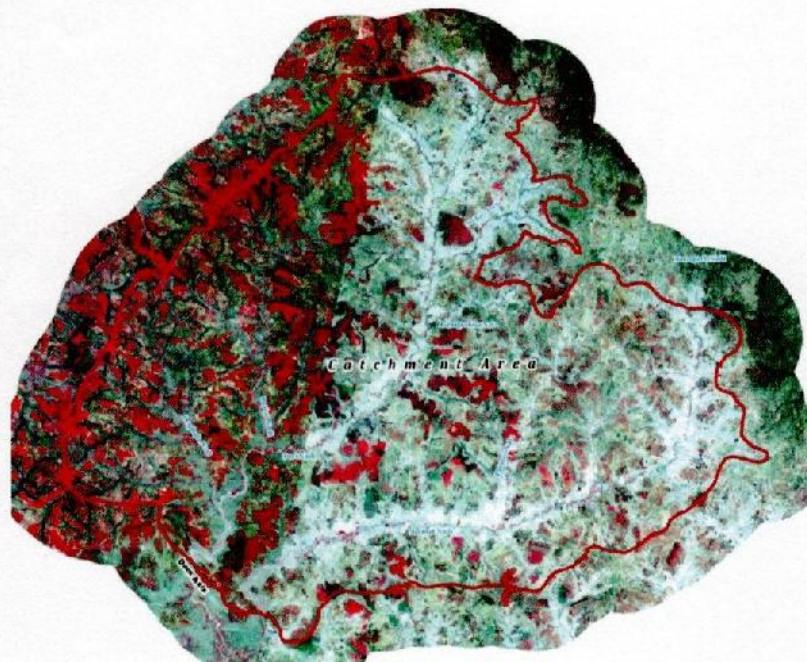




GOVERNMENT OF ODISHA
DEPARTMENT OF WATER RESOURCES

**CATCHMENT AREA TREATMENT (CAT)
FOR
TURI-GUNTAT IRRIGATION PROJECT**



DIST: NABARANGPUR, ODISHA

Jeypore, Koraput
Oct 2015

Executive Engineer
Koraput Investigation Division,
Jeypore, Koraput

1. Introduction

The Catchment Area Treatment (CAT) 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.

The CAT Plan would cover the following aspects:

- Identification of free draining catchment
- Assessment of Land Use, Soil, Slope in the catchment based on Remote Sensing (RS) /Geographic Information System (GIS) and Validation through field survey
- Erosion levels the watershed and prioritization of water sheds 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.

2. Need

Pondage formed by barrage 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 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 (Silt) 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 categorized 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 totaling 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 form watershed Atlas of India 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 the maps of National Bureau of Soil Survey and Land Use Planning (NBSS&LUP)
- Assigning weightage 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
- Watershed Prioritization
- Selection of locations of treatment and Catchment Treatment (CAT) Plan
- Cost Estimate

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Thematic data integration and erosion index modeling was done using relevant map layers in GIS. Silt Yield Index (SYI) of various sub 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 runoff
- manage & utilize runoff for useful purpose

4. Salient feature of Turi-Guntat Barrage Catchment

Turi-Guntat Irrigation Project is an integrated diversion scheme. It envisages to construct two barrages one each across River Turi near Chatahandi village and River Guntat at Deula Village, it will intercept a catchment of 612 km². A link canal will be constructed to transfer surplus water from Turi barrage to Guntat barrage. Guntat is tributary to Turi and Turi is a tributary to Indravati River. Other two major tributary of Turi is Petaphula Nadi and Basini nadi. The catchment is relatively flat with vegetation cover in patches. The catchment map of Turi-Guntat Barrage Project is enclosed at Plate-1.

5. 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 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 Sol and is also suggested in National Map Policy. Datum used for the projection is WGS 1984 and Zone is UTM 44 North.

5.1. Catchment and Watershed map

The catchment boundary of Turi-Guntata Barrage was delineated from Survey of India (Sol) topo sheets E44-E/7 and E44-E/11, looking at the contours and drainage. The drainage and contour map of the project is enclosed at Plate-2. The entire catchment is a part of the Watershed 4E2G3 (Right Bank of Indravati 1060 km²) as per the Watershed Atlas of India published by SLUSI. Since the catchment is very small, it was decided to prepare the CAT plan at Sub-watershed level instead of

Watershed level. The Sub-watersheds are prepared using the information available in Watershed Atlas of India and the micro watershed boundary collected from Watershed Mission of Odisha. The Sub-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 derive 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-1: Area falling under different slope category

Slope Category	Slope (%)	Area in Km ²	Area in%
Gently Sloping	0-15	586.64	95.86
Moderately sloping	15-30	18.83	3.08
Strongly sloping	30-45	6.53	1.07
Steeply sloping	45-60		
Very steeply sloping	60-75		
Extremely sloping	>75		
Total		612.00	100.00

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: IRS-P6
 Sensor: LISS-IV MX (Multi Spectral)
 Date of Pass: 1st April 2015
 Path: 103
 Row: 059

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 classes

Description	Area in Km ²	Area in %
Dense Forest	-	-
Moderately Dense Forest	62.59	10.23
Open Forest/Plantation	69.56	11.37
Scrub	6.02	0.98
Crop Land	448.75	73.33
Barren Rocky	0.42	0.07
Settlement	18.83	3.08
River & Water body	5.83	0.95
Total	612.00	100.00

5.4. Soil Map

Soil map was prepared by digitizing 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 erosion category is depicted in **Table-3**.

Table-3: Area falling under different soil category

NBSS & LUP Code	Description	Texture	Area in KM ²	Area in%
10	Deep, poorly drained, fine cracking soils with clayey surface and slight erosion.	Clayey	89.77	14.67
14	Deep, well drained, fine soils with loamy surface, moderate erosion and moderate stoniness.	Loamy	2.96	0.48
24	Moderately shallow, imperfectly drained, fine-loamy soils with loamy surface and slight erosion.	Loamy	6.98	1.14
72	Deep moderately well drained fine loamy soils with loamy surface and moderate erosion	Loamy	4.54	0.74

NBSS & LUP Code	Description	Texture	Area in KM²	Area in%
73	Deep, moderately well drained fine loamy soils with loamy surface and moderate erosion	Loamy	104.52	17.08
74	Deep well drained fine-loamy soils with loamy surface and moderate erosion	Loamy	7.50	1.23
79	Moderately shallow, well drained fine loamy soils with loamy surface and moderate erosion	Loamy	10.36	1.69
94	Deep, moderately well drained fine cracking soils with loamy surface and moderate erosion	Loamy	1.49	0.24
106	Moderately deep, well drained, fine-loamy soils with loamy surface and moderate erosion	Loamy	6.84	1.12
136	Deep, imperfectly drained fine soils with sandy surface and severe erosion	Sandy	9.27	1.51
137	Very deep, poorly drained, fine soils with loamy surface and slight erosion	Loamy	39.75	6.50
138	Very deep, excessively drained. Sandy soils with strong salinity and moderate erosion	Sandy	290.87	47.53
143	Moderately shallow, somewhat excessively drained clayey skeletal soils with loamy surface, moderate erosion and strong stoniness	Loamy	37.16	6.07
	Total		612.00	100.00

6. Estimate of Soil Loss intensity using Silt Yield Index (SYI) method

The Sedimentation (Silt) Yield Index Model (SYI), considering sedimentation as product of erosivity, erodibility and areal 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:

$$SYI = \frac{\sum (A_i \times W_i) \times D_i \times 100}{A_w} \quad [\text{where } i = 1 \text{ to } n \text{ (n is the No. of EIU)}]$$

A_i = Area of i^{th} unit (EIU)

W_i = Weightage value of the i^{th} unit EIU

D_i = Delivery Ratio of the i^{th} unit EIU

A_w = Total area of Sub-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 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 EIU in each sub 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 km	1.00
1.0 - 2.0 km	0.95
2.1 - 5.0 km	0.90
5.1 - 15.0 km	0.80
15.1 - 30.0 km	0.70

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

7. Prioritization of Sub Watershed based on SYI findings

The objective of the SYI method is to prioritize sub watershed in a catchment area for treatment. For prioritizing the sub 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 sub watershed wise SYI and category of erosion is depicted in **Table-4** and **Plate-8**

Table-4: Soil Erosion Priority Category of Sub Watersheds

SL	MWS Code	SYI	Priority
1	4E2G3P	1342	Very High
2	4E2G3L	1332	Very High
3	4E2G3M	1331	Very High
4	4E2G3K	1306	Very High
5	4E2G3Q	1299	High
6	4E2G3S	1282	High
7	4E2G3N	1281	High
8	4E2G3G	1274	High
9	4E2G3O	1269	High
10	4E2G3W	1267	High
11	4E2G3H	1263	High
12	4E2G3U	1257	High
13	4E2G3V	1247	High
14	4E2G3T	1219	High
15	4E2G3R	1172	Medium

Area under Very High categories is proposed to be treated at the project proponent's cost. 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 **4E2G3L** micro watershed (Area 3139 Ha) was finally selected for catchment area treatment plan which is directly draining to the Turi 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.

7.1. Demography of the watershed

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

Sl.	Name	POPULATION	MALE	FEMALE	SC	ST	LITERATE	WORKER
1	Chingudisara	589	303	286	33	480	231	346
2	Darkarguda	900	469	431	2	0	330	509
3	Dengaguda	917	456	461	77	410	236	360
4	Ekori	1863	949	914	0	1772	422	988
5	Ghataguda	1160	821	839	805	273	765	721
6	Kharki	1201	588	613	329	756	392	495
7	Makia	2071	1031	1040	447	1095	753	1186
8	Palapur	1673	828	845	127	918	556	839
9	Papadahandi	9390	4522	4868	1275	3857	5021	3977
10	Sirisi	1014	506	508	52	598	380	554
11	Sorisapadar	898	457	441	1	739	310	514

8. 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 (73.33%), awareness campaign will be done for farm management (negatives of burning farm residuals, adoption of proper cropping pattern etc.), digging of farm pond, controlled grazing in graze land, etc.

8.1. Assisted Natural Regeneration

Assisted Natural Regenerations suggested in the 40 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**.

8.2 Block Plantation/Afforestation

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

All areas are in Ha

Sl.	Name	Govt.	Forest	Total
1	Chingudisara	138.45	21.92	160.37
2	Darkarguda	206.69	46.96	253.65
3	Dengaguda	218.55	35.84	254.39
4	Ekor	405.45	42.49	447.94
5	Ghataguda	22.04	4.93	26.97
6	Kharki	378.74	44.13	422.87
7	Makia	528.87	65.69	594.56
8	Palapur	1281.3	383.63	1664.93
9	Papadahandi	505.16	41.1	546.26
10	Sirisi	330.83	20.02	350.85
11	Sorisapadar	208.46	41.95	250.41

As more than 125ha of forest land is available in Plapur and Makia village but there is no forest growth, it is proposed to block plantation in each of the village. The detailed estimate is enclosed at **Annexure-2**.

8.3. 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.	Village	Gochara	Population
1	Chingudisara	18.25	589
2	Dakaraguda	22.85	900
3	Dengaguda	33.15	917
4	Ekor	67.73	1298
5	Ghantaguda	0	458

6	Kharki	33.95	1201
7	Makia	71.23	2071
8	Palapur	52.34	1673
9	Papadahandi	89.58	90309
10	Sirisi	49.48	1014
11	Sorisapadar	21.24	898

Looking at the availability of Gochar land and population it is proposed to develop 5 blocks (of 10 ha each) of fodder land development in Kharki, Sirisi, Makia, Palpur and Papadahandi. The detail estimate is given at [Annexure-3](#).

8.4. 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 spectacular evidence of the destruction of soil. The gullies usually deepen and widen with every heavy rainfall. They cut up large fields into small fragments and, in course of time, make them out of shape for cultivation.

Gully plugging work is required for reduction of runoff velocities within permissible limits and for controlling gully erosion of micro-watersheds. Appropriate gully plugging works would be selected from brush wood check dams, palisading works, gabion structures, sunken pits, etc. A provision is kept for 40 gully plugging in the hilly streams. The typical Estimate of Gully Plugging is depicted at [Annexure-4](#).

8.5. 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 metre to 3 metre and length varies from less than 3m to 10m.

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

The locations 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.

9. Cost Estimate

SL	Item	Rate in Rs.	Unit	Physical	Financial (Rs, in Lakh)
Biological Measure					
1	Afforestation including maintenance	85,248	Ha	125	106.56
2	Enrichment of Plantation/Re-densification	29,098	Ha	40	11.63
3	Fodder land development per 10 ha	14,62,000	Ha	50	73.10
Engineering Measure					
4	Loose Boulder wall gully plugging	3318	No	40	1.33
5	Masonry Stone Check Dam	2,16,500	No	5	10.82
Others					
6	Awareness campaign for farm management, control grazing etc.	-	-	-	15.00
	Total				218.44

Total cost of Biological, Engineering measure an silt observation at site = Rs. 218.44akh

Micro Planning Cost @ 5% = Rs. 10.922 lakh

Sub Total = **Rs. 229.362 lakh**

Contingency cost @ 5% = Rs 11.468 Lakh

Sub Total = **Rs. 240.83 lakh**

Administrative Expenditure @12% = Rs. 28..90 Lakh

Total = **Rs. 269.73 lakh**

Pluy
Executive Engineer
Koraput Investigation Division
Jeypore (K)

Swaga
District Forest Officer
Koraput Division

COUNTERSIGNED
mlaf
Regional Chief Conservator of Forests
Koraput Circle, Koraput

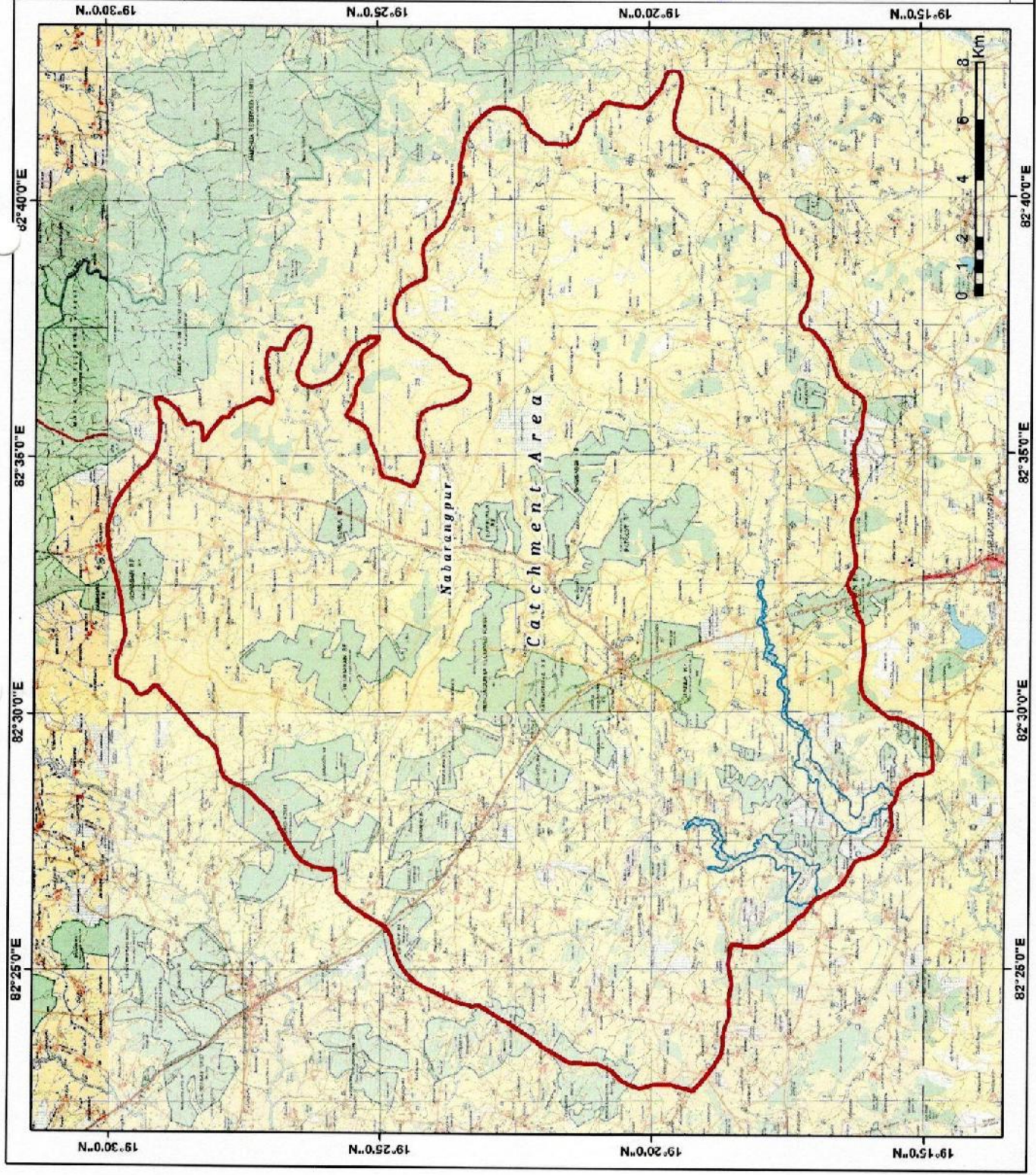
Catchment Area Treatment Plan
Turi-Guntat Irrigation Project
Catchment Map

Legend

Reservoir

Catchment

[Signature]
Executive Engineer
Koraput Investigation Division
Jeypore (K)



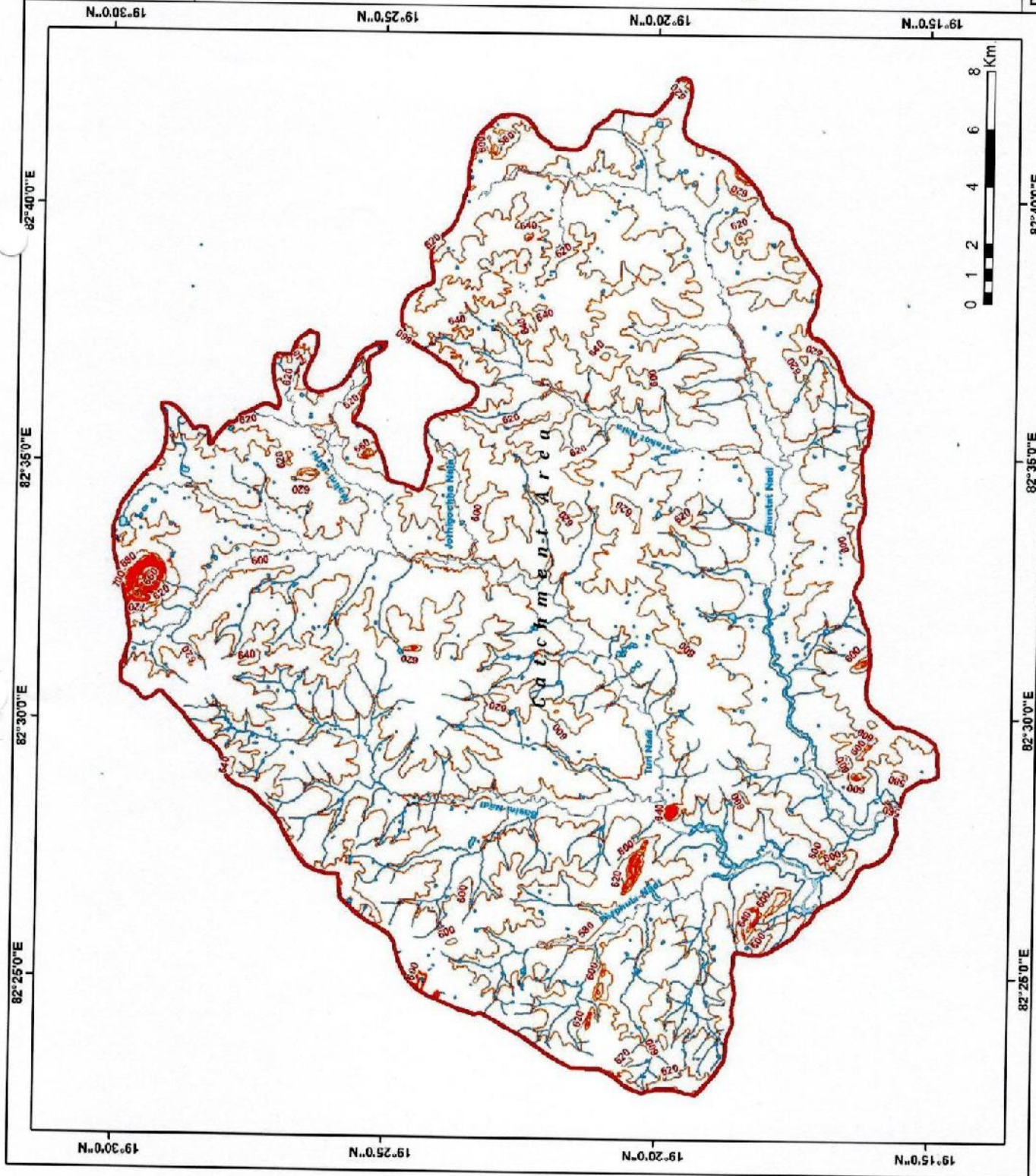
**Catchment Area Treatment Plan
Turi-Guntat Irrigation Project
Drainage & Contour Map**

Legend

-  Catchment
-  Reservoir
-  Drainage
-  River/Waterbody
-  Contour (100 m Interval)
-  Contour (20 m Interval)

Rou

**Executive Engineer
Koraput Investigation Division
Jeypore, (K)**



Catchment Area Treatment Plan
Turi-Guntal Irrigation Project
Sub Watershed Map

Legend

- Catchment
- Sub Watershed
- ~ Drain/River

Devi
Executive Engineer
Koraput Investigation Division
Jeypore (K)

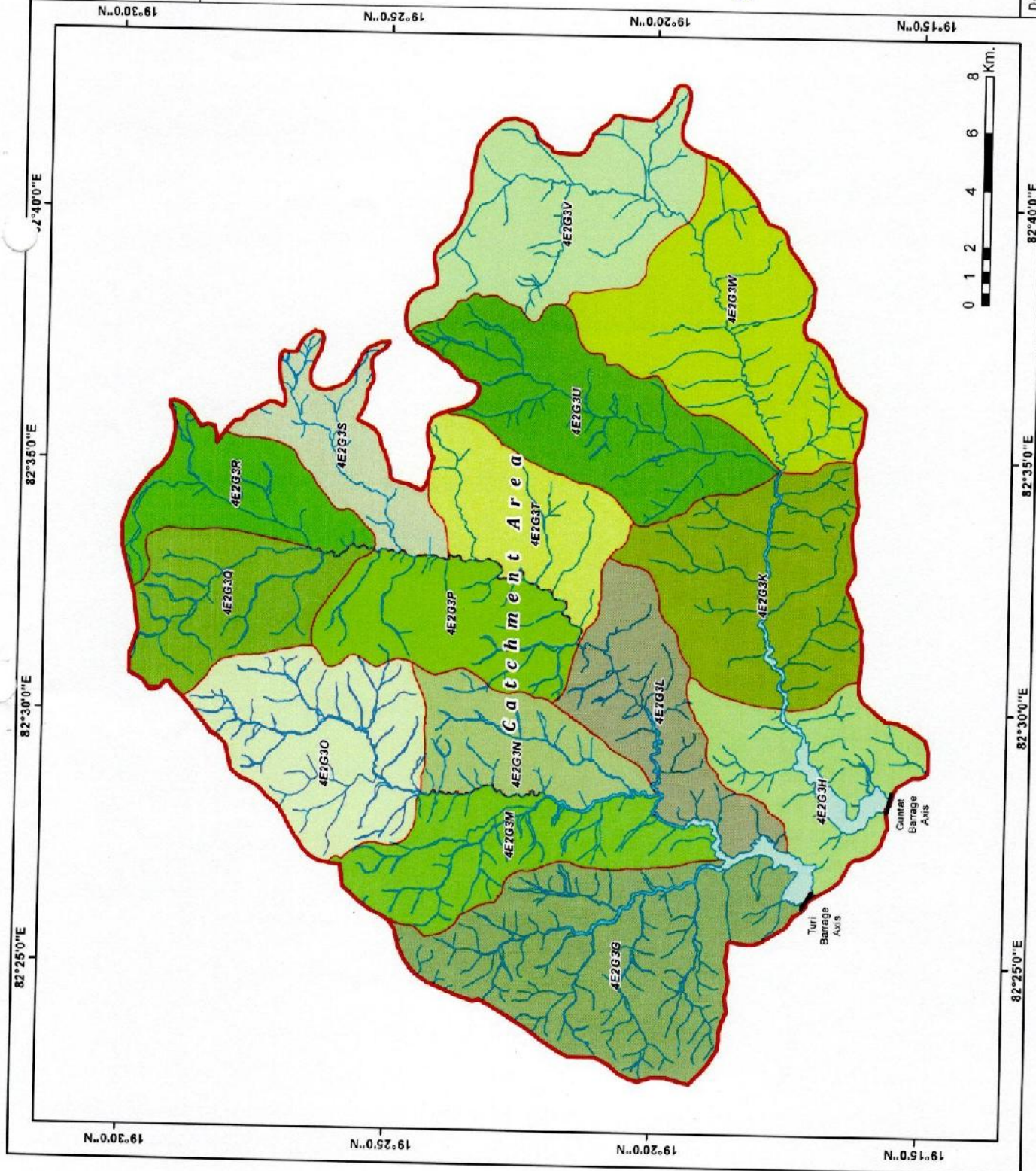


Plate-4

Catchment Area Treatment Plan

Turi-Guntat Irrigation Project

Slope Map

Legend

- Catchment
- Gently Sloping
- Moderately Sloping
- Strongly Sloping
- Drain/River

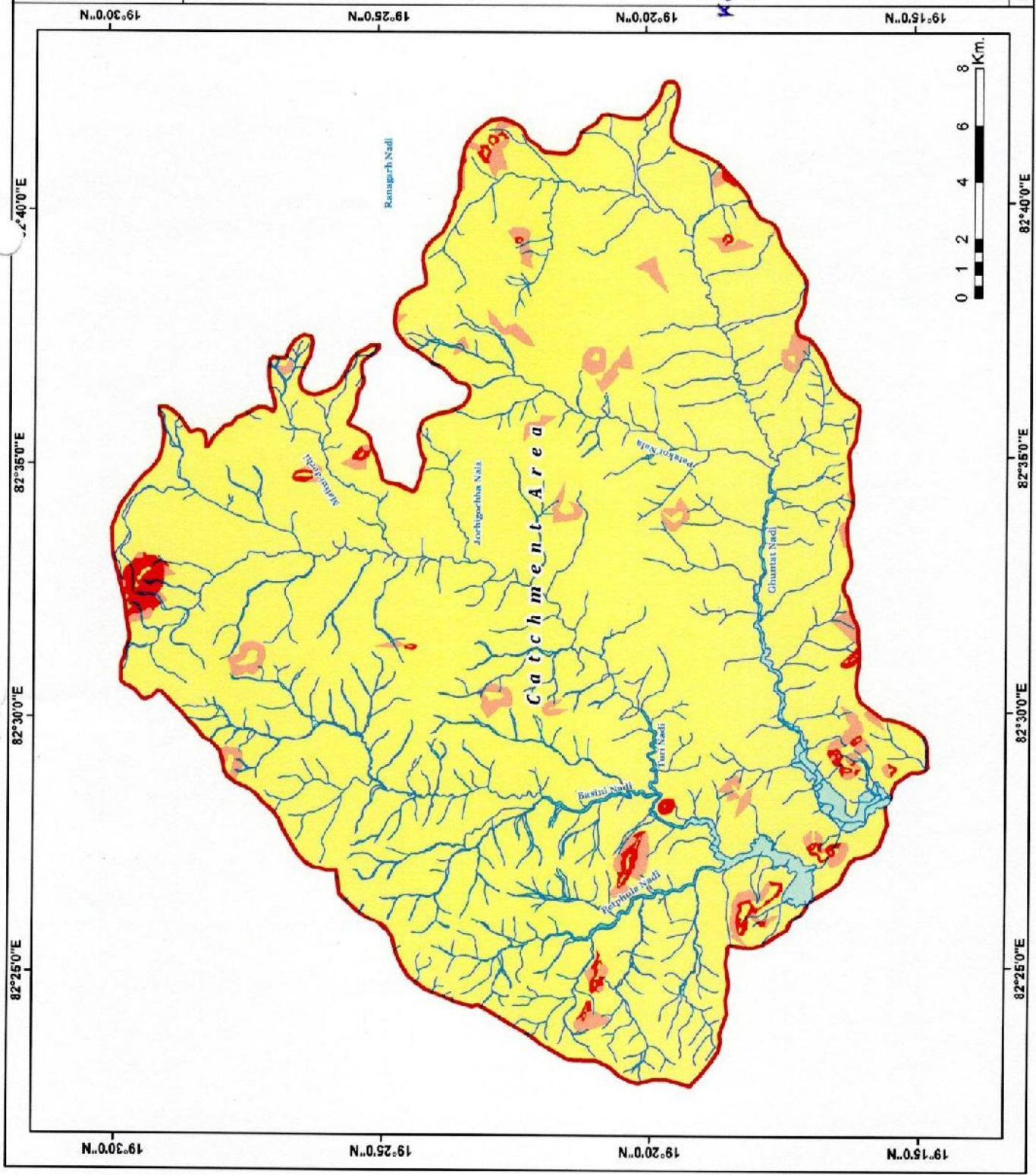
Ravi

Executive Engineer

Koraput Investigation Division

Jeypore (K)

Department of Water Resource, ODISHA

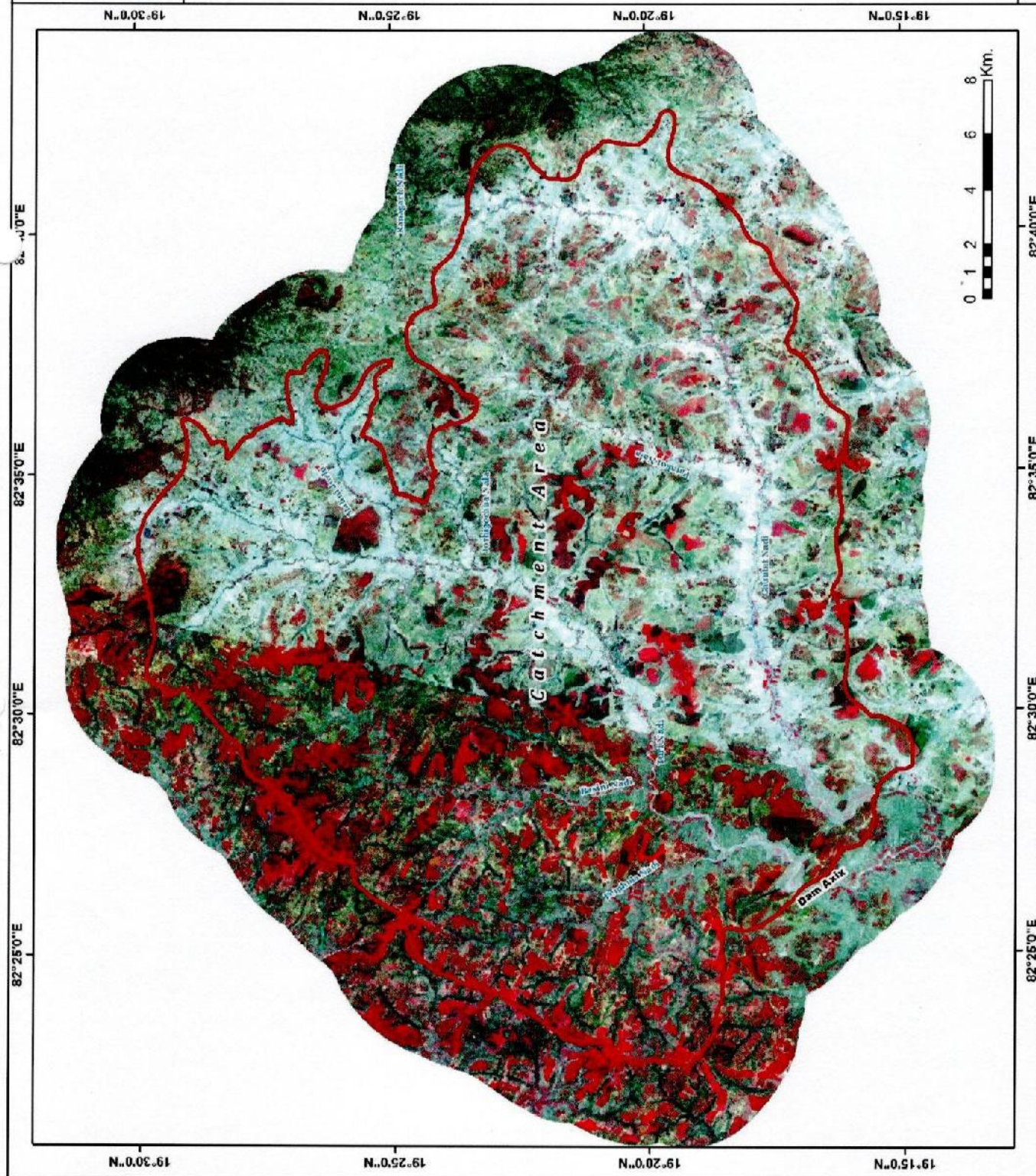


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Raj
Executive Engineer
Computer Investigation Division
Jeypore (K)

Department of Water Resource, ODISHA



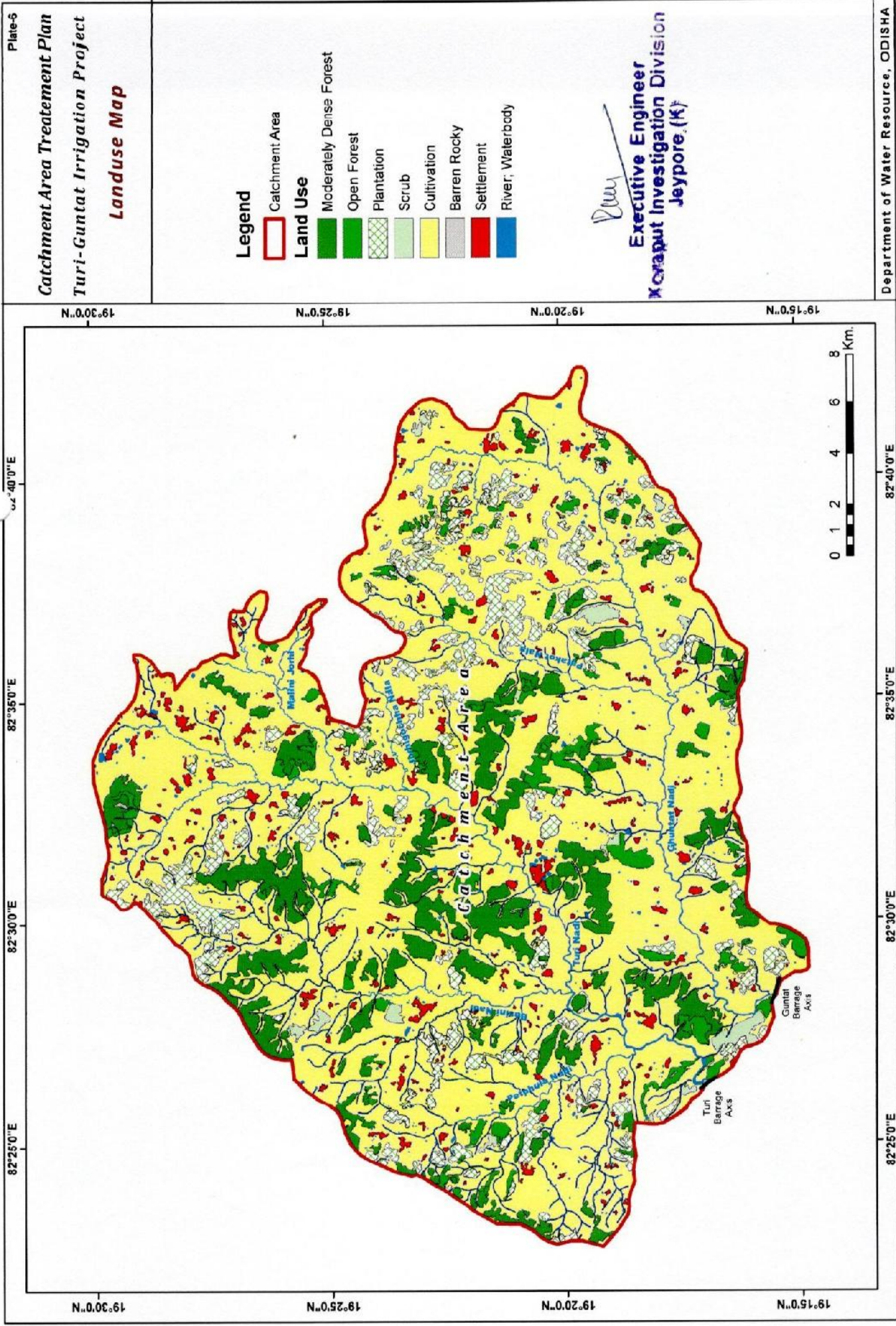
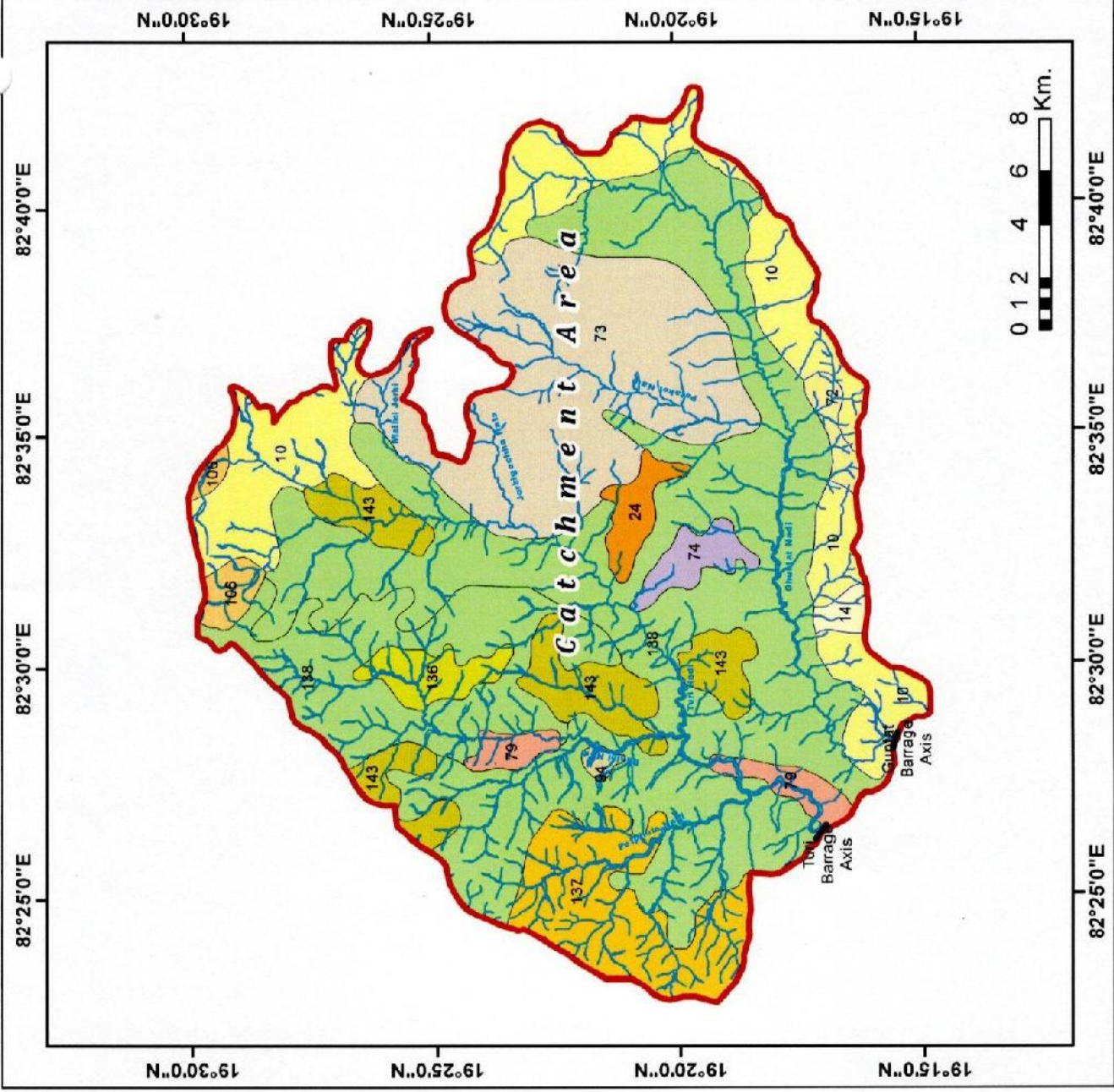


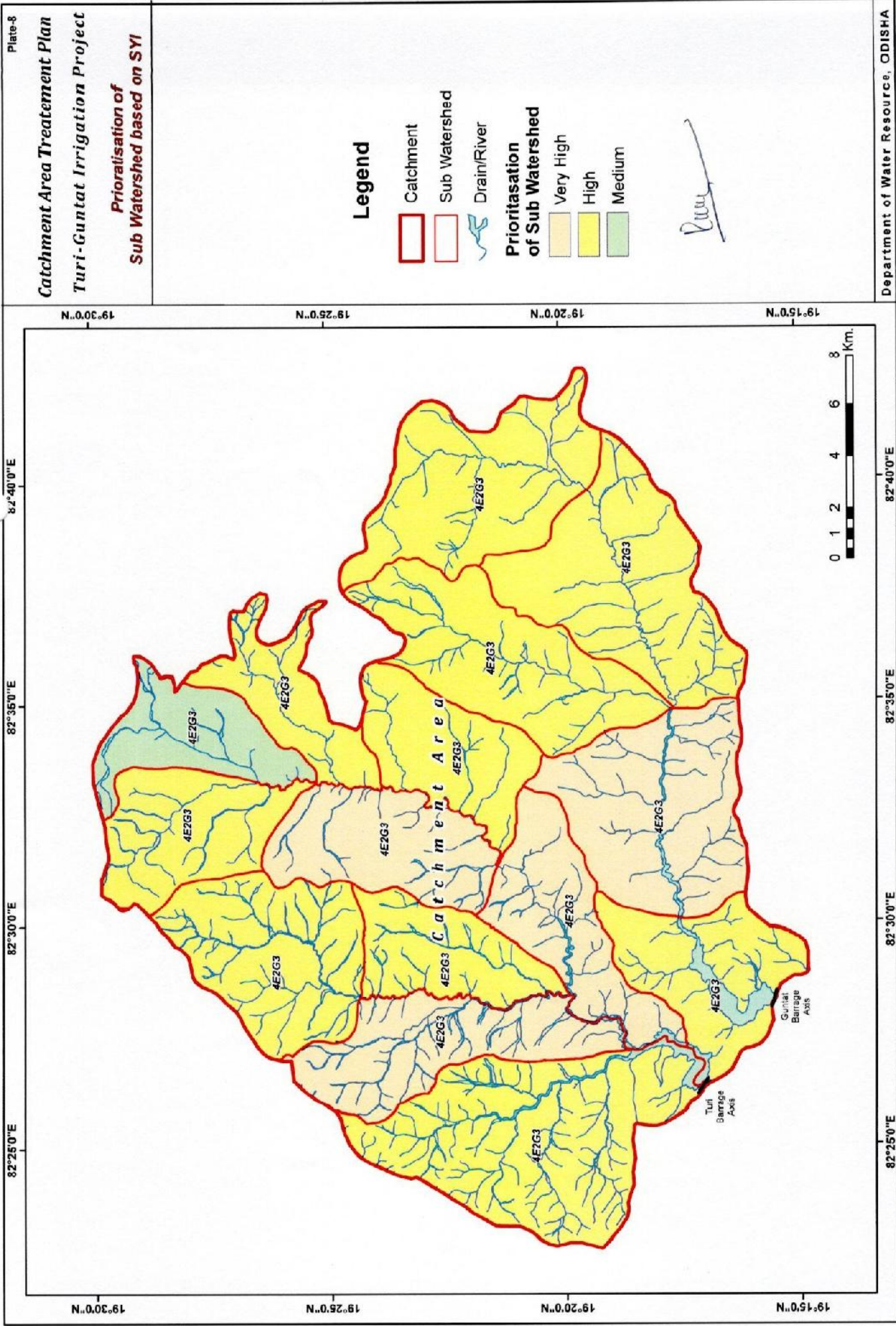
Plate-7
Catchment Area Treatment Plan
Turi-Guntat Irrigation Project
Soil Map

Legend

NBSS & LUP Code	Description
10	Deep, poorly drained, fine cracking soil with clayey surface and slight erosion.
14	Deep, well drained, fine soil with loamy surface, moderate erosion and moderate stoniness.
24	Moderately shallow, imperfectly drained, fine-loamy soils with loamy surface and slight erosion.
72	Deep, moderately well drained fine loamy soil with loamy surface and moderate erosion
73	Deep, moderately well drained fine loamy soils with loamy surface and moderate erosion
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105	Moderately deep, well drained, fine loamy soils with loamy surface and moderate erosion
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137	Very deep, poorly drained, fine soil with loamy surface and slight erosion
138	Very deep, excessively drained. Sandy soils with strong salinity and moderate erosion
143	Moderately shallow, somewhat excessively drained clayey skeletal soils with loamy surface, moderate erosion and strong stoniness

Devi
Executive Engineer
Koraput Investigation Division
Jeypore (K)





Catchment Area Treatment Plan
Turi-Guntat Irrigation Project
Detail Map for
Preparation of Treatment Plan

Legend

- Catchment Area
- Sub Watershed

Slope

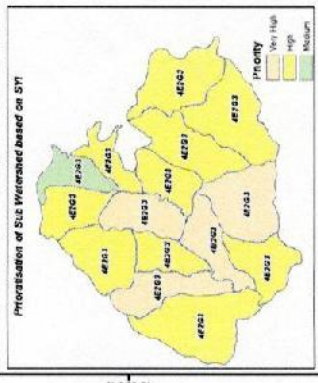
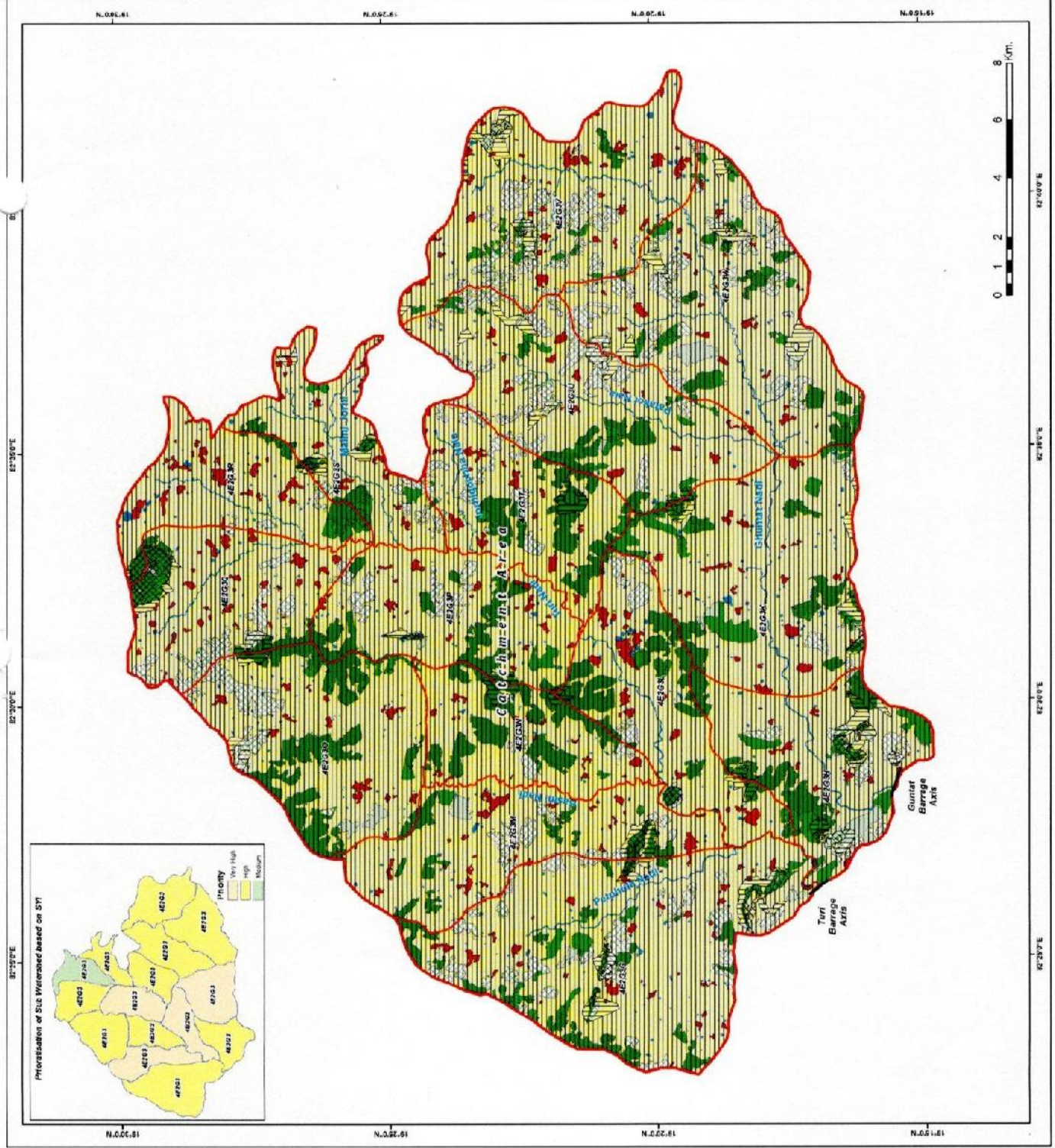
- Gently Sloping
- Moderately Steep
- Steep

Land Use

- Moderately Dense Forest
- Open Forest
- Plantation
- Scrub
- Crop Land
- Barren Rocky
- Settlement
- River/Waterbody

Signature

Executive Engineer
Koraput Investigation Division
Jeypore, (K)



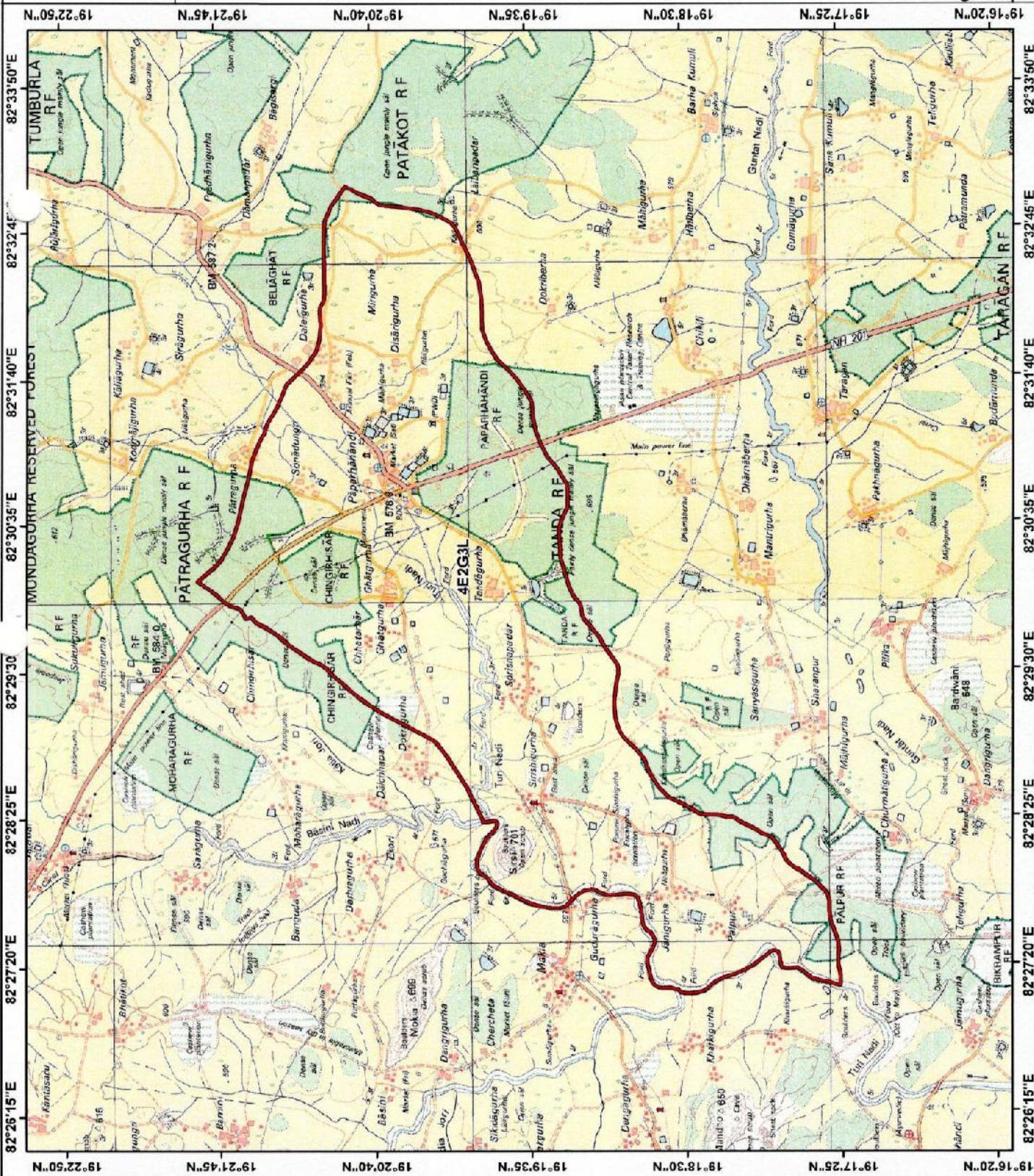
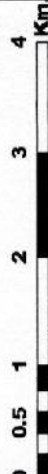
Catchment Area Treatment Plan
Turi-Guntat Irrigation Project
Topographic Map of the
Priority Watershed

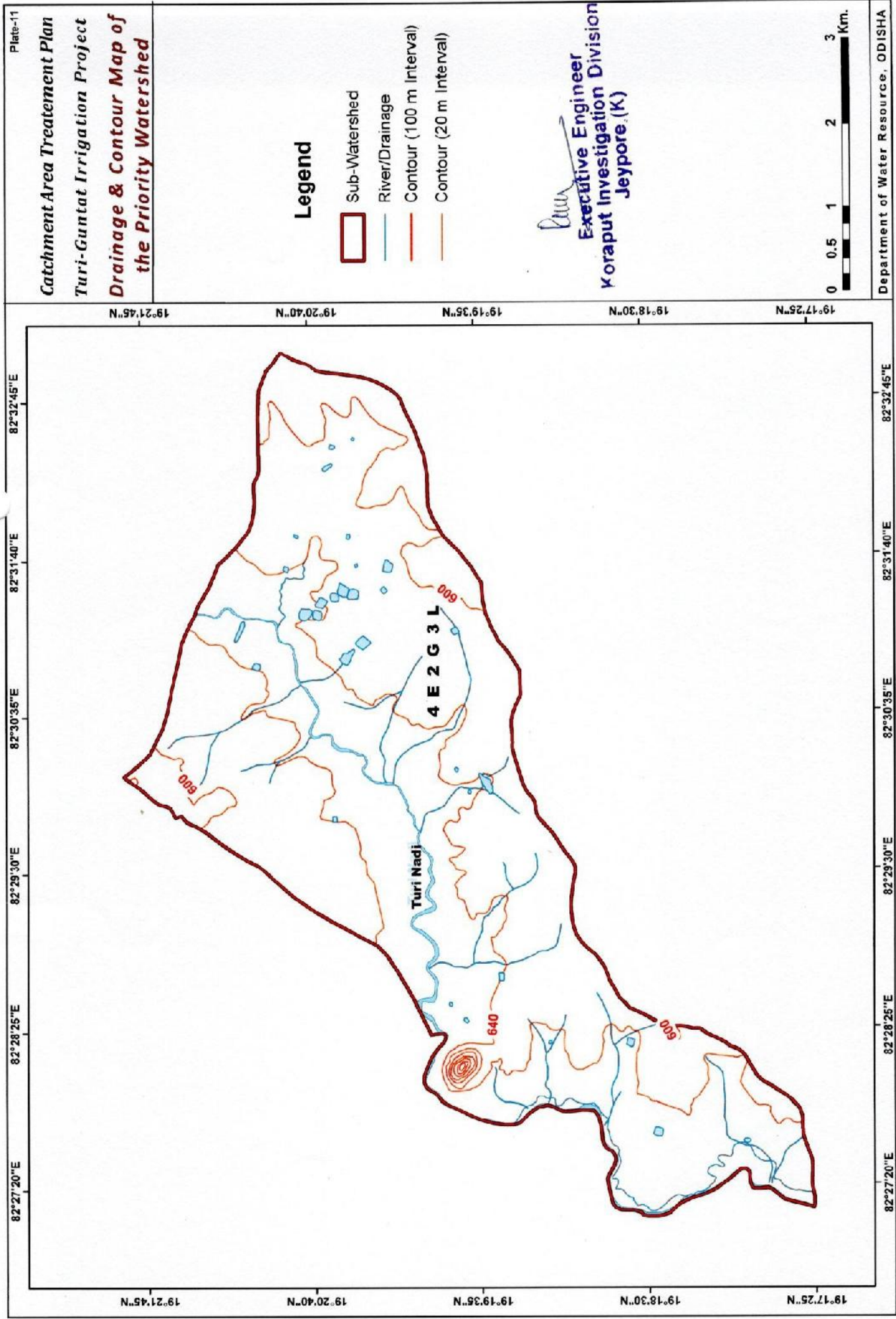
Legend



Watershed Boundary

Run
Executive Engineer
Koraput Investigation Division
Jeypore (K)





82°30'0"E

Plate-12

Catchment Area Treatment Plan
Turi-Guntat Irrigation Project
Land Use & Slope Map of
the Priority Watershed



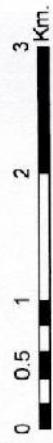
Landuse

- Dense Forest
- Open Forest
- Waste Land with Scrub
- Plantation
- Barren Rocky
- Cultivation
- Settlement
- River/Waterbody

Slope

- Steep
- Moderately Steep
- Gently Sloping

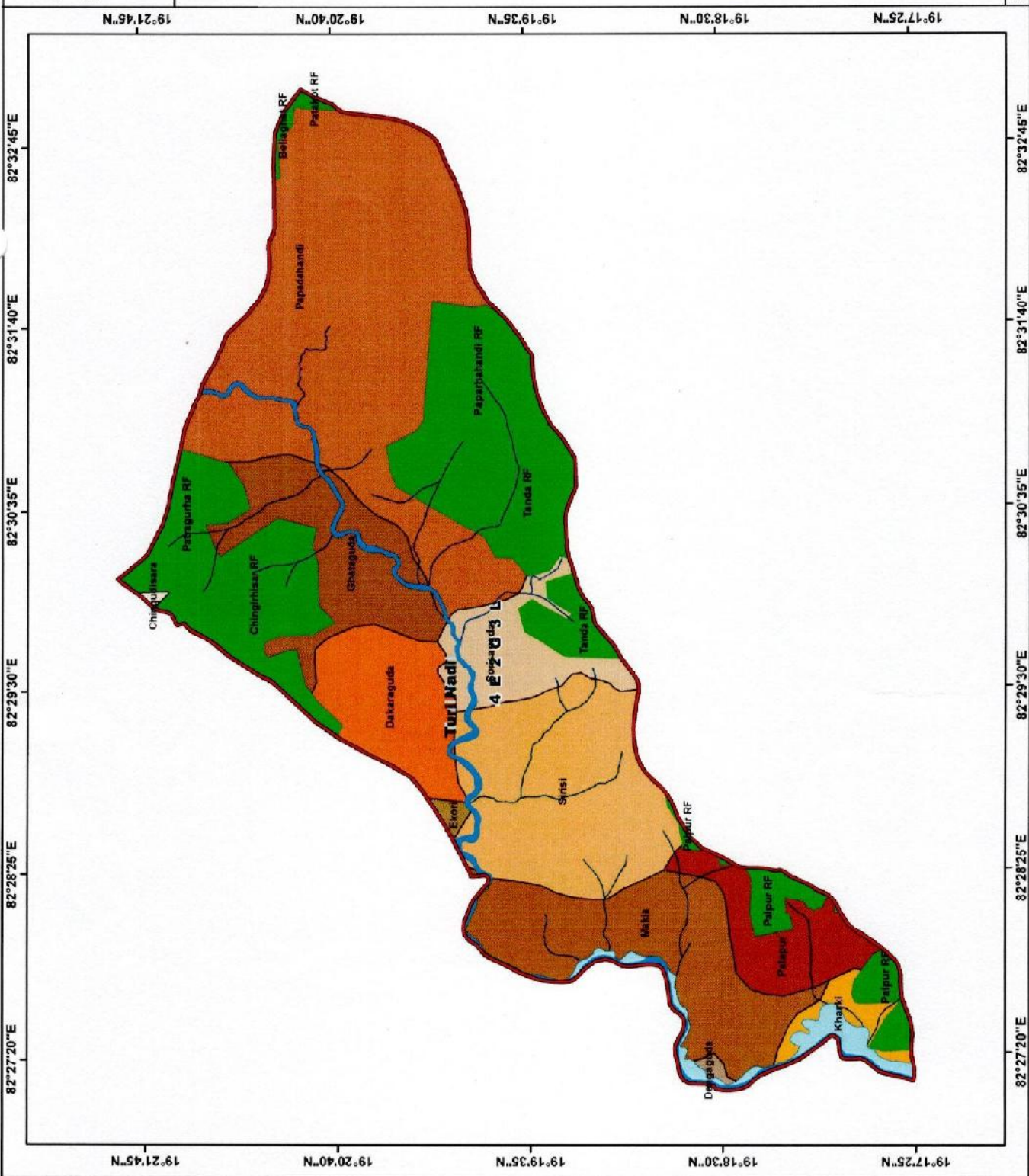
Vijay
Executive Engineer
Koraput Investigation Division
Jeypore, (K)

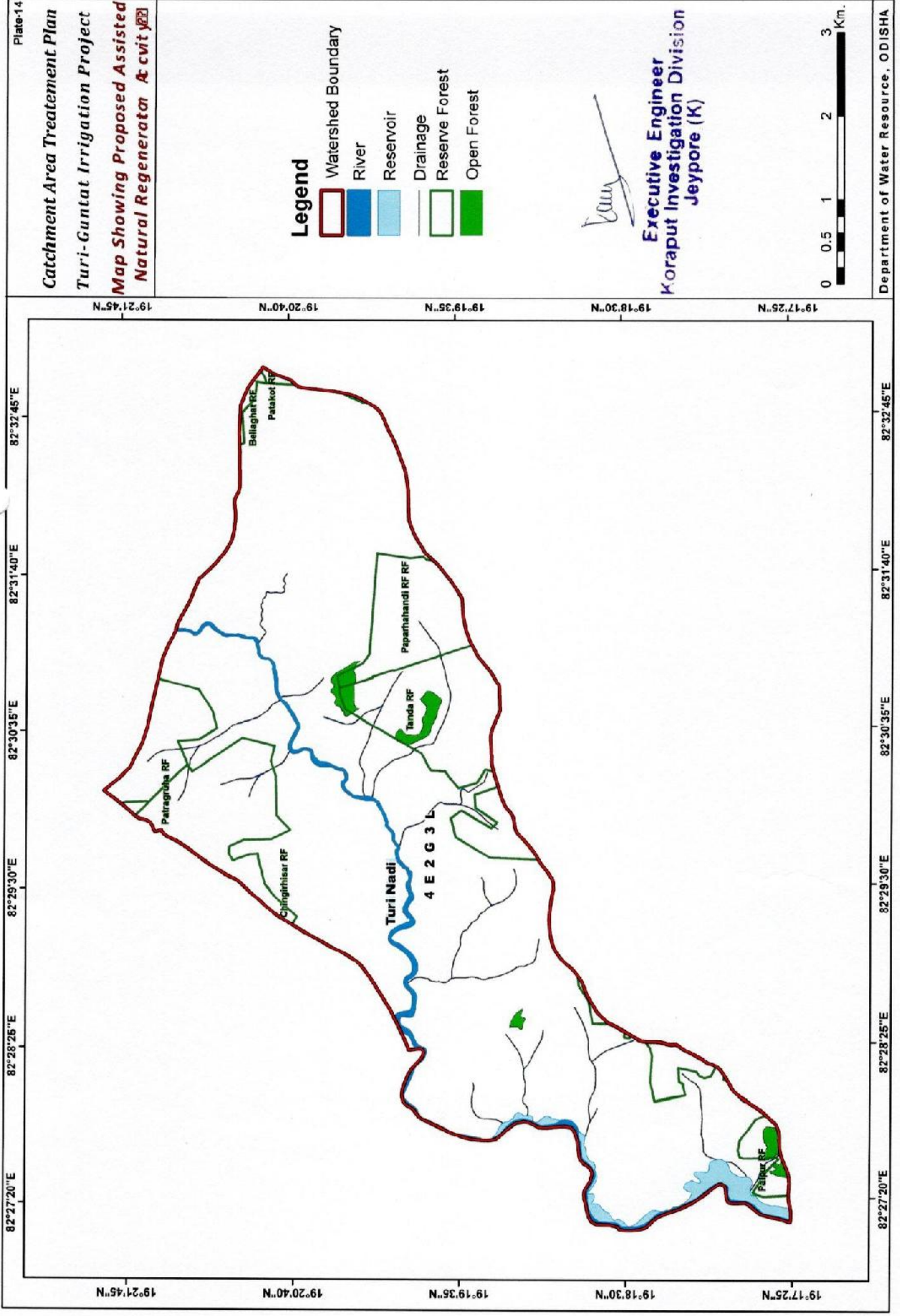


82°30'0"E

Department of Water Resources, ODISHA

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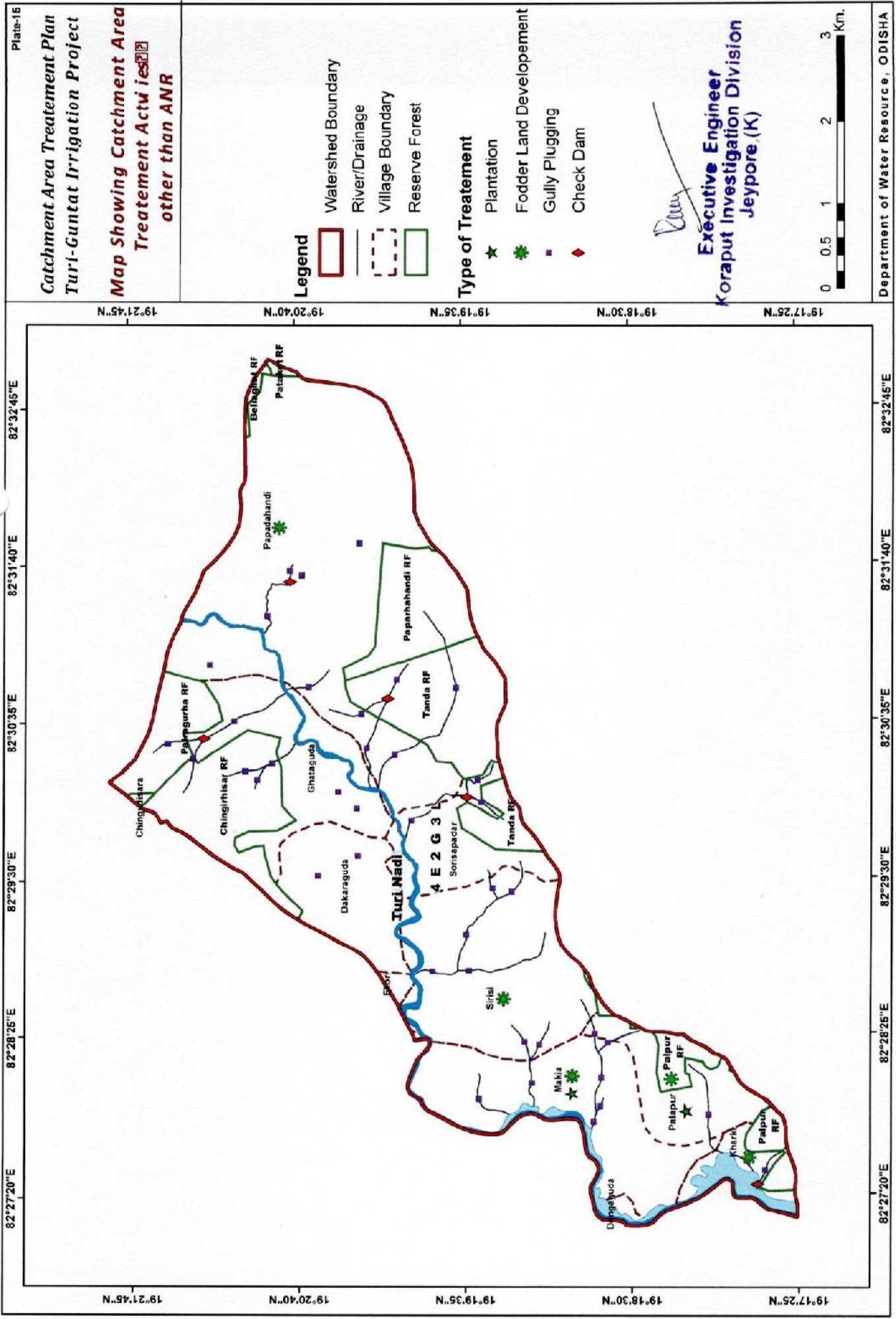


82°27'20"E 82°28'25"E 82°29'30"E 82°30'35"E 82°31'40"E 82°32'45"E

82°27'20"E 82°28'25"E 82°29'30"E 82°30'35"E 82°31'40"E 82°32'45"E

19°17'25"N 19°18'30"N 19°19'35"N 19°20'40"N 19°21'45"N

19°17'25"N 19°18'30"N 19°19'35"N 19°20'40"N 19°21'45"N



Annexure-1

COST NORM FOR AIDED NATURAL REGENERATION (ANR)@200PLANTS PER HECTARE
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 0 th year + Rs. 2.78 in 1 st 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 months 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 Vermi compost @ 200 gms/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 fertiliser (a) Urea 70 gms/plant in two subsequent doses @ Rs. 6/- per Kg = Rs. 84.00 (b) NPK 50 gms/plant @ Rs. 24/- per Kg = Rs. 240.00 as basal dose	0	0	324	324
7	Silvicultural Operation involving clearance of weeds, cutting of climbers, singling of shoots etc.	15	3000	0	3000
8	Soil Conservation Measures (Staggered trenches of dimension 2 m X 0.5 m X 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	Contingency and Unforeseen Expenditures	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 @ 20/- per Kg = Rs.20/-per Kg = Rs. 800.00 (b) Granular Insecticide 5 gms/plant for 20 plants 100 gms @ Rs. 80/- per Kg. = Rs. 8.00	0	0	808	808
5	Soil Conservation Measures (Renovation of staggered trenches etc.)	8	1600	0	1600
6	Fire line Tracing 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	1178	5378
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 Tracing and Inspection Path	1	200	0	200
2	Watch & word and Cultural operations	2	400	0	400
TOTAL		3	600	0	600
5TH YEAR MAINTENANCE					
1	Fire line Tracing and Inspection Path	1	200	0	200
2	Watch & word and Cultural operations	2	400	0	400
TOTAL		3	600	0	600
6TH YEAR MAINTENANCE					
1	Fire line Tracing and Inspection Path	1	200	0	200
2	Watch & word and Cultural operations	2	400	0	400
TOTAL		3	600	0	600
7TH YEAR MAINTENANCE					
1	Fire line Tracing and Inspection Path	1	200	0	200

2	Watch & word and Cultural operations	2	400	0	400
TOTAL		3	600	0	600
8TH YEAR MAINTENANCE					
1	Fire line Tracing and Inspection Path	1	200	0	200
2	Watch & word and Cultural operations	2	400	0	400
TOTAL		3	600	0	600
9TH YEAR MAINTENANCE					
1	Fire line Tracing and Inspection Path	1	200	0	200
2	Watch & word and Cultural operations	2	400	0	400
TOTAL		3	600	0	600

ABSTRACT

Sl. No	Item of Work	Person days	Labour (Rs.)	Material (Rs.)	Total Cost (Rs.)
1	0 th Year	14.5	2900	500	3400
2	1 st Year	64.5	12900	1620	14520
3	2 nd Year	21	4200	1178	5378
4	3 rd Year	10	2000	200	2200
5	4 th Year	3	600	0	600
6	5 th Year	3	600	0	600
7	6 th Year	3	600	0	600
8	7 th Year	3	600	0	600
9	8 th Year	3	600	0	600
10	9 th Year	3	600	0	600
TOTAL		128	25600	3498	29098

Bluy
Executive Engineer
Koraput Investigation Divi-
Jeypore (K)

Annexure-2

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

Sl. No	Items of work	Person days	Labour cost Rs. 200 per day	Material Cost (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 months old seedling) part @ Rs. 9.45/- seedling (Rs. 6.67 in 0 th year + Rs. 2.78 in 1 st year) for 1760 seedlings (1600+160)	44	8800	2939	11739
TOTAL		96	19200	2939	22139
1ST YEAR/ PLANTING YEAR					
6	Nursery cost (6 months old seedling) balance @ Rs. 2.78 for 1760 seedlings	21.5	4300	593	4893
7	Carriage & planting, 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 = 80kg @ 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	1 st weeding (complete weeding)	7	1400	0	1400
10	Manuring Urea 35 gm	5	1000	0	1000
11	2 nd 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 X 0.5 m X 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

2 ND 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) (Rs. 24/-per Kg & Insecticide @ 5 gms /plant for 160 plants 800 gms @ Rs 80/- per Kg)	0	0	2752	2752
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 (2m, Wide fire line over 400 m long)	3	600	0	600
22	Watch & Ward	15	3000	0	3000
TOTAL		39	7800	4264	12064
3 RD YEAR MAINTENANCE					
23	Weeding & 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 fertiliser	7	1400	0	1400
26	Fire line Tracing (2m. Wide fire line over 400m length)& cultural operation	3	600	0	600
27	Watch & ward	15	3000	0	3000
TOTAL		32	6400	1920	8320
4 TH YEAR MAINTENANCE					
28	Fire line Tracing (2m. wide fire line over 400 m length) & cultural operation	3	600	0	600
29	Watch & word	15	3000	0	3000
TOTAL		18	3600	0	3600
5 TH YEAR MAINTENANCE					
30	Fire line Tracing (2m. wide fire line over 400 m length) & cultural operation	3	600	0	600
31	Watch & word	15	3000	0	3000
TOTAL		18	3600	0	3600
6 TH YEAR MAINTENANCE					
32	Fire line Tracing (2m. wide fire line over 400 m length) & cultural operation	3	600	0	600
33	Watch & word	15	3000	0	3000
TOTAL		18	3600	0	3600
7 TH YEAR MAINTENANCE					
34	Fire line Tracing (2m. wide fire line over 400 m length) & cultural operation	3	600	0	600
35	Watch & word	15	3000	0	3000

TOTAL		18	3600	0	3600
8TH YEAR MAINTENANCE					
36	Fire line Tracing (2m. wide fire line over 400 m length) & cultural operation	3	600	0	600
37	Watch & word	15	3000	0	3000
TOTAL		18	3600	0	3600
9TH YEAR MAINTENANCE					
38	Fire line Tracing (2m. wide fire line over 400 m length) & cultural operation	3	600	0	600
39	Watch & word	15	3000	0	3000
TOTAL		18	3600	0	3600

ABSTRACT

Year	No. Person days	Labour Cost @ Rs. 200/- per day	Material Cost (in Rs)	Total Cost (in Rs)
0 th Year	96	19200	2939	22139
1 st Year	86.5	17300	3825	21125
2 nd Year	39	7800	4264	12064
3 rd Year	32	6400	1920	8320
4 th Year	18	3600	0	3600
5 th Year	18	3600	0	3600
6 th Year	18	3600	0	3600
7 th Year	18	3600	0	3600
8 th Year	18	3600	0	3600
9 th Year	18	3600	0	3600
TOTAL	361.5	72300	12948	85248

Praveen
Executive Engineer
Koraput Investigation Division
Jeypore (K)

Annexure-3

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

Rupees in Lakh

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
1. Capital Investment		
A	Demarcation of boundary, fencing/ (trench / brushwood / barbed wire)	0.75
B	Land Development (10 hectares)@10 lakhs per ha. (including soil treatment and weeding)	0.75
C	Farm sheds – for equipment, seed, manure, and office	1.50
D	Purchase of agricultural implements	0.50
E	Creation of irrigation facilities: wells, pumps, power line, water tank, pump room, pipelines etc.	3.00
	Sub- Total	6.50
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	8.50
	Add for inflation of 9 years @8% per annum = $8.5 \times 9 \times 8\% =$	6.12
	Total	14.62


Executive Engineer
Koraput Investigation Division
Jeypore (K)

Annexure-4**(Gully with 1.3 m width, 0.6 m bottom width and depth 0.6 m)**

(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 $2 \times 0.5 \times 0.85 \times 2.25 \times 0.6 = 1.15$ Foundation for stone packing $1 \times 2.3 \times 1.8 \times 0.3 = 1.24$ D/S guard wall $1 \times 1.3 \times 0.5 \times 0.6 = 0.39$ Side wall $2 \times 2.13 \times 0.5 \times 0.3 = 0.64$ Total = 3.42	1.74	200	348
3	a. Dry stone packing in the foundation of structure U/S dumping (deflected by 45 deg.) $1 \times \{(1.3+2.2)/2\} \times 0.45 \times 0.3 = 0.24$ Head wall and D/S dumping $1 \times 1.3 \times 0.9 \times 0.3 = 0.35$ Apron $1 \times 1.3 \times 0.9 \times 0.3 = 0.35$ Side walls $2 \times 3.95 \times 0.5 \times 0.33 = 1.19$ D/S guard wall $1 \times 1.3 \times 0.5 \times 0.6 = 0.39$ b. Dry stone packing in super structure U/S dumping $1 \times \{(3.2+2.3)/2\} \times 0.45 (0.45+0)/2 = 0.27$ D/S dumping $1 \times 2.3 \times 0.45 \times (0.45+0.2)/2 = 0.33$ Head wall $1 \times 2.3 \times 0.45 \times 0.45 = 0.47$ Apron $1 \times 0.9 \times 1.3 \times 0.15 = 0.18$ Side walls $2 \times 3.95 \times 0.5 \times 0.3 = 1.30$ Total (a+b) = 5.07	2.6 MD 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 $2 \times 10 \times \{(1.05+0.45)/2\} \times 0.3 = 4.5 - 3.42 = 1.08$ 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 $2 \times 10 \times 0.42 = 8.40$ Top $1 \times 10 \times 0.45 = 4.50$ For 2 no. bunds $2 \times 12.90 = 25.80$ sq m	0.8 MD	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 1.0mt width of 3 rows including foliar spraying with Urea. No. of sleeves required = $(2.3/0.23) \times 3 = 30$ nos.	0.2 MD	200	40
7	Contingencies 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


Executive Engineer
Koraput Investigation Division
Jeypore (K)

Annexure-5**Earthen Check dam, 10 m with Concrete Core wall**

(As per Manual on Land and Water Management of Orissa Tribal Empowerment & Livelihoods Program 2010)

Labour cost			
Ordinary Labour	310 mandays	200/-	62000/-
Skilled Labour (Mason etc.)	15 mandays	240/-	3600/-
Total			65,600/-
Material Cost			
Cement	230 bags	405.00/-	93,150/-
Sand	15 truck	300.00/-	4,500/-
Brick	2500 Nos.	7.50/-/-	18,750/-
Aggregate (40 mm)	5 truck	6000	30,000/-
Bamboo	60 nos.	75/-	4,500/-
Total			1,50,900/-

Total Cost: 65,600.00 + 1,50,900.00=Rs.2,16,500/-

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


Executive Engineer
Koraput Investigation Division
Jeypore (K)

Year Wise Cash Flow

Item	0 th Year	1 st Year	2 nd Year	3 rd Year	4 th Year	5 th Year	6 th Year	7 th Year	8 th Year	9 th Year	Total
Afforestation including maintenance	27.67	26.40	15.09	10.40	4.50	4.50	4.50	4.50	4.50	4.50	106.56
Enrichment of Plantation/Re- densification	1.36	5.80	2.15	0.88	0.24	0.24	0.24	0.24	0.24	0.24	11.63
Fodder land development	14.62	14.62	14.62	14.62	14.62						73.10
Loose Boulder wall gully plugging			1.33								1.33
Masonry Stone Check Dam			10.82								10.82
Awareness campaign for farm management, control grazing etc.			15.00								15.00
Total cost of Biological, Engineering measure	43.65	46.82	59.01	25.90	19.36	4.74	4.74	4.74	4.74	4.74	218.44
Micro Planning Cost @ 5%	2.18	2.34	2.95	1.30	0.97	0.24	0.24	0.24	0.24	0.24	10.92
Sub Total	45.83	49.16	61.96	27.20	20.33	4.98	4.98	4.98	4.98	4.98	229.36
Contingency cost @ 5%	2.29	2.46	3.10	1.36	1.02	0.25	0.25	0.25	0.25	0.25	11.47
Sub Total	48.12	51.62	65.06	28.55	21.34	5.23	5.23	5.23	5.23	5.23	240.83
Administrative Expenditure @12%	5.77	6.19	7.81	3.43	2.56	0.62	0.62	0.62	0.62	0.62	28.90
Total	53.99	57.81	72.87	31.98	23.90	5.85	5.85	5.85	5.85	5.85	269.73

Devi
Executive Engineer
Koraput Investigation Division
Jeypore (K)