing of Fire lines	180 RM	2.25 man-days/Km	0.41	143.5
	<b>Total Labour oriented Works cost (A)</b>				<b>8336</b>
<b>B. Material Component</b>					
1	Cost of fertilizer (DAP/Urea) and Pesticides @ 40g and 10g / plant respectively	25 Kg	24 Rs/kg	0	600
2	Cost of Diesel for Irrigation	1 Job	L.S.	0	1000
3	Contingency	1 Job	L.S.	0	200
	<b>Total Material Component Cost (B)</b>				<b>1800</b>
	<b>Total Third Year</b>				<b>10136</b>



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<b>Fourth Year - Second year of Maintenance</b>					
<b>A. Labour oriented works</b>					
1	Carrying out first weeding, nirai operations and application of fertilizer and pesticides including replacing of dead plants of previous year	500	1.25 man-days/100 No.	6.25	2406.25
2	Applying Irrigation	1 job	L.S.	0	1950
3	Watch and ward	1 job	L.S.	0	3000
	<b>Total Labour oriented Works cost (A)</b>				<b>7356.25</b>
<b>B. Material Component</b>					
1	Cost of Diesel for Irrigation	1 Job	L.S.	0	1100
2	Contingency	1 Job	L.S.	0	200
	<b>Total Material Component Cost (B)</b>				<b>1300</b>
	<b>Total Fourth Year</b>				<b>8656.25</b>
<b>Fifth Year - Third year of Maintenance</b>					
<b>A. Labour oriented works</b>					
1	Fencing repair	1 ha.	2 man-days/ha.	2	848
2	Watch and ward	1 job	L.S.	0	3300
	<b>Total Labour oriented Works cost (A)</b>				<b>4148</b>
<b>B. Material Component</b>					
1	Contingency	1 Job	L.S.	0	220
	<b>Total Material Component Cost (B)</b>				<b>220</b>
	<b>Total Fifth Year</b>				<b>4368</b>
<b>Sixth Year - Fourth year of Maintenance</b>					
<b>A. Labour oriented works</b>					
1	Watch and ward	1 job	L.S.	0	3600
	<b>Total Labour oriented Works cost (A)</b>				<b>3600</b>
<b>B. Material Component</b>					
1	Contingency	1 Job	L.S.	0	240
	<b>Total Material Component Cost (B)</b>				<b>240</b>
	<b>Total Sixth Year</b>				<b>3840</b>
<b>Seventh Year - Fifth year of Maintenance</b>					



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Sl. No	Particular of Work	Quantity	Rate/ Man days per unit	Total Man days	Total Amount (Rs)
<b>A. Labour oriented works</b>					
1	Watch and ward	1 job	L.S.	0	4000
	<b>Total Labour oriented Works cost (A)</b>				<b>4000</b>
	<b>B. Material Component</b>				
1	Contingency	1 Job	L.S.	0	300
	<b>Total Material Component Cost (B)</b>				<b>300</b>
	<b>Total Seventh Year</b>				<b>4300</b>
<b>Abstract of Cost of Plantation and Maintenance</b>					
First year-preparation					88454.20
Second Year-Plantation					12493.30
Third year-First year of Maintenance					10136.00
Fourth year-Second year of Maintenance					8656.25
Fifth year-Third year of Maintenance					4368.00
Sixth year-Fourth year of Maintenance					3840.00
Seventh year-Fifth year of Maintenance					4300.00
<b>Total Cost</b>					<b>132247.80</b>
					<b>Say Rs 1.32lakh</b>

## 1.11.3 High Density Energy Plantation

The cost analysis of high density energy plantation per hectare with plantation of 1600 plants /ha, with five strand barbed wire fencing stretched across RCC fence posts, has been assessed as Rs. 2.26 lakh/has shown in **Table-1.11**.

**Table 1.11: Cost Analysis per ha. of High Density Energy Plantation**

Sl. No.	Particular of Work	Quantity	Rate/ Man days per unit	Total Man days	Total Amount
<b>First year preparation year</b>					
<b>A. Labour oriented works</b>					
1	Survey and demarcation of plantation area	1 ha	0.45 man-days /ha	0.45	130.05
2	Weeding of obnoxious weeds except lantana	1 ha	4 man-days/ha	4	1156
3	Dag Belling with line for siting pits	1600	2.5 man-days/1000 no.	4	1156
4	Digging pits 45x45x45 cm	1600	5 man-days/100 no.	80	23120
5	Filling pits with FYM mix with soil and Pesticides	1600	1.5 man-days/100 no.	24	6936
6	Preparation of Path	240m	30 man-days/km	7.2	2080.8



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Sl. No.	Particular of Work	Quantity	Rate/ Man days per unit	Total Man days	Total Amount
	<b>Total Labour cost (A)</b>				<b>34578.85</b>
<b>B. Material Component</b>					
1	Cost of FYM including carriage @ 10% of volume of pit i.e. 1600(0.45x0.45x0.45) x0.1	14.58 m <sup>3</sup>	1200 / m <sup>3</sup>	0	17496
2	Providing fertile soil including carriage @ 10% of volume of pit i.e. 1600(0.45x0.45x0.45) x0.1	14.58 m <sup>3</sup>	500 Rs/m <sup>3</sup>	0	7290
3	Applying cost of Neem Cake @ 30g/pit	48 Kg	55 Rs/ Kg	0	2640
4	Cost of plant	1760 no.	11 Rs/Plant	0	19360
5	Cost of Service Pipe	100 RM	55 Rs/m	0	5500
6	Proportionate cost for providing irrigation implements like tank, pipe fittings & electric motor etc.	1 job	L.S.	0	4200
7	Proportionate cost for providing chowkidar hut	1 job	L.S.	0	2000
	<b>Total Material cost (B)</b>				<b>58486</b>
<b>C. Chain Link Fencing Work</b>					
1(a)	Cost of 2m high RCC pole @ 2.5m c/c (140x1.1)/2.5=62	62	296.3/no.	0	18370.60
1(b)	<u>GST@18%</u>	Rs 18370.6	0.18	0	3306.70
2(a)	Cost of barbed wire in five strands (141x5)/7=100	100 Kg	90 Rs /kg	0	9000.00
2(b)	<u>GST@18%</u>	9000	0.18	0	1620.00
3(a)	Cost of U-nails	10 Kg	90 Rs /kg	0	900.00
3(b)	<u>GST@18%</u>	900	0.18	0	162.00
4(a)	Cost of GI wire	3 Kg	100 Rs /kg	0	300.00
4(b)	<u>GST@18%</u>	300	0.18	0	54.00
5	Cost of labour for stretching & fixing barbed wire and other miscellaneous work	141	0.16 Man days / RM	6.56	1521.90
6	Excavation of pit for poles	62	2.5 man-days/100 No.	1.55	359.60
7	Cost of fixing poles in pit with PCC 1:3:6 mix	2.32 m <sup>3</sup>	3643/m <sup>3</sup>	0	8451.80
8	Erection of poles	62	Rs 80/ Pole	0	4960.00
	<b>Total Fencing cost (C)</b>				<b>49006.60</b>
	<b>Total Cost First year</b>				<b>142071.45</b>
<b>Second Year - Plantation Work</b>					
<b>A. Labour oriented works</b>					
1	Carriage of plant raised in nursery over a distance of 45 Km	1760 No.	170/100 No.	0	2992
2	Carriage of plants from road side to plantation site by manual labour up to 2 Km	1600	0.4Mandays/100 No	6.4	2035.2



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3	Planting saplings in pits	1600	1.8 Man days/100 No	28.8	9158.4
4	Carrying out first weeding, nirai operations and application of fertilizer and pesticides including replacing of dead plants of previous year	1600	1.25 man-days/100 No.	20	6360
5	Carrying out second weeding, nirai operations and application of fertilizer and pesticides including replacing of dead plants of previous year	1600	1 man-days/100 No.	16	5088
6	Spraying pesticides and insecticides	1600	0.6 man-days/100 No.	9.6	3052.8
7	Applying Irrigation	1 job	L.S.	0	1600
8	Clearing of Fire lines	180 RM	2.25 man-days/Km	0.41	128.8
	<b>Total Labour oriented Works cost (A)</b>				<b>30415.2</b>
<b>B. Material Component</b>					
1	Cost of fertilizer (DAP/Urea) and Pesticides @ 40g and 10g / plant respectively	80 Kg	24 Rs/kg	0	1920
2	Cost of Diesel for Irrigation	1 Job	L.S.	0	1000
3	Contingency	1 Job	L.S.	0	200
	<b>Total Material Component Cost (B)</b>				<b>3120</b>
	<b>Total Second Year</b>				<b>33535.2</b>
<b>Third Year - Maintenance</b>					
<b>A. Labour oriented works</b>					
1	Repair of fencing	1 ha.	2 man-days/ha.	2	700
2	Cost of replacing of dead plants (10% motility)	160	Rs 15 /No.	0	2400
3	Carriage of plant raised in nursery over a distance of 45 Km	160 No.	170/100 No.	0	272
4	Carriage of plants from road side to plantation site by manual labour up to 2 Km	160	0.4Mandays/100 No	0.64	224
5	Carrying out first weeding, nirai operations and application of fertilizer and pesticides including replacing of dead plants of previous year	1600	1.25 man-days/100 No.	20	7000
6	Carrying out second weeding, nirai operations and application of fertilizer and pesticides including replacing of dead plants of previous year	1600	1 man-days/100 No.	16	5600
7	Spraying pesticides and insecticides	1600	0.6 man-days/100 No.	9.6	3360



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Sl. No.	Particular of Work	Quantity	Rate/ Man days per unit	Total Man days	Total Amount
8	Applying Irrigation	1 job	L.S.	0	1600
9	Clearing of Fire lines	180 RM	2.25 man-days/Km	0.41	143.5
	<b>Total Labour oriented Works cost (A)</b>				<b>21299.5</b>
<b>B. Material Component</b>					
1	Cost of fertilizer (DAP/Urea) and Pesticides @ 40g and 10g / plant respectively	80 Kg	24 Rs/kg	0	1920
2	Cost of Diesel for Irrigation	1 Job	L.S.	0	1000
3	Contingency	1 Job	L.S.	0	200
	<b>Total Material Component Cost (B)</b>				<b>3120</b>
	<b>Total Third Year</b>				<b>24419.5</b>
<b>Fourth Year - Second year of Maintenance</b>					
<b>A. Labour oriented works</b>					
1	Carrying out first weeding, nirai operations and application of fertilizer and pesticides including replacing of dead plants of previous year	1600	1.25 man-days/100 No.	20	7700
2	Applying Irrigation	1 job	L.S.	0	1950
3	Watch and ward	1 job	L.S.	0	3000
	<b>Total Labour oriented Works cost (A)</b>				<b>12650</b>
<b>B. Material Component</b>					
1	Cost of Diesel for Irrigation	1 Job	L.S.	0	1100
2	Contingency	1 Job	L.S.	0	200
	<b>Total Material Component Cost (B)</b>				<b>1300</b>
	<b>Total Fourth Year</b>				<b>13950</b>
<b>Fifth Year - Third year of Maintenance</b>					
<b>A. Labour oriented works</b>					
1	Fencing repair	1 ha.	2 man-days/ha.	2	770
2	Watch and ward	1 job	L.S.	0	3300
	<b>Total Labour oriented Works cost (A)</b>				<b>4070</b>
<b>B. Material Component</b>					
1	Contingency	1 Job	L.S.	0	220
	<b>Total Material Component Cost (B)</b>				<b>220</b>
	<b>Total Fifth Year</b>				<b>4290</b>
<b>Sixth Year - Fourth year of Maintenance</b>					
<b>A. Labour oriented works</b>					
1	Watch and ward	1 job	L.S.	0	3600
	<b>Total Labour oriented Works cost (A)</b>				<b>3600</b>
<b>B. Material Component</b>					
1	Contingency	1 Job	L.S.	0	240
	<b>Total Material Component Cost (B)</b>				<b>240</b>
	<b>Total Sixth Year</b>				<b>3840</b>



Sl. No.	Particular of Work	Quantity	Rate/ Man days per unit	Total Man days	Total Amount
<b>Seventh Year - Fifth year of Maintenance</b>					
<b>A. Labour oriented works</b>					
1	Watch and ward	1 job	L.S.	0	4000
	<b>Total Labour oriented Works cost (A)</b>				<b>4000</b>
<b>B. Material Component</b>					
1	Contingency	1 Job	L.S.	0	300
	<b>Total Material Component Cost (B)</b>				<b>300</b>
	<b>Total Seventh Year</b>				<b>4300</b>
<b>Abstract of Cost of Plantation and Maintenance</b>					
<b>First year-preparation</b>					142071.45
<b>Second Year-Plantation</b>					33535.20
<b>Third year-First year of Maintenance</b>					24419.50
<b>Fourth year-Second year of Maintenance</b>					13950.00
<b>Fifth year-Third year of Maintenance</b>					4290.00
<b>Sixth year-Fourth year of Maintenance</b>					3840.00
<b>Seventh year-Fifth year of Maintenance</b>					4300.00
<b>Total cost</b>					<b>226406.2</b>
<b>Say Rs 2.26 lakh/ha.</b>					

#### 1.11.4 Pasture Reclamation

The pasture reclamation by rotational closure with live hedge fencing, sodding with local grass and legume plants inclusive of maintenance shall be carried out.

#### 1.11.5 Nursery Support

In the light of the fact that the CAT plan entails plantation over approximately 185 ha area, a substantial requirement of saplings / plants is comprehended. Such requirement shall have to be met out partly from the existing nurseries while a small new nursery will be established. Being an undulating and upland area the suitable sites for developing new nurseries are not too many. Besides, the free of cost saplings shall be distributed to the JFM group for raising horticulture crops and private pasture development.

Availability of quality planting material well in time and near the areas where afforestation is to be undertaken, remains a major constraint in implementation of large scale afforestation. The proposed large-scale afforestation in the area due to establishing of various projects, will certainly lead to establishment of decentralized nurseries through credit support.

### 1.12 Cost Analysis of Different Works under Soil and Water Conservation Measures

#### 1.12.1 Bio-engineering Works

Bio-engineering works shall involve minor soil conservation works, fixing of brush wood check dams, patch sowing of grass and legume seeds, plantation of bio-engineering species of shrubs, herbs and trees i.e. @ 500 shrubs and 150 trees/ ha., fencing of the area with live hedge and maintenance for



shrub species and tree species.

### 1.12.2 Cost Analysis of Vegetative Structure, Civil Structures for Land Slide and Stream Bank Stabilization and Moisture Retention Operations

These structures are to be constructed as landslide control and stream bank stabilization over visually active slides and eroded banks of the main river and its tributaries falling under “Severe” and “Very Severe” erosion intensity areas to control the sediment flow and further degradation of the free draining catchment areas. Since these measures are to be carried out by construction of individual structure such as wire crate spurs, check dams, contour staggered trenches, catch water drains, retaining walls etc. on site specific basis, the cost of each of such structure must be analyzed based on dimensions adopted. The analysis of rates of such structures is presented in **Table 1.12**.

**Table 1.12 Cost Analyses of Structures**

S. No.	Item	Quantity	Unit	Rate	Amount
<b>1.</b>	<b>Dry Rubble Stone masonry (DRSM) Check Dam</b>				
(a)	Excavation in foundation with 50% soft rock & 50% E & B involving peak and jumper work in 5.60 m x 1.80 m x 0.50 m = 5.04 cubic meter	5.04	Cum	224.88	1133.39
(b)	Collection of boulder	23.52	Cum	175.25	4121.88
	I-Step 5 x 1.5 x 1.25 = 9.38				
	II – Step 7 x 1.0 x 0.75 = 5.25				
	Wing Walls 2 x 3.75x 0.6 x 1.5 = 6.75 Total 21.38 x1.1= 23.52				
(c)	Carriage of boulder by manually beyond initial 100 m lead up to 1 km	21.38	Cum	561.00	11994.18
(d)	Labour charges for dry stone masonry with outer face stone dressed & 100 m lead.	21.38	Cum	277.50	5932.95
				Total	23182.40
<b>Add 3% Contingencies</b>					695.47
<b>Grand Total Rs.</b>					23877.87
<b>Say Rs.</b>					24000.00
<b>2.</b>	<b>Wire Crate Check Dam</b>				
(a)	Excavation in foundation with 50% soft rock & 50% E & B involving peak and jumper work in 6.60 m x 2.30 m x 0.50 m = 7.59 cubic meter	7.59	Cum	224.88	1706.84
(b)	Collection of boulder	35.24	Cum	175.25	6175.81
	Foundation Step - 6.0 x 2.0 x 1.0 m = 12 cubic meters				
	I- Step - 6.0 m x 1.9 m x 1.0m = 11.40 cubic meter				
	II- Step – 6.0 m x 1.8 m x 0.8 m = 8.64 cubic meter				
	Total requirement of boulder = 32.04 x 1.1 = 35.24 cubic meter				



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S. No.	Item	Quantity	Unit	Rate	Amount
(c)	Carriage of boulder manually average lead 1 km	32.04	M <sup>3</sup>	561.00	17974.44
(d)	Weaving of wire netting of GI wire mesh size 15 cm x 15 cm	113.2	M <sup>2</sup>	21.75	2462.10
	Foundation Step-2(6x2+6x1+2x1) = 40 m <sup>2</sup>				
	I- Step-2(6x1.9+6x1+2x1) = 38.8 m <sup>2</sup>				
	II- Step- 2(6x1.8 + 6x0.8 + 2x0.8) = 34.4 m <sup>2</sup>				
	Total = 113.2 m <sup>2</sup>				
(e)	Filling of boulder and hand packing in wire crates	32.04	M <sup>3</sup>	144.25	4621.77
(f)	Cost of GI wire	2.25	Qtl	8000	18000.00
(g)	Carriage of GI wire manually to an average lead of 1 km	2.25	Qtl	83.50	187.88
<b>Total Rs.</b>					<b>51128.84</b>
<b>Add 3% Contingencies</b>					<b>1533.86</b>
<b>Grand Total Rs.</b>					<b>52662.70</b>
<b>Say Rs.</b>					<b>52700</b>
<b>3.</b>	<b>Double row brush wood check dam</b>				
(a)	Cutting of conversion of vegetative posts	40	No.	1295.25/%	518.00
(b)	Carriage of vegetative posts to 5 km. distance @ Rs. 207.95 per hundred number per km.	40	No.	1817/%/5 km	727.00
(c)	Digging of holes for vegetative posts	40	No.	906.75/%	363.00
(d)	Fixing of vegetative posts	40	No.	696.13/%	278.00
(e)	Fixing of vegetative spurs double row	12	RM	58.38/RM	700.00
(f)	Filling of gaps between rows of brush wood with the bundles of bushes and tied with ropes of grass	01	Job	LS	400.00
<b>Total</b>					<b>2986.00</b>
<b>Or Say</b>					<b>3000.00</b>
<b>4.</b>	<b>Catch water drain in cement stone masonry per RM</b>				
a.	Excavation in formulation with 50% soft rock and 50% E & B 1 x 1.50 x 0.55 = 0.825 cubic meter	0.825	Cum	224.88	185.53
b.	Foundation concrete (CC 1:3:6) 1 x 1.50 x 0.15 = 0.225 cubic meter	0.225	Cum	3125.00	703.13
c.	RR stone masonry in cement mortar 1: 6 2 x 0.4 x 0.4 = 0.32 cubic meter	0.32	Cum	2550	816.00
d.	Flush cement pointing 2(0.4+0.4) = 1.6 sq.	1.60	Sq. m.	70	112.00
<b>Total</b>					<b>1816.60</b>
<b>Add 3% Contingencies</b>					<b>54.50</b>
<b>Grand Total</b>					<b>1871.10</b>
<b>Or Say</b>					<b>1870.00</b>
<b>5.</b>	<b>RCC retaining wall 6 m high/RM</b>				
a.	Excavation in soft rock 1 x 3.6 x 0.5 = 1.80 cubic meter	1.80	Cum	292.50	526.50





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S. No.	Item	Quantity	Unit	Rate	Amount
b.	Concrete M:20 (CC 1:1.5:3) Base = $1 \times 3.60 \times 0.4 = 1.44$ Stem = $1 \times 5.60 \times 0.33 = 1.85$ Total = 3.29 cubic meter	3.29	Cum	4700	15463.00
c.	Steel reinforcement at 1% i.e. 40 kg/cubic meters = 1.32 Qt	1.32	Qt	6000	7920.00
d.	Shuttering / form work Base = $2 \times 3.60 = 7.20$ Stem = $2 \times 5.60 = 11.20$ Total = 18.40 sq.	18.40	Sq. m.	134	2465.60
<b>Total</b>					<b>26374.50</b>
<b>Add 3% Contingencies</b>					<b>791.24</b>
<b>Grand Total</b>					<b>27165.74</b>
<b>Or say</b>					<b>27200.00</b>
<b>6.</b>	<b>RR Dry stone masonry / RM</b> <b>Average dimension = 5 m long, 2m high</b> <b>and side slope 1:4</b>				
a.	Excavation in foundation with 50% soft rock and 50% E & B $5 \times 1.10 \times 0.3 = 1.65$	1.65	Cum	224.88	371.05
b.	RR stone masonry dry $5 \times (1.10 + 0.60 / 2) \times 2.0 = 8.5 \text{ cum}$	8.5	Cum	277.50	2358.75
<b>Total</b>					<b>2729.80</b>
<b>Add 3% Contingencies</b>					<b>81.89</b>
<b>Grand Total</b>					<b>2811.69</b>
<b>Or say</b>					<b>2800.00</b>
<b>7</b>	<b>Bench terracing / ha excavation</b>				
a.	Earth work	100	Cum	157.25	15725.00
<b>Total</b>					<b>15725.00</b>
<b>8</b>	<b>Contour staggered trenches</b> <b>,0.45mx0.45m / R.M.</b>	<b>1</b>	<b>R.M</b>	<b>31.79</b>	<b>31.79</b>
<b>Say</b>					<b>32.00</b>

### 1.12.3 Abstract of Works under Civil Structures

The Break-up of works under different sub-watersheds in respect of vegetative structure, civil structures for land slide and stream bank stabilization and moisture retention operations with their costs is shown in **Table-1.13**.



**Table 1.13: Abstract of Works under Civil Structures**

Name of WS	DRSM check dam @ Rs. 0.24 lakh each		Wire Crate Check Dam @ Rs. 0.527lakh each		Soil water regime improvement works @2.5 lakh each		Catch Water Drain @Rs 0.0187 lakh/RM		Contour Staggered Trenches @ Rs 0.32lakh/km		Contour Bunding (03mx0.3m) @Rs0.062 lakh/ha		Total Cost (Rs. lakh)
	Number	Cost	Number	Cost	Number	Cost	RM	Cost	km	Cost	ha	Cost	
Maa Ratangarh	320	76.80	120	63.24	25	62.50	3000	56.10	40	12.80	1500	93.0	364.44



### **1.13 Treatment of Private Land**

The silt contribution of private land holding is very significant because it interrupts the natural drainage and contributes to 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 proposed soil cover to increase soil moisture content. Therefore, it is proposed to provide treatment to private holdings for development of horticulture, agriculture and private pasture development. An area of 50 ha and 25ha have been earmarked to be undertaken for horticulture and private pasture development respectively under this plan as a joint venture with the owners of the land with their share of the cost being the cost of maintenance. Besides this, terracing in 1500 ha area along with some engineering measures to control erosion/sliding witnessed in the agricultural land is also proposed. The cost of works proposed under this head work out to Rs. **183.60 lakh**.

### **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. The eco-restoration works, livelihood support works, 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.

#### **1.14.1 Implementation of Support Infrastructure Cost**

In order to execute the catchment area treatment plan, the forest department would be requested to establish a catchment area treatment cell for which the executing agency shall need necessary infrastructure support. Accordingly, provisions have been made for purchase of office equipment and survey equipment. For movement of the field staff and labour, forest footpath and bridges/culvers would need construction and repair.

#### **1.14.2 Training and Extension Program**

There is a need to keep all members of the existing registered VFDCs and committees to be constituted in other villages and NGOs involved in program 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 program has to be properly devised and carried out at range office for which a provision of **Rs. 13.00 lakh** is being made.

#### **1.14.3 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 must be prepared as per



norms. The micro plan for each beats of sub-watershed shall be prepared in consultation with the members of concerned VFDCs with due regards to the environmental functions and productive potential of the forests and their carrying capacity. For this purpose, a provision of **Rs. 6.00 lakh** is being made.

#### **1.14.4 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. 5.00 lakh** is proposed. The documentation would inter alia include implementation report, progress reports, photography, videography etc. Publication of the work done may be distributed to concerned panchayat and village Forest Development Committees/Societies for wider dissemination.

#### **1.14.5 Gender Support**

There is a need to keep women in center stage in program implementation so that they can play an active role in preservation of the ecology as well as the socioeconomic development of the area. Considering the immense potential and genuine needs for women's participation in JFM program, proper training with respect to work related to NTFP cultivation, animal husbandry, gardening and farm works etc. shall be imparted for which a provision of **Rs. 10.00 lakh** is being made.

#### **1.14.6 Provision for Mobilizing User Groups**

Based on the ground truth reality in each of the Village Forest Development Committee or Society falling under the different sub-watersheds, mobilizing the user groups will be of utmost importance to involve them in afforestation and other agreed activities of the CAT Plan. For this purpose, a provision of **Rs. 5.00 lakh** is being made.

#### **1.14.7 Funds for Educational Activities related to Medicinal Plant Sector**

A provision of **Rs. 14.00 lakh** is earmarked for various conservation and educational activities related to medicinal plant sector.

#### **1.14.8 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 10.0 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.

#### **1.14.9 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 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 to verify the work executed on site itself and to ascertain the rate of survival of plants 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 IRS P6 LISS-IV with high resolution (5.6 m x 5.6 m) 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 extensive experience of carrying out similar work on land use data and evaluating environment impact.

A provision of **Rs. 12.00 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.

#### **1.14.10 Provision for Providing Environmental Services**

A provision of **Rs.82.00 lakh** is being made under this sub-head for carrying out such works which enhance the environmental status and 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 Madhya Pradesh 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;

- To 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 watchtowers 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 tribal population, 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.

#### **1.14.11 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, construction of check-posts, watch towers have to be undertaken. Besides these construction / repair of forest boundary pillars shall also be carried out. The forest staff shall have to be properly equipped with modern utility gadgets like walky-talky, GPS and fire-fighting equipment's. For these a provision of **Rs. 15.00 lakh** is being earmarked.

#### **1.14.12 Capacity Building**

Since the effectiveness of the biological and engineering measures and their proper implementation will depend on the understanding and preparedness of the forest staff. It is important that the Forest Department makes efforts to sensitize the staff on implementation and management of plantation issues, soil conservation, flood protection works and provide guidance and encourage them to build requisite capacities. Capacity building can be achieved through training programs for which a provision of **Rs.52.00 lakh** has been made in the plan.

### **1.15 Institutional Mechanism**

#### **1.15.1 Role of Project Proponent**

The forest department would implement the Catchment Area Treatment Plan. A joint inspection group is suggested that would include officers drawn from State Forest Department of and officials from the Environment Cell of MPWRD. The management will have liaison with the forest officials. As far as the financial disbursement to undertake activity involvement of various stake holders and collaborative public participation should be encouraged to have transparency in the system.

**1.15.2 CAT Implementation**

The designated Environmental Officer of MPWRD would coordinate with the forest department for the implementation of the proposed Plan. The Environment Officer would evaluate/monitor financial aspects. The modalities of financial disbursement need to be worked out. The implementing agency shall submit completion certificate in the light of guidelines fixed by the Madhya Pradesh Forest Department. The implementation of CAT Plan should have enough flexibility and should be subject to changes as per requirements of specific ecosystem and periodic gains.

**1.15.3 Project Monitoring and Reporting Procedures**

Meetings would be held every three months to resolve problems arising in plan implementation. A Joint committee may be formed with the Environment Cell of Project Proponent and State Forest Department; the team members must ensure implementation and monitoring of the CAT works and review the progress from time to time. Quarterly progress reports and completion certificates would be submitted to Project Proponent for evaluation and disbursement of finance. In addition, the work done should be published through public awareness campaigns. Visual and print media may be used to gain maximum benefit by beneficiaries. Such efforts would resolve conflicts which otherwise are potential sources for project delays.

**1.16 Summary of Cost of Works**

The cost of all works proposed in the CAT plan is enumerated in **Table-1.14**.

**Table 1.14: Cost Estimate of CAT Plan**

S. No.	Particulars	Amount (Rs. In Lac)
<b>1.</b>	<b>Habitat treatment works under free draining catchment</b>	
(a)	Normal afforestation (155 ha @ Rs. 184000/ ha)	285.20
(b)	Enrichment Plantation (600 ha @ Rs. 132000/ ha)	792.00
(c)	High density energy plantation (42 ha @ Rs. 226000/ ha)	94.92
(d)	Pasture reclamation (30ha @ Rs. 150000/ ha)	45.00
(e)	Nursery support	45.00
	<b>Sub- total (1)</b>	<b>1262.12</b>
<b>2.</b>	<b>Soil and water conservation measures</b>	
(a)	Bio-engineering measures (30ha @Rs. 125000/ha)	37.50
(b)	DSRM check dam (320 no. @Rs 24000/ha each)	76.80
(c)	Wire crate check dam (120 no. @ Rs. 52700/each)	63.24
(d)	Soil water regime improvement works (25 @Rs. 250000 each)	62.50
(e)	Catch water drain (3000 RM @ Rs. 1870/RM)	56.10
(f)	Contour staggered trenches (40km @Rs. 32000/km)	12.80
(g)	Contour Bunding (1500ha @6200/ha)	93.00
	<b>Sub- total (2)</b>	<b>401.94</b>
<b>3.</b>	<b>Private land treatment</b>	
(a)	Horticulture development (50ha @ Rs. 150000/ha)	75.00
(b)	Private pasture development (25ha @Rs 60000/ha)	15.00
(c)	Bench terracing (1500ha @ Rs. 6200/ha)	93.00



**WATER RESOURCES DEPARTMENT, MADHYA PRADESH**

Project: Environmental Management Plan for Maa Ratangarh Multipurpose Project, District Datia, Madhya Pradesh

**FINAL EMP REPORT**

<b>S. No.</b>	<b>Particulars</b>	<b>Amount (Rs. In Lac)</b>
	<b>Sub- total (3)</b>	<b>183.60</b>
4.	Implementation of Support Infrastructure Cost	25.00
6.	Training and Extension Program	13.00
7.	Provision for Micro Plan	6.00
8.	Documentation	5.00
9.	Gender Support	10.00
10.	Mobilizing user groups	5.00
11.	Funds for Educational activities related to medicinal plant sector	14.00
13.	Provision for floristic survey and forestry research	10.00
14.	Provision for Monitoring and Evaluation Activities	12.00
15.	Provision for providing Environmental Services	82.00
16.	Forest Protection	15.00
17.	Capacity building	5.00
	<b>Sub- total (3)</b>	<b>202.00</b>
	<b>Grand Total.</b>	<b>2049.66</b>
	<b>Say Rs.</b>	<b>2050.00</b>