REPORT ON

SOIL CONSERVATION PLAN

GARE PALMA SECTOR -II COAL MINE,

TEHSIL TAMNAR, DISTRICT RAIGARH, CHHATTISGARH

PROPONENT

MAHARASHTRA STATE POWER GENERATION COMPANY LTD.

Prakashgad, Plot No. G-9 Prof Anant Kanerkar Marg, Bandra (E), Mumbai-400051 (MS)

PREPARED BY

SRUSHTI SEVA PRIVATE LIMITED

Harihar Niwas, Agresan Road,
Near Adivasi Bhavan, Giripeth,
Nagpur-440010, (Maharashtra)
Tel No 0712-2542426,
Email-Srushtisewa@Yahoo.Com,
srspl15@gmail.com

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INDEX

LIST OF TABLES

LIST OF FIGURES

REPORT ON

SOIL CONSERVATION PLAN OF GARE PALMA SECTOR –II COAL BLOCK

1.0 INTRODUCTION:

Background :

Maharashtra State Power Generation Company Limited (hereinafter referred to as MAHAGENCO) is a State owned Public Sector Unit of Government of Maharashtra engaged in power generation having its registered office situated Plot No. G-9, Prof Anant Kanekar Marg, Bandra (East), Mumbai. **Maharashtra State Power Generation Co Ltd**. has been incorporated under Indian Companies Act 1956 pursuant to decision of Govt. of Maharashtra to reorganize erstwhile **Maharashtra State Electricity Board** (herein after referred to as "MSEB"). The said reorganization of the MSEB has been done by Govt. of Maharashtra pursuant to Part XIII read with section 131 of The Electricity Act 2003. MAHAGENCO has been incorporated on 31.5.2005 with The Registrar of Companies, Maharashtra, Mumbai and has obtained Certificate of Commencement of Business on 15.09.2005. MAHAGENCO is engaged in the business of generation and supply of electricity and has been vested with generation assets, interest in property, rights and liabilities of MSEB.

MAHAGENCO has the highest overall generation capacity and the highest thermal installed capacity amongst all the state power generation utilities in India. In terms of installed capacity, it is the second highest generation company after NTPC. The company has a generation capacity of 13186 MW comprising of 9750 MW Thermal Power Plants, 2580 MW Hydel Power Plant, 672 MW Gas Turbine and 184 MWp Solar. The details of the power plants are given below.

Table 1.0 : Installed Capacity of MAHAGENCO Plants

Sr. No.	Power Station	Units & Size (MW)	Installed Capacity (MW)
A : Thermal Power Stations			
1	Koradi Units 6 To 10	2 x 210 + 3 x 660	2400
2	Nashik Units 3 To 5	3x210	630
3	Bhusawal Units 3 To 5	1x210 + 2x500	1210
4	Paras Units 3 & 4	2x250	500
5	Parli Units 6 to 8	3x250	750

Sr. No.	Power Station	Units & Size (MW)	Installed Capacity (MW)
6	Khaparkheda Units 1 To 5	4x210 + 1x500	1340
7	Chandrapur Units 3 To 9	2x210 + 5x500	2920
Total Installed Capacity of TPPs			9750
B : Gas Turbine Power Station			
	Uran Gas Turbine.	4x108	432
	W.H.R. Units 1&2	2x120	240
Total Installed Capacity of Gas-based Plants			672
C Hydro Power Stations			
	Koyna Hydro	St I&II- 4x70 + 4x80, St III- 4x80, St. IV- 4x250 & Koyna Dam Foot- 2x18	1956
	Small Hydropower projects		374
	Ghatghar Pump Storage	2x125	250
Total Installed Capacity of Hydel Plants			2580
D : Solar			184
Total Installed Capacity (A+B+C+D)			**13186**

2

The Project : The Gare Palma Sector II coal block has been allocated to Maharashtra State Power Generation Company Limited (MAHAGENCO) by Ministry of Coal, Govt. of India for end-use at its own plants in Maharashtra. The Gare Palma Sector II Coal Block spread over an area of 25.83 sq.km (2583.486 ha) is part of the Mand Raigarh Coalfield in Tamnar Tehsil of Raigarh District, Chhattisgarh. The mine lease area is located in the 14 villages of Bhalumura, Chitwahi, Dholnara, Dholesara, Gare, Jhinkabahal, Kunjemura, Libra, Murogaon, Pata, Radopali, Saraitola, Sarasmal, and Tihlirampur The peak capacity of the mines will be 23.6 MTPA with both Opencast (22.0 MTPA) and Underground (1.6 MTPA) operations with a mine life of 69 years.

The area is covered in the Survey of India Toposheet No. 64 N/8 & 12 (R.F. 1:50,000) and is bounded by the coordinates shown in table below.

Site Coordinates

Boundary Point	Latitude	Longitude
A	22° 08' 51.495" N	83° 26' 15. 580" E
B	22° 10' 05.178" N	83° 26' 15.433" E
C	22° 10' 49.891" N	83° 27' 26.624" E

D	22° 09' 09.892" N	83° 28' 57.871" E
E	22° 08' 03.774" N	83° 29' 49.271" E
F	22° 06' 24.215" N	83° 31' 12.632" E
G	22° 07' 18.066" N	83° 29' 13.857" E
H	22° 06' 50.059" N	83° 29' 15.318" E

The Raigarh - Sundargarh road is 9 km away in south east direction and Ambikapur Highway (SH-1) is 6 km in west direction from Phase-II site. The District headquarter is Raigarh which is aerially about 35km from the site and the nearest town is Tamnar at a distance of about 10 km to the south. The nearest railway station is also at Raigarh while the nearest airport is Raipur at a distance of 290 km in the south west direction. The inter-state boundary with Odisha is almost adjacent to the block on the eastern side, 10 km to the east. The details of the project site are given in Table below

Project Location

Sl.No.	Aspect	Description
1.	Project	Gare Palma Sector-II Coal Mine Project of 23.60 MTPA of MAHAGENCO,Raigarh District, Chhattisgarh over 2,583 Hectares of Land
2.	Location	
(i)	State	Chhattisgarh
(ii)	District	Raigarh
(iii)	Thesil	Tamnar
(iv)	Villages	Bhalumura, Chitwahi, Dholnara, Dholesara, Gare, Jhinkabahal, Kunjemura, Libra, Murogaon, Pata, Radopali, Saraitola, Sarasmal, Tihlirampur
(vi)	Latitude	22° 6' 24.215" N to 22° 10' 49.891" N
(vii)	Longitude	83° 26' 15.433" E to 83° 31' 12.632" E
3.	Distance	
(i)	Nearest Town	Tamnar, 10 km, S
(ii)	District Headquarters	Raigarh, 35 km, S
(iii)	Major Roads	Raigarh-Ambikapur Highway (SH-1), 6 km, W Raigarh-Gharghoda Road via Tamnar
(iv)	Railway Station	Raigarh, 35 km, S
(v)	Airport	Raipur, 290 km, SW

1.1 General

The Gare Palma-II Coal Block comprising total lease area of 25.83 km^2 has been allotted to Maharashtra State Power Generation Company Limited (MAHAGENCO) in the district of Raigarh of Chhattisgarh state. The location map is given in **Figure 1.1.**

M/s Maharashtra State Power Generation Company Limited (MAHAGENCO) is in process of obtaining Environmental and Forest Clearance for Gare Palma-II Coal Block which requires Soil Conservation Plan (SC). In context of above, the need for preparation of report for Soil Conservation has been envisaged with special reference to soil being generated by over burden. Accordingly, M/s Srushti Seva Private Limited, Nagpur have been entrusted the Job vide Service Order no. HO/4500108857 dated 28.02.2020 with the following scope of work.

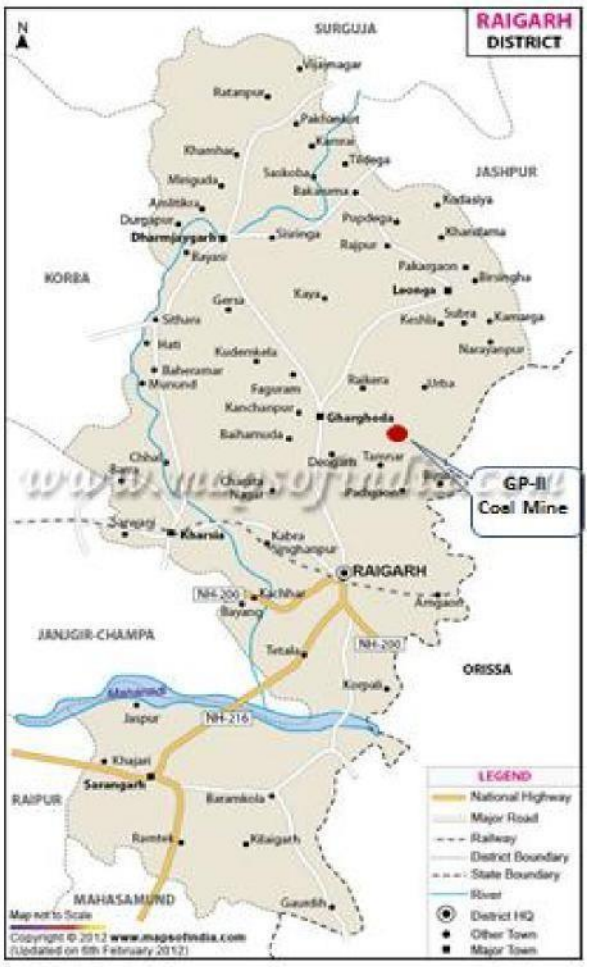

Figure 1.1 Location Map

1.2 Scope of Work:

I. Preparation Soil Conservation Plan:

- Proper mitigate measures to minimize soil erosion and choking of streams shall be prepared.
- Planting of adequate drought hardy plant species and sowing of seeds to arrest soil erosion.
- Study of construction of check dam, retention/toc walls to arrest sliding down of the excavated material along the contour.
- No damage shall be caused to the top-soil ad the user agency will follow the top soil management plan.
- Additional measures to avoid the soil Erosion.
- Soil Conservation Map

1.3 Location of the Project:

The Gare Palma Sector–II Coal Block is located in Mand Raigarh Coalfield in Tamnar Thesil Raigarh district of Chhattisgarh State. The mine site is located at Tilhi Rampur, Kunjemura, Gare, Saraitola, Murogaon, Radopali, Pata, chitwahi, Dholnara, Jhinka Bahal, Dolesara, Bhalumura, Sarasmal and Libra village. The area is covered in the Survey of India Toposheet No. 64 N/8 & 12 (R.F.1:50,000)) and is bound by

Latitude: 22° 06’ 24.215” N to 22° 10’ 49.891” N

Longitude: 83° 26’ 15.433” E to 83° 31’ 12.632” E

The Gare Palma is situated around 35 km towards north from Raigarh Township, which is also the nearest railway station on Mumbai-Howrah main line of SE Railway.

1.4 Location of Study Area :

The location of study area for soil conservation plan restricted to mine lease area. Hereafter, this refers as study area. The study areas have been considered based on the Mine Plan Limited to mine lease area. The study exclusively focuses on the soil erosion caused due to excavation of overburden, backfilling, and topsoil stability into mine. The area under study comprises 25.83 km^2. The location of study area on toposheet showing Mine Lease area is given in **Figure 1.2**.

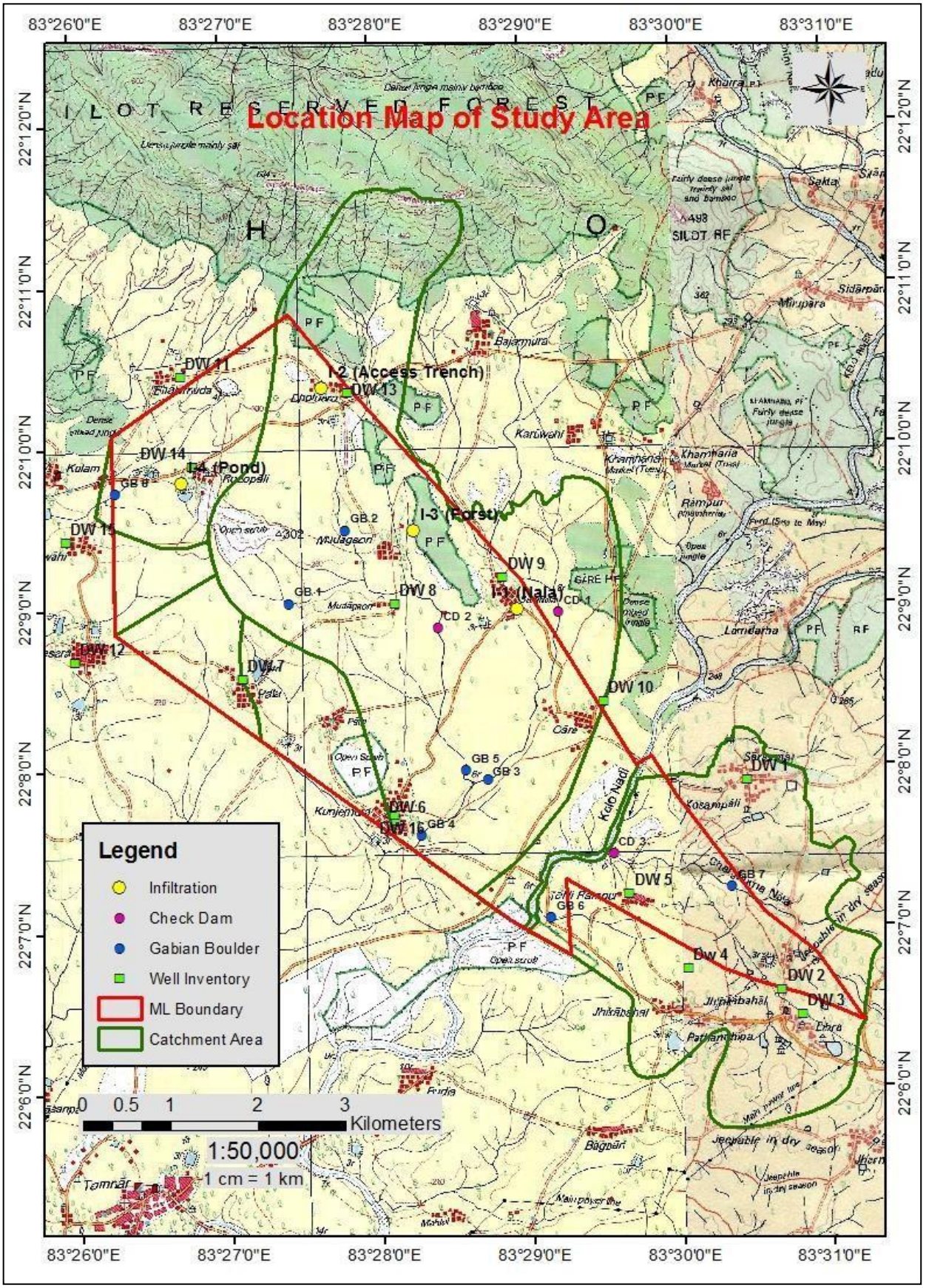

Figure 1.2 : Location on Toposheet

1.5 Demography of Watershed:

There are 14 villages within the SC Plan. The population and demographic profile of these villages are as follows given in **Table 1.2**

Table 1.2 Demographic Data

Source: (Census: 2011)

Village Name	Total Population	%	Male	Female
Bhalumura	490	3.63	228	262
Dholnara	512	3.79	243	269
Chitwahi	853	6.31	396	457
Dolesara	1326	9.82	644	682
Rodopali	752	5.57	374	378
Kunjemura	1364	10.10	689	675
Gare	828	6.13	412	416
Pata	1358	10.05	688	670
Mudagaon	553	4.09	270	283
Saraitola	653	4.83	320	333
Sarasmal	535	3.96	261	274
Tihli Rampur	1962	14.52	1051	911
Jhinku Bahal	905	6.70	494	411
Libara	1418	10.50	720	698
	13509	**100 %**		

1.6 Need for Soil Conservation Plan :

Soil Conservation Plan is normally applicable for Hydroelectric and Irrigation Projects where impounding of water is proposed by construction of Barrage, Dam etc. This project is coal mining Project coming within catchment area of Kelo River. Besides this Kelo dam is situated downstream of this project. Prevention of siltation in Kelo Dam, due to coal mining from project, has to be given top most priority. The location of this mining project with reference to Kelo dam is depicted in **Figure 1.3.** It is well established fact that the reservoir are subject to sedimentation. The study of erosion and sediment yield from excavation of this mine is of the utmost importance in order to suggest proper mitigation measure to avoid deposition of sediment in Kelo reservoir. Sedimentation will reduce its capacity, and thus affecting the water availability for competing users. Properly designed Soil Conservation Plan (SCP) &

Catchment Area Treatment Plan (CAT) are essential to ameliorate the above mentioned adverse process of soil erosion and sedimentation in Reservoir.

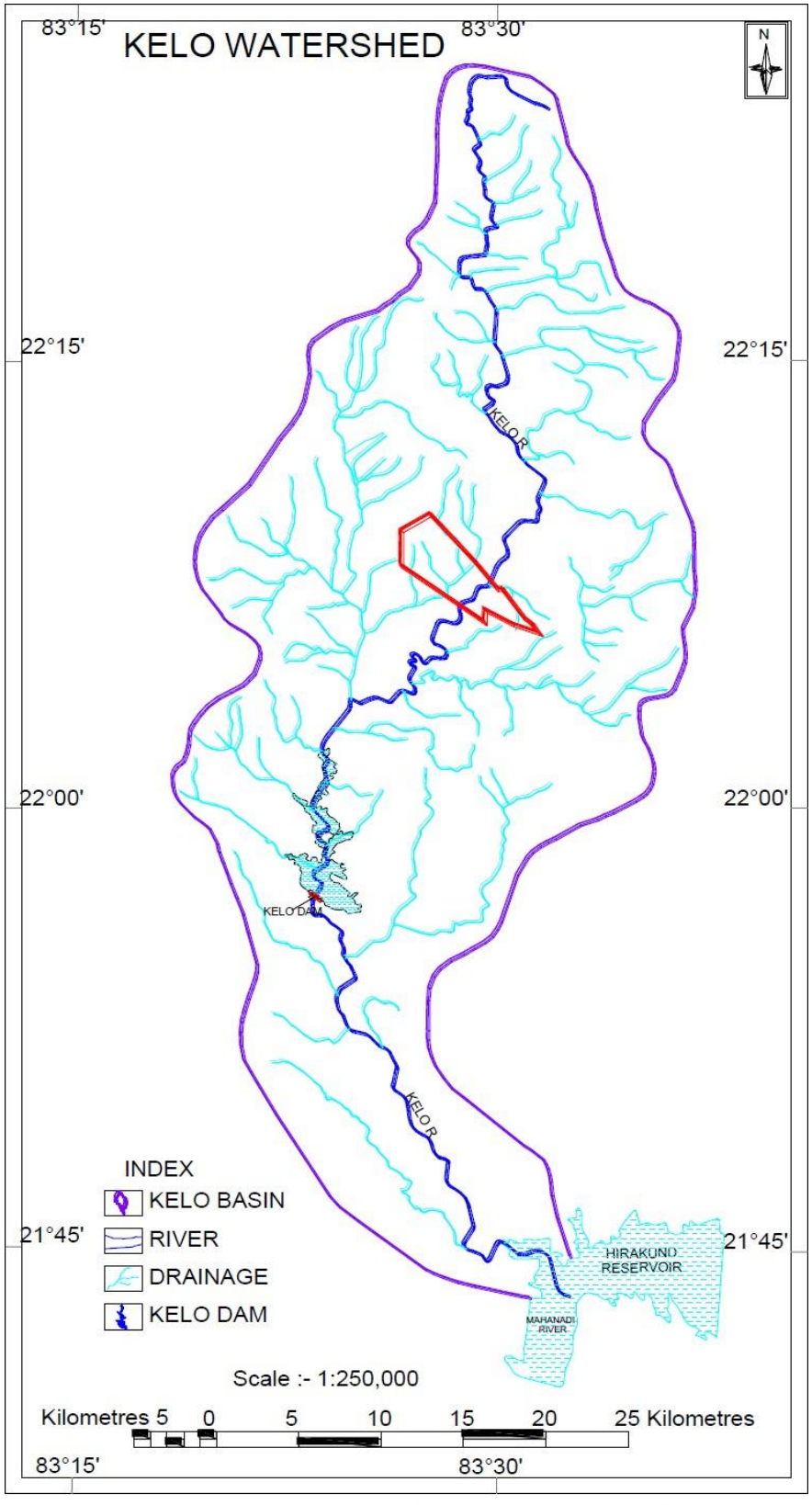

Figure 1.3: Drainage map of Kelo River with study area

1.6.1 Objective of SC Plan : The objective of SC Plan is to rejuvenate various potential and degraded ecosystems in the Mine area. The opencast mining activities disturb large tracts of land and produced greatly increased downstream sediment load.

The objective of this report is to present the outline of opencast coal mining surface erosion problem, method of modelling sediment yield, measures to be taken for reducing or controlling sediment discharges. The action plans have been prepared for this purpose with the following objectives.

1. To facilitated the hydrological functioning of the mining area and augment the water quality of the Kelo River.
2. Conservation of soil cover and to arrest the soil erosion, flood and siltation of the river and its tributaries and consequent relation of siltation in the river of Kelo and its reservoir.
3. Soil conservation through biological & engineering measures to reduce sediment load in river and tributaries, thus improving quality of water.
4. Increase vegetative cover and water retaining properties.

1.7 Open-cast coal Mining Surface Erosion Problems

The problem related to surface erosion during open cast coal Mine may be due to following.

1. Soil erosion and sediment transport depend on the following factors :

   a. Climatic conditions,
   b. Soil and spoil erosivity
   c. Overland slope and slope length
   d. Ground cover
   e. Soil conservation control practices
   f. Catchment drainage characteristics

2. Open-cast mining activities tend to change radically several of these factors and severe sediment production could occur in the following locations :

   a. Topsoil stockpiles
   b. Spoil piles
   c. Waste dumps
   d. Bare topsoil areas
   e. Steep outslopes
   f. Ramps
   g. Haul roads

Scalping, blasting, material handling, heavy vehicular travel over replaced spoils and Top soiling activities generally produce compacted area of soil and spoil materials with a high colloidal content. Colloidal particles require a very long detention time in an impoundment

before they will settle out of suspension and frequently deposition does not occur until the sediment laden flows discharge into dams.

1.8 Sediment Control Techniques

The major causes of erosion problems in surface mining operation are due to disturbed areas, which is integrated with the mining operations. In developing a sediment control plan the following basic approach has been adopted

- **1'** Minimize the area which is disturbed at any one time
- **1'** Develop a drainage control, system for the mine lease area
- **1'** Integrate drainage, erosion and sediment control, into each stage of the mining operation.
- **1'** Develop a mining and rehabilitation plan prior to initiating mining activities.
- **1'** Construct drainage and erosion controls in advance of mining activities
- **1'** Divert storm runoff away from area with high erosion potential.
- **1'** Incorporate measures to reduce the flow velocity of storm runoff.
- **1'** Limit the handling of spoil and topsoil materials.
- **1'** Rehabilitate area as soon as possible.
- **1'** Maintain drainage and erosion control measure.

1.9 Soil Productivity & Water Quality :

In course of investigation 20 soil samples were collected by proponent from the forest area around mine lease. The samples were analyzed by State Govt. Laboratory at Ambikapur and submitted detail note on soil productivity. The results given in **Table 1.3.**

Table 1.3 Soil Productivity

Sl. no.	Physical Properties		Chemicl Properties	
	Parameter	Value	Parameter	Value
1.	Type of soil	Sandy Loam	PH	5.95
2.	Texture	Semi solid	EC	0.26 DC/M
3.	Humidity	Dry (16.08 %)	Organic Carbon	0.32 %
4.	Depth	Medium depth (45cm)	Nitrogen	132.36 kg/ha
5.	Humus	Medium	Phosphorous	14.59 kg/ha
6.	Soil Erosion	Medium	Potash	257.25 kg/ha
7.	Water Holding capacity	Medium	Zinc	0.215 PPM/ha
8	Behavior of soil	Medium Acidic	Copper	0.105 PPM /ha
9.	EC	Normal	Iron	1.32 mg/ha
10	Available organic carbon	Average	Manganese	0.915 mg/ha
11	-	-	Boron	0.215 mg/ha

The analysis of soil suggest that during erosion by water the chemical quality of runoff water will be within permissible limit of Indian standard (IS : 2296). There will not be any adverse impact on quality of water of Kelo river & reservoir due to erosion of soil during mining of GP-II Opencast Coal Mine

2.0 LAND USE PLAN:

The land use plan for pre-mining and post- mining including stages of mining is essential input for formation of Soil Conservation Plan. The data in respect of above has been adopted from approved Mine Plan.

2.1 Pre-mining Land use :

2.1.1 Total Mining Lease Area : Pre-mining Land Use Plan for Mine area is given below in **Table 2.1 & Figure 2.1.**

Table 2.1
Pre-mining Land Use Plan in Mine Lease Area

(area in Ha)

Private Land (Non Adivasi)	Adivasi Land	Government Land				Forest Land	Total
		Chote Bade Jhad ki Jungle	Abadi	Others	Total		
987.505	1090.113	115.134	90.328	200.672	406.134	99.735	2583.487

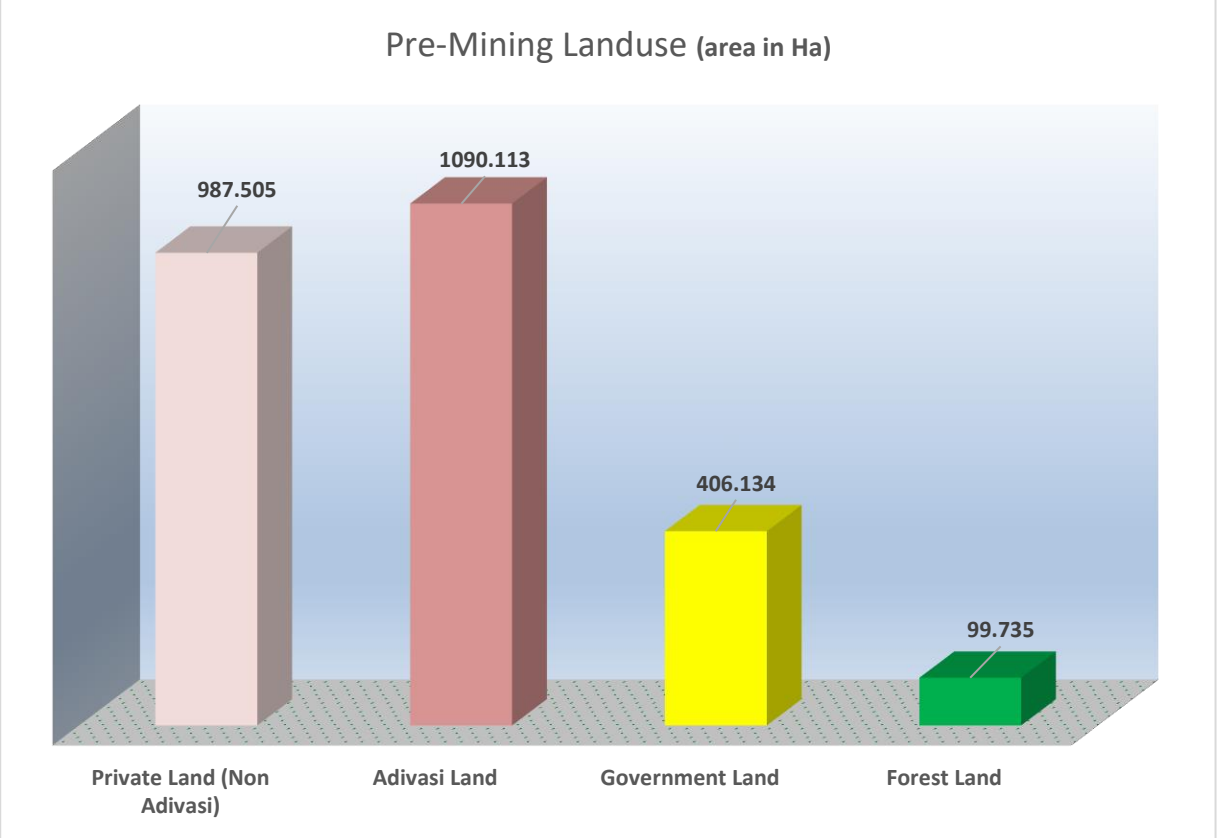

Figure 2.1: Land Use in Mine Lease Area

2.1.2 Forest Land Schedule:

The Soil Conservation Plan (SC Plan) is being prepared inclusive forest area of 76 km^2. The land schedule for purpose of SC in respect of forest area is given below in **Table 2.2 & Figure 2.2.**

Table 2.2

Extent of CAT Area & Land Schedule

Sr. No.	Reserved	Percentage %
1	Dense Forest	0
2	Open Forest Land	16
3	Open Mixed Forest Land	84
4	**Total**	**100**

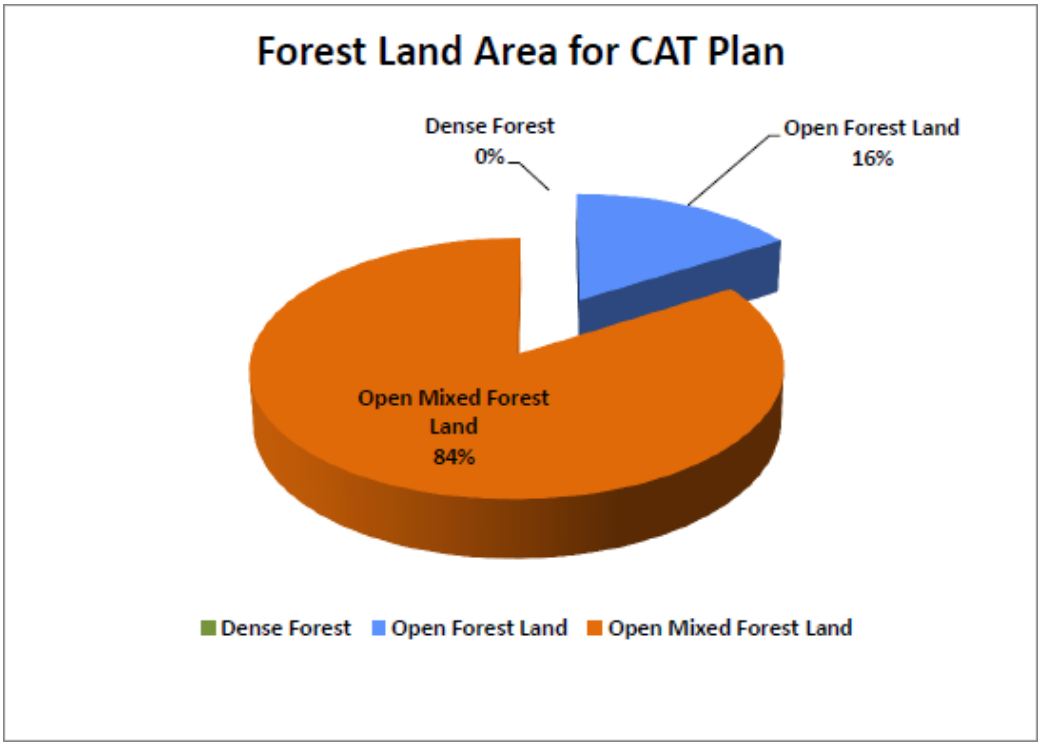

Figure 2.2: Distribution of Forest Land

2.2 Land use - Mining Activity:

The entire land coming within lease hold area of coal mine is 2583.48 ha will be utilized for mining and ancillary activities are given in **Table 2.3**.

Table 2.3
Land use Cover of Proposed Mine

Sr. no.	Landuse	At the end of 5th Year	At the end of 25th Year	At the end of OC mining 29th Year
1	Excavation	380.70	2272.42	2440.55
2	Backfill	0.00	1535.00	2248.77
3	Void	380.70	737.42	191.78
4	Surface dump	380.00	0.00	0.00
5	Bund	5.20	5.20	5.20
6	Green Belt	36.07	36.07	36.07
7	Top Soil Dump	60.00	00.00	0.00
8	Settling Pond	10.00	5.00	5.00
9	Road Diversion	30.30	30.30	30.30
10	Facilities (West)	50.94	50.94	50.94
11	Facilities (East)	68.54	0.00	0.00
12	Under Kelo River	15.42	15.42	15.42
13	Dismatling	0.00	0.00	0.00
14	Disturbed area	1017.17	2415.35	2583.48
15	Undisturbed	1566.31	168.13	0.00
	Total	**2583.48**	**2583.48**	**2583.48**

3.0 BASIC DATA GENERATION

The basic data have been generated and given in report for CAT Plan. However, in order to recapitulate the following basic information is reproduced for ready reference.

1. Micro Watershed including mine lease area.
2. Digital Elevation Model (DEM) of pre-mining.
3. Climate Water Balance
4. Intensity of rainfall
5. Runoff Coefficient
6. Infiltration test
7. Water table
8. Rainfall –Runoff-Infiltration relation.
9. Grain size & Silt Yield Index.
10. Soil loss & Sediment Yield

3.1 Micro watershed

The study have been subdivided into 7 numbers of Micro watershed which are the smallest size Hydrologic unit. The map is placed at **Figure 3.1**

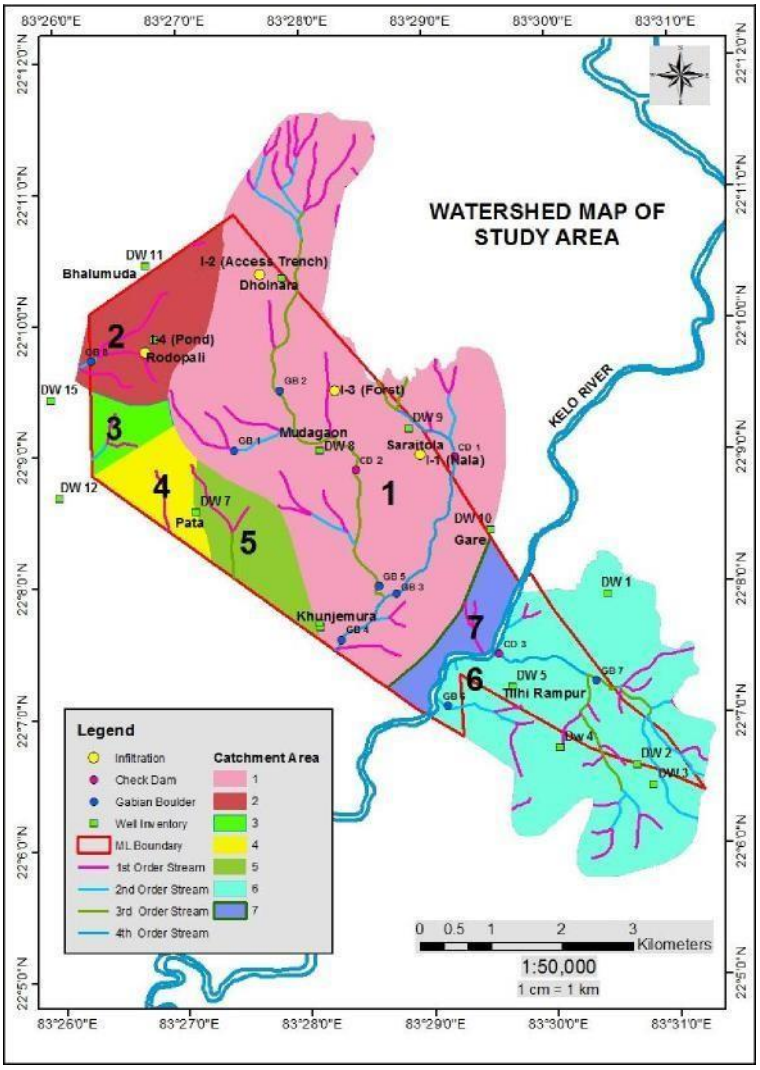

Figure 3.1 Micro Watershed Map

3.2 Digital Elevation Model (DEM):

The area under study is plain having rolling topography with occasional undulating feature, except a hillock in the north outside, Mine Lease area. In mine lease area the highest elevation is 320 m amsl in the North while lowest 246 m amsl around Kelo River. The Digital Elevation Model (DEM) is prepared by GIS tool and the same is reproduced below as **Figure 3.2.**

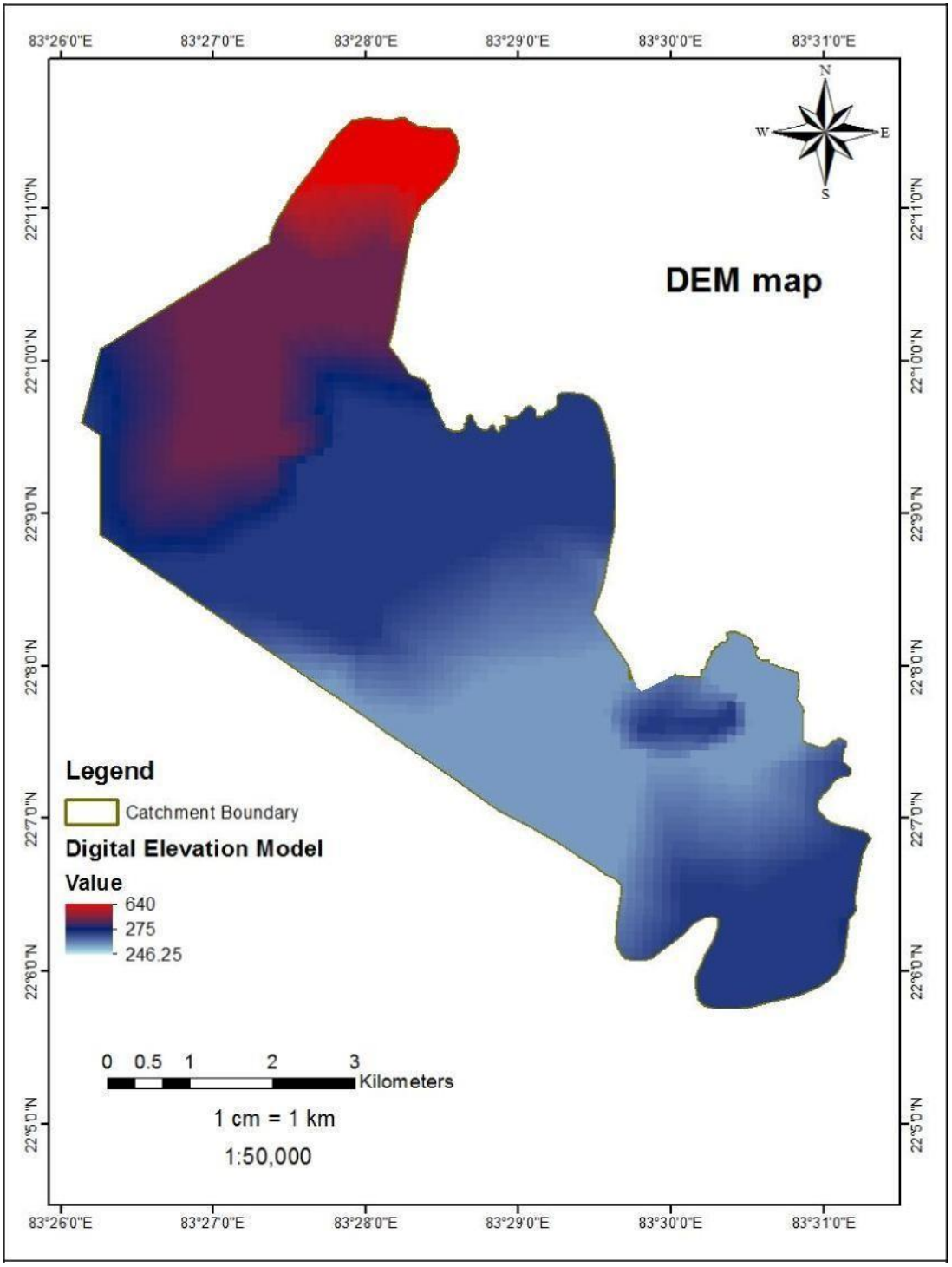

Figure 3.2 Digital Elevation Model (DEM)

3.3 Climatic Water Balance:

The idea of climatic water balance was first put forth by Thornth waite in 1944. Subsequently he developed water balance technique. Elements of climatic water balance for watershed located in and near the project area is computed.

3.3.1 Water Balance Techniques: It is a climatic balance obtained by comparing the match of precipitation with evapotranspiration, yielding a number of moisture parameters like water surplus, water deficiency, soil moisture change and runoff. The basic relation governing the water balance concept is;

P = AE +RO ± ΔS.

1321 = 811 + 707 - 197

Where,

P = Precipitation in mm	Accumulated potential water loss (accumulated negative value of P-PE) = ACC (P-PE)
AE = Actual Evaporation in mm	Storage (S)
ΔS = change of soil moisture in mm	Water surplus (WS)Water deficit (WD)
Ro = Runoff in mm	ACC = 200 mm

An important feature of the water balance concept is the recognition of the part played by soil in the exchange of moisture between the earth's surface and the atmosphere. Soil-acts as a medium for storing water (up to a limit) in times of excessive rainfall and releasing the same (in a restricted manner) at other times for purposes of evaporation and transpiration.

3.3.2 Water Balance Table : Using the method described in the above paragraph, the climatic water balance has been computed with the following information for the normal rainfall an placed in **Table 3.1 and graphically depicted in Figure 3.3.**

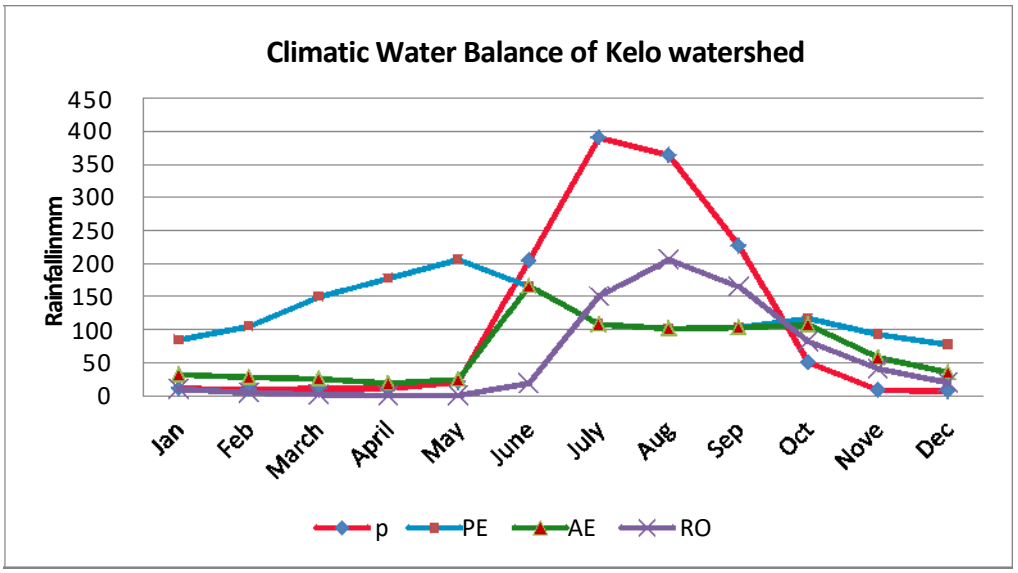

Figure 3.3 Climatic Water Balance of Kelo watershed

Table 3.1
Climatic Water Balance of Kelo watershed

(Unit mm)

Parameter	Jan	Feb	Mar	April	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Total
PE	85	105.3	149.7	178	207	166	108.6	101.5	103.4	117.1	93	77.3	1492.4
P	11.6	10.8	11.6	11.7	21.3	205	390.8	363.7	227.5	50.8	8.7	7.7	1321.2
P-PE	-73.4	-94.5	-138.1	-166.3	-185.7	39	282.2	262.2	124.1	-66.3	-84.3	-69.6	-171.2
ACCP-PE	-293.6	-388.1	-526.2	-692.5	-878.2	0	0	0	0	-66.3	-150.6	-220.2	-3215.7
S	46.077	28.726	14.401	6.270	2.477	200	200	200	200	143.569	94.190	66.507	1202.217
ΔS	-20.430	-17.351	-14.325	-8.125	-3.793	197.523	0	0	0	-56.431	-49.379	-27.683	±197.53
AE	32.03	28.151	25.925	19.835	25.093	166	108	101.5	103.4	107.231	58.079	35.363	810.607
WD	52.97	77.149	123.775	158.175	181.907	0	0	0	0	9.869	34.921	41.917	680.683
WS	0	0	0	0	0	39	282.2	262.2	124.1	0	0	0	707.5
Ro	10.332	5.166	2.583	1.295	0.645	19.500	150.85	206.52	165.31	82.65	41.328	20.664	706.843

Climatic Water Balance :-
P = AE + RO ± ΔS.

1321 = 811 + 707 - 197

3.4 Intensity of Rainfall:

The rainfall intensity corresponding to a duration and desired probability of exceedence i.e. return period. This is rainfall-frequency duration relationship for the given catchment area. I.M.D. has prepared Isopluvial maps for the different return period for given catchment area. C.W.C. has also adopted the same for their publication of February 1997 in respect of flood estimation report for Mahanadi sub zone-3. The Isopluvial maps for 25 year return period, 50 year return period and 100 year return period are taken from CWC publication.

The rainfall intensity for different return period for one hour is estimated by multiplying conversion ratio with 24 hrs. maximum rainfall of mine. The intensity of rainfall for 1 hour have been estimated and given in **Table 3.2**

Table 3.2
Intensity of Rainfall for 1 hrs

Sr. No.	Return Period	24 hrs maximum rainfall	Conversion factor for 1 hr	Intensity of rainfall in 1 hr	Remark
	Year	Mm/24hrs	Coefficient	Mm/hr	-
1	25	230	0.390	89.7	-
2	50	290	0.390	113.1	-
3	100	320	0.390	124.8	Use for Mine

The intensity of rainfall for catchment treatment plan has been estimated based on 100 year return period which is 124.8 mm/hr (12.5 cm/hr)

Intensity of Rainfall – 12.5 cm/hr

3.5 Runoff Coefficient:

The runoff coefficient is a dimensionless coefficient relating to amount of runoff to the amount of precipitation received. It is larger value for area with low infiltration and high runoff and lower for permeable well vegetated area (forest, flat land). The runoff coefficient has been considered is 25% as per Central Ground Water Board Report on Mahanadi Basin.

Runoff Coefficient – 25 % of Monsoon rainfall

3.6 Infiltration Test:

Infiltration is the flow of water into the ground through the soil surface. Since infiltrated water may contribute to the ground water discharge in addition to soil moisture, the process can be schematically modeled**.** The infiltration characteristics of a soil at a given location has been estimated by using flooding infiltrometer**.** Highest infiltration of 0.85 cm/hr have been recorded near Nala. The infiltration test data of different locations were processed and summarized in **Table-3.3.** Location of Infiltration site is given in **Figure 3.4**

Table-3.3 Infiltration Test Data

Time since start		Infiltration rate (cm/hr)			
Minutes	**Hour**	**Site I-1 Saraitola Nala**	**Site I-2 Dholnara Incline**	**Site I-3 Mudagaon Forest**	**Site I-4 podopali pond**
10	0.16	18.28	14.02	12.65	10.10
20	0.33	7.24	5.98	3.80	4.15
30	0.50	4.82	3.05	3.10	3.74
45	0.75	3.98	2.10	2.05	2.82
60	1.00	2.30	1.50	1.02	1.40
90	1.50	2.00	0.98	0.72	0.64
120	2.00	1.70	0.81	0.54	0.52
150	2.50	0.85	0.54	0.42	0.30
180	3.00	0.85	0.54	0.42	0.30
210	3.50	0.85	0.54	0.42	0.30
Constant Infiltration rate cm/hr		0.85	0.54	0.42	0.30
Infiltration zone		High	Moderate	Moderate Low	Low
Recharge/Discharge		Recharge	Transit	Discharge	Discharge

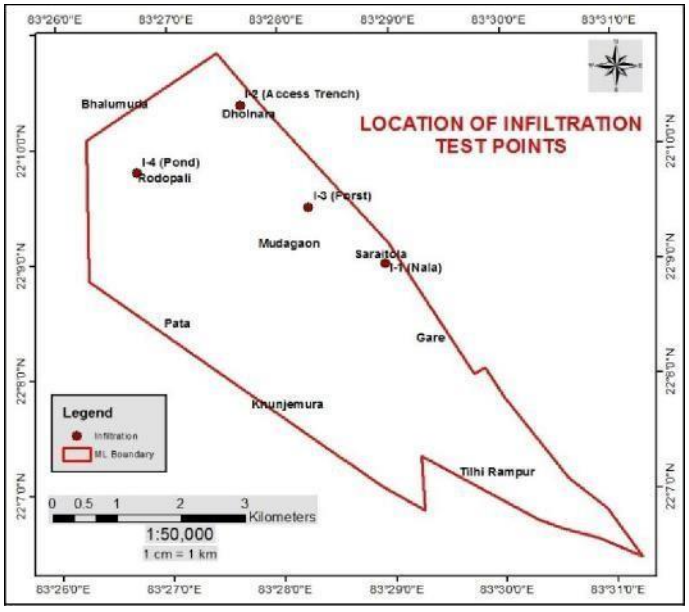

Figure 3.4 Location of Infiltration Test Point

3.7 Water table:

Based on data of observation wells a water table map has been prepared for the pre-monsoon and post-monsoon period. The pre-monsoon and post-monsoon water table maps are depicted at **Figure 3.5 and 3.6** respectively. The study of map reveals that the water table is following topography of the area. The movement of groundwater flow is towards Kelo River from both West & East sides. The groundwater is contributing into Kelo River. Thus, the Kelo River is gaining river and the post-monsoon water available in Kelo River is strictly groundwater runoff.

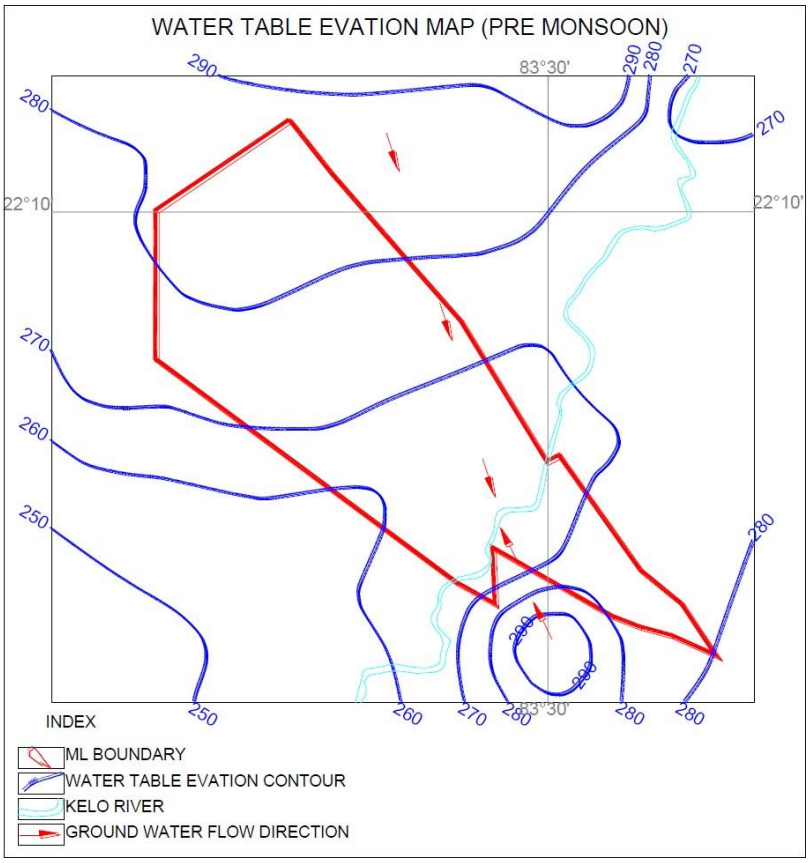

Figure 3.5: Pre-monsoon water table map

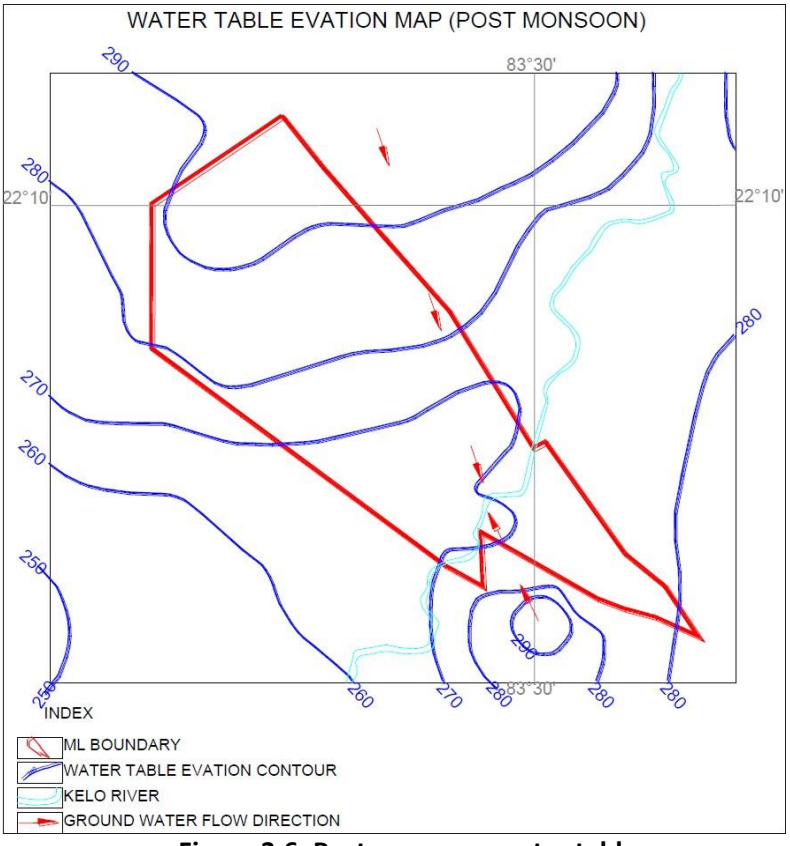

Figure 3.6: Post-monsoon water table map

3.8 Rainfall –Runoff – Infiltration Relation: Based on UNDP study, carried out in Indian Coalfield, for Hydrological consequences in respect of pre & post mining in study area, the relationship between Rainfall –Runoff – Infiltration has been studied and result given in **Table 3.4**

Table: 3.4
Rainfall –Runoff – Infiltration Relation

Phase/Condition	Area of CAT	Normal rainfall in monsoon	Surface Water		Ground water	
			Runoff Coefficients	Runoff	Infiltration coefficient	Groundwater Recharge
	Km^2	m	%	MCM	%	MCM
Pre mining	38.50	1.187	25	11.42	10	4.57
Post Opencast mining	38.50	1.187	15	6.87	21	9.60

The study reveal that due to mining operation and backfilling there is reduction of surface runoff to the tune off 4.55 MCM whereas, due to high rate of infiltration there is increase in groundwater recharge to the tune of 5.03 MCM

3.9 Soil Erosion:

Soil erosion may be defined as the defacement and transportation of soil. Water is the major agent responsible for this erosion.

The Soil Erosion highlights the management technique to control erosion in the catchment area. The Soil Conservation Plan involves the following parameters.

1. Understanding the erosion characteristics
2. Suggesting remedial measures to reduce the erosion rate
3. Detain the Silt/Charged particles in the runoff in nala on the way and prevent/reduce the transportation of soil to streams/reservoirs.

The result of the modeling was interpreted to identify the areas with high soil erosion rates. The primary and secondary data collected as a part of the field studies have used as an input for the model.

3.9.1 Grain size analysis of soil : The grain size analysis of the soil in respect of area in and aound of study area is given in **Table 3.5.** The data obtain from EIA of GP-III is adopted for the study area as it has similar soil condition.

Table 3.5
Grain size Analysis in %

Type of Grain	Notation	Bajaramunda	Mallupara	Khamariya	Karuwahi	Bhalumuda	Average %
		S1	S2	S3	S4	S5	
Sand	(SAN)	54.49	57.32	30.79	15.42	15.42	34.688
Silt	(SIL)	23	27.88	46.73	59.73	59.73	43.414
Clay	(CLN)	8.08	7.88	16.41	23.22	23.22	15.762
Organic	(C)	14.43	6.92	6.07	1.63	1.63	6.136
	%	**100**	**100**	**100**	**100**	**100**	**100**

(Source : EIA of GP-III)

3.9.2 Silt Yield Index:

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.

The Silt Yield Index (SYI) in respect of micro watershed has been estimated and given in **Table 3.6**

Table 3.6
Silt Yield Index (SYI)

Sr. No.	Nomenclature of Watershed	W1	Area in Hectar A1	Silt Yield Index
1	W-01	30	1946	1516
2	W-02	30	289	225
3	W-03	30	82	64
4	W-04	30	138	108
5	W-05	30	199	155
6	W-06	30	1072	835
7	W-07	30	125	97
8	Total		3851	3000

3.9.3 Slop of Tract : The slop map of the area have been prepared and placed at **Figure 3.7.** the slop map area distribution in furnished in **Table 3.7**

Table 3.7

Slope of the Tract

Sr. No.	Slope class (Gradient in %)	Area in Ha	Percentage	Remark
1	0-0.5%	5066	51.74%	Low soil loss
2	0.5 – 10%	2294	45.19%	Medium
3	>10-%	6.00	3.07%	High
	Total	**3850**	**100**	

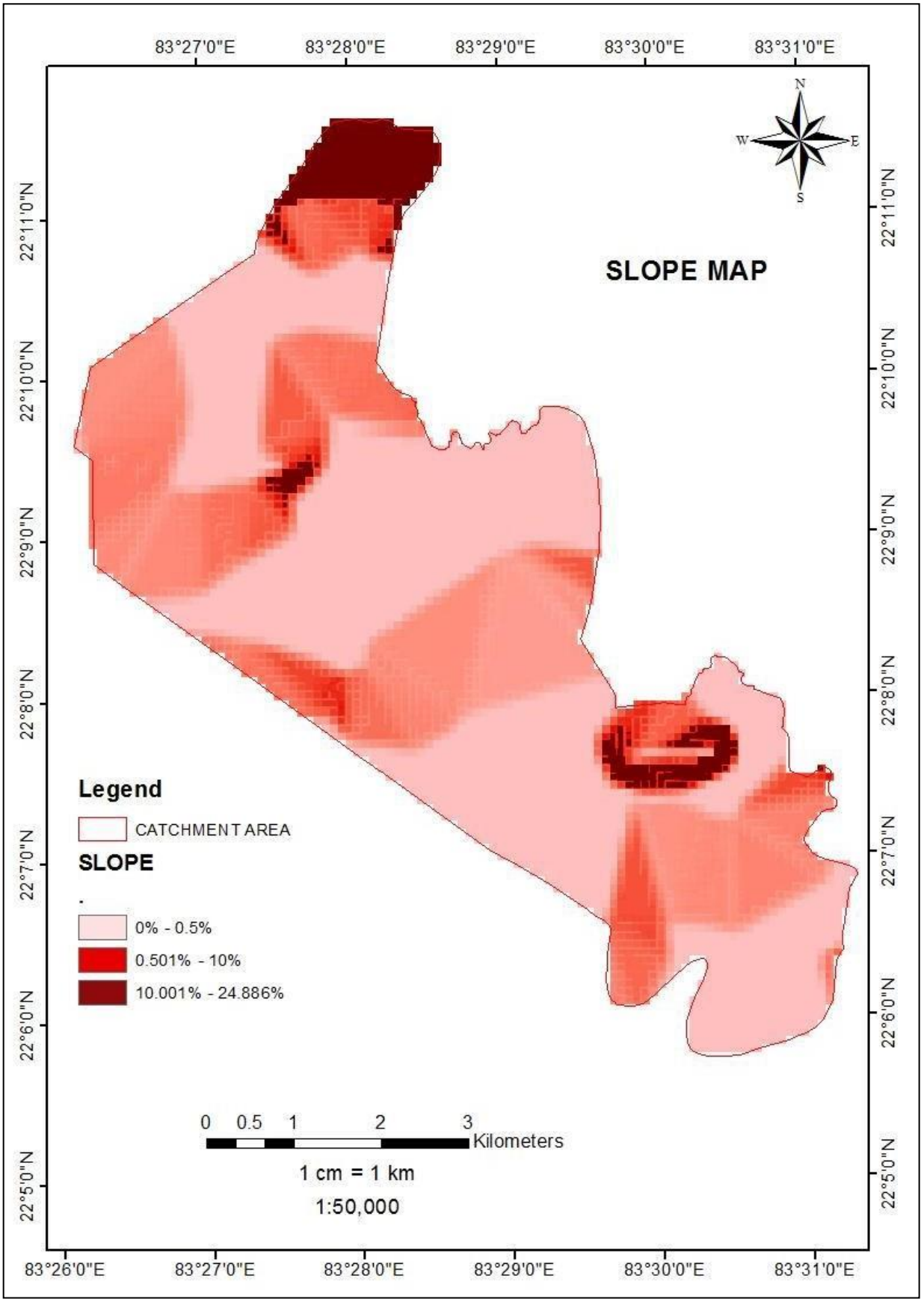

Figure 3.7 : Slope on Tract

3.10 Soil Loss and Sediment yield:

Annual soil loss and sediment yield due to water erosion has been evaluated for Soil Conservation Plan

3.10.1 Equation for Soil loss:

The most commonly used model for predicting soil loss from water erosion is the Universal Soil Loss Equation (USLE). It estimates the average annual soil loss A in area as

A = RKLSCP

Where R is the rainfall erosivity factor, K is the soil erodibility factor, L and S are topographic factors representing length and slope, C is the cover and management factor and P is the support practices factor.

Despite the USLE's plot-scale spatial focus, the model has often been used to estimate soil erosion on much larger areas, such as watersheds or even whole continents.

The relation between gradient (in %) to Soil loss per ha is represented below in **Figure 3.8**

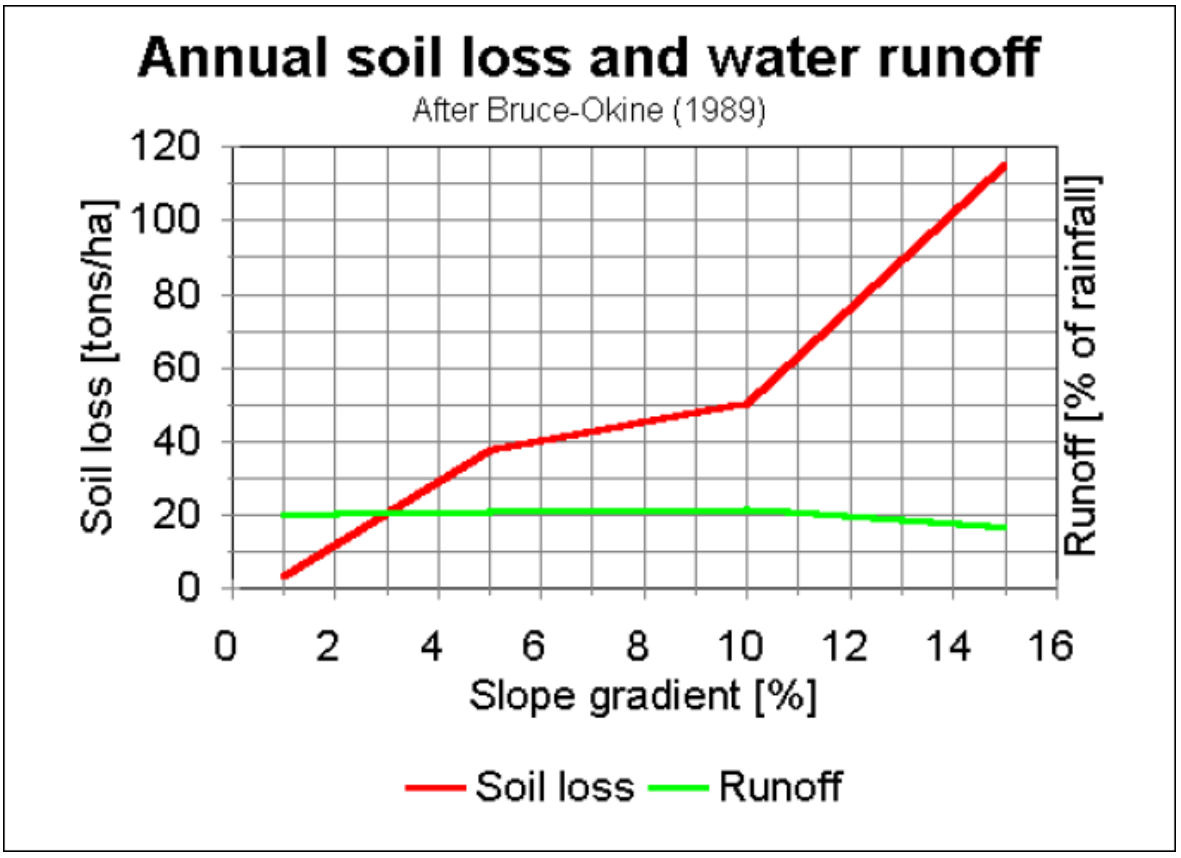

Figure 3.8 : Theoretical Annual Loss and Water Runoff

3.10.3 Analytical modeling for potential Gross Erosion : During course of operation of open cast mining and backfilling, witness different topographic conditions like, slop length, slop and canopy cover like bare soil, ground cover etc. The sediment yield as gross erosion will depend on combination of above condition. In order to have most operative plan for Soil Conservation it is imperative to prepare analytical model for this mine. The result have been tabulated for day today execution of Soil Conservation Plan.

The model have been developed with assumption of factors given in above **Table 3.9.** All values are relative to a grassed area with a ground cover 0% and an erodibility factor (K) of 0.1 with slop length 100 m. The erosion for this condition is derived above to the tune of 8 tone/ ha/year. The concept of model is derived by Andy ward et. Al. (1984). The area under study is similar to study area case of Andy Wood Model hence, same is adopted for this mine.

Table 3.9 Analytical modeling for potential gross Erosion

Erodibility Factor(K)	Slope Length 100m Slope: 1:30: 1:10 1:3			Slope Length 50m Slope: 1:30 1:10 1:3			Slope Length 25m Slope: 1:30 1:10 1:3		
BARE SOIL									
0.1	1.11	5.23	17.76	0.89	1.89	13.32	0.36	1.33	8.88
0.2	2.22	10.66	35.52	1.78	3.77	26.64	0.71	2.66	17.76
0.3	3.33	15.99	53.28	2.67	5.66	39.96	1.07	3.99	26.64
0.4	4.44	21.32	71.04	3.56	7.54	53.28	1.42	5.32	35.52
GROUND COVER 0%*									
0.1	0.50	2.40	8.00	0.40	0.85	6.00	0.16	0.60	4.00
0.2	1.00	4.80	16.00	0.80	1.70	12.00	0.32	1.20	8.00
0.3	1.50	7.20	24.00	1.20	2.55	18.00	0.48	1.80	12.00
0.4	2.00	9.60	32.00	1.60	3.40	24.00	0.64	2.40	16.00
GROUND COVER 20%									
0.1	0.22	1.06	3.52	0.18	0.39	2.64	0.07	0.27	1.76
0.2	0.44	2.11	7.04	0.35	0.75	5.28	0.14	0.53	3.52
0.3	0.66	3.17	10.56	0.53	1.14	7.92	0.21	0.80	5.28
0.4	0.88	4.22	14.04	0.7	1.50	10.56	0.28	1.06	7.04

Source : Andy Wood et. Al. (1984)

Model can now be used as a basis for developing a sediment control strategy. It can be seen that if highly erodible soil (K of 0.4) is placed on steep out slopes, soil erosion could be over 70 times greater than during pre-mining conditions. If, however, the same material is placed on flatter areas, and terraces or diversion ditches are provided every 25-50m, erosion will be very similar to that from undisturbed areas. Model also illustrates the importance of rapid rehabilitation. Erosion from a bare soil condition is 5 time that from a well established grassed area. The particle size distribution of waste dump and topsoil materials indicated a high silt content and it was established that sediment ponds with a detention time of 2-6 h would be required. Based on the single event hydrological analysis it was established that it would be impractical to design ponds for events larger than a 10 year return period of 24 hr. flood and that the ponds would need to be cleaned out several times.

3.11 Discussion – Database Generation :

The database exhibit that the all areas with a slope of less than 5% will achieve the arable land standard. Less than than 10% of the rehabilitated area will not satisfy the arable land standard. These areas will, however, provide good grazing land but will need careful management as they are susceptible to severe erosion.

Consideration was primarily given to diversion ditches, terracing and sediment ponds.

4.0 PROBABLE SOURCE OF SOIL EROSION

4.1 General :

In course of mining excavation activity will be taken up over an area of 2440 ha during complete Mining Operation. The location of excavation, dump, backfilling and uncut area within Mine lease boundary for different stages of mining area given in **Figure 4.1 to 4.6.** In the first five year there will be two dumps i.e. External dump for waste rock and Topspoil. The external dump will be over an area of 300 ha with a height of 90 m in three tires of 30 m each with over all slope angles of 28°. Adequate management strategy has been prescribed in the mining plan to check soil, erosion from dumps. The management practices are prescribed hereafter.

4.2 Top Soil Management:

Top soil will be properly stacked at earmarked dump site with adequate measures. It will be used for growing plants along the fringes of the site roads and reclamation of external dump and backfilled area. The top soil stockpiles will be low height and will be grassed to retain fertility. Besides this topsoil stacks there will be temporary stacks near the excavation area and area to be reclaimed which will be made use of for concurrent laying without bringing the topsoil to the soil stack near the OB dump.

4.3 Over Burden Dump.

The Over Burden likely to be generated during life of the mine is 2746.46 MCum . The year wise position is furnished below.

Table 4.1 : Dump Schedule

YEAR	Exavation Area	OB + TS Removal	Topsoil Generateed From Exavation	Pure OB From Exavation Mcum
	Progressive	Progressive	Progressive	Progressive
Const. (0)	0.00	0.00	0.00	0.00
1st	26.16	5.00	0.16	4.84
2nd – 3rd	103.81	129.97	0.62	43.48
4th – 5th	25.73	152.60	1.50	123.50
6th – 10th	718.67	675.00	4.31	670.69
11th – 15th	647.69	624.00	3.88	620.11
16th – 20th	202.79	495.00	1.22	493.78
21st – 25th	322.57	495.00	1.94	493.06
26th – 29th end of the mine	168.13	298.00	1.01	296.99
Closure plan 30th – 32th	0.00	0.00	0.00	0.00
Total	**2440.55**	**2761.10**	**14.64**	**2746.46**

(Source : Mining Plan)

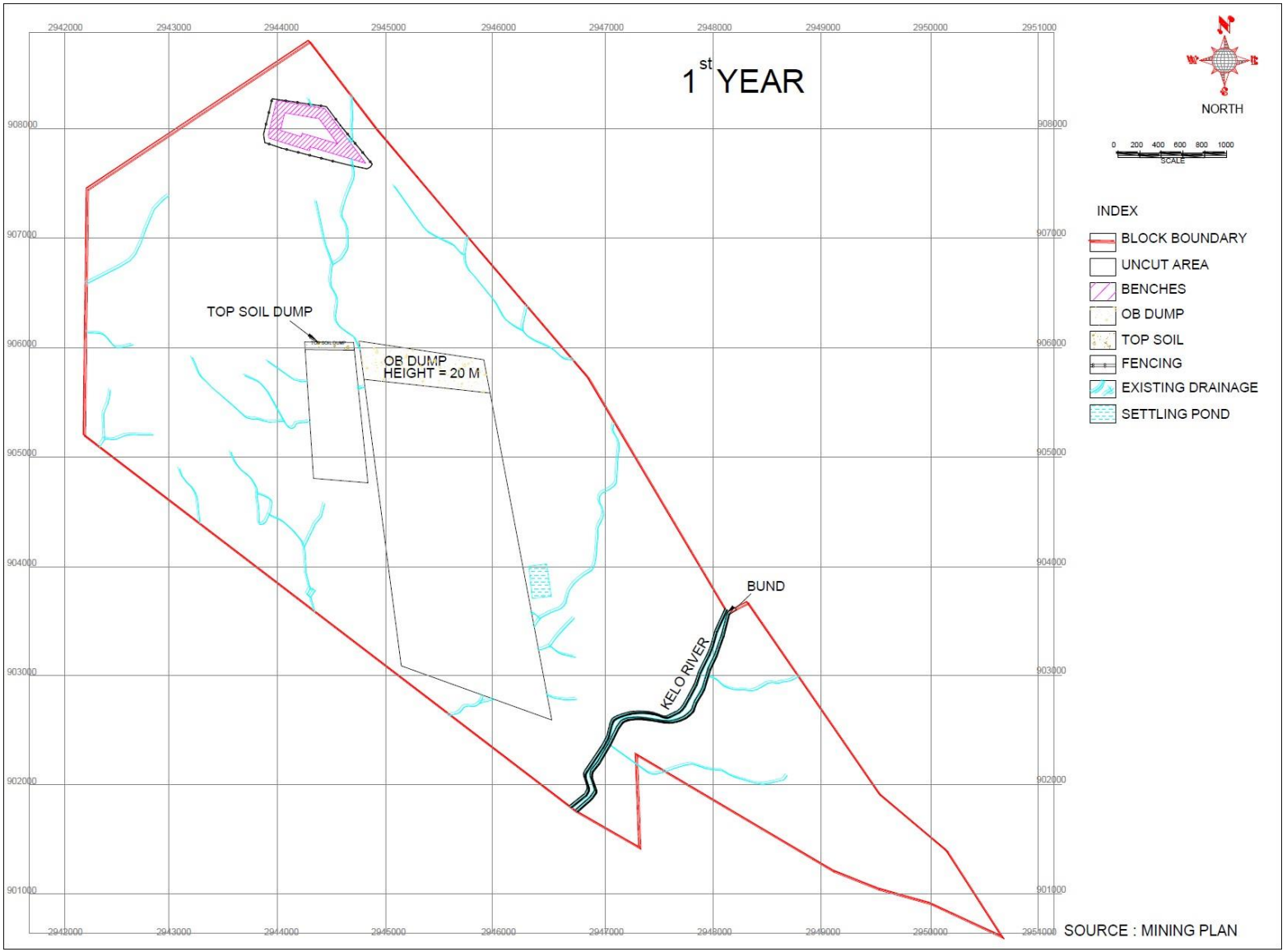

Figure 4.1 Mine Plan for the 1st Year

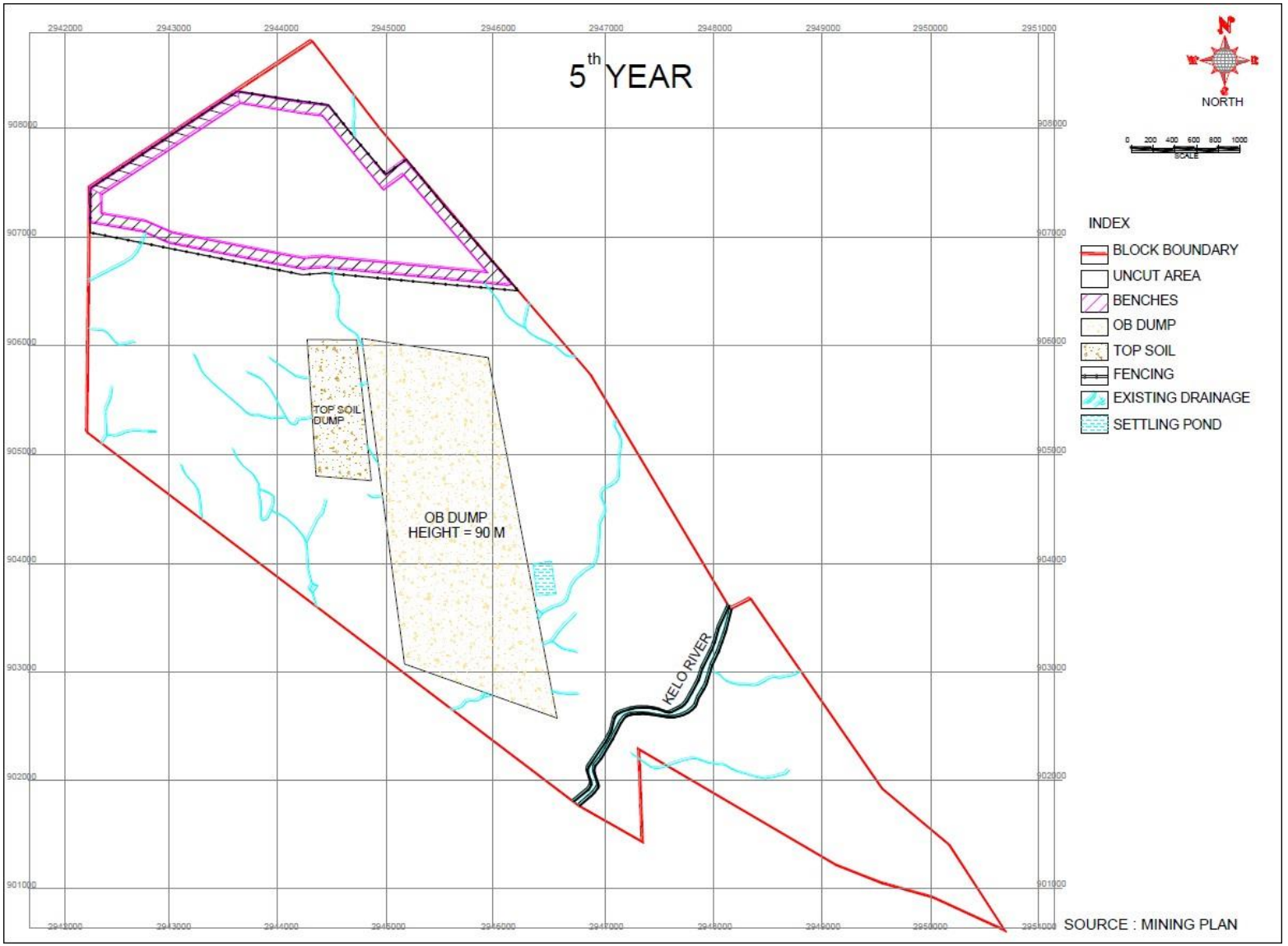

Figure 4.2 Mine Plan for the 5th Year

Figure 4.3 Mine Plan for the 10th Year

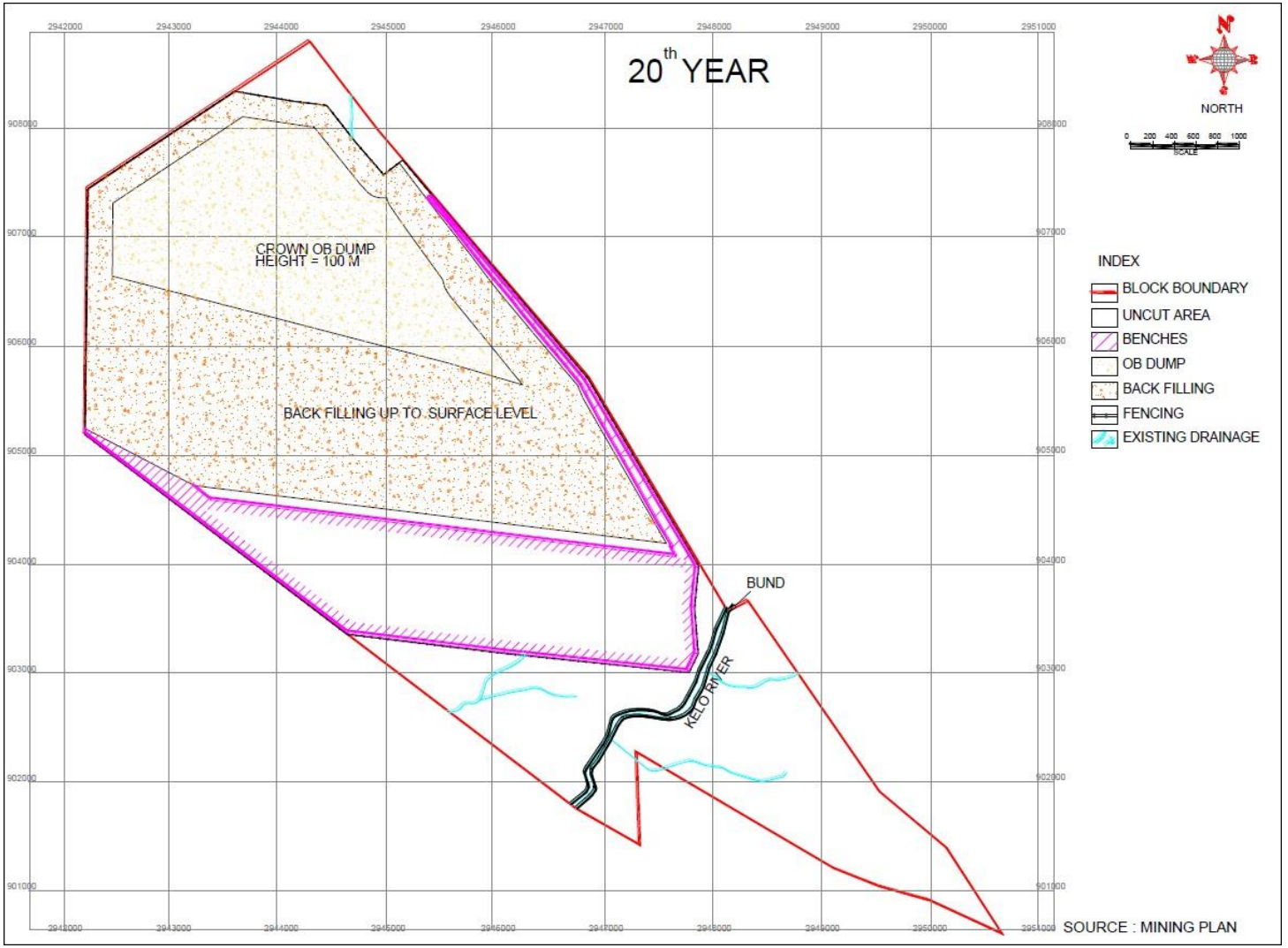

Figure 4.4 Mine Plan for the 20th Year

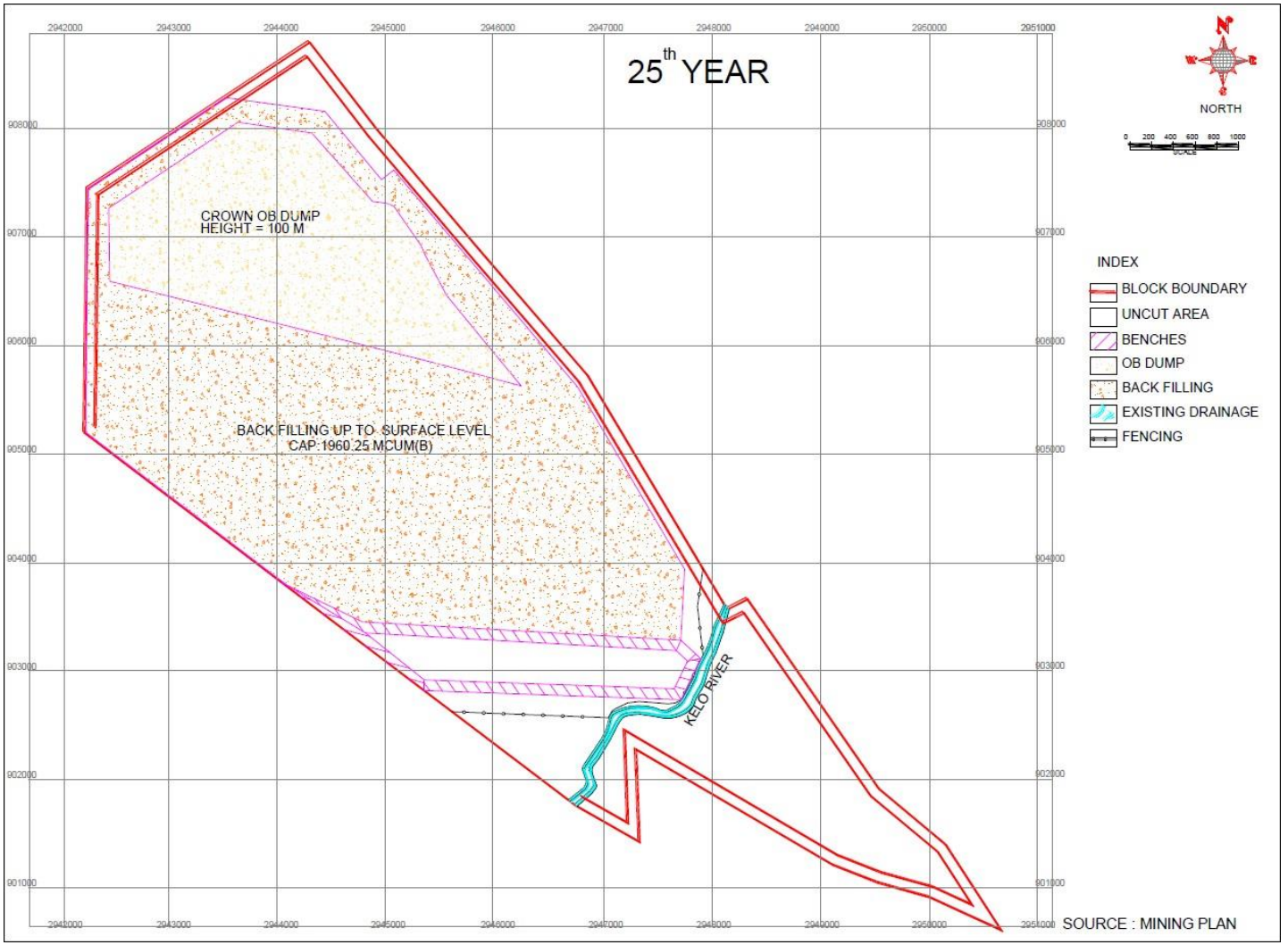

Figure 4.5 Mine Plan for the 25th Year

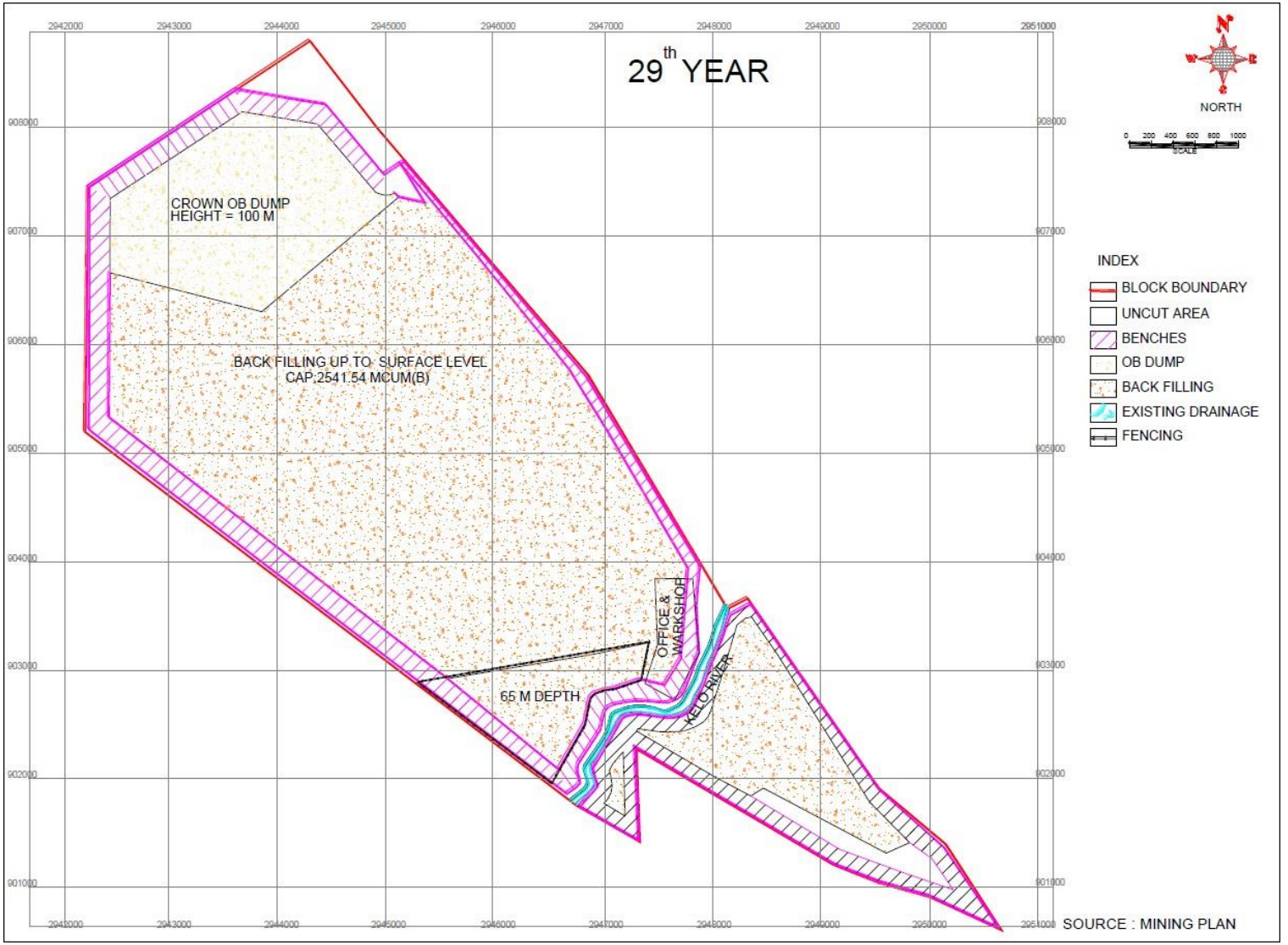

Figure 4.6 Mine Plan for the 29th Year

4.4 Stabilization of Over Burden Dump

4.4.1 Steps to be taken to avoid Dump Slides

- Dumping of top soil will be avoided at the bottom of the cut as it leads to in stability. Dumping of soil and clayey material will be done away from the working area, that is on farther end of the dump so that formation of weak planes is avoided.
- Afforestation by planting trees will helped a lot in improving stability of dumps by preventing erosion.

4.4.2 Reclamation of overburden dumps:

Following activities shall be taken up for reclamation of Overburden dumps.

- Stabilization of overburden dumps
- Construction of retaining walls
- Construction of drain for drainage
- Provision of jute mesh for facilitating grass or vegetative growth on slopes
- Provision of good soil mixed with manure and subsequent irrigation for growth of grass for anchorage on slopes. Plantation mixed with indegenous and fast growing plant species
- The degraded area will be reclaimed and rehabilitated with local species of plantation in a phased manner;
- Plantation will be carried out on waste dumps;
- The haulage roads will be flanked by trees on either side; and
- A belt of trees with thick canopy will be created along the mine boundary to intercept dust, gaseous pollutants and noise.

During quarry operations, it is necessary to adopt suggested mining parameters for the stability of benches, high-walls and spoil dumps. It is also mandatory to examine systematically the fencing of mine working, landslides and cracks between benches. It is required to maintain well graded and wide roads on benches keeping the width of working areas sufficient for spreading of blasted rock and movement of the mining and transport equipment.

5.0 SOIL CONSERVATION PLAN

Mitigative Measures

Mitigative measures to minimize soil erosion will be undertaken by two plan –

1) Biological Conservation Plan,

2) Engineering Conservation Plan

5.1 Biological Conservation Plan:

5.1.1 Approach Plan

The following biological conservation plan will be adopted to mitigate soil erosion.

- Dumping of top soil will be avoided at the bottom of the cut as it leads to in stability. Dumping of soil and clayey material will be done away from the working area that is on farther end of the dump so that formation of weak planes is avoided.
- Afforestation by planting trees will helped a lot in improving stability of dumps by preventing erosion.
- Stabilization of overburden dumps
- Provision of jute mesh for facilitating grass or vegetative growth on slopes
- Provision of good soil mixed with manure and subsequent irrigation for growth of grass for anchorage on slopes. Plantation mixed with indigenous and fast growing plant species
- The degraded area will be reclaimed and rehabilitated with local species of plantation in a phased manner;
- Plantation will be carried out on waste dumps;
- The haulage roads will be flanked by trees on either side; and
- A belt of trees with thick canopy will be created along the mine boundary to intercept dust, gaseous pollutants and noise.

A thick green belt, 7.5 m wide will be developed along the three sides of mine boundary (leaving one side open for access roads & infrastructure) by planting hardy plant species. The Afforestation Program is given in **Table 5.1**

Table : 5.1 Afforestation Program

Afforestation Programme					
Period	**Greenbelt on Safety Area and ML Boundary**		**Reclaimed Area 0/B Dump**		**Total Saplings**
	Ha	**No. Saplings**	**Ha**	**No of Saplings**	
1st year	7.21	18025	0.0		18025
2nd-3'd year	14.43	36075	0.0		36075
4th-5th year	14.43	36075	0.0		36075
6[91]-10th year			198.97	984325	984325
11th-15th year			281.30	703250	703250
16th-20th year			514.51	1286275	1286275
20th-25th year			418.95	1057375	1057375
OCP-closure Stage			612.04	1530100	1530100
Total	**31.25**	**90175**	**22 20 .53**	**5551325**	**5651500**

Planning for plantation is done keeping the following objectives in mind:

- Compensate the damage to vegetation due to setting up and operation of the mine.
- Prevent the spread of fugitive dust generated due to mining and allied activities.
- Attenuate noise generated by the mine.
- Reduce soil erosion.
- Help stabilize the slope of external overburden dumps.
- Increases green cover and improve aesthetics.

Green belt development and afforestation will be carried inside the mining lease area to restore and increase the green cover of the region. Progressive Green Belt development and plantation in and around the mining area to control soil erosion. Progressive green belt development and plantation in the available areas will be carried out in a phase-wise manner till end of the mine life. Saplings will be planted at the rate of 1500 trees/ha in external/internal dumps and in other areas. Stretches of un-worked areas in the mining lease, which will not be covered by any activity, will also be selected for afforestation. Plantation will commence there from the initial years of excavation and plantation will be expanded in such areas in progressive stages.

Attempts will be made for plantation of drought hardy plant species for generation of green belt as furnished below: -

Table 5.2 : Trees and Shrubs

Common name		*Botanical Name*
For Dumps		
• Sal	-	*Shorea robusta*
• Mahua	-	*Madhuca longifolia*
• Neem	-	*Azadirachta indica*
• Sagaun	-	*Tectona grandis*
• Male Bamboo		*Dendrocalumus strictus*
• Biradi		*Delbergia sissoo*
• Peepal		*Ficus religiosa*
• Behada		*Terminalia bellirica*
• Mundi		*Sphaeranthus Indicus*
• Haldu		*Haldina Cordifolia*
• Saja		*Terminalia Elliplica*
• Bija		*Pterocarpus Marsupium*
• **For Slopes**		
• Khus		Vetiveria zizanioides
• Lemon Grass		Cymbopogon
• Grass		Stylohamata
• Shishu		Delbargia Sishu
• Bamboo		*Bambusa spp*
• Khair		*Casia katachu*

The species for draught hardy species, if any more, will be selected in consultation with the State Forest Department. Phase-wise plantation activities on the OB dumps and excavated / mined out areas are dealt in the progressive mine closure plan. It is proposed to take the extensive plantation of varieties on the dump slopes for stabilization and moisture conservation.

5.1.2 Post plantation care: Prescribed post plantation care shall be adopted to ensure maximum survival of the plants. Funds for maintenance of the plants for the first five years after the plantation shall be kept. Immediately after planting the seedlings, watering will be done. Further watering will depend on the rainfall. In the dry seasons, watering will be regularly done especially during March to June. Watering in one year planted saplings will be more

frequent (thrice a week). Manuring will be done using organic manure (animal dung,). Diseased and dead plants will be uprooted and destroyed and replaced by fresh saplings. Growth / health and survival rate of saplings will be regularly monitored and remedial actions will be undertaken as required.

5.1.3 Fencing: As some part of area is nearer to the habitation and lies adjacent to the agricultural land there is every chances of biotic interference to the plantation area. Therefore it has been proposed to provide fencing towards habitation area.

5.1.4 Executing Agency: In all cases, the works shall be executed by the User Agency having specialized departments headed by qualified persons with outsourced man and machinery as and where required. To facilitate this, the User agency shall establish its own executing and supervision cells along with required infrastructural facilities. In order to maintain the quality of work, in house supervision through competent personnel shall be provided. The entire work shall be carried out through close coordination with the Forest Department.

5.2 Engineering Conservation Plan :

5.2.1 Approach Plan : In this Plan, considering the topography and contours of the lease area, emphasis has been given to arrest sliding down of excavated materials along the contour by constructing check dams and retention walls at specified locations in the mining lease. Locations are judiciously selected within the leasehold and plans are prepared.

The salient features of the drainage management plan are as follows:

- The overall drainage planning has been done in such a manner that it maintains the overall slope direction so that runoff distribution is not affected.
- Garland drains have been planned on all around the external dumps. The garland drains shall be routed through settling tanks to settle out the suspended solids in storm water. The clean water will be discharged to natural water courses.
- Check dams across the drain will check water current and arrest solids. These need to be cleaned periodically.
- Stone pitching will be made at suitable places as per requirement to regulate water flow. Some of the drains which will serve for a long time shall be made pucca.
- Garland drains and settling tanks shall be cleaned regularly, especially during monsoon.
- Outside of the garland drains on the drainage lines shall be reinforced with green cover.

5.2.2 Engineering Construction : Retaining walls/Toe walls and garland drains shall serve the purpose of protection against rolling boulders on the slopes and drainage respectively. The drains will be provided with settling pits at regular intervals as required. Outside of the garland drains on the drainage lines shall be reinforced with green cover.

Check dams will be constructed at identified locations to prevent the rainwater run-offs from adjoining high-lying areas to enter the OB area. After physical reclamation, top soil shall be spread on the dumped material and water sprinkling on the soil will be carried out.

5.2.3 Structural Measures: Construction of retaining walls/Toe walls: Retaining walls is a structure which aims at resisting the lateral pressure of soil when there is a change in ground elevation that exceeds the angle of repose of soil. Such retaining walls will be constructed around the OB dump to arrest sliding down of the excavated material.

Details of the structural measure proposed to be constructed around the external OB dump are summarized below:

5.2.4 Construction of Garland drains: Garland drains shall be constructed around the OB dumps. These garland drains will serve the dual purpose of drainage of rain water and also for protection against rolling boulders on the slope. Garland drains will be constructed all along the external OB Dump.

5.2.5 Construction of siltation pits: The run-off / storm water flowing through the network of garland drains around quarries and dumps will be led through siltation pits to settle out suspended solids. The clear water will be discharged to the nearby seasonal streams / nala. Coagulant, if necessary, will be added in the settling pits in monsoon season. Siltation settling pits will be constructed along the garland drains. It is expected that 4 numbers of settling tanks are required. The structure would be checked against overturning and sliding etc. Proper abutment at both sides should be made with earth filling so that excess run-offs would pass through only the siltation pits without any breach elsewhere.

5.2.6 Inspection, Monitoring And Evaluation : For successful implementation of the above proposed program, intensive inspection and technical guidance from the concerned technical wing to be set up by the user agency is required. Infrastructure, conveyance and all other required facilities will be provided by the User agency for proper implementation of the program.

5.2.7 Executing Agency:

In all the cases, the works shall be executed by the User agency having specialized departments headed by qualified persons with outsourced manpower and machinery as and where required. To facilitate this, the user agency shall establish its own executing and supervision cells along with required infrastructural facilities. In order to maintain the quality of work, in house supervision through competent personnel shall be provided.

Photograph showing width measurement of Nala in Mine Lease area for SC plan

Photographs showing temporary SC Plan for OB dump of Gare- IV/VII at the north boundary of GP-II

6.0 COST ESTIMATE

Cost of Mitigative Measures to arrest Soil Erosion & Top Soil Management Plan in respect of both Biological and Engineering plans are proposed. The detail cost estimate is given in subsequent paragraphs.

6.1 Cost estimate for Biological Plan :

This plan include cost for greenbelt and showing of seeds activities the cost estimate is given in **Table 6.1**

Table 6.1
Cost estimate for Biological Conservation Plan

Sr.No	Activity	Amount	Exp for first 5 years	Exp for 5-10 years	Exp for 10-15 years	Exp beyond 15th years
1	Cleaning of the area(6.64 Ha) X 12 Mandays x Rs .130.90/ per mandays	10430	2945.25	2356.2	2474.01	2654.54
2	Demarcation of the area (15200m x 0.7 mandays x Rs 130.90 per mandays)	14950	4230	3370	3550	3800
3	Barbed wire fencing with RCC pole a) RCC Pole 1.6 m @ 4 m distance (no. of poles =17715 running m/4 x Rs. 113.0	500000	141250	113000	118650	127100
	b) Cost of Barbed Wire (17715 running m x 5 rows/6.5 Kg x Rs 42.50	580000	163461.5	130769.2	137307.7	148461.539
	c)Fixing of RCC Poles and Barbed Wire (17715 m x 0.25 mandays x Rs.130.90	580000	163461.5	130769.2	137307.7	148461.539
4	Pit digging in size (45 x 45 x 45 cm)(4450 x 4.5 mandays/100 Nos x 130.90	26500	7363.125	5890.5	6185.025	7061.35
5	Mixing of cow dung Manure with soil (6.64 Ha x 3.5 manday x 130.9)	3050	859.0313	687.225	721.5863	782.1575
6	Cost of sapling @Rs.8/Sapling (4450 x8)	35600	10000	8000	8400	9200
7	Planting Charges of Sapling (4450 x 2.5 mandays/100 Nos x 130.9)	14600	4090.625	3272.5	3436.125	3800.75
8	Hoeing and weeding First year first(4450 samplings x 1.20 mandays/100 Nos x 130.9)	6990	1975	1566	1643	1806
9	Hoeing and weeding First year second(4450 samplings x 1.25 mandays/100 Nos x130.9)	7282	2045	1636	1718	1882
10	Hoeing and weeding First year third(4450 samplings x 1.30 mandays/100 Nos x 130.9)	7575	**2127.125**	1701.7	1786.785	1959.39
11	Hoeing and weeding second year first(4450 samplings x 1.20 mandays/100 Nos x 130.9)	6990	**1963.5**	1570.8	1649.34	1806.36
12	Hoeing and weeding second year second(4450 samplings x 1.25 mandays/100 Nos x 130.9)	**7282**	2045.313	1636.25	1718.063	1882.375
13	Hoeing and weeding Third year first(4450 samplings x 1.20 mandays/100 Nos x 130.9)	6990	1963.5	1570.8	1649.34	1806.36
14	Watch & Ward (365 days x 4 year x 4 Mandays x Rs 130.90	764456	764456	0	0	0
15	Showing of seeds – Topsoil dump area (60000 m^2@ Rs. 16.15/m_2)	969000	0	969000	0	0
	TOTAL	**3541695**	**1274236.782**	**1376796.625**	**428196.7373**	**462464.7355**

6.2 Cost estimate for Engineering Plan :

This plan include cost for garland drain, catch pit, settling pond, check dam and toe wall activities the cost estimate is given in **Table 6.2, 6.3, 6.4, 6.5 and 6.6 respectively.**

6.2.1 Garland Drains: Garland drains will be provided at following location to prevent and arrest soil being carried along the runoff water form hills of side of boundary as well as mine's working area.

Table: 6.2 Garland drains

SI No	Location of drain	Dimension/ Volume	Man days@ 0.67/m	Total Exp P Rs.130.90 der man day	Exp for first5 years	Exp for 5-lOyears	Exp for 10-15years	Exp beyond 15th year
1	All along the mine boundary OR North side of mine	5500mx2mx2 m= 22000m^3	14740	1929466	613921	526218	526218	263109
2	Around the OB Dump area	2000mx2mx2 = 8000m^3	5360	701624	701624	0	0	0
3	Around the Top Soil Dump Area	950m X2mx2m=3800 m300m3	2546	333271	333271.4	0	0	0
	TOTAL		**22646**	**2964361.4**	**1648816**	**526218**	**526218**	**263109**

6.2.2 Catch Pits:

Catch pits will be provided all along the garland drain at an interval of 1 km, to allow the site & sedimentation to settle down.

Table : 6.3 Catch Pits

Total Number of Catch Pits	Dimension Volume	Man days @ 0.67 /m^3	Total Expenditure@ Rs.130.90 per man day	Exp for first 5 years	Exp for 5-10 years	Exp for 10-15 years	Exp beyond 15th year
9 Nos	8m(l)x5m(w)x2.5m(d)=100m3x9=900m3	603	78932	26310	26310.9	17540	8770

6.2.3 Setting Ponds : It is proposed to construct a pair of settling ponds in series for mine runoff water and another pair of settling pound in series for external dump runoff water, as per the following dimensions & specifications given in **Table 6.4 (A).**

Table 6.4 (A).

Dimension of pond

Sr N	POND	Dimensions(L X B X Depth)	Capacity (Cum)
1	External dump settling ponds	50m x 34m x 5m(2 Nos)	17000
2	Mine settling ponds	117m x 100m x 5m (2 Nos)	117000
		Total	134000

The cost estimate for settling pond is given in **Table 6.4(B)**

Table 6.4(B)
cost estimate for settling pond

Total Volume of settling ponds (4Nos)	Man days @ 0.67/m^3	Total Expenditure @ Rs.130.90 per man day	Exp for first 5 years	Exp for 5-10 years	Exp for10-15 years	Exp beyond15th year
134000	89780	11752202	5876101	5876101	0	0

6.2.4 Check dam/ Toe walls will be provided to arrest sediment flow into stream. This will prevent choking of stream. The cost estimate for check dam and toe wall are given in **Table 6.5**

Table 6.5
Cost estimation for Check dam/ Toe walls

Sr. No	Places	Dimension/ Volume	Exp @ Rs.300.00 per Cum.	Exp for first 5years	Exp for5-10 years	Exp for 10-15 years	Exp beyond 15th year
01	(i) where the garland drain around the 0/13 dump discharges in to the main drain.	10m X 2mX 2m=40m^3	12000	12000	0	0	0
	(i) where the drain around the top soil dump discharges in to the main drain	10m X 2mX 2m=40m^3	12000	12000	0	0	0
02	(i) A toe wall (coupled with the Garland drain) all around the top soil dump	2.5(h)X2m(top width) X3m (botto mwidth) X300m=6.25X 300=1875m^3	562500	562500	0	0	0
	(ii)A toe wall between the main drain & the OB dump.	2.5m(h) X 2m (to p width) X 3m (bottem width) X 585m=6.25 X585=3700m3	1110000		1110000	0	0

6.3 Total cost of Mitigative Measures for Soil Conservation:

The total expenditure prosed for taking up the works connected to "Mitigative Measures for soil Erosion, choking of streams and following top soil Management Plan":

Table 6.6
Total cost of Mitigative Measures

Sl No	Activity	Location	Total Exp (Rs)	Exp for first 5 years	Exp for 5-10 years	Exp for 10-15 years	Exp beyond 15th years
A. Biological Plan							
01	Green Belt development	Along the three sides of the block Boundary	2572695	1274225	407801	428203	462465
02	Sowing of seeds	Top soil dump area (60000 Sq m x 16.15 per Sq m)	969000	0	969000	0	0
B. Engineering Plan							
03	Garland Drain	(1) Alone the mine boundary	1929466	613921	526218	526218	263109
		(2) Around the OB	701624	701624	0	0	0
		(3) Around the top soil	333272	333271	0	0	0
04	Catch Pits	In the garland drain at an interval of every km	78933	26310	26310	17540.6	8770
05	Setting Ponds	SE- Corner of the Coal Block	11752202	5876101	5876101	0	0
06	Check Dams/ Toe Walls	(i) SW-OB dump garland	12000	12000	0	0	0
		(ii) SE — OB dump garland drain	12000	12000	0	0	0
		Sub - Total	0	0	0	0	0
		(i) Around top soil	562500	562500	0	0	0
		(ii) Between main drain and OB Dump	1110000	0	1110000	0	0
	GRAND TOTAL (A + B)		**20033692**	**9411954**	**8915431**	**971961**	**734344**
	TOTAL (Rounded off thousand) to nearest thousand)		**20033000**	**9412000**	**8915000**	**972000**	**734000**

Cost of Soil Conservation Plan - Rs. 20033000 in four stages

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