

प्रति,

श्री बिजेन्द्र स्वरूप,  
वन महानिरीक्षक (एफ.सी.)  
भारत सरकार, पर्यावरण वन एवं जलवायु परिवर्तन मंत्रालय,  
इंदिरा पर्यावरण भवन, अलीगंज,  
जोरबाग रोड़, नई दिल्ली-110003

विषय:-जिला खण्डवा के अंतर्गत भाम (राजगढ़) मीडियम लिफ्ट सिंचाई परियोजना के निर्माण हेतु 148.75 हेक्टेयर वन भूमि जल संसाधन विभाग को उपयोग पर देने बाबत।

संदर्भ:-भारत सरकार, पर्यावरण वन एवं जलवायु परिवर्तन मंत्रालय, नई दिल्ली का पत्र क्रमांक 8-34/2018-FC दिनांक 26/02/2021

—0—

विषयांतर्गत में भारत सरकार के उक्त संदर्भित पत्र से प्रकरण में चाही गई अतिरिक्त जानकारी आवेदक संस्था से प्राप्त कर निम्नानुसार प्रेषित है :-

i The Site Inspection Report by the AIGF(C), Integrated Regional Office, Bhopal on dated 25.07.2018, clearly mentions that 44 families are going to be displaced on account of the instant project. However, the state govt. has not submitted the approved copy of the R&R plan. The approved R&R plan along with the detail of compensation accorded to each individual/family is required before Stage-II approval.

उक्त बिन्दु के पालन में आवेदक संस्था द्वारा लेख किया गया है कि इस परियोजना निर्माण से कोई मकान/परिवार विस्थापित नहीं हो रहा है। इस परियोजना में 44 पट्टेधारियों की भूमि प्रभावित हो रही है, जिन्हे शासन नियमानुसार मुआवजा दिया जायेगा।

ii The approved CAT plan shall be submitted in accordance to Para 9.2 (vi) of Handbook, 2019 of F(C) Act.

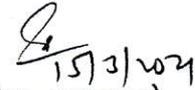
उक्त बिन्दु के पालन में स्वीकृत CAT plan मय तकनीकी स्वीकृति सहित संलग्न है।

iii The approved Land Use plan submitted does not reveal the complete details of Land Use. Therefore the approved Land Use Plan with complete details Land Use shall be submitted as under.

उक्त बिन्दु के पालन में Land Use Plan निर्धारित प्रारूप में संलग्न है।

अतः अनुरोध है कि प्रकरण में भारत सरकार, की औपचारिक अनुमति प्राप्त कर अवगत कराने का कष्ट करें।

संलग्न:-उपरोक्तानुसार।



(सुनील अग्रवाल)

अपर प्रधान मुख्य वन संरक्षक (भू-प्रबंध)

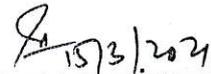
मध्यप्रदेश, भोपाल

भोपाल, दिनांक 15-3-21

पृ. क्रमांक/एफ-3/103/2017/10-11/10/177  
प्रतिलिपि:-

1. मुख्य वन संरक्षक, (क्षेत्रीय) खण्डवा वृत्त खण्डवा, मध्यप्रदेश।
2. वनमंडलाधिकारी, सामान्य वन मण्डल खण्डवा, मध्यप्रदेश।
3. कार्यपालन यंत्री, जल संसाधन संभाग, खण्डवा, मध्यप्रदेश।

की ओर सूचनार्थ अग्रेषित।



अपर प्रधान मुख्य वन संरक्षक (भू-प्रबंध)

मध्यप्रदेश, भोपाल

4

कार्यालय ग्राम पंचायत सरमेश्वर जनपद पंचायत खालवा जिला पूर्व निमाड़ खंडवा

प्रमाण पत्र

प्रमाणित किया जाता है कि भाम मध्यम सिंचाई परियोजना के डूब में ग्राम सरमेश्वर का जो वन क्षेत्र प्रभावित हो रहा है | उस डूब प्रभावित वन भूमि में कोई भी परिवार निवासरत नहीं है | समस्त पट्टेधारी परिवार ग्राम सरमेश्वर में तथा शेष भूमि में निवास करते हैं जो डूब प्रभावित नहीं है |

  
ग्राम पंचायत सरमेश्वर

  
ग्राम पंचायत सरमेश्वर

  
(V.K. Gupta)

  
अनुसंधान अधिकारी  
मुख्य शोध विभाग  
क्रमांक १०१/२०२१

  
१.३.२१

ग्रामपालक रीती  
ग्राम पंचायत संभाग  
खालवा (म.प्र.)

कार्यालय प्रधान मुख्य वन संरक्षक (कक्ष-भू प्रबंध), सतपुड़ा भवन, मध्यप्रदेश, भोपाल

तकनीकी स्वीकृति आदेश

आदेश क्रं/एफ-3/103/2017/10-11/10/21

भोपाल, दिनांक 6-3-2020

भारत सरकार द्वारा वन (संरक्षण) अधिनियम, 1980 के तहत नई गाईड लाईन जो कि दिनांक 08.03.2019 से प्रभावशील होने के निर्देश एवं प्रधान मुख्य वन संरक्षक एवं वन बल प्रमुख म0प्र0 भोपाल के आदेश क्रमांक/एफ-3/2019/10-11/03, दिनांक 31.05.2019 से प्रदत्त अधिकारों के अन्तर्गत गठित समिति की बैठक दिनांक 04.09.2019 को आयोजित की गयी। बैठक में भाम मध्यम सिंचाई परियोजना के केचमेन्ट एरिया ट्रीटमेन्ट प्लान का परीक्षण करने पर इसमें सुधार करने के निर्देश दिये गये।

कार्यपालन यंत्री, जल संसाधन संभाग खण्डवा द्वारा प्रस्तुत संशोधित केचमेन्ट एरिया ट्रीटमेन्ट प्लान का पुनः दिनांक 06.02.2020 को समिति द्वारा परीक्षण करने पर यह पाया गया, कि केचमेन्ट एरिया ट्रीटमेन्ट प्लान में वृक्षारोपण/चारागाह विकास के कार्य प्रावधानित नहीं है। अतः इस संबंध में केचमेन्ट एरिया ट्रीटमेन्ट प्लान संशोधित करने के निर्देश कार्यालयीन पत्र क्रमांक/एफ-3/2020/10-11/503, दिनांक 07.02.2020 से कार्यपालन यंत्री, जल संसाधन संभाग खण्डवा को दिये गये।

कार्यपालन यंत्री, जल संसाधन संभाग खण्डवा के द्वारा अपने पत्र क्रमांक/557/कार्य/वन पत्रा./2020, दिनांक 03.03.2020 से निर्देश अनुसार पुनरीक्षित केचमेन्ट एरिया ट्रीटमेन्ट प्लान प्रस्तुत किया गया। इस प्रस्तावित पुनरीक्षित केचमेन्ट एरिया ट्रीटमेन्ट प्लान कार्य की तकनीकी स्वीकृति निम्नानुसार प्रदान की जाती है :-

वनमण्डल का नाम	परिक्षेत्र का नाम	योजना का नाम	उपचार हेतु रकबा (हे0 में)	राशि (रूपये में)
खण्डवा	गुडीखेडा एवं खालवा	भाम मध्यम सिंचाई परियोजना (148.75 हेक्ट.)	11201.19	6,72,07,140

(राशि रूपये छः करोड बहात्तर लाख सात हजार एक सौ चालीस)

उक्त तकनीकी स्वीकृति निम्नलिखित शर्तों के अधीन रहेंगी :-

1. कार्यपालन यंत्री, जल संसाधन संभाग खण्डवा द्वारा प्रस्तुत प्राक्कलन के प्रस्तावों पर दी जाती है। यदि प्रस्तावों में कोई परिवर्तन स्थानीय परिस्थितियों को दृष्टिगत रखते हुए आवश्यक हो तो अनुमोदन उपरांत कराएं।
2. इस स्वीकृति के अधीन केचमेन्ट एरिया ट्रीटमेन्ट प्लान कार्य हेतु प्रशासकीय स्वीकृति प्राप्त होने पर प्राप्त राशि के अंतर्गत ही व्यय करेंगे, केवल तकनीकी स्वीकृति के आधार पर कार्य प्रारंभ न किया जावे। कैम्पा कक्ष द्वारा दिये आवंटन के अनुसार ही कार्य कराया जावे।
3. इस कार्य की उपयोगिता प्राक्कलन अनुसार कार्य के लिये है।
4. कार्य का संपादन तकनीकी स्वीकृति के साथ संलग्न प्राक्कलन एवं मानचित्र में दर्शित तकनीकी मापदण्डों के अनुसार कराया जावे। कार्य के दौरान स्थल की भौगोलिक स्थिति के अनुसार किसी प्रकार के परिवर्तन/संशोधन की आवश्यकता होने पर सक्षम अधिकारी से पूर्व अनुमति लेना अनिवार्य होगा।
5. केचमेन्ट एरिया ट्रीटमेन्ट प्लान अंतर्गत कार्य हेतु स्थल उपयुक्तता प्रमाण-पत्र प्राप्त कर ही कार्य किया जावे।
6. केचमेन्ट एरिया ट्रीटमेन्ट प्लान कार्य की गुणवत्ता पर सतत निगरानी रखी जावे।
7. कोई भी सामग्री क्रय करते समय भण्डार क्रय नियम का पालन करें।
8. कार्य प्रारंभ के पूर्व विस्तृत कार्यवार स्थल अनुरूप डी.पी.आर. तैयार कर कार्य प्रारंभ करावे।

06/03/2020

(सुनील अग्रवाल)

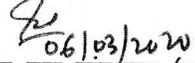
अपर प्रधान मुख्य वन संरक्षक (भू-प्रबंध)  
मध्यप्रदेश, भोपाल

पृ. क्रं/एफ-3/103/2017/10-11/10/936  
प्रतिलिपि:-

भोपाल, दिनांक 6-3-2020

1. अपर प्रधान मुख्य वन संरक्षक (विकास), सतपुडा भवन, मध्यप्रदेश भोपाल।
2. अपर प्रधान मुख्य वन संरक्षक (कैम्पा), सतपुडा भवन, मध्यप्रदेश भोपाल।
3. प्रमुख अभियंता, जल संसाधन विभाग, 1250, तुलसी नगर, भोपाल, मध्यप्रदेश।
4. मुख्य वन संरक्षक, (क्षेत्रीय) खण्डवा वृत्त खण्डवा, मध्यप्रदेश।
5. वनमण्डलाधिकारी, ता.0 वनमंडल खण्डवा, मध्यप्रदेश, की ओर उक्त केचमेन्ट एरिया ट्रीटमेन्ट प्लान की प्रति संलग्न है। इस परियोजना की अंतिम स्वीकृति प्राप्त होने पर इस कार्य के लिए राशि की मांग कैम्पा शाखा से करें।
6. कार्यपालन यंत्री, जल संसाधन संभाग खण्डवा, जिला खण्डवा, मध्यप्रदेश की ओर सूचनार्थ अग्रेषित कर निर्देशित किया जाता है, कि उपरोक्तानुसार केचमेन्ट एरिया ट्रीटमेन्ट प्लान कार्य की राशि ई-पोर्टल पर कैम्पा मद मे जमा करें।

संलग्न:- अनुक्रमांक 4 एवं 5 के लिए केचमेन्ट एरिया ट्रीटमेन्ट प्लान की प्रति।

  
06/03/2020  
अपर प्रधान मुख्य वन संरक्षक (भू-प्रबंध)  
मध्यप्रदेश, भोपाल



**WATER RESOURCES DEPARTMENT, MADHYA PRADESH**

Catchment Area Treatment Plan for Bham Medium Irrigation Project, District Khandwa, Madhya Pradesh

Subdu Copy

Dr. 03/03/20

# **GOVERNMENT OF MADHYA PRADESH**



**Water Resources Department**

**Bham Medium Irrigation Project**

**Catchment Area Treatment Plan**

**Amount Rs. 672.07 Lakhs**

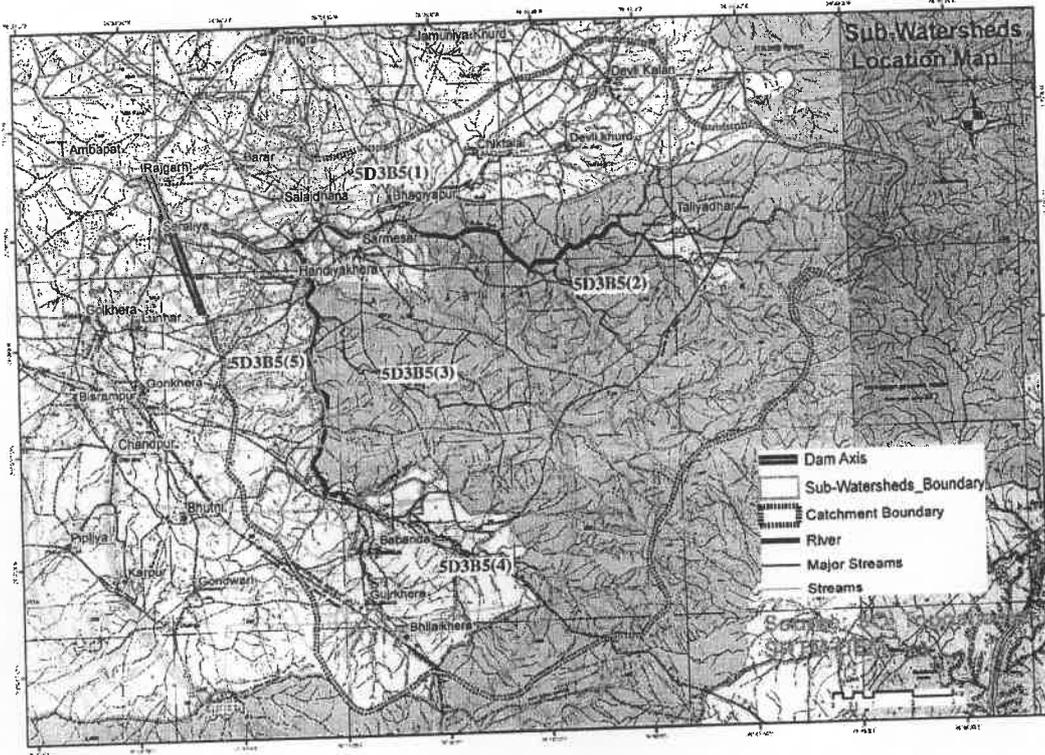
**Distt. Khandwa**

**Block Pandhana**

---



# BHAM-RAJGARH MEDIUM IRRIGATION PROJECT KHANDWA



## CATCHMENT AREA TREATMENT PLAN (COST Rs. 672.07 Lakhs)

CHIEF ENGINEER N.T. BASIN  
WATER RESOURCES DEPARTMENT  
INDORE, M.P.



## Contents

### **CATCHMENT AREA TREATMENT PLAN FOR BHAM MEDIUM IRRIGATION PROJECT**

---

- 1.1 Introduction
- 1.2 Objectives
- 1.3 Catchment Area
- 1.4 Free Draining Catchment
- 1.5 Topography
- 1.6 Soil
- 1.7 Land use
  - 1.7.1 *Land use-Land Cover Classification*
  - 1.7.2 *Land use Categories and Erosion*
  - 1.7.3 *Slope*
- 1.8 Methodology Used for the Study
  - 1.8.1 *Soil Loss Using Silt Yield Index (SYI) Method*
- 1.9 Catchment Area Treatment Plan
- 1.10 Treatment of Individual Sub-Watershed
  - 1.10.1 *Activities to be Undertaken*
- 1.11 Cost Estimation for Cat Plan



## **1. CATCHMENT AREA TREATMENT PLAN**

### **Introduction**

It is a well established fact that reservoirs formed by dams on rivers area subjected to sedimentation. The process of sedimentation embodies the sequential processes of erosion, entrainment, transportation, deposition and compaction of sediment. The study of erosion and sediment yield from catchment is of utmost importance as the deposition of sediment in reservoir reduces its capacity, thus affecting the water available for the designated use. The eroded sediment from catchment when deposited on streambeds and banks causes braiding of river reach. The removal of top fertile soil from catchment also adversely affects the agricultural production and growth of plants. Another crucial factor that adds to the sediment load and which contributes to soil degradation is grazing pressure.

The lack of proper vegetal cover is a factor to cause degradation and thereby results in severe run off/soil erosion, and subsequently premature siltation of the reservoir. Thus, a well-designed Catchment Area Treatment (CAT) Plan is essential to ameliorate the above-mentioned adverse cause and process of soil erosion. The catchment area treatment involves the understanding of the erosion characteristics of the terrain and suggesting remedial measures to reduce the erosion rate. For this reason, the catchment of the directly draining rivers, streams, tributaries, etc. are treated and the cost is included in the project cost.

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

Catchment Area Treatment (CAT) plans for the free draining catchment area of the proposed project has been prepared for areas with high soil erosion intensity. The CAT Plan targets towards overall improvement in the environmental conditions of the region. All the activities are aimed at treating the degraded and potential areas with severe soil erosion. The plan provides benefits due to biological and engineering measures and its utility in maintaining the ecosystem health. The plan with objectives addresses issues such as prevention of gully erosion, enhancing the forest cover for increasing soil holding capacity; and arresting total sediment flow in the reservoir and flowing waters.

### **Objectives**

Integrated watershed management plan minimizes the sedimentation of reservoir. The main aim of the Catchment Area Treatment Plan is to rejuvenate various potential and degraded ecosystems in the catchment area for longevity of the reservoir storage capacity. For this purpose, the action plan has been prepared with the following objectives:

1. To facilitate the hydrological functioning of the catchment and to augment the quality of water of the river and its tributaries.
2. Conservation of soil cover and to arrest the soil erosion, floods and siltation of the river along with its tributaries and consequent reduction of siltation in the reservoir of the project.



- 3 Demarcation of the priority of watersheds for treatment based on soil erosion intensity in the catchment area.
- 4 Rehabilitation of degraded forest areas through afforestation and facilitating natural regeneration of plants.
- 5 Mitigation of landslide, landslip and rock falls.
- 6 Soil conservation through biological and engineering measures to reduce sediment load in river and tributaries, incidentally improving the quality of water.
- 7 Ecosystem conservation resulting from increased vegetal cover and water retaining properties of soil.

### **Catchment Area**

Bahm river rises in District Khandwa from Teliya Dhar Reserved Forest near Chormundri at an elevation of 455 mamsl. The river flows in a generally east-westerly direction up to the dam site. The river has little base flow due to ground water and receives maximum discharge during monsoon in direct response to precipitation.

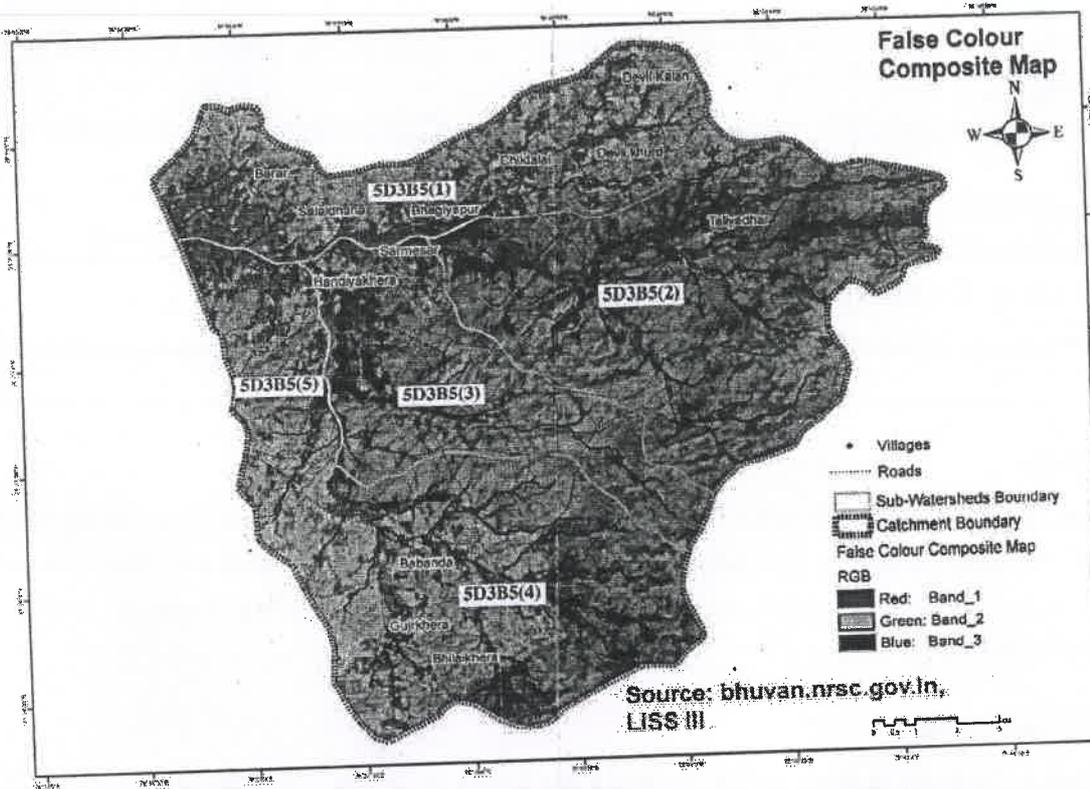
### **Free Draining Catchment**

The total catchment area of river up to the proposed site is 193.46 sq. km and shall be intercepted by three proposed minor projects having aggregate catchment area of 56.39 sq. km. Since there are no major or medium water resource project on upstream, the Catchment Area Treatment Plan shall be formulated for entire catchment (193.46sq. km). As per nomenclature contained in Water Atlas of India, Edition 1993, the catchment under the study area lies in Water Resource Region-5 (Narmada); basin 5D (Narmada), Catchment 5D3, sub-catchment 5D3Band watershed 5D3B5 (Bham).

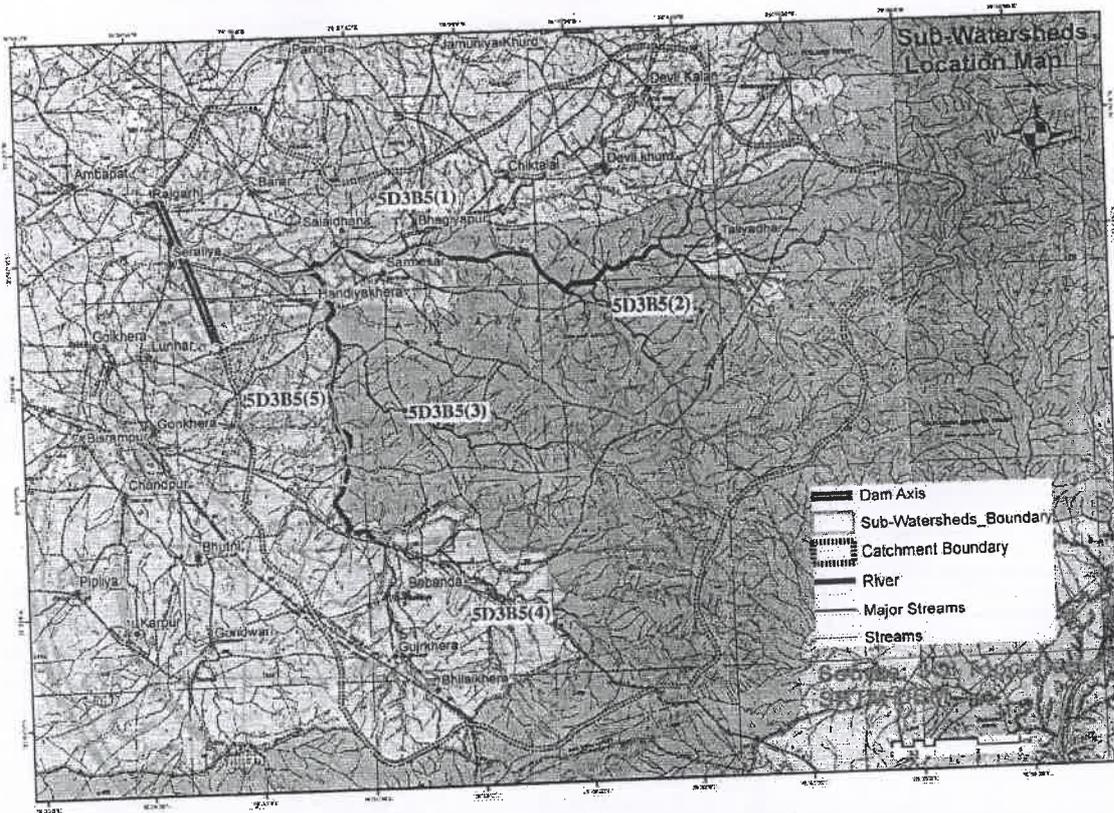
The basin characteristics of different sub-watersheds are illustrated in **Table 1.1**, the satellite imagery of the free draining catchment is presented in **Figure 1.1**, and the mosaic map of sub-watershed location is shown in **Figure 1.2**.

**Table 1.1: Basin Characteristics of Different Sub-watersheds**

Sl. No	Sub-watersheds	Total catchment area (Sq.km.)	Highest Altitude (mamsl)
1	5D3B5(1)	36.91	446
2	5D3B5(2)	60.82	455
3	5D3B5(3)	30.41	380
4	5D3B5(4)	49.51	422
5	5D3B5(5)	15.81	360
	<b>Total</b>	<b>193.46</b>	



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

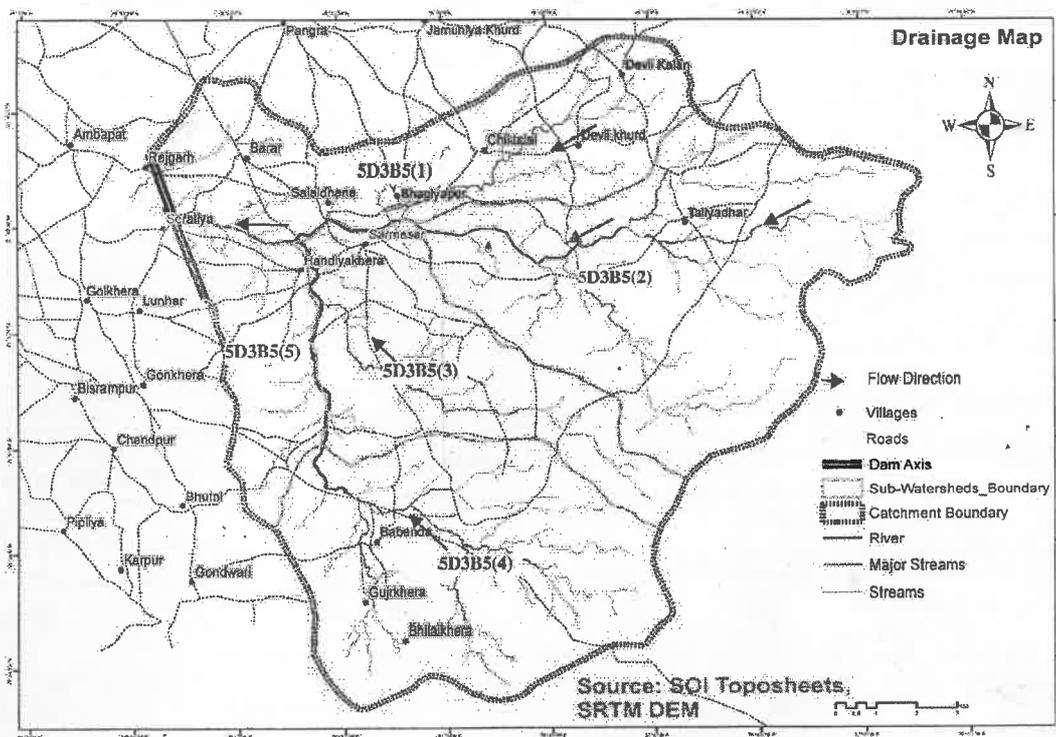


**Figure 1.2: Mosaic Map Showing Location of Sub-watersheds**



## Topography

The project catchment area is hilly and nearby 60% of catchment is covered by forest of deciduous dry type with Teak and Bamboo. Total Catchment area of project is 193.459 Sq. Km and there are 3 proposed minor proposed on the upstream of this project. The elevation of the catchment area varies from El. 309 mamsl near riverbed at project site to El. 455 mamsl. The drainage map of the catchment is shown in **Figure 1.3**.



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

## Soil

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

- Soil map unit 3

These are very shallow, somewhat excessively drained, loamy-skeletal soils on moderately sloping hills and hills ranges with severe erosion and moderately stony, associated with: Extremely shallow, excessively drained, loamy soils on moderately steep sloping with very severe erosion and strongly stony.

- Soil map unit 20

These are shallow, somewhat excessively drained, loamy-skeletal soils on moderately sloping residual



hills with narrow valleys with severe erosion and strongly stony, associated with: very shallow, well drained, clayey-skeletal soils on gently sloping with severe erosion

**Soil map unit 57**

These are very shallow, well drained, clayey soils on gently sloping plateau with severe erosion and moderately stony, associated with: Very shallow, somewhat excessively drained, loamy-skeletal soils on gently sloping with severe erosion and slightly stony.

- **Soil map unit 74**

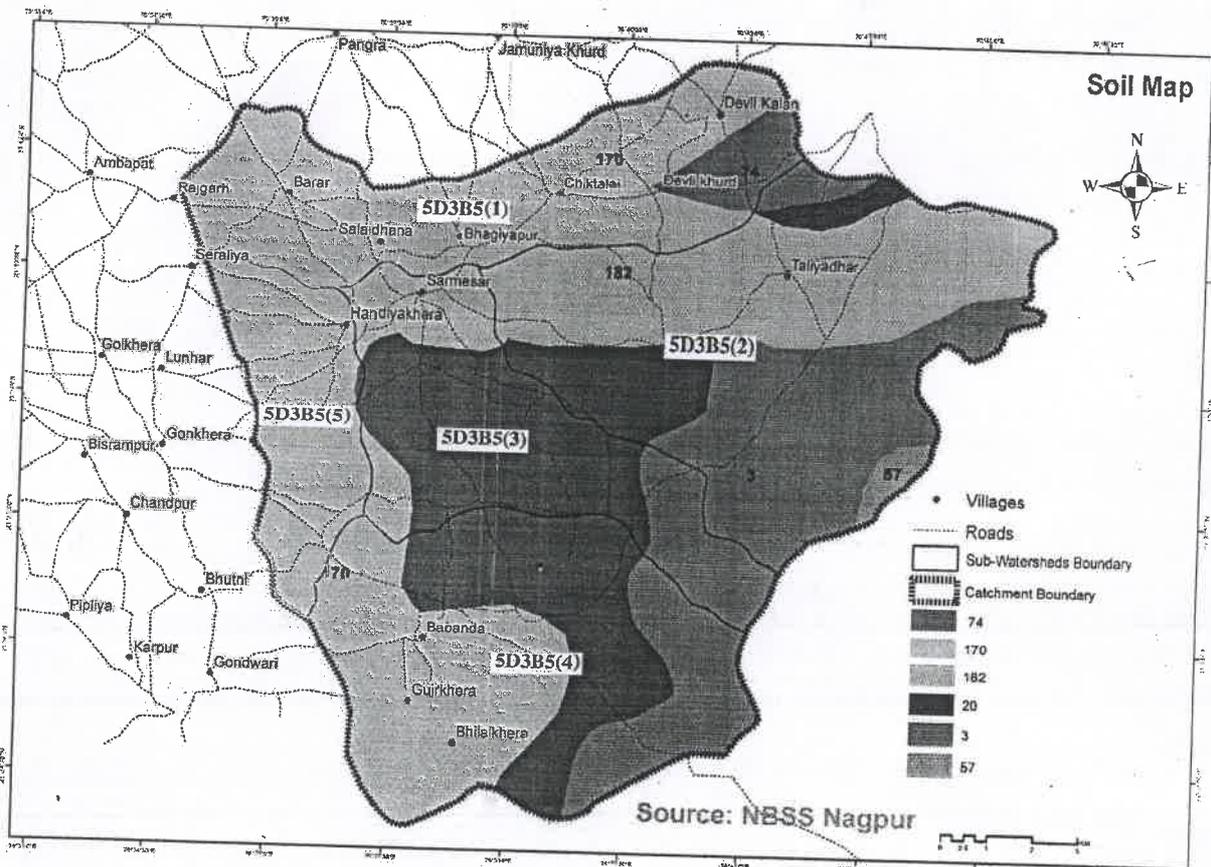
These are slightly deep, moderately well drained, calcareous, clayey soils on gently sloping plain land with moderate erosion. Associated with: Slightly deep, moderately well drained, calcareous, clayey soils on gently sloping with moderate erosion.

- **Soil map unit 170**

These are shallow, well drained, clayey soils on gently sloping undulating plains with moderate erosion and moderately stony, associated with: Very shallow, well drained, loamy soils on gently sloping with severe erosion.

- **Soil map unit 182**

These are deep, moderately well drained, calcareous, clayey soils on moderately sloping plain land (slightly dissected) with moderate erosion, associated with: Slightly deep, moderately well drained, calcareous, clayey soils on gently sloping with moderate erosion.





**Figure 1.4: Soil Map of Catchment**

## **Land use**

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

Based on satellite data and topo-sheets, a land-use map has been prepared and verified in detail during ground surveys i.e. crosschecked with ground truths. The Land use/ Land-cover map of the catchment area is presented in **Figure 1.5** and its details are presented in **Table 1.2**.

### **Land use Categories and Erosion**

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

#### **Agricultural Land**

Around 77.20 sq. km area of the catchment constituting 39.90% of the total catchment comes under this category. Plain to Well-planned and developed terraces were seen at some places. In general, at places the sheet and rill type of soil erosion predominates with few gullies in early stage of its development. Very few or no measures are taken to conserve soil and tendency exists to interrupt the natural drainage due to faulty agricultural practices. Runoff often exceeds the safe velocity on long slope lengths. It is suggested to repair and better design the agricultural terraces, which follows the faulty agricultural practices.

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

#### **Settlement**

Under settlement category about 2.59 sq. km area of catchment constituting 1.34% of the total catchment is present.

#### **Open Forest Land**

Under open forest category about 1.33 sq. km constituting 0.69% of the total catchment, is present. Forest crown density ranges from 0-40% or on average 20% crown density can be assumed present in the area. Soils have relatively good water holding capacity, humus, nutrient content and moderate to slight erosion rates on steeper slopes. Therefore, rill erosion predominates which in due course leads to scrub land formation with gullies. Afforestation is suggested so as increase the crown density by 20% in whole of the area to reduce erosion.

#### **Dense Forest**

Dense forest covers about 104.90 sq. km area constituting 54.23% of the catchment with the forest crown density above 40%. Soils are very good in water holding capacity, humus and nutrients with no erosion but due to steeper slopes, some area requires soil conservation measures.



**River / Water body**

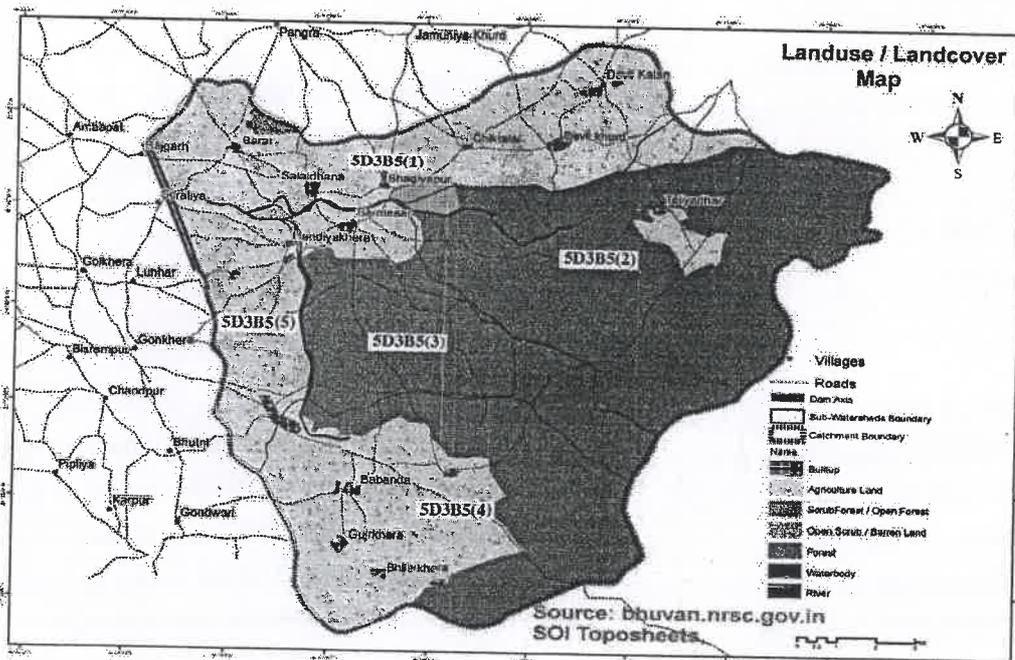
Around 1.66 sq. km area constituting 0.85% of the catchment area is classified under water bodies. The category needs no treatment except that the unstable bank shall be provided stream bank stabilization through protection measures whenever required.

**Scrub**

Under scrub category about 5.78 sq. km area of catchment constituting 2.99% of the total catchment is present.

**Table 1.2: Land use Details of Sub-watersheds in the Catchment**

Sub-watershed	Land Use Category						Area (sq. km)
	Dense Forest	Open Forest	Scrub	Agriculture	Settlement	Water body	
5D3B5(1)	0.87	0.68	3.12	30.99	0.82	0.43	36.91
5D3B5(2)	54.88	0.65	0.00	4.83	0.11	0.35	60.82
5D3B5(3)	25.73	0.00	0.00	4.09	0.14	0.45	30.41
5D3B5(4)	23.42	0.00	0.00	25.11	0.71	0.27	49.51
5D3B5(5)	0.00	0.00	2.66	12.18	0.82	0.15	15.81
Total	104.90	1.33	5.78	77.20	2.59	1.66	193.46
Percentage	54.23	0.69	2.99	39.90	1.34	0.85	100.00



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

**Slope**

The slope of a watershed plays a key role in controlling the soil and water retention thereby affecting



the land-use capability. The percentage of the slope in a watershed determines the soil erosion susceptibility and forms the basis for classifying different of the watershed into suitable classes for formulating effective soil erosion conservation measures. Broadly, the following slope classes and ranges (**Table 1.3**) as per norms of All India Soil & Land Use Survey were adopted to classify the slopes for the present study.

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

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

The Slope map of the free draining catchment is presented in **Figure 1.6** and slope details are as presented under **Table 1.4**. The data shows that about 87.05% area lies between very gentle to gentle slope category of slope and balance 12.65% falls from moderate slope to moderately steep slope category while 0.3% pertains to steep classification.

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

S. N.	Description	Sub-watershed					Area (sq. km)	Area (%)
		5D3 B5(1)	5D3 B5(1)	5D3 B5(1)	5D3 B5(1)	5D3 B5(1)		
1	Very Gentle Slope	18.59	20.64	10.51	20.23	7.53	77.50	40.06
2	Gentle Slope	15.69	28.77	15.20	24.13	7.12	90.91	46.99
3	Moderate Slope	2.45	9.27	4.21	4.36	1.14	21.42	11.07
4	Moderately Steep	0.18	1.72	0.46	0.68	0.02	3.06	1.58
5	Steep	0.00	0.42	0.03	0.11	0.00	0.56	0.30
<b>Total</b>		<b>36.91</b>	<b>60.82</b>	<b>30.41</b>	<b>49.51</b>	<b>15.81</b>	<b>193.46</b>	<b>100.00</b>

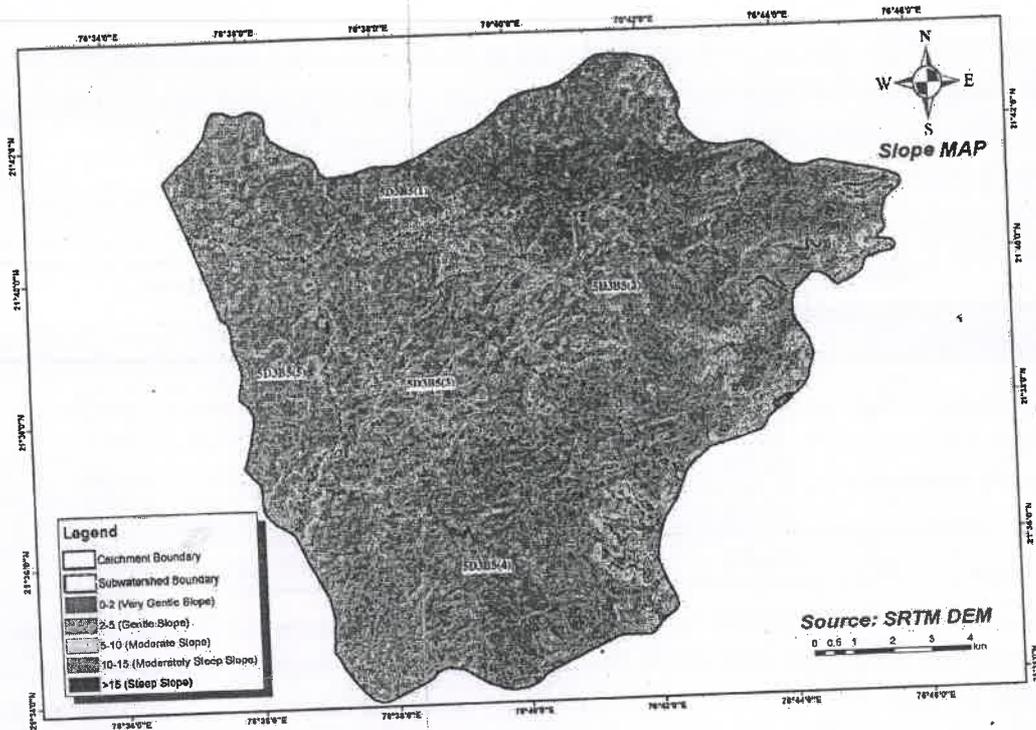


Figure 1.6: Slope Map of Catchment

### Methodology Used for the Study

Superimposing topography, slope, soil and land use data/maps, a tentative estimation of erosion prone areas and landslides area in the catchment were made. The vulnerable and problematic areas were identified in different physiographic zones.

These data sets were used for preparation of the thematic maps, calculation of sediment yield index and Erosion Intensity Units.

### Soil Loss Using Silt Yield Index (SYI) Method

- The Silt Yield Index Model (SYI), considering sedimentation as product of erosivity, erodibility and aerial extent was conceptualized in the All India Soil and Land Use Survey (AISLUS) as early as 1969 and has been in operational use since then to meet the requirements of prioritization of smaller hydrologic units within river valley project catchment areas.
- Methodology for the calculation of sediment yield index developed by All India Soil & Land Use Survey (Development of Agriculture, Govt. of India) was followed in this study.

### Erosion Intensity and Delivery Ratio

- Determination of erosion intensity unit is primarily based upon the integrated information on soil characters, physiography, slope, land-use/land-cover, litho logy and structure. This is achieved through super-imposition of different thematic map overlays. Based upon the field data collected during the field survey and published data, weightage value and delivery ration were assigned to each erosion intensity unit. The composite map for delineating different erosion intensity units was prepared through superimposition of the maps showing soil types, slope and land-use/land-cover. This thematic mapping of erosion intensity for entire catchment was done using the overlay and



union techniques. Based on ground truth verification conducted during fieldwork and published data, weightage and delivery ratio was assigned to each erosion intensity units. The composite erosion intensity map was then superimposed on the drainage map with sub-watershed boundaries to evolve CEIU for individual sub-watershed.

- Each element of erosion intensity unit is assigned a weightage value. The cumulative weightage values of the erosion intensity units represent approximately the relative comparative erosion intensity within the watersheds. A basic factor of  $K=10$  was used in determining the cumulative weightage values. The value of 10 indicated an equilibrium condition between erosion and deposition. Any value of  $K (10+X)$  is suggestive of erosion intensity in an ascending order whereas the value of  $K (10-X)$  is suggestive of deposition intensity in descending order.
- The delivery ratios were calculated for each composite erosion intensity unit. The delivery ration suggests the percentage of eroded material that finally finds entry into the reservoir or river/stream. Total area of different erosion intensity classes (composite erosion intensity unit) in each watershed was then calculated.
- The delivery ratio is generally governed by the type of material, soil erosion, relief length ratio, cover conditions, distance from the nearest stream, etc. However, in the present study the delivery ratios to the erosion intensity units were assigned upon their distance from the nearest stream. (being the most crucial factor responsible for delivery of the sediments) per the following scheme. The delivery ratio criteria adopted for the study is presented in **Table 1.5**.

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

Nearest Stream	Delivery Ratio (DR)
0-0.9 km	1.00
1.0-2.0 km	0.90
2.1-5.0 km	0.80
5.1-15.0 km	0.70
15.1-30.0 km	0.50

**(ii) Sediment Yield Index & Prioritization of Sub-Watersheds**

- The erosivity determinates are the climatic factors and soil and land attributes that have direct or reciprocal bearing on the units of the detached soil material. The relationship can be expressed as:

$$\text{Soil erosivity} = f(\text{Climate, physiography, slope, soil parameters land use/land cover, soil management})$$

- The Silt Yield Index (SYI) is defined as the Yield per unit area and SYI value for hydrologic unit is obtained by taking the weightage arithmetic mean of the products of the weightage value and delivery ratio over the entire area of the hydrologic unit by using suitable empirical equation.
- Prioritization of smaller hydrological units within the vast catchments is based on the SYI of the smaller units. The boundary values of range of SYI values for different priority categories are arrived at by studying the frequency distribution of SYI values and locating the suitable breaking point. The watersheds/sub-watersheds are subsequently rated into various categories corresponding to their respective SYI values.



- The application of SYI model for prioritization of sub-watersheds in the catchment areas involves the evaluation of:
  - Climatic factors comprising total precipitation, its frequency and intensity
  - Geomorphic factors comprising land forms, physiography, slope and drainage characteristics
  - Surface cover factors governing the flow hydraulics
  - Management factors.
- The data on climatic factors can be obtained for various locations in the catchment area from the meteorological stations whereas the field investigations are required for estimating the other attributes.
- The various steps involved in the application of model are:
  - Preparation of a framework of sub-watershed through systematic delineation
  - Rapid reconnaissance surveys on 1:50,000 scale leading to the generation of a map indicating erosion-intensity mapping units.
  - Assignment of weightage values to various mapping units based on relative silt-yield potential.
  - Computing Silt Yield Index for individual watersheds/sub watersheds.
  - Grading of watersheds/sub-watersheds into very high, high medium, low and very low priority categories.
  - The area of each of the mapping units is computed and silt yield indices of individual sub-watersheds are calculated using the following equations:

#### Silt Yield Index

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

Where

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

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

	<u>Priority Category</u>	<u>SYI Values</u>
1.	Very High	>1300
2.	High	1200-1299
3.	Medium	1100-1199





### Catchment Area Treatment Plan

There are mainly five categories of Land uses for which a proper treatment plan should be developed. First is the Agricultural Land, as this activity can never be eliminated, because the faulty practice results in heavy loss of fertile soil. Second, being open forestland for obvious conservation reasons. Third is scrub or degraded land, which contributes heavily to the silt load and possibilities exist to bring this area under pastures and other plantation to meet the local demand of fuel and fodder and thus decreasing the biotic pressure on the forests and leading to environment friendly approach of sustainable development. The fourth and most important category is Barren land because with practically no vegetal cover, the area produces huge amount of silt load. The fifth is dense forestland where in a few places soil conservation measures are required. For treatment of catchment area, the areas that require treatment have been delineated from the Composite Erosion Intensity Unit Map. The sum of weightages was reclassified as per the Table 1.7 below to further subdivide the area as per the erosion intensity classes. The weightages for Land use, Slope & Soil were summed to get the Erosion Intensity Classes.

**Table 1.7: Erosion Intensity & Weightages**

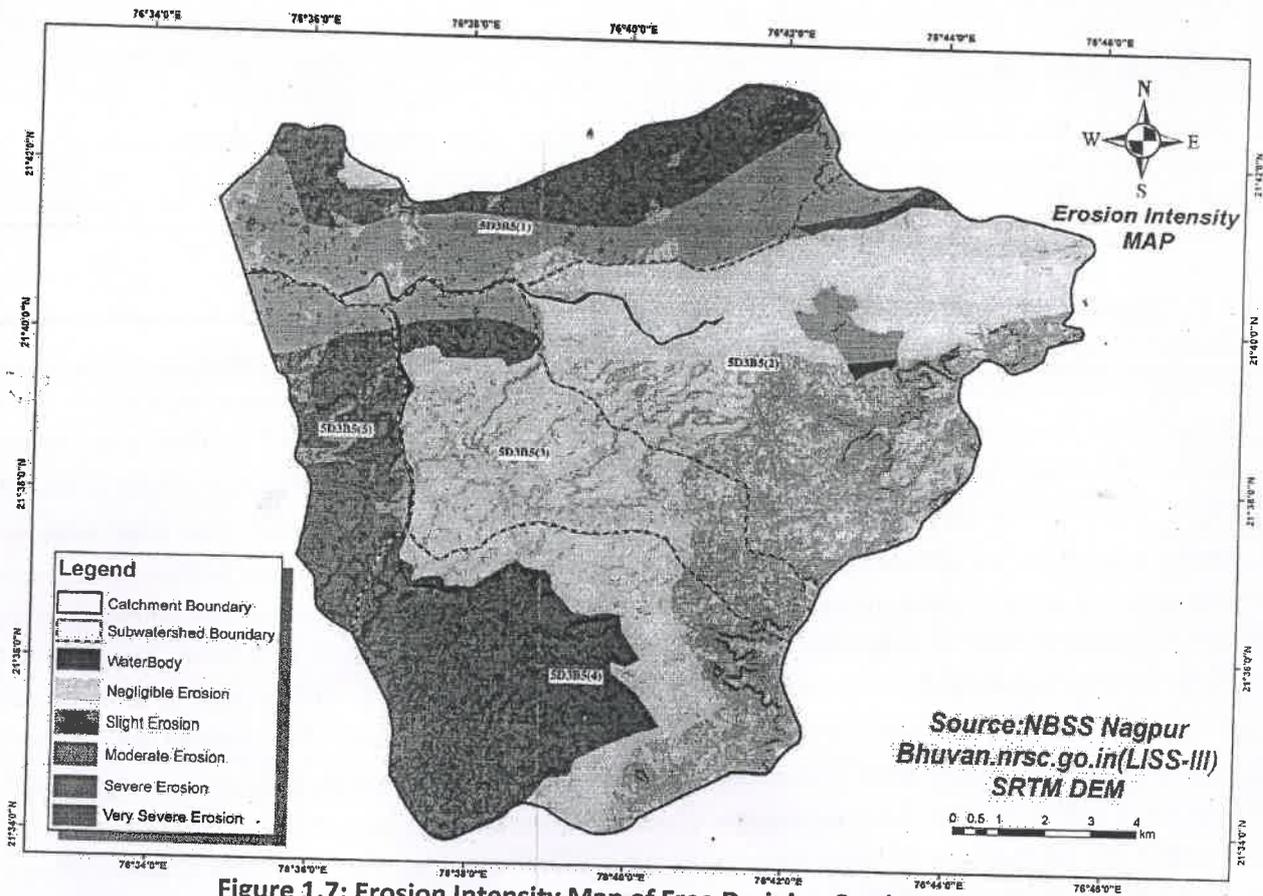
Erosion Intensity Class	Sum of weightages
Very severe (E5)	12 to 14
Severe (E4)	9 to 11
Moderate (E3)	6 to 8
Slight (E2)	4 to 5
Negligible (E1)	0 to 3

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

Considering the topographic factors, soil type, climate, land-use/land-cover in the catchment area following engineering and biological measures have been proposed to be undertaken with the aim to check the soil erosion, prevent/check siltation of reservoir and to maintain its storage capacity in the long run. The Erosion Intensity Map of the free draining catchment has been generated based on SYI data and is presented in Figure 1.7 and the statistics are presented in Table 1.8.

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

Sr. No	Sub-water-shed	Very Severe	Severe	Moderate	Slight	Negligible	Water bodies	Total
1	5D3B5(1)	0.81	5.93	9.41	17.82	2.50	0.43	36.91
2	5D3B5(2)	0.14	0.73	1.54	20.66	37.40	0.35	60.82
3	5D3B5(3)	0.15	1.03	1.46	8.84	18.47	0.45	30.40
4	5D3B5(4)	1.91	12.68	12.00	15.55	7.10	0.26	49.50
5	5D3B5(5)	0.68	4.68	6.39	3.82	0.08	0.16	15.81
<b>Total</b>		3.69	25.04	30.80	66.70	65.56	1.65	193.46



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

### Treatment of Individual Sub-Watershed

There are mainly five categories of land uses for which a proper treatment plan should be developed. First is the agricultural land as this activity can never be eliminated. And, agriculture activities, if faulty, result in heavy loss of fertile soil. Second, is open forest land for conservation reasons Third is scrub or degraded land, which contributes heavily to silt load. Possibilities exist to bring this area under pastures and plantation to meet local demand of fuel and fodder and thus decreasing the biotic pressure on the forests leading to environment friendly approach of sustainable development. The fourth and most important category is barren land because with practically no vegetal cover the area produces huge amount of silt load. The fifth is dense forest land where a few places soil conservation measures are required.

In the present case, An area of 11201.19 Ha. falling under forest would be taken up for conservation under the CAT plan within the free draining catchment.

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.



## **Activities to be Undertaken**

### **Enrichment Plantation**

There are a few locations within forest in the catchment area where the crown density is poor and plantation can be done to increase the patch density of crop and to create dense forest.

### **Treatment of Pasture**

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

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

### **Nursery Support**

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

### **Civil Structures**

These structures are to be constructed as landslide control and stream bank stabilization over visually



active slides and eroded banks of the main river and its tributaries falling under "Severe" and "Very Severe" erosion intensity areas to control the sediment flow and further degradation of the free draining catchment areas. Since these measures are to be carried out by construction of individual structure such as wire crate spurs, check dams, contour staggered trenches, catch water drains, retaining walls etc.

**Brush wood Check Dams and Retaining Walls**

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

**Slope Modification by Stepping or Terracing**

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

**Bench Terracing**

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

**Gully Control-Check Dams**

Gullies are mainly formed because physiographic, soil type, and heavy biotic interference in an area. The scouring of streams at their peak flows and sediment-laden run-off cause gullies. The gullies would be required to be treated with engineering/mechanical as well as vegetative methods. Check dams would be constructed in some of the areas to promote growth of vegetation that will consequently lead to the stabilization of slopes/area and prevention of further deepening of gullies and erosion. Diverse types of check dams would be required for different conditions comprising of different materials depending upon the site conditions and the easy availability of material (stones) at local level and transport accessibility. Generally, brush wood check dams are recommended to control the erosion in the first order basin/streams in upper reaches and dry random stone masonry check dam shall be provided in the lower reaches where discharge is higher. In such stream where discharge and velocity of flow are still higher gabion structure shall be provided. Lower down the sub-watershed, i.e., in the third order drainage silt retention dams in the form of gabion structure shall be provided.

**Stream bank Protection**

Stream bank erosion is caused by variety of reasons such as destruction of vegetative cover, mass movement on unstable bank slopes, undermining of top portion of lower bank by turbulent flow and



sliding of slopes when saturated with water. The Stream Bank Protection would include wire crate boulder spurs in two to three tiers depending upon the high flood level of the streams.

**Contour Staggered Trenches**

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

**Landslide Control**

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

**Catch-water Drains**

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

**Provision for Forest Protection**

The need for rigorous watch and ward of the forest covered under the catchment area becomes more imperative in view of proposed new plantation under the CAT plan and due to increased human activity in the form of labour, who shall be engaged for forestry works. Thus, fire protection measures including construction and maintenance of fire lines, construction of check-posts, watch towers have to be undertaken. Besides these construction / repair of forest boundary pillars shall also be carried out. The forest staff shall have to be properly equipped with modern utility gadgets like walky-talky, GPS and fire-fighting equipment's.

**Cost estimation for treatment in Forest area comes under Catchment Area**

Total Catchment Area = 193.46 Sqkm

Total Forest area lie within C.A. = 112.01 Sqkm

Name of Forest Range:- Gudikheda & Khalwa, Dist. Khandwa

Daily Wages Rate:- Rs. 302/-



**Cost estimation for treatment in Forest area comes under Catchment Area**

Total Catchment Area = 193.46 Sqkm

Total Forest area lie within C.A. = 112.01 Sqkm

Name of Forest Range:- Gudikheda & Khalwa, Dist. Khandwa

Daily Wages Rate:- Rs. 302/-

**Cost Abstract (For 100 Hact.)**

(Estimate is prepared on basis of approved estimate of Birsinghpur dam project CAT plan.)

Sl. No.	Description of Work	Unit	Quantity	Rate in Mandays per unit	Total Amount (Rs.)
1	Survey of Area with Cleaning in 3 M wide strip & Marking over tree lie within 3m strip and fixing of pegs on 200-200 Meter interval with making of frame (Khancha) & writing over them.	Hact.	100	0.45	13590/-
2	Excursion in area & Preparation of Catchment area treatment plan	Hact.	100	0.25	7550/-
3	Dressing of Sagwan stalk (Doonth) and Other species Tree.	Hact.	100	2.00	60400/-
4	Construction of Checkdam by Collection of loose Boulders spread over surface of forest area	2 Cum/ Hact.	100	1.26 /cum	76104/-
5	Making of Contour Trench / Contour Bund in Forest Area	25 RM/ Hact.	100	0.10/RM	75500/-
6	Collection of Seeds / Purchase	5kgs./Hact.	100	100/- per Kg.	50000/-
7	In Second (II) Year, Sowing of Seeds in Check dam/Contour Trench/Contour Bund	Per Hact.	100	1.00	30200/-
8	Foddar Development @ 5% i.e. 5Ha./100Ha. of Area	Hact.	100	0.67/Hact.	20234/-
9	Percolation Tank	No./Hact	100	8.4/Hact.	253680/-
10	Other Miscellaneous Exp.	100 Hact.	Lumpsum		12742/-
<b>Total Amount</b>					<b>600000/-</b>

Total Expenditure for 100 Hactare = Rs. 6,00,000/

Therefore amount required for 01 Hactare = Rs. 6,000/-



### Compartment wise Amount Requirement

Sl. No.	Compartment No.	Area of Compartment (Hact.)	Rate per Hact. (Rs.)	Amount (Rs.)
1	748	144.88	6000	869280
2	749	301.60	6000	1809600
3	750	8.00	6000	48000
4	753	680	6000	4080000
5	754	323	6000	1938000
6	755	826	6000	4956000
7	756	384.90	6000	2309400
8	757	483	6000	2898000
9	758	663	6000	3978000
10	759	778	6000	4668000
11	760	471.90	6000	2831400
12	761	490	6000	2940000
13	762	514	6000	3084000
14	763	697	6000	4182000
15	764	380.10	6000	2280600
16	765	439	6000	2634000
17	766	771	6000	4626000
18	767	702	6000	4212000
19	768	525	6000	3150000
20	769	215	6000	1290000
21	770	375	6000	2250000
22	776	81.81	6000	490860
23	777	752	6000	4512000
24	778	176	6000	1056000
25	779	19	6000	114000
	<b>Total =</b>	<b>11201.19</b>		<b>67207140</b>

Total Cost for Catchment area treatment for forest area of Bham medium irrigation project is Rs. 6,72,07,140/- (In words Rs. Six Crore Seventy Two Lakhs Seven Thousand One Hundred Forty Only).

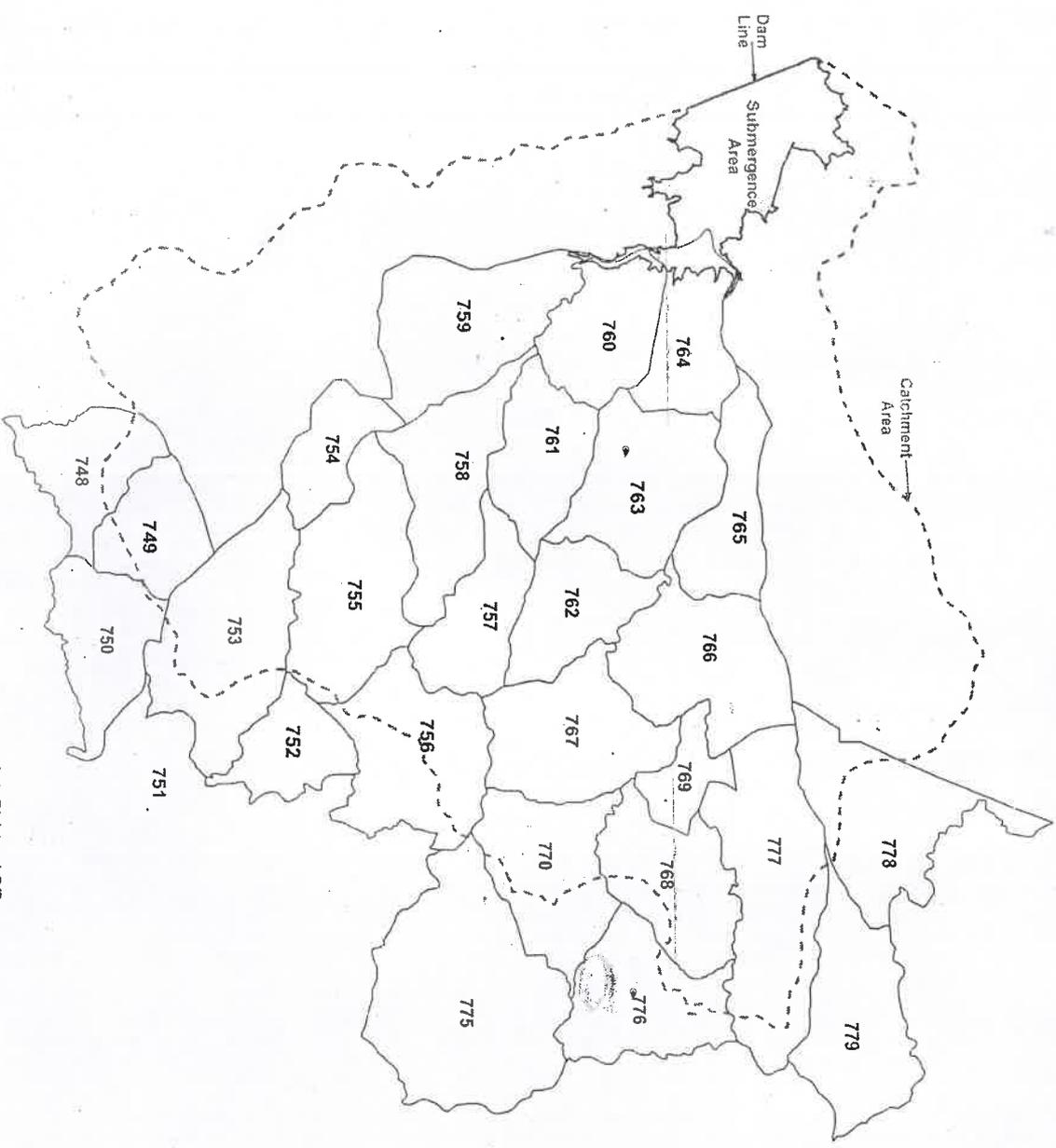
(A. K. Jain)

Executive Engineer

Water Resources Division Khandwa

S.D.O.

**BHAM MEDIUM TANK PROJECT**  
**CATCHMENT AREA TREATMENT PLAN**  
**Compartment Map**



Sub Divisional Officer  
Sukia Head Work Sub Division  
Borgaon

Executive Engineer  
Water Resources Division  
Khandwa

(iii) Landuse Plan

**Bham Medium Irrigation Project**

S.NO.	LANDUSE TYPE	FOREST LAND (Ha)	NON FOREST LAND (Ha)	REMARK
1	2	3	4	5
1	Dam Sheet (Earth Dam)	Nil	24.864	Dam Length 3108 m.
2	Spill Channel	Nil	3.00	Ogee spillway 250 m.
3	Sluice	Nil	0	-
4	Control Room	Nil	1.00	Situated downstream of the dam
5	SCADA Room, Pump house	Nil	4.00	Consturation of SCADA room is out of Forest aera
6	Submergance aera	148.75 (101 ha forest land and 47.75 ha.land is revenue chhote-bade jhaad ka jungle)	679.196	Non forest land is revenue land of village Rajgath, Semliya, Barar, Handiyakheda
	<b>Total</b>	<b>148.75</b>	<b>712.06</b>	-



**Sub Divisional Officer**  
**Sukta H/w Sub Division**  
**No. 6 Borgaon**



**Executive Engineer**  
**Water Resources Division, Khandwa**