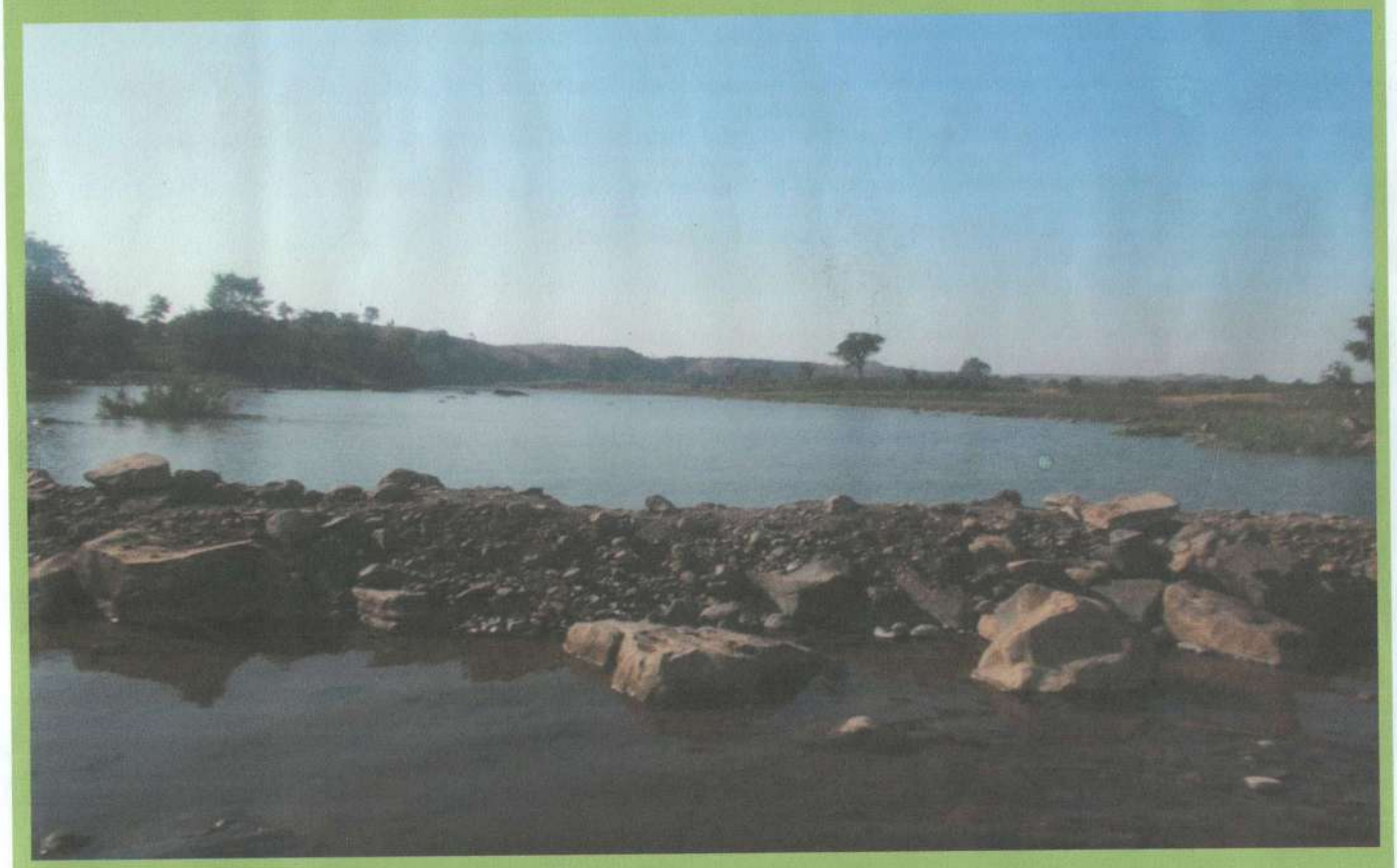
GOVERNMENT OF ODISHA

WATER RESOURCES DEPARTMENT

CAT Plan Report

FOREST CLEARANCE OF HIDSING MEDIUM IRRIGATION PROJECT



Angul Investigation Division,
Angul
District, Angul (ODISHA)

Catchment Area Treatment Plan

1 CATCHMENT AREA TREATMENTPLAN

1.1 Introduction

The study of erosion and sediment yield from a catchment area is of paramount importance due to its direct impact on reservoir capacity. Accumulated sediment in reservoirs significantly reduces their water storage capacity, ultimately affecting their intended purposes. Additionally, sediment deposition from catchment erosion onto streambeds and banks can lead to river braiding, further exacerbating the issue. The loss of topsoil from the catchment area also has detrimental effects on agricultural productivity. Another noteworthy contributor to sediment load and soil degradation is the extensive grazing pressure from cattle, sheep, and goats, which continuously graze mountainous pastures for approximately six months.

The absence of adequate vegetative cover plays a pivotal role in degradation, resulting in excessive runoff, soil erosion, and, subsequently, premature siltation of the reservoir. Hence, the development of a well-structured Catchment Area Treatment (CAT) Plan is imperative to mitigate these adverse effects of soil erosion. This plan involves a comprehensive assessment of terrain erosion characteristics and the proposal of remedial measures to reduce erosion rates and soil losses. Consequently, the treatment of catchment areas, including directly draining rivers, streams, tributaries, etc., is incorporated into the project's budget to address these concerns effectively.

A fundamental prerequisite for successful watershed management is the collection of multifaceted data, encompassing geology, geomorphology, topography, soil composition, land use/land cover, climate patterns, hydrology, drainage patterns, and more. The Action Plan for Catchment Area Treatment is formulated based on this comprehensive data, sourced from various published references and firsthand observations in these watersheds.

Catchment Area Treatment (CAT) plans have been meticulously devised for the naturally draining catchment areas within the proposed project's vicinity, with a specific focus on regions characterized by high soil erosion rates. These CAT Plans are designed to enhance the overall environmental conditions of the region. All activities are geared towards addressing areas with significant degradation and a high potential for soil erosion. The plan incorporates both biological and engineering measures, contributing to the preservation of ecosystem health. The objectives of the plan include preventing gully erosion, increasing forest cover to enhance soil retention capacity, and effectively halting the flow of sediment into the reservoir and water bodies.

Chapter-9 (**Irrigation and Hydro-Electric Projects, including Catchment Area Treatment (CAT) Plan**) of the Handbook deals with the requirement and necessary guidelines for the preparation of Catchment Treatment Plan for the irrigation projects. As per guideline 9.2,

> **9.2. Catchment Area Treatment (CAT) plans:** A proposal for diversion of forest land forIrrigation/Hydro-electric projects **shall invariably be accompanied by detailed CAT plan**except in respect of small hydel projects (maximum up to 10 MW capacity), which are eithercanal head or run-of the river projects and do not involve impounding of water/submergenceof forest land.

CATCHMENT AREA TREATMENT

The CAT Plan is an important and essential plan for enhancing and maintaining the ecological health of the catchment area of the proposed irrigation/hydroelectric project through **site-specific biological and engineering measuresfor conservation of soil & moisture**
and management of water regime. Among other provisions, the measures should focus on **arresting soil erosion, improving effective drainage in the area, and rejuvenation of the degraded eco system in the catchment**. Following general principals should be kept in view while formulating CAT plans.

i. **In the dense forest areas** major concentration should be on soil & water conservation including water harvesting for which various water harvesting structures like check dams, gully plugging, gabion dams, contour trenches and vegetative structures should be made.

ii. **In the open forest areas** besides taking up soil & water conservation measures, plantation of local indigenous tree and shrub species, including rare/medicinal plants, should be done. In higher altitudes plantation of Chir pine should be avoided.

iii. The CAT plan should include **a component of fodder development** on the civil soyam
forest or on revenue/private lands in order to meet the requirement of fodder/small timber/fire wood for the local population with a view to reduce pressure on the forests.

iv. The CAT Plan should have a socio-economic component including supply of CNG connections to the project affected families to be implemented through Joint Forest Management Committees (the nomenclature may vary among the States/UTs).

v. The infrastructure component like construction of buildings, vehicles, salaries of staff etc. may be provided based on a careful analysis of the need for the same with detailed justification and should constitute a very small percentage (say up to 5%) of the total cost of the CAT plan.

vi. CAT plan shall be approved by the Principal CCF &HoFF or any other officer authorized by him for the purpose.

vii. Regular monitoring is essential for effective implementation of the CAT Plan. The Chief Project Officer of the User Agency must be associated in implementation as well
as monitoring of the progress of CAT plan. For this, a committee with following composition may be constituted at State level for quarterly review of progress of implementation of various CAT plans and take immediate steps to ensure the same:

1. PCCF &HoFF– Chairman
2. Secretary (Agriculture) or his representative – Member
3. Secretary (Animal Husbandry) or his representative – Member
4. Project Officer-User Agency – Member
5. Concerned Conservator of Forests – Member
6. Nodal Officer (FC) o/o PCCF -Member Secretary

"

1.1.1 Project Details

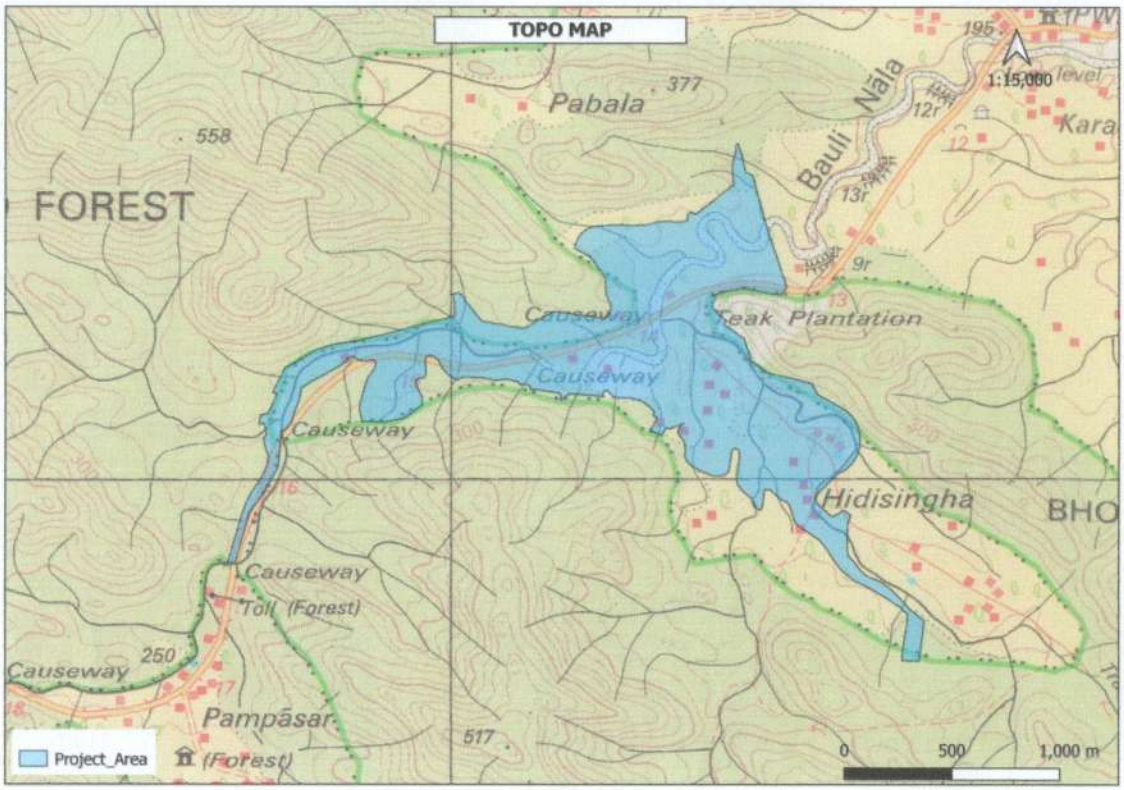
Short narrative of the proposal and Project/Scheme for which the Forest Land is requested:

-

CATCHMENT AREA TREATMENT

This proposal is for diversion of 87.520 Ha. of Forest land out of 437.330 Ha of total land required for Construction of Hidsing Irrigation Project including alternate road due to submergence of (Angul – Tikarapada Road) S.H 23.The Private Non-forest land 287.579 Ha + Govt. Non-forest land 62.231 Ha + forest land 87.52 Ha (Reserve forest 38.619 Ha + Revenue forest land 7.276 Ha + DLC forest land 19.55 Ha + Private forest land 22.075 Ha) = Total 437.330 Ha of land involved for Construction of Hidsing Irrigation Project including alternate road proposed to be done across the river Bauli Nallah near Village Karadising in Brahmani Basin of Anugul Forest Division &Anugul District, by the Department of Water Resources, Govt. of Odisha. The Bauli Nallah is a major tributary of Lingara nallah joining near Ramkasinga. Lingara Nallah in turn joins the river Brahmani on its right bank near village Meramundali. The Bauli Nallah originates from hill ranges of Balanga in Angul Block of Angul District and traverses in the north-east direction. The Project includes a water reservoir with a homogeneous earth dam and a Central Spillway & 2 main (Right & Left) canals with Distributaries, Minors & sub minors & outlets from the main Canal & an alternate road (due to Submergence of Anugul - Tikarapada road S.H 23) has been provided. This project has been technically approved by the Central Water Commission; Govt. of India vide their letter no. M & A/AP-1/2012/13-15 dated- 04.01.2013 (Annexure-I).

The project is located in Angul block of Angul district near village Karadasing at Latitude 200 - 43' - 00" N and Longitude 840 - 58' - 30"E vide Toposheet No. 73H/2, 73D/14. An Index map showing location of the project is enclosed. The dam site, which is near village Karadasing is 25 Kms from Angul, the district head-quarters, Angul. The National Highway - 55 connecting Sambalpur and capital city of the state, Bhubaneswar. The nearest railway station of East coast Railway is Angul 30 Kms from proposed dam site. The dam site is 180 Kms from the state capital and nearest airport, Bhubaneswar.



1.1.2 SALIENT FEATURES OF HIDSING IRRIGATION PROJECT

A. GENERAL

i.	State	:	Odisha
ii.	District	:	Angul
iii.	Sub-Division	:	Angul
iv.	Village	:	Karadasing
v.	River	:	Bauli Nallah

B. LOCATION

i.	Latitude	:	$20^0 - 43' - 00"$
ii.	Longitude	:	$84^0 - 58' - 30"$
iii.	Topo Sheet	:	73H/2, 73D/14
iv.	Nearest Railway Station	:	Angul
v.	Nearest Air Port	:	Bhubaneswar
vi.	Distance from State Capital	:	180Km. to Project Site

C. HYDROLOGY

i.	Catchment Area	:	72.30 Sq. Km.
ii.	Rainfall		
	a) Maximum annual rainfall	:	2693.40mm.

b)	Minimum annual rainfall	:	769.00mm.
c)	75% dependable year rain	:	1138.90mm.
d)	Net 75% dependable yield	:	1726.30Ham.
e)	Design Flood discharge	:	778.00 Cumecs.

D. RESERVOIR

i.	Gross storage at FRL	:	1765.58 Ham.
ii.	Dead storage capacity	:	245.30 Ham.
iii.	Live storage capacity	:	1520.28 Ham.
iv.	Full Reservoir Level	:	RL 228.00m.
v.	Dead storage level	:	RL 214.00m.
vi.	Top Bank Level	:	RL 231.00m.
vii.	Submerged area at FRL/MWL	:	324.95Ha.
viii.	Number of villages submerged	:	2 Nos.
ix.	Length of NH to be submerged	:	NIL
x.	Length of S.H. to be submerged	:	3.65KM.
xi.	Forest area to be submerged	:	74.357 Ha.

E. SUBMERGENCE

i.	Number of villages affected	:	3 Nos.
	Number of villages fully affected	:	2 Nos. of village namelyHidising&Dimiripal.
	Number of villages partly affected	:	1 No.Karadasing
ii.	Number of families affected	:	161 Nos.

F. DAM

i.	Type	:	Homogeneous Earth Dam
ii.	Length of Earth Dam	:	933m.
iii.	Maximum height	:	32.50m.
iv.	Top width	:	6.00m.

G. SPILLWAY

i.	Location and type	:	Central Spillway and Ogee Crest
ii.	Length of Spillway	:	36m.
iii.	Crest Level of Spillway	:	RL 220.00m.
iv.	Size of Gate	:	10m x 8m.
v.	Numbers of bays	:	3 Nos.

H. DISTRIBUTION SYSTEM

i.	G.C.A.	:	3943 Ha.
ii.	C.C.A.	:	2958 Ha.
iii.	Percentage of CCA & GCA	:	75%
iv.	Intensity of Irrigation during Khariff	:	80%
v.	Intensity of Irrigation during Rabi	:	25%
vi.	Area to be irrigated during Khariff	:	2366 Ha.
vii.	Area to be irrigated during Rabi	:	740 Ha.
viii.	Annual Irrigation	:	3106 Ha.
ix.	Annual intensity of Irrigation	:	105%
x.	Utilization factor	:	77.52%
xi.	Length Main Canal on Right side	:	8.460Km.
xii.	Length Main Canal on Left side	:	17.700Km.
xiii.	Number of villages to be benefitted	:	29 Nos.

I. COST

i.	Cost of Head Works	:	Rs. 16583.89 Lakhs
ii.	Cost of Distribution system	:	Rs. 7965.37 Lakhs
iii.	Total Cost of the Project	:	Rs. 24549.26 Lakhs
iv.	Cost per hector of annual irrigation	:	Rs. 7.90 Lakhs
v.	B.C. ratio (10% rate of interest rate)	:	Rs. 1.53

1.2 Objectives

Integrated watershed management plans are comprehensive strategies designed to sustainably manage and develop the resources within a watershed. These plans aim to address various environmental, social, and economic objectives. Here are detailed pointwise objectives typically included in an integrated watershed management plan:

1 Water Resource Management:

- Improve water quality through pollution prevention and control measures.
- Enhance groundwater recharge and maintain base flow in rivers and streams.

2 Soil Conservation and Land Management:

- Mitigation of landslide, landslip and rockfalls.
- Soil conservation through biological and engineering measures to reduce sediment load in river and tributaries, incidentally improving the quality ofwater.
- Implement erosion control measures to reduce soil erosion and sedimentation.
- Promote soil conservation practices to maintain soil fertility and structure.

- Prevent land degradation and ensure the sustainable use of land resources.

3 Biodiversity and Habitat Protection:

- Preserve and restore natural habitats and biodiversity within the watershed.
- Promote the conservation of endangered species and ecosystems.
- Establish and maintain buffer zones and green corridors for wildlife.

4 Riparian Zone Protection:

- Protect and restore riparian zones along water bodies to maintain water quality.
- Establish vegetative cover to stabilize stream banks and reduce erosion.
- Ecosystem conservation resulting from increased vegetal cover and water retaining properties of soil.
- Enhance wildlife habitat and promote aquatic biodiversity in riparian areas.

5 Afforestation and Reforestation:

- Rehabilitation of degraded forest areas through afforestation and facilitating natural regeneration of plants.
- Implement tree planting programs to increase forest cover and combat deforestation.
- Restore degraded forest ecosystems and promote sustainable forestry practices.
- Enhance carbon sequestration and mitigate the effects of climate change.

6 Agricultural Sustainability:

- To meet the fuel and fodder requirements of localpeople.
- Promote sustainable agricultural practices that minimize the use of harmful chemicals.
- Improve crop and livestock management to increase productivity and reduce runoff.
- Support small-scale farmers through training and capacity-building programs.

7 Community Engagement and Livelihood Improvement:

- Involve local communities in watershed management planning and decision-making.
- Enhance livelihoods through income-generating activities, such as eco-tourism or agroforestry.
- Promotion of non-conventional energy device to reduce pressure on forest.
- Strengthen social cohesion and community resilience.

8 Infrastructure Development:

- Construct and maintain water harvesting structures, check dams, and irrigation systems.

- Develop sustainable sanitation facilities to reduce water pollution.
- Build and maintain roads and trails for improved access and mobility.

9 Education and Awareness:

- Raise awareness about the importance of watershed management among stakeholders.
- Provide training and educational programs on sustainable resource management.
- Foster a sense of ownership and responsibility among the community.

10 Monitoring and Evaluation:

- Establish a robust monitoring and evaluation system to assess the effectiveness of interventions.
- Continuously collect data on key indicators to track changes in the watershed.
- Adjust management strategies based on monitoring results.

Integrated watershed management plans play a crucial role in promoting sustainability, resilience, and the long-term well-being of communities and ecosystems within a watershed. These objectives are typically tailored to the specific needs and characteristics of each watershed, taking into account its unique environmental, social, and economic conditions and are basedonsoilerosionintensityinthecatchment area.

1.3 Methodologies

The CAT Plan would cover the following aspects

1. Identification of directly / free draining catchment to be donebasing on remote sensing and validation through field survey.
2. Erosion levels the watershed and prioritization of water sheds will be done by appropriate methods.
3. As per the requirement of Ministry of Environment & Forests and Climate Change (MoEF& CC), Government of India, the SMC treatment measures will be proposed for the area falling under very dense forest cover while intensive treatment measures including afforestation and rehabilitation of degraded lands will be suggested in severe erosion categories. Both Engineering as well as biological treatment measures will be proposed in the CAT plan.
4. The CAT Plan also includes a socio-economic component including supply of CNG connections to the project affected families to be implemented through Van SurakhyaSamities (VSSs).
5. The infrastructure component like construction of buildings, vehicles, salaries of staff etc. may be provided based on a careful analysis of the need for the same with detailed justification and should constitute a very small percentage (say up to 5%) of the total cost of the CAT plan.
6. The cost of the administrative set up and mitigate measures will include recommendation from State Forest Department for all forest land and from the Soil Conservation Department for non-forest land.

1.4 Scope of the Work

The detailed Scope of work for development of CAT plan for Hidsing (Medium Irrigation) Project is as under:

1.4.1 Data Collection:

- Survey of India (SOI) Topo Sheets.
- Project Map / Catchment Area Map from concerned Project Authorities.
- Satellite imagery acquisition (Liss-IV) from Open-Source platforms.
- Soil map from All India Soil and Land Use Survey and other open sources.

1.4.2 Data Generation:

- Drainage & Hydrology from Digital Elevation Model (DEM).
- Contour from Digital Elevation Model (DEM).
- Land Use: The land used classification and coverage in the Project Catchment Area.
- Physiography / Soil: Project area will have a variety of soils, mainly dependent on the lithology, topography, altitude, climate and vegetation cover. This shall be derived from map prepared by All India Soil and Land Use Surveys and other available data.
- Micro Watershed generation from DEM, Toposheet and Bhuvan data.
- Data Elevation Model (DEM): Derived contours from topographical maps will be used for preparation of DEM of the free draining catchment area and to prepare a slope-oriented map.
- Slope: Generation of Slope from SOI Topo sheets.

1.4.3 Data Analysis / Modeling:

- Google Earth Engine (GEE) has been used to analyze the various Data related to Land Use, Soil, Slope values, Soil erosion, rainfall and runoff etc.
- Watershed prioritization based on the Soil loss data
- Plan for Watershed Management:
    - Treatment measures / options.
    - Sub watershed wise afforestation plan.

1.4.4 THEMATIC MAP GENERATION:

As mentioned in the methodology, various thematic layers like catchment, watershed, drainage, contour, slope, land use, soil were prepared in Geographic Information System (GIS) platform. For seamless integration of different thematic layers and interactive spatial analysis, the themes were generated in a real-world coordinate system, i.e. UTM(Universal Transverse Mercator). This projection system is used in the recent publication Open Series Map (OSM) of SOI and is also suggested in National Map Policy. Datum used for the projection is WGS 1984 and Zone is UTM 45North.

1.4.5 CATCHMENT AND WATERSHED MAP:

The catchment boundary of Hidsing barrage was delineated from Cartosat DEM image file using SAGA watershed algorithm in GIS software. It was further confirmed with the SOI Topo sheets No. F45T02 & F45S14 looking at the contours and drainage. It was decided to prepare the CAT plan at Micro Watershed level instead of Watershed level due to small

catchment area of 74 sq km. The micro watersheds are prepared using the information available in Watershed Atlas of India and website and Land Use Survey of India (SLUSI) and the micro watershed boundary collected from Watershed Mission of Odisha.

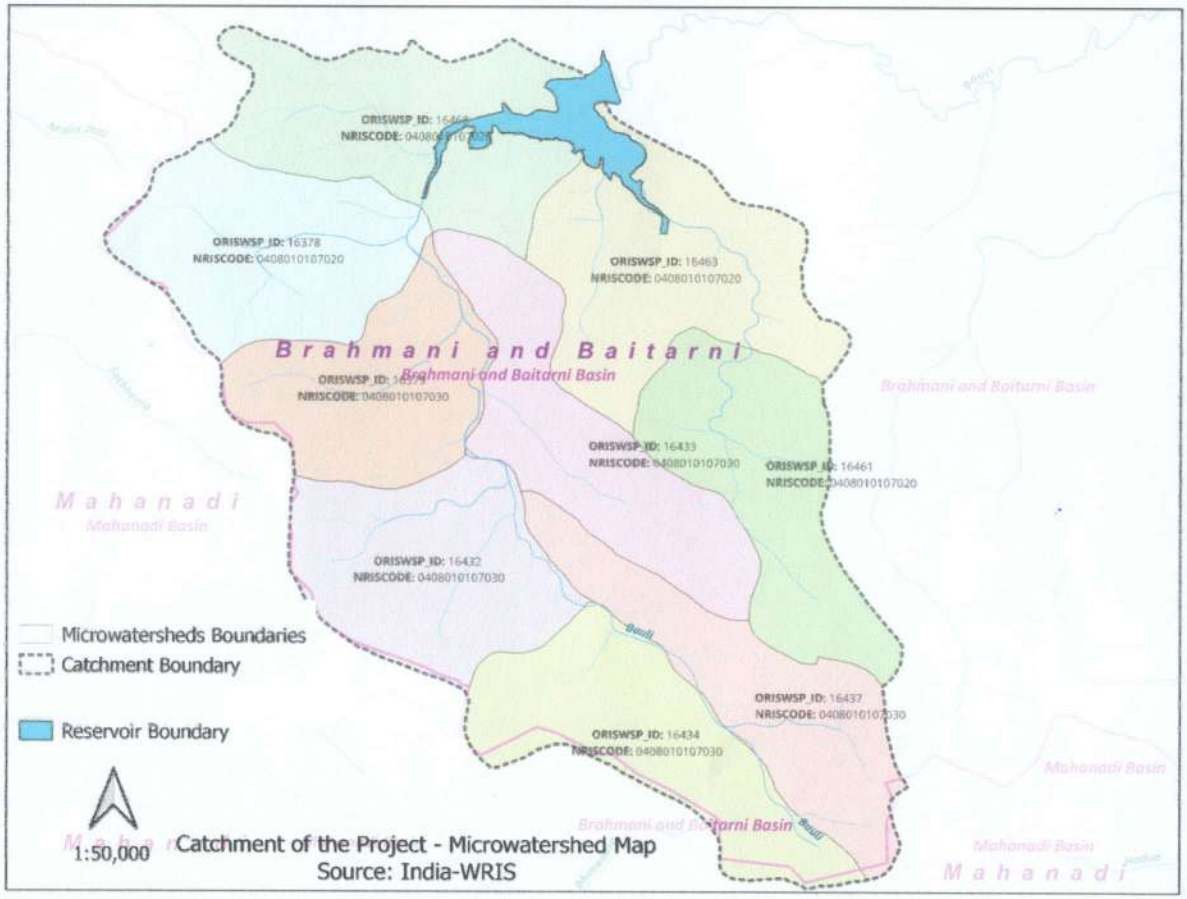


Figure 1: The Catchment Area Map of Hidsing Barrage Project

1.4.6 SLOPE MAP:

The Slope was prepared using the derived contours from SOI Topo sheet. These contours were used for preparation of Digital Elevation Model (DEM) of the catchment area before preparation of the slope map. A surface was created using the elevation values stored in the form of contours or points. After marking the catchment area, all the contours on the topographical maps were derived.

A Digital Terrain Model (DTM) of the area was then prepared, which was used to derive aslope map.

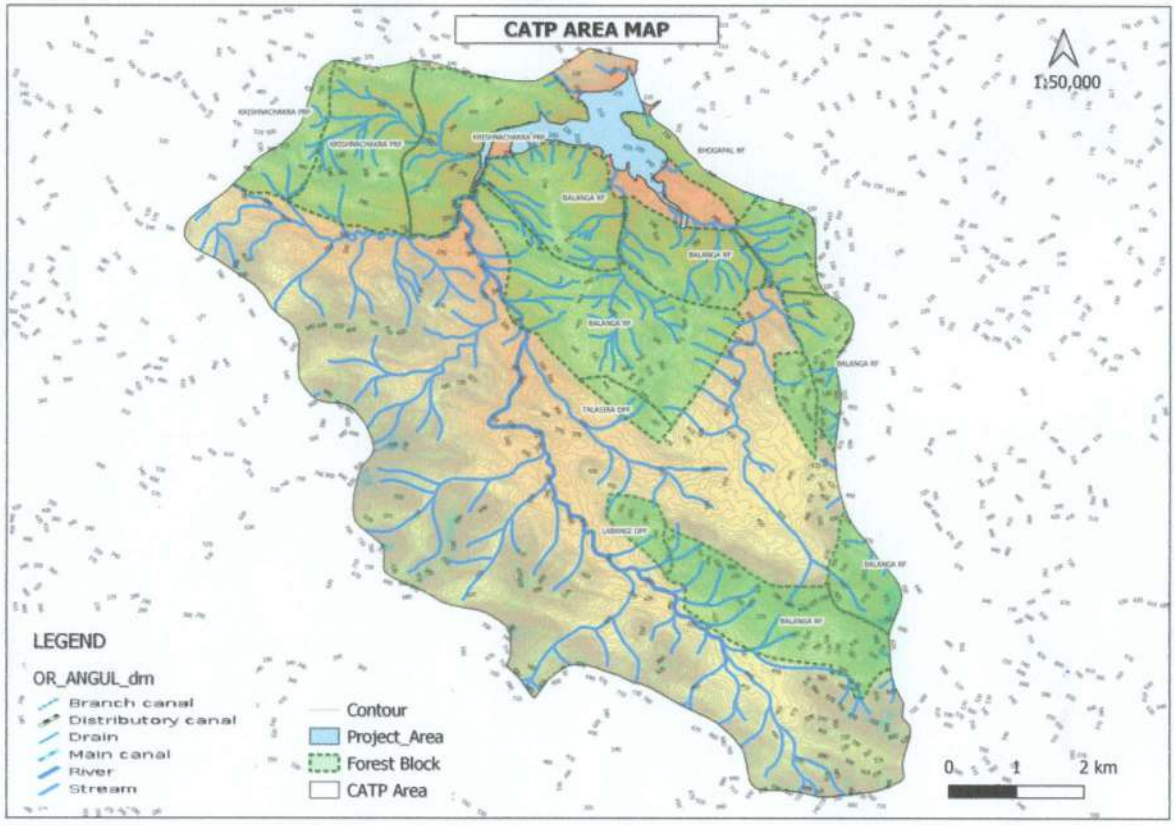


Figure 2: Map showing Contours in the Catchment Area

The slope was divided in classes of slope percentages.

The slope of a watershed plays an important role in controlling the soil and water retention thereby affecting the land-use capability. The percentage of the slope in a watershed determines the soil erosion susceptibility and forms the basis for classifying different of the watershed into suitable classes for formulating effective soil erosion conservation measures. Broadly, the following slope classes and ranges (Table 1.3) 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	0-2	Very Gentle Slope
2	2-5	Gentle Slope
3	5-10	Moderate Slope
4	10-18	Moderately Steep Slope

The Slope map of the free draining catchment is presented in **Figure 3.**

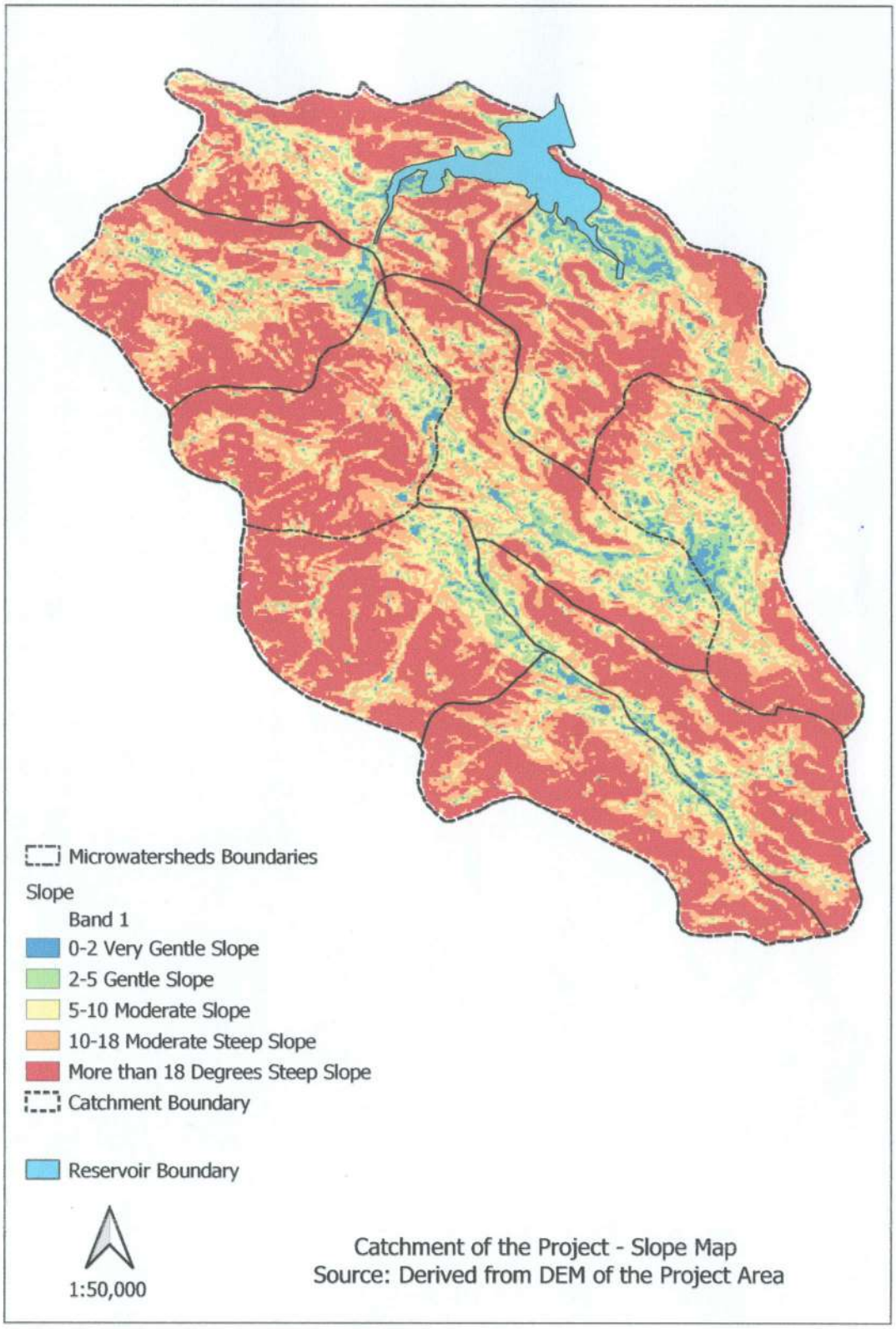


Figure 3: Slope Map of the catchment Area

1.4.7 Land Use/ Land Cover Map:

Land Use map was analyzeddirectly in Google Earth Engine from recent LISS-IV Multi-Spectral Satellite Image.

1.4.8 SOIL MAP:

Soil classification was prepared and used in Google Earth Engine from _____.

1.5 CatchmentArea

The project intercepts a catchment area of 72.30 sq km at the proposed dam site. The catchment is fairly fan shaped and is bounded by steep hills and covered by thick forest. Bauli Nallah originates from the hill ranges of Balanga and traverses in the North-East directions. Bauli Nallah is a tributary of Lingara Nallah joining it near Rankasinga. Lingara Nallah in turn joins the river Brahmani on its right bank near the village Meramundali. The stream is seasonal and rain fed, receiving maximum discharge during monsoon in direct response to precipitation.

1.3.1 Free Draining Catchment

The total catchment area of Bauli river up to the proposed site is 72.30 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 (72.30 sq km).

As per nomenclature contained in Water Atlas of India, Edition 1993, the free draining catchment under the study area lies in Water Resource Region-4 (All drainage flowing into the Bay of Bengal except those of Ganges and Brahmputra Drainage); basin 4G (Mahanadi), Catchment 4G1. The free draining catchment has been further sub-divided into 9micro-watersheds. The basin characteristics of different micro-watersheds 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 sub-watershed location is shown in **Figure 1.2.**

Table 1.1: Basin Characteristics of Different Micro-watersheds

S. No.	Micro-watershed	Area in Sq KM		
1	4H1A7b2b	7.85		
2	4H1A7b1a	8.22		
3	4H1A7c2a	7.82		
4	4H1A7c1b	8.34		
5	4H1A7b1b	9.55		
6	4H1A7c2b	7.58		
7	4H1A7c1c	8.05		
8	4H1A7c1a	7.1		
9	4H1A7b2a	10.16		
	Total	**74.67 Sq KM**		

1.6 Topography

The catchment is largely hilly terrain and has undulated topography and tracts of agriculture land and dry deciduous forest.

The elevation map along with drainage map of the catchment is shown in **Figure1.3.**

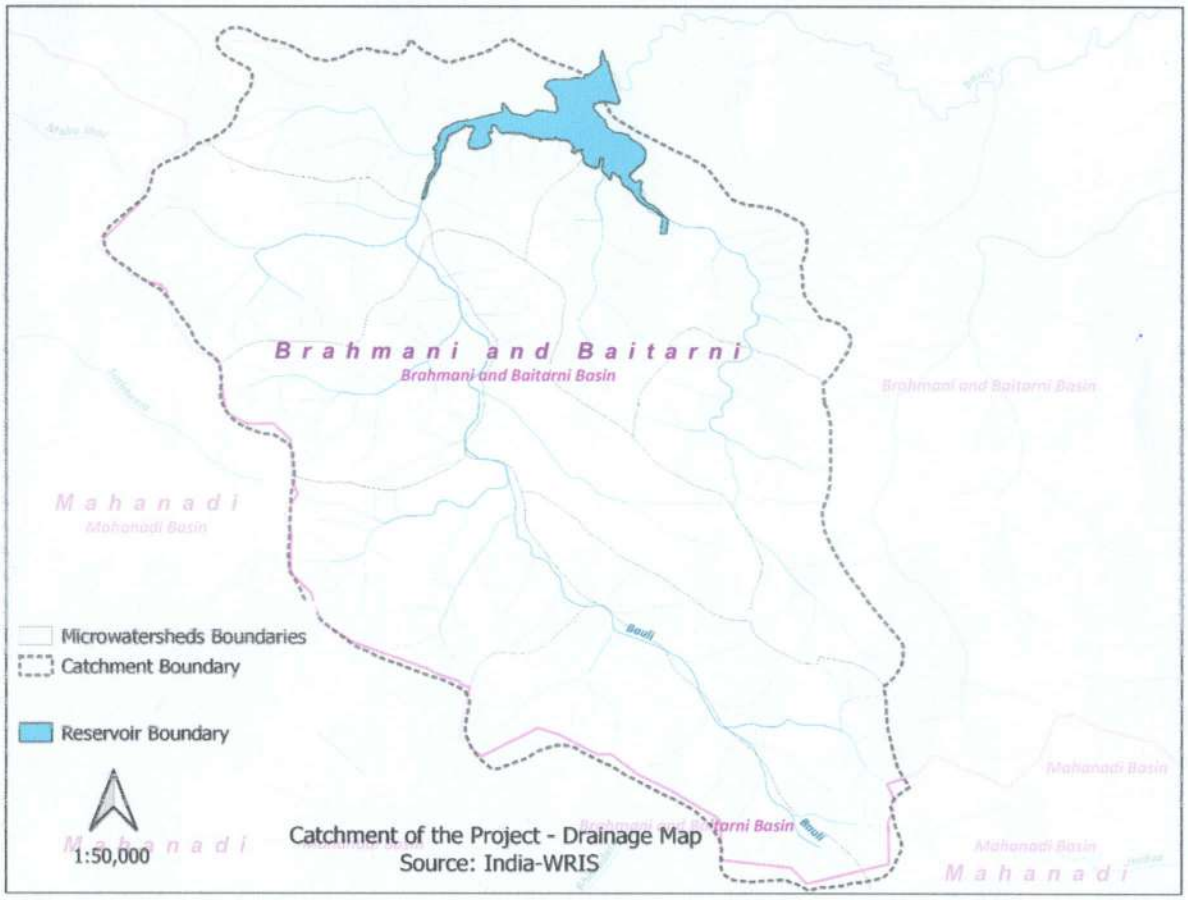


Figure 1.3: Drainage map of the catchment.

1.7 Soil

Slightly deep well drained, clayey soils on gently sloping interveinal plateau with moderate erosion.

Based on satellite data, topo-sheets and other secondary data, 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**.

1.7.2 Land use Categories andErosion

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.

1.7.2.1 AgriculturalLand

Around 3.21 sq km area of the catchment constituting 4% 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, contour trenches, ponds etc. which follows the faulty agriculturalpractices.

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

1.7.2.2 Settlement

Under settlement category about 0.18 sq km area of catchment constituting less than 1% of the total catchment is present.

1.7.2.3 Open ForestLand

Under open forest category, about 8.01 sq km, constituting 11% 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 and drainage treatmentsare suggested so as increase the crown density by 20% in whole of the area to reduceerosion.

1.7.2.4 DenseForest

Dense forest covers about 48 sq. km area constituting 64% 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 conservationmeasures.

1.7.2.5 River / Waterbody

Around 1.19 sq km area constituting 2% 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 in the Catchment

S. No.	Land use category	Area (sq km)	Area (%)
1	Dense Forest/Vegetation	48	64%
2	Open Forest/Vegetation	8.01	11%
3	Tree Clad Area	5.43	7%
4	Tree Clad Area (Open)	4.66	6%
5	Crop Land-Kharif Crop	3.21	4%
6	River/Stream	1.19	2%
7	Land With Scrub	1.18	2%
8	Groves/Orchard/S. Trees	0.69	1%
9	Mango/Jack Fruit/ Other Fruit Bearing Orchards	0.52	1%
10	Forest Plantation	0.45	1%
11	Grazing Land (Gochar)	0.28	0%
12	Village Settlement	0.18	0%
13	Vacant Land Inside/Periphery of Villages	0.16	0%
14	Metalled /Earth Road	0.14	0%
15	Dense Scrub	0.07	0%
16	Other Misc	0.27	0%
	Grand Total	**74.44**	100%

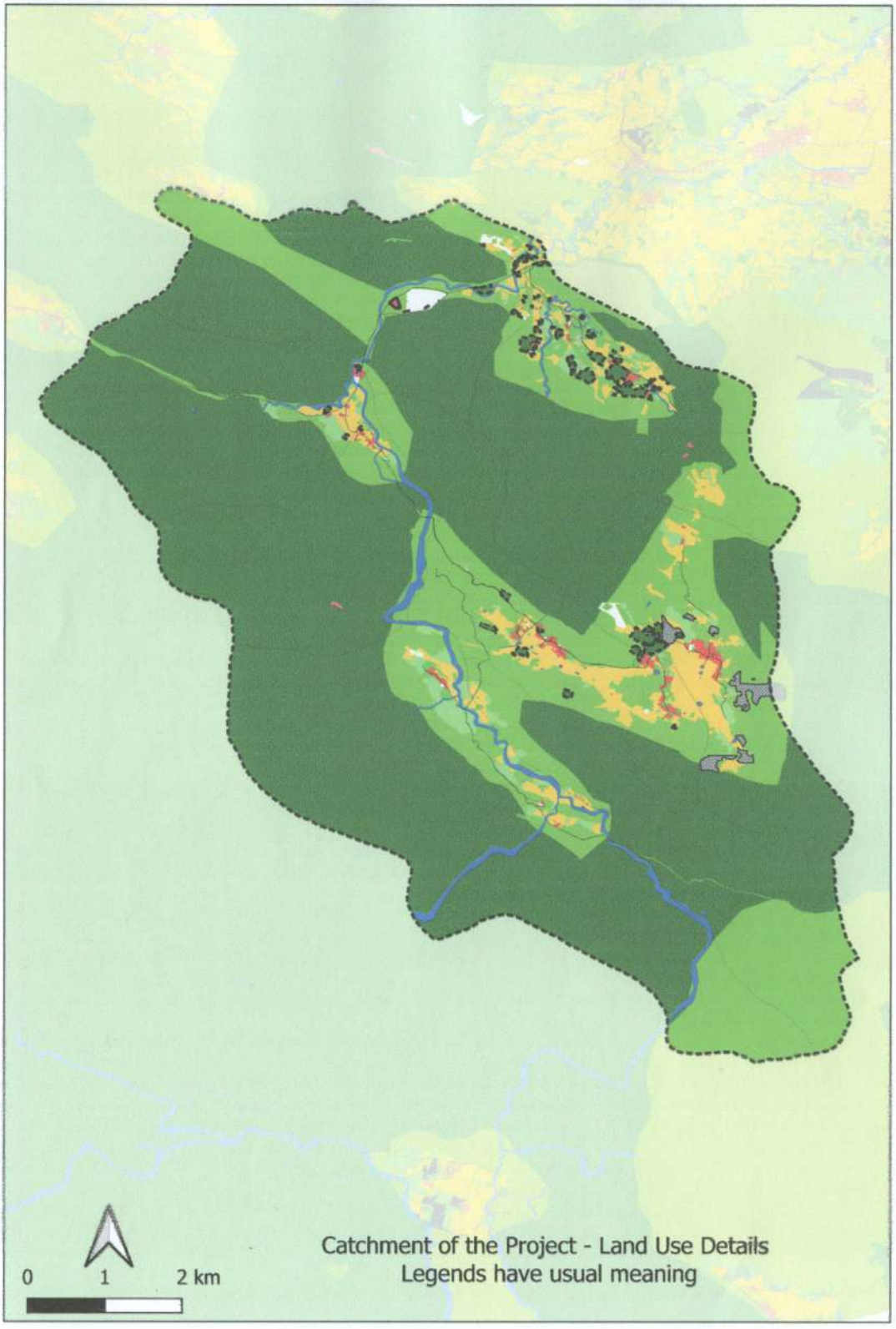


Figure 4.5: Land Use Plan of the Catchment Area

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.

1.7.1 Soil Loss Using RUSLE Method

Curve Number Method as discussed in Identification of Soil Erosion Prone Areas of Madhya Pradesh using USLE/ RUSLEby Ashwini Suryawanshi, Anupam Kumar Nema, Rahul Kumar Jaiswal,SukantJain andSaswat Kumar Kar" published in Journal of Agricultural Engineering, Vol. 58 (2) has been used for the calculation of Soil Loss data in different micro watersheds in the Catchment.

To develop the SCS CN model using cloud data and the GEE server, different sources of data availability were examined. The methodology was finalized with the help of a flowchart to use dynamic LULC (MCD12Q1.006 MODIS Land Cover), rainfall (Climate Hazards Group InfraRed Precipitation (CHIRPS) with Station Data), Global Soil data (OpenLandMap), and other data for SCS CN model.

Sl. No.	Data	Data resolution	Source of data
1.	Total rainfall amount	CHIRPS-2.0 (Resolution 0.05°)	Climate Hazards Group Infrared Precipitation with Station (www.legacy.chg.ucsb.edu/data/chirps/index.html)
2.	Soil type	DSMW at scale 1:5 million.	Digital Soil Map of the World, FAO (www.fao.org)
3.	Land use	MODIS (Moderate Resolution Imaging Spectroradiometer) image format with (30 m resolution)	National Aeronautics and Space Administration's (NASA), (http://www.usgs.gov)
4.	NDVI	eMODIS image (250m resolution)	National Aeronautics and Space Administration's (NASA) ,(http://www.usgs.gov)
5.	LS and Slope	DEM (30m resolution)	Shuttle Radar Terrain Mapper (SRTM), (http://www.usgs.gov)

The USLE and RUSLE models can be expressed by the following equation:

$$A = R*K*L*S*C*P \quad \ldots (1)$$

Where,

A = Computed soil loss caused by sheet and rill erosion, t.ha^{-1}.yr^{-1},

R = Rainfall erosivity factor, MJ.mm.ha^{-1}.h^{-1}.yr^{-1},

K = Soil erodibility factor, t.ha.h. ha^{-1}.MJ^{-1}.mm^{-1},

L = Slope length factor, dimensionless,

S = Slope steepness factor, dimensionless,

C = Cover and management factor, dimensionless, and

P = Support practice factor, dimensionless.

The conceptual framework of soil erosion approximation by USLE/RUSLE model are depicted in Fig. 2, and the

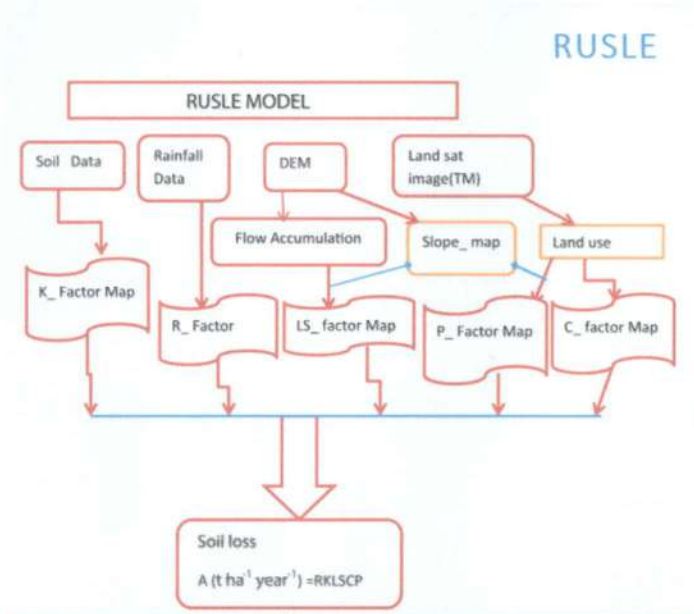


Image Source: https://www.sciencedirect.com/science/article/pii/S2095633915301076

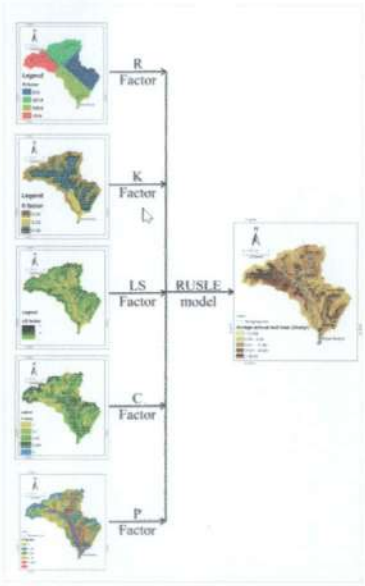


Image Source: http://www.gathacognition.com/article/gca41

Summary of the Analysis

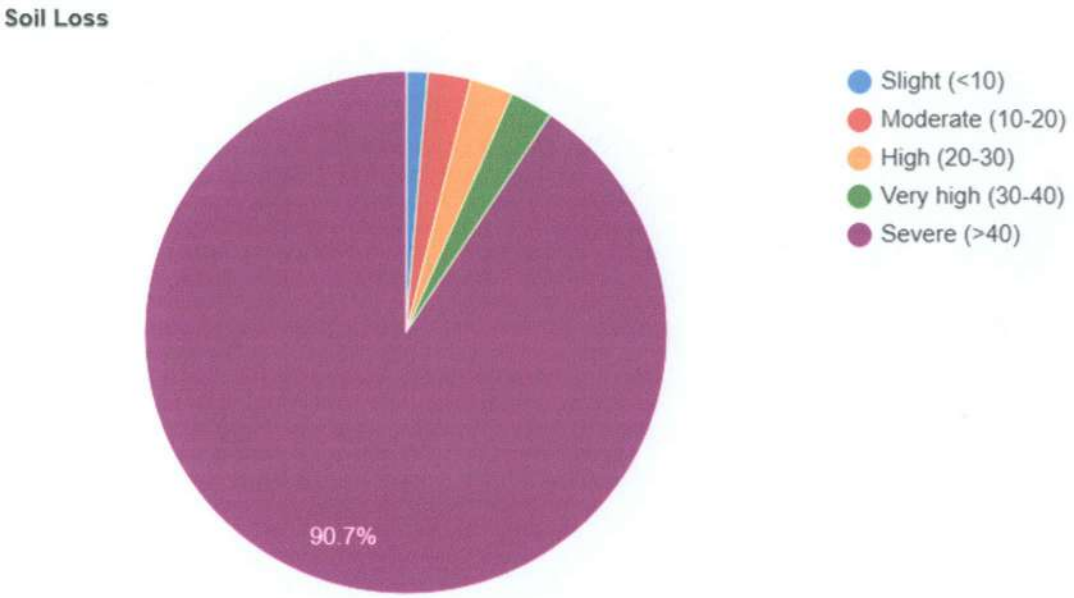
On analysis, it has been found that out of 74.67 Sq km area in the catchment, 15 sq km area is having very steep slope of more than 25 degree. And hence, it is not advisable to suggest SMC interventions there. However, such area needs to be protected from any kind of soil disturbance caused by excessive grazing or logging activities for livelihood activities.

The Soil Loss Map of the free draining catchment has been generated based on RUSLE analysis data and is presented in **Figure 1.7** and the statistics are presented in **Table 1.8**.

However, when area with slope more than 25 degree is excluded from the study area, it has been found that mean soil loss in tonne per Ha per year is still very high at 358.95 tonnes in comparison to acceptable limit of 40 tonnes. More than 88 percent of the area comes under severe soil loss category.

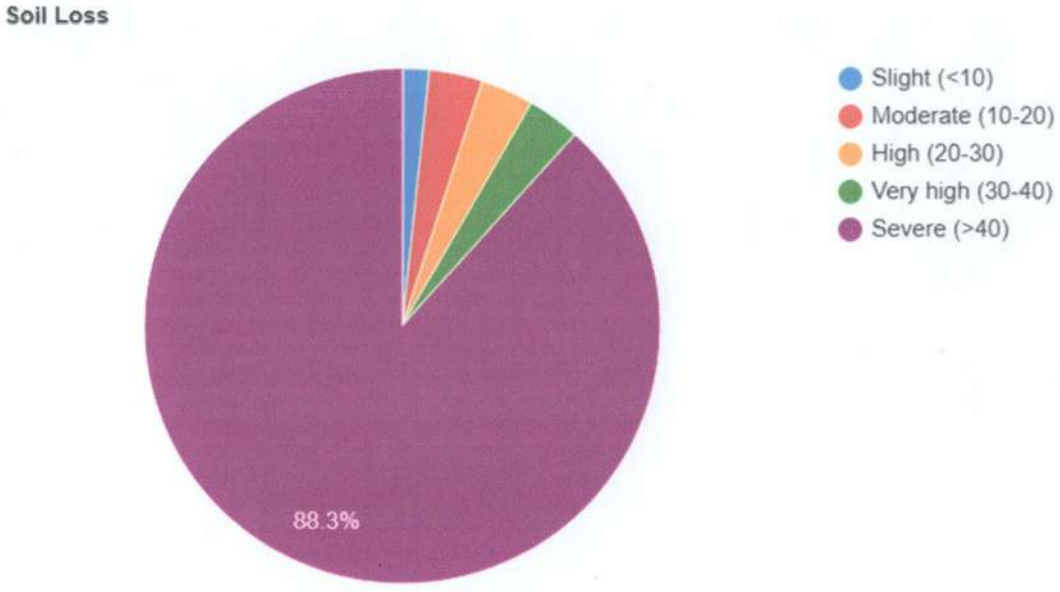
Table 1.8: Micro-watershed soil loss categories(sq km)

Sr. No	Micro water shed	Area in Sq KM	Slight (<10)	Moderate (10-20)	High (20-30)	VERY High (30-40)	Severe (>40)	Mean Soil Loss
1	4H1A7b2b	7.85	0.074	0.162	0.177	0.231	7.203	667.28
2	4H1A7b1a	8.22	0.091	0.220	0.230	0.234	7.446	517.85
3	4H1A7c2a	7.82	0.043	0.140	0.196	0.243	7.200	475.84
4	4H1A7c1b	8.34	0.066	0.178	0.199	0.201	7.695	950.91
5	4H1A7b1b	9.55	0.174	0.307	0.362	0.329	8.380	537.02
6	4H1A7c2b	7.58	0.092	0.152	0.172	0.162	7.000	903.45
7	4H1A7c1c	8.05	0.095	0.203	0.188	0.161	7.406	644.63
8	4H1A7c1a	7.1	0.028	0.068	0.107	0.119	6.782	687.21
9	4H1A7b2a	10.16	0.234	0.441	0.467	0.396	8.620	463.57
	Total	**74.67**	**0.895**	**1.871**	**2.098**	**2.077**	**67.733**	**641.51**



CATCHMENT AREA TREATMENT

Sr. No	Micro water shed	Area in Sq KM	Slight (<10)	Moderate (10-20)	High (20-30)	VERY High (30-40)	Severe (>40)	Mean Soil Loss per Ha
1	4H1A7b2b	6.332	0.074	0.162	0.177	0.231	5.688	332.73
2	4H1A7b1a	6.596	0.091	0.220	0.230	0.234	5.821	309.04
3	4H1A7c2a	7.044	0.043	0.140	0.196	0.243	6.422	316.33
4	4H1A7c1b	5.575	0.066	0.178	0.199	0.201	4.931	408.26
5	4H1A7b1b	7.984	0.174	0.307	0.362	0.329	6.811	322.43
6	4H1A7c2b	5.969	0.092	0.152	0.172	0.162	5.392	545.71
7	4H1A7c1c	6.115	0.095	0.203	0.188	0.161	5.469	371.92
8	4H1A7c1a	5.416	0.028	0.068	0.107	0.119	5.093	416.81
9	4H1A7b2a	8.640	0.234	0.441	0.467	0.396	7.103	277.41
	Total	**59.670**	**0.895**	**1.871**	**2.098**	**2.077**	**52.730**	**358.95**



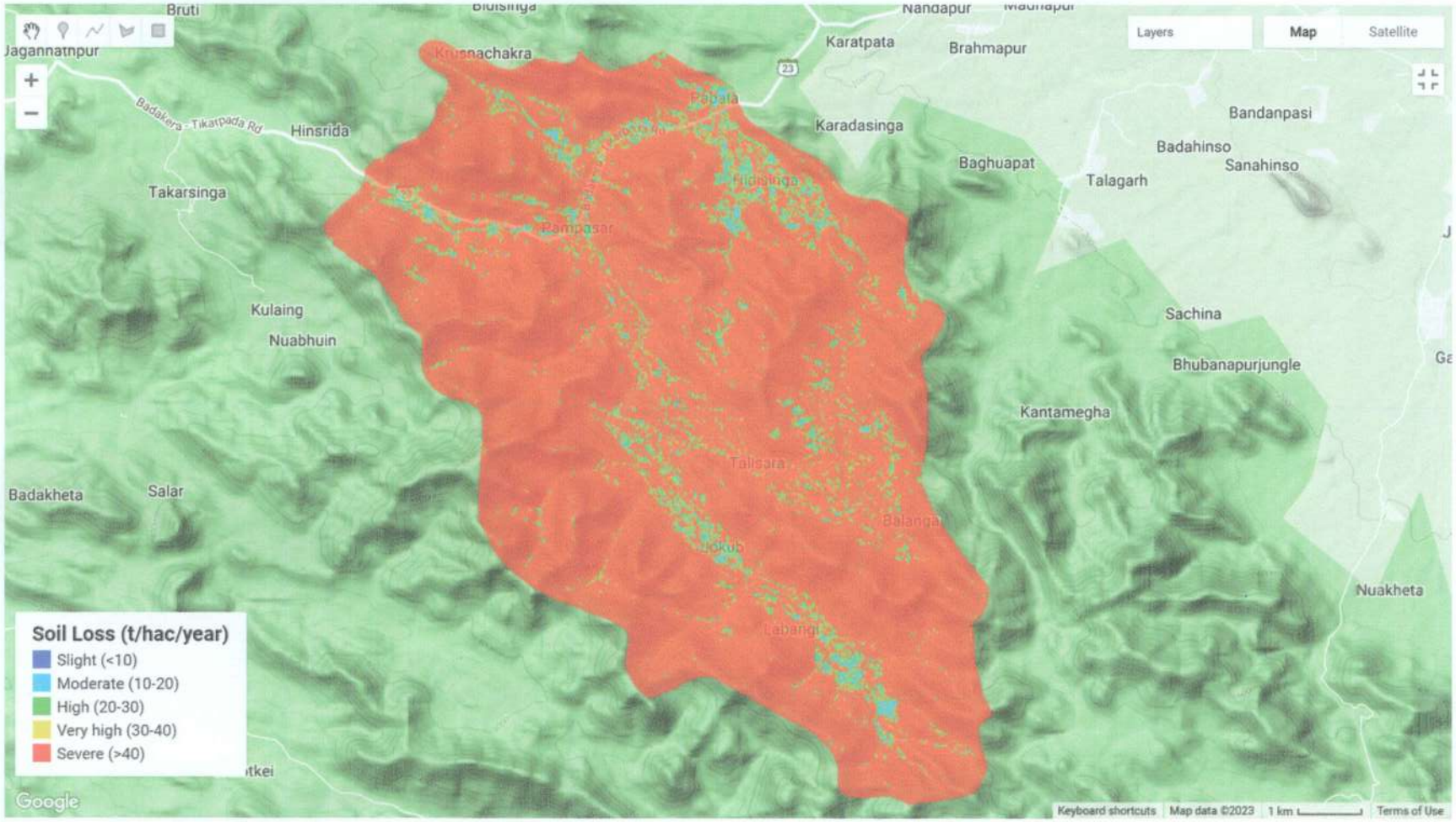


Figure 1.7: Soil Loss Categories for all the catchment area

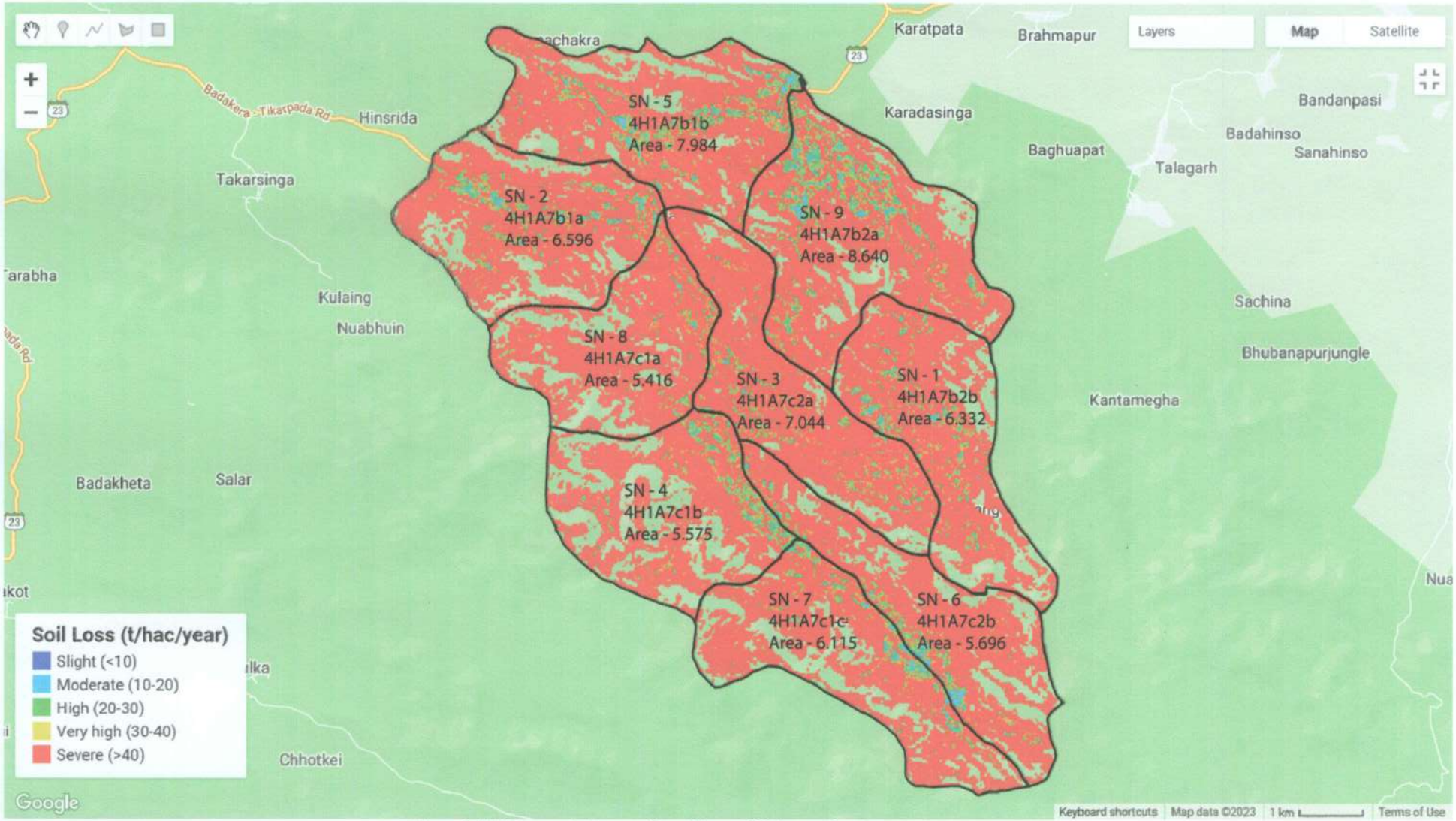
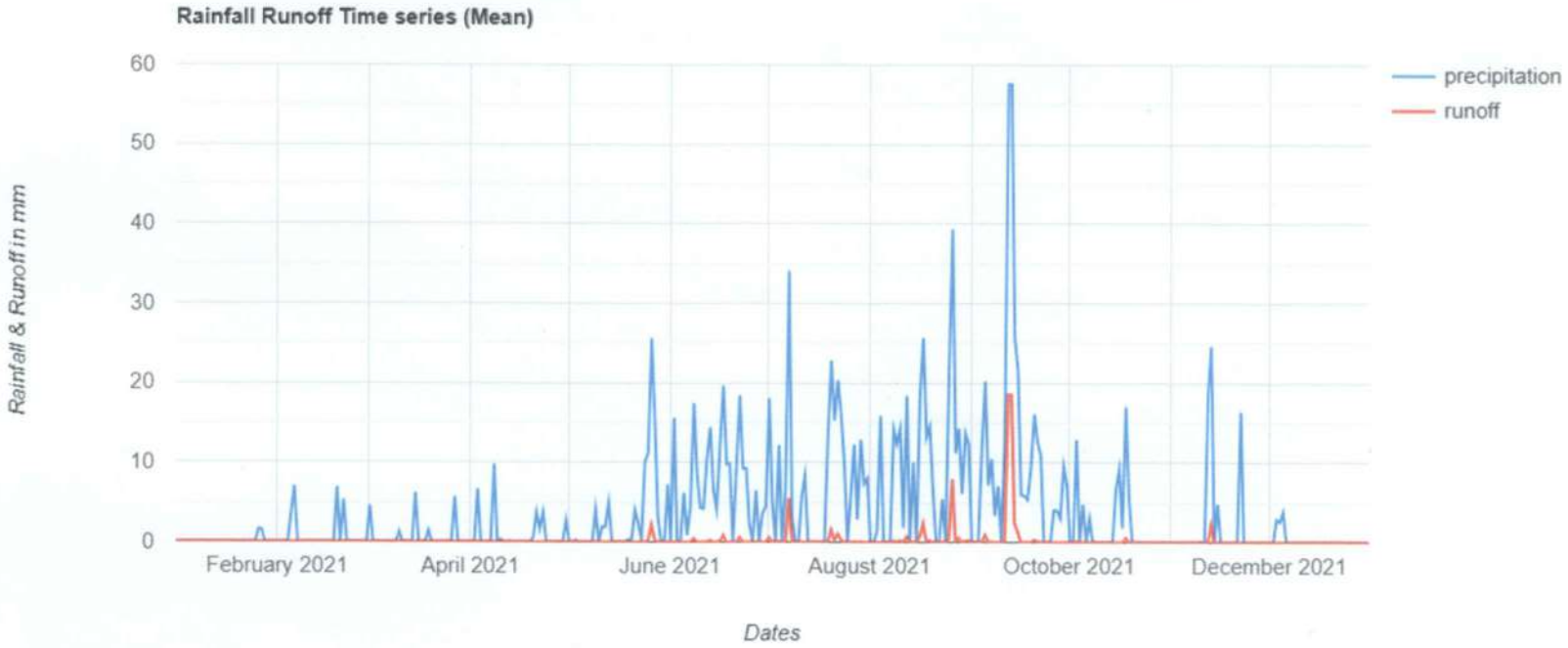


Figure 5: Soil Loss excluding very Steep Slopes >25 degrees from treatment

Rainfall and Runoff Calculations –

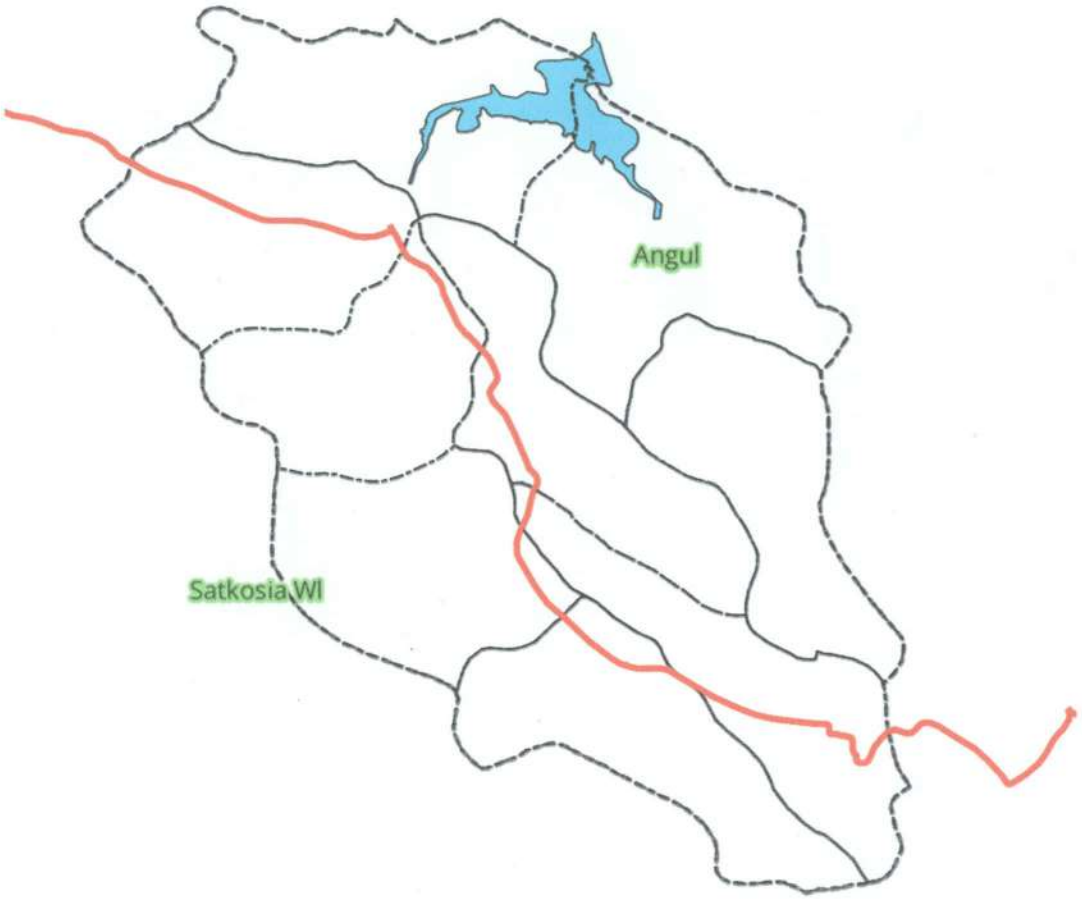


Analysis of the Rainfall and runoff from the catchment area indicates the runoff of about 6%. Runoff is restricted to the period of monsoon season and there, in the days of heavy rainfall, it can go up to 25% of daily rainfall.

S. No.	Micro-watershed	Area in Sq KM	Rainfall in CUM	Runoff in CUM	% runoff
1	4H1A7b2b	7.85	10825958.22	716517.75	6.62%
2	4H1A7b1a	8.22	11294680.64	631153.97	5.59%
3	4H1A7c2a	7.82	10839657.64	677368.03	6.25%
4	4H1A7c1b	8.34	11283182.49	665679.81	5.90%
5	4H1A7b1b	9.55	13852374.47	953593.18	6.88%
6	4H1A7c2b	7.58	10208088.25	498079.89	4.88%
7	4H1A7c1c	8.05	10601287.17	378744.46	3.57%
8	4H1A7c1a	7.1	9502472.339	599624.21	6.31%
9	4H1A7b2a	10.16	14313696.56	995539.1	6.96%
	Total	**74.67 Sq KM**			

Average Rainfall in mm in the catchment area = 1375.67 mm
Average runoff in mm over the catchment area = 59.54 mm or 5.95% of the total rainfall.

1.8 Catchment Area TreatmentPlan



Catchment area is almost bifurcated into two divisions. Satkosia WL and Angul (T) forest Division. 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 forest land where in a few places soil conservation measures are required. For treatment of catchment area, the areas that require treatment have been delineated from the Composite Erosion Intensity Unit Map. The sum of weightages was reclassified as per the **Table 1.7** below to further subdivide the area as per the erosion intensity classes.TheweightagesforLanduse,Slope&SoilweresummedtogettheErosionIntensityClasses.

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 CATPlan.

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.

1.9 Treatment of IndividualSub-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, Gochar 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 treatment of the drainage lines based on their orders to protect them from bank erosion and stream siltation. 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 25^0slope 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. In the present case, an area of _____ ha has been proposed to be treated under the CAT plan. This area includes _____ ha area of catchment which shall be treated by biological / engineering measures and ____ ha area under private land treatment within the free drainingcatchment.

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.

1.9.1 Activities to be Undertaken

1.9.1.1 Concrete bonding in hilly area

Erosion Control: One of the primary benefits of concrete bonding in hilly terrain is its ability to control erosion. Concrete surfaces can prevent soil erosion caused by rain, runoff, and gravity, helping to maintain the integrity of the landscape and reducing the risk of landslides.

I. Stability: Concrete bonding provides a stable and durable foundation for various structures in hilly areas, such as buildings, retaining walls, and roads. This stability minimizes the risk of structural damage, subsidence, and uneven settling.

II. Safety: Well-bonded concrete surfaces in hilly areas enhance safety for residents, visitors, and property owners. They reduce the risk of accidents and injuries caused by unstable ground or slippery slopes.

III. Improved Accessibility: Concrete bonding allows for the creation of pathways, driveways, and roads in hilly regions. This improves accessibility to properties and makes it easier to navigate steep slopes.

IV. Aesthetics: Concrete bonding can be used to create visually appealing landscaping features like terraces, patios, and walkways, enhancing the overall aesthetics of hilly properties.

V. Increased Property Value: Properly executed concrete bonding projects can increase the value of hilly properties by providing usable space, improving curb appeal, and enhancing the property's overall appearance.

VI. Easier Maintenance: Concrete surfaces in hilly areas generally require less maintenance than natural terrain. They are less prone to erosion, wear, and the need for regular upkeep, which can save time and money.

VII. Customization: Concrete can be designed in various colors, textures, and patterns to complement the surrounding landscape or meet the property owner's preferences, allowing for a high degree of customization.

VIII. Support for Retaining Walls: Concrete bonding is often used to construct retaining walls in hilly areas, which can prevent soil erosion, create flat areas for landscaping or buildings, and enhance property functionality.

IX. Durability: Properly designed and constructed concrete structures in hilly areas can have a long service life, providing stability and utility for many years.

X. Cost Savings: Although the initial cost of concrete bonding may be higher than alternative methods like soil stabilization or natural landscaping, it often leads to cost savings over time by reducing maintenance and repair expenses.

XI. Sustainability: Using concrete can contribute to sustainable practices by reducing soil disturbance and the need for extensive grading. It can also be designed with permeable or environmentally friendly options, depending on the project's goals.

The benefits of concrete bonding in hilly areas are contingent on proper planning, design, and execution. Engaging experienced professionals and engineers, conducting site-specific assessments, and adhering to best practices are essential to realize these advantages while mitigating potential challenges.

Work done asper below estimate

ADD ESTIMATE COPY

1.9.1.2 Wire mesh fences can be constructed using various types of wire and materials, including different types of stone, to create aesthetically pleasing and durable boundary fences.

Wire mesh fences can be constructed using various types of wire and materials, including different types of stone, to create aesthetically pleasing and durable boundary fences. Here are some common types of stone wire mesh fences:

i. Gabion Wire Mesh Fence: Gabions are wire mesh containers filled with various types of stone or rock. These cages are stacked to create retaining walls or fences. They provide a natural, rustic appearance and are excellent for erosion control and landscaping in hilly or sloped areas.

ii. Rustic Stone Wire Mesh Fence: This type of fence combines wire mesh with irregularly shaped, uncut stones. The stones are placed within the mesh, giving the fence a rustic, natural appearance. It's often used in gardens or to create a visually appealing boundary.

iii. Crushed Stone Wire Mesh Fence: Crushed stones or gravel can be incorporated into wire mesh fencing. This style offers a more uniform and modern appearance compared to irregularly shaped stones. It's often used in contemporary or industrial settings.

iv. Slate Stone Wire Mesh Fence: Slate stones are flat and can be incorporated into wire mesh fences to create a more refined, modern appearance. Slate stone wire mesh fences are often seen in urban environments and modern landscapes.

v. Limestone Stone Wire Mesh Fence: Limestone is a versatile stone that can be used to create wire mesh fences with a clean and classic appearance. Limestone wire mesh fences are popular in both residential and commercial applications.

vi. Granite Stone Wire Mesh Fence: Granite stones can be used to create sturdy and durable wire mesh fences. These fences have a high-end appearance and are often used to enclose upscale properties or institutions.

vii. Sandstone Stone Wire Mesh Fence: Sandstone is known for its wide range of colors and textures. It can be used to create attractive wire mesh fences with a variety of design possibilities.

viii. Marble Stone Wire Mesh Fence: Marble stones can be used to create elegant and luxurious wire mesh fences. They are often chosen for high-end residential and commercial applications.

When selecting the type of stone for your wire mesh fence, consider the aesthetic you want to achieve, the durability required for the specific application, and the overall budget.

Additionally, it's essential to ensure that the wire mesh and stone combination is assembled properly to create a structurally sound and long-lasting fence.

Work done asper below estimate

ADD ESTIMATE COPY

1.9.1.3 Incentives to VSS for the promotion of Alternate Livelihood Activities around the areas 5 Nos of VSS x 20000 each x for 5year

Incentives provided to Vana Surakhya Samitis, which are community-based organizations dedicated to forest and environmental conservation in India, can yield several benefits, both for the local communities and the broader environment. Some of these benefits include:

i. Increased Participation and Motivation: Incentives can encourage more community members to actively participate in conservation efforts. This increased participation is crucial for the success of conservation programs, as it mobilizes a broader base of support.

ii. Enhanced Conservation Practices: Incentives can promote the adoption of sustainable and eco-friendly conservation practices. This can include reforestation, afforestation, wildlife protection, and sustainable resource management.

iii. Improved Livelihoods: Many Vana Surakhya Samiti members are dependent on the forest for their livelihoods. Incentives can provide them with alternative income sources, reducing the pressure on the forest resources. This can include training in sustainable agriculture, animal husbandry, or non-timber forest products collection.

iv. Reduced Dependence on Forest Resources: By providing incentives, Vana Surakhya Samitis can help reduce the overexploitation of forest resources. This is vital for the long-term sustainability of forests and biodiversity.

v. Biodiversity Conservation: Incentives can support activities that directly benefit biodiversity, such as the protection of critical habitats, endangered species, and the preservation of local flora and fauna.

vi. Community Empowerment: Incentives can empower local communities by giving them a stake in forest conservation. This leads to a sense of ownership and responsibility for the environment, making it more likely that conservation efforts will be successful.

vii. Conflict Mitigation: Incentives can help reduce conflicts between wildlife and humans. Compensation or benefits for crop damage or livestock losses can encourage communities to coexist peacefully with wildlife and report human-wildlife conflicts promptly.

viii. Knowledge and Skill Building: Incentives can fund training and capacity-building programs for Vana Surakhya Samiti members. This can enhance their knowledge of sustainable forest management, conservation, and ecological restoration.

ix. Strengthened Collaborations: Incentives can encourage partnerships and collaborations between Vana Surakhya Samitis, government agencies, NGOs, and other stakeholders. This collective effort can lead to more effective conservation initiatives.

x. Cultural and Social Benefits: Incentives can support cultural and social activities within the community, reinforcing the value of traditional ecological knowledge and customs related to nature and conservation.

xi. Economic Development: Incentives can contribute to local economic development by creating jobs and income opportunities related to conservation and sustainable land use.

xii. Environmental Benefits: Ultimately, incentives to Vana Surakhya Samitis can result in cleaner air, water, and soil, helping to mitigate the impacts of climate change and ensuring a healthier environment for all.

It's important to tailor incentives to the specific needs and goals of each Vana Surakhya Samiti and to ensure that the incentives are designed in a way that supports long-term sustainability and conservation efforts. Collaboration with local communities and a deep understanding of their needs and aspirations are essential for the success of such programs.

1.9.1.4 Solar Lights (min 30 W)

Supplying solar lights to wildlife areas can offer several benefits for both the environment and the local communities that live in or near these regions. Here are some of the advantages of providing solar lights in wildlife areas:

i. Reduced Dependence on Fossil Fuels: Solar lights do not rely on fossil fuels, reducing greenhouse gas emissions and the carbon footprint in these areas. This is important for mitigating climate change, which can have severe impacts on wildlife and their habitats.

ii. Wildlife Protection: Adequate lighting can help reduce human-wildlife conflicts by making it easier for local residents to see and avoid wildlife at night. This can reduce harm to both humans and animals.

iii. Enhanced Safety: Solar lights improve safety for both wildlife and humans by reducing the risks of accidents and confrontations during the night. This is particularly important in areas where dangerous animals may roam.

iv. Community Development: Providing solar lights can enhance the quality of life for local communities in wildlife areas by extending the hours during which productive activities can take place. This can include education, economic activities, and social gatherings.

v. Education and Literacy: Solar lights enable children and adults to study and learn after dark, which can lead to improved literacy rates and educational outcomes in these communities.

vi. Economic Opportunities: Extended lighting hours can foster economic development by enabling businesses to operate in the evening, expanding income-generating activities, and creating job opportunities.

vii. Reduction in Indoor Air Pollution: Solar lighting can reduce the need for kerosene lamps and other sources of indoor lighting that generate harmful indoor air pollutants. This has significant health benefits for residents.

viii. Preservation of Natural Darkness: By using solar lights designed to minimize light pollution, it's possible to balance the need for lighting with the preservation of natural darkness in wildlife areas. This is essential for the health of nocturnal wildlife and ecosystems.

ix. Cost Savings: Solar lights require minimal operating costs once installed and can lead to long-term cost savings compared to traditional grid-based lighting solutions.

x. Community Engagement: The provision of solar lights can engage local communities in conservation efforts, fostering a sense of ownership and responsibility for their environment and wildlife.

xi. Promotion of Sustainable Energy: Introducing solar lights encourages the use of renewable and sustainable energy sources, setting an example for responsible energy practices in wildlife areas.

xii. Wildlife Research and Observation: Solar lights can support nocturnal wildlife research, enabling scientists to observe and study wildlife behavior during the night.

It's essential to design solar lighting projects in wildlife areas carefully, taking into account the specific needs and concerns of the local community and the potential impacts on the natural environment. Additionally, using energy-efficient and dark-sky-friendly lighting solutions can help mitigate potential adverse effects on wildlife and ecosystems.

1.9.1.5 Other unforeseen Expeditures like computer, printer and etc.

1.9.1	Activities	Unit Cost	Quantity	Unit	Total Cost of interventi on
1.9.1.1	Concrete bonding in hilly area	8881	600	Ha	5328600
1.9.1.2	Wire mesh fences can be constructed using various types of wire and materials, including different types of stone, to create aesthetically pleasing and durable boundary fences.	5364.28	1200	Ha	6437136
1.9.1.3	Incentives to VSS for the promotion of Alternate Livelihood Activities around the areas 5 Nos of VSS x 20000 each x for 5year	100000	5	Villages	500000
1.9.1.4	Solar Lights (min 30 W)	50000	12	Numbers	600000
1.9.1.5	Other unforeseen Expeditures like computer, printer and etc.	100000	5	Years	500000
	Total				**13365736**

ANGUL DIVISION

Para	Activities	Unit Cost	Quantity	Unit	Total Cost of intervention	Calendar of Operation				
1.9.1						1st Year	2nd Year	3rd Year	4th Year	5th Year
1.9.1.1	Concrete bonding in hilly area	8881	600	Ha	5328600	1065720	1065720	1065720	1065720	1065720
1.9.1.2	Wire mesh fences can be constructed using various types of wire and materials, including different types of stone, to create aesthetically pleasing and durable boundary fences.	5364.28	1200	Ha	6437136	1287427	1287427	1287427	1287427	1287427
1.9.1.3	Incentives to VSS for the promotion of Alternate Livelihood Activities around the areas 5 Nos of VSS x 20000 each x for 5year	100000	5	Villages	500000	100000	100000	100000	100000	100000
1.9.1.4	Solar Lights (min 30 W)	50000	12	Numbers	600000	200000	100000	100000	100000	100000
1.9.1.5	Other unforeseen Expeditures like computer, printer and etc.	100000	5	Years	500000	100000	100000	100000	100000	100000
				Total	**13365736**	**2753147**	**2653147**	**2653147**	**2653147**	**2653147**
				Add. 20% escalation cost Rs.	**26,73,147**					
				Grand Total Rs.	**1,60,38,883 or say Rs. 1,60,40,000/-**					

Rs. 1,60,40,000/- (Rupees One crore sixty lakh forty thousand) only.

Divisional Forest Officer
Angul Division

Divisional Forest Officer
Angul, Division

13.X.2023

Asst. Engineer,
Angul Investigation Sub-Division

Angul Inv Sub-Division
Angul

13.10.23

Asst. Executive Engineer
Angul Investigation Sub-Division

Angul Inv. Sub-Div.
Angul.

13/X/2023

Superintending Engineer,
Angul Investigation Division

Superintending Engineer
Angul Investigation Division
Angul

SATKOSIA WILDLIFE DIVISION, ANGUL

Para	Activities	Unit Cost	Quantity	Unit	Total Cost of intervention	Calendar of Operation				
1.9.1						1st Year	2nd Year	3rd Year	4th Year	5th Year
1.9.1.1	Concrete bonding in hilly area	8881	600	Ha	5328600	1065720	1065720	1065720	1065720	1065720
1.9.1.2	Wire mesh fences can be constructed using various types of wire and materials, including different types of stone, to create aesthetically pleasing and durable boundary fences.	5364.28	1200	Ha	6437136	1287427	1287427	1287427	1287427	1287427
1.9.1.3	Incentives to VSS for the promotion of Alternate Livelihood Activities around the areas 5 Nos of VSS x 20000 each x for 5year	100000	5	Villages	500000	100000	100000	100000	100000	100000
1.9.1.4	Solar Lights (min 30 W)	50000	12	Numbers	600000	200000	100000	100000	100000	100000
1.9.1.5	Other unforeseen Expeditures like computer, printer and etc.	100000	5	Years	500000	100000	100000	100000	100000	100000
				Total	**13365736**	**2753147**	**2653147**	**2653147**	**2653147**	**2653147**
				Add. 20% escalation cost Rs.	**26,73,147**					
				Grand Total Rs.	**1,60,38,883 or say Rs. 1,60,40,000/-**					

Rs. 1,60,40,000/- (Rupees One crore sixty lakh forty thousand) only.

13.10.23

Divisional Forest Officer
Satkosia Wildlife Division, Angul

Satkosia Wildlife Division, Angul

13·X·2023

Asst. Engineer,
Angul Investigation Sub-Division

Asst. Engineer
Angul Inv. Sub-Division
Angul

13.10.23

Asst. Executive Engineer
Angul Investigation Sub Division

Asst. Ex. Engineer
Angul Investigation Sub Division
Angul.

13/X/2023

Superintending Engineer,
Angul Investigation Division

Superintending Engineer
Angul Investigation Division
Angul

ABSTRACT

Name of the Division	Amount
Angul Division	1,60,40,000
Satkosia WL, Division, Angul	1,60,40,000
Total Amount	**3,20,80,000**

Rs. 3,20,80,000/- (Rupees Three Crore twenty lakh eighty thousand) Only

Divisional Forest Officer
Satkosia Wildlife Division, Angul

Divisional Forest Officer
Angul Division

Asst. Engineer
Angul Investigation Sub-Division

Asst. Executive Engineer
Angul Investigation Sub-Division

Superintending Engineer,
Angul Investigation Division

GOVERNMENT OF ODISHA

DEPARTMENT OF WATER RESOURCES

ODISHA, BHUBANESWAR

Name of the work –Estimate for Concrete Bonding at Hilly Slope of Catchment Area of H.I.P.

Estimated Cost – Rs. 8,881.00 (Per Running Meter)

Superintending Engineer
Angul Investigation Division
Angul.

ESTIMATE FOR CONCRETE BONDING
AT HILLY SLOPE OF CATCHMENT AREA OF H.I.P.

1 Earth work in excavation of foundation in stoney earth & gravelled mixed with stone bolders etc.

	1	x	3	'-	0 "	x	3 '-	0 "	x	4 '-	0 "	=	36.00	cft.	
											Net	=	**36.00**	**Cft**	
												Or	**1.02**	**cum.**	
											@ Rs.		**206.80**	**/cum.**	**210.69**

2 Supplying, filling foundation and plinth with sand in well watered and rammed including all cost etc.complete with sand

	1	x	3	'-	0 "	x	3 '-	0 "	x	0 '-	8 "	=	6.00	cft.	
											Net	=	**6.00**	**Cft**	
													0.17	**Cum**	
											@ Rs.		**932.70**	**/ cum.**	**158.37**

3 Cement concrete (1:3:6) in foundation using 4 cm size h.g.c.b. metal etc. complete.

	1	x	3	'-	0 "	x	3 '-	0 "	x	1 '-	0 "	=	9.00	cft.	
											Net	=	**9.00**	**Cft**	
												Or	**0.25**	**cum.**	
											@ Rs.		**5808.50**	**/ cum.**	**1,452.13**

4 C.C. (1:2:4) using 12mm size black hard granite chips.

0.50	x	3	'-	0 "	x (	2 '-	0 "	+	1) '-	x	5 '-	0"	=	22.50	cft.
														22.50	**cft.**
												Or		**0.64**	**cum**
											@ Rs.			**7202.80**	**/ cum.**	**4609.79**

5 Centering & Shuttering

	1	x	3	'-	0 "	x	5 '-	7 "				=	16.75	Sft	
	1	x	3	'-	0 "	x	5 '-	6 "				=	16.50	Sft	
	2	x	1	'-	6 "	x	5 '-	0 "				=	15.00	Sft	
													48.25	Sft	
												Or	**4.48**	**Sqm**	
											@ Rs.		**233.90**	**/ Sqm.**	**1048.44**

6 Supplying, filling foundation and plinth with excavated earth

Qnty	1/3 of item no 1 =		1	/	3								**0.34**	**Cum**	
												@	**137.87**	**/Cum**	**46.88**
															7526.29
														Says	**7,526.00**
														TOTAL	**7,526.00**
	Add GST 18 %														1,354.68
															8,880.68
														Grand Total	**8,880.68**
														Says.	**8,881.00**

(Rupees Eight Thousand Eight Hundred Eighty One) Only

Assistant Engineer

10.10.23
Asst. Ex. Engineer

10/10/2023

ANALYSIS OF RATES

1 Earth work in excavation of foundation in stoney earth & gravelled mixed with stone bolders etc.

Data for 100 Cum

Sl No	Materials	Quantity	Rate	Unit	Amount		
1	Mulia	43	345.00	Each	14835.00		
	Over head Charges	7.5%			1112.63		
	Contractor's Profit	7.5%			1112.63		
					17060.26		138.46
	Add for excavation	20%			3412.05		1.38
					20472.31		139.84
	Add Cess towards laboure welfare		@	1%	204.72		
					20677.03		
					20677.00	*Per 100 Cum*	
				Say	***206.80***	*Per Cum*	

2 Filling foundation and plinth with **sand** well watered and rammed.

Data for 100 Cum

Sl No	Descriptions	Quantity	Rate	Unit	Amount	
1	Female Mulia	12.36	345.00	Each	4264.20	
2	Sand	100	71.94	Cum	7194.00	
		Over head Charges		7.5%	859.37	
		Contractor's Profit		7.5%	859.37	
					13176.93	
		Rate per 1 Cum			131.77	
	Caraiage of Materials					
1	Sand	1.00	791.70	Cum	791.70	
					923.47	
	Add Cess towards laboure welfare		@	1%	9.23	
					932.70	
				Say	***932.70***	*Per One Cum*

3 Cement concrete **(1:3:6)** using 4cm size black hard granite metal.

Sl No	Descriptions	Quantity	Rate	Unit	Amount	
1	Metal c.b.h.g.40mm	0.96	995.25	Cum	955.44	
2	Sand	0.48	76.88	Cum	36.90	
3	Cement	2.29	535.86	Qntl	1227.12	
4	Mason (2nd class)	0.18	435.00	Each	78.30	
5	Mulia	3.90	345.00	Each	1345.50	
		Over head Charges		7.5%	273.24	
		Contractor's Profit		7.5%	273.24	
					4189.75	
	Add extra cost towards lead & Royality					
1-	Metal c.b.h.g.40mm	0.96	1171.27	*Cum*	1124.42	
2-	Sand	0.48	791.70	*Cum*	380.02	
3-	Cement	2.29	24.79	*Qntl*	56.77	
					5750.95	
	Add Cess towards laboure welfare		@	1%	57.51	
					5808.46	
				Say	***5808.50***	*Per One Cum*

4 C.C. **(1:2:4)** using 12mm size black hard granite chips.

Basic Rate

Sl No	Descriptions	Quantity	Rate	Unit	Amount	
1	Chips 12mm	0.90	1396.62	Cum	1256.96	
2	Sand	0.45	76.88	Cum	34.60	

3	Cement	3.23	535.86	Qntl	1730.83		
4	Mason (2nd class)	0.68	435.00	Each	295.80	*295.80*	
5	Mulia	4.60	345.00	Each	1587.00	*1587.00*	
		Over head Charges		7.5%	367.89	*141.21*	
		Contractor's Profit		7.5%	367.89	*141.21*	
					5640.97	***2165.22***	
				Say	***5641.00***	*Per One Cum*	
	Add extra cost of lead & royalty of materials						
1	Chips	0.90	1171.27	Cum	1054.14		
2	Sand	0.45	791.70	Cum	356.27		
3	Cement	3.230	24.79	Qntl	80.07		
					7131.48		
	Add Cess towards laboure welfare		@	1%	71.31		
					7202.79		
				Say	**7202.80**	*Per One Cum*	

5 Centering & Shuttering

Raft foundation, Column base and Plinth bend

Sl No	Descriptions	Quantity	Rate	Unit	Amount		
	Data for 10 Sqm						
1	25mm thick plank	0.267	58374.79	Cum	15586.07		
2	Non sal bullah 80mm dia	12.60	30.81	Mtr.	388.21		
3	Carriage of wood	0.3284	198.30	Cum	65.12		
	For 10 times				**16039.40**		
	For One time	16039.40 / 10		=	1603.94		
	Labour						
1	S.S. Mulia	0.50	385.00	Each	192.50	192.50	
2	Carpenter 2nd class	0.50	435.00	Each	217.50	217.50	
		Over head Charges		7.5%	151.05	30.75	
		Contractor Profit		7.5%	151.05	30.75	
					2316.03	*471.50*	
	For 1 Sqm.	2316.03 / 10		=	231.60		
	Add Cess towards labour welfare		@	1%	2.32		
					233.92		
				Say	***233.90***	*per Sqm*	

6 Supplying, filling foundation and plinth with excavated earth

Qnty	2/3 of item no 1	=	206.80 x (2 / 3) =	137.87	*per Cum*

Asst. Engineer,
Angul Investigation Sub Division
Angul

Assistant Engineer
Angul Inv. Sub-Division
Angul

10.10.23

Asistant Executive Engineer,
Angul Investigation Sub-Division.
Angul

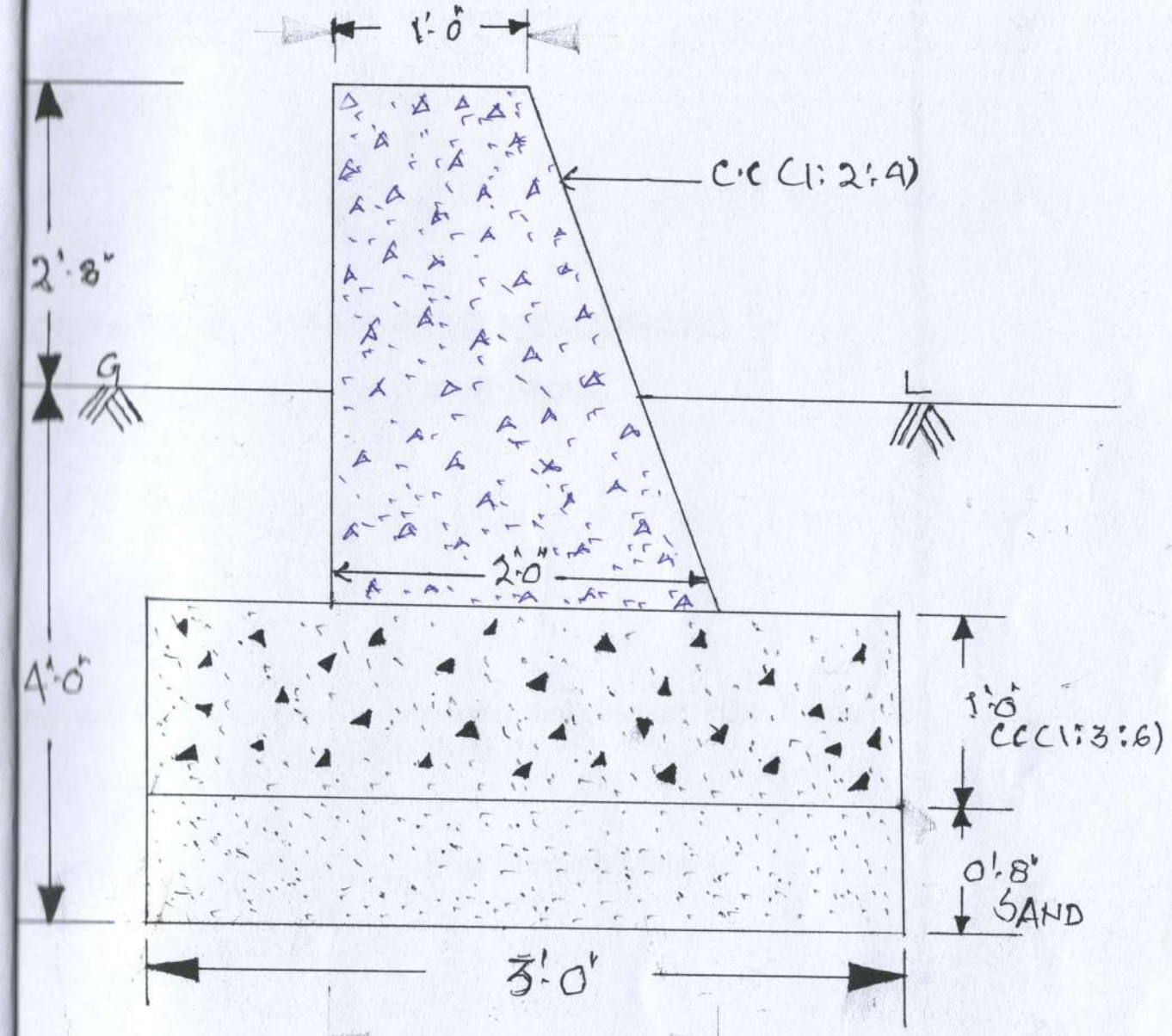
Asst. Ex. Engineer
Angul Inv. Sub-Divn
Angul.

10/X/2023

Superintending Engineer,
Angul Investigation Division
Angul

Superintending Engineer
Angul Investigation Division
Angul

DETAILS OF CONC BONDING (NOT TO SCALE)



Assistant Engineer
Angul Inv Sub-Division
Angul.

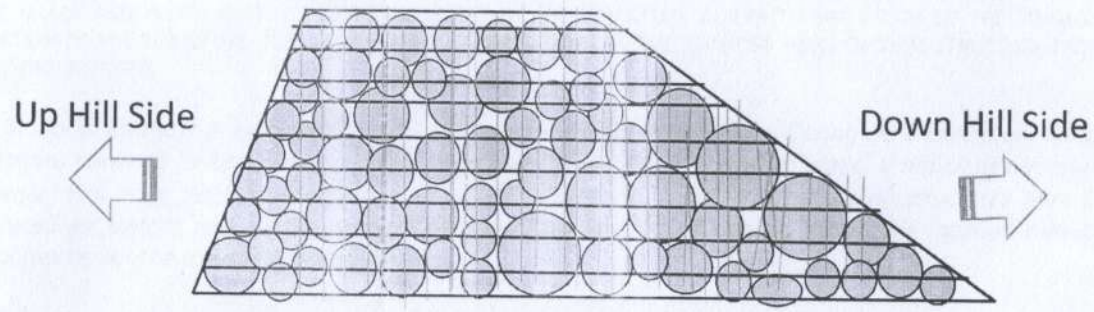
10.10.2023
Asst. Ex. Engineer
Angul Inv. Sub-Divn.
Angul.

10/10/2023
Superintending Engineer
Angul Investigation Division
Angul

3: Design of WLBCD

Design of Wire Mesh Loose Boulder Check Dam (WM LBCD)

Cross Section



Model Estimate of Wire Mesh LBCD

Providing & making Gabion structure with Mechanically Woven Double Twisted Hexagonal Shaped Wire mesh Gabion Boxes as per IS 16014:2012,MORTH Clause 2500, of required size, Mesh Type 10x12 (D=100 mm with tolerance of ± 2%) Zinc coated, Mesh wire diameter 3.0 mm, mechanically edged/selvedges with partitions at every 1m interval and shall have minimum 10 numbers of openings per meter of mesh perpendicular to twist, tying with lacing wire of diameter 2.2mm,supplied @3% by weight of Gabion boxes, filled with boulders with least dimension of 200 mm,

Details of Cost for: 2.00 Cum

SL No.	Description	Unit	Quantity	Rate (In Rs.)	Amount (In Rs.)
MATERIALS:					
1	Crates made of GI Mesh Type 10x12 (D=100 mm with tolerance of ± 2%) Zinc coated, Mesh wire diameter 3.0 mm) For size 2 m X 1m X 1m. Surface area is 11.00Sqm	Sqm	11	480.00	5280.00
	Stone boulder with least dimension 200 mm	Cum	2	880.00	1760.00
	Total (A)				**7040.00**
	LABOUR:				
	Mate	Day	0.1	392.00	39.2
	Mason Second class	Day	0.5	442.00	221
	Man Mulia	Day	1.5	352.00	528
	Total (B)				**788.2**
	Total (A+B)				**7828.2**
	Add OH Charges @ 7.5% on (A+B)				**587.115**
	Contractor Profit @ 7.5% on (A+B)				**587.115**
	Total:-				**9002.43**
	Add LC @ 1%				**90.0243**
	Total:-				**9,092.45**

	Cost for 2.00 Cum				**9,092.45**
	Cost for 1.00 Cum				4546.23
				(Or)	**4,546.00**
	Cost for 1.00 Cum with 18% GST				**5364.28**

NOTE: FOR LBCD AND WIREMESH LBCD THE **UPHILLSIDE SLOPE IS TAKEN AS 1:1** AND **DOWNHILLSIDE SLOPE TAKEN AS 1:3** FOR THE PURPOSE OF VOLUMETRIC CALCULATION. THE LENGTH OF THE STRUCTURE REFERES TO THE CROSSESCTION OF THE *NAALA* AND WIDTH OF THE STRUCTURE REFERS TO THE STRUCTURE REFERS TO THE WIDTH OF THE TOPMOST PORTION OF THE STRUCTURE. HEIGHT REFERES TO THE DISTANCE OF THE TOPMOST POINT OF THHE STRUCTURE FROM THE GROUND LEVEL.

***N. B**: Model Estimate prepared based on Local rate to work out the budget. During work Execution, actual estimate needs to be prepared for approval as per site condition in specific place. If deficit of approved budget may arise due to prevailing market and site-specific condition, the no of structures may be reduced, or budget may be adjusted as per the requirement. Geo-Coordinates of the location may be changed as per the site-specificcondition.*

13/10/2023
Assistant Engineer
Angul Inv Sub-Division
Angul

13.10.23
Asst. Ex. Engineer,
Angul Inv. Sub-Divn.
Angul.

13/10/2023
Superintending Engineer
Angul Investigation Division
Angul

Map showing Type of Soil Erosion and Soil Type of Hidsing Catchment Area

Annexure-I