1.1 EXECUTIVE SUMMARY

An environmental management study was carried out in an area of about 40 km radius with Tentoi as centre in Angul and Dhenkanal districts in Orissa. The study was undertaken to assess the possibility of establishment of thirteen thermal power stations and supportive infrastructure and associate small and medium industries. The proposed development will also need opening of new mines and enhancement of the capacity of the existing coal mines in Talcher coalfield. The objectives were as given below.

- Assessment of present status of air, water, land use, bio-diversity and socio-economic components including noise.
- Identification and quantification of significant impacts due to the mining and other industrial operations (both existing and proposed) on various components of the environment and plan for the corrective measures.
- Prediction of impacts on different environmental components based on the existing and projected scenario.
- Preparation of an appropriate Regional Environmental Management Plan (REMP) based on the capacities of air, water and sub-systems outlining the control technologies to be adopted for mitigation of adverse impacts.
- Delineation of the post project environmental quality monitoring programme to be pursued by the mines and industrial owners and Government authorities in the region.

The Angul-Talcher-Meramundali area of Orissa has important natural resources, which include coal, forests, fertile land, minor minerals, ground and surface water, etc. and is only developed mainly in the coal bearing areas. Major industries operating in the area include aluminum smelter, thermal power plants, ferro alloy plant, coal mines, etc.

The area has a potential for large-scale industrial development due to availability of a large quantity of coal and other natural resources. There are proposals for establishing 13 thermal power plants with a total capacity of 14,770 MW in the next decade. In addition some other major industries may also be established. The daily demand of coal will be about 2,50,000 tonne.

The present industrial activities and those envisaged in future will impact all the components of the environment of the study area. This calls for devising measures for effective control and management of the environmental parameters while taking care of needs of the people and requirements for social and industrial development. Formulation of the present Regional Environmental Management Plan on the basis of the prevailing environmental scenario and taking into account the proposed industrial development is a step towards achieving this. For the development of the Plan the study covered the following aspects.

Land Environment	• Study of the general topography, development of the geological maps of the study area. • Defining land use pattern of the study area based on land use plan as well as remotely sensed data with adequate field

	verification. • Preparation of soil maps and soil quality data based on soil sampling and its subsequent analysis. • Assessment of existing and perspective mining areas. • Identification of the locations and characteristics of the urban agglomeration and transport and road network and future expansion plan. • Identification of the locations and characteristics of ecological sensitive areas.
Resource Accounting	• Assessment of coal availability and its consumption pattern. • Assessment of water availability, water demand, flow and consumption pattern. • Assessment of forest cover and plantation. • Study of flora and fauna including appropriate conservation plan of scheduled species. • Assessment of agriculture and horticulture pattern and products
Ambient Air Quality including noise	• Assessment of meteorological parameters. • Assessment of ambient air quality (SPM, RSPM, SO_2, NO_x, etc.) in the study area for summer, post-monsoon and winter seasons. • Assessment of ambient noise quality status at in industrial, commercial, residential as well as sensitive areas.
Water Quality	• Assessment of *surface water quality* of water available in rivers; reservoirs; and major ponds in four seasons as per existing norms. • Assessment of *ground water quality* in three seasons as per existing norms. • Assessment of seasonal variation and depletion of water table through existing hydrological maps and basic measurement of water level in well.
Socio-Economic Information	• Assessment of the socio-economic profile of the study area covering demography, health and food status, access to health care facilities, access to education, occupational pattern, income pattern, education, etc. • Assessment of the future socio-economic scenario on the basis of the proposed industrial and developmental activities.
Urban Activities	• Study of the urban development in combination with industrial development. • Present status as well as future requirement of drinking water and its management. • Present status of vehicular traffic at critical locations and management of the same in future on the basis of the planned mining and associated activities in the study area.
Assessment of existing environmental management	• Preparation of an inventory of activity wise existing environmental management measures and assessment of their efficacy.

measures and identification of environmental problems	• Identification of environmental problems (existing and proposed development in pipe line). • Modelling of environmental parameters. • Pollution indexing and development of Environmental Impact Matrix.
Development of Environmental Management Plan with recommendations for taking care of the components.	

1.1.1 ASSESSMENT OF EXISTING AND FUTURE ENVIRONMENTAL STATUS AND THEIR INDEXING

POPULATION

The total population of the two districts, i.e., Angul and Dhenkanal is about 22,00,000 and the growth of the population in future is anticipated to be as given below.

Angul district

In 2001 – 2011: 13,21,000 at 16% decennial growth rate
In 2011 – 2021: 15,33,000 at 16% decennial growth rate
In 2021 – 2031: 17,78,000 at 16% decennial growth rate

Dhenkanal district

In 2001 – 2011: 11,94,000 at 12% decennial growth rate
In 2011 – 2021: 13,38,000 at 12% decennial growth rate
In 2021 – 2031: 14,98,000 at 12% decennial growth rate

Hot spots (high population density/growth zones)

Villages and urban centres with projected 16% decennial growth rate and in-migration at 16% decennially have been identified. These have been designated as "hot spots" with respect to high population density and growth. The list of such villages and urban centres (about 15) is presented below.

Villages and Urban Centers	Hot spot[#] w.r.t population growth	Population as per 2001 census	Estimated Population in 2007[+]	Projected population in 2011[+]	Projected population in 2021[+]
GRID C16					
Chhendipada		4,904	5,453	5,688	6,598
Kosala		4,837	5,379	5,610	6,508
GRID D13					
Tukuda		3,488	3,879	4,046	4,693
Kanjara		3,220	3,851	3,735	4,332
Tubey		4,005	4,454	4,645	5,389

Villages and Urban Centers	Hot spot[#] w.r.t population growth	Population as per 2001 census	Estimated Population in 2007[+]	Projected population in 2011[+]	Projected population in 2021[+]
GRID G4					
Bijigol		3,123	3,473	3,622	4,202
Seepur		3,797	4,222	4,404	5,109
Tipo		4,133	4,596	4,794	5,561
GRID HI					
Gobara		3,298	3,667	3,825	4,437
Kangula		6,461	7,185	7,494	8,693
Balaramprasad		7,440	8,273	8,630	10,011
Kulad	Hot spot	4,184	5,121	5,522	7,290
Budhapanka		5,211	5,795	6,044	7,011
Gotamara	Hot spot	6,229	7,624	8,222	10,853
Nuahata	Hot spot	4,696	5,748	6,198	8,182
Kukudanga		3,340	3,714	3,874	4,494
Jarasingha	Hot spot	5,054	6,186	6,671	8,806
Turanga	Hot spot	3,952	4,837	5,216	6,885
Kumanda	Hot spot	5,337	6,532	7,044	9,299
Anugul (NAC*)	Hot spot	38,018	46,534	50,183	66,242
FCI Township (CT**)		7,058	7,848	8,187	9,497
TTPS Township (CT)	Hot spot	6,621	8,104	8,739	11,536
Dera Colliery T'ship (CT)	Hot spot	18,592	22,757	24,541	32,394
Ghantapada (CT)	Hot spot	15,593	19,086	20,582	27,169
Nalco (CT)	Hot spot	18,045	22,087	23,819	31,441
Talcher Municipality	Hot spot	34,998	42,838	46,197	60,980
GRID H5					
Kualo		3,942	4,384	4,572	5,304
Saranga		5,343	5,941	6,197	7,189
Badajhara		3,184	3,541	3,693	4,284
Barihapur		4,787	5,323	5,552	6,441
Kandarsingha		3,370	3,747	3,909	4,534
Parjang		3,613	4,018	4,191	4,861
Sanda		6,099	6,782	7,074	8,206
Kamalanga		3,370	3,747	3,909	4,534
Mangalpur	Hot spot	3,895	4,767	5,141	6,786
Kharagprasad	Hot spot	4,221	5,167	5,571	7,354
Balaramprasad	Hot spot	3,027	3,705	3,995	5274
GRID H9					
Indipur		4,335	4,821	5,028	5,833
Kamakshyanagar (NAC)		15,003	16,683	17,403	20,188

NAC* means Notified Area Council/ Committee

Potential areas for urban development, R&R sites and Industrial development)

The Orissa Government has planned for massive industrial growth in the region by way of establishing a large number of thermal power plants, steel plants and other coal based industries, for which a large area of land and other human and natural resources will be required. Based on the existing land-use/ land-cover potential areas for industrial development are suggested. These are as given below.

1) Grid number H-1 (south-east corner):
    - ❖ South of Banerpal (south of NH-42); and
    - ❖ North of Nigra/ Lingara nadi, south of Khaliberana village.
2) Grid number H-5 (south-west corner):
    - ❖ Around Meramundali (west and south of NH-42),
    - ❖ Between Brahmani river and NH-42;
    - ❖ North of Brahmani river to south of Kumasi village;
    - ❖ North of Brahmani river and south and west of Bhirenia village; and more broadly on either side of Brahmani river preferably to the south.
3) Grid number H-6 (north-west corner): north of Sanamunda village.
4) Barren and unused land lying on either side of NH-42 in Grid number H-1 or H-5.
5) All barren land which is available surrounding/adjacent to the "hot spots" can also be considered for future development.

Education

The studies indicated that the literacy rate in the study area is low. Among the total literates, only 9% have qualifications above class X, whereas overwhelming 70% respondents have qualifications below class V. The remaining 21% have qualifications between class V and X. Therefore, it is necessary to take measures for improving the educational facilities and motivate the people.

Employment and Income pattern

In the study it was observed that majority of the population of the area is dependent on agriculture for livelihood. While agricultural labour engaged in cultivation is 35.8% 47.04% are employed in industries. About 15.71% people do their own cultivation, whereas only 1.45% people have their own cottage/SSI units. The share of the income of the families from various sources was as given below.

- Cultivation of own land - 29.28%
- Agricultural labour - 22.17%
- Cottage and other industries - 42.63%
- Own business – 3.71%
- Fisheries and bee keeping - 2.21%

The average monthly income of the families was about Rs.2,000. Considering 5 members per family the per capita monthly income is about Rs 400 only. This indicates economic backwardness of the people living in the area specially in the villages.

Health & Medical facility

The study revealed an unhealthy life style of the people living in the region on account of addictions. They are addicted to smoking (31%), chewing beetle nuts and tobacco (62.54%), drinking alcohol (5.95%), and others using a local made tobacco based product (popularly known as GUDAKHU) (7.9%).

Water borne diseases are common ailment in the region (32.88%). Air borne, heart-related and eye diseases are also prevalent among the population. A large section of population (53.15%) suffers from malaria, tuberculosis, scabies, leprosy, acute respiratory infection, etc.

Probable future scenario and suggested strategy

The details of existing activities in the study area and projected level of industrialisation outlined earlier indicate that the resources available in the area will be exploited in near future. Since, coal is the major resource establishment of coal based industries, i.e., thermal power plants, steel plants, etc. is envisaged. The addition of these activities will stress all the components of prevailing environment. The anticipated impacts on the societal parameters are given below.

1. There will be a marked increase in the total population of the area.
2. The overall literacy of the area will increase with the establishment of the industries as well as due to implementation of Central and State governments social upliftment programs.
3. The surrounding areas of Angul-Talcher-Meramundali region has either dense forest lands or falls under the Mahanadi delta which is more suited for agriculture. The ensuing industrialization in the study area will lead to wide-scale mobility from rural to urban centres – thereby further stressing the environmental components, if appropriate planning with respect to development of infrastructure and civic facilities is not taken up urgently.
4. With the implementation of projected industrialisation some urban agglomerates will emerge around Angul, Kanhia, Talcher, Banarpal, Odapada blocks, etc. Hence, it is necessary to launch an effective regional planning with respect to spatial strategy, economy, housing and transportation around the development sites in the areas.
5. In the future scenario, as more industries will be set up in the region, migration of population from rural to urban areas/centers will take place. In order to maintain a balance between rural and urban settlements and population suitable measures shall be needed in the overall development planning.

In order to plan for future societal development of the study area with the addition of the planned coal based and associated industries the mining and other industries will be required to plan and implement all the measures required for the fulfillment of their '**Corporate Social Responsibility**' with a view to meeting the emotional, mental and physical needs of the society as well as an improvement in the quality-of-life

commensurate with the level of economic activities. The following aspects need due attention.

1. Control of population development
2. Creating awareness among the society about the advantages and impacts of mining and associated coal based activities
3. Development of adequate infrastructure (roads, transport, communication, etc.)
4. Development of educational and medical facilities
5. Development of R&R packages and rehabilitation action plans
6. Development of overall community development plans
7. Optimization of impacts on the natural and manmade resources
8. Development of strategy for proper closure of the mines
9. Conservation and development of the manmade and natural resources other than minerals
10. Preservation of the entity of the areas in terms of social, religious, archeological and cultural significances
11. Any other need as per the typical features of the area

The corporate sector, i.e., mining and other companies responsible for the industrial development will be required to look into the following measures so as to be able to fulfill their **Corporate Social Responsibility.**

1. Agricultural development
2. Forest management
3. Overall land use management
4. Water resource management
5. Population control
6. Health, education and well being of the people
7. Promotion of agro-based cottage industries
8. Converting impacts into resources

LAND USE AND SOIL

Land-cover

The northern and southern parts of the study area are hilly and the rest of the area is having a number of fertile valleys. Almost all the hilly terrains (i.e., about 35%) of the study area are having forest cover. The remaining 65% of the study area is plain dominated by agricultural land (with frequent fallows) and other land-uses. Barren / waste lands with gullies (about 14% of the study area) exist throughout the study area. The terrain is undulating and accommodates a large number of human settlements and fertile lands as outlined earlier. The overall land use situation is as given below.

Sl no	Use	Percent of land
1	Mining area	0.61%
2	Human settlements	3.81%
3	Forest land including plantation	36.29%
4	Agriculture land	42.31%
5	Barren land/ waste land	14.13%
6	Water bodies	2.85

Soil resources

Typic Ustochrepts is the dominant (56.6%) soil type (soil sub-group), followed by Aeric Haplaquepts (13.4%) and Vertic Haplaquepts (13.1%) in the study area. These soils are slightly acidic and have high available water capacity. The dominant land-use associated with these soils is paddy cultivation.

Hot spots (areas having severe soil erosion and unacceptable soil quality)

About 150 sq km of barren land in Grid 73G/4 with a lot of gullies and ravines has been considered as hot spot from the point of view of severe soil erosion. As per 1973 Survey of India topographic sheets the area was covered by dense mixed Sal jungles. This forest land as per 2007 satellite imagery has been considerably eroded.

A number of power plants, mines, steel plants and their supporting ancillary industries are expected to come up in near future in this area. This will affect land use and soil quality of the area.

MINERAL RESOURCES

In terms of geographical distribution of mineral resources in Orissa, the Angul-Talcher-Meramundali area contributes to the state mainly in terms of power grade coal and fire clay although a few other non-metallic or industrial minerals like graphite, kyanite, quartz, quartzite and a few precious stones are also available in the region. The details of the resources and present scenario have been described in Chapter 2.

Future Scenario

Potentiality of Talcher Coalfield: The life of Talcher coalfield has been estimated to be 70 years. The present mineable reserve are estimated to be 1,373 Mt. Apart from the mines of Mahanadi Coalfields Limited a number of coal blocks have been allotted to the private sector for captive use mainly for power generation and sponge iron plants. The estimated geological reserves of these captive blocks are 7,418 Mt. The MCL has planned to produce about 3.6 Mt from the underground coal mines and the rest from the opencast mines in the future.

Solid Waste (overburden) generation

The stripping ratio of the existing mines is varying from 0.5 to 0.8. As estimated from the orientation and cross section of the coal seams the stripping ratio in future will not exceed 1.5. The mines will have to be planned in such a way that the overburden of one mine may be used to fill the void of another mine so that the mining craters are reclaimed properly. The projected volume of overburden to be generated by the mines through 2021-22 as 359.79 m^3.

FLORA AND FAUNA RESOURCES

Flora: As per Survey of India toposheet, 1972, the noticeable forest cover of the Angul-Talcher-Meramundali region was 2315.04 sq km (46.04 %). The satellite imagery of December 2007 shows forest cover as 1770.32 sq km (35.20 %). This reveals a decrease of 23.54 % forest cover since 1972.

Most of the Angul-Talcher-Meramundali region is covered with tropical deciduous forests of different types. Forty-six plant families with 115 species are thriving in the entire area.

Shorea robusta was maximum in number as per quadrat analysis undertaken in the study area. Next dominating species was *Buchanania lanzan*, *Madhuca indica* and *Butea monosperma*. The structure and function of tropical deciduous forests in Angul-Talcher-Meramundali region is dominantly controlled by *Shorea robusta*. The study area represented different communities in terms of species composition. The diversity index revealed that the forests were moderate in species richness and lower in stem density and basal area.

Aquatic and Terrestrial Fauna: Fishes, amphibians and water snakes are the major aquatic fauna. The terrestrial fauna includes common invertebrates and vertebrates. It is pertinent to mention that wild animals, like Bear, Boer, Tiger, Leopard and Elephants are not seen in the site. Elephants and Bears are the only migratory mammals in the area coming from distant places. However, it is not a common migratory route for wild animals. Among the amphibians, *Rana tigrina* is a threatened species and in reptiles V*aranus* is threatened.

Livestock: As per 2001 livestock census the cattle population of Angul district is 5,72,619 out of which 5,30,867 are indigenous and 41,752 are crossbreed. The buffalo population is 43,616, which are of indigenous type. The sheep, goat, pig, poultry population is 63,951; 2,38,663; 3,047; and 3,63,830 respectively as per 2001 livestock census. The sheep available are mostly of local non-descript type. Goats are reared mostly in hilly areas.

Hot spots (protected forests, areas having rich bio-diversity, endangered species, degraded forest areas and loss of prime agriculture land)

Extensive mining, urbanisation and population growth in the area has triggered increase in the number of urban and rural settlements, degradation of forest area and loss of prime agricultural land. Decrease in agricultural land in the study area may be attributed to the shift in occupation by the people from cultivation to the lucrative mining jobs and also due to lack of improvement in irrigation facilities. Deforestation due to various reasons has also triggered an increase in barren land and subsequent loss of soils. Ecological hot spots are given below.

Category of hot spots	Status at present	Anticipated status
Degraded protected forests	About 144, 86, 76 and 77 sq km of forest land has been degraded to barren land in Grids 73G/4, 73G/8, 73H/5 and 73H/6 respectively since 1973 to 2007. There is also a marked decrease in forest land in Grids 73C/16, 73D/13, 73H/2, 73H/1, & 3H/9.	The satellite imagery (Fig 3.3.2), clearly depicts how the forest cover in the study area has degraded over a span of

Category of hot spots	Status at present	Anticipated status
Loss of prime agricultural land	About 80 and 50 sq km of prime agricultural land has been degraded to barren land in Grids 73C/6 and 73D/13 respectively since 1973 to 2007. There is also a decrease in prime agricultural land in Grids 73H/1, 73H/9 and 73G/12	34 years. This trend is likely to continue in view of the anticipated growth of population, increased coal mining and setting up of more and more industries, which will require large areas of land. Obviously either the forest land or agricultural land shall be used for this purpose. (Fig 6.2.1)
Areas having rich Biodiversity	Wildlife habitats, namely, Satakosia Gorge Sanctuary, Malyagiri, Bulajhar, Panchadhara and Mahanadi river systems lie in and around the study area. These are fragile and have biologically diverse habitats. 146 different species of trees, 3 of Bamboos, 59 of shrubs, 46 of herbs, 24 of perennial grasses, 8 of annual grasses and 57 of climbers are thriving in the region. Thus, the area has considerable variation in plant diversity. The diversity index revealed that the forests were moderate in species richness. Fishes, amphibians and water snakes are major aquatic fauna. The terrestrial fauna includes common invertebrates and vertebrates. Details are given in Chapter 3.	The industrialisation and urbanisation of the area will impact the forest cover of the area, which is a habitat to a number of birds and animals, thereby threatening their existence.
Endangered species	Among the amphibians, *Rana tigrina* is a threatened species and in reptiles V*aranus* is threatened.	

WATER RESOURCES

The area under study has all the three types of geological formations, i.e., sedimentary, metamorphic and igneous rocks. The coal and other deposits are available only in the sedimentary formations. The area has both surfaced and underground sources of water.

Brahmani River basin

The Angul-Talcher-Meramundali area falls in the "Brahmani River Basin", which is an inter-state river basin. It is spread across the states of Chhattisgarh, Jharkhand and Orissa. The Central Water Commission (CWC) has estimated the annual renewable water resources of the basin as 21,920 million cubic meters. This includes surface and ground water resources. The annual renewable groundwater recharge has been assessed as 5,171 million cubic meters. Out of this, a recharge of 4,395 million cubic meters is considered utilizable for irrigation.

Surface water resource in the study area

The Central Water Commission has estimated the annual renewable water resources of the Brahmani river basin as 21,920 million cubic meters (MCM). This includes surface and groundwater. Out of this, it is estimated that 16,618 MCM of water (about 75%) would continue to flow to the sea.

There is a significant variation of rainfall from year to year. The rainfall in the area during the last 10 years varied between 896 mm and 1,744 mm. The average rainfall in the study area in 2007 was 1,111 mm. But it is alarming to note that about 85% of the total surface run off is available in four months of monsoon season, i.e., from June to September. The total surface runoff estimated in the study area in 2007 is 5,589 MCM. But considerable amount of this valuable water resource is flowing into the sea untapped. The rest of the year (October to May) is almost dry. Unless means to tap this huge water that is flowing into the sea are explored urgently, severe water availability problems are to be faced both for industrial as well as domestic purposes. This may affect the industrial development in the area.

The month-wise rainfall and surface run-off in 2007 were collected during peak period (June to September) and lean period (October to May). Annually about 1,029 MCM (about 18%) is recharged as groundwater. There are more than 1,000 ponds (covering an area of 28 sq km), 4 small reservoirs (covering an area of 3.6 sq km) and Brahmani river and its first and second order streams (covering an area of 111.5 sq km) in the study area which hold a significant quantity of surface water. The ponds and reservoirs hold about 111 MCM and the rivers and drains can hold 390 MCM water. Thus the total water holding capacity of the study area is 501 MCM. It is found that about 73% of the surface run off would continue to flow to the sea. As such, necessary measures need to be explored to tap this water on priority basis in order to avoid severe water availability problem in the area.

Groundwater

The study area is blessed with rich groundwater availability in the sedimentary and metamorphic rock regions. The annual renewable groundwater recharge has been assessed as 5,171 MCM in the entire Brahmani river basin. The annual renewable groundwater resource in Angul and Dhenkanal districts is about 1,029 MCM as given below.

District	Basin area (km^2)	Gross recharge 10^6 m^3	Utilizable recharge (85%) of gross recharge 10^6 m^3
Angul	4,235	547.18	465.10
Dhenkanal	3,969	481.53	409.30

Source CWC

The water sources both surface and underground, are impacted by both opencast and underground mining.

Water demand in Angul-Talcher industrial area

The area is fast emerging as an important source of coal, aluminum and thermal power in the country. About 711 km^2 area forms the core industrial zone. Water of Brahmani river and its tributaries cater to the industrial/domestic need of this fast growing complex. The major part of the area forms the plains of river Brahmani and its tributaries like Nandira Jhor, Singada Jhor and Tikra River.

Raw water to the extent of about 86 million cubic meters/annum is drawn from the river for industry/ mining activity, apart from other surface and ground withdrawals (36 million cubic meters/annum) .

Water scenario of mining

Talcher coalfield has both the opencast and underground mines and as is well known both the methods of mining severely impact the surface and ground water sources.

Impacts of opencast mines

- The first and second order streams and sometimes the third order streams on the surface are severely affected due to alterations in the surface topography by way of formation of the mine, overburden dumps, soil stacks, and other supporting services of the mines.
- By removing the overlying rock mass the water table and the aquifers lying over the coal beds are cut across and hence get damaged. In many situations it has been noticed that due to this the availability of water from these sources is affected due to draw down up to a distance of about 0.50 to 1.50 km.

Underground mines

- Underground mining of coal seams either with caving or with backfilling causes subsidence movements on the surface, which results in the modification of surface topography. The alterations in the topography affect the nature and flow characteristics of first and second order streams.
- The water table and the aquifers overlying the coal seams get damaged due to subsidence movements because of the disturbance caused in the overlying rock mass. The impacts are more severe in the underground mines planned with caving. In these situation also the water availability from underground sources is affected due to draw down and this affect may be up to a distance of about 1.00km.

Water Balance (in the study area)

Based on the available data, a broad outline of water budget of the study area has been drawn for the year 2007 for both **Peak** (June to September) and **Lean** (October to May) periods of the year. In addition, water budget for the years 2011, 2016 and 2021 has also been projected as shown below:

Water Balance in Peak period (June to September)

Figures in million Cu.m

Sl. no		2007	2011	2016	2021	Remarks
1.	INPUT: Rainfall (1111 mm annual) (available as total surface runoff in peak period within the study area)	5589	5589	5589	5589	No change is considered for future years
2.	**MEANS OF STORAGE:**					
a)	Ground water recharge (includes wells)	1029	1029	1029	1029	-do-
b)	Retained by ponds and reservoirs in peak season	111	111	111	111	-do-
c)	Retained by rivers and drains in peak season	390	390	390	390	-do-
	Sub-Total	**1530**	**1530**	**1530**	**1530**	
3.	**CONSUMERS:**					
a)	Rural population (from wells) @ 70 LPCD	28.9 (11.30 lakh)	29.7 (11.64 lakh)	31.2 (12.22 lakh)	32.8 (12.83 lakh)	Considering 1% growth/year
b)	Urban population @ 140 LPCD	9.1 (1.78 lakh)	10.0 (1.96 lakh)	11.0 (2.16 lakh)	12.1 (2.37 lakh)	Considering 2% growth/year
c)	Livestock: - Cattle & Buffalos – (estimated 10 lakhs) @ 50 LPCD	18.3	18.8	19.7	20.7	Considering 1% growth/year
d)	Other live stock: - pigs, sheep, goats, etc. @ 10% of livestock	1.83	1.88	1.97	2.07	Considering 1% growth/year
e)	Agriculture (irrigation) (2128 sq km) @ 200 mm per Ha	425	425	425	425	No growth considered

Sl. no		2007	2011	2016	2021	Remarks
f)	Forests and other vegetation (1825.2 sqkm) @ 400 mm per Ha	730	730	730	730	No growth considered
g)	Industrial use	122	653	653	653	No growth considered after 2011
	Sub-Total	**1335.13**	**1868.38**	**1871.87**	**1875.67**	
4.	**WATER LOSS:**					
a)	Return flow from industries (waste water - 50% of industrial use)	62	313	313	313	Can be utilised only after recycling
b)	Runoff into Sea including evaporation (73%)	4059	4059	4059	4059	Can be tapped for utilisation
	Sub-Total	**4121**	**4372**	**4372**	**4372**	
5.	**Balance (2-3)**	**(+)194.87**	**(-)338.38**	**(-)341.87**	**(-)345.67**	
6.	**Gross Balance: Water loss + Balance (4+5)**	**(+)4315.87**	**(+)4033.62**	**(+)4030.13**	**(+)4026.33**	Estimated

There is a surplus of 195 MCM water in the study area during the peak period at present. However, the same will be on the deficit side (338 to 346 MCM) in future years if no suitable water conservation measures are taken.

Water Balance in Lean period (October to May)

Figures in million Cu.m

Sl. no		2007	2011	2016	2021	Remarks
1.	INPUT: Rainfall (154 mm in lean period – October to May) (available as total surface runoff in lean period within the study area)	774	774	774	774	No change is considered for future years
2.	MEANS OF STORAGE: (Storage is considered 20% that of as in peak period)					
a)	Ground water recharge (includes wells)	206	206	206	206	-do-

Sl. no		2007	2011	2016	2021	Remarks
b)	Retained by ponds and reservoirs in lean season	22	22	22	22	-do-
c)	Retained by rivers and drains in lean season	78	78	78	78	-do-
	Sub-Total	**306**	**306**	**306**	**306**	
3.	**CONSUMERS*:** (in lean period)				2/3rd of yearly consumption *Details similar to those given at Table 6.5.3	
a)	Rural population (from wells)	19.3	19.8	20.8	21.9	Considering 1% growth/year
b)	Urban population	6.0	6.7	7.3	8.1	Considering 2% growth/year
c)	Livestock: - Cattle & Buffalos	12.2	12.5	13.1	13.8	Considering 1% growth/year
d)	Other live stock: - pigs, sheep, goats, etc.	1.22	1.25	1.31	1.38	Considering 1% growth/year
e)	Agriculture (irrigation)	283	283	283	283	No growth considered
f)	Forests and other vegetation	487	487	487	487	No growth considered
Sl. no		**2007**	**2011**	**2016**	**2021**	**Remarks**
g)	Industrial use	81	435	435	435	No growth considered after 2011
	Sub-Total	**889.72**	**1245.25**	**1247.51**	**1250.18**	
4.	**WATER LOSS:**					
a)	Return flow from industries** (waste water - 50% of industrial use)	41	209	209	209	** 2/3rd of yearly figures. Can be utilised only after recycling
b)	Runoff into Sea including evaporation (73%)	nil	nil	nil	nil	(As Storage is considered)
	Sub-Total	**41**	**209**	**209**	**209**	
5.	**Balance (2-3)**	**(-)583.72**	**(-)939.25**	**(-)941.51**	**(-)944.18**	
6.	**Gross Balance: Water loss + Balance (4+5)**	**(-)542.72**	**(-)730.25**	**(-)732.51**	**(-)735.18**	

The water availability situation in the lean periods is alarming. There is deficit of 584 MCM currently and would increase to 939 MCM by 2011 and further in the future during the lean period.

Ground water table fluctuation

There was considerable fluctuations in seasonal water table as outlined hereunder.

Pre-monsoon season : 1.74 to 10.92 m
Monsoon season : 0.6 to 8.3 m
Post monsoon seasons: 1.3 to 9.1 m
Winter season : 1.7 to 9.1 m

The variations in water table were due to intensive mining and other activities. The mining area and an area up to a distance of about 1.0 – 1.5 km around mines experienced ground water table depletion due to mining and associated activities.

Surface water quality

The assessment of the quality of water available from surface sources was done by analyzing the water quality parameters of the composite samples for four seasons from 26 locations. Water quality of various rivers, streams and Jhors of the study area was of medium to good category in all four seasons. Derjang reservoir and a few Ponds (Pond water near Manapur, Turang, Kumanda, Kandasaar villages) had bad water quality in post monsoon season by having slightly acidic nature (pH: 5-6), low DO concentration and high coliforms. The quality of pond water of Manapur and Turang villages was bad during summer season due to the presence of coliforms and organic matter.

Pollution of ground water

The assessment of quality of ground water available from different sources was done by analyzing the water quality parameters of composite samples for three seasons from 24 locations. As per annual average of the seasonal water quality index the overall quality of ground water ranged from poor to very good. Out of 24 locations, ground water quality at four locations, namely, Nuasahi open well, Tulsipal open well, Longipeda tube well and Gadrakhai open well was in poor category mainly due to the proximity of the smelter. The data indicates that water available from these sources was conforming to the parameters defined in IS 10,500 except for fluoride concentration, which was on the higher side. At other locations the water quality was in good category.

Floods

The study area has rain fall as the main source of surface water and sometimes due to heavy rains there may some flooding**.** During floods, river Brahmani turns into a large turbulent channel posing potential threat to the life and properties in the basin. The highest flood level in the river was recorded on 20 August, 1975. There is a history of frequent floods in the study area until the development of Rengali Multipurpose Project, which is located to the north of the study area. As per available literature, areas on both sides of Brahmani river are prone to floods. The probable flood zone extends from either banks of Brahmani river to the area covered by the 60 to 70 m RL contour, covering an area of about 261 sq km.

AIR ENVIRONMENT

The exiting status of air quality in the study area and the anticipated air quality in future are as given below.

Existing Air Quality

Ambient air quality monitoring for SPM, RPM, SO_2 and NO_x was done at 51 locations in the study area during summer, post-monsoon and winter seasons as per CPCB guide lines. Fluoride concentration (both in particulate and gaseous forms) was monitored at 9 locations around NALCO Smelter. The Air Quality Index (AQI) with respect to SPM, RPM, SO_2 , NO_x and fluoride revealed the following status.

- The opencast mines, i.e., Lingaraj, Bhubaneswari, Ananta and Jagannath, had moderately polluted status with AQI ranging from 4 to 6.
- Frequent vehicular movement through Dera Chowk, Sharma Chowk and Banerpal Junction was the main reason for moderately pollution status of these areas with the index ranging from 4 to 6.
- Other monitoring locations had low pollution status with index ranging from 1 to 3.
- Grid 73 H/1 had low to moderate air quality status while Grids 73 H/5, 73 G/4, 73 C/16 and 73 D/13 had low pollution status.
- The fluoride concentration in Kuladh and Girang villages was on the higher side as a result of the discharges from NALCO smelter.

In the overall analysis the ambient air quality of the study area was moderately good.

Anticipated Air Quality

The anticipated air quality, with the addition of the proposed thermal power plants and other industries as well opening of new mines and reorganization of the existing mines, was computed with the help of a model. The exercise was carried out to assess the air quality status in the years 2007-08, 2011-12, and 2016-17.

Suspended Particulate Matter		
1	**Existing Status in 2007-08**	The predicted SPM concentration due to operating ***coal mines***, reveal the following: • Maximum concentration zone was confined to Ananta and Jagannath mines. • Ananta OCP (A9) and surrounding locality had SPM concentration from 207 to 311 µg/m^3. • Dera Chowk (A36), Mukundnali village (A50), situated in close vicinity of Ananta and Jagannath mines and Ananta Guest House (A48) had SPM concentration from 103.6 to 207.0 µg/m^3. • In rest of the area SPM concentration was <103 µg/m^3.

		The predicted SPM concentration due to operating ***thermal power plants/industries*** revealed the following: • NALCO commercial area (A25), Turang village (A29),Khandasar (A28),Kuladh village (A26),Girang village (A27)Gotamara (A24) had maximum SPM concentration of 29.1 to 32.6 µg/m^3. • Banarpal Junction (A38) had SPM concentration of 11.6 to 15.0 µg/m^3. • Rest of the locality had SPM concentration <11.6 µg/m^3. The predicted SPM concentration of ***integrated activities including road traffic***, revealed the following: • Ananta mine (A9) registered SPM concentration of 303.5 to 346.7 µg/m^3. • Mukundnali village (A50) and Dera chowk (A36) had maximum concentration 173.8 to 260.0 µg/m^3. • Ananta Guest House (A48) registered SPM concentration of 130.0 to 173.8 µg/m^3. • Kalinga township (A12), situated in close vicinity of Hingula OCP, Talbera village (A44),Ekgharai village (A46), had SPM concentration of 87.0 to 130.6 µg/m^3 whereas Raghunathpur village (A17), Bharatpur colony (A11), and Rakash village (A49) had SPM concentration of 44.0 to 87.0 µg/m^3.
2	**Anticipated Status in 2011-12**	The predicted SPM concentration due to operating ***coal mines***, revealed that the maximum SPM profile (776 to 876 µg/m^3) will shift to Chendipada, Utkal and Gopalprasad villages and surrounding areas as the proposed mines are expected to come in these areas. There will be some reduction in SPM concentration in 2011-12 compared to the present situation, i.e., 2007-08 even when the number of mines as well as production levels will increase. This can be attributed to an increase in the aerial extent of the new mines. The predicted SPM concentration due to ***operating thermal power plants/industries***, will be the same as that of 2007-08 as no proposed thermal power plants has been considered here. The predicted SPM concentration due to ***integrated activities including road traffic***, revealed the following. Here also no proposed thermal power plants has been considered. • Maximum concentration of 175.48 µg/m^3 will have in Chendipada locality. • Ananta Guest House (A48), Kalimga Township (A12), Raghunathpur village (A17), Gopal Prasad village (A14), Kalamchuin Village (A45), Kalinga township (A12), Utkal village (A15), Jagannath OCP (A10), Bharatpur colony (A11), Bhubaneswari mine (A8), Ananta OCP (A9), will have maximum concentration 16 to 36 µg/m^3. • Rest of the locality will have SPM concentration < 16 µg/m^3.

3	**Anticipated Status in 2016-17**	The predicted SPM concentration due to ***operating coal mines***, revealed the following: • Maximum SPM profile (708 to 796 µg/m^3) will shift to Chendipada, Utkal and Gopalprasad villages and surrounding areas as new proposed mines are expected to come to their vicinity. • Chendipada (A13) will have maximum SPM concentration of 354 to 442 µg/m^3 • Raghunathpur village (A17) will have maximum SPM concentration of 88 to 177 µg/m^3. • Rest of the area will have SPM concentration < 88 µg/m^3. The predicted SPM concentration due to operating ***thermal power plants/industries*** in 2016-17 will be same to that of 2007-08 as no proposed thermal power plants has been considered. The predicted SPM concentration of **integrated activities including road traffic**, revealed the following: • Chendipada locality will have the maximum SPM concentration of 493.16 µg/m^3. • Raghunathpur village (A17) will have the SPM concentration of 93 to 197 µg/m^3. • Rest of the area will have SPM concentration < 93 µg/m^3
Oxides of nitrogen (NOx)		
1	**Existing Status 2007-08**	The predicted NOx concentration due to existing ***thermal power plants/industries*** revealed the following: • The entire study area had NO_x concentration < the permissible limit of 80 µg/m^3. • Gotamara village (A24) had NOx concentration of 17.9 to 21.3 µg/m^3. • Banarpal junction (A38), NALCO commercial area (A25), Kuladh village (A26), Girang village (A27) had NOx concentration of 14.6 to 17.9 µg/m^3. • Karadih village (A1) and NTPC Kaniha-CISF camp (A2), NTPC Kaniha main gate (A3), Executive engineer office near Samal barrage (A6) had NOx concentration of 11.3 to 14.6 µg/m^3. • Kalinga Township (A12), Ananta Guest House (A48), Ananta OCP(A9), Raghunathpur village (A17), Bhubaneswari mines (A8), Dera Chawk (A8), Mukundnali (A50), Rakash village (A49), and Talbera (A44) had maximum NOx concentration of 8.0 to 11.0 µg/m^3. • Rest of the locality had NOx concentration < 11.0 µg/m^3. The predicted NOx concentration of ***integrated activities including road traffic*** revealed the following:

		• Gotamara village (A24), Banarpal junction (A38) and Bonda village (A30) had maximum NOx concentration within 15.0 to 17.0 µg/m^3. • Kuladh village (A26), Girang village (A27), Tentuli village (A19) and NALCO commercial area (A25) had NOx concentration within 11.5 to 13.5 µg/m^3. • Karadih village (A1), NTPC Kaniha-CISF camp (A2), NTPC Kaniha main gate (A3), Executive Engineer Office near Samal Barrage (A6), and Ekgharia village (A46) had maximum NOx concentration within 9.4 to 11.5 µg/m^3. • Rest of the locality had NOx concentration < 9.4 µg/m^3.
2	**Anticipated Status in 2011-12**	The predicted NOx concentration due to ***thermal power plants/industries*** (2011-12 will be same as that of 2007-08 as no proposed thermal power plant has been considered here. The predicted NOx concentration of ***integrated activities including road traffic*** reveal the following: • Gotamara village (A24) and NALCO commercial area will have maximum NOx concentration of 27.5 µg/m^3. • Kuladh village (A26), Girang village (A27), Tentuli village (A19), TSTPP Kaniha locality (A2), Karadih village (A1) will have NOx concentration within 14.0 to 21.0 µg/m^3. • Rest of the locality will have NOx concentration < 14 µg/m^3.
3	**Anticipated Status in 2016-17**	• Gotamara village (A24) will have maximum NOx concentration of 27.45 µg/m^3. • NALCO commercial area (A25) and Banerpal Junction (A38) will have maximum concentration of 20.0 to 24.0 µg/m^3. • Rest of the localities will have NOx concentration < 20.0 µg/m^3.
Sulfur-di-oxide (SO_2)		
1	**Existing Status in 2007-08**	The predicted SO_2 concentration due to ***thermal power plants/industries*** revealed the following. • The entire study area had SO_2 concentration less than the permissible limit of 80 µg/m^3. • Banarpal junction (A38), Dera Chawk (A36) and Gotamara (A24) will have maximum SO_2 concentration of 40.0 to 52.0 µg/m^3. • Kalinga Township (A12), Donnara village (A16), Lingraj OCP (A7), Talcher Guest House (A20), Talcher Residential area (A21), Tentuli village (A19) and NALCO Commercial area (A25) will have maximum SO_2 concentration of 27.8 to 40.0 µg/m^3. • Bonda village (A30), RSPCB office (A31) and Angul Township (A32), Notified Area Council (A33), Vikashnagar

		(A47), Fire station (A37), Kuladh village (A27), Girang village (A26), Gopal prasad village (A14), Donnara village (A16), Kalamchui village (A45), Raghunathpur village (A17), Ananta Guest House (A48), Rakash village (A49) and Ananta OCP (A9) will have maximum SO_2 concentration of 15.7 to 27.8 µg/m^3. • Rest of the locality SO_2 had concentration < 0.65 µg/m^3. The predicted SO_2 concentration for **integrated activities (including road traffic)** will be same as that of 2007-08 as SO_2 emission from existing mines and road traffic is negligible.
2	Anticipated Status with proposed Thermal power plants	A separate study was done to evaluate predicted SO_2 concentration due to the proposed 14 thermal power plants (having 1000 MW capacity each) as discussed in Chapter 5 and summarized below: ❖ When all the proposed power plants (14 numbers having 1000 MW capacity each) having no control measures are operative along with existing power plants, the SO_2 level is expected to increase to a maximum value of 122.5 µg/m^3 - thereby exceeding the permissible levels of industrial as well as residential, rural and other areas. ❖ The same are expected to be 96.15 and 95.6 µg/m^3 when all the proposed power plants with Flue gas desulphurization (FGD) process having 90% and 95% efficiency respectively are operative. ❖ All the power plants, both proposed and existing, having FGD process with 90% efficiency, however, will give a better environment – thereby limiting the maximum SO2 level to 12.2 µg/m^3.

NOISE ENVIRONMENT

The status of the existing noise environment in different types of locations in the study area was as given below. It may be mentioned here that the overall noise situation in general was within the permissible norms.

Industrial Area: The average Leq levels in the six industrial areas, namely, Kaniha STPP surrounding area, Jagannath OCP locality, Ananta locality, TTPS surrounding area, CPP NALCO surrounding area and NALCO Smelter surrounding area were within the range of 62.3 to 65.7 dB(A) during day time and 51.5 to 55.5 dB(A) during night time

respectively. As such, both the day and night time noise levels (Leq) were within permissible norms of 75 and 70 dB(A) respectively. The average background levels, i.e., L_{90} were within the range of 52.1 to 57.9 and 44.2 to 49.4 dB(A) for day and night time respectively.

Commercial Area: The average Leq levels in different commercial areas (Dera Chowk, Sharma Chowk, Angul District Library locality, NALCO commercial area, Banerpal Junction and Angul Town junction point) were within the range of 49.3 to 62.3 dB(A) during day and 42.3 to 53.1 dB(A) during night time. Both day time and night time Leq levels were within the permissible standard of 65 and 55 dB(A) respectively. The average background levels, i.e., L_{90} were within the range of 44.1 to 55.1 and 39.1 to 47.8 dB(A) for day and night time respectively.

Residential Areas: The average Leq levels for all the residential areas were in the range of 47.1 to 53.9 dB(A) during day time and 40.5 to 46.6 dB(A) during night time respectively. Both day time and night time Leq levels were more or less within the norms of 55 and 45 dB(A) respectively. The average background levels, i.e., L_{90} were within the range of 40.3 to 48.9 and 37.1 to 44.5 dB(A) for day and night time respectively.

Sensitive Area: The average Leq levels for all the sensitive areas were in the range of 42.9 to 62.9 dB(A) during day time and 40.1 to 48.3 dB(A) during night time respectively. Both Leq, day [62.9 dB (A)] and Leq, night [48.3 dB(A)] at SDM Court locality were exceeding the norms of 50 and 40 dB(A) respectively. Similarly Leq levels of both day and night time at Angul Govt. Hospital, Central Hospital, Govt. College, Angul were slightly more than the permissible standards. The average background levels were within the range of 39.2 to 53.2 and 37.1 to 42.3 dB(A) for day and night time respectively.

The proposed industrialization and developments may increase the noise situation manifolds unless suitable control measures are not taken.

OVERALL ENVIRONMENTAL EVALUATION

The existing environmental status as well as that anticipated in 2011-12 and 2016-17 were indexed using BEES methodology. The assessed indices are given below. It can be noted that even with the protection measures the overall environmental quality will deteriorate. For taking care of the overall environmental status measures have been suggested in the recommendations.

(Total weightage = 1,000)

Parameters	**Assigned Importance (PIU)**	**(2007-08) (EIU)**	**After proposed development**	
			EIU 2011-12	**EIU 2016-17**
Ecology	**200**	140	110	105
Environmental	**450**	360	285	265
Pollution	**100**	75	65	60

Aesthetics Human Interest	**250**	130	170	200
Total	**1,000**	**705**	**630**	**630**

1.1.2 RECOMMENDATIONS

The studies presented in these chapters indicated that for maintaining proper environmental status in the area certain mitigative measures will be required to be taken. The steps required to be taken with respect to various components of environment are recommended in brief hereunder.

MEASURES OF AIR MANAGEMENT

a) Talcher Thermal Power Station, Talcher

- Improvement of the efficiency of ESPs to meet the emission standard of 150 mg/Nm^3.
- Incorporation of appropriate desulphurization (FGD) process for each of the units.
- Upgradation of dust collection systems in the plant.

b) NALCO Smelter

- It is desirable to increase the process efficiency and pollution control efficiency.
- The fugitive emission control measures are necessary to reduce the overall emissions.

c) Captive power Plant (NALCO)

- Improvement of the efficiency of the existing ESP so as to conform to emission standard of 150 mg/Nm^3.
- Incorporation of appropriate desulphurization (FGD) process for each of the units.
- Upgradation of dust collection systems in the plant.

d) NTPC, Kaniha

- Incorporation of appropriate desulphurization (FGD) process for each of the units.
- Upgradation of dust collection systems in the different units inside the factory for control of dust in the work environment.
- Containment of fugitive emissions in the coal handling and ash disposal areas by water spraying and green belt plantation.

e) Nava Bharat Ferro Alloys

- ❖ Improvement of the efficiency of the existing ESP so as to conform to emission standard of 150 mg/Nm^3.
- ❖ Incorporation of appropriate desulphurization (FGD) process for each of the units.
- ❖ Upgradation of dust collection systems in the plant.

f) Proposed New Power plants

- ❖ All the proposed new power plants should have state of the art ESP in order to conform existing emission standard of the State Pollution Control Board of 150 mg/Nm^3.
- ❖ Flue gas desulphurization **(**FGD) process needs to be an integral part of the new thermal power plant design.

g) Coal mines

- ❖ Appropriate dust suppression and dust extraction techniques need to be designed in various dust generating sources/locations in appropriate manner.
- ❖ It is advocated to use slurry explosives as stemming material for blasting and water infusion for slackening of hard coal.
- ❖ Transportation of coal should be done by covering the loaded trucks to avoid dispersion of coal dust.
- ❖ Appropriate dust consolidation need to be applied in haul road with approved chemicals by the statutory body in order to minimize dust generation.
- ❖ General safety measures recommended under Mine Regulation Act (1956) for prevention of coal fires should be followed.

h) General Air Pollution Control Measures applicable to all the industries

- ❖ All the industries should undertake effective control measures as mentioned in Section 8.2.8.
- ❖ Besides, green belts of pollution tolerant species need to be developed in and around industries.

MEASURES FOR WATER MANAGEMENT

a) **Water Balance:** Means of taping run off water that is flowing into the sea during the peak period need to be explored urgently to conserve water in the form of additional surface and underground water bodies. The subsided areas can be used for the formation of surface water bodies.

b) **Watershed Development** should be taken up as an integrated manner.

Formation of suitable size reservoirs at suitable locations to store rain water and hence to augment the water availability should be looked into as a part of water shed management.

c) **Development of small water reservoir/damps** to meet the water requirement of proposed thermal power plants.

d) **Industrial Effluent treatment measures**

CPP, NALCO Effluent Treatment

- ❖ Construction of clarifier for treating ash pond overflow to remove suspended solids.
- ❖ Recycling of ash pond overflow for industrial purposes and other uses (irrigation).
- ❖ Provision of aeration tank and secondary clarifier 9in addition to existing neutralization tank) to bring down BOD, COD and SS in D.M plant effluent.
- ❖ The waste water from coal handling plant should continue to be discharged into the ash pond to allow settling.
- ❖ Recycling all effluents after treatment for achieving zero discharge in true sense.
- ❖ To ensure adequate treatment of township effluents before it is used on land.

NALCO Smelter Effluent Treatment

- ❖ Constant updradation of the existing treatment units.
- ❖ Must ensure that after providing complete treatment the treated effluents shall be reused and recycled within the industry so as to make zero discharge from the industry in true sense.

Talcher Thermal Power Station Effluents Treatment

- ❖ Provision of clarifier to reduce SS from ash ponds overflow and recycled the same for industrial, plantation and irrigation uses.
- ❖ Along with the existing system, the neutralization tank should be supplemented with aeration tank and secondary clarifiers to bring down BOD, COD and SS of effluents of D.M Plant within desired levels.
- ❖ Adequate treatment of township effluents before it is used on land.

NTPC, Kaniha

- ❖ Recycling of ash pond overflow into industry
- ❖ Must ensure adequate treatment of township effluents before it is used on land or discharge it to the natural water bodies.

Talcher Coalfield, MCL effluents

- The mine water should be used for water spraying on roads and dust control in mines.
- The quality of mine water need to be augmented for domestic uses.
- Recycling mine effluents for reclamation of mine out areas, stabilization of overburden dump yards and for water plantations in the mine areas.

Treatment Measures for the Proposed Thermal Power Plants

- Implementation of the measures proposed in the EMP approved by MOEF, Govt. of India for iron removal, oil removal, pH correction for waste water generated from pretreatment plant, etc.
- Recycling ash pond overflow into the plant
- Complete domestic sewage treatment plant for the proposed township.

e) **Domestic Effluent Treatment Measures**

- Construction of sewerage network along with sewage treatment plants in towns of Angul, Talcher and Dera townships
- Construction of community septic tanks and soak pits in vallages where individual septic tanks are not affordable.
- Encourage low cost sanitation methods for individuals proposing to set up their independent facility.
- Provide stabilization ponds for detention of drainage before the wastes are let out into streams as immediate temporary arrangement until ful fledged sewerage and drainage collection and treatment systems are provided.

f) **Protection of water quality of Brahmani river and Nandira Jhor**

- To discourage all the industries to use either Nandira or Brahmani as the final discharge point;
- Ensure reuse/recycle technology to be followed by all industries for their liquid/solid waste thereby achieving zero discharge from their premises;
- Ensure industries meet the EPA, 1986 amended standards applicable for discharge of effluents into surface water bodies.
- Provide sanitation facilities in the villages on the banks of Nandira jhor and Brahmani river.
- Certain minimum dredging/desilting of Nandira jhor is required.
- Development of multi-row green belt for Nandira banks from NALCO CPP ash pond to Kamalang.

NOISE QUALITY MANAGEMENT

- Ensure adoption of latest control measures to contain industrial noise at source.
- Retrofitted control measures need to be taken for old machinery.
- Provide ear muffler to all the industrial workers having high noise dose.
- All the industrial premises and public land should be thickly vegetated with species of rich canopy.
- There will be a necessity of controlling the noise situation along roads especially in locations close to sensitive areas. Site specific measures should be planned, such as, erection of barriers on both sides of the roads, development of green belts, etc.

FLY ASH MANAGEMENT

- Since utilization of fly ash for manufacturing of products may be only up to 15-20%, emphasis need to be given for its bulk use for stowing in underground mines and filling voids in quarries. MCL has already been initiated reclamation of mine out areas by fly ash. An exercise was done in Chapter 5 for quantification of fly ash to be generated by proposed thermal power plants and their utilisation in reclamation of mine out areas.
- Filing low lying areas
- Amongst various options for utilising fly ash as products, the mose promising ones are:
    - Construction of roads and parking areas as mentioned above.
    - To promote its use as bricks. Its use as fly ash-sand-lime bricks for government building construction should be made mandatory.
- The other categories solid wastes should be treated as per the provisions in relevant legislation.

LAND MANAGEMENT

- The most probable land use after the closure of the mines will be agriculture and forestry. Similarly, the land occupied by the industries dependent on the coal and other minerals mined in the area will need to be brought to these uses after their closure.
- Attentions need to be for the development of reclamation plans incorporating soil management, drainage planning, etc.; subsidence management plans; water management; development of surface and underground water bodies; preservation and management of non-mineral local resources; etc.

- Assessing the probable status of the people who will be living in the area after the closure of the mines and dependent industries and activities base on population dynamics study of the area.
- Green belt development around quarries, dumps, CHPs, etc.
- The provisions in the legislation related with tribal rights, etc. will need to be taken into consideration while planning for land reclamation and development.

Soil Management (top-soil and sub-soil)

- Strict soil conservation measures need to be incorporated. The standard procedures defined for soil removal, transportation, stack formation and storage, relaying, etc. should be followed /incorporated in the mining plans and industrial development plans.
- The design of post mining/industries' topography should take into account the development of the land for various uses. The moist important part of this design is to control drainage and erosion.
- The soils likely to be removed in future but not to be used simultaneously should be properly stacked or should be planned for relaying in the nearby areas which need suitable soil amendments.

Drainage pattern

- A detailed study of the drainage pattern and water shed of the study area should be carried out before designing the layout of any further mining and industrial activities to ensure that the current and future activities do not alter the drainage pattern such as to cause water logging, especially during rainy seasons, and excessive erosion of the soils.
- Formation of surface water bodies to control water logging and minimize soil erosion.
- Wherever feasible rain water harvesting should be planned for conserving water resources. In this efforts surface water bodies can be planned during reclamation of the opencast mines. The abandoned/closed underground mines can also be used for the development of underground water bodies.

ECOLOGICAL QUALITY MANAGEMENT

- To the extent possible the existing forest land and prime agricultural land should not be diverted for non-forest activities/non-agricultural activities.
- No permanent construction of buildings, metalled roads etc. be undertaken in existing forest area as far as possible. However, communication and

electric lines may be allowed on case to case basis when alternative alignment is not possible.

- The mines and the industries in the forest land should be planned with properly optimizing the land requirement. The mining methods should be designed for least possible damages to forest areas in case of underground mines. The opencast mines planned in the forest areas should necessarily have concurrent reclamation with appropriate actions incorporated in the mine plans to develop forest land for forestry after proper rehabilitation of the mined out areas.
- As per the provisions in the Forest Act, it is necessary for the mines and industries to undertake compensatory afforestation.
- It will be advisable to develop a flora bank in the region for the preservation of flor**a.** Special attention should be given to endangered species
- Existing 227 Vana Sanrakshana Samities, which were formed in connection with Joint Forest Management Resolution. 1993 of Govt. of Orissa, should operate efficiently in order to protect the forests with active participation of local people.
- Generation of bio-gas from refuse, use of LPG, solar cookers and community solar energy harvesting systems be encouraged as far as possible.
- The industrial and social activities in the area should be planned in such a manner that the noise, vibrations, and other pollutants do not disturb the wild life in the nearby forests. For the protection of fauna the activities should be planned as per the provisions in the Wild Life Protection Act for both terrestrial and aquatic fauna
- Intensification of the activities of Gharial Research & Conservation Unit (GRACU), set up at Tikapara inside Satakosia Gorge Sanctuary in 1975.
- The selection of the species for plantation should be done after assessing their usefulness and suitability with respect to top-soil characteristics.
- People should be educated and trained in social forestry activities. This should include plantation of trees relevant to the soil of the region. Neem, Peepal, Amla, Sal, Sagwaan, Cashew nut, Mango, etc. should be encouraged. The local people and NGOs should be involved in this effort.
- Besides, efforts should be made for plantation as recommended in section 8.7 of Chapter 8.

SOCIETAL IMPACT MANAGEMENT

a) Rehabilitation of Human settlements

- The packages for rehabilitation and resettlement of the PAFs of all the categories need to be developed in confirmation with the provisions in the R&R Policy of the State Government or the National R&R Policy or R&R Policies of the industrial companies whichever is having better provisions. For selection of new settlement sites for rehabilitation as a result of proposed industrial development by way of establishing a large number of thermal power plants, steel plants and other coal based industries, considerations as discussed in Section 8.8 of Chapter 8.
- The locations should provide adequate scope for future growth for housing, infrastructure, commerce, recreation, etc. and well served with roads and other communication links and should have easy access to market, administrative centers, etc.

b) Provision of drinking water supply

Following provisions of drinking water supply schemes need to be organised :

- Villages falling in the periphery of industries to be covered as a part of the peripheral development plan of the industries;
- Villages on the banks of river Brahmani and Nandira jhor since the surface water source has been polluted;
- Villages in and around in MCL area due to scarcity of water in summer; and
- Villages where there is occurrence of high fluorides in surface and ground water.

c) Action Plan for Fluoride Affected Locations of Talcher, Angul and Meramundali Area

- Full fledged defluoridation plants need to be constructed in the villages where fluoride content is 1.0-1.5 mg/l or above. As such, provision for domestic defluoridation as well as community level defluoridation plant, as discussed in Section 8.8 of Chapter 8, need to be conceptualised in urgent basis

d) Education and health care facilities

In order to increase the **literacy rate**, following considerations need to be taken in serious manner:

- Creating awareness among the local people as well as encouraging to undertake the task of improving literacy.

- Special attention should be given to literacy of women/house-wifes.
- Improving the facilities in the primary schools, middle school, making mid day meal attractive, supply of free books to the children whose parents are below poverty line, imparting education through audio-visual aids, etc.
- Improving adult education program and making it suitable and attractive for all classes of people.
- Each Public Sector Undertaking be advised to adopt at least one or two villages and impart education through Total Literacy Campaign (TLC).

For improving **health care facilities** following measures are suggested**:**

- Medical facilities available right from the district HQ level to the villages need to be accessible to the entire cross-section of the society in the villages and also in the urban settlements. As such, it is required to plan for developing the systems for making the corporate and governmental facilities available to large cross-section of the society as far as possible.
- Initiatives are needed to develop public private partnership for sharing the responsibility of health care services for disadvantaged population. The private sector should share with the Government' the efforts as a measure towards fulfilling their Corporate Social Responsibility (CSR).
- A detailed study of the pattern of seasonal diseases in the villages and settlements is urgently needed to take measures for controlling their spread.
- It is important to create awareness amongst the local people about health and hygiene, especially towards water consumption, domestic garbage disposal, drainage, and cleanliness.

e) Improvement in Transport & Communication Network

- Construction of roads to every village and improvement of the damaged roads using fly ash aggregates.
- An transport corridor as detailed in Chapter 5 need to be constructed in order to maintain a better linkage among the all industrial sectors is quite necessary.
- Need based state owned public transport system should be developed for the area
- Provision of a sub-post office at every settlement having population of 2,500 and opening of telegraph offices in all the settlements having 5,000 population.

f) **Improvement of the economic status of the people :** Necessary measures as discussed in Section 8.8 of Chapter 8 need to be undertaken.

1.1.3 ENVIRONMENTAL QUALITY MONITORING PROGRAMME

The environmental quality assessment given earlier indicates that although the present environmental status is satisfactory and it is expected to remain the same with the suggested measures. The overall efforts in the area should be to improve the environmental status as much as possible. The efficacy of the management measures for various components of environment will need careful monitoring to assess the effects of the measures as well as for taking corrective measures. The suggested environmental quality monitoring program for the study area is as given below.

Areas/Components	Monitoring Frequency	Aspects to be considered
1. Ecological aspects	Once a year	• Status of compensatory afforestation in the forest land and also in the non-forest land • Development of green belts • Status and development of flora bank • Status and care measures for endangered species • Tribal welfare measures • Measures for the protection for terrestrial and aquatic fauna
2. Environmen-tal Pollution	**Air Pollution** Twice a week throughout the year (24 hourly)	• It is desirable not only to monitor the present level of air pollutants like SPM,NOx, SO2 and Fluoride but also to measure the incremental change because of the proposed new industries. • Micro-meteorological parameters like wind speed, wind direction, temperature, rainfall, relative humidity, cloud cover and solar radiation • Assessment of efficacy of air pollution control measures for SPM, RPM, SO_2, NO_x and fluoride.
	Water regime Once a month	• Water quality monitoring at different strategic points • Water treatment efficacy at appropriate level • Water balance.

Areas/Components	Monitoring Frequency	Aspects to be considered
		• Efforts for augmentation of water availability. • Development of surface and underground water bodies in the mining areas • Industrial and mining effluent management • Sewerage and domestic effluent management
	Noise levels Twice a year	• Noise generated at different industrial complexes. • Ambient noise status at different residential and sensitive areas • Efficacy of noise control measures, especially due to road traffic.
	Soil and Land Once a year	• Land use changes • Land capacity assessment for agriculture and afforestation • Soil management status • Reclamation of land areas affected by mining and industrial activities • Management of solid wastes including fly-ash and bottom-ash • Management of hazardous and bio-medical wastes
3. Aesthetics	Once in a year	• Design and development of surface topography • Reclamation planning to merge with the surrounding and to take care of water logging and surface drainage • Rehabilitation of reclaimed and other categories of land affected by the mining and industrial activities • Design and planning of surface layouts for

Areas/Components	Monitoring Frequency	Aspects to be considered
		the mining and industrial activities and their supporting services and colonies • Avenue plantation • Development of agricultural land
4. Human Interest	Once in a year	• Management of population dynamics • Discharge of Corporate Social Responsibility • Rehabilitation and resettlement of Project Affected Families with adequate improvements in their quality-of-life • Development of educational and medical facilities • Development of civic and infrastructure facilities • Care of the families of tribal people and also the families living below poverty limit

1.1.4 Compliance as per TOR

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Sl No	TOR Requirement	Coverage in the Study
1.1	**Baseline information**	**Chapters 2 and 3**
1.2	**Land Environment**	**Chapter 3**
1.3	**Resource Accounting**	**Chapters 5 and 6**
1.4	**Ambient Air Quality**	**Chapters 3 , 4** and 5
1.5	**Water Quality** **Surface water quality** **Ground water quality**	**Chapters 3** and 6
1.6	**Socio-economic Information**	**Chapters 3 and 6**
2.0	**Industrial and Mining Activities**	**Chapters 2 and 6**
2.1	**Description of Industries and mines**	**Chapters 2 and 6**
2.2	**Pollution Load**	**Chapters 4** and 6
3.0	**Urban Activities**	**Chapter 6**
4.0	**Assessment of existing Environmental Management and Identification of Environmental Problems.**	**Chapter 7**
5.0	**Environmental Management Plan for existing and proposed Industrial/Mining development**	**Chapter 8**
6.0	**Recommendations**	**Chapter 9**