GOVERNMENT OF ODISHA
DEPARTMENT OF WATER RESOURCES

CATCHMENT AREA TREATMENT (CAT)

FOR UPPER LANTH MEDIUM IRRIGATION PROJECT
UNDER BELPARA AND KHAPRAKHOL BLOCK
IN THE BOLANGIR DISTRICT, ODISHA

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1. Introduction:

The Catchment Area Treatment (CAT) of Upper Lanth Medium Irrigation Project targets overall improvement in the environmental conditions of the region. All the activities are aimed at treating the degraded and potential areas of severe soil erosion. The plan provides benefits due to biological and engineering measures.

This Plan would cover the following aspects:

- Identification of free draining catchment
- Assessment of Land Use, Soil, Slope in the Upper Lanth catchment based on Remote Sensing (RS)/Geographical Information System (GIS) and validation through field survey.
- Erosion levels the watershed and prioritization of watersheds will be done by appropriate methods.
- As per the requirement of Ministry of Environment & Forests and Climate Change,(MoEF & CC) Government of India, the treatment measures will be proposed for the area falling higher priority erosion categories. Both Engineering measures as well as Biological treatment measures will be proposed in the CAT plan.
- The cost of the administrative set up and mitigative measures will include recommendation from State Forest Department for all forest lands and from the Soil Conservation Department for non-forest land.

2. Need:

Reservoirs formed by dams on rivers are subject to sedimentation. The process of sedimentation embodies the sequential processes of erosion, entertainment, transportation, deposition and compaction of sediment. The study of erosion and sediment yield from catchments is of utmost importance as the deposition of sediment in reservoir reduces its capacity and thus affecting the water availability for the designated use. The eroded sediment from catchment when deposited on streambeds and banks causes threading of river reach. The removal of top fertile soil form catchment adversely affects the agricultural production. Thus a well-designed catchment area treatment plan is essential to ameliorate the above-mentioned adverse process of soil erosion.

The Catchment Area Treatment (CAT) plan highlights the management techniques to control erosion in the catchment area of a water resource project. The life span of a reservoir is

greatly reduced due to erosion in the catchment area. Adequate preventive measures are thus needed for the treatment of catchment for its stabilization against future erosion.

Quantifying soil erosion and reservoir sedimentation is necessary for prioritizing catchments for treatment and development of a suitable treatment mix. It is therefore, also required that the effect of various treatments on controlling soil erosion are quantitatively known. River gauging data are the best information source for undertaking the above activities. As such data are not available for this catchment, so estimation procedure is adopted. At the present level of data availability and also based on the past experience, Sedimentation (Slit) Yield Index (SYI) appears to be an acceptable parameter for use in catchment prioritization work.

SYI is calculated using an empirical formula. Based on the numerical value of SYI, catchments are categorised into five priority classes from very high (SYI>1300) priority to very low (SYI<1000) priority. The method was proposed by **All India Soil Survey and Land Use Planning (AISSLUP) currently known as Soil and Land Use Survey of India (SLUSI)** based on several studies. The method has been used to prioritize catchments in India totalling in area of millions of hectares. It is reported that, the SYI procedure is fairly reliable for determining priority watersheds. The empiricism in this method is manifest in the selection of unit area (mapping unit) and assigning an appropriate value of delivery ratio to it. SYI method is widely used because of the fact that it is easy to use and lesser data requirement. Moreover, it can applied to larger areas like sub watersheds etc.

3. Methodology Adopted:

Database on natural resources, terrain conditions, soil type of the catchment area is a pre-requisite to prepare CAT Plan. Various thematic maps were prepared and used in preparation of the CAT plan, in Geographic Information System (GIS) platform.

The methodology adopted for development of CAT plan for the project is as under:

- Catchment boundary delineation from Survey of India Topo sheets.
- Watershed boundary from watershed Atlas of India and website of Soil and Land Use Survey of India(SLUSI) and the micro watershed boundary collected from Watershed Mission of Odisha.
- Land Use/Land Cover map preparation from recent 5.8m resolution LISS-IV Multi Spectral Satellite Image.
- Contour digitization from Survey of India OSM topo sheet and generation of slope map.
- Soil Map preparation from National Bureau of Soil Survey and Land Use Planning (NBSS & LUP)

- Assigning weight age value of mapping units based on slope land use and soil texture and Delivery ratio based on distance from nearest stream.
- Estimation of Soil Loss using Silt Yield Index.
- Selection of locations of treatment and CAT plan.
- Cost Estimate

Thematic data integration and erosion index modelling was done using relevant map layers in GIS.

Silt Yield Index (SYI) of various micro watersheds within the free catchment was estimated. Watershed management approach were proposed for optimal use of soil and water resources within the catchment with the broad objective of

- Increasing infiltration into soil
- Control excessive run off
- Manage & utilize run off for useful purpose

4. Salient features of Upper Lanth Dam Catchments:

Lanth River is a tributary to Tel River which is a major river system of Odisha.The River originates in **Manguri Paharah** and enters Khaprakhol Block near village Bender and joins Tel on right about 119.851km downstream of Bolangir. The total length of the stream from the origin to confluence with Tel River is about 99.405 km. Upper Lanth Dam intercepts the river at RD 12 km.

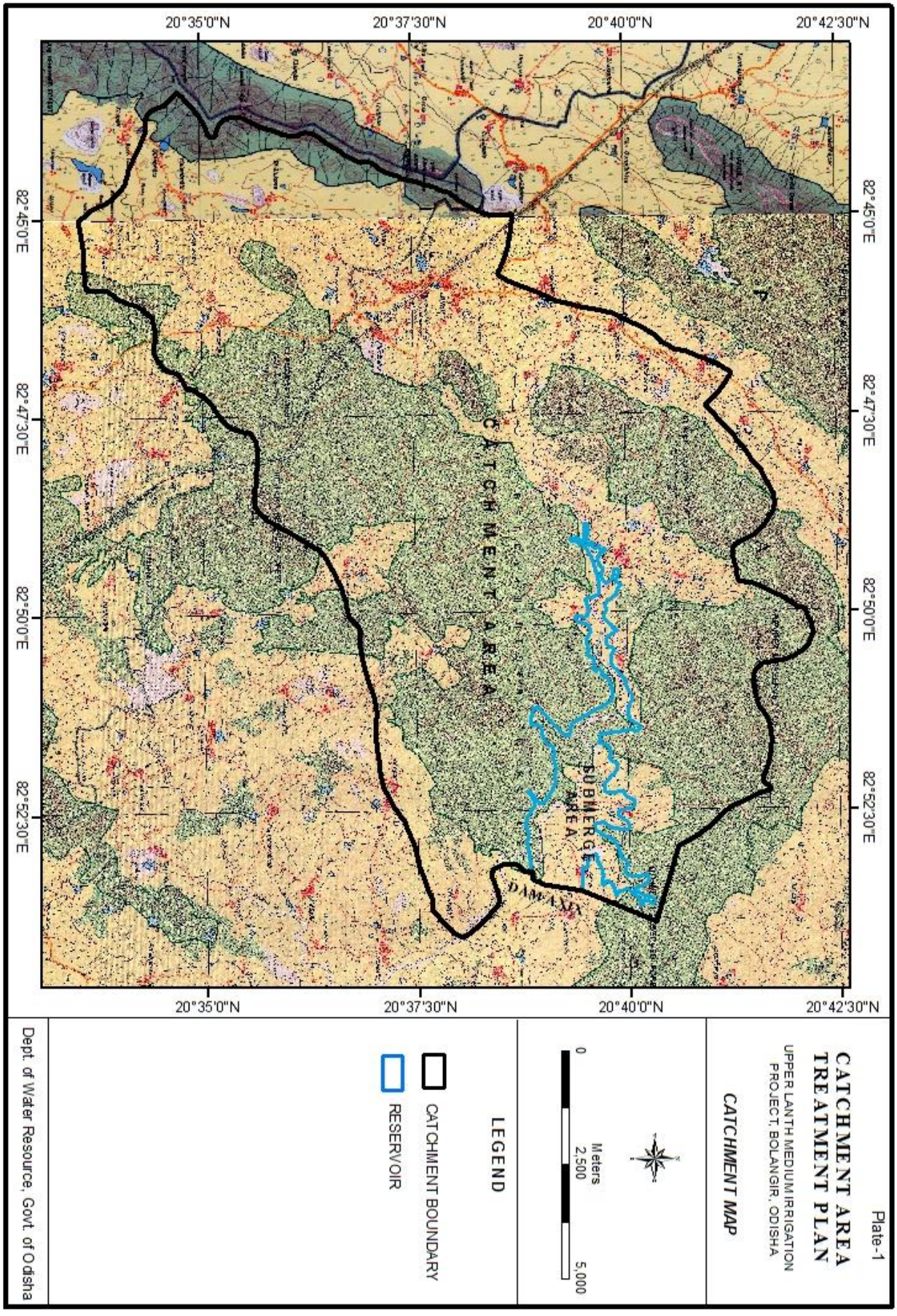
The total catchment area of the proposed project at dam site is 150.31 km^2 .The catchment map of Upper Lanth Dam project is enclosed at **Plate-I.**

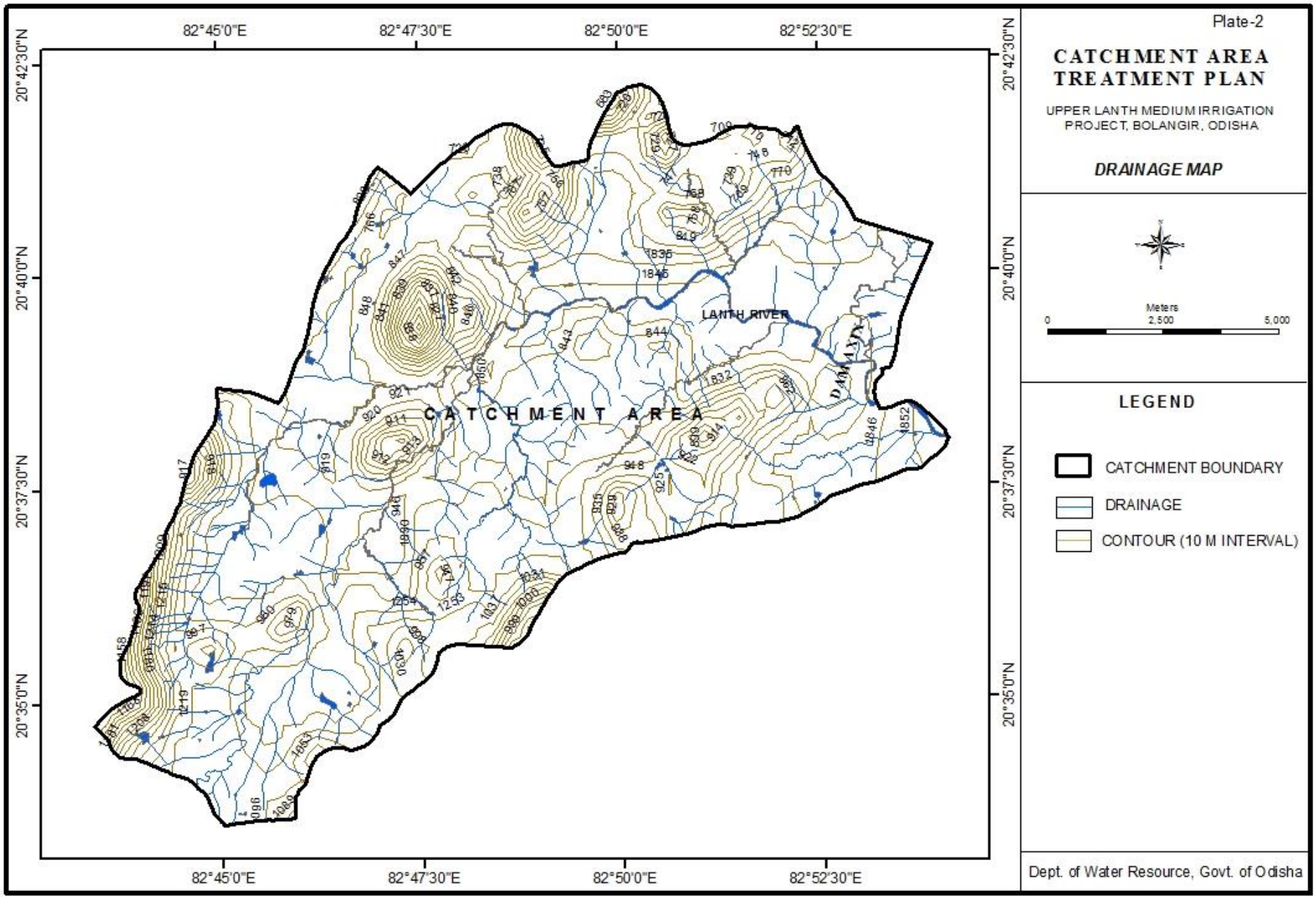
5. Thematic Map Generation

As mentioned in the methodology, various thematic layers like catchment, watershed, drainage, contour, slope, Land use, soil were prepared in Geographical Information System (GIS) platform using satellite image, OSM Sol Topo Sheet and other secondary source data. For Seamless integration of different thematic layers and interactive spatial analysis, the themes were generated UTM (Universal Transverse Mercator) projection system. 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 in WGS 1984 and Zone is UTM 44 North.

5.1. Catchment Map

The catchment boundary of Upper Lanth Dam was delineated from SOI Topo Sheets F44W14, looking at the contours and drainage. The contour and drainage map of the project is enclosed at **Plate-2**.

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20°42'30"N
20°40'0"N
20°37'30"N
20°35'0"N
LANTH RIVER
CATCHMENT AREA
DAM AXIS
Plate-2
CATCHMENT AREA TREATMENT PLAN
UPPER LANTH MEDIUM IRRIGATION PROJECT, BOLANGIR, ODISHA
DRAINAGE MAP
Meters
0
2,500
5,000
LEGEND
CATCHMENT BOUNDARY
DRAINAGE
CONTOUR (10 M INTERVAL)
Dept. of Water Resource, Govt. of Odisha

The entire catchments a part of the watershed 0407010605090201 (upper lanth dam) as per the watershed Atlas of India published by **SLUSI**. The total area of the watershed is 959.162 km². Since the catchment is very small, it was decided to prepare the CAT plan at Micro Watershed level instead of Watershed level. The Micro watersheds are prepared using the information available in Watershed Atlas of India, website of Land Use Survey of India (SLUSI) and the micro watershed boundary collected from watershed mission of Odisha. The micro watershed map is enclosed at **Plate-3**.

5.2. Slope Map

The Slope map was derived from contours shown on Sol topo sheet. After marking the catchment area, all the contours and spot heights shown on the topographical maps were mapped with 'Z' value (height above MSL in m). Since the area is mostly flat and contours are wide spaced, the spot heights collected in DGPS (differential GPS) during ground truthing of land use were also used as input.

A surface was created using the elevation values stored in the form of contours or points . A Digital Terrain Model (DTM) of the area was then prepared, which was used to derived a slope map. The slope was divided in classes of slope percentages. The areas falling under various standard slope categories have been tabulated in **Table-1** and the slope map is enclosed at **Plate-4.**

Table-: Area falling under different slope category

Slope category	Slope (%)	Area in km²	Area in %
Gently Slopping	0-15	70.10	46.64
Moderately Slopping	15-30	55.02	36.60
Strongly Slopping	30-45	7.55	5.02
Steeply Slopping	45-60	17.64	11.74
Total		**150.31**	**100**

5.3. Land Use/Land Cover Map

Land use map was prepared from recent 5.8m resolution LISS-IV Multi Spectral satellite image collected from National Data Centre of National Remote Sensing Centre (NRSC), Hyderabad. Details of Satellite Image are given bellow**.**

Satellite	:	RESOURCE SAT-2	Path	:	103
Sensor	:	LISS-IV MX (Multi Spectral)	Row	:	58
Date of pass	:	14th JAN 2016	Quadrant	:	B

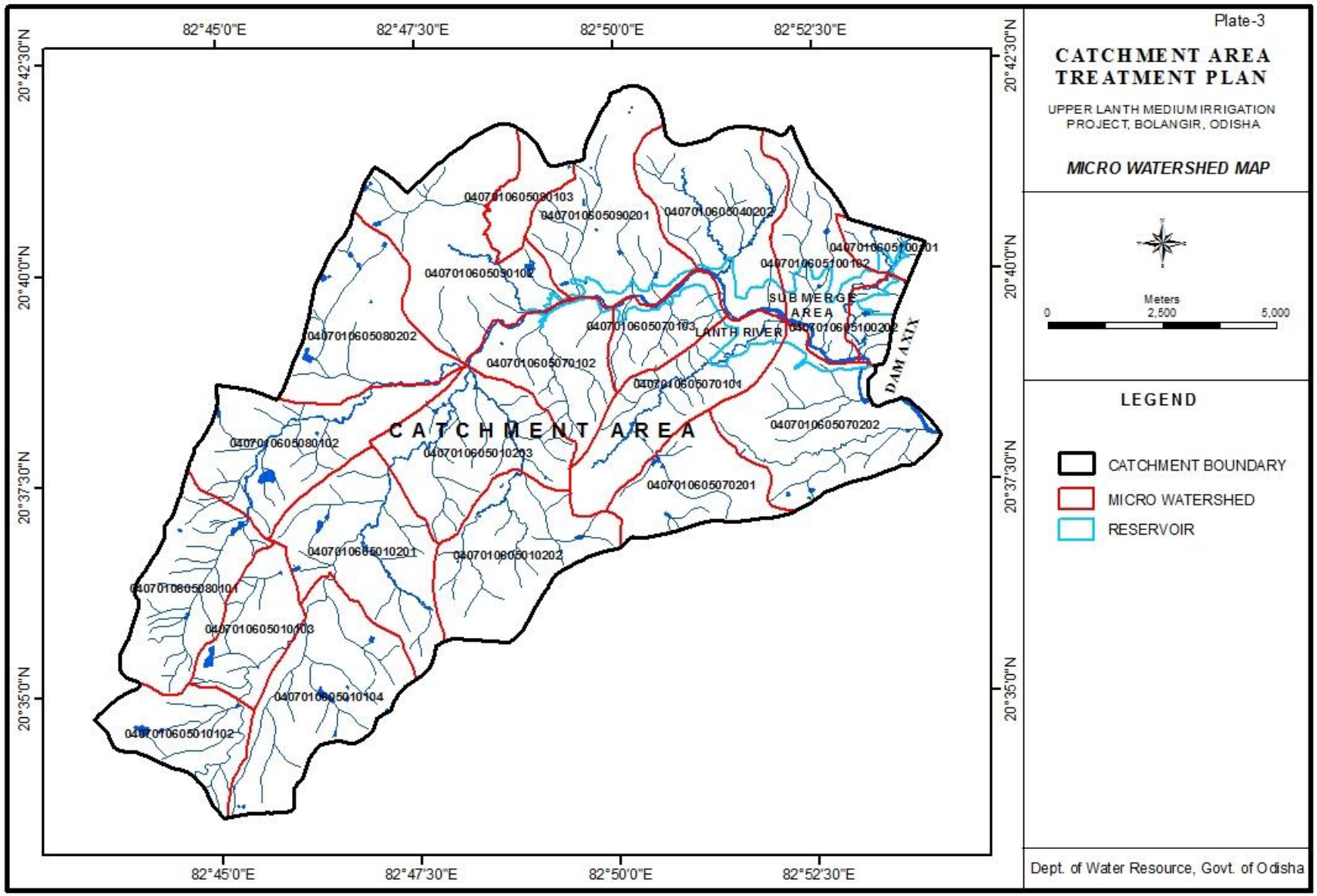
Plate-3
CATCHMENT AREA TREATMENT PLAN
UPPER LANTH MEDIUM IRRIGATION PROJECT, BOLANGIR, ODISHA
MICRO WATERSHED MAP
82°45'0"E
82°47'30"E
82°50'0"E
82°52'30"E
20°42'30"N
20°40'0"N
20°37'30"N
20°35'0"N
0407010605090103
0407010605090201
0407010605040202
0407010605100201
0407010605090102
0407010605100102
SUBMERGE AREA
0407010605070103
LANTH RIVER
0407010605100202
0407010605080202
0407010605070102
0407010605070101
DAM AXIX
CATCHMENT AREA
0407010605070202
0407010605080102
0407010605010203
0407010605070201
0407010605010201
0407010605010202
0407010605080101
0407010605010103
0407010605010104
0407010605010102
Meters
0
2,500
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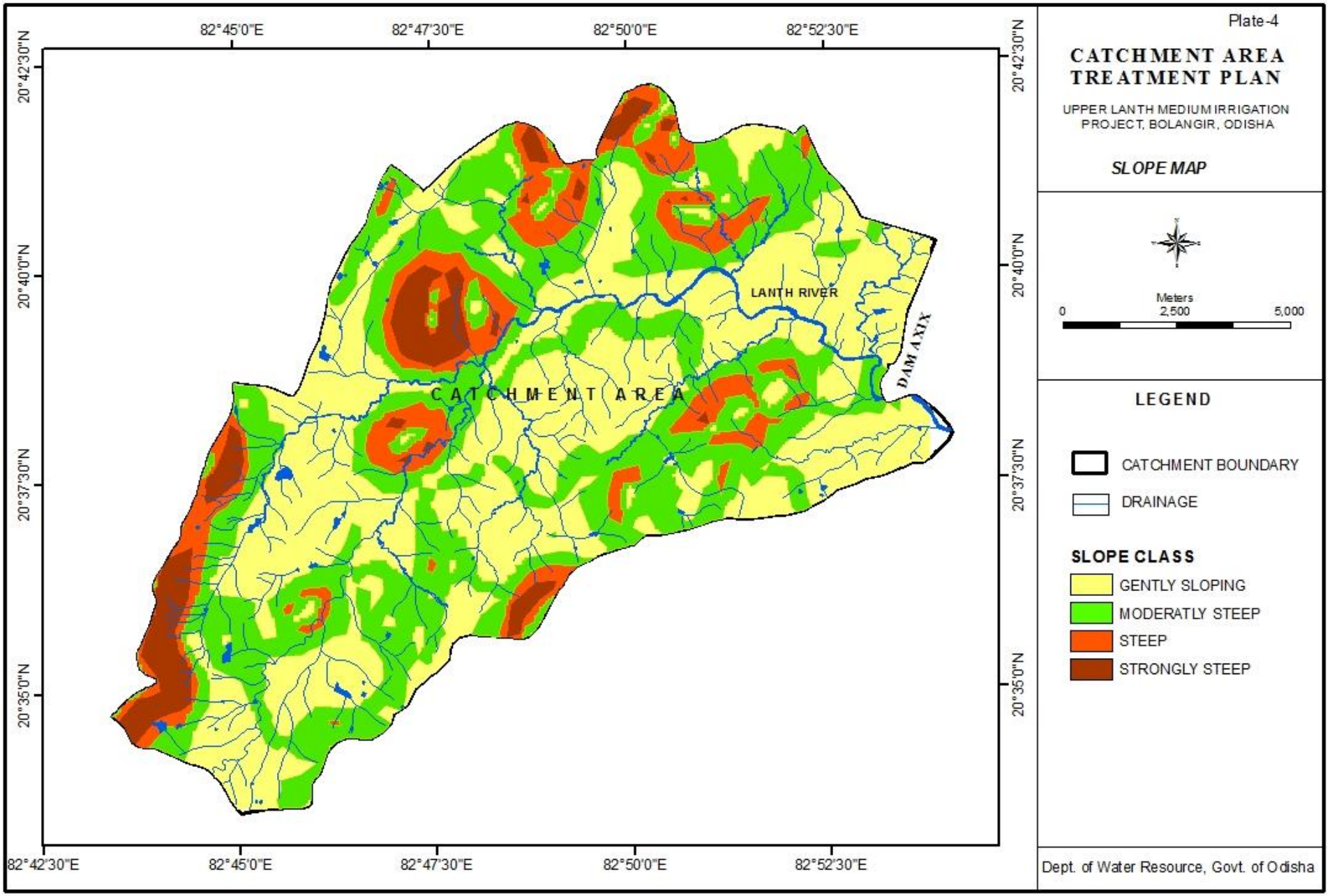
LEGEND
CATCHMENT BOUNDARY
MICRO WATERSHED
RESERVOIR
Dept. of Water Resource, Govt. of Odisha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20°42'30"N
20°40'0"N
20°37'30"N
20°35'0"N
LANTH RIVER
DAM AXIX
CATCHMENT AREA
Plate-4
CATCHMENT AREA TREATMENT PLAN
UPPER LANTH MEDIUM IRRIGATION PROJECT, BOLANGIR, ODISHA
SLOPE MAP
Meters
0
2,500
5,000
LEGEND
CATCHMENT BOUNDARY
DRAINAGE
SLOPE CLASS
GENTLY SLOPING
MODERATLY STEEP
STEEP
STRONGLY STEEP
Dept. of Water Resource, Govt. of Odisha

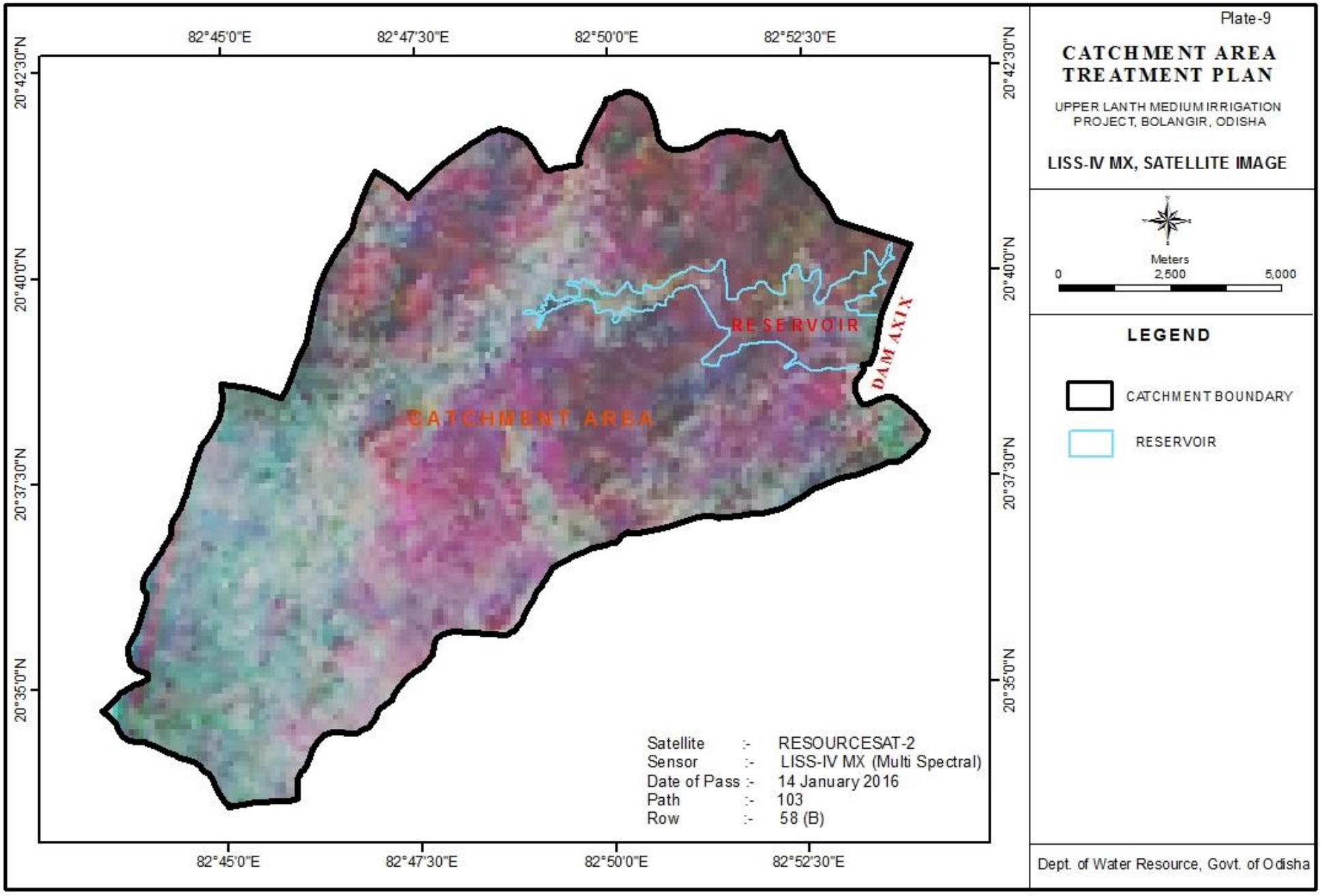
The image was geo-referenced using the common Ground Control Points (GCP) of Survey of India topographical sheets and satellite image with the help of feature registration techniques in standard image processing software. The satellite image map is enclosed at **Plate-5**. As the catchment area is very small, visual interpretation of the geo-referenced satellite data was done by qualified professionals using standard enhancement techniques followed by detail ground truthing to enhance the quality of image interpretation. The classified land use map of the catchment area is depicted in Table-2 and the map is enclosed at **Plate-6**.

Table-2: Area falling under different Land Use

Description	Area in Km^2	Area in %
Settlement	1.72	1.21
Road	0.16	0.11
Agriculture	55.06	36.54
Dense Forest	4.88	3.31
Open Forest	42.12	27.96
Scrub Forest	28.12	18.70
Tree cover area	3.06	2.10
Waste Land	12.72	8.44
Forest Plantation	0.09	0.06
Barren Rocky	1.32	0.87
Water body	1.06	0.70
Total	**150.31**	**100.00**

5.4. Soil map

Soil map was prepared by digitalizing the soil map collected from National Bureau of Soil Survey and Land Use Planning (NBSS & LUP) for Odisha and undivided Madhya Pradesh. The soil map is depicted at **Plate-7** and catchment area coming under different soil category is depicted in **Table-3**.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82°52'30"E
20°42'30"N
20°40'0"N
20°37'30"N
20°35'0"N
RESERVOIR
DAM AXIX
CATCHMENT AREA
Satellite :- RESOURCESAT-2
Sensor :- LISS-IV MX (Multi Spectral)
Date of Pass :- 14 January 2016
Path :- 103
Row :- 58 (B)
Plate-9
CATCHMENT AREA TREATMENT PLAN
UPPER LANTH MEDIUM IRRIGATION PROJECT, BOLANGIR, ODISHA
LISS-IV MX, SATELLITE IMAGE
Meters
0
2,500
5,000
LEGEND
CATCHMENT BOUNDARY
RESERVOIR
Dept. of Water Resource, Govt. of Odisha

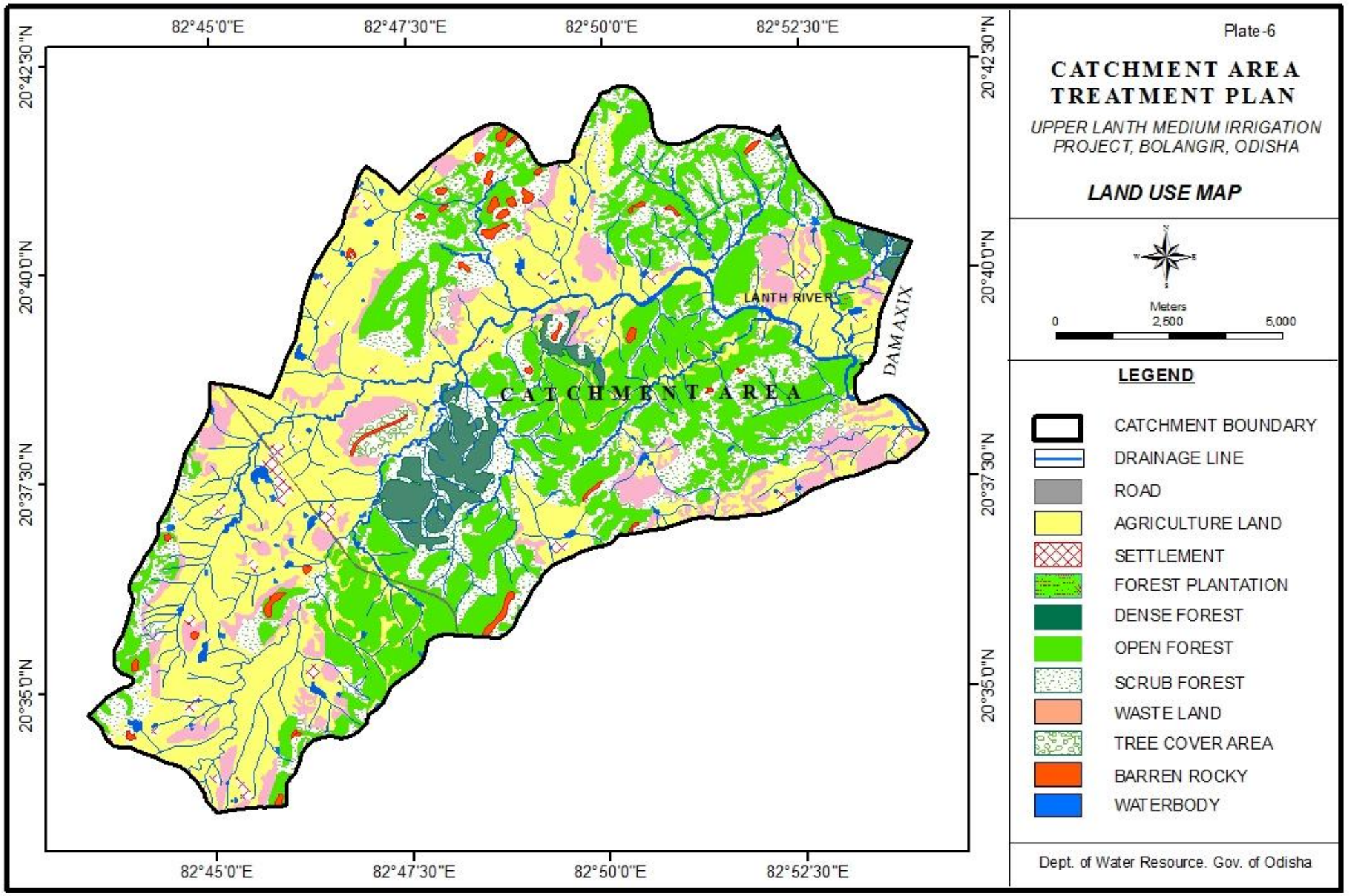
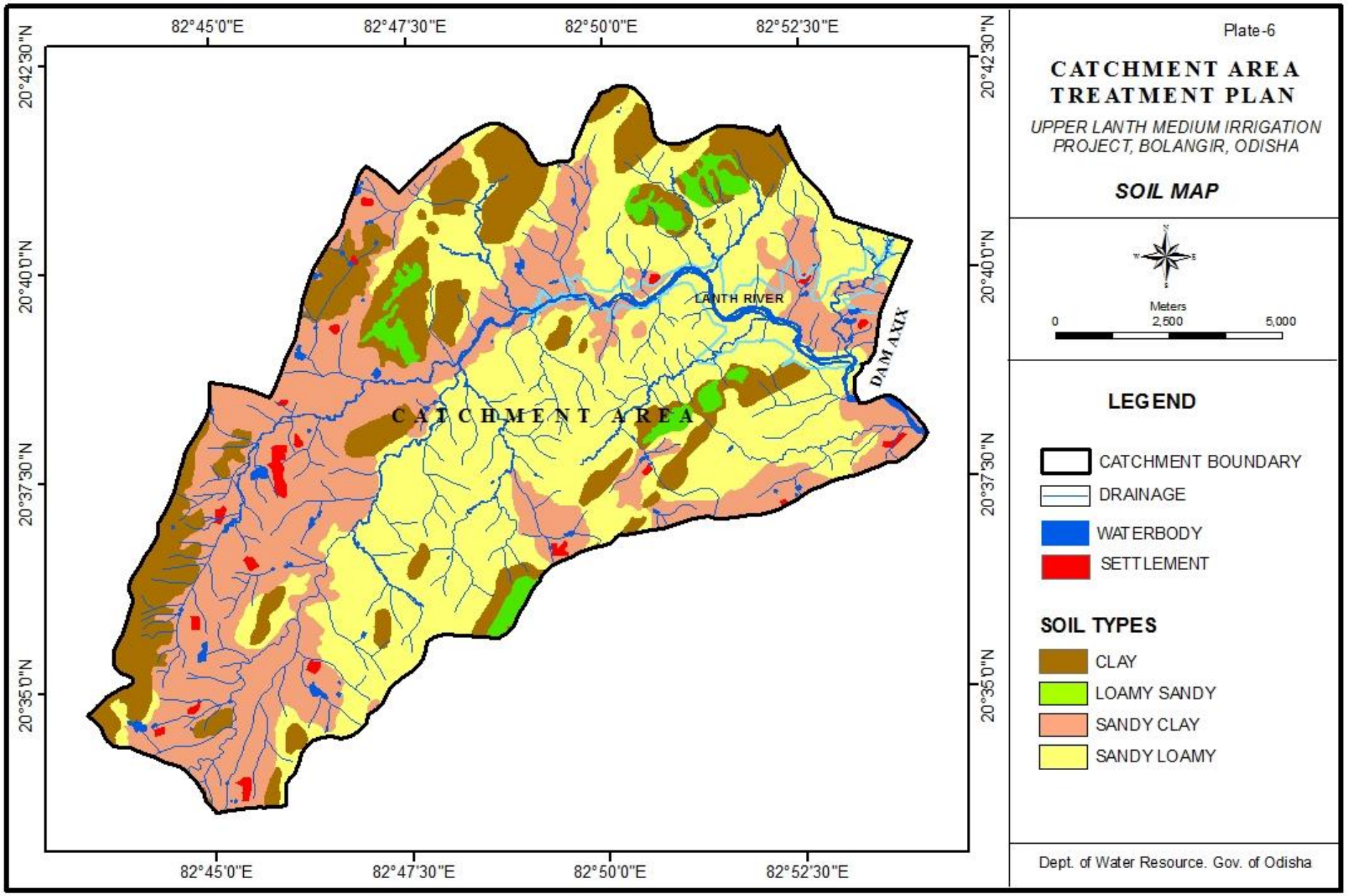


Plate-6
CATCHMENT AREA TREATMENT PLAN
UPPER LANTH MEDIUM IRRIGATION PROJECT, BOLANGIR, ODISHA
LAND USE MAP
82°45'0"E
82°47'30"E
82°50'0"E
82°52'30"E
20°42'30"N
20°40'0"N
20°37'30"N
20°35'0"N
LANTH RIVER
DAM AXIX
CATCHMENT AREA
Meters
0
2,500
5,000
LEGEND
CATCHMENT BOUNDARY
DRAINAGE LINE
ROAD
AGRICULTURE LAND
SETTLEMENT
FOREST PLANTATION
DENSE FOREST
OPEN FOREST
SCRUB FOREST
WASTE LAND
TREE COVER AREA
BARREN ROCKY
WATERBODY
Dept. of Water Resource. Gov. of Odisha


82°45'0"E
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20°42'30"N
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20°37'30"N
20°35'0"N
LANTH RIVER
DAM AXIS
CATCHMENT AREA
Plate-6
CATCHMENT AREA TREATMENT PLAN
UPPER LANTH MEDIUM IRRIGATION PROJECT, BOLANGIR, ODISHA
SOIL MAP
N
W
E
S
Meters
0
2,500
5,000
LEGEND
CATCHMENT BOUNDARY
DRAINAGE
WATERBODY
SETTLEMENT
SOIL TYPES
CLAY
LOAMY SANDY
SANDY CLAY
SANDY LOAMY
Dept. of Water Resource. Gov. of Odisha

Table-3: Area falling under different soil category

Land Capability Class	Land Category	Soil Depth	Slope Class	Soil Texture	Area in Km^2	Area in %
I	Agricultural Land	Deep	Nearly Level / Gently Slope	Clay	25.76	17.09
II	Agricultural Land	Deep	Moderate	Loamy Sandy	3.70	2.45
IV	Cultivable Land	Moderate to poor	Moderate	Sandy Clay	52.19	34.64
V	Cultivable Waste Land/ Fallow Land	Moderate to poor	Moderate Strong	Sandy Loamy	66.52	44.15
VI	Waste Land	Poor	Strongly Slope	Clay	25.76	17.09
VIII	Barren Rocky/Water Logged Area	Present in different Slope	Present in different Slope	Loamy Sandy	3.70	2.45
				TOTAL	**177.63**	**117.87**

6. Estimate of Soil Intensity Using Silt Yield Index (SYI) method

The sedimentation (silt) Yield Index Model (SYI), considering sedimentation as product of erosivity, erodibility and arial extent was conceptualized in the AISLUS , as early as 1969 and has been in operational use since then to meet the requirements of prioritization of smaller hydrologic units. The erosivity determinants are the climatic factors and soil and land attributes that have direct or reciprocal bearing on the unit of the detached soil material.

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

In SYI methodology, each Erosion Intensity Unit (EIU) is assigned a weightage value. When considered collectively, the weightage value represents approximately the relative comparative erosion intensity. The slope, soil and land use theme of the catchment were combined using union tool in GIS and EIU were formed using different combination of soil, slope and land use categories.

SYI was calculated using following empirical formula:

$$SYI = \frac{\sum (Ai \times Wi) \times Di \times 100}{Aw} \qquad [\text{Where } i = 1 \text{ to } n \text{ (n is the No. (EIU)}]$$

Ai= Area of i^{th} unit (EIU) Di = delivery Ratio of the i^{th} unit EIU

Wi = Weightage value of the i^{th} unit EIU Aw = Total area of Micro- Watershed

Weightage Value (W)

Weightage Value is a combination of two factors K and X. A basic Factor of K =10 was used in determining the weightage values. The value of 10 indicates a static condition of equilibrium between erosion and deposition. Any addition to the factor of K= (10+X) is suggestive of erosion in ascending order whereas subtraction, i.e. (10-X) is indicative of deposition possibilities.

Delivery Ratio (D)

Delivery ratios were assigned for each of the erosion intensity unit. The delivery ratio suggests the percentage of eroded material that finally finds entry into reservoir. Area of each EUI in each micro watershed was then estimated.

Delivery ratios were assigned to all erosion intensity units depending upon their distance from the nearest stream. The criteria adopted for assigning the delivery ratio are as follows:

Nearest stream	Delivery Ratio
0– 0.9	1.00
1.0-2.0	0.95
2.1-5.0	0.90
5.1-15.0	0.80
15.1-30.0	0.70

1.0km, 2.0 km, 5.0 km, 15.0 km and 30.0 km buffers were created around the main stream and reservoir using GIS .EIUs falling in different buffer zone were assigned the delivery ratio of the respective buffer zone.

Prioritization of Micro Watershed based on SYI findings.

The objective of the SYI method is to prioritize micro watershed in a catchment area for treatment. For prioritizing the micro watersheds, these are to be divided in to different categories based on their SYI. The SYI values for classification of various categories of erosion intensity rates are depicted below.

Priority categories	SYI Values
very high	>1300
high	1200-1299
medium	1100-1199
low	1000-1099
very low	<1000

The micro watershed wise SYI and category of erosion is depicted in **Table-4** and **Plate-8.**

Table-4: Soil Erosion Priority Category of Micro Watersheds

SL	MWS code	Priority	SYI
1	0407010605010102	MEDIUM	1193
2	0407010605010103	MEDIUM	1195
3	0407010605080101	MEDIUM	1191
4	0407010605080102	MEDIUM	1191
5	0407010605080202	MEDIUM	1190
6	0407010605090201	MEDIUM	1192
7	0407010605100202	MEDIUM	1197
8	0407010605010104	LOW	1083
9	0407010605010201	LOW	1082
10	0407010605090102	LOW	1085
11	0407010605090103	LOW	1079
12	0407010605010202	VERY LOW	981
13	0407010605010203	VERY LOW	979
14	0407010605040202	VERY LOW	981
15	0407010605070101	VERY LOW	981
16	0407010605070102	VERY LOW	980
17	0407010605070103	VERY LOW	979
18	0407010605070201	VERY LOW	980
19	0407010605070202	VERY LOW	981
20	0407010605100101	VERY LOW	980
21	0407010605100102	VERY LOW	980

Area under very high categories is proposed to be treated at the project proponent's cost. A base map showing land use, reserve forest boundary, slope, major drains and priority watershed is enclosed at Plate-9 for micro planning of the catchment area treatment plan as the steep areas are more prone to soil erosion, looking at the land use and topography **0407010605090201** micro watershed (area 959.162 Ha) was finally selected for catchment area treatment plan which is directly draining to the Lanth river .The topographic map, drainage and contour map and land use and slope map of the sub watershed is enclosed at **Plate-10, 11, and 12** respectively.

6.1. Demography of the watershed

Village	Total Population	Male	Female	SC	ST	Literate	Total Worker
Bender	**1220**	**613**	**607**	**128**	**353**	**198**	**477**
Bhaluchuan	**162**	**76**	**86**	**0**	**96**	**76**	**79**
Badimal	**254**	**126**	**128**	**67**	**136**	**142**	**123**
Bharuamunda	**2220**	**1095**	**1125**	**294**	**703**	**1150**	**1145**

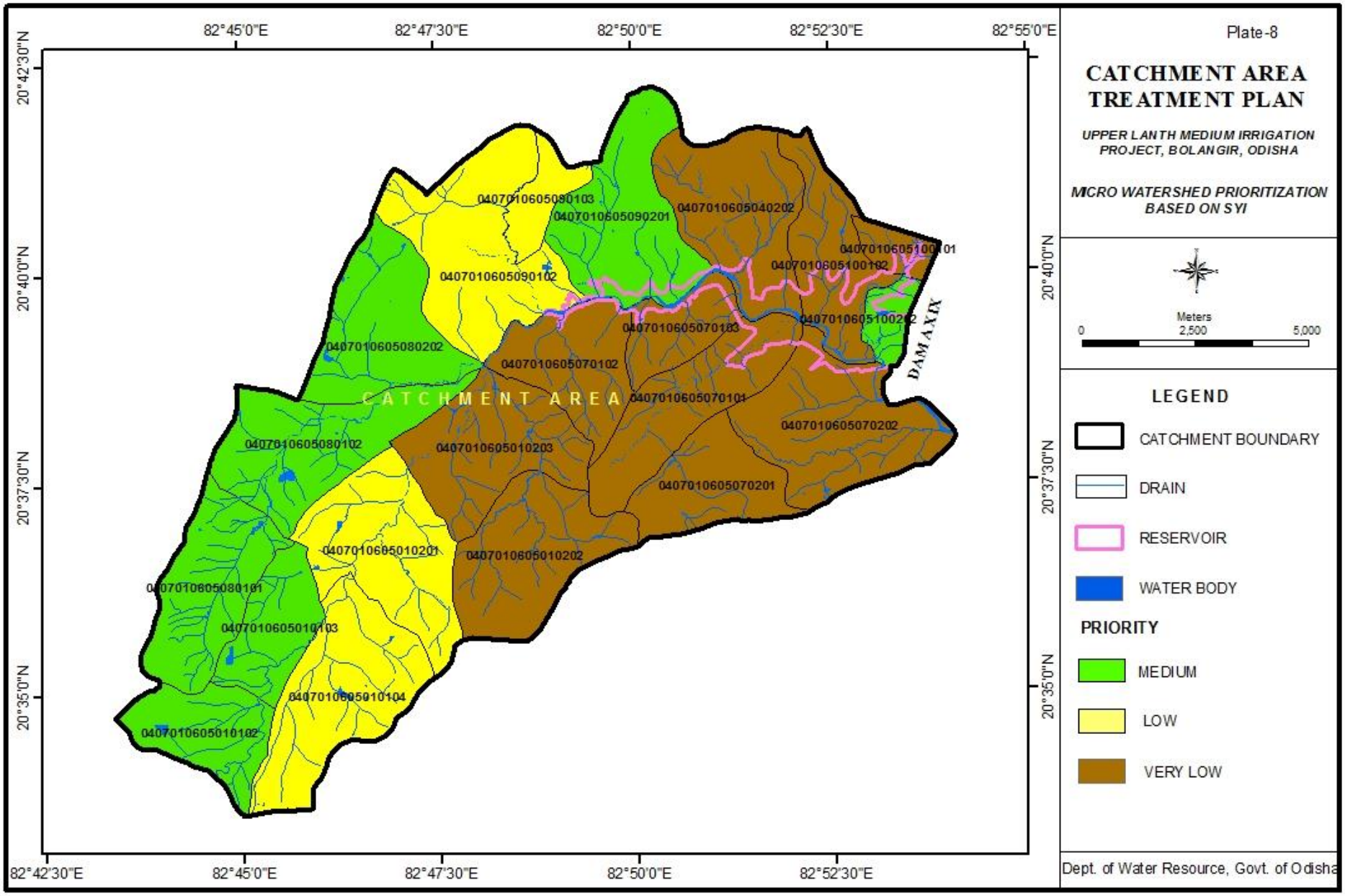
Plate-8
CATCHMENT AREA TREATMENT PLAN
UPPER LANTH MEDIUM IRRIGATION PROJECT, BOLANGIR, ODISHA
MICRO WATERSHED PRIORITIZATION BASED ON SYI
82°45'0"E
82°47'30"E
82°50'0"E
82°52'30"E
82°55'0"E
20°42'30"N
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82°42'30"E
0407010605080103
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0407010605100101
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0407010605070103
0407010605100202
0407010605080202
0407010605070102
DAM AXIS
CATCHMENT AREA
0407010605070101
0407010605080102
0407010605010203
0407010605070202
0407010605070201
0407010605010201
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0407010605080101
0407010605010103
0407010605910104
0407010605010102
Meters
0
2,500
5,000
LEGEND
CATCHMENT BOUNDARY
DRAIN
RESERVOIR
WATER BODY
PRIORITY
MEDIUM
LOW
VERY LOW
Dept. of Water Resource, Govt. of Odisha

The village map of the sub watershed is enclosed at **Plate-13**.The demography of the villages as per **Census 2011** is depicted below.

7. Catchment Area Treatment (CAT) Plan

Following Engineering and Biological measures are planned for the catchment area treatment depending upon the requirement and suitability.

a. Biological Measures
- Assisted Natural Regeneration
- Block Plantation /Afforestation
- Fodder land Development

b. Engineering measures
- Loose boulder wall-gully plugging in small hilly streams
- Stone masonry check dams – in major drains

As the majority of the area is agricultural land (36.54%) awareness campaign will be done for farm management (negative of burning farm residuals, adoption of proper cropping pattern etc), digging of farm pond, controlled grazing in graze land ,etc.

7.1. Assisted Natural Regeneration

Assisted Natural Regeneration is suggested in the 50.00 Ha of open forest available within the Reserve Forests. The sites to be treated are depicted in **Plate-14**. The detail estimate is depicted at **Annexure-1.**

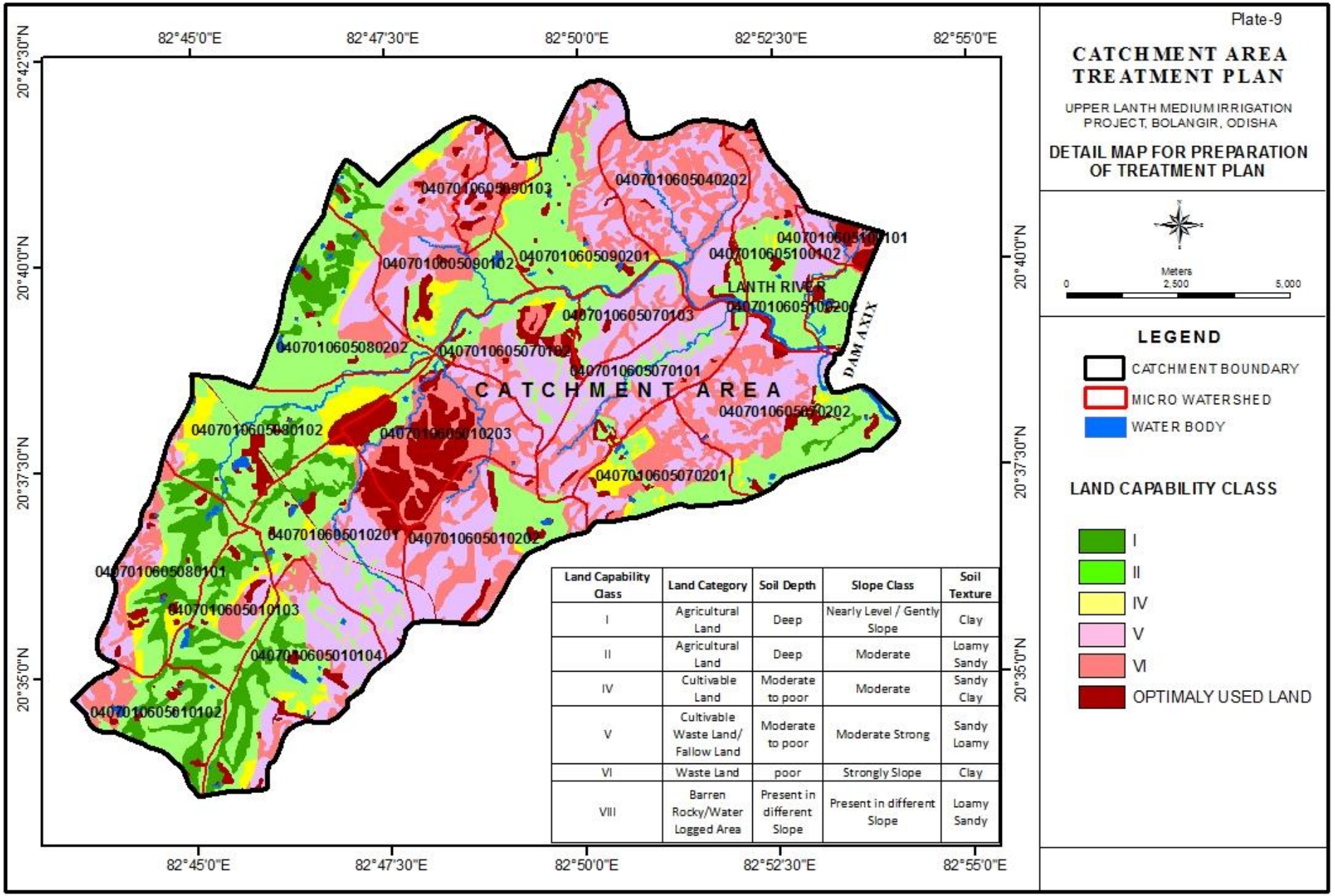
7.2 Block Plantation/ Afforestation-1A

The village wise revenue forest and govt. land is depicted in the table below.

All areas are in Ha.

SL	Name of the village	Govt.	Forest	Total
1.	Badimal	5.023	0	5.023
2.	Bender	7.124	15.812	22.936
3.	Bhaluchuan	1.983	16.002	17.985
4.	Bharuamunda	11.258	14.373	25.631
5.	Bender-I Reserve Forest For afforestation &Plantation	-	50.000	50.000
TOTAL		**25.388**	**96.187**	**121.575**

As **50** Ha of forest land is available in **Bender-I R.F** but there is no forest growth, it is proposed for block plantation of **20** Ha. and afforestation of **30** Ha. Now the total area proposed for block plantation will be 45.388 Ha(As 20 ha. from Bender-I R.F and 25.388 Ha. from Govt).Likewise the total forest area for afforestation will be 76.187 Ha.(96.187Ha.-20.000 Ha.) The detailed estimate is enclosed at **Annexure-2.**



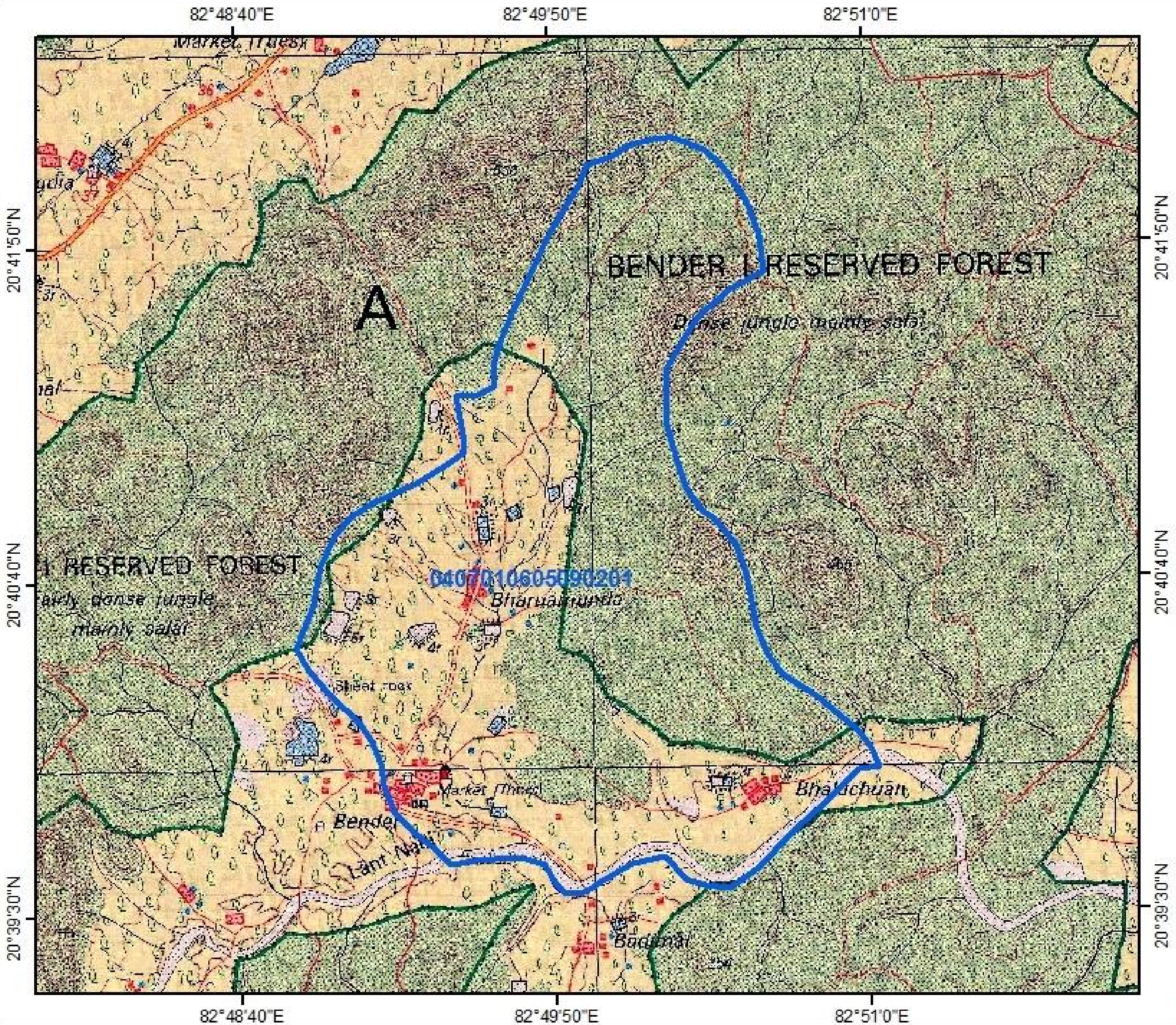
Land Capability Class	Land Category	Soil Depth	Slope Class	Soil Texture
I	Agricultural Land	Deep	Nearly Level / Gently Slope	Clay
II	Agricultural Land	Deep	Moderate	Loamy Sandy
IV	Cultivable Land	Moderate to poor	Moderate	Sandy Clay
V	Cultivable Waste Land/ Fallow Land	Moderate to poor	Moderate Strong	Sandy Loamy
VI	Waste Land	poor	Strongly Slope	Clay
VIII	Barren Rocky/Water Logged Area	Present in different Slope	Present in different Slope	Loamy Sandy

Plate-10

CATCHMENT AREA TREATMENT PLAN

UPPER LANTH MEDIUM IRRIGATION PROJECT, BOLANGIR, ODISHA

TOPOGRAPHIC MAP OF THE PRIORITY WATERSHED



Meters

0 350 700 1,400

LEGEND

PRIORITY WATERSHED BOUNDARY

Dept. of Water Resource, Govt. of Odisha

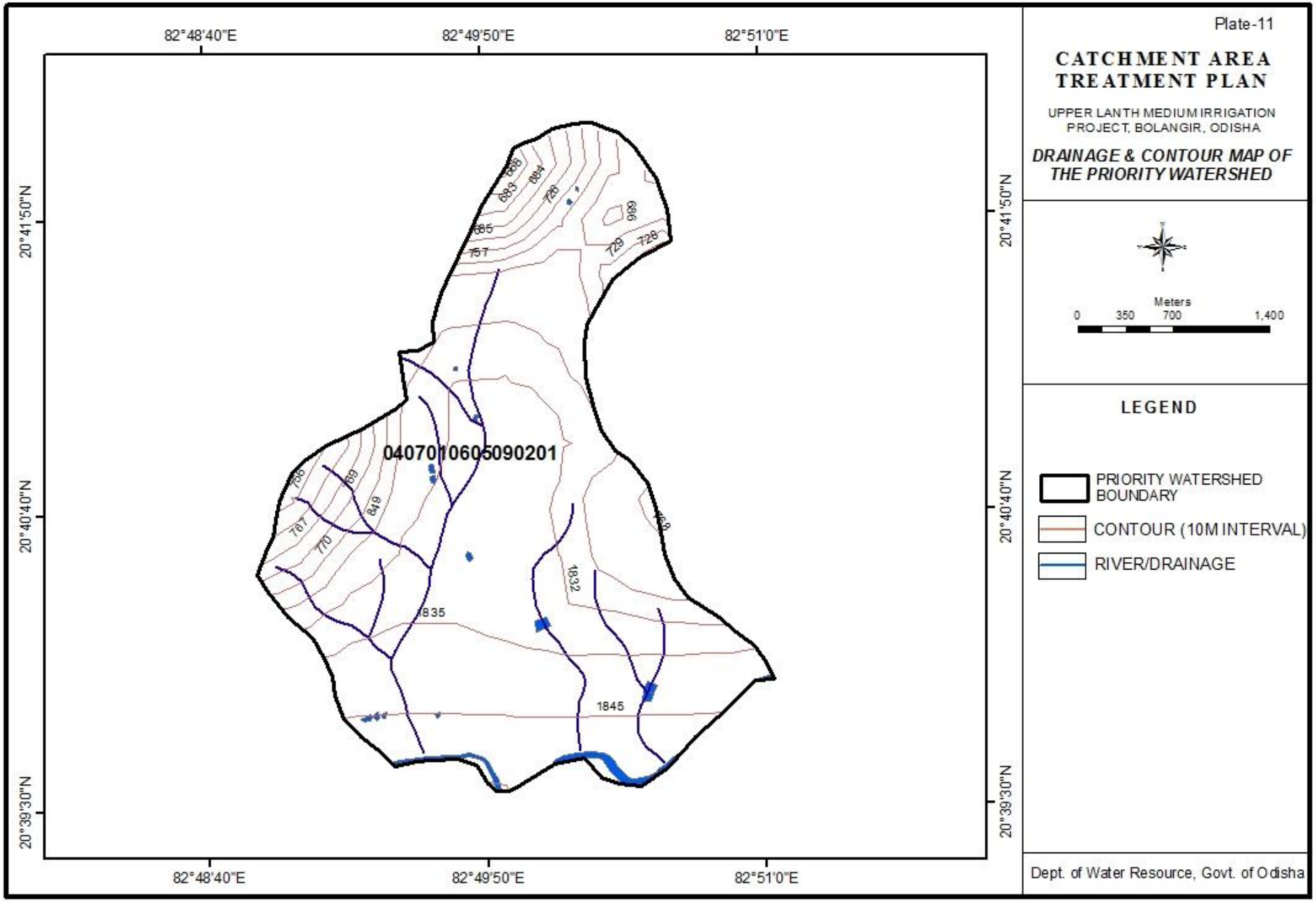


Plate-11
CATCHMENT AREA TREATMENT PLAN
UPPER LANTH MEDIUM IRRIGATION PROJECT, BOLANGIR, ODISHA
DRAINAGE & CONTOUR MAP OF THE PRIORITY WATERSHED
82°48'40"E
82°49'50"E
82°51'0"E
20°41'50"N
20°40'40"N
20°39'30"N
0407010605090201
Meters
0 350 700 1,400
LEGEND
PRIORITY WATERSHED BOUNDARY
CONTOUR (10M INTERVAL)
RIVER/DRAINAGE
Dept. of Water Resource, Govt. of Odisha

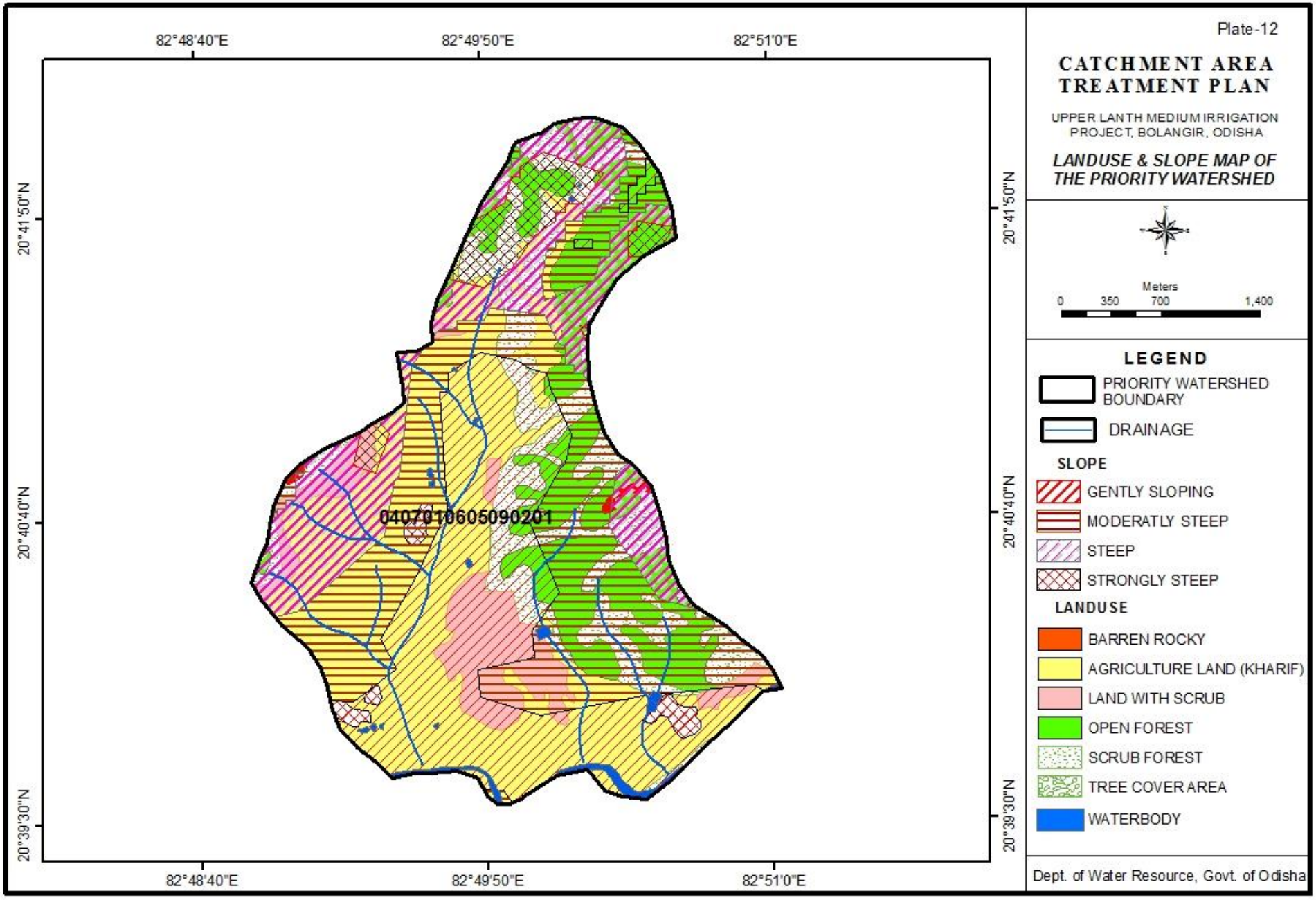
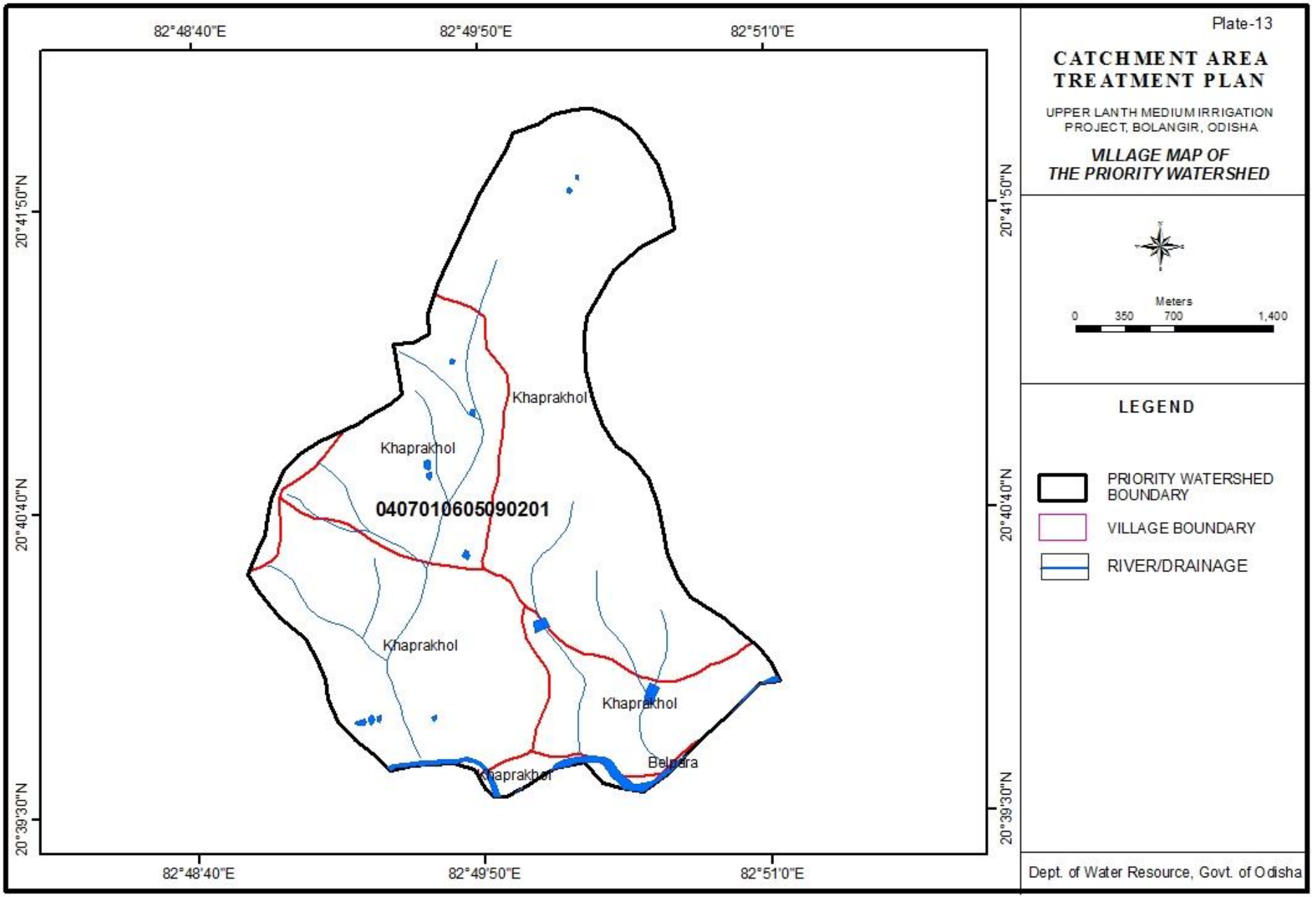
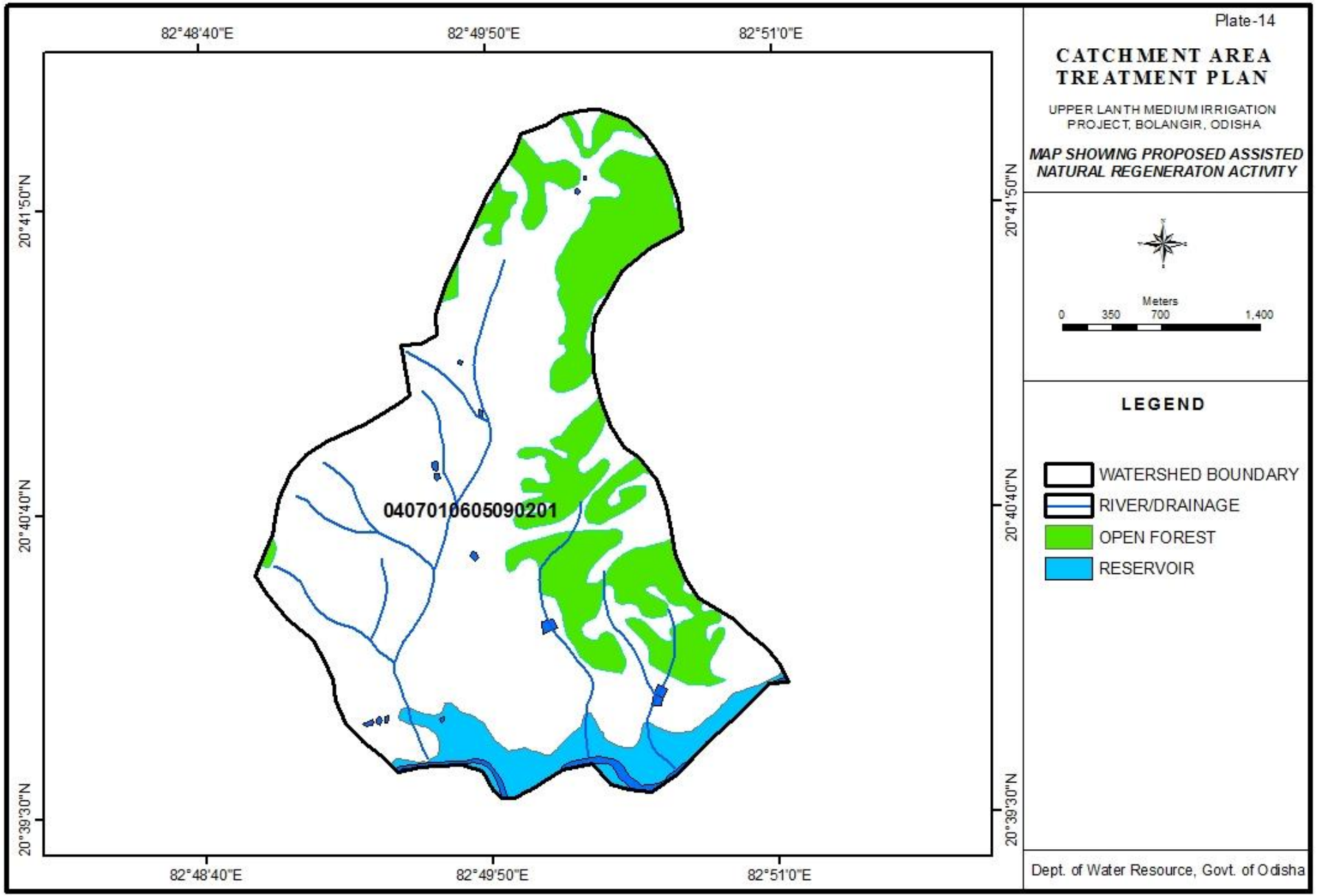


Plate-12
CATCHMENT AREA TREATMENT PLAN
UPPER LANTH MEDIUM IRRIGATION PROJECT, BOLANGIR, ODISHA
LANDUSE & SLOPE MAP OF THE PRIORITY WATERSHED
82°48'40"E
82°49'50"E
82°51'0"E
20°41'50"N
20°40'40"N
20°39'30"N
0407010605090201
Meters
0
350
700
1,400
LEGEND
PRIORITY WATERSHED BOUNDARY
DRAINAGE
SLOPE
GENTLY SLOPING
MODERATLY STEEP
STEEP
STRONGLY STEEP
LANDUSE
BARREN ROCKY
AGRICULTURE LAND (KHARIF)
LAND WITH SCRUB
OPEN FOREST
SCRUB FOREST
TREE COVER AREA
WATERBODY
Dept. of Water Resource, Govt. of Odisha


82°48'40"E
82°49'50"E
82°51'0"E
20°41'50"N
20°40'40"N
20°39'30"N
Khaprakhol
Khaprakhol
0407010605090201
Khaprakhol
Khaprakhol
Khaprakhol
Belpara
Plate-13
CATCHMENT AREA TREATMENT PLAN
UPPER LANTH MEDIUM IRRIGATION PROJECT, BOLANGIR, ODISHA
VILLAGE MAP OF THE PRIORITY WATERSHED
Meters
0
350
700
1,400
LEGEND
PRIORITY WATERSHED BOUNDARY
VILLAGE BOUNDARY
RIVER/DRAINAGE
Dept. of Water Resource, Govt. of Odisha


82°48'40"E
82°49'50"E
82°51'0"E
20°41'50"N
20°40'40"N
20°39'30"N
0407010605090201
Plate-14
CATCHMENT AREA TREATMENT PLAN
UPPER LANTH MEDIUM IRRIGATION PROJECT, BOLANGIR, ODISHA
MAP SHOWING PROPOSED ASSISTED NATURAL REGENERATON ACTIVITY
Meters
0 350 700 1,400
LEGEND
WATERSHED BOUNDARY
RIVER/DRAINAGE
OPEN FOREST
RESERVOIR
Dept. of Water Resource, Govt. of Odisha

7.3. Fodder land development

To minimize the pressure on forest for grazing, it is suggested to develop fodder land in the Watershed. **All areas are in Ha**

Sl No	Villages	No of Patches	Gochara	Population
1.	Badimal	0	0	254
2.	Bender	33	31.650	1220
3.	Bhaluchuan	23	17.639	162
4.	Bharuamunda	9	10.276	2220
			59.565	

Looking at the availability of Gochar land and population, it is proposed to develop 15 Ha. of Gochar land for fodder development in Badimal, Bender, Bhaluchuan, and Bharuamunda. The detail estimate is given at **Annexure-3.**

7.4 Loose Boulder Wall-gully plugging In Small Hilly Streams

Gully Erosion, including ephemeral gully erosion, refers to the cutting of narrow channels resulting from concentration of sheet and rill flow of runoff water. Ephemeral gullies are small channels of approximately 3 to 12 inches deep. Gullies may be one to several feet deep. Gully erosion occurs when rill erosion is neglected. The tiny grooves develop into wider and deeper channels, which may assume a huge size. This state is called 'gully' erosion. Gullies are the most widen with every heavy rainfall.

Gully plugging work is required for reduction of runoff velocities within permissible limits and for controlling gully erosion of micro-watershed.

Appropriate gully plugging work would be selected from bush/wood check dam, Pall-siding works, gabion, structure, sunken pits etc.

A provision is kept for three numbers of gully plugging in the hilly streams. Estimate at **Annexure-4.**

7.5 Stone masonry check dams – in major drains

Check dams range in size, shape and cost. It is possible to build them out of easily available materials and even at a very little cost. Decision of building such a dam depends on its location. Essentially a check dam has an earthen dam and masonry spillway.

It cuts the velocity and reduces erosive activity. The stored water improves soil moisture of the adjoining area and allows percolation to recharge the aquifers Spacing between the check dams should be such that water spread of one should be beyond the water spread of the other Height depends on the bank height, varies from 1 meter to 3 meter and length varies from less than 3m to 10 m. A provision of 4 no. Stone masonry checks dams.

The typical Estimate of earthen of earthen check dam with concrete core is depicted at **Annexure-5**

The location of proposals for all treatments other than ANR activities are depicted in **Plate-15.** The detail year wise cash flow estimate is depicted at **Annexure-6.**

Cost Estimate:

SL	Item	Rate in Rs.	Unit	Physical	Financial (Rs. In Lakhs)
Biological Measure					
1	Afforestation including maintenance	85,824	Ha	76 **(As per cl. no. 7.2)**	65.23
2	Enrichment of plantation / Re-densification	29,170	Ha	45 **(As per cl. no. 7.2)**	13.13
3	Fodder land development	1,50,500 **(As per Anx. no. 3)**	Ha	15	22.57
Engineering Measure					
4	Loose Boulder wall gully plugging	3318	No	03 **(As per cl. no. 7.4)**	0.10
5	Masonry stone Check Dam	2,14,650	No	04 **(As per cl. no. 7.4)**	8.59
	Total				109.62

Total cost of Biological, Engineering measure an site observation at site = Rs. 109.62 Lakhs

Micro Planning Cost @ 5% = Rs. 5.48 Lakhs

Sub Total = **Rs.** 115.10 **Lakhs**

Contingency cost @ 5% = Rs. 5.76 Lakhs

Sub Total = **Rs.** 120.86 **Lakhs**

Administrative Expenditure @ 12% = Rs . 14.50 Lakhs

Total = **Rs.** 135.36 **Lakhs**

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Annexure-1

COST NORM FOR AIDED NATURAL REGENERATION (ANR) @ 200 PLANTS PER HECTRE

WAGE RATE Rs.200/-PER DAY

SL NO	Items of work	Person days	Labour (Rs.)	Material (Rs.)	Total (Rs.)
1	2	3	4	5	6
	0th YEAR				
1	Survey, Demarcation & Pillar posting ,GPS reading with mapping	2	400	0	400
2	Site preparation	2	400	0	400
3	Silvicultural Operation including clearance of weed, climber cutting, high stump cutting, singling of shoots etc.	5	1000	0	1000
4	Nursery cost(6 months old seedling)part @ Rs.9.45/- seedling (Rs. 6.67 in 0th year + Rs.2.78 in 1st year) for 220 seedlings(200+20)	5.5	1100	367	1467
5	Contingency and Unforeseen Expenditures	0	0	133	133
TOTAL		**14.5**	**2900**	**500**	**3400**
	1st YEAR OPERATION				
1	Nursery cost(6 month old seedling)Balance @ Rs.2.78 for 220 seedlings	2.5	500	112	612
2	Pitting 30 cm cube size	6	1200	0	1200
3	Carriage & Planting including Casualty Replacement	5	1000	0	1000
4	Complete weeding, Soil working, Manuring	6	1200	0	1200
5	Cost of vermin compost@ 200gms/plant @Rs.20/-per Kg= Rs. 800.00 and Granular Insecticide 5 gms/Plant @ Rs.80/-per Kg=Rs.80.00	0	0	880	880
6	Cost of Chemical Fertilizer (a) Urea 70 gms/plant in two subsequent doses @Rs. 6/-per Kg= Rs.84.00 (b) NPK @ 50 gms/plant as basal dose @ Rs.24/kg =24 x 10 = Rs 240/-	0	0	324	324
7	Silvicultural Operation involving clearance of weeds, climber cutting, singling of shoots etc.	15	3000	0	3000
8	Soil Conservation Measures (Staggered Trenches of Dimension 2m× 0.5 m ×0.5 m @60 nos per ha)or its equivalent.	20	4000	0	4000
9	Fire line Tracing & Inspection Path	3	600	0	600
10	Watch & ward	7	1400	0	1400
11	Contingeency ad Unforeseen Exp.	0	0	304	304
TOTAL		**64.5**	**12900**	**1620**	**14520**

2nd YEAR MAINTENANCE					
1	Casualty Replacement including cost of seedling, carriage and planting	1	200	189	389
2	Completing weeding and cultural operations	2	400	0	400
3	Soil working and manuring	2	400	0	400
4	Cost of fertilizer and insecticide (a) Vermi compost 200 gms/plant @200 nos of plants/per Kg = 40 Kg @Rs.20.00= Rs.800.00 (b) Granular Insecticide 5 gms/plant for 200 plants 1000 gms @ Rs.80/-per Kg= Rs.80.80	0	0	880	880
5	Soil Conservation Measures(Renovation of staggered trenches etc.)	8	1600	0	1600
6	Fire line Tracking and Inspection Path	1	200	0	200
7	Watch &Ward(whole year)	7	1400	0	1400
8	Contingency and Unforeseen Expenditures	0	0	181	181
TOTAL		**21**	**4200**	**1250**	**5450**
3rd YEAR MAINTENANCE					
1	Complete weeding and Cultural operations	1	200	0	200
2	Soil working	1	200	0	200
3	Fire line Tracing and Inspection Path	1	200	0	200
4	Watch &Ward(whole year)	7	1400	0	1400
5	Contingency and Unforeseen Expenditures	0	0	200	200
TOTAL		**10**	**2000**	**200**	**2200**
4th YEAR MAINTENANCE					
1	Fire line Tracking and Inspection Path	1	200	0	200
2	Watch &Ward and Cultural Operations	2	400	0	400
TOTAL		**3**	**600**	**0**	**600**
5th YEAR MAINTENANCE					
1	Fire line Tracking and Inspection Path	1	200	0	200
2	Watch &Ward and Cultural Operations	2	400	0	400
TOTAL		**3**	**600**	**0**	**600**
6th YEAR MAINTENANCE					
1	Fire line Tracking and Inspection Path	1	200	0	200
2	Watch &Ward and Cultural Operations	2	400	0	400
TOTAL		**3**	**600**	**0**	**600**
7th YEAR MAINTENANCE					
1	1Fire line Tracking and Inspection Path	1	200	0	200
2	Watch &Ward and Cultural Operations	2	400	0	400
TOTAL		**3**	**600**	**0**	**600**
8th YEAR MAINTENANCE					
1	Fire line Tracking and Inspection Path	1	200	0	200
2	Watch &Ward and Cultural Operations	2	400	0	400
		3	**600**	**0**	**600**
9th YEAR MAINTENANCE					
1	Fire line Tracking and Inspection Path	1	200	0	200
2	Watch &Ward and Cultural Operations	2	400	0	400
TOTAL		**3**	**600**	**0**	**600**

ABSTRACT

(Enrichment of Plantation/Redensification)

SL NO	Item of work	Person days	Labour (Rs.)	Material (Rs.)	Total Cost (Rs.)
1	0th Year	14.5	2900	500	3400
2	1st Year	64.5	12900	1620	14520
3	2ndYear	21	4200	1250	5450
4	3rd Year	10	2000	200	2200
5	4th Year	3	600	0	600
6	5th Year	3	600	0	600
7	6th Year	3	600	0	600
8	7th Year	3	600	0	600
9	8th Year	3	600	0	600
10	9th Year	3	600	0	600
Total		**128**	**25600**	**3570**	**29170**

Annexure-2

COST NORM FOR BLOCK PLANTATION@1600 PLANTS PER HECTRE
WAGE RATE Rs.200/-PER DAY

SL NO	Items of work	Person days	Labour (Rs.)	Material (Rs.)	Total (Rs.)
1	2	3	4	5	6
0th YEAR(advance work)PRE-PLANTING OPERATION					
1	Survey, Demarcation & Pillar posting	2	400	0	400
2	Site preparation	8	1600	0	1600
3	Alignment & Stacking of pits	2	400	0	400
4	Digging of pits(30 cm cube)	40	8000	0	8000
5	Nursery cost(6 month old seedling)part @Rs.9.45/-seedling (Rs.6.67 in 0th year +Rs.2.78 in 1St year) for 1760 seedlings(1600+160)	44	8800	2939	11739
TOTAL		**96**	**19200**	**2939**	**22139**
1st YEAR OPERATION					
6	Nursery cost(6 month old seedling)Balance @ Rs.2.78 for 1260 seedlings	21.5	4300	593	4893
7	Carriage & Planting including Casualty Replacement and application of insecticide, manure etc.	21	4200	0	4200
8	Cost of insecticide & fertilizer (a) NPK @ 50 gms/plant as basal dose = 80 Kg @ Rs. 24/-per Kg= Rs. 1920.00 (b) Ureas @ 70 gms/plant in two subsequent doses @ Rs. 6/-per Kg= Rs. 672.00 (c) Granular insecticide (Themet, foeate etc.)@ 5 gms/plant @ Rs. 80/-per Kg= Rs.640	0	0	3232	3232
9	1st weeding (complete weeding)	7	1400	0	1400
10	manuring Urea 35 gms	5	1000	0	1000
11	2nd weeding (complete weeding)	5	1000	0	1000
12	Soil working (50 cms. Radius around plants) & manuring Urea 35 gms per plant	7	1400	0	1400
13	Soil Conservation Measures in the form of Staggered Trenches of size 2m× 0.5 m ×0.5 m @30 nos per ha	10	2000	0	2000
14	Fire line Tracing & Inspection Path	3	600	0	600
15	Watch & ward	7	1400	0	1400
TOTAL		**86.5**	**17300**	**3825**	**21125**

2nd YEAR MAINTENANCE					
16	Casualty Replacement (10%) with nursery cost	4	800	1512	2312
17	Weeding (Complete weeding)	6	1200	0	1200
18	Cost of fertilizer (NPK @70 gms/plant)for 1600 plants = 112 Kg @Rs.24/per Kg and Insecticide@ 5 gms/plant for 1600 plants 8Kg@ Rs.80/per Kg	0	0	3328	3328
19	Soil working(50 Cms. Radius around plants)	7	1400	0	1400
20	Application of fertilizer & Insecticide	4	800	0	800
21	Fire line Tracing (2 m, Wide fire line over 400 m long)	3	600	0	600
22	Watch &Ward(whole year)	15	3000	0	3000
TOTAL		**39**	**7800**	**4840**	**12640**
3rd YEAR MAINTENANCE					
23	Weeding and Application fertilizer	7	1400	0	1400
24	Cost of fertilizer (NPK @50 gms/plant)@ Rs.24/- per Kg	0	0	1920	1920
25	Soil working(50 Cms. Radius around plants) & Application of fertilizer	7	1400	0	1400
26	Fire line Tracing (2 m, Wide fire line over 400 m length) and cultural operation	3	600	0	600
27	Watch &Ward	15	3000	0	3000
TOTAL		**32**	**6400**	**1920**	**8320**
4th YEAR MAINTENANCE					
28	Fire line Tracing (2 m, Wide fire line over 400 m length)and cultural operation	3	600	0	600
29	Watch &Ward	15	3000	0	3000
TOTAL		**18**	**3600**	**0**	**3600**
5th YEAR MAINTENANCE					
30	Fire line Tracing (2 m, Wide fire line over 400 m length)and cultural operation	3	600	0	600
31	Watch &Ward	15	3000	0	3000
TOTAL		**18**	**3600**	**0**	**3600**
6th YEAR MAINTENANCE					
32	Fire line Tracing (2 m, Wide fire line over 400 m length)and cultural operation	3	600	0	600
33	Watch &Ward	15	3000	0	3000
TOTAL		**18**	**3600**	**0**	**3600**
7th YEAR MAINTENANCE					
34	Fire line Tracing (2 m, Wide fire line over 400 m length)and cultural operation	3	600	0	600
35	Watch &Ward	15	3000	0	3000
TOTAL		**18**	**3600**	**0**	**3600**
8th YEAR MAINTENANCE					
36	Fire line Tracing (2 m, Wide fire line over 400 m length)and cultural operation	3	600	0	600
37	Watch &Ward	15	3000	0	3000
TOTAL		**18**	**3600**	**0**	**3600**
9th YEAR MAINTENANCE					
38	Fire line Tracing (2 m, Wide fire line over 400 m length)and cultural operation	3	600	0	600
39	Watch &Ward	15	3000	0	3000
TOTAL		**18**	**3600**	**0**	**3600**

ABSTRACT

(Afforestation including maintenance)

SL NO	Year	Person days	Labour Cost @ Rs.200/- per Day	Material Cost Rs.)	Total Cost (Rs.)
1	0th Year	96	19200	2939	22139
2	1st Year	86.5	17300	3825	21125
3	2ndYear	39	7800	4840	12640
4	3rd Year	32	6400	1920	8320
5	4th Year	18	3600	0	3600
6	5th Year	18	3600	0	3600
7	6th Year	18	3600	0	3600
8	7th Year	18	3600	0	3600
9	8th Year	18	3600	0	3600
10	9th Year	18	3600	0	3600
Total		**361.5**	**72300**	**13524**	**85824**

Annexure 3

Cost estimates of Grassland Development Including Grass for one unit (10 Hectare)

As per Guideline of Dept. of Animal Husbandry and Dairying (2007)

SL	Item	**CPR, Gochar land/community land/Waste land which does not need treatment of soil (Rupees in Lakhs)**
1. Capital Investment		
A	Demarcation of boundary, fencing/(trench/ brushwood/barbed wire	0.75
B	Land Development(10 hectares)@0.10 lakhs per ha.(including soil treatment and weeding)	1.00
C	Farms sheds- for equipment, seed , manure, and office	1.50
D	Purchase of agriculture implements	0.50
E	Creation of Irrigation facilities: wells, pumps, power line, water tank, pump room, pipelines etc	3.00
	Sub Total	**6.75**
2. Recurring Expenditure		
A	Wages of supervisory staff	0.20
B	Seeds, fertilizer, / manure, insecticides	0.40
C	Cultivation charges	0.50
D	Irrigation electricity/ fuel charges	0.30
E	Maintenance of store/ dead stock	0.30
F	Maintenance of store/ dead stock	0.30
	Sub Total	**2.00**
	Grand Total	**8.75**
	Add for inflation of 9 years @8% per annum=8.75× 9×8%=	**6.30**
	Total (Rupees in lakhs)	**15.05**

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Annexure 4

(Gully with 1.3 m width, 0.6 m bottom width and depth 0.6m)

(As per manual on land and water management of Orissa Tribal Empowerment & Livelihoods Program 2010)

Sl No	Details of work	MD	RATE	AMOUNT IN Rs.
1	Survey, alignment, demarcation	1	200	200
2	Earth work excavation in stony earth mixed with gravel within initial lead and lift Edging out of gully 2×0.5×0.85×2.25×0.6=1.15 Foundation for stone packing 1×2.30×1.8×0.3 =1.24 D/S guard wall 1×1.3××0.5×0.6 =0.39 Side wall 2×2.13×0.5×0.3=0.64 Total =**3.42**	1.74	200	348
3	***a. Dry stone packing in the foundation of structure*** U/S dumping (deflected by 45 deg.) 1×{(1.3+2.2)/2}×0.45×0.3=0.24 Head wall and D/S Dumping 1×1.3×0.9×0.3=0.35 Apron 1×1.3×0.9×0.3=0.35 side walls 2×3.95×0.5×0.33=1.30 D/S guard wall 1×1.3×0.5×0.6=0.39 **b. Dry stone packing in super structure** U/S dumping 1×{(3.2+2.3)/2×0.45(0.45+0)/2=0.27D/S dumping1×2.3×0.45×(0.45+0.2)/2=0.336 Head wall 1×2.3×0.45×0.45=0.47 Apron 1×0.9×1.3×0.15=0.18 side walls 2×3.950×0.5×0.3=1.185 **Total(a+b)=5.07**	*2.6MD material 2 tractor load*	*200* *900**	*520* *1800*
4	Earth work in hard soil for side bund of 10m length in both side of structure 2×10×{(1.05+0.45)/2}×0.3=4.5-3.42=1.08 i.e excavated earth in the foundation will be adjusted for the side bund	0.6 MD	200	120
5	Fine dressing and turfing locally available grass within initial lead and lift both side slopes 2×10×0.42=8.40 Top 1×10×0.45=4.50 for no. bunds 2×12.90=25.80 sq m	0.8MD	200	160
6	Vetiver plantation with locally collected vetiver sleeves in D/S of the structure with spacing (0.23×0.23)sq m over 1.3 mt span and 1.0 mt width of 3 rows including foliar spraying with Urea. No .of sleeves required=(2.3/0.23) ×3=30 nos.	0.2 MD	200	40
7	Contingency and unforeseen charges			130
	Total			**3318**

Note: Labour rate revised from 90 to 200 and tractor load rate increased by 50% for inflation rate of 8% For 6 years.

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Annexure 5

Earthen Check Dam, 10 m with Concrete Core Wall

(As per Manual on Land and Water Management of Odisha Tribal Empowerment &

Livelihoods Program 2010

Labour Cost		**(Rs.)**	**(Rs.)**
Ordinary Labour	310 man days	200.00	62,000.00
Skilled Labour(Mason etc)	15 man days	240.00	3,600.00
Total			**65,600.00**
Material Cost		**(Rs.)**	**(Rs.)**
Cement	230 bags	305.00	70,150.00
Sand	15 truck	1,370.00	20,550.00
Brick	2500Nos	7.50	18,750.00
Aggregate(40mm)	5 truck	6,000.00	30,000.00
Bamboo	60nos	160.00	9,600.00
Total			**1,49,050.00**

Total Cost: (Rs. 65,600.00 + Rs.1,49,050.00) = Rs.2,14,650.00

Note: Material rate increased by 50% for inflation rate of 8%for 6 years

Annexure 6

Year wise Cash Flow

Item	0th year	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year	8th year	9th year	Total
Afforestation Including maintenance	11.07	10.56	6.32	4.16	1.80	1.80	1.80	1.80	1.80	1.80	42.91
Enrichment of Plantation/Re-densification	1.70	7.26	2.73	1.10	0.30	0.30	0.30	0.30	0.30	0.30	14.59
Fodder land development	15.05	15.05	15.05	15.05							60.20
Loose boulder wall gully plugging			0.17								0.17
Masony Stone Check Dam			10.73								10.73
Total cost of Biological, Engineering measures	27.82	32.87	35.00	20.31	2.10	2.10	2.10	2.10	2.10	2.10	128.60
Micro Planning Cost @5%	1.39	1.64	1.75	1.02	0.11	0.11	0.11	0.11	0.11	0.11	6.46
Sub Total	**29.21**	**34.51**	**36.75**	**21.33**	**2.21**	**2.21**	**2.21**	**2.21**	**2.21**	**2.21**	**135.06**
Contingency cost@5	1.46	1.73	1.84	1.07	0.11	0.11	0.11	0.11	0.11	0.11	6.76
Sub Total	**30.67**	**36.24**	**38.59**	**22.40**	**2.32**	**2.32**	**2.32**	**2.32**	**2.32**	**2.32**	**141.78**
Administrative Expenditure @12%	3.68	4.35	4.63	2.69	0.28	0.28	0.28	0.28	0.28	0.28	17.01
Total	**34.35**	**40.59**	**43.22**	**25.09**	**2.60**	**2.60**	**2.59**	**2.59**	**2.59**	**2.59**	**158.79**