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CHAPTER-1
INTRODUCTION

1.1 GENERAL

M/s Vedanta Aluminium Limited (VAL) a part of the US$ 6 billion Vedanta Resources Plc, a London listed 100 FTSE company. Other major Group companies operating under the same banner in India are Sterlite Industries (I) Ltd. (SIIL), which has a copper smelting plant at Tuticorin, Bharat Aluminium Company Ltd (BALCO) operating a 345,000 TPA integrated aluminium complex at Korba, in Chattisgarh state, The Madras Aluminium Company Ltd. (MALCO) operating a 35,000 TPA aluminium smelter at Mettur in Tamilnadu and Hindustan Zinc Ltd (HZL) operating zinc (280,000 TPA) and lead (95 TPA) smelters in Rajasthan. HZL is also operating zinc smelter (70,000 TPA) at Visakapatnam in Andhra Pradesh.

VAL has set up an Alumina Refinery of 1 MMTPA capacity at Lanjigarh, Dist. - Kalahandi, Orissa and is proposing for its expansion to 6 MMTPA Alumina production capacity. In alignment with alumina production, VAL is also proposing to expand the capacity of aluminium smelter by 13.5 LTPA with Captive Power Plant of 5 x 135 MW (675 MW) capacity at Jharsuguda, Orissa. After expansion, the total capacity of smelter will be 16 LTPA and 1350 MW CPP. The total expansion is envisaged in lieu of the global demand of alumina and aluminium to cater to the deficit at national and international levels.

The total cost for the proposed expansion is estimated to be around Rs.6,500 Crores. The raw material will be brought from the captive bauxite mine at Lanjigarh around 3.7 km (aerial) from the plant site for which Environmental Clearance is in advanced stage with MoEF or other sources in India and abroad depending on the requirement and availability.

1.2 JUSTIFICATION OF THE PROJECT

In the present scenario, there is a great demand for Alumina and Aluminium in domestic as well as international market. Since there is a large gap between the demand and availability of Alumina, the proposed Alumina refinery expansion would reduce this already widening gap. Moreover Orissa ranks first in Bauxite reserve and production in the country. It has more than 50% of total bauxite reserves of India and the bauxite is of good quality and low in silica content.

Orissa is having vast deposits of bauxite estimated to be over 2 billion Ton located mainly in the east coast ghats starting from Vizag to Gandhmardan. Presently, NALCO is the main user and exploiting nearly 340 million ton of Bauxite located at Panchpatmali Hills. VAL shall be exploiting Lanjigarh bauxite deposit that is estimated to be of the order of 75 million ton. Thus, major Bauxite deposits are still available for further exploitation. An agreement has been signed with OMC for additional 150 million ton. Discussions are on with OMC for other deposits in Orissa. Hence, it is worthwhile considering expansion of existing VAL refinery to 6 MMTPA for making the VAL as a world class Alumina Refinery in comparison to the best practices being followed in other part of the world. Alumina produced shall be utilized to meet the expansion requirements of its smelter plant and the rest will be utilized within the country or/ and exported in the international market.

In general, the proposed expansion project is designed to meet the following requirements:

- Low specific consumption of fuel, water and chemicals;
- Low annual maintenance;
- Adequate instrumentation and automatic controls to ensure consistent quality and ease of operations;
- Adequate environmental protection measures to minimize the pollution;
- Cope up with the requirements of the CREP guidelines;
- Adequate facilities to ensure safe operations of the plant

1.3 PURPOSE OF THE STUDY

According to sub-rule(3) of rule 5 of the Environmental(Protection) Rules 1986, for requirements of Environmental Clearance (EC) from the Ministry of Environment and Forests, the proposed expansion falls under category ‘A’ in the schedule.

M/s Vedanta Aluminium Limited (VAL) have retained the services of GLOBAL EXPERTS, Bhubaneswar to undertake an Environmental Impact Assessment (EIA) study and preparation of Environmental Management Plan (EMP) for various environmental components that may be affected due to the impacts arising out of the proposed expansion of the project.

Preliminary survey of the region was conducted in the month of March 2007 and subsequently, monitoring had been commenced for meteorology, ambient air quality, surface-water quality, groundwater quality, soil characteristics, noise levels, flora and fauna at the identified locations. The air monitoring locations have been selected based on the predominant wind directions recorded at Indian Meteorological Department (IMD), Bhawanipatna and site meteorological data recorded at Lanjigarh plant site. The other studies such as socio-economic profile, land use pattern etc. are based on secondary data collected from various Government agencies and through primary socio-economic survey conducted by the Asian Institute for Sustainable Development, Ranchi.

The Environmental Impact Assessment (EIA) report is based on the primary data collected during 1st March 2007 through 29th February 2008 representing all seasons. This region enjoys four primary seasons of Pre Monsoon (March - May), Monsoon (June - September), Post Monsoon (October – November) and winter (December - February).

In the processes of main plant as well the auxiliary plants along with the useful products and by-products several waste material will also be generated. These waste materials include gaseous emissions, wastewater and solid wastes.

- The stack flue gas and fugitive emissions include particulate matter, Sulphur dioxide and nitrogen Oxides
- The wastewater includes process waste water and floor washings from alumina refinery plant, cooling tower boiler blow down and sewage.
- The solid wastes mainly includes red mud, ash from the boiler and minor quantities of scale from the de-scaling of equipment and
- Miscellaneous solid wastes from packaging, maintenance activities etc.
- Besides physico-chemical and biological impacts on the environment, there will be socio-economic impacts on the habitants of the region as well.

1.4 SCOPE & COVERAGE OF THE REPORT

- Brief description of the site, surroundings, process & facilities of the proposed plant, within 10 km radius from the proposed expansion site.
- Detailed description of present environmental status covering meteorology, air quality, surface water & ground water quality, noise level, soil quality, ecology, land use, & Socio-Economic aspects.
- Identification of impacts due to various project activities on various environmental attributes.
- Prediction of the impacts on the ambient environmental parameters.
- Comprehensive Environmental Management Plan.
- Project benefits and Conclusion

The above scope includes the TOR issued by the Ministry for preparation of EIA and conduct of Public Hearing. The necessary compliance to TOR conditions is enlisted in **Table-1.1.**

Table 1.1: COMPLIANCE TO TOR CONDITION

Sl. No.	TOR CONDITIONS	COMPLIANCES
1.	Present land use should be prepared based on satellite imagery. Location of national parks / wildlife sanctuary / reserve forests within 10 km. radius should specifically be mentioned	Details of present land use pattern is given in Table-3.1, section 3.3.2 of Chapter-3 at page-38 Details of reserve forests within 10 km is given in Table 2.1 of Chapter-2 at page-17-18
2.	Possibility of reducing requirement of private land. Details of land acquired. Rehabilitation and resettlement should be as per policy of the Govt. of Orissa and a detailed action plan should be included	Details are given in Section 2.2.1 of Chapter-2 at page-18. R & R details are given in Section 5.2.5 of Chapter-5 at page-137
3.	Identification and details of land to be used for ash and red mud disposal should be included	Details are given in Figure-2.2 at page-16 and Table-2.3 of Chapter-2 at page-19
4.	Design details of the red mud pond as per the CPCB guidelines with garland drains should be included	Details are given in Section 6.7 of Chapter-6 at page-175
5.	Red mud pond for at least for 10 years capacity, land availability, structure of pond should be included	Details are given in Section 6.7 at page-175 and in Table-6.2 of Chapter-6 at page-181
6	Measures to be taken to prevent impact of	Details are given in Section 6.6

	particulate emissions / fugitive emissions, if any from the proposed plant on the surrounding reserve forests should be included. Further, Conservation Plan for the conservation of wild fauna in consultation with the State Forest Department shall be prepared and included	of Chapter-6 at page-168 Details of wildlife conservation is given in Chapter-3 at page-114
7.	A list of industries containing name and type in 25 km radius should be incorporated	Nil
8.	Residential colony should be located in upwind direction	Details are given in Section-5.2.1 of Chapter-5 at page-136
9.	List of raw material required and source should be included	Details are given in Table-2.5 and 2.6 in Section 2.3 of Chapter-2 at page-31
10.	Source of Alumina and status of environmental clearance of mine should be included	Details are given in Section 1.1 of Chapter-1 at page -5
11.	Design details of all the plants and manufacturing process should be included	Details are given in Section 2.2 of Chapter-2 at page-24-28
12.	Site-specific micro-meteorological data using temperature, relative humidity, hourly wind speed and direction and rainfall should be collected	Details are given in Table 3.2 to 3.6 in Section 3.4 of Chapter-3 at page-43-47
13.	Data on air emissions, wastewater generation and solid waste management for the existing plant should be incorporated	Details are given in Table-5.5 at page-142 and Table-5.3 of Chapter-5 at page-139
14.	Point-wise compliance to the specific and general conditions stipulated in the environmental clearance for the existing plant should be included	Details are given in Annexure-I at page-211
15.	Ambient air quality at 8 locations within the study area of 10 km., aerial coverage from project site with one AAQMS in downwind direction should be carried out	Details are given in Section 3.5.1 and Table-3.8 of Chapter-3 at page-52-53
16.	The suspended particulate matter present in the ambient air must be analyzed for the presence of poly-aromatic hydrocarbons (PAH), i.e. Benzene soluble fraction. Chemical characterization of RSPM and incorporating of RSPM data	Details are given in Table-3.12 and 3.14 of Chapter-3 at page-58-59
17.	Determination of atmospheric inversion level at the project site and assessment of ground level concentration of pollutants from the stack emission based on site-specific meteorological features should be included	Details are given in Section 5.4.1.3 of Chapter-5 at page-142

18.	Air quality modeling for Alumina Refinery plant for specific pollutants needs to be done. APCS for the control of emissions should also be included	Details are given in Section 5.4.1.3 of Chapter-5 at page-142 Details of APCS is given in Table-5.5 of Chapter-5 at page 142
19.	One season data for gaseous emissions other than monsoon season is necessary	Details of monitoring in winter season are given in Table 3.12 Chapter-3 at page-58
20	An action plan to control and monitor secondary fugitive emissions from all the sources as per CPCB guidelines should be included	Details are given in Section 6.6.1 and Table-6.1 of Chapter-6 at page-169-174
21.	A plan for the utilization of gases in the WHRB for generating power should be incorporated	Details are given in Section 2.1.2 and 2.2 of Chapter-2 at page-20-28
22.	Impact of the transport of the raw materials and end products on the surrounding environment should be assessed and provided	Details are given in Section 5.4.1 of Chapter-5 at page-141
23.	Permission for the drawl of 26,000 m^3/day water for the expansion project from River Tel at Kesinga and water balance data including quantity of effluent generated, recycled and reused and discharged is to be provided. Methods adopted/to be adopted for the water conservation should be included	Permission letter for drawl of 56,500 m^3/day is given as Annexure-V at page-238 Water balance details is given in Figure-5.4 of Chapter-5 at page-151 Water conservation details are given in Section 6.8 at page-182
24.	Surface water quality of River Tel at Kesinga (60 m upstream and downstream) and other surface drains at eight locations must be ascertained	Water quality of River Tel at Kesinga is given in Annexure-IV at page-237. Other surface water quality details are given in Tables 3.23, 3.24, 3.25 and 3.26 of Chapter-3 at page- 77-84
25.	Ground water monitoring minimum at 8 locations and near solid waste dump zone. Geological features and Geo-hydrological status of the study area are essential as also. Ecological status (Terrestrial and Aquatic) is	Details are given in Table-3.22 at page 73-74 and Table-3.27 to 3.30 of Chapter-3 at page-85-92 Geological features and geo-hydrological status is given in Section 3.2.3 at page-36 and Figure-3.1 of Chapter-3 at page-39 Ecolological status is detailed

	vital	in Section-3.9 of Chapter-3 at page- 105
26.	Action plan for solid/hazardous waste generation, storage, utilization and disposal should be incorporated	Details are given in Section 6.7 of Chapter-6 of page-175-182
27.	Risk assessment and damage control needs to be addressed	Details are given in Chapter-7 at page-190-199
28.	Occupational health of the workers needs elaboration	Details are given in Section 8.5.5 of Chapter-8 at page-206
29.	Green belt development plan in 33 % area and a scheme for rainwater harvesting have to be put in place	Details are given in Section 6.9.1 of Chapter 6 at page-183 and Section 6.8.3 of Chapter-6 at page-182
30.	Socio-economic development activities need to be elaborated upon	Details are given in Section 6.11 of Chapter-6 at page-185-189
31.	Plan for the implementation of the recommendations made for the Alumina Refinery in the CREP guidelines must be prepared	Details are given in Annexure-II at page-216

The EMP part is to deal with:

- Environmental management Plan is integrated with project development and product activity starting from raw material procurement to marketing of products.
- Suitable pollution Control measures to confirm the standard prescribed by statutory bodies.
- Setting up of Environmental management cell to implement the EMP
- Cost-benefit analysis of EMP

Methodology adopted in EIA Study

Based on the reconnaissance survey and the following considerations, the sampling locations for baseline data generation were identified:

- Predominant wind directions in the study area as recorded by India Meteorological Department (IMD) at Bhawanipatna and site specific data at Lanjigarh;
- Topography, location of surface water bodies like ponds, canals and rivers;
- Location of villages/towns/sensitive areas;
- Accessibility, power availability and security of monitoring equipment, pollution pockets in the area;

- Areas which represent baseline conditions;

Field studies were conducted to determine existing conditions of various environmental attributes as outlined in **Table-1.2**.

TABLE-1.2: ENVIRONMENTAL ATTRIBUTES AND FREQUENCY OF MONITORING ADOPTED

Sr. No.	Attribute	Parameters	Frequency of Monitoring
1	Ambient air quality	TSPM, RPM, SO_2 and NO_x	The monitoring was carried out at ten locations at a frequency of 24 hourly samples twice a week for four seasons.
2	Meteorology	Wind Speed and Direction, Temperature, Relative Humidity, Rainfall & duration and other non instrumental observations like visibility, hail, thunder storms, dust storms, fog and smog.	a] Continuous with hourly recording through setting up of site specific meteorological station; b] Data collected from secondary sources like IMD station at Bhawanipatna
3	Water quality	Physical, Chemical and Bacteriological Parameters	Twice during the study period at sixteen locations (seven surface water and nine ground water)
4	Ecology	Existing terrestrial and aquatic flora and fauna	Through field visits
5	Noise levels	Noise levels in dB(A)	Twice during study period at twelve locations
6	Soil characteristics	Soil profile, characteristics, soil type and texture, heavy metal, NKP value etc	Twice during study period at ten locations
7	Land use	Land use for different categories	Based on data published in latest

Sr. No.	Attribute	Parameters	Frequency of Monitoring
			published district census handbooks and satellite imagery.
8	Socio-economic aspects	Socio-economic characteristics, labour force characteristics, boom town effects, R&R measures proposed	Based on data published in latest published district census handbooks
9	Geology	Geological history	Based on data collected from secondary sources
10	Hydrology (Surface and Ground)	Drainage area and pattern, nature of streams, aquifer characteristics, recharge and discharge areas	Based on data collected from secondary sources and satellite imagory
11	Risk assessment, Disaster Management Plan and Occupational Health and Safety	Identify areas where disaster can occur and identify areas of occupational hazards.	Based on assessment

CHAPTER-2
PROJECT PROFILE

2.1 LOCATION

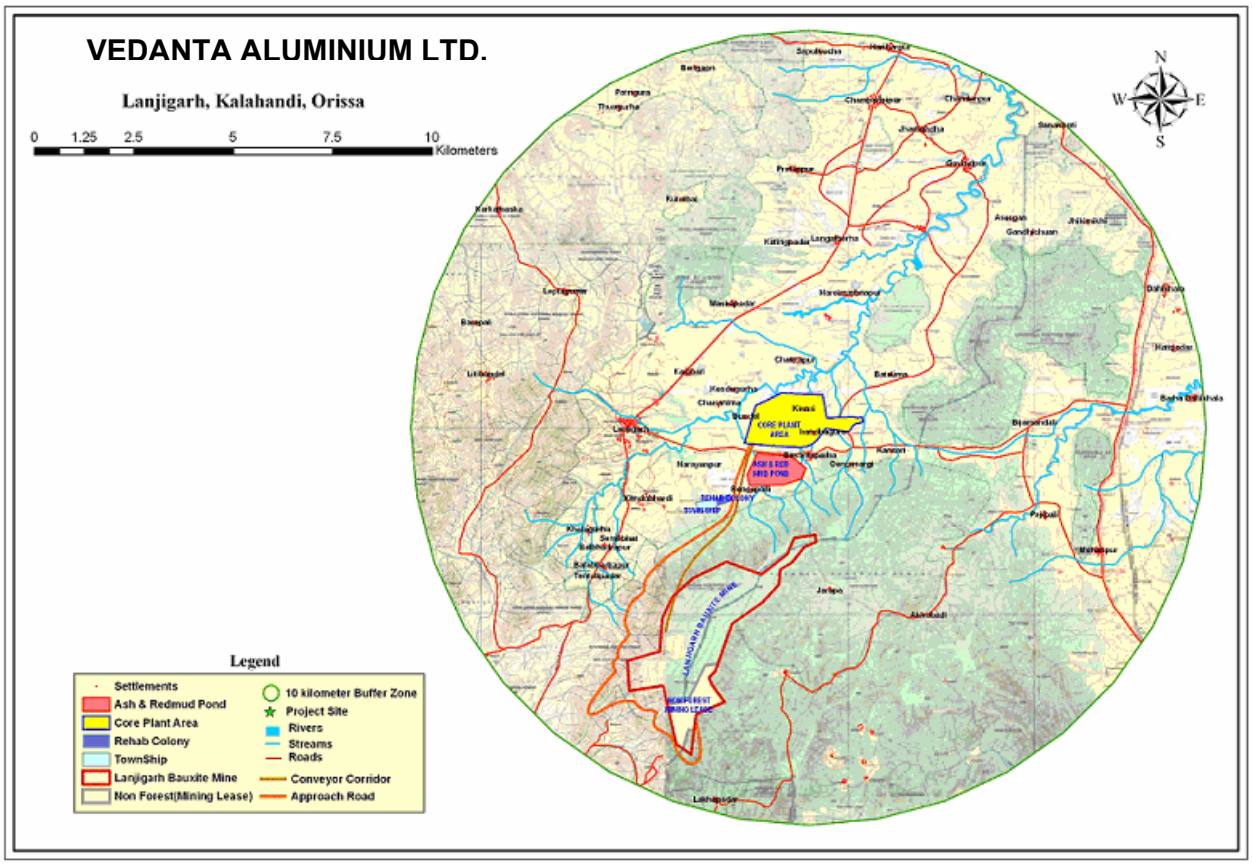
The Proposed expansion of Alumina refinery plant is located within and adjacent to the existing plant at Lanjigarh in Kalahandi district of Orissa. The proposed expansion will be to increase the production capacity from 1MMTPA to 6MMTPA of Calcined Alumina. This is envisaged within the existing plant location with necessary technological changes and debottlenecking of the existing system and by adding additional streams. The Plant Site is well accessed by road network connected to all major towns/cities of the state, availability of bountiful water resources are some of the justification for the existence of the Plant. Further the proposed expansion will lead to socio-economic growth and development of the local area.

The existing plant site is about 3.7-km (aerial distance) from Lanjigarh and the nearby villages are Kinari, Bandagruha, Kapagruha, Basantapara & Sindhabahal. The plant is located on the road connecting state highway SH-6 (Bhawanipatna-Rayagada) to Lanjigarh. Small villages, agricultural lands and grazing lands, mainly surround the site. Niyamdangar forms a topographical high land in the area with an elevation of 1300-m above MSL. Niyamgiri plateau (1210-m), Bamandeb dongar (1033-m) and Niyamgiri hill (1306-m) are the major elevated land features in the area. The valleys are mostly narrow and well dissected.

The nearest district town is Bhawanipatna at about 65-km by road. The nearest railway station is at Muniguda at a distance of about 25-km (by road). The vicinity map and the study area map covering 10-km radius of the plant site is shown in **Figure-2.1 and Figure-2.2**. The details are given in **Table-2.1**.

Figure-2.1:Vicinity Map

Figure 2.2 Location map showing 10 km. radius



Source: Topo sheet no. 65M/6/NE

Table-2.1: Salient Features of the Project

Sl.No.	Description	Plant Site
1.	Topo sheet no	65M/6/NE
2.	Location of the plant area Latitude / longitude	Latitude -19°43' to 19°44' North Longitude- 83°24' to 83°25' East
3.	Site altitude above MSL	420 m – 430 m
4.	Nearest city / Big town & distance by road	Lanjigarh –is 3.7km Bhawanipatna – 65 Km
5.	Nearest Railway Station	Muniguda – 25 km NE
6.	Access Rly. Distance from site	21 Km. from Plan Site – Ambadola
7.	Nearest Highway	SH-6
8.	Access Roadway distance from site	6.5 Km.
9.	Nearest Meteorological station	Bhawanipatna
10.	Nearest Airports	Visakhapatnam - 252 Km. Bhubaneswar – 280 Km., Raipur – 275 Km.
11.	Water source	Tel River
12.	Distance from water source	67 Km.
13.	Coal source	IB valley coalfield (MCL)
14.	Furnace oil / L.D.O. source by Rail	Sambalpur (262 Km)/ Visakhapatnam (264 Km)
15.	Distance from Bauxite Deposit	3.7 Km conveyor length
16.	Nearest port	Visakhapatnam (264 Km), Kakinada (about 440 km)
17.	Lime source	Katni / Jabalpur
19.	List of Industries around the Plant Site within 10 Km radius	NIL
20.	Climatic conditions	a] Annual Max. Temp: 42.0^{o}C b] Annual Min. Temp: 7.0^{0}C c] Annual total rainfall: 1380 mm
23	Present land use at the plant site	Industrial Purpose
24	Nearest airstrip	Utkala (80-km NW)
25	Hills/valleys	The plant is located within the valley area and the nearest hill is 1.5 km away from the plant in NE-NW direction
26	Ecologically sensitive zones/ National Parks/ Wildlife sanctuary/ Biosphere	None within a radius of 10 km from the plant site
27	Historical places	None within a radius of 10 km from the plant site
28	Defense Installations	None within a radius of 10 km from

		the plant site
29	Reserve Forests in 10 km	1] Bori R.F at 5.2-km, NW 2] Hatisal R.F at 3.5-km NW 3] Raula Jhimiri at 5.2-km WNW 4] Niyamagiri at 3.5-km SW 5] Khambesi R.F at 2.0-km S 6] Kudilima R.F at 9.7-km SE 7] Patragruha R.F at 6.4-km ESE 8] Batarilima R.F at 2.3-km E 9] Dahikhala R.F at 4.0-km ENE 10] Patragruha R.F at 2.2-km NE

2.1.1 Land Requirement

Existing

The total land requirement for the proposed expansion including the existing Plant would be 2007.72 hectares. The details being,

Existing land (1.0 MMTPA)		
Purpose	**Acres**	**Ha**
Main Plant	691.58	279.87
Red Mud	452.06	182.94
Ash Pond	235.79	95.42
Township	129.61	52.45
Railway	132.96	53.81
Total	**1642**	**664.49**

Expansion

The proposed expansion would require additional land to be acquired (about 1343 Ha) for accommodating the additional facilities of the plant, red mud pond, ash pond, township and railway corridor. The land, that has been identified and under acquisition is mostly barren land and un-irrigated. Care has been taken not to acquire irrigated land. There are no home steads in the land that is under acquisition. The additional land is under process of

acquisition. The layout plan is enclosed as **Figure 2.3**. The land proposed is on the eastern side of the refinery. The following table indicates the proposed expansion provision.

Additional land (6 MMTPA)		
Purpose	**Ac**	**Ha**
Main Plant	348	140.84
Red Mud	2200	890.34
Ash Pond	541	218.94
Township	70	28.33
Railway	160	64.75
Total	**3319**	**1343.20**

The total area of the expanded Alumina Refinery will be 2007.72 Ha. No forest land will be utilized for the project. The additional land will be acquired through IDCO. The project site is mostly barren land. The total land required has been optimized and what is being acquired is the bare minimum that is required for setting up of the plant.

The existing and proposed land use breakup of the plant site is given in **Table -2.3**

Table- 2.3: Land use pattern of Core Zone

S. No.	**Land Use Pattern**	**Area Existing Plant (Ha)**	**Area After Expansion (Ha)**
1	Main Plant (including storages and green belt)	279.87	420.72
2	Red mud including green Belt	182.94	1073.29
3	Ash Pond including green Belt	95.42	314.37
4	Township and miscellaneous including green Belt	52.45	80.78
5	Railway line including green Belt	53.81	118.56
	Total	**664.49**	**2007.72**

2.1.2 Utilities and Services

- **General**

In addition to the raw material and consumables described in the previous sections, there are various other utilities and services which will be required for proper functioning of the alumina refinery. Major utilities and services are as follows:

- Co-generation Plant
- Water Supply
- Compressed Air
- Fuel Oil
- Cooling Water
- Fire Water System
- Central Control Room
- Plant Laboratory
- Maintenance and Ware House Complex and
- Other Facilities

- **Co-Generation Plant**

Steam is an essential requirement for alumina refining and is used in various areas like digestion, evaporation etc. which also maintains the water balance in the circuit. Bauxite digestion is an endothermic reaction that is carried out at 140° C or higher. The best and easily available fuel for steam generation is coal, which is abundantly available in the state of Orissa. Coal based co-generation plants are well proven in alumina industry and elsewhere. Further, the generation of power as by-product from steam in co-generation plant will be more energy efficient and also more economical compared to power supply from GRIDCO (Orissa) coupled to steam generation purely for the process. In addition, the Kalahandi / Rayagada areas are not developed, and a reliable and robust power distribution system is not established. A refinery requires a reliable source of steam and power to operate efficiently, uninterruptedly and to ensure environmental impacts are minimised. Therefore, in the expanded facility production of additional electricity as well as steam is considered. The maximum use is made of the extraction of steam from turbines to produce electricity: steam is produced at higher pressure and is expanded through turbo-generators to pressures required for alumina

circuit. Steam to process will increase from approximately 400 TPH to 2200 TPH for the expanded facility.

The total power requirement for 6.0 MMTPA capacity alumina plant is estimated at 250 MW. To increase electrical energy production and efficiency of generation, the existing 3 X 25 MW condensing / extraction turbines will be augmented with additional 3 X 50 MW & 2 X 30 MW back-pressure / extraction turbine. The existing plant consists of 3 X 287 TPH boilers and for expansion five more 320 TPH boilers will be added.

- **Water Supply**

Water requirement of the plant, mines and township will be met entirely from Tel River near Kesinga located at about 67-km from the plant site. An intake tower and collection field, a two stage pumping facility and a 67-km long pipeline of 700 mm diameter are in place for the initial development. An intermediate pumping station is located at Lanjigarh Road at about 32 km from the plant. For expansion to 6 MMTPA capacity, the existing pumping facilities will be enhanced, but no further facilities will be required. The existing water requirement of the alumina refinery and township is 14,895 m^3/day and after expansion the water requirement will be 56,250 m^3/day which includes water for the proposed mines. The break-up of water requirement for existing as well for after proposed expansion is given in **Table-2.4.**

TABLE-2.4: EXISTING AND PROPOSED WATER REQUIREMENT AND IT'S BREAK-UP

Particulars	Water requirement Existing (1 MMTPA)	Water requirement Expansion (6 MMTPA)
CGPP		
Boiler and Cooling tower	6665	29398
Refinery And Mines		
Cooling tower make-up and Process make-up	5450	22541
Dust Suppression system		
CGPP	480	831
Refinery	180	300
Domestic		
Onsite	120	180
Township	2000	3000
Total	14895	56250

- **Compressed Air Supply**

A centralized compressor house caters for the air need of alumina refinery as well as co-generation plant. Dry air is supplied for instrumentation as well as for general purpose compressed air for tools and miscellaneous usage.

For the expansion there will be an increase in the compressor capacity by 33%. To increase the process efficiency the compressor house of Alumina refinery and CGPP are separated. Five more compressors would be added to cater the needs of Alumina Refinery.

- **Fuel Supply**

Fuel oil will be required mainly for the calcination plant. Additionally, some fuel oil will also be required as supporting fuel for initial firing of the boilers in the co-generation plant. Railway tankers will supply fuel oil to the alumina refinery. An independent railway tanker unloading station for fuel oil will be provided.

A storage facility of 16000 tons will be provided. 3 more storage tanks will be added to the existing storage system of FO. From storage tanks the fuel oil will be distributed up to the battery limits of calcination and co-generation plants. The facilities required for internal distribution of fuel oil including day tanks will be provided as required.

- **Caustic Soda Unloading and Distribution**

Infrastructure has been developed for the existing plant which can handle the entire requirement of caustic soda in case of importing of caustic lye having 47-50% NaOH. Necessary port and rail facilities have been provided at Visakhapatnam port to handle and transport the imported caustic lye by dedicated rail tankers to the alumina refinery. An independent caustic tanker unloading station is provided. No change to these facilities is required to manage the caustic use of the expanded plant. It is proposed to use a mix of Indian and imported caustic. The amount of indigenous material use is likely to be controlled by the supply capacity and logistics of the Indian producers. India supplied caustic will be either railed to site or trucked depending on the logistics at the supplier end.

In order to meet the cooling water requirement of various units of the alumina refinery independent closed circuit cooling towers are installed. Four more cooling towers (three for refinery and one for CGPP) will be added to meet the cooling water supply requirement.

- **Fire Water System**

No change will be required to the main fire fighting system. Additional local lines and hydrants will be placed in the new facilities.

- **Central Control Room**

A centralized control room will be established for the core plant of the alumina refinery. In addition to this, there will be a separate control room for the co-generation plant.

The control room of alumina refinery in itself is designed to accommodate the expanded plant requirements, so no new control room will be added. Additional operator workstations will be added as necessary. However, the control room for CGPP would be in the upcoming CGPP building.

- **Plant Laboratory**

In addition to the state of art distributed control system (DCS), the plant laboratory plays a complimentary role towards fulfillment of overall process control objectives. No additional equipment is required for the expansion. The plant laboratory is equipped with the state of the art instruments which are necessary infrastructural facilities for carrying out the following process control activities:

- Analysis of raw materials viz. bauxite, lime, coal, fuel oil etc.;
- Analysis of process samples such as process liquor, red mud, hydrate etc.; and
- Environmental monitoring.

- **Maintenance and Ware-House Complex**

To ensure smooth and uninterrupted operation of the plant, repair and maintenance facilities are provided within the plant. No additional facilities

apart from local tool rooms or work areas will be required to serve the expanded facilities.

- **Other Facilities**

In addition to the various facilities mentioned in the above sections, other essential services such as canteen, first-aid, gate-house, fire station, etc. are also being provided within the plant. No changes in the above facilities would be required after expansion.

2.1.3 Green Belt Development and Landscaping

One third the area would be covered under Green Belt. Open spaces will be suitably landscaped.

2.2 GENERAL PROCESS DESCRIPTION

The proposed expansion of Alumina refinery is to employ the Bayer process, which dissolves the alumina component of bauxite ore in sodium hydroxide (caustic liquor), removes impurities from the liquor and precipitates aluminium-trihydrate, which is then calcinied to aluminium oxide (alumina).

2.2.1 Bauxite Handling and Grinding

The function of bauxite handling is to receive ore from the mine, provide a buffer stock and to improve the uniformity of feed to the plant by blending. Grinding is used to reduce the particle size of bauxite feeding to refinery to the appropriate level required for efficient gibbsite digestion, silica dissolution and slurry suspension in subsequent process areas.

Bauxite from mines (-80 mm) will be transported through long distance pipe conveyer and stored at a stockpile area inside the plant where it is stacked to achieve better blending. Bauxite is reclaimed, crushed (to -20 mm) and fed to surge bins in the grinding section. Closed circuit wet grinding using spent liquor is adopted.

Bauxite is ground from a size of –20mm to a nominal D_{50} of –350 microns and screen to restrict the maximum size to 1.2mm using ball mills in a closed circuit. The grinding allows better solid liquid contact during the digestion

phase of the refining process. A side stream of recycled caustic liquor is added to the bauxite in the grinding circuit, to produce pumpable slurry of about 40 to 50% solids.

2.2.2 Predesilication and Digestion

Predesilication allows the silica in the bauxite to dissolve and reprecipitate as DSP (Sodalite). This reduces silica level in the liquor circuit and hence controls the product impurities with in the limits of downstream users.

The slurry from grinding mill area is heated to approximately 95^0C and fed to a series of predesilication tanks where it is agitated for approximately 12 hours to allow the silica to react and to precipitate sodalite.

The Digestion area heats a mixture of bauxite and spent liquor to 145^0C using steam recovered from slurry exiting the area and steam. Digestion vessels provide sufficient time (approximately 40 minutes) for the bauxite to dissolve and desilication to reach completion.

$Al_2O_3.3H_2O + 2NaOH \rightarrow 2NaAlO_2 + 4H_2O$

In the digestion area, the desilicated bauxite slurry is mixed with spent liquor and then passed through a series of recuperative and live steam heat exchangers before it is fed to digesters at a pressure of 4-5 kg/cm^2 and at temperature of approximately 145^0C. At this condition, alumina from bauxite is dissolved into spent liquor at high extraction efficiency and spent liquor is converted into pregnant liquor. Slaked lime is added in the digestion process to assist in the extraction of alumina and removal of impurities. The digestion slurry is then flashed through a series of flash vessels to bring down its pressure and temperature to below atmospheric boiling point, suitable for mud clarification.

2.2.3 Clarification and Filtration

Clarification and Filtration separates the pregnant liquor from solids, residue or red mud, a mixture of undissolved gangue and precipitated DSP. Washing removes caustic soda and produces slurry with a high-solid concentration, suitable for environmentally safe disposal.

The digestion or blow-off slurry is fed to raked thickeners (settlers) where it is separated into clear pregnant liquor and a high-solid stream (mud and sand). Flocculent is added in settlers to increase the settling rates and produce a denser underflow stream. Settled mud from the underflow of settler is pumped to a series of washers (raked tanks similar to the settlers) where the mud is washed through counter-current water flow and a thickened residue paste is produced and disposed off to the red mud pond.

Clarified overflow liquor from the settlers is sent to security filters to remove residual suspended solids from the pregnant liquor. This improves alumina quality with respect to iron, silica and other contamination. A metered quantity of Tri-Calcium Aluminate (TCA), filter aid, prepared by mixing pregnant liquor and slaked lime, is added to the overflow liquor to improve the filtration efficiency.

2.2.4 Heat Interchange and Precipitation

After the liquor from the clarification and filtration stage is further cooled, by a series of plate heat exchangers. The temperature of the pregnant liquor is brought down to desired level to facilitate precipitation. Continuous precipitation of alumina-trihydrate crystals occurs in large agitated open top tanks. This allows the dissolved alumina to be recovered from the liquor. Alumina precipitates as the trihydrate form $Al_2O_3.3H_2O$ as per the following reaction.

$2NaAlO_2+4H_2O \rightarrow Al2O_3.3H_2O+ 2NaOH$

Inter-stage cooling of the slurry is done in the precipitation tanks by means of ISCs. This facilitates faster and coarser alumina precipitation to meet the smelter grade and other downstream users requirement.

2.2.5 Hydrate Classification and Filtration

The final slurry consisting of crystals of alumina trihydrate is classified in a series of classification cyclones. The coarse material from the classification cyclones, cyclone underflow, is pumped to a hydrate slurry tank in pan filtration area. The cyclone overflow is then pumped to a set of seed filters to recover the spent liquor. The filtered cake is then repulped with pregnant liquor

coming from heat interchange area. This is then sent back to precipitation tanks as seed for precipitation. The spent liquor recovered is then sent to evaporation unit via heat interchange department and then recycled again for digestion.

The process described above is the process of expansion plant. This is a process improvement made to increase the efficiency of the refinery by eliminating one stage of classification and incorporation of coarse seed filtration to eliminate HST.

In the current refinery, there are two stages of classification in which the primary cyclone cluster is used to separate product and seed. The product is then sent to a product filter to recover the spent liquor and is then sent to hydrate washing area. The cyclone overflow (seed) is then sent to the next set of the cyclones to classify them further. The slurry of mid size material from the classification cyclones is recycled as secondary seed into the precipitators. The slurry of fine material from the classification cyclones is sent to HST to thicken the fine seed and separate spent liquor from the same. The underflow from HST is then filtered and washed to remove caustic and organic impurities. The filter cake from the filters is recycled to the precipitators as fine seed and the filtrate flows to oxalate destruction. The HST overflow is spent liquor Spent liquor from the hydrate seed thickeners and from product filtration is sent via heat exchangers to evaporation.

2.2.6 Evaporation

Spent liquor is re-concentrated by passing through an evaporation process which removes water. This is accomplished in a multi stage flash evaporator which maximizes energy efficiency. It is proposed that the low temperature flash vapour is condensed utilizing indirect cooling. The indirect cooling circuit is currently proposed to use fresh water. The water removed by evaporation is used in residue washing.

Fresh caustic soda is added to make up for process losses resulting from reactions with impurities in bauxite, particularly silica. The caustic liquor is then recycled to dissolve further alumina in the digesters at the start of the process.

2.2.7 Hydrate Washing and Calcination

Pan filters for product washing are used to wash and dry product hydrate slurry from product deliquoring to produce a washed coarse hydrate cake suitable for feeding to calciners. The calciner converts washed product hydrate cake to smelter or other down stream requirement grade alumina. The hydrate is heated (at 1100^0C) through fuel oil burners to remove water. The alumina is counter-current cooled in the calciner to recover energy then finally cooled to 80°C and conveyed to alumina load-out bins through belt conveyers. The calciner exhaust gases pass through ESP before discharge to atmosphere. The 1.0 MMTPA plant is having two calciners of 2500 TPD capacity each. In phase 2 after debottlenecking the calciner capacity will be raised to 3000 TPD each. For 6.0 MMTPA alumina production three more calciners of 3300 TPD capacity will be added.

2.2.8 Steam and Power

The process uses approximately 2.3 ton of steam / ton of product and 250 kWh of electricity /ton of alumina. At flow sheet production, a 1MMTPA and 6MMTPA refinery will hence use approximately 290 TPH / 800 TPH of steam to process, and 32 MW/94 MW of power respectively. This is produced in a coal-fired cogeneration plant. The existing system produces steam at 67 bar and 490^0C. The upcoming cogeneration power plant is designed to produce steam at 100 bar and 540°C to improve boiler efficiency. This steam is sent to steam turbines to produce electricity. Steam is extracted from turbine at two stages and distributed to refinery to various areas. The pressure and temperature of the extracted steam is regulated as per the refinery's requirement. The unextracted steam goes to a condensate pot and is re-circulated to the boiler.

For the expansion, the condensing component will be minimized to improve energy efficiency. The flue gas from the boilers is scrubbed in high efficiency ESPs prior to discharge via a 145-m stack find as per the CPCB guide lines for Stack Height. Bottom ash and balance fly ash after providing to downstream industries like cement, brick and land filling are mixed and sent to an ash pond in the form of High Concentration Slurry Disposal (HCSD) System. The existing and proposed layout of the Alumina refinery is presented in **Figure-2.3** segregating the existing and proposed layouts by colour. The overall flow sheet of Alumina manufacturing is given in **Figure-2.4.**

Figure 2.3: Plant General Layout Indicating the disposition of the different Plant units

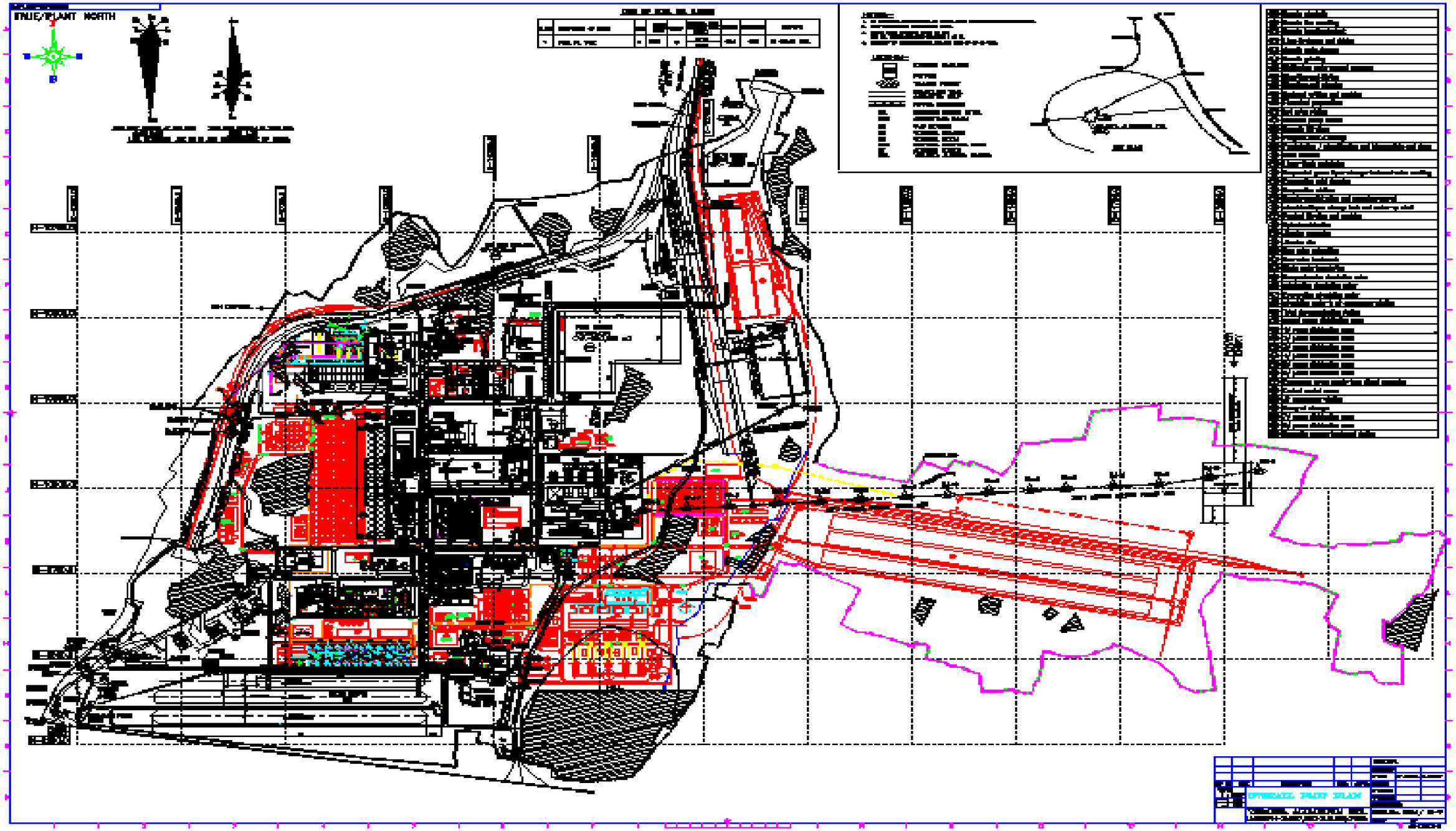
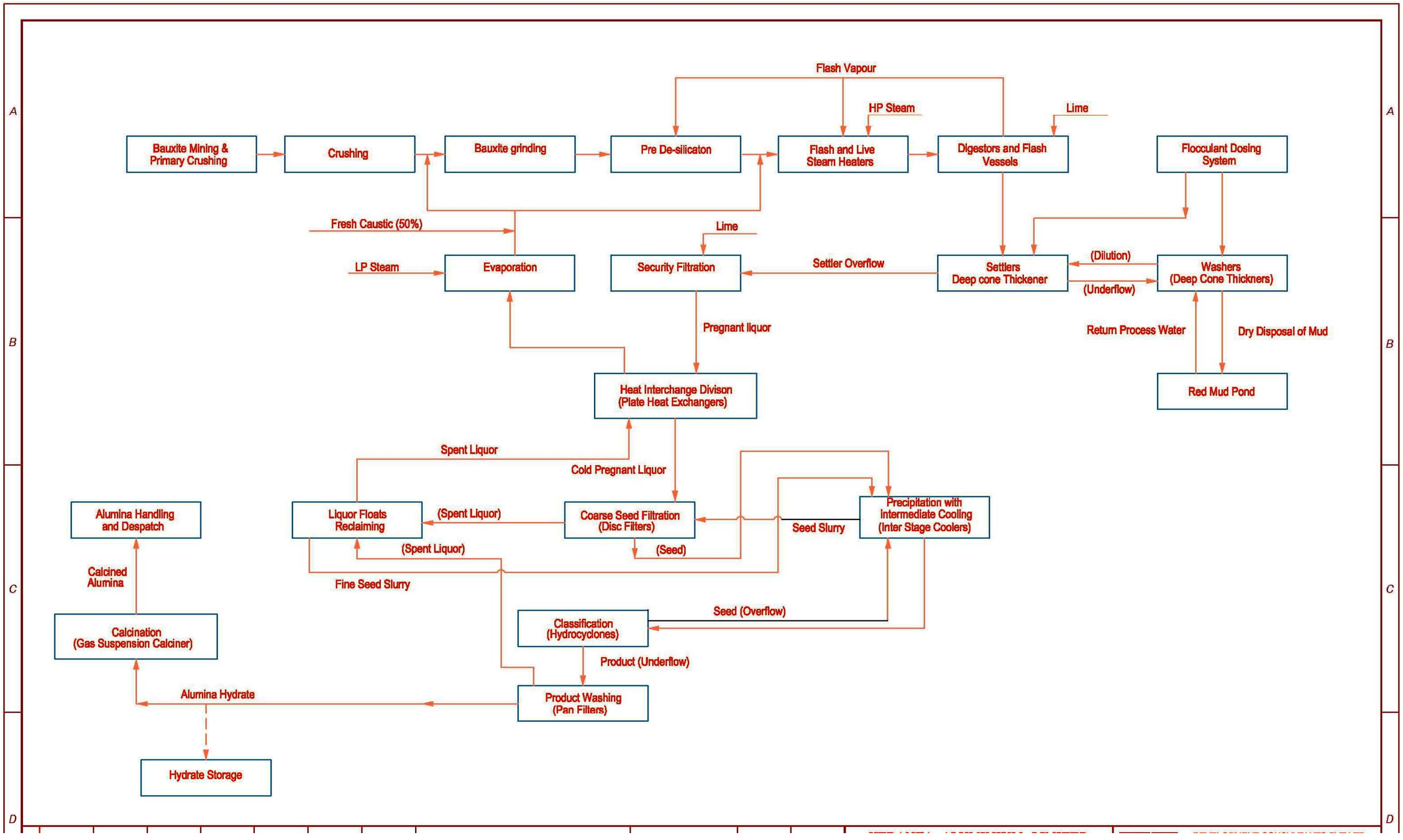


Figure 2.4: Process Flow Diagram



2.3 RAW MATERIAL

Table- 2.5: Raw material Inventory

PARAMATERS	UOM	1 MMTPA (Existing)	6 MMTPA (After Expansion)
Bauxite (Dry Basis)	T/T	2.61	2.58
Caustic Soda (as Na_2O)	Kg/T	70	65
Lime (CaO – 70%)	Kg/T	44	50
Flocculant	Kg/T	0.50	0.40
Furnace Oil / LDO	L/T	72	70
Steam	T/T	2.1	1.9
Coal (3500 Kcal/Kg)	T/T	0.67	0.67
Energy (Aluminium)	KWh/T	250	220

Raw Material Source:

The source of the required raw materials for the proposed project is as per the table below at **Table-2.6**:

Table – 2.6: Raw material Source

Sl. No.	Material	Existing Source	Proposed Source
1	Bauxite	East Coast Bauxite – Lanjigarh / OMC	East Coast Bauxite – Lanjigarh / OMC/ Imported
2	Caustic Soda	Domestic / Imported	Domestic / Imported
3	Lime	Katni, Rajasthan	Indigenous / Imported
4	Fuel Oil	HPCL / IOCL	HPCL / IOCL
5	Coal	IB-Valley (MCL)	IB-Valley (MCL)
6	Power	Captive	Captive

2.4 EXISTING WATER SUPPLY

Water is being drawn from River Tel located at Kesinga at a distance of approx. 67 Km from the refinery for the existing facility with an intermediate pumping station at Lanjigarh Road at about 32 Km from Plant.

One pipeline supplies water from Tel River to the Raw Water Reservoir in the plant. A Raw Water Treatment Plant (RWTP) has been installed in the plant to treat the water and make it usable for different purposes. RWTP consists of Pressure Sand Filter (PSF) unit, Activated Carbon Filter (ACF) unit and chlorination unit.

Water supplied to CGPP DM unit is treated only with PSF and pumped to it. Water for drinking and other purposes is treated through PSF, ACF and chlorination units and pumped accordingly.

2.5 PROPOSED WATER SUPPLY

The approval for drawing 56,500 MTPD of water is already available. The Copy of the same is attached as **Annexure–V**. The water requirement for the proposed expansion would be met from the allocation already available. No additional water allocation is envisaged for the proposed expansion. This will be achieved by efficient and effective water management. However, an additional pumping system with new pipeline would be set up to meet the requirement of the water. Also, the present Reservoir in the plant is sufficient enough to cater the requirement. But, a new RWTP would be set up to enhance the treatment and pumping capacities.

Water Quality & Treatment

There will be five types of wastewater sources from the proposed alumina refinery plant, viz.:

1] Alkaline wastewater from various sources of the refinery plant
2] Cooling Tower and boiler Blow down;
3] DM Plant Regeneration;
4] Filter Back wash; and
5] Domestic sewage

All these waste water will be recycled back to the process for various usages such as dust suppression, & greenbelt development after necessary treatment.

The wastewater quality during constructional and operational phase with its treatment prospect is given below in **Table-2.7**:

Table-2.7: Water Quality & Usage

Phase	Water Quality (probable impact)	Treatment Measure
Constructional	Increase in suspended solids due to soil run-off during heavy precipitation	Temporary sedimentation Tank will be used
Operational	Deterioration of water quality of surface water	Wastewater will be completely recycled for various uses in the plant after necessary treatment if required and no discharge of wastewater outside the premises is envisaged except during monsoon

2.6 ORGANIZATION AND MANPOWER

2.6.1 Organization Structure

Broadly the organization structure is divided into operational and non-operational groups. The operational group is headed by Chief Executive Officer (CEO), followed by the plant managers and operational managers. Environment cell comes under the non-operational group headed by a Senior Executive, responsible for all installations, implementations, and coordination related to any environmental issues and take proactive steps to mitigate the measures. The environmental cell directly reports to the Project Head for all purposes. This is a reinforcible & reversible management practice for sustainability and quality.

2.6.2 Manpower Requirements

There will be considerable potential for generating direct and indirect employment during construction as well as during normal operation of the plant. It is estimated that nearly 6000-8000 people shall be used during construction phase, which will help in improving the socio-economic condition of the area.

Existing

The existing permanent manpower of VAL is around 500 and for its associated partners the manpower is around 2000.

Expansion

For 6 MMTPA plant, it is estimated that the total manpower for Vedanta would be around 1200 and its associate partners would be around 2500.

2.7 CAPITAL COST ESTIMATE

The projected estimated cost for the proposed expansion is based on the bulk estimation on the following categories as listed in **Table-2.8.** This cost is tentative subjected to actual procurement of plant and machinery. The fixed and recurring costs are merged under the mentioned categories for the figurative marks of the proposed cost. The total capital cost of the project including Environment Management cost is 6500 crores. (The Environment Management cost being 593 crores)

Table 2.8: Capital Cost Distribution of the Expansion Project

Estimated Cost for Expansion	**Rs. In Crores**
A) PLANT AND MACHINERY	
Plant & Machinery	**5225.00**
Land Acquisition	**127.00**
Housing / Township	**445.00**
R&R	**110.00**
Total Cost	**5907.00**
B) ENVIRONMENTAL MANAGEMENT	
Pollution Control Equipments & Monitoring	**495.00**
CSR Cost	**20.00**
Greenbelt Development	**78.00**
Total Cost	**593.00**
Total Capital Cost (including Environment Management)	**Rs. 6,500.00**

CHAPTER-3
PRESENT ENVIRONMENTAL SETTING

3.1 STUDY AREA

The study area considered is 10 km radius of the proposed expansion project and data has been generated for all relevant parameters

Description of environmental setting of the study area

The brief description of the present environmental scenario obtained from primary (monitored) data and partly from the secondary sources (Government offices). The description covers the major environmental components like

(i) Physico-chemical (air, water, soil, noise etc)
(ii) Biological (flora, fauna, ecology)
(iii) Human (socio-economic) and
(iv) Aesthetics

3.2 LAND ENVIRONMENT

3.2.1 Regional settling

The proposed plant is located at village Lanjigarh of Kalahandi district, Orissa. The proposed site is featured in survey of India Topo Sheet No-65M/6/NE.

3.2.2 Topography

The topography of the study area is usually flat land (Valley type) at the foothills of mountain ranges. The type of land may be categorized as mostly barren & some for agricultural usage. The soil type is residual in nature varying between sandy clay to silty clay. The phenomenon of weathering is predominant in this area which reduces as the depth increases.

3.2.3 Geology & Hydrogeology

Denuded hills occupy more than 50% of the total study area. The predominant rock type is Khondalite of Archaean age, the weathering of which has given rise to good soil cover for good growth of natural vegetation. Lateritic plateaus of varying sizes are found to occur on top of hills. Lateritisation has taken place in these plateaus as a result of prolonged in-situ weathering and

erosion. Some prominent lateritisation is observed in plateaus of Niyamadanger of Niyamagiri reserved forest, at and around "Lamba" of Niyamagiri, at "Upara" Duaragurhi and in plateaus of Bhatikiri Dangar (**Figure-3.1**).

Pediments occur in narrow strips on the outer fingers of denudational hill and are distributed sporadically throughout the study area. Open forest largely cover the pediments (**Figure- 3.2**)

Pediplain is another major hydrogeomorphological unit of the study area. They occupy nearly 32% of the study area extending from foot hill till river valley. Valley fill occurs all along the River Vamsadhara, the River Nagavali, Barha Nadi, Sakata Nala, Karikona Nala, Pitadar Nala, Daleiband Nala and other major streams. Flood plans are observed in the meandering river courses of Nagavali River and Vamsadhara River.

3.2.4 Drainage

Drainage pattern of the study area is characterized by moderately undulating topography with presence of low-lying hills and mounds at places. The area is mainly drained by river Vamsadhara. The area has a dendritic drainage pattern as observed in the rainy seasons only (**Figure- 3.3**).

3.3 LAND USE PATTERN

3.3.1 Land Use Pattern of the Core zone

The project area under reference covers a part of Lanjigarh village, under Lanjigarh Police station limits of Kalahandi district, Orissa. This area does not form part of any National Park, Wild life sanctuary and Natural/Biosphere reserve. It also does not contain any features of archeological/historical and cultural/aesthetics importance.

3.3.2 Land Use Pattern of the study area

The study area covers an area of 227.02 sq. km (22702.73 ha) within the circle encompassed by 10-km radius around the proposed plant site. In comparison with the satellite data, the wasteland and marginal areas of non-cultivable land are been utilized by the existing project and further the non-cultivable land will

be utilized for the expansion project. The detail of land use pattern as per satellite imagery is given in **Table-3.1**.

TABLE-3.1: LANDUSE PATTERN OF REVENUE LAND IN STUDY AREA

Sr. No.	Particulars	Study Area (ha)	Percentage Study Area
1	Forest Land	3172.95	14.0
2	Land under Cultivation		
	a) Irrigated Land	427.08	1.9
	b) Un irrigated Land	9524.13	42.0
3	Cultivable Waste Land	3042.28	13.4
4	Area not available for cultivation	6536.29	28.8
	Total Area	22702.73	100.0

Source: District Primary Census Data of Rayagada and Kalahandi, 1991 Forests

There are no National Parks or Wildlife Sanctuary within 10 km radius of the project site.

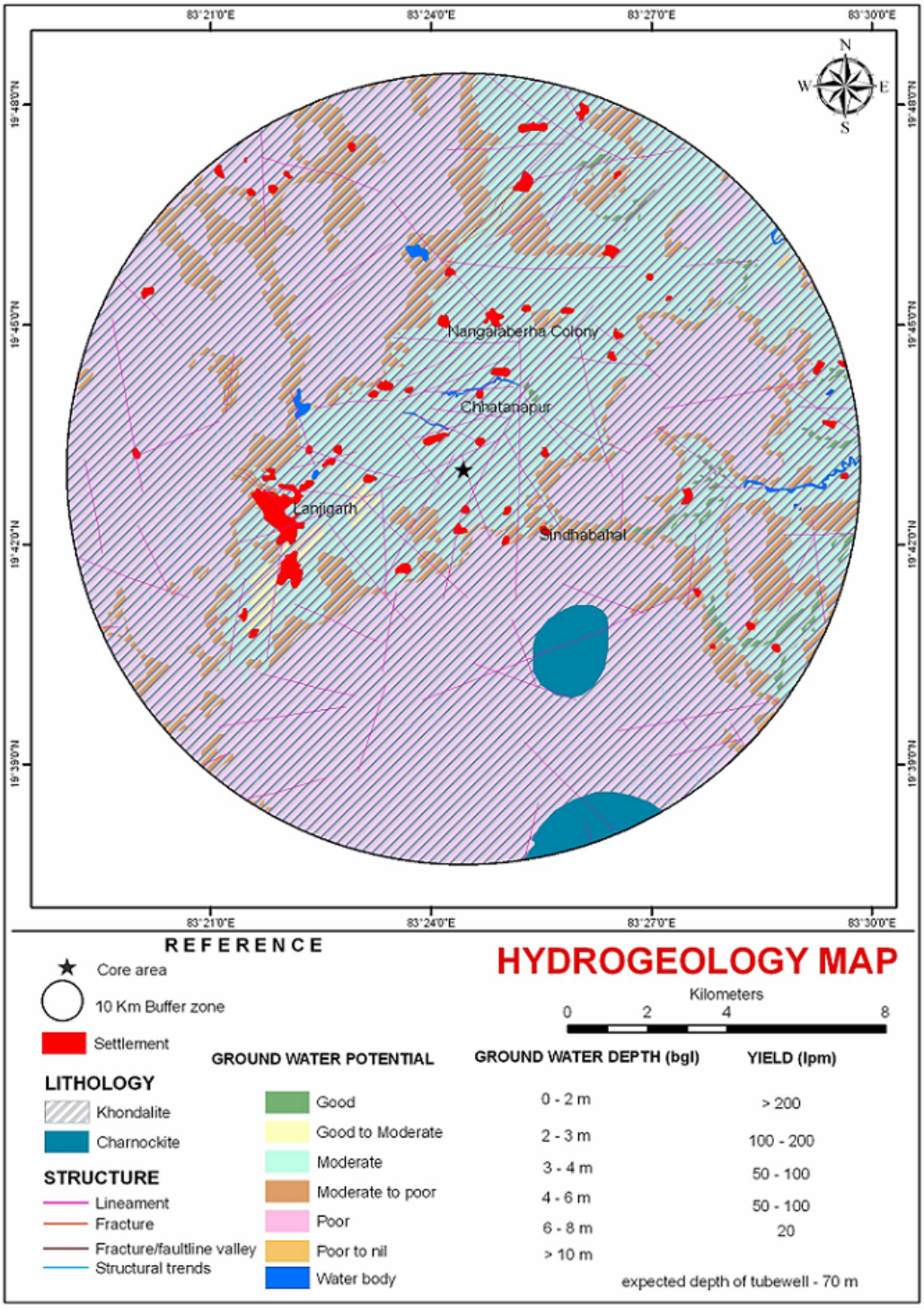
3.3.2.1 Methodology Adopted

The base map showing river, canal, major road, railway line, etc has been prepared from survey of India topographical sheets. Visual interpretation has been adopted to identify various land use/land cover features taking color, textures, pattern, association, etc into consideration. The final map shows the identified features along with the legend.

The land use/land cover map around the existing Plant Site and proposed area has been prepared in 1:25,000 scale using remote sensing technology. Various land use/land cover feature have been identified basing on the spectral signatures of different objects.

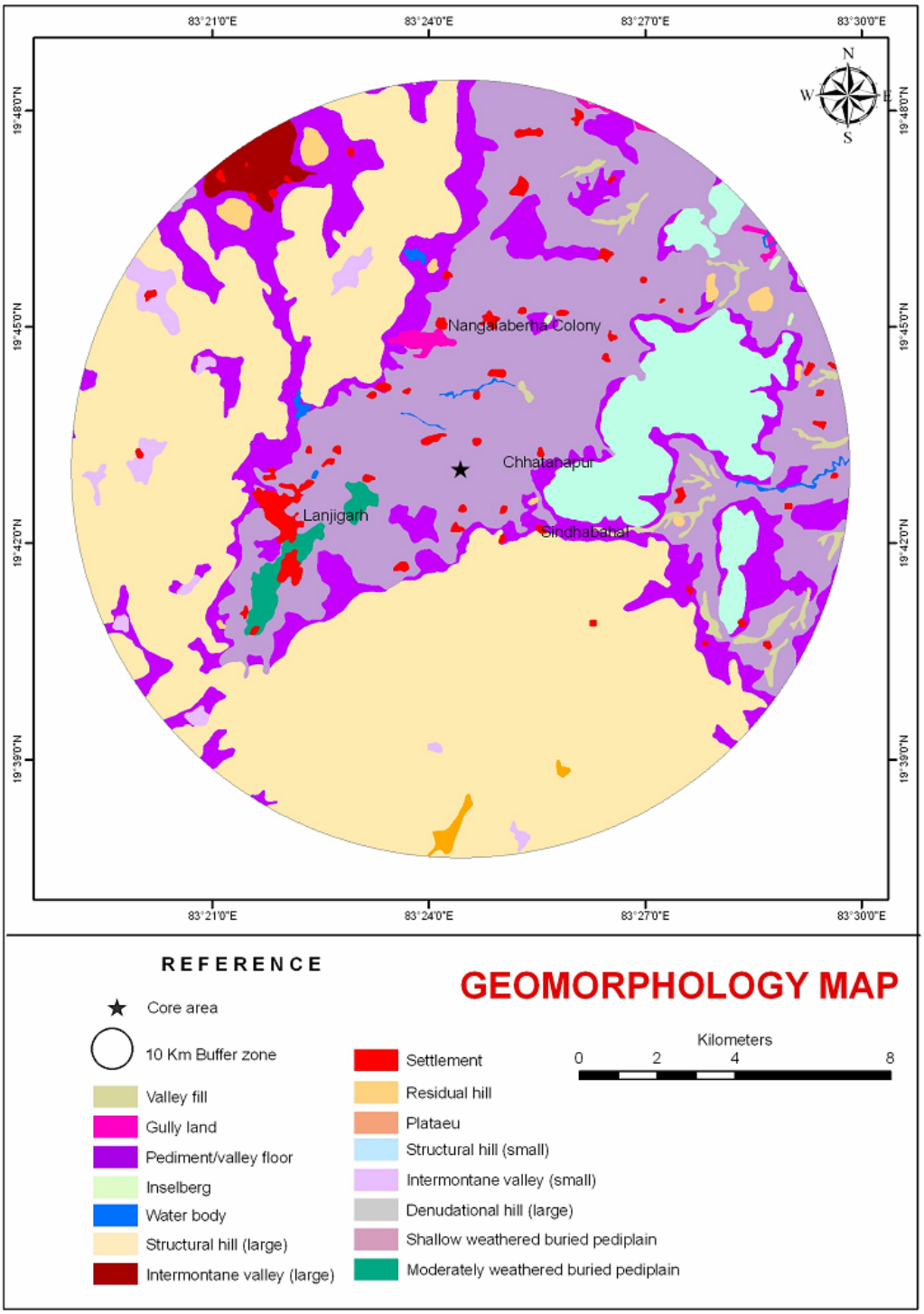
The Database used are Survey of India : Topographical sheet no. 65M/6/NE, False Color Composites of LISS II Band 2, 3 & 4, Indian remote Sensing Satellite- ID, date of acquisition of satellite image: Nov. 2006 to Jan 2007 and Limited Ground survey. The extent of forest cover around this area in the buffer zone is illustrated in **Figure-3.4**.

Figure -3.1: Geology & Hydrogeology of the Area



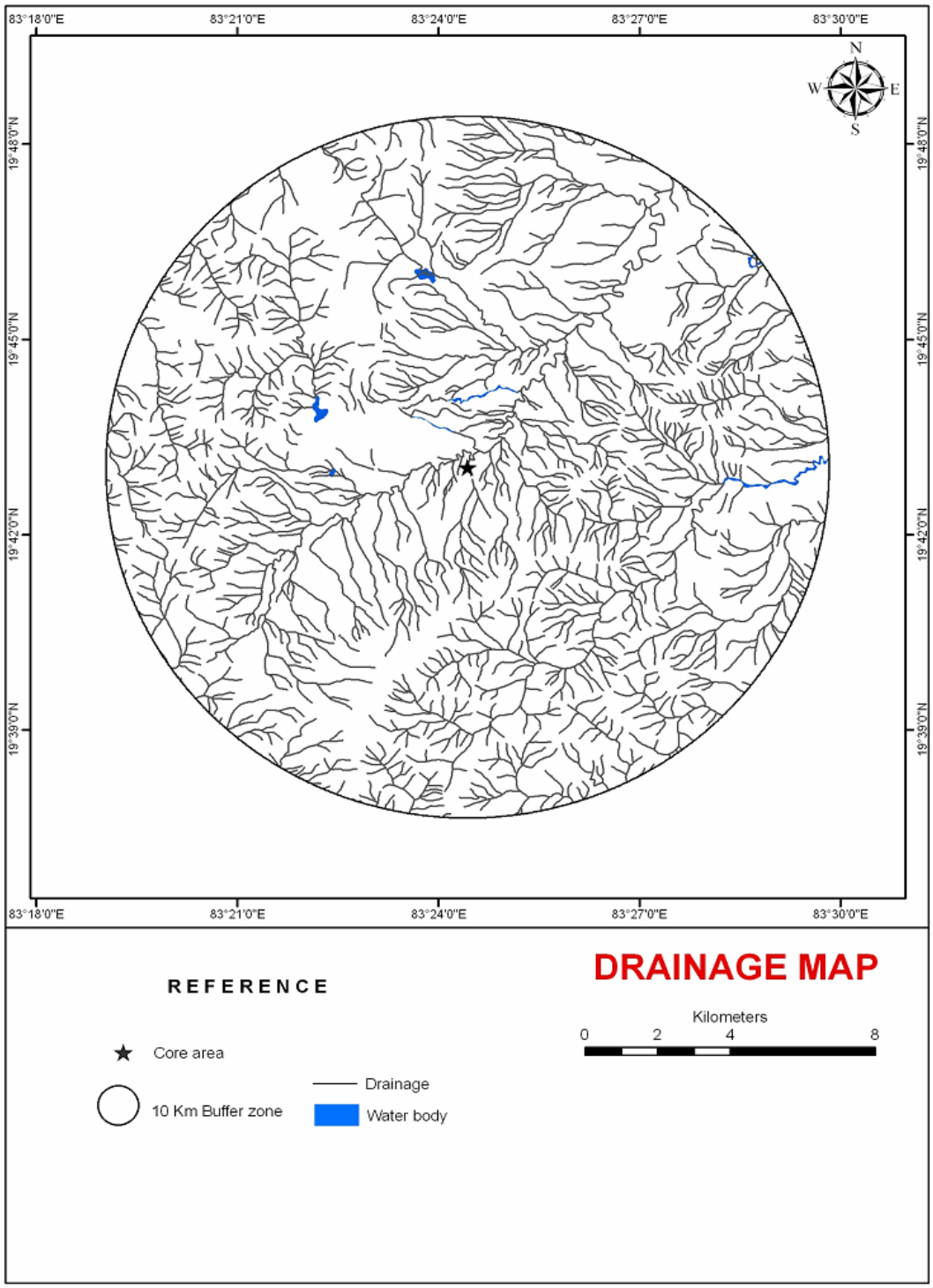
Source: IRSP6 LISS III

Figure-.3.2: Geomorphology of Buffer zone



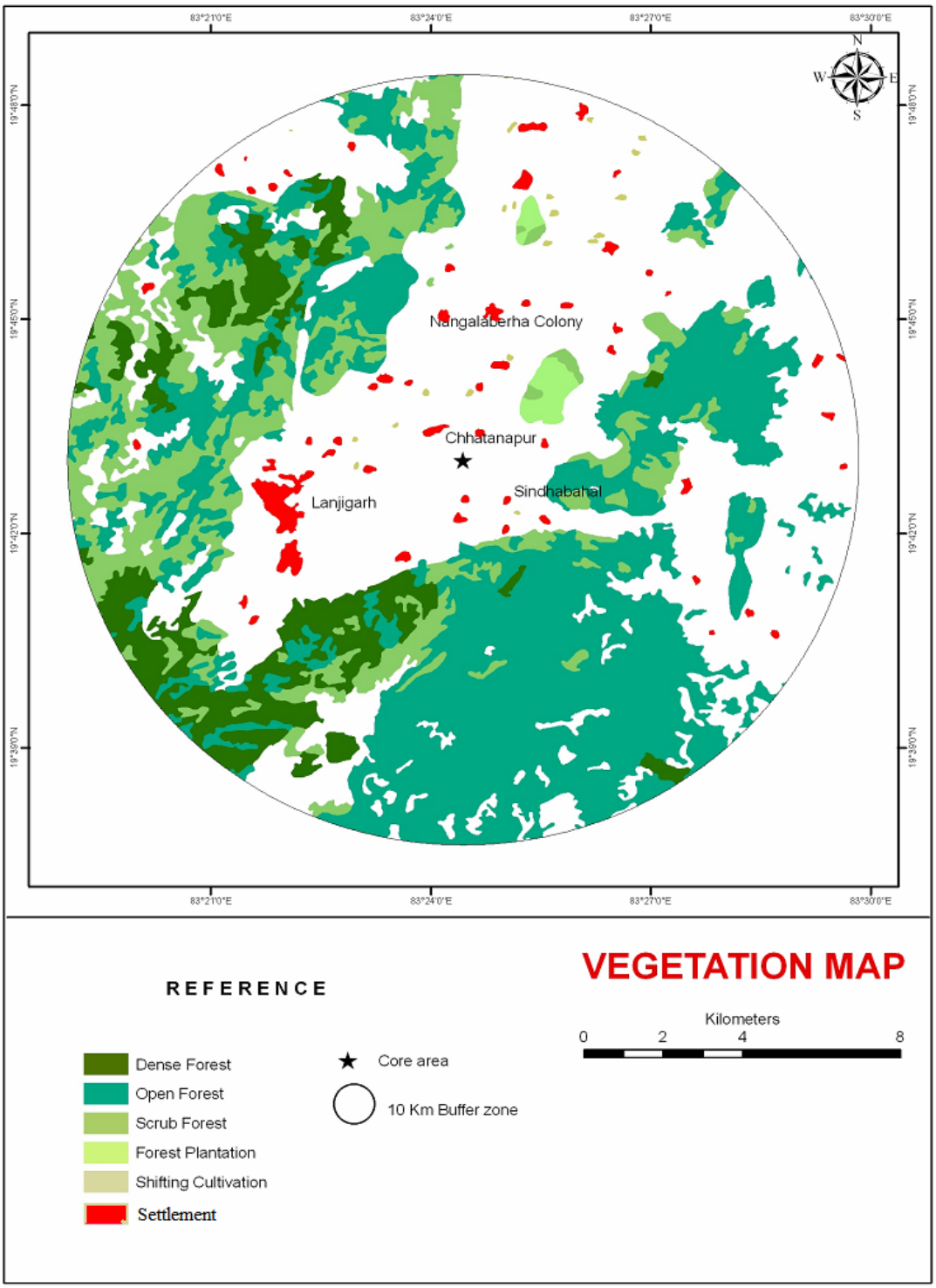
Source: IRSP6 LISS III

Figure -3.3: Drainage Pattern of Buffer zone



Source: IRSP6 LISS III

Figure -3.4: Vegetation / Forest Cover / Settlements in Buffer zone



Source: IRSP6 LISS III

3.4 CLIMATE AND MICROMETEOROLOGY

3.4.1 Temperature

A micrometeorological station was setup in the project site and data recorded as per the requirement.

During the pre-monsoon period (i.e. March to May) it was found that the temperature was 39.0 °C (maximum) in the month of March which gradually increased to 41.5 °C in the month of April & the minimum temperature was 15.0 °C in the month of March which also increased to 20.0 °C in April and again comes down to 19.0 °C in May. This shows that in the said area, April-May is the hottest period of the year.

During the monsoon period (i.e. month June to September) the maximum temperature was 41.5 °C which gradually decreased to 33.5 °C in the month of September. The minimum temperature was 21.5 °C in the month of June which increased to 22.5 ^{0}C in the month of July but again came back to its previous level and remained same up to the month of September. The high temperature in Monsoon season is probably due to high humidity content in the atmosphere.

During the months of post monsoon period (i.e. October & November), it has been observed that the maximum and minimum temperature variances were between 33.0^{0}C - 39.0^{0}C and 15.0^{0}C - 19.0^{0}C respectively. From this period onwards the temperature starts dropping with the incoming of Winter Seasons.

During the winter period (i.e. December to February) it was found that the temperature was 30.6 °C (maximum) in the month of December which gradually increased to 32.7 °C in the month of February and the minimum temperature was 8.4 °C in the month of January which was 10.6 °C in December. This shows that in the said area, January-February is the coldest period of the year.

The overall study of the meteorology of the area has about 25%-30% deviation from the nearest meteorological station at Bhawanipatna. This variation is

attributable to the distance and topographical characteristics of the study area as compared to the area of the IMD Station.

3.4.2 Relative Humidity

During the period of March & April, it has been observed that Relative Humidity was 71.0% (maximum), 13.5% (minimum) & 68.5% (maximum), 15.5% (minimum) respectively. During the month of May, it has been observed that the Relative Humidity recorded was 76.0 % (maximum) and 18.0 % (minimum). During the period of June and July, it has been observed that Relative Humidity was 79.1 % (maximum), 63.6 % (minimum) & 92.2 % (maximum), 70.7 % (minimum) respectively. During the month of August and September, it has been observed that the Relative Humidity recorded was 91.4 % (maximum) & 77.0 % (minimum), 86.5 % (maximum) & 80.1 % (minimum) respectively.

During the period of October & November, the maximum and minimum Relative Humidity varied between 88.0% - 79.0% & 38.0% - 32.0% respectively. This is due to the fact that the retreating monsoon has sporadic rain mostly in the month of October and towards the end of October, the atmospheric humidity decreases with incoming winter conditions.

3.4.3 Rainfall

During pre-monsoon period the rainfall recorded at the project site was 91.0 mm (maximum) i.e. during the month of May and minimum was 6.5mm (during the month of March.). During the monsoon period the rainfall recorded at the project site was 421 mm (maximum) i.e. during the month of June and minimum was 325 mm (i.e. during the month of September). During the post-monsoon period the rainfall recorded at the project site was 182 mm (maximum) i.e. during the month of November and minimum was 52 mm (during the month of October).

3.4.4 Wind Speed and Direction

During Pre monsoon, the average winds from SE direction were observed for 15.5% within the frequency range of 0.92 to 3.54 total times. The other direction and percentage frequencies were observed from NW (0.4%), WSW (2.7%), SW (11.6%), NE (1.2%), ENE (3.1%), ESE(12.8%), NNE(7.7%),

N(5.5%), NNW (.95%), WNW(1.0%), SSW(5.2%), SSE(9.4%), E(10.7%) and W(8.2%) . The calm conditions were observed to be for 6.34% of the total time **(Figure-3.5)**.

During monsoon, the average winds from SW direction were observed for 27.5% within the frequency range of 0.82 to 3.12 total times. The other direction and percentage frequencies were observed from WSW (10%), SSW (7.2%), SE (9.2%), ESE (11.8%), NNE (5.7%), N (4%), SSE (2.4%), E (7.7%) and W (2.8%). The calm conditions were observed to be for 8.30% of the total time **(Figure-3.6)**.

During Post monsoon, the average winds from SW direction were observed for 14.5% within the frequency range of 0.82 to 3.12 total times. The other direction and percentage frequencies were observed from WSW (4.7%), SW (14.6%), SE (10.2%), ESE (11.8%), NNE (6.7%), N (3.5%), SSE (9.4%), E (4.7%) and W (1.8%). The calm conditions were observed to be for 15.10% of the total time **(Figure-3.7)**.

During winter, the average winds from NNE direction were observed for 50.4% within the frequency range of 0.5 to 2.1. The second predominant wind direction is NE (27.5%). The calm conditions were observed to be for 14.10% of the total time **(Figure-3.8)**.

The wind pattern for Pre-Monsoon, Monsoon, Post-Monsoon and Winter season is given in **Tables- 3.2, 3.3, 3.4, and 3.5** respectively. The overall summary of wind pattern at site is mentioned in **Table- 3.6** and related wind rose **Figure-3.9**. The overall wind frequency distribution is given in **Table-3.7**

TABLE-3.2
MICRO-METEOROLOGICAL DATA AT SITE
Pre-Monsoon

Period: 1st March 2007 to 31st May 2007 **Location:** At Plant Site

Month	Temperature (^oC)		Relative Humidity (%)		Rainfall (mm)	Atmospheric Pressure(mb)		Cloud Cover
	Max	Min	8.30 hrs	17.30 hrs	Total	8.30 hrs	17.30 hrs	Max
March	39.0	15.0	71.0	13.5	6.5	979.9	978.8	1/8
April	41.5	20.0	68.5	15.5	9.5	979.7	975.3	1/8
May	41.0	19.0	76.0	18.0	91.0	978.4	973.8	3/8

TABLE-3.3

MICRO-METEOROLOGICAL DATA AT SITE
Monsoon

Period: 1st June 2007 to 30th September 2007 **Location:** At Plant Site

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)	Atmospheric Pressure (mb)		Cloud Cover
	Max	Min	8:30 Hrs	17:30 Hrs		8.30 Hrs	17.30 Hrs	Max
June	41.5	21.5	79.1	63.6	421	969	967	0
July	34.5	22.5	92.2	70.7	146	971	970	1
August	34.5	21.0	91.4	77.0	802	968	967	1
September	33.5	21.5	86.5	80.1	325	971	969	1

TABLE-3.4

MICRO-METEOROLOGICAL DATA AT SITE
Post-Monsoon

Period: 1st October 2007 to 30th November 2007 **Location:** At Plant Site

Month	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)	Atmospheric Pressure (mb)		Cloud Cover
	Max	Min	8.30 hrs	17.30 hrs	Total	8.30 hrs	17.30 hrs	Max
October	39.0	19.0	88.0	38.0	52.0	997.0	996.0	1/8
November	33.0	15.0	79.0	32.0	182.0	997.0	996.0	3/8

Table-3.5

MICRO-METEOROLOGICAL DATA AT SITE
Winter

Period: 1st December 2007 to 29th February 2008 **Location:** At Plant Site

Month	Temperature (^{0}C)		Relative Humidity (%)		Rainfall (mm)	Atmospheric Pressure (mb)	
	Max	Min	8:30 Hrs	17:30 Hrs		8:30 Hrs	17:30 Hrs
December	30.6	10.6	78.7	43.9	0.0	979.6	978.7
January	30.7	8.4	81.8	38.3	12.5	978.4	978.4
February	32.7	10.0	80.3	40.2	2.5	979.0	977.8

TABLE-3.6

SUMMARY OF WIND PATTERN IN STUDY AREA

Period: 1st March 2007 to 29th Feb 2008 **Location**: At Plant Site

Season	**First Predominant Wind Direction**	**Location**	**Second Predominant Wind Direction**	**Predominant Wind Speeds (Kmph)**	**Calm (%)**
Pre-monsoon	SE [15.5%]	Plant Site	ESE [12.8%]	0.92 to 3.54 0.63 to 14.29	6.34
Monsoon	SW [27.5%]	Plant Site	SE [10%]	7.56 to 20.5 7.56 to 8.28	8.30
Post-monsoon	SW [14.5%]	Plant Site	SE [11.2%]	0.82 to 3.12 0.72 to 11.29	15.10
Winter	NNE [50.4%]	Rangopalli	NE [27.5%]	0.5 to 2.1	14.10

FIGURE-3.5
COMPOSITE WIND ROSE FOR PRE MONSOON

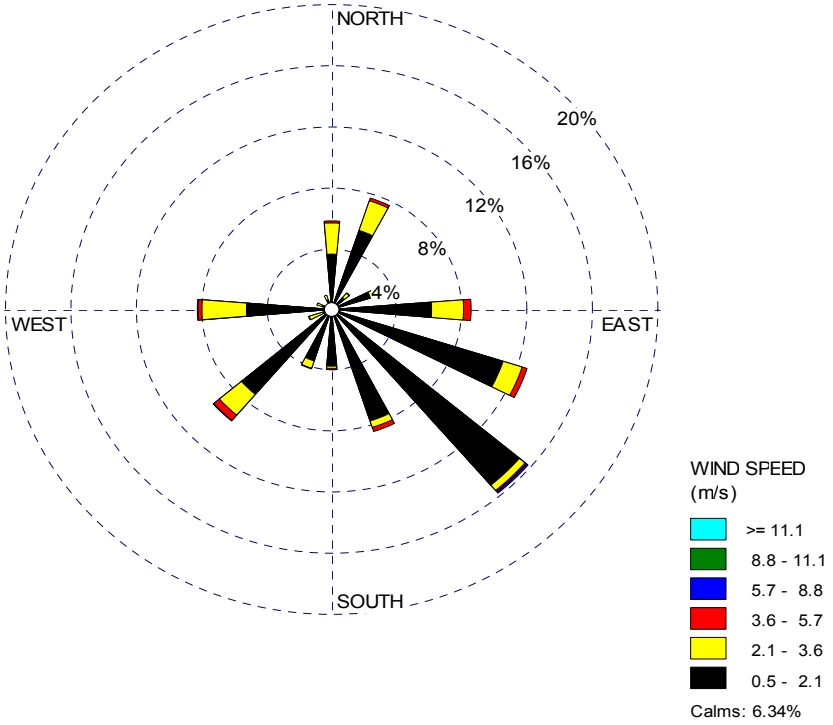


FIGURE- 3.6
COMPOSITE WIND ROSE FOR MONSOON

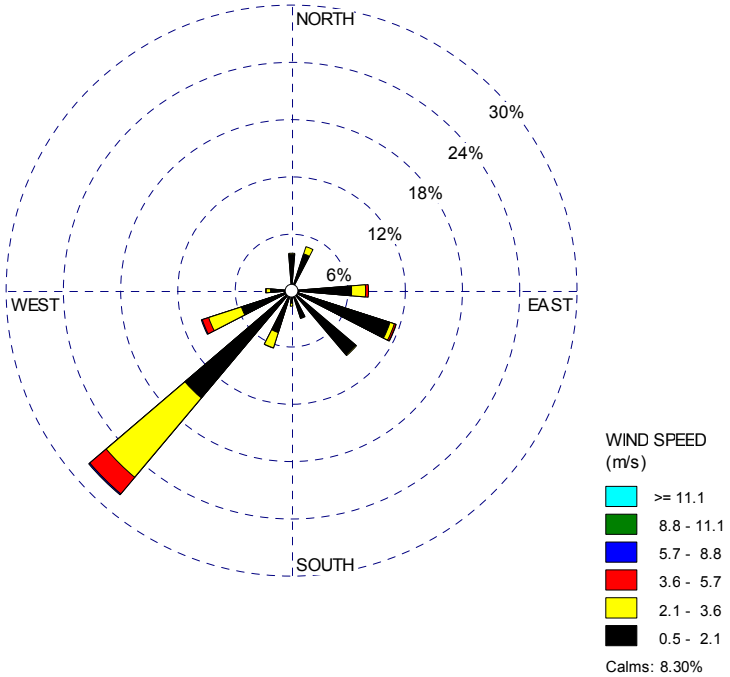


FIGURE-3.7

COMPOSITE WIND ROSE FOR POST-MONSOON

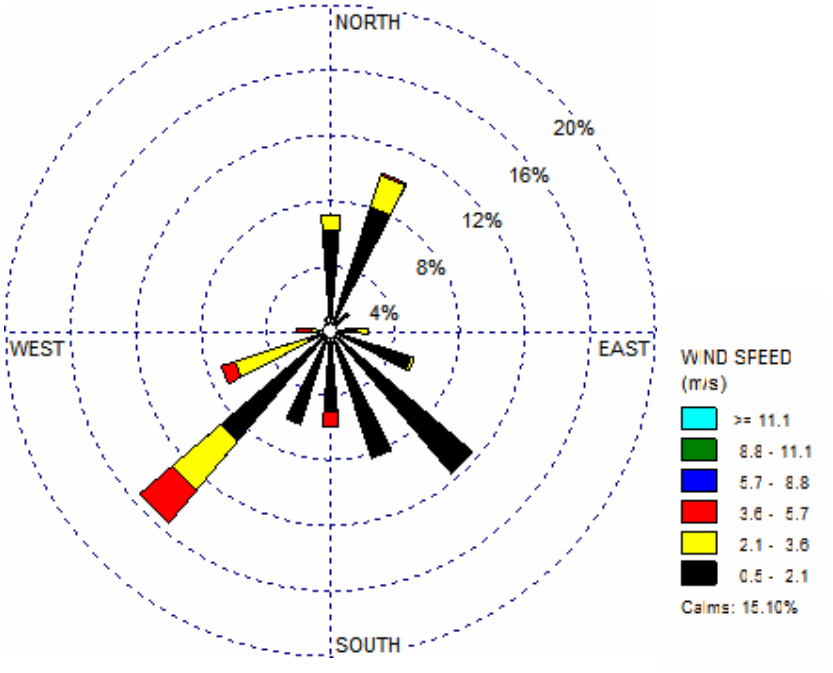


FIGURE-3.8

COMPOSITE WIND ROSE FOR WINTER

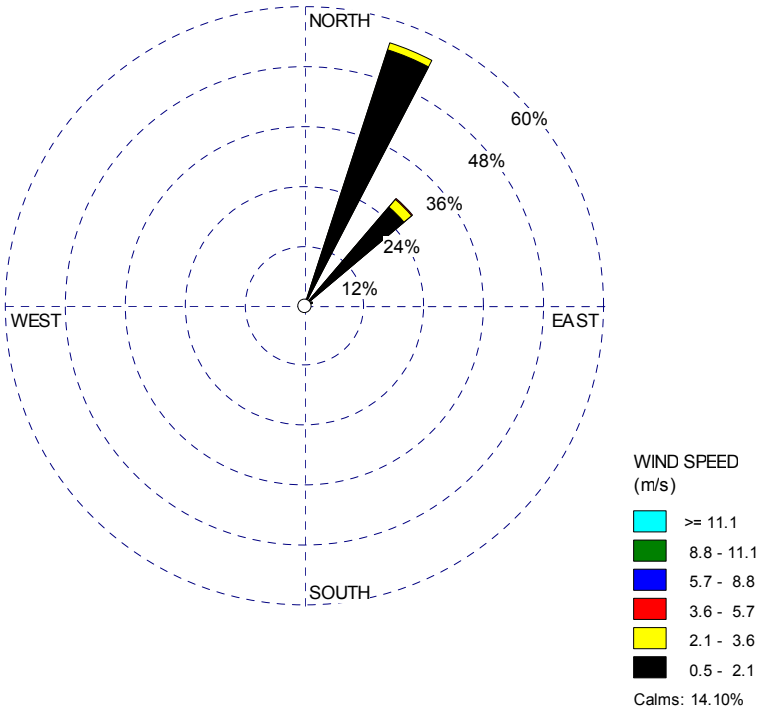


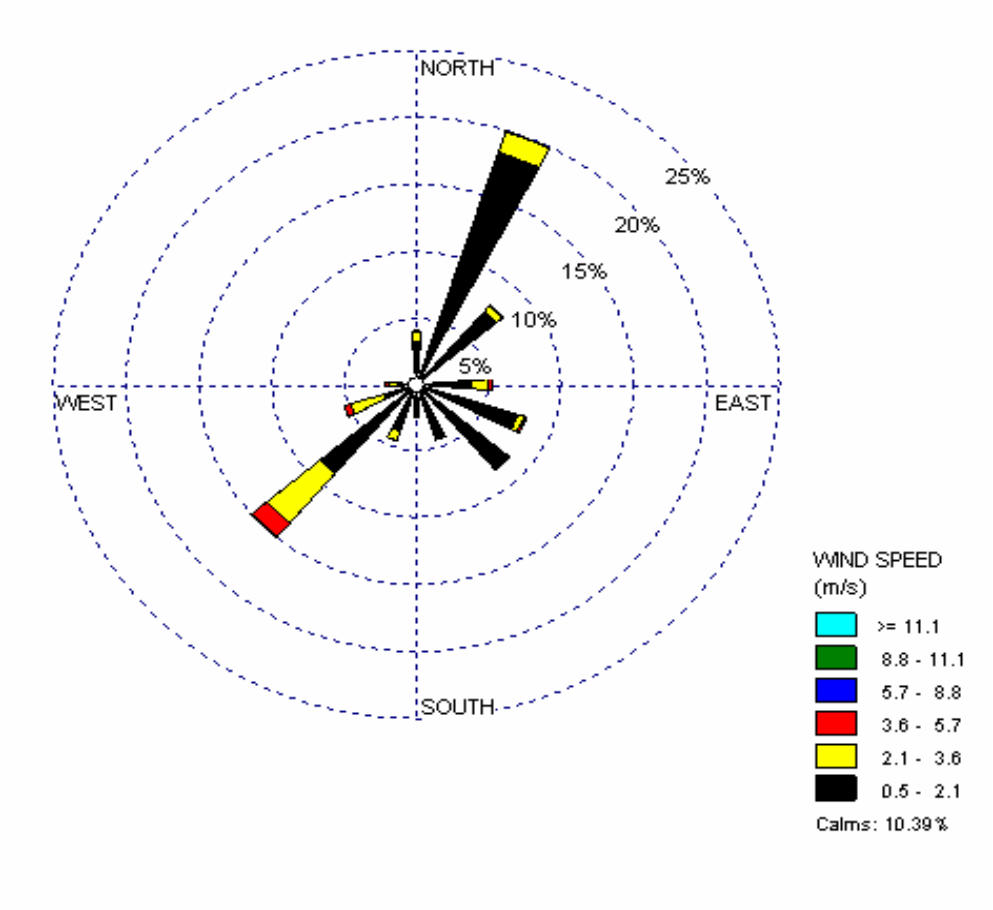
Table-3.7: Overall Wind frequency distribution (1st Mar 2007- 29th Feb 2008)

Station ID: 43042 Run ID: Vedanta-Lanjigarh
Year: 2007 - 2008
Date Range: March 1, 2007 – February 29, 2008
Time Range: 00:00 hr - 23:00 hr

Frequency Distribution (count) Speed m/s							
Wind Direction	0.5 - 2.1	2.1 - 3.6	3.6 - 5.7	5.7 - 8.8	8.8 - 11.1	>= 11.1	Total
348.75 - 11.25	280	75	2	0	0	0	357
11.25 - 33.75	1606	137	8	0	0	0	1751
33.75 - 56.25	632	48	6	0	0	0	686
56.25 -78.75	44	1	0	0	0	0	45
78.75 - 101.25	335	107	18	1	0	0	461
101.25 - 123.75	649	37	14	4	0	0	704
123.75 - 146.25	738	7	1	0	0	0	746
146.25 -168.75	383	5	1	0	0	0	389
168.75 - 191.25	196	11	15	0	0	0	222
191.25 - 213.75	329	63	4	0	0	0	396
213.75 - 236.25	769	424	119	6	0	0	1318
236.25 - 258.75	215	211	37	3	0	0	466
258.75 - 281.25	116	58	17	0	0	0	191
281.25 -303.75	37	12	1	0	0	0	50
303.75 - 326.25	32	2	0	0	0	0	34
326.25 - 348.75	44	11	0	0	0	0	55
Sub Total	6405	1209	243	14	0	0	7871
Calms							913
Missing/Incomplete							0
Total							8784

Frequency of Calm Winds: 10.39%
Average Wind Speed: 1.27 m/s

Figure- 3.9 Overall Wind rose diagram (1st Mar 2007- 29th Feb 2008)



3.5 AMBIENT AIR QUALITY

The ambient air quality with respect to the buffer zone of 10 km radius around the plant site forms the baseline information. The various sources of air pollution in the region are due to traffic, urban and rural activities supplemented by the existing alumina refinery within the core zone. This is also useful for assessing the conformity to standards of the ambient air quality, specified by Central Pollution Control Board (as per IS: 5182) during the plant operation. The study area represents mostly the plant area as core zone and residential environment in the buffer zone.

3.5.1 Location and Methodology

Selection of sampling locations

The baseline status of the ambient air quality has been assessed through a scientifically designed ambient air quality-monitoring network. The design of monitoring network in the air quality surveillance program has been based on the following considerations:

- Meteorological conditions on synoptic basis;
- Topography of the study area;
- Representatives of regional background air quality for obtaining baseline status
- Representatives of likely impact areas.

Ambient Air Quality Monitoring (AAQM) Stations were set up at ten locations with due consideration to the above monitoring points. **Table-3.8** gives the details of environment setting around each monitoring station. The location of the selected stations with reference to the plant to given in the same table and depicted in **Figure-3.10.** Necessary care has been taken to fix stations in the upwind and downwind directions covering all areas.

Frequency and Parameters for Sampling

Ambient air quality monitoring was carried out at a frequency of 24 hours twice a week for the complete season at each location representing Pre-monsoon season. The baseline data of air environment was generated for the below mentioned parameters:

- Suspended Particulate Matter (SPM)
- Respirable Particulate Matter (RPM)
- Sulphur dioxide ($SO_{2)}$
- Oxides of Nitrogen (NO_x)

The ambient air quality results for all the seasons are listed in **Table-3.9, 3.10, 3.11** and **3.12.** The methodology of sampling and analysis with equipment used is given in **Table-3.13**. The overall summary of ambient air quality is given in **Tables-3.14** and **3.15** respectively.

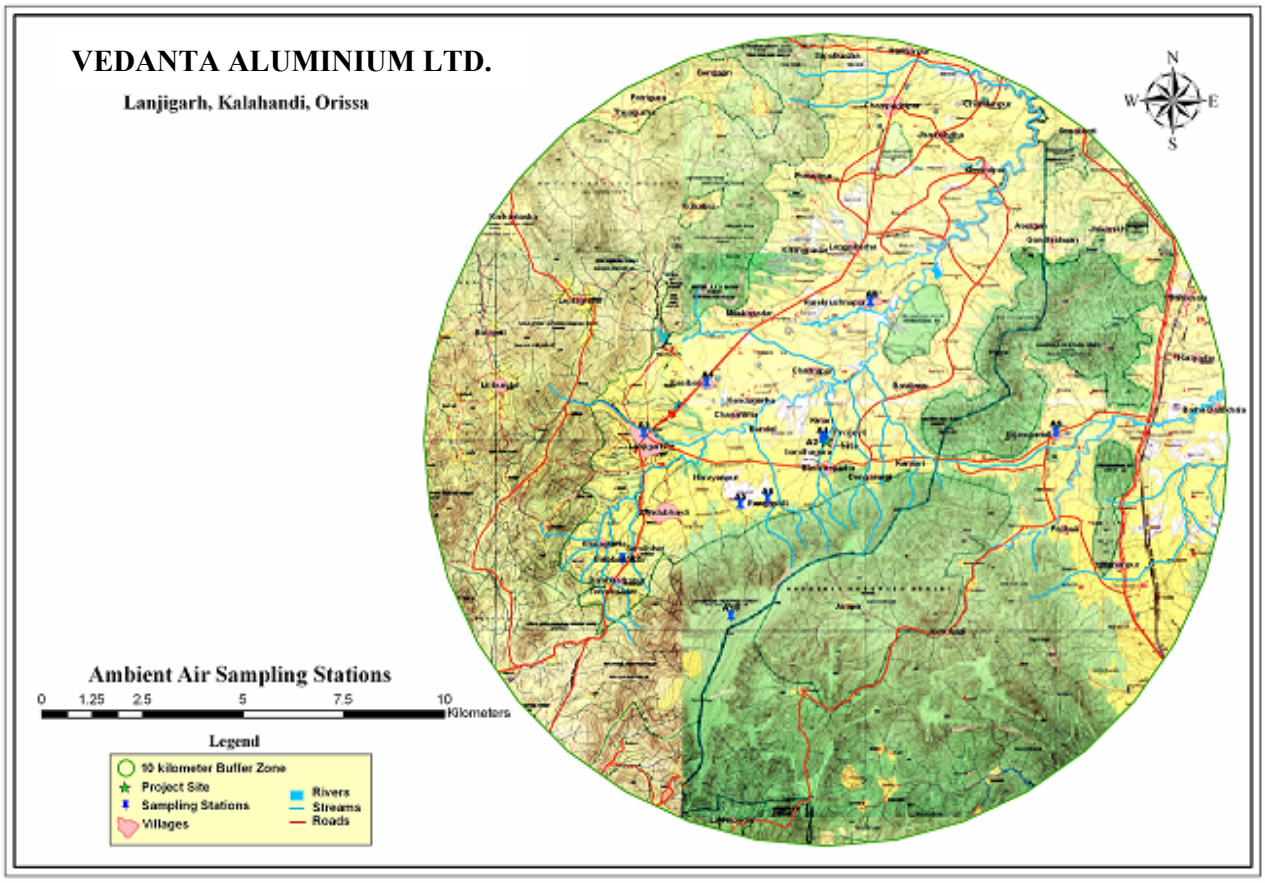
Table 3.8 Ambient Air Quality Sampling Locations

Code	Name of Sampling Stations	Distance from Project site (Km)	Direction from Project Site	Type of Area
A1	Plant site (Project Office)	-	-	Core Zone
A2	Plant site (Power Block)	-	-	Core Zone
A3	Lanjigarh	4	W	Rural, residential environmental setting with local traffic with crosswind conditions.
A4	Kasibari	3.5	NW	Rural, residential environmental setting representing roadside (Lanjigarh to Bhawanipatna) crosswind conditions.
A5	Rehab colony	2.5	SW	Rural, residential environmental setting representing crosswind conditions.
A6	Rengopali * (Red Mud Pond)	1.5	SW	Rural, residential environmental setting representing crosswind conditions.
A7	Balabhadrapur	6.2	SW	Rural, residential environmental setting representing crosswind conditions.
A8	Harikrishnapur	3.8	N	Rural, residential environmental setting representing crosswind conditions.
A9	Bijabandali	5.5	E	Rural, residential environmental setting representing crosswind conditions.
A10	Mines area (East of Tentulipadar)	3.5	SW	Rural & Working environmental setting representing crosswind conditions.

** This location is situated towards down wind direction of the project site.*

Figure-3.10

Ambient Air Quality Monitoring Locations



Source: Topo sheet no. 65M/6/NE

TABLE-3.9

SUMMARY OF AMBIENT AIR QUALIUTY RESULTS (Concentrations are expressed in µg/m^3)

FOR PRE-MONSOON PERIOD

Locations	SPM				RPM				SOx				NOx			
	Max	Min	Avg.	98%	Max	Min	Avg.	98%	Max	Min	Avg.	98%	Max	Min	Avg.	98%
Project Office	260.8	250.4	256.2	257.4	98.8	98.0	98.2	98.4	16.4	13.5	15.1	16.2	29.8	29.0	29.2	29.6
Plant site (Power Block)	261.6	250.7	254.2	255.4	116.5	98.3	102.4	104.7	26.5	20.6	24.2	24.8	41.6	36.5	38.2	39.2
Lanjigarh	147.5	112.6	135.6	136.2	52.9	44.5	47.6	48.2.	9.6	7.0	8.1	8.6	14.3	11.6	12.8	13.0
Kasibari	68.2	63.4	65.9	66.7	36.1	34.2	35.4	35.9	7.1	5.1	6.1	6..6	11.9	8.8	9.9	10.7
Rehab colony	150.6	130.5	141.0	146.0	73.4	70.7	71.5	72.0	8.2	6.3	7.4	7.9	14.1	11.4	13.0	13.2
Rengo palli (Red mud)	192.4	187.7	190.8	191.4	94.6	91.5	92.6	92.8	18.5	16.8	17.9	18.1	34.3	33.3	33.9	34.1
Balabhadrapur	135.9	122.9	128.7	130.6	89.2	79.6	82.7	83.6	8.3	6.0	7.7	7.8	12.2	10.5	11.4	11.8
Harikrishna pur	174.9	166.8	168.7	172.8	76.4	74.9	75.3	75.8	7.9	6.3	7.0	7.2	12.0	9.2	10.6	11.2
Bijabandeli	201.6	181.1	191.0	201.2	98.8	96.8	97.7	97.8	6.8	5.1	6.0	6.2	11.7	9.1	10.5	11.2
Mines Area	59.2	55.5	57.7	58.2	32.7	30.8	32.2	32.5	6.6	5.8	6.2	6.4	10.6	10.0	10.4	10.5
	261.6 – 55.5				**116.5 – 30.8**				**26.5 – 5.1**				**41.6 – 8.8**			

TABLE-3.10

SUMMARY OF AMBIENT AIR QUALIUTY RESULTS (Concentrations are expressed in µg/m^3)

FOR MONSOON PERIOD

Locations	SPM				RPM				SO_2				NO_X			
	Max	Min	Avg.	98%	Max	Min	Avg.	98%	Max	Min	Avg.	98%	Max	Min	Avg.	98%
Project Office	130.8	110.6	117.2	122.6	68.4	60.4	64.8	66.4	14.0	11.6	13.0	13.2	16.6	15.2	15.8	15.9
Plant site (Power Block)	165.4	141.2	149.6	161.5	69.2	64.3	67.3	68.5	14.6	12.4	13.8	14.0	24.4	20.6	23.2	23.6
Lanjigarh	112.8	82.8	97.8	106.4	48.6	42.8	46.2	48.2.	8.6	6.8	7.8	8.4	12.6	10.8	11.8	12.2
Kasibari	54.2	48.6	51.4	52.2	24.8	22.4	23.8	24.2	6.6	4.8	5.8	6.5	10.6	8.4	9.6	10.2
Niyamgiri Vedanta Nagar	130.8	108.6	118.6	128.0	68.8	60.6	65.2	66.8	7.4	6.0	6.8	7.2	13.0	10.8	12.0	12.7
Rengo palli (Red mud)	140.4	102.6	122.8	136.4	78.6	64.8	72.4	74.4	12.8	11.6	12.4	12.6	18.7	15.6	16.8	17.9
Balabhadrapur	184.6	156.6	172.2	174.2	74.3	63.8	69.1	72.8	7.4	5.2	6.4	7.2	11.6	10.2	11.0	11.5
Harikrishnapur	134.6	121.4	126.8	130.8	64.2	60.8	62.8	63.8	6.8	5.8	6.2	6.4	11.2	8.8	9.9	10.2
Bijabandeli	162.6	148.6.	155.8	162.4	78.2	68.8	74.6	76.8	5.8	5.0	5.5	5.6	10.8	8.9	9.9	10.7
Mines Area	88.4	54.8	70.5	71.4	48.2	32.5	40.8	41.3	5.9	5.0	5.5	5.6	9.8	9.0	9.4	9.6
	165.4-54.8				**69.2-32.4**				**14.6-4.8**				**24.4-8.4**			

TABLE-3.11

SUMMARY OF AMBIENT AIR QUALIUTY RESULTS (Concentrations are expressed in µg/m^3)

FOR POST-MONSOON PERIOD

Locations	SPM				RPM				SO_2				NO_X			
	Max	Min	Avg.	98%	Max	Min	Avg.	98%	Max	Min	Avg.	98%	Max	Min	Avg.	98%
Project Office	325.1	262.2	294.5	295.3	91.4	78.5	85.0	85.6	18.8	13.6	16.2	17.3	24.5	21.8	22.7	23.2
Plant site (Power Block)	396.2	332.3	364.9	365.3	137.5	118.6	128.5	128.8	19.4	13.9	16.6	17.4	27.2	22.8	25.1	25.8
Lanjigarh	141.3	112.4	127.2	128.1	59.5	44.6	52.5	52.8	9.2	7.6	8.4	8.8	14.2	12.4	12.8	13.7
Kasibari	108.4	82.5	96.0	96.4	52.7	41.8	47.6	47.2	6.9	5.0	5.9	6.1	11.8	8.5	9.3	10.6
Niyamgiri Vedanta Nagar	152.2	134.3	143.8	144.0	89.2	71.3	80.7	80.2	9.2	8.0	8.6	8.8	15.3	12.4	13.8	14.6
Rengopalli (Red mud)	156.4	118.5	137.6	138.0	72.7	67.8	68.7	70.1	15.2	13.1	14.3	14.8	24.6	21.3	22.2	23.4
Balabhadrapur	182.6	97.7	112.7	116.9	91.8	82.9	84.9	86.2	9.6	6.3	8.1	8.7	14.4	12.1	13.8	14.0
Harikrishnapur	141.7	123.8	133.2	133.6	66.1	54.2	60.8	60.1	6.8	6.2	6.5	6.6	11.5	8.7	10.4	11.2
Bijabandeli	204.3	167.4	186.0	186.5	91.3	77.4	85.3	85.9	7.2	6.3	6.8	7.0	12.8	11.2	12.0	12.2
Mines Area	96.5	87.6	84.7	85.0	53.7	35.8	44.9	44.7	7.6	7.2	7.4	7.4	12.4	11.2	11.9	12.3
	396.2 – 82.5				**137.8-35.8**				**19.4-5.0**				**27.2-8.5**			

Table-3.12

SUMMARY OF AMBIENT AIR QUALIUTY RESULTS (Concentrations are expressed in µg/m^3)

FOR WINTER PERIOD

Locations	SPM					RPM				SO_2				NO_X			
	Max	Min	Avg.	98%	PAH *	Max	Min	Avg.	98%	Max	Min	Avg.	98%	Max	Min	Avg.	98%
Project Office	292.3	239.4	241.6	259.2	BDL	95.8	87.1	90.7	92.5	17.9	13.8	15.2	16.7	24.3	22.0	22.6	23.3
Plant site (Power Block)	260.8	215.5	230.2	229.4	BDL	145.4	120.3	126.5	125.7	19.9	15.1	16.6	16.8	27.8	23.1	24.3	25.8
Lanjigarh	193.1	135.4	163.2	162.5	BDL	88.3	60.7	73.6	72.8	12.3	8.6	8.0	9.7	12.8	10.5	10.1	11.7
Kasibari	116.5	91.1	97.5	96.0	BDL	66.6	52.4	58.7	57.5	7.2	5.2	5.8	6.4	12.1	10.1	10.8	11.2
Niyamgiri Vedanta Nagar	178.3	145.1	160.5	159.4	BDL	90.7	82.4	85.3	84.6	10.2	8.0	8.9	9.1	15.8	12.3	13.2	13.9
Rengopalli (Red mud)	187.2	154.2	167.6	168.0	BDL	81.3	70.2	74.4	78.9	16.2	13.2	14.1	14.8	25.1	21.1	22.5	23.6
Balabhadrapur	209.9	168.2	187.7	197.9	BDL	82.5	75.5	77.5	80.2	10.4	7.2	7.9	8.1	14.9	12.2	12.9	13.1
Harikrishnapur	143.5	129.4	135.8	135.1	BDL	70.3	58.2	63.6	62.7	8.9	6.3	7.7	8.2	13.2	10.5	11.7	12.8
Bijabandeli	206.8	176.1	190.6	189.5	BDL	95.8	87.3	91.7	90.3	8.5	6.6	6.8	7.4	13.3	10.2	11.7	12.1
Mines Area	146.7	103.3	121.6	120.8	BDL	65.5	46.2	51.4	50.1	9.2	7.4	8.3	8.6	15.5	13.1	13.7	14.1
	292.3 – 91.1					**145.4 – 51.4**				**19.9-5.2**				**27.8-10.1**			

* PAH was monitored in the month of May 2008

Table 3.13 Methodology of Sampling & Analysis and Equipment used

Sl. No.	Parameter	Instrument/ Apparatus used	Method followed	Reference
1.	Suspended particulate Matter (SPM)	High Volume Air Sampler (HVAS), Filter Paper (EPM – 2000), Balance	Gravimetry	CPCB Notification of 11.4.94
2.	Respirable Particulate matter (RPM)	Respirable Dust Sampler (RDS), Filter Paper (EPM-2000), balance	Gravimetry	CPCB Notification of 11.4.94
3.	Nitrogen Oxides (NO_x)	HVAS with Impinger tubes, spectrophotometer	Jacob and Hocheiser modified (Na-Arsenite) Method	CPCB notification of 11-4-94
4.	Sulphur di-oxide (SO_2)	HVAS with Impinger tubes, spectrophotometer	Improved West & Gaecke method	CPCB notification of 11-4-94

Table 3.14 Summarized (Annual) Ambient air quality status of RPM and SPM of the study area

Locations	SPM(µg/m^3)					RPM(µg/m^3)			
	Max	Min	Avg	98%	PAH *	Max	Min	Avg	98%
Project Office	325.1	110.6	217.85	295.3	BDL	98.8	60.4	79.6	98.4
Plant site (Power Block)	396.2	141.2	268.7	365.3	BDL	145.4	64.3	104.85	125.7
Lanjigarh	193.1	82.8	137.95	162.5	BDL	88.3	42.8	65.55	72.8
Kasibari	116.5	48.6	82.55	96	BDL	66.6	22.4	44.5	57.5
Rehab colony	150.6	130.5	140.55	146	BDL	73.4	70.7	72.05	72
Rengo palli (Red mud)	192.4	102.6	147.5	191.4	BDL	94.6	64.8	79.7	92.8
Balabhadrapur	209.9	97.7	153.8	197.9	BDL	91.8	63.8	77.8	86.2
Harikrishnapur	174.9	121.4	148.15	172.8	BDL	76.4	54.2	65.3	75.8
Bijabandeli	206.8	148.6	177.7	189.5	BDL	98.8	68.8	83.8	97.8
Mines Area	146.7	54.8	100.75	120.8	BDL	65.5	30.8	48.15	51.4

***** PAH was monitored in the month of May 2008

Table 3.15 Summarized (Annual) Ambient air quality status of SO_2 and NOx the study area

Locations	SO_2 (µg/m^3)				NOx (µg/m^3)			
	Max	Min	Avg	98%	Max	Min	Avg	98%
Project Office	18.8	11.6	15.2	17.3	29.8	15.2	22.5	29.6
Plant site (Power Block)	26.5	12.4	19.45	24.8	41.6	20.6	31.1	39.2
Lanjigarh	12.3	6.8	9.55	9.7	14.3	10.5	12.4	13
Kasibari	7.2	4.8	6	6.4	12.1	8.4	10.25	11.2
Rehab colony	8.2	6.3	7.25	7.9	14.1	11.4	12.75	13.2
Rengo palli (Red mud)	18.5	11.6	15.05	17.9	34.3	15.6	24.95	34.1
Balabhadrapur	10.4	5.2	7.8	8.1	14.9	10.2	12.55	13.1
Harikrishnapur	8.9	5.8	7.35	8.2	13.2	8.7	10.95	12.8
Bijabandeli	8.5	5	6.75	7.4	13.3	8.9	11.1	12.1
Mines Area	9.2	5	7.1	8.6	15.5	9	12.25	14.1

As observed from the ambient air quality monitoring in and around the plant site, it is observed that the SPM and RPM concentrations are within the Industrial permissibile Limit at plant site and red mud pond areas mostly during post-monsoon and winter periods. In alignment with SPM & RPM, the SO_2 and NOx values are comparatively higher in the same areas during the same period but are well within the standards prescribed for residential / rural areas. This is attributable to the heavy traffic and vehicular movements in construction zones and material handling areas within the plant site. The higher values of NOx in the same areas, where RPM and SPM values are comparatively higher subsidize the traffic conditions for the spiked values. Alumina refinery uses only coal as the fuel for the cogeneration power plant which is augumented at times with HFO/LDO. There is no material that is used in the refinery which generates PAH. This is mainly in smelter and not in Alumina refinery. However as advised in the TOR condition, the same has been measured in the month of May 2008 which is found to be BDL. The details are given in **Table-3.12**.

3.6 NOISE CHARACTERISTICS

The physical description of sound concerns its loudness as a function of frequency. Noise in general is sound which is composed of many frequency components of various loudness distributed over the audible frequency range. Various noise scales have been introduced to describe, in a single number, the response of an average human to a complex sound made up of various frequencies at difference loudness levels. The most common and universally

accepted scale is the A weighted Scale which is measured as dB (A). This is more suitable for audible range of 20 to 20,000 Hz. The scale has been designed to weigh various components of noise according to the response of a human ear.

The environmental assessment of noise from the industrial activity, construction activity, and vehicular traffic can be undertaken by taking into consideration various factors like potential damage to hearing, physical responses, and annoyance and general community responses.

The main objective of noise monitoring in the study area is to assess the baseline noise levels.

3.6.1 Parameter Measured During Monitoring

A preliminary reconnaissance survey has been undertaken to identify the major noise generating sources in the area. Noise at different noise generating sources has been identified based on the activities in the village area and ambient noise due to traffic.

The noise monitoring has been conducted for determination of ambient noise levels in the study area. The areas were chosen at the same sites of the Ambient Air Monitoring stations. The noise levels at each location were recorded for 24 hours. The environment setting of noise monitoring locations is given in **Table -3.16, 3.17, 3.18, 3.19 & 3.20** and depicted in **Figure -3.11.** The comparable standards for Noise Levels are listed in **Table-3.21.**

For noise levels measured over a given period of time interval, it is possible to describe important features of noise using statistical quantities. This is calculated using the percent of the time certain noise levels exceeds the time interval. The notation for the statistical quantities of noise levels is described below:

- Hourly L_{eq} values have been computed by integrating sound level meter.
- **L_{day}:** As per CPCB guidelines the day time limit is between 07:00 hours to 22.00 hours as outlined in Ministry of Environment and Forest Notification S.O. 123 (E) dated 14/02/2000.

- **L_{night}:** As per the CPCB guidelines the night time limit is between 22:00 hours to 07:00 hours as outlined in Ministry of Environmental and Forest Notification S.O. 123 (E) dated 14/02/2000.

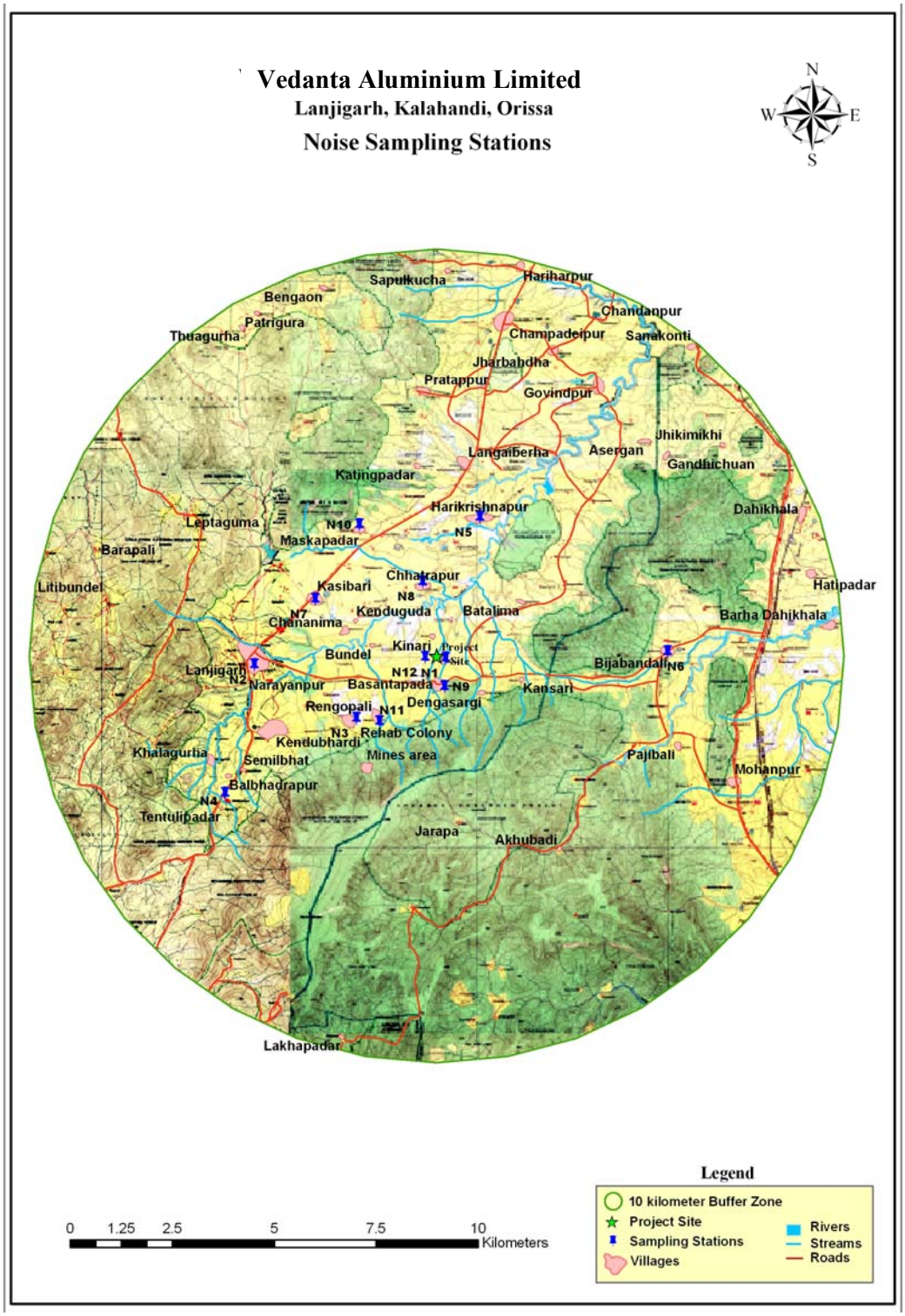
A rating developed by Environmental Protecting Agency, (US-EPA) for specification of community noise from all the sources is the Day-Night Sound Level, (L_{dn}).

L_{dn}: It is similar to a 24 hr equivalent sound level except that during night time period (10 PM to 07 AM) a 10 dB (A) weighting penalty is added to the instantaneous sound level before computing the 24 hr average. This night time penalty is added as more annoying than the same noise during the daytime.

The L_{dn} for a given location in a community may be calculated from the Leq's, by the following equation.

$$L_{dn} = 10Log \frac{[\sum_{i=1}^{16} 10^{(L_{eq}i/10)} + \sum_{i=1}^{8} 10^{(L_{eq}i+10/10)}]}{24}$$

Figure 3.11: Noise Sampling Stations



Source: Topo sheet no. 65M/6/NE

Table- 3.16
Noise Level in the Study Area during Pre- Monsoon Period

Station code	Location village	Distance from plant site (Km)	Direction from plant site	L_{day}	L_{night}	$L_{daynight}$	L_{10}	L_{50}	L_{90}	Leq
N1	Plant site			62	48.0	60.88	59.7	51.5	48.6	55.3
N2	Lanjigarh	4.0	W	52	42.0	52.0	48.7	44.5	42.0	47.5
N3	Rehab Colony	2.5	SSW	53	45.0	53.86	50.4	45.2	42.1	49.3
N4	Balabhadrapur	6.2	SW	54	45.0	54.40	51.9	49.4	46.8	51.2
N5	Harikrishnapur	3.8	NNE	40	36.0	43.26	41.0	39.1	37.5	38.3
N6	Bijabendeli	5.4	E	54	38.2	52.59	52.7	49.7	42.7	46.9
N7	Kasibari	3.5	NW	48	41.2	49.48	47.9	42.3	37.6	45.8
N8	Chhatrapur	1.6	N	44	39.1	46.64	44.8	41.3	38.4	42.9
N9	Basanthapada	1.5	SE	50	44.2	52.07	51.8	47.9	44.4	48.4
N10	Maskapadar	3.5	NW	46	40.4	48.19	45.6	43.5	38.5	44.3
N11	Rangopali (Redmud)	1.5	SW	53	46	55.10	54.7	50.3	47.5	50.4
N12	Plant Site (Power Block)			78.2	66.6	72.2	72.4	69.3	67.8	75.4

Table-3.17

Noise Level in the Study Area during Monsoon Period

Station code	Location village	Distance from plant site (Km)	Direction from plant site	L_{day}	L_{night}	$L_{daynight}$	L_{10}	L_{50}	L_{90}	Leq
N1	Plant site			58	46	57.3	57.6	51.5	46.5	53.5
N2	Lanjigarh	4.0	W	47.8	41.7	49.7	46.4	44.5	42.4	44.8
N3	Rehab Colony	2.5	SSW	48	44	51.3	47.2	45.2	44.4	45.3
N4	Balabhadrapur	6.2	SW	46	43	50.0	45.1	44.1	43.3	44.2
N5	Harikrishnapur	3.8	NNE	43	38	45.6	42.0	39.8	38.7	40.0
N6	Bijabendeli	5.4	E	46	39	46.5	45.1	41.7	40.2	42.1
N7	Kasibari	3.5	NW	46	41	47.9	45.3	42.4	42.2	42.6
N8	Chhatrapur	1.6	N	42	38.5	45.6	41.6	39.6	38.9	39.7
N9	Basanthapada	1.5	SE	48	42	49.9	46.8	44.6	43.2	44.8
N10	Maskapadar	3.5	NW	45	40	49.0	43.7	41.8	40.3	42.0
N11	Rangopali (Redmud)	1.5	SW	50	45	52.6	49.2	47.2	46.2	47.4
N12	Plant Site (Power Block)			60	50	60.0	57.4	54.6	52.8	54.9

Table-3.18

Noise Level in the Study Area during Post-Monsoon Period

Sr.No.	Location	Distance from plant site (Km)	Direction from plant site	L_{day}	L_{night}	$L_{daynight}$	L_{10}	L_{50}	L_{90}	Leq
1	Plant site (Project office)			62.6	57.6	65.1	62.1	60.2	58.3	60.4
2	Lanjigarh	4.0	W	52.4	45.2	53.6	51.7	49.2	46.7	49.6
3	Niyamgiri Vedanta Nagar	2.5	SSW	48.7	40.3	49.3	49.2	47.6	42.5	48.3
4	Balabhadrapur	6.2	SW	47.3	39.8	48.3	48.3	45.9	42.7	46.4
5	Harikrishna Pur	3.8	NNE	45.4	37.3	46.3	46.4	44.8	41.3	45.2
6	Bijabandeli	5.4	E	53.4	46.7	54.8	50.2	47.6	42.1	48.6
7	Kasibari	3.5	NW	50.6	41.2	50.7	48.8	44.7	43.1	45.2
8	Chhatrapur	1.6	N	47.2	38.3	47.5	46.9	45.2	41.7	45.6
9	Basantapada	1.5	SE	52.2	42.4	52.2	52.7	49.3	47.6	49.7
10	Maskapadar	3.5	NW	45.7	36.9	46.1	46.9	44.3	39.7	45.1
11	Rengopali	1.5	SW	55.7	46.8	56.0	53.1	49.6	45.8	50.4
12	Plant Site (Power Block)			65.3	59.0	67.0	64.2	61.3	59.6	61.6

Table-3.19

Noise Level in the Study Area during Winter Period

Station code	Location village	Distance from plant site (Km)	Direction from plant site	L_{day}	L_{night}	$L_{daynight}$	L_{10}	L_{50}	L_{90}	Leq
N1	Plant site			64.9	59.8	67.4	64.3	62.1	60.0	62.4
N2	Lanjigarh	4.0	W	52.7	46.5	54.5	52.0	49.4	46.9	49.8
N3	Rehab Colony	2.5	SSW	50.0	42.4	51.0	49.7	47.9	42.8	48.6
N4	Balabhadrapur	6.2	SW	49.3	42.6	50.8	48.8	46.0	43.0	46.5
N5	Harikrishnapur	3.8	NNE	46.2	39.7	47.8	46.0	44.4	41.0	44.8
N6	Bijabendeli	5.4	E	50.9	42.0	51.3	50.6	47.8	42.4	48.9
N7	Kasibari	3.5	NW	48.9	42.3	50.4	48.4	44.2	42.8	44.7
N8	Chhatrapur	1.6	N	46.8	41.1	48.9	46.5	44.9	41.3	45.3
N9	Basanthapada	1.5	SE	53.3	47.8	55.5	53.0	50.1	48.1	50.5
N10	Maskapadar	3.5	NW	47.1	39.0	47.9	46.4	44.0	39.3	44.8
N11	Rangopali (Redmud)	1.5	SW	53.5	46.1	54.6	53.3	49.9	46.3	50.7
N12	Plant Site (Power Block)			66.8	61.2	68.9	66.6	63.7	61.4	64.1

Table-3.20: summarized (Annual) Noise Level in the study area

Station code	Location / Village	L_{day} (dBA)		L_{night} (dBA)		$L_{daynight}$ (dBA)	
		Max	Min	Max	Min	Max	Min
N1	Plant site	64.9	58	59.8	46	67.4	57.3
N2	Lanjigarh	52.7	47.8	46.5	41.7	54.5	49.7
N3	Rehab Colony	53	48	45	42.4	53.86	51
N4	Balabhadrapur	54	46	45	42.6	54.4	50
N5	Harikrishnapur	46.2	40	39.7	36	47.8	43.26
N6	Bijabendeli	54	46	42	38.2	52.59	46.5
N7	Kasibari	48.9	46	42.3	41	50.4	47.9
N8	Chhatrapur	46.8	42	41.1	38.5	48.9	45.6
N9	Basanthapada	53.3	48	47.8	42	55.5	49.9
N10	Maskapadar	47.1	45	40.4	39	49	47.9
N11	Rangopali (Redmud)	53.5	50	46.1	45	55.1	52.6
N12	Plant Site (Power Block)	78.2	60	66.6	50	72.2	60

Table-3.21 Standards with respect to Ambient Noise Level

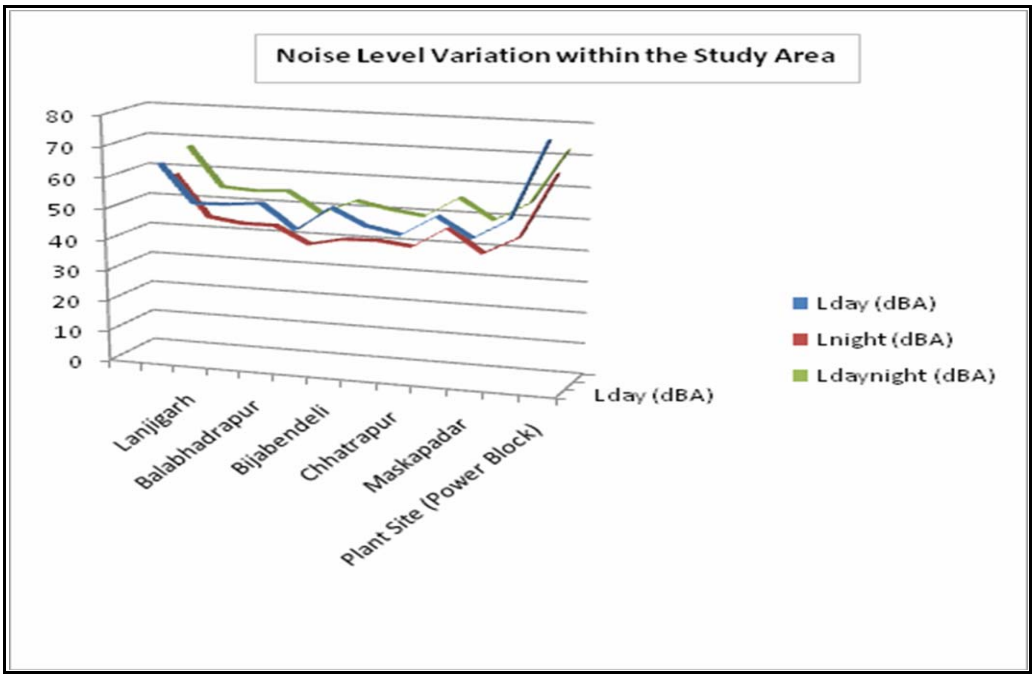
Land use category	*Limit in dB(A)*	
	*Day time (*7 AM to 10 PM)	*Night time(*10 PM to 7 AM*)*
Industrial area	75	70
Commercial area	65	55
Residential area	55	45
Silence area	50	40

3.6.2 Discussions

As expected, the noise levels at plant locations are higher than the buffer zone locations. Both day time and night time noise levels are well within the limits as mentioned above. Further the newer technological implementation and better working environment will further reduce the work zone noise levels. Therefore no noise pollution is anticipated in any form from the proposed expansion project.

The Day-Night noise levels at Plant Site and the Lanjigarh Village are symptomatic of the operations at Plant Site and General Traffic conditions near the village areas. This is further to be noticed that including the operational phase in the plant, the noise levels are well within the permissible limit (**Figure-3.12**). Further the spiked increase of noise levels in Plant Site has little or no effect on the peripheral areas.

Figure 3.12: Noise Level Variation within the study area



3.7 WATER ENVIRONMENT

Selected water quality parameters of surface and ground water resources within 10 km radius of the study area has been studied for assessing the water environment and evaluate anticipated impact of the proposed project. Understanding the water quality is essential for Environmental Impact Assessment study and to identify critical issues with a view to suggest appropriate mitigation measures for implementation.

The purpose of this study is to:

- Assess the water quality characteristics for critical parameters;
- Evaluate the impacts on agricultural productivity, habitat conditions recreational resources and aesthetics in the vicinity; and
- Predict impact on water quality by this project and related activities.

The information required has been collected through primary surveys and secondary sources like Ground Water Board reports, and OSPCB Status reports.

3.7.1 Surface Water Resources

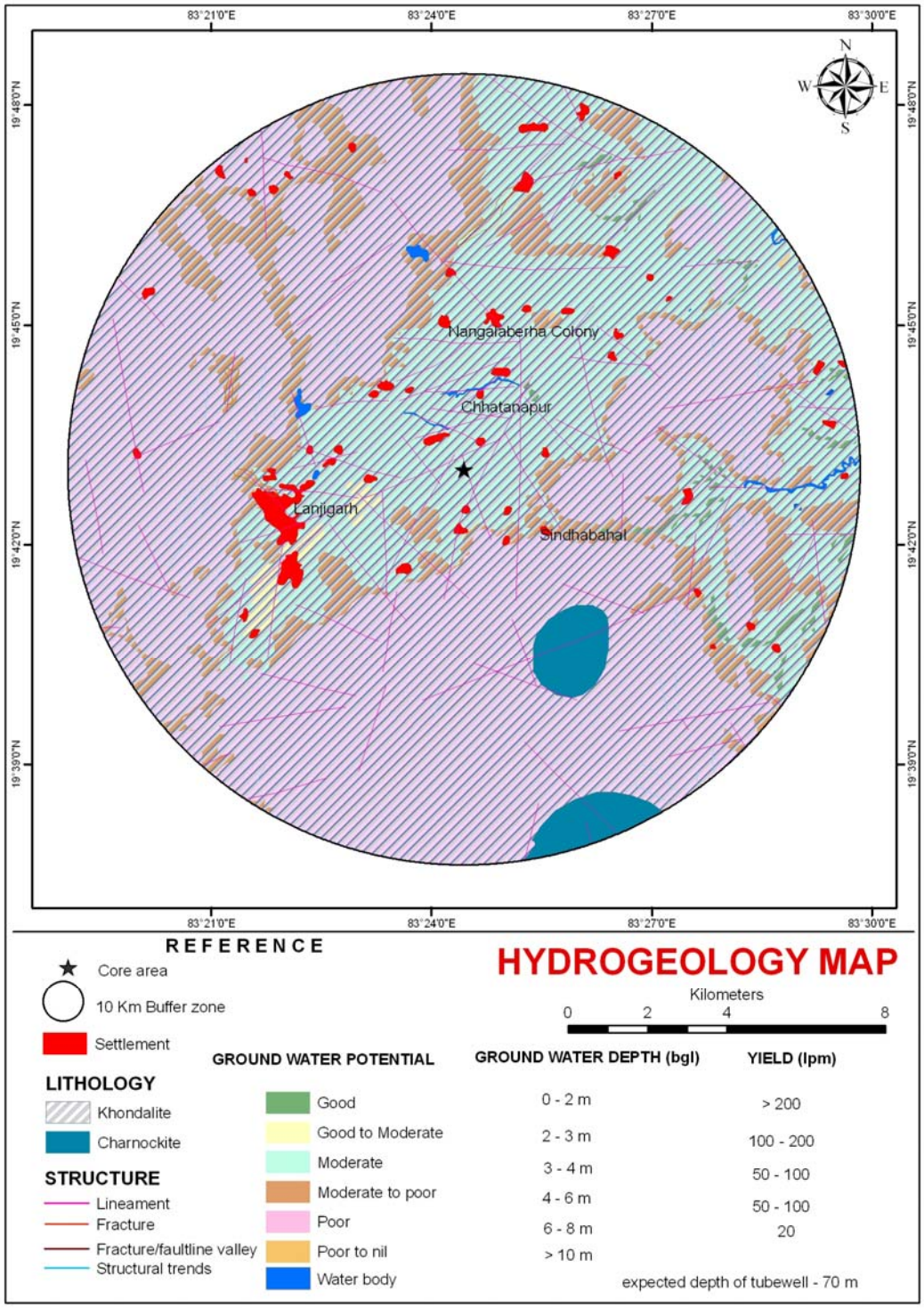
The nearest surface water source is from River Tel at around 67 km from the project site. The necessary water will be drawn from Tel River via private pipeline to a reservoir located within the premises. Also the rain water harvesting will refurbish the tentative water deficit during the off season. All the storm water drains will be networked to the WTP (Water Treatment Plant), after which will be stored in the reservoir. The reservoir has a capacity to hold 3960000 KL of water to be used for two months.

3.7.2 Ground Water Resources

The average groundwater depth varies from 2-4m within the core zone. Based on the groundwater potential, the area can be classified as moderately available zone. The occurrence of groundwater is confined to weathered Khondalitic lithology and where the surface rocks are weathered. Further the fractures within the Khondalite beneath the surface soil are potential sources of ground water. Due to the topographic location, the surface runoff is more

and during the rainy season, the groundwater table rises to 1-2m above the general water table. Again other than the fractured zones, the seepage factor is very low for any ground water recharge conditions. The existing project has not explored the groundwater resources for any purposes. The satellite data is been interpreted for the buffer zone for the groundwater potential analysis for the area and is represented in **Figure- 3.13**.

Figure 3.13: Ground Water Potentiality of the Study area



Source: IRSP6-LISSIII

Location and Methodology for Surface Water and Ground Water

Water samples were collected from **sixteen locations**. These samples were taken as grab samples and were analyzed for various parameters to compare with the standards for drinking water as per IS: 10500(1991) for ground water sources and IS: 2292 for surface water sources. The water sampling locations are identified in **Table-3.22**. The surface water locations are as depicted in **Figure-3.14** and for groundwater it is depicted in **Figure- 3.15.**

Water quality parameters of surface and ground water resources within 10-km radius of the study area have been studied for assessing the water environment and to evaluate anticipated impact of the proposed project. Understanding of the water quality is essential in preparation of Environmental Impact Assessment and to identify critical issues in view to suggest appropriate mitigation measures for implementation.

Nine ground water and *seven* surface water sources covering 10 km radial distance were examined for physico-chemical, heavy metals and bacteriological parameters in order to assess the effect of industrial and other activities on surface and ground water. The samples were analyzed as per the procedures specified in 'Standard Methods for the Examination of Water and Wastewater' published by American Public Health Association (APHA).

Table 3.22 Surface and Ground Water Sampling Locations

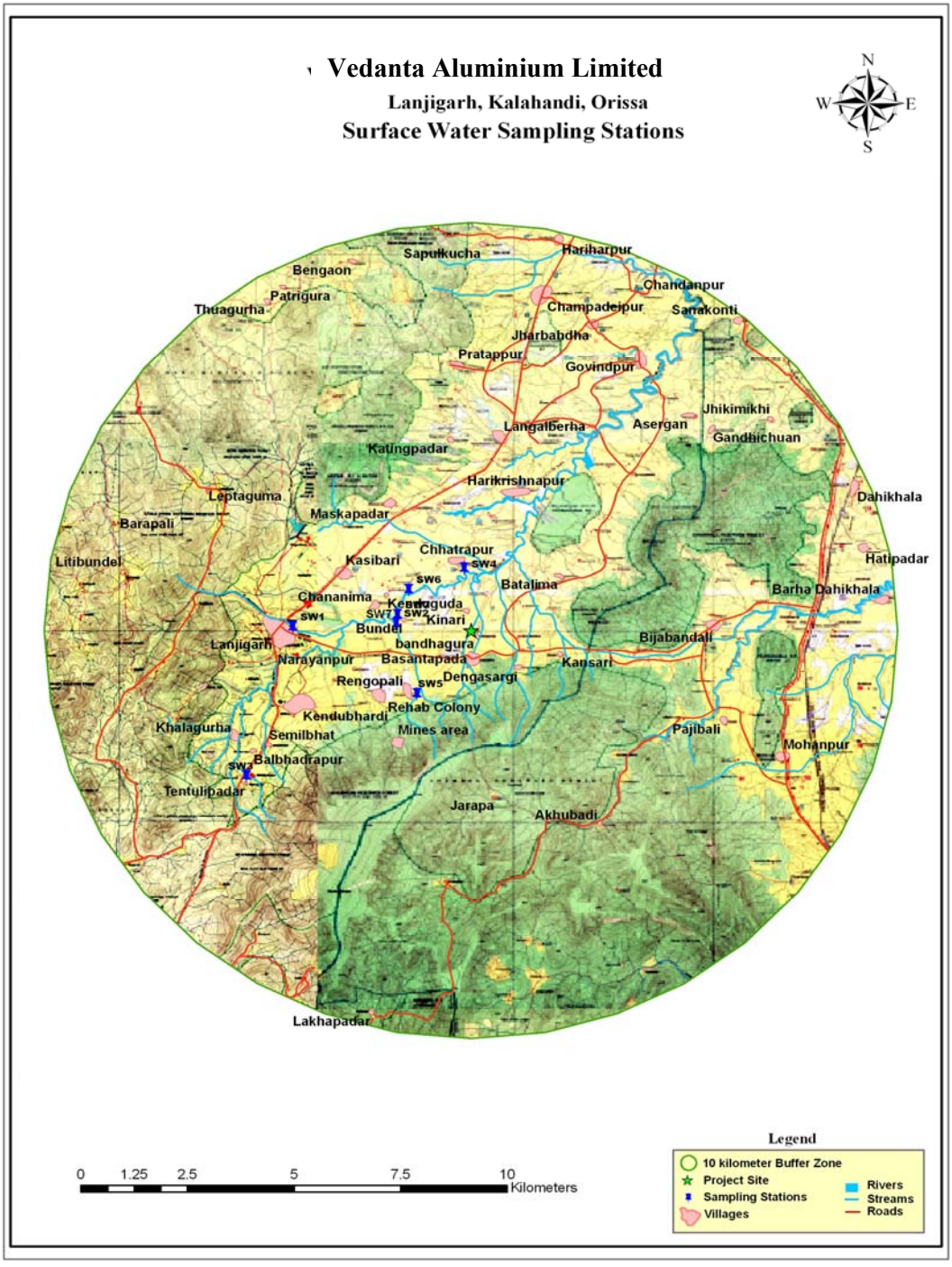
Sl. No.	Code	Location	Distance (KM)	Direction
			w.r. t proposed plant site	
Surface water				
1	SW1	Vansadhara river near Lanjigarh	4.0	W
2	SW2	Vansadhara river near Bundel	1.5	W
3	SW3	Stream near. Tetulipadar	5.8	SW
4	SW4	Vansadhara river near Chatrapur*	1.6	N
5	SW5	Stream near Rengopali#	2.0	S
6	SW6	Stream near Kenduguda	2.0	W
7	SW7	Stream near Bundel	4.0	E
Ground water				
1	GW1	Plant Site		
2	GW2	Bore well at Lanjigarh	4	W
3	GW3	Bore well at Rengopali#	2	S
4	GW4	Bore well at Chhatrapur*	1	N
5	GW5	Bore well at Chanalima	1.7	WNW

6	GW6	Bore well at SW of Redmud pond	1.5	SW
7	GW7	Bore well at south of Ash pond	4.0	NW
8	GW8	Bore well at Process Water Lake	1.6	NW
9	GW9	Bore well at Bundel	4.0	W

** upstream # downstream*

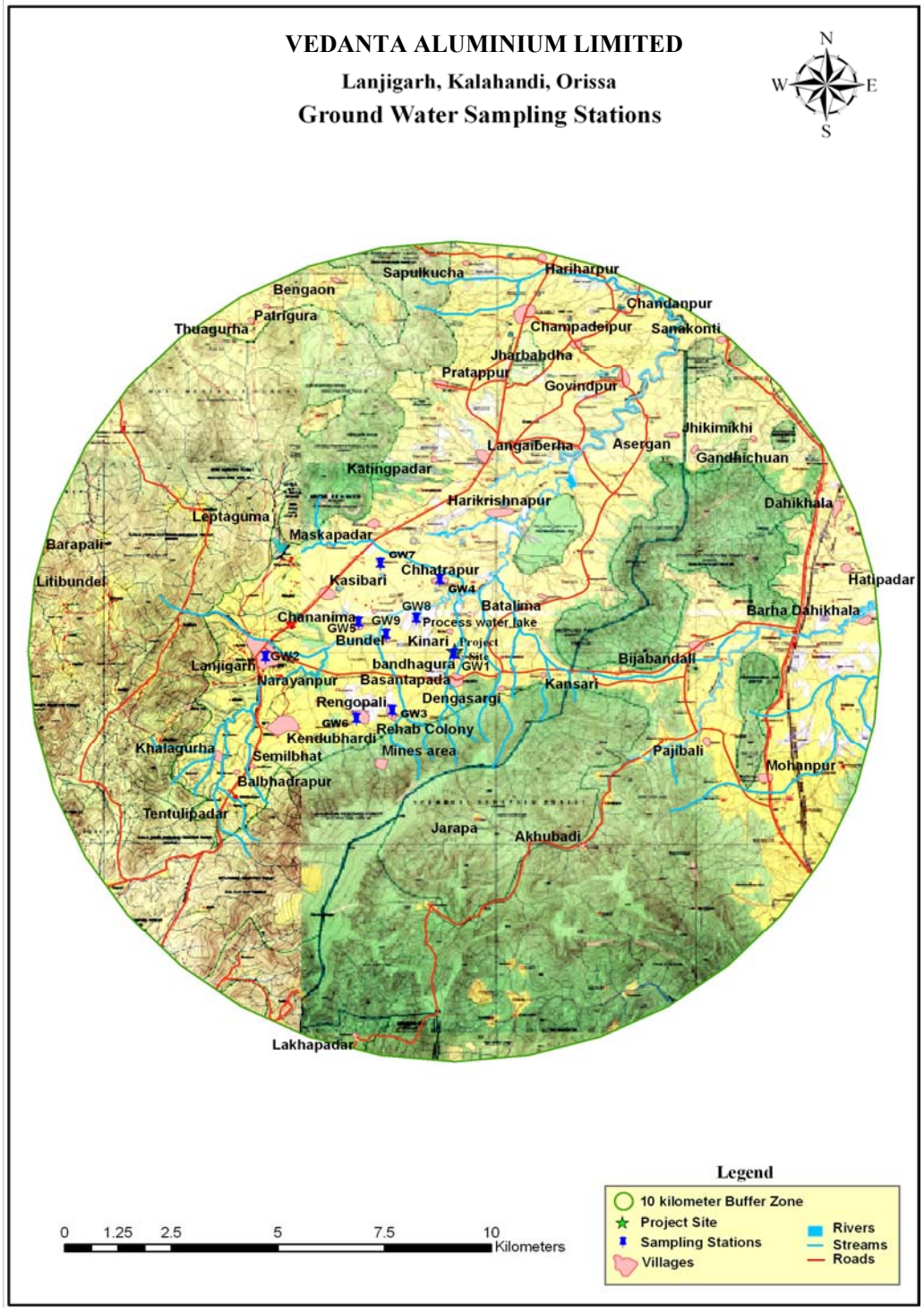
The surface water analysis for all seasons is listed in **Tables-3.23, 3.24, 3.25 and 3.26**. Similarly the groundwater analysis results for all seasons are listed in **Tables 3.27, 3.28, 3.29,** and **3.30.**

Figure-3.14: Surface Water Sampling Locations



Source: Topo sheet no. 65M/6/NE

Figure-3.15: Ground Water Sampling Locations



Source: Topo sheet no. 65M/6/NE

TABLE-3.23

SURFACE WATER ANALYSIS REPORT (Pre-Monsoon Period)

Sl. No.	SAMPLING LOCATION	Vamsadhara River near LANJIGARH	Vamsadhara River near BUNDEL	Stream Near TETULIPADAR	Vamsadhara River near CHATRAPUR	Stream near RENGOPALI	Stream near KENDUGUDA	Stream near BUNDEL	IS:2296 Permissible limit
	PARAMETER	**SW1**	**SW2**	**SW3**	**SW4**	**SW5**	**SW6**	**SW7**	
1	Color (Haz.unit)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	300 (Hazen.unit)
2	Taste	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
3	Odour	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable	Unobjectionable
4	P^H	7.52	7.82	7.12	8.25	7.15	7.08	7.05	6.5-8.5
5	TEMP.(^{0}c)	30.2	32.4	34.6	32.4	32.6	32.5	32.6	$
6	EC(µs/cm)	120.8	36.24	159.0	199.5	111.3	187.6	108.6	$
7	TDS(mg/l)	68.32	20.28	88.69	111.5	62.34	104.5	60.4	1500 mg/l
8	TURBIDITY (NTU)	36.8	21	24	38	18	28	10	$
9	R/Cl_2 (mg/l)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	$
10	T.HRD(mg/l)	42	18	140	56	60	42	40	$
11	Ca(mg/l)	11.2	3.2	38.4	14.4	9.6	11.2	9.6	$
12	Mg(mg/l)	5.8	2.4	10.6	4.8	8.6	3.4	3.8	$
13	Cl(mg/l)	20	16	14	30	22	24	18	600 mg/l (Max)
14	S^O_4(mg/l)	0.5	0.4	0.3	0.7	0.5	0.6	0.4	400 mg/l (Max)
15	F(mg/l)	0.3	0.2	0.2	0.5	0.3	0.4	0.2	1.5 mg/l (Max)
16	Alkalinity(mg/l)	96	116.8	142.6	98.0	124.6	138.4	130.4	$
17	Total Coliform (MPN/100ml)	6	10	8	8	6	6	6	5000(Max) MPN/100ml
18	Fecal Coliform	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	$

	(MPN/100ml)								
19	Dissolved Oxygen (mg/l)	5.0	4.5	4.7	4.4	4.7	4.8	4.8	4 mg/l (Min)
20	NO^{3}(mg/l)	0.3	0.3	0.3	0.9	0.5	0.9	0.4	50 mg/l (Max)
21	PO_4(mg/l)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	$
22	Fe(mg/l)	0.04	0.03	0.02	0.06	0.04	0.04	0.02	50 mg/l (Max)
23	Cu(mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	1.5 mg/l (Max)
24	Pb(mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.1 mg/l (Max)
25	As(mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.2 mg/l (Max)
26	Mn(mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	$
27	Cr(mg/l)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	$
28	Hg(mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	$
29	Se(mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05 mg/l (Max)
30	Al(mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	$
31	PAH	BDL	BDL	BDL	BDL	BDL	BDL	BDL	$
32	BOD_{3day} at 27^0C	12.4	12.1	2.1	9.8	2.2	2.4	1.9	30mg/l
33	COD	34.2	28.3	9.8	23.2	8.6	9.2	8.8	250 mg/l

Note: $ indicates no limits have been specified. BDL is below detectable limit.

TABLE-3.24

SURFACE WATER ANALYSIS REPORT (Monsoon Period)

Sl. No.	SAMPLING LOCATION	Vamsadhara River near Lanjigarh	Vamsadhara River near Bundel	Stream near Tentulipadar	Vamsadhara River near Chhatrapur	Stream near Rengopali	Stream near Kenduguda	Stream near Bundel	IS:2296 Permissible limit
	PARAMETER	**SW1**	**SW2**	**SW3**	**SW4**	**SW5**	**SW6**	**SW7**	
1	Color(Haz.unit)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	300 (Hazen.unit)
2	Taste	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
3	Odor	UO	UO	UO	UO	UO	UO	UO	UO
4	pH	7.05	7.28	6.84	7.58	6.92	6.75	6.86	6.5-8.5
5	Temperature(^{0}C)	29.4	29.6	29.6	29.5	29.6	29.5	29.6	$
6	ECvity(µs/cm)	202	170	82	174	112	132	91	$
7	Total Dissolved Solid(mg/l)	116	98	49	102	94	90	84	1500 mg/l
8	Turbidity (NTU)	57	46	33	52	29	31	27	$
9	Residual Chlorine(mg/l)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	$
10	Total Hardness (mg/l)	56	40	32	36	40	40	28	$
11	Calcium (mg/l)	15.6	8	3.2	8	8	8	4	$
12	Magnesium (mg/l)	4.3	7.2	2.9	3.8	4.8	4.8	4.3	$
13	Chloride (mg/l)	15	10	4	14	4	10	10	600 mg/l (Max)
14	Sulphate (mg/l)	2.0	1.4	0.3	1.8	0.4	0.5	0.5	400 mg/l (Max)
15	Fluoride (mg/l)	0.2	0.2	0.3	0.3	0.3	0.2	0.1	1.5 mg/l (Max)
16	Alkalinity (mg/l)	56	58	20	70	58	56	44	$

17	Total Coliform Count (MPN/100ml)	4	8	6	6	4	4	4	5000(Max) MPN/100ml
18	Feacal Coliform Count (MPN/100ml)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	$
19	Dissolved Oxygen (mg/l)	6.2	6.4	4.1	6.8	4.2	4.4	4.3	4 mg/l (Min)
20	Nitrate (mg/l)	0.2	0.3	0.3	0.5	0.3	0.4	0.2	50 mg/l (Max)
21	Phosphate (mg/l)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	$
22	Iron (mg/l)	0.03	0.02	0.02	0.02	0.03	0.04	0.01	50 mg/l (Max)
23	Copper (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	1.5 mg/l (Max)
24	Lead (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.1 mg/l (Max)
25	Arsenic (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.2 mg/l (Max)
26	Manganese (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	$
27	Chromium (mg/l)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	$
28	Mercury (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	$
29	Selenium (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05 mg/l (Max)
30	Aluminium (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	$
31	PAH	BDL	BDL	BDL	BDL	BDL	BDL	BDL	$
32	BOD_{3day} at 27^0C	4.2	4.4	2.3	4.4	2.4	2.5	2.2	30 mg/l
33	COD	22.4	23.6	13.8	22.2	14.6	14.2	12.0	250 mg/l

Note: $ indicates no limits have been specified. BDL is below detectable limit

TABLE-3.25

SURFACE WATER ANALYSIS REPORT (Post-Monsoon Period)

Sl. No.	SAMPLING LOCATION	Vamsadhara River near Lanjigarh	Vamsadhara River near Bundel	Stream near Tentulipadar	Vamsadhara River near Chhatrapur	Stream near Rengopali	Stream near Kenduguda	Stream near Bundel	IS:2296 Permissible limit
	PARAMETER	**SW1**	**SW2**	**SW3**	**SW4**	**SW5**	**SW6**	**SW7**	
1	Color (Haz.unit)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	300 (Hazen.unit)
2	Taste	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
3	Odour	UO	UO	UO	UO	UO	UO	UO	UO
4	pH	7.23	7.45	6.96	7.72	7.05	6.97	6.98	6.5-8.5
5	Temperature(^{0}c)	24	23	24	24	24	24.5	24.2	**$**
6	EC (µs/cm**)**	178	98	138	146	139	141	129	**$**
7	Total Dissolved Solid (mg/l)	96	77	63	80	106	98	93	1500 mg/l
8	Turbidity (NTU)	25	14	20	22	18	18	16	**$**
9	Residual Chlorine (mg/l)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	**$**
10	Total Hardness (mg/l)	65	46	29	51	45	41	20	**$**
11	Calcium (mg/l)	16.2	12.4	6.2	11	10	8	6	**$**
12	Magnesium (mg/l)	5.8	3.6	3.24	6	4.8	4.8	3.6	**$**
13	Chloride (mg/l)	19	12	8	20	7	15	14	600 mg/l (Max)
14	Sulphate (mg/l)	1.7	1.2	0.2	1.5	0.3	0.5	0.4	400 mg/l (Max)
15	Fluoride (mg/l)	0.2	0.1	0.2	0.3	0.2	0.1	0.1	1.5 mg/l (Max)
16	Alkalinity (mg/l)	64	51	24	76	62	52	39	**$**

17	Total Coliform (MPN/100ml)	6	6	4	7	5	4	5	5000(Max) MPN/100ml
18	Feacal Coliform (MPN/100ml)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	**$**
19	Dissolved Oxygen (mg/l)	5.3	5.2	3.8	5.4	4.0	4.2	4.1	4 mg/l (Min)
20	Nitrate (mg/l)	0.1	0.2	0.3	0.5	0.3	0.3	0.2	50 mg/l (Max)
21	Phosphate (mg/l)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**$**
22	Iron (mg/l)	0.03	0.02	0.02	0.02	0.03	0.04	0.01	50 mg/l (Max)
23	Copper (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	1.5 mg/l (Max)
24	Lead (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.1 mg/l (Max)
25	Arsenic (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.2 mg/l (Max)
26	Manganese (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**$**
27	Chromium (mg/l)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	**$**
28	Mercury (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	**$**
29	Selenium (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05 mg/l (Max)
30	Aluminium (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**$**
31	PAH	ND	ND	ND	ND	ND	ND	ND	**$**
32	BOD_{3days}	3.8	3.9	2.0	4.2	2.2	2.3	2.2	30 mg/l
33	COD	25.1	24.6	11.4	26.1	12.7	13.1	10.9	250 mg/l

Note: $ indicates no limits have been specified. BDL is below detectable limit

TABLE-3.26

SURFACE WATER ANALYSIS REPORT (Winter Period)

Sl. No.	SAMPLING LOCATION	Vamsadhara River near Lanjigarh	Vamsadhara River near Bundel	Stream near Tentulipadar	Vamsadhara River near Chhatrapur	Stream near Rengopali	Stream near Kenduguda	Stream near Bundel	**IS:2296 Permissible limit**
	PARAMETER	**SW1**	**SW2**	**SW3**	**SW4**	**SW5**	**SW6**	**SW7**	
1	Color (Haz.unit)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	300 (Hazen.unit)
2	Taste	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
3	Odour	UO	UO	UO	UO	UO	UO	UO	UO
4	pH	7.4	7.5	7.0	8.1	7.4	7.3	6.9	6.5-8.5
5	Temperature (^{0}c)	32	32	31	32	30	31	30	**$**
6	Conductivity (µs/cm**)**	213	191	85	198	168	141	136	**$**
7	Total Dissolved Solid(mg/l)	127	113	42	115	97	84	82	1500 mg/l
8	Turbidity (NTU)	19	16	11	13	10	12	12	**$**
9	Residual Chlorine (mg/l)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	**$**
10	Total Hardness (mg/l)	64	54	46	76	42	40	38	**$**
11	Calcium (mg/l)	42	38	32	48	28	28	26	**$**
12	Magnesium (mg/l)	22	16	14	28	14	14	12	**$**
13	Chloride (mg/l)	10	8	8	82	7	8	10	600 mg/l (Max)
14	Sulphate (mg/l)	2.2	1.3	0.4	2.4	0.6	0.5	0.4	400 mg/l (Max)
15	Fluoride (mg/l)	0.3	0.3	0.4	1.6	0.5	0.4	0.3	1.5 mg/l (Max)
16	Alkalinity (mg/l)	74	65	32	84	72	68	48	**$**

17	Total Coliform (MPN/100ml)	6	8	4	10	4	4	5	5000(Max) MPN/100ml
18	Feacal Coliform (MPN/100ml)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	**$**
19	Dissolved Oxygen (mg/l)	4.4	4.6	4.4	4.2	4.6	4.5	4.6	4 mg/l (Min)
20	Nitrate (mg/l)	0.4	0.4	0.3	0.6	0.3	0.2	0.3	50 mg/l (Max)
21	Phosphate (mg/l)	0.1	0.1	<0.1	0.1	<0.1	<0.1	<0.1	**$**
22	Iron (mg/l)	0.03	0.03	0.02	0.04	<0.02	0.03	0.02	50 mg/l (Max)
23	Copper (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	1.5 mg/l (Max)
24	Lead (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.1 mg/l (Max)
25	Arsenic (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.2 mg/l (Max)
26	Manganese (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**$**
27	Chromium (mg/l)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	**$**
28	Mercury (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	**$**
29	Selenium (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05 mg/l (Max)
30	Aluminium(mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**$**
31	PAH	ND	ND	ND	ND	ND	ND	ND	**$**
32	BOD_{3days}	7.6	6.8	2.2	5.6	2.4	2.4	2.2	30 mg/l
33	COD	29.4	27.8	12.4	25.2	13.2	12.4	11.8	250 mg/l

Note: $ indicates no limits have been specified. UO indicates for unobjectionable.

TABLE-3.27
GROUND WATER ANALYSIS REPORT (PRE-MONSOON PERIOD)

Sl. No.	**SAMPLING LOCATION**	B.W at Plant site	B.W at Lanjigarh	B.W at Rengopali	B.W at Chhatrapur	B.W at Chhanalima	B.W at Redmud	B.W at Ashpond	B.W at Process Water Lake	B.W at Bundel	**Limits as Per IS:10500**
	PARAMETERS	**G.W.1**	**G.W.2**	**G.W.3**	**G.W.4**	**G.W.5**	**G.W.6**	**G.W.7**	**G.W.8**	**G.W.9**	
1	Color (Hz.U)	1.0	2.0	1.0	2.0	1.0	2.0	3.0	1.0	2.0	5 (Hazen Unit)
2	Taste	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
3	Odour	U O	U O	U O	U O	U O	U O	U O	U O	U O	U O
4	P^H	7.11	7.04	7.86	6.76	7.12	7.10	7.13	7.16	7.12	6.5-8.5
5	Temp.	30.0^0c	30.0^0c	30.0^0c	30.0^0c	30.0^0c	30.0^0c	30.0^0c	30.0^0c	30.0^0c	**$**
6	EC (µs/cm)	228.4	923.8	144.3	219.2	352.8	126.8	617.8	21.56	552.5	**$**
7	TDS(mg/l)	114.4	470.1	79.64	121.4	199.7	69.85	337.9	10.74	292.7	500 mg/l (Min)
8	TDTY(NTU)	0.52	0.74	0.48	0.67	0.71	0.54	0.67	0.12	1.05	5 NTU
9	R/Cl_2(mg/l)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0.2 mg/l (Min)
10	T. Hard. (mg/l)	56	298	80	56	161	52	210	4.0	220	300 mg/l (Min)
11	Ca^{+2} (mg/l)	15.2	74	20	12	53.6	11.2	62.4	0.8	60.8	75 mg/l (Max)
12	Mg^{+2}(mg/l)	5.3	24.9	8.0	6.3	9.5	5.6	13.2	0.5	16.4	30 mg/l (Max)
13	Cl (mg/l)	24	44	8	12	8	10	10	6	8	250 mg/l (Max)
14	$S0_4$ (mg/l)	1.2	3.4	0.3	0.5	0.7	0.7	0.5	0.5	0.6	200 mg/l (Max)
15	F (mg/l)	0.5	0.9	0.3	0.4	0.3	0.3	0.3	0.3	0.3	1.0 mg/l (Max)
16	Alkalinity (mg/l)	54	422	130	24	225.6	60.0	200.0	12.0	140.0	400 mg/l (Max)
17	T.C.C (MPN/100ml)	2	4	1	1	1	1	1	1	1	10 (Max)

18	T.F.C (MPN/100ml)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	**$**
19	NO_3(mg/l)	0.4	0.4	0.2	0.3	0.2	0.2	0.3	0.2	0.2	45 mg/l (Max)
20	PO_4(mg/l)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**$**
21	Fe (mg/l)	0.02	0.05	0.02	0.16	0.12	0.05	0.01	0.05	0.01	0.3 mg/l (Max)
22	Cu(mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05mg/l (Max)
23	Pb(mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05mg/l (Max)
24	As(mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01mg/l (Max)
25	Mn(mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.1 mg/l (Max)
26	Cr (mg/l)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05mg/l (Max)
27	Hg(mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001mg/l(Max)
28	Se(mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01mg/l (Max)
29	Al^{+3}(mg/l)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03mg/l (Max)
30	PAH	N.D	N.D	N.D	N.D	N.D	N.D	N. D	N.D	N.D	**$**
31	Boron(mg/l)	0.03	0.03	0.02	0.02	0.04	0.03	0.02	0.02	0.02	1 mg/l (Max)
32	A.Ion(mg/l)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.2 mg/l
33	Pesticide(mg/l)	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent

Note: $ indicates no limits have been Specified; B.W indicates bore well

TABLE-3.28
GROUND WATER ANALYSIS REPORT (MONSOON PERIOD)

Sl. No.	SAMPLING LOCATION	B.W at Plant site	B.W at Lanjigarh	B.W at Rengopali	B.W at Chhatrapur	B.W at Chanalima	B.W at Red mud	B.W at Ash pond	B.W at Process Water Lake	B.W at Bundel	Limits as Per IS:10500
	PARAMETERS	**G.W.1**	**G.W.2**	**G.W.3**	**G.W.4**	**G.W.5**	**G.W.6**	**G.W.7**	**G.W.8**	**G.W.9**	
1	Color (Hazen)	1.0	1.0	1.0	2.0	1.0	2.0	2.0	1.0	2.0	5 (Haz Unit)
2	Taste	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
3	Odor	UO	UO	UO	UO	UO	UO	UO	UO	UO	UO
4	pH	7.44	7.64	7.13	7.68	7.17	7.23	7.26	7.76	7.12	6.5-8.5
5	Temperature	29.0^{0}c	28.9^{0}c	28.9^{0}c	29,0^{0}c	28.9^{0}c	28.8^{0}c	28.9^{0}c	29.0^{0}c	28.9^{0}c	**$**
6	E C (µs/cm)	266.8	746	198	419	133	108	259	197	220	**$**
7	TDS (mg/l)	148	436	114	243	235	182	428	344	385	500mg/l(Min)
8	Turbidity(NTU)	4	5	4	3	5	4	3	5	4	5 NTU
9	Residual Cl (mg/l)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0.2 mg/l(Min)
10	Total Hardness (mg/l)	84	340	56	194	90	56	214	154	162	300 mg/l (Min)
11	Calcium (mg/l)	16	96	10.5	44.8	19.2	8.8	57.6	43.2	48	75 mg/l(Max)
12	Magnesium(mg/l)	11	24	7.2	19.7	10.1	8.2	16.8	11.0	10.1	30 mg/l(Max)
13	Chloride (mg/l)	24	46	10	14	8	10	10	10	10	250 mg/l (Max)
14	Sulphate (mg/l)	1.2	4	1.4	2.1	1.6	1.7	1.8	1.5	1.6	200 mg/l (Max)
15	Fluoride (mg/l)	0.5	0.4	0.5	0.2	0.1	0.1	0.1	0.2	0.1	1.0 mg/l (Max)

16	Alkalinity (mg/l)	92	280	84	240	60	124	276	294	230	400 mg/l (Max)
17	Total Coliform (MPN/100ml)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	10 (Max)
18	Feacal Coliform (MPN/100ml)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	**$**
19	Nitrate (mg/l)	0.2	0.6	0.3	0.3	0.4	0.5	0.4	0.5	0.3	45 mg/l (Max)
20	Phosphate(mg/l)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**$**
21	Iron (mg/l)	0.05	0.04	0.04	0.06	0.05	0.04	0.05	0.05	0.05	0.3 mg/l (Max)
22	Copper (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05 mg/l(Max)
23	Lead (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05 mg/l(Max)
24	Arsenic (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01 mg/l(Max)
25	Mn (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.1 mg/l (Max)
26	Chromium (mg/l)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05 mg/l (Max)
27	Mercury (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001mg/l Max
28	Selenium (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01 mg/l(Max)
29	Alumina (mg/l)	0.03	0.02	0.03	0.03	0.04	0.03	0.03	0.04	0.03	0.03mg/l (Max)
30	PAH	N.D	N.D	N.D	N.D	N.D	N.D	N. D	N.D	N.D	**$**
31	Boron(mg/l)	0.02	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	1mg/l (Max)
32	Anionic Ion(mg/l)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.2 mg/l
33	Pesticide (mg/l)	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent

Note: $ indicates no limits have been Specified; B.W indicates bore well UO indicates Unobjectionable

TABLE-3.29
GROUND WATER ANALYSIS REPORT (POST-MONSOON PERIOD)

Sl. No.	SAMPLING LOCATION	B.W at Plant site	B.W at Lanjigarh	B.W at Rengopali	B.W at Chhatrapur	B.W at Chanalima	B.W at Redmud	B.W at Ashpond	B.W at Process WaterLake	B.W at Bundel	Limits as Per IS:10500
	PARAMETERS	**G.W.1**	**G.W.2**	**G.W.3**	**G.W.4**	**G.W.5**	**G.W.6**	**G.W.7**	**G.W.8**	**G.W.9**	
1	Color (Hz.U)	1.0	1.0	1.0	2.0	1.0	2.0	2.0	1.0	2.0	5 (Hazen Unit)
2	Taste	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
3	Odour	UO	UO	UO	UO	UO	UO	UO	UO	UO	UO
4	pH	7.29	7.58	7.24	7.61	7.42	7.19	7.21	7.69	7.05	6.5-8.5
5	Temp (^{0}c)	24	24	23	24	24	24	24.2^{0}c	24.2^{0}c	24.4^{0}c	**$**
6	EC (µs/cm)	324	482	173	486	169	169	211	183	179	**$**
7	TDS (mg/l)	176	248	86	282	102	98	119	92	111	500 mg/l (Min)
8	Turbidity(NTU)	3 .8	3.6	3	4.2	3.6	3.9	4.1	4	4	5 NTU
9	Residual Chlorine(mg/l)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0.2 mg/l (Min)
10	Total Hardness (mg/l)	139	212	79	226	92	74	198	132	148	300 mg/l (Min)
11	Calcium (mg/l)	34	48	19	53	25	16	43	31	37	75 mg/l (Max)
12	Mg (mg/l)	13	22	7.1	23	7.1	8.1	21	13.08	13.3	30 mg/l (Max)
13	Chloride (mg/l)	28.2	41.3	13.9	18.6	11.7	13.2	14.6	12.5	13.5	250 mg/l (Max)
14	Sulphate (mg/l)	2.1	6.1	2.2	2.4	1.8	1.9	1.7	1.9	1.8	200 mg/l (Max)
15	Fluoride (mg/l)	0.4	0.4	0.5	0.7	0.3	0.4	0.4	0.5	0.3	1.0 mg/l (Max)
16	Alkalinity (mg/l)	82	209	63	221	72	124	285	268	219	400 mg/l (Max)

17	Total Coliform (MPN/100ml)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	10 (max)
18	Feacal Coliform (MPN/100ml)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	**$**
19	Nitrate (mg/l)	0.2	0.5	0.3	0.4	0.4	0.5	0.6	0.5	0.2	45 mg/l (Max)
20	Phosphate (mg/l)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**$**
21	Iron (mg/l)	0.05	0.04	0.05	0.05	0.05	0.04	0.05	0.06	0.04	0.3 mg/l (Max)
22	Copper (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05 mg/l (Max)
23	Lead (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05 mg/l (Max)
24	Arsenic (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01 mg/l (Max)
25	Mn (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.1 mg/l (Max)
26	Cr (mg/l)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05 mg/l (Max)
27	Mercury (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001 mg/l (Max)
28	Selenium (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01 mg/l (Max)
29	Aluminium (mg/l)	0.03	0.02	0.03	0.03	0.04	0.03	0.03	0.04	0.03	0.03 mg/l (Max)
30	PAH	N.D	N.D	N.D	N.D	N.D	N.D	N. D	N.D	N.D	**$**
31	Boron(mg/l)	0.02	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	1mg/l (Max)
32	Anionic Ion(mg/l)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.2 mg/l
33	Pesticide (mg/l)	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent

Note: $ indicates no limits have been Specified; B.W indicates bore well UO indicates Unobjectionable

Table- 3.30
GROUND WATER ANALYSIS REPORT (WINTER PERIOD)

Sl. No.	**SAMPLING LOCATION**	B.W at Plant site	B.W at Lanjigarh	B.W at Rengopali	B.W at Chhatrapur	B.W at Chanalima	B.W at Red mud	B.W at Ash pond	B.W at Process Water Lake	B.W at Bundel	**Limits as per IS:10500**
	PARAMETERS	**G.W.1**	**G.W.2**	**G.W.3**	**G.W.4**	**G.W.5**	**G.W.6**	**G.W.7**	**G.W.8**	**G.W.9**	
1	Color (Hazen)	1.0	1.0	1.0	2.0	1.0	2.0	2.0	1.0	2.0	5 (Hazen Unit)
2	Taste	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
3	Odour	UO	UO	UO	UO	UO	UO	UO	UO	UO	UO
4	pH	7.3	7.1	6.7	7.3	7.0	6.9	7.2	6.8	7.2	6.5-8.5
5	Temp(^{0}c)	29	29	30	29	30	30	29	29	29	**$**
6	EC (µs/cm)	252	712	196	404	132	96	262	184	224	**$**
7	TDS (mg/l)	141	422	108	238	84	63	161	111	167	500 mg/l (Min)
8	Turbidity(NTU)	7	4	8	5	4	4	3	6	4	5 NTU
9	Residual Chlorine (mg/l)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0.2 mg/l (Min)
10	Total Hard.(mg/l)	148	380	62	24	96	70	242	64	188	300 mg/l (Min)
11	Calcium (mg/l)	120	312	48	172	78	54	192	50	152	75 mg/l (Max)
12	Mg (mg/l)	28	68	14	32	18	16	50	14	36	30 mg/l (Max)
13	Chloride (mg/l)	10	36	6	10	6	6	8	4	8	250 mg/l (Max)
14	Sulphate (mg/l)	0.6	3.2	1.2	1.7	1.1	0.6	1.9	1.0	1.3	200 mg/l (Max)
15	Fluoride (mg/l)	0.3	0.6	0.2	0.4	0.2	0.1	0.4	0.2	0.3	1.0 mg/l (Max)
16	Alkalinity (mg/l)	86	336	72	80	60	48	128	76	108	400 mg/l (Max)
17	Total Coliform (MPN/100ml)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	10 (Max)

18	Total Feacal (MPN/100ml)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	**$**
19	Nitrate (mg/l)	0.4	0.8	0.2	0.6	0.2	0.2	0.4	0.3	0.3	45 mg/l (Max)
20	Phosphate (mg/l)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**$**
21	Iron (mg/l)	0.03	0.05	0.02	0.03	0.02	0.02	0.03	0.02	0.02	0.3 mg/l (Max)
22	Copper (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05 mg/l (Max)
23	Lead (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05 mg/l (Max)
24	Arsenic (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01 mg/l (Max)
25	Mn (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.1 mg/l (Max)
26	Chromium mg/l)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05 mg/l (Max)
27	Mercury (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001 mg/l(Max)
28	Selenium (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01 mg/l (Max)
29	Al(mg/l)	0.03	0.02	0.03	0.03	0.04	0.03	0.03	0.04	0.03	0.03 mg/l (Max)
30	PAH	N.D	N.D	N.D	N.D	N.D	N.D	N. D	N.D	N.D	**$**
31	Boron(mg/l)	0.02	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	1mg/l (Max)
32	Anionic Ion(mg/l)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.2 mg/l
33	Pesticide (mg/l)	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent

Note: $ indicates no limits have been Specified; B.W indicates bore well , UO indicates Unobjectionable

3.7.3 Discussions

Considering the location of the plant site, Chatrapur location (North of the core zone) is considered as upstream for both surface water and ground water, where as Rengopali location(South of the core zone) is considered as downstream for both groundwater and surface water quality studies with reference to the Vamsadhara River. The River Vamsadhara is referenced for the surface water quality study for pollutant load analysis due to the existing plant and for future estimation of the proposed expansion. The downstream of Vamsadhara River has increased concentration of Alkalinity and hardness, and all other parameters have decreased values which indicate some form of dilution in the downstream river conditions. As there is no industrial discharge to this river, therefore the increased values of Alkalinity and Hardness could be due to some form of surfacial contamination at the downstream. The surface water quality varies with seasonal fluctuations in pH, Alkalinity, Hardness, considering the Vamsadhara River as reference (**Figure-3.16**). The adjacent groundwater locations have a similar trend in the water quality as the surface water (**Figure-3.17**). Mostly the downstream water quality for both surface water and ground water shows a form of dilution in concentration, for which the downstream concentrations are lower than the upstream concentrations both in pre-monsoon and post-monsoon seasons. Therefore it can be inference that the net effect from the proposed project will have a minimum impact on the water quality of the area.

Figure- 3.16: Surface Water Quality Comparison

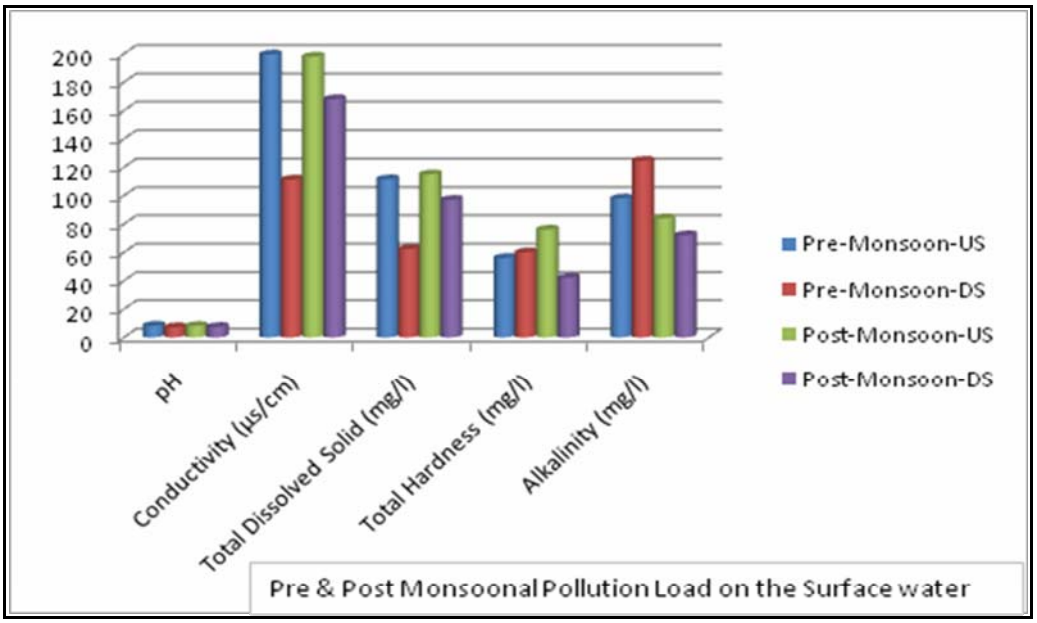
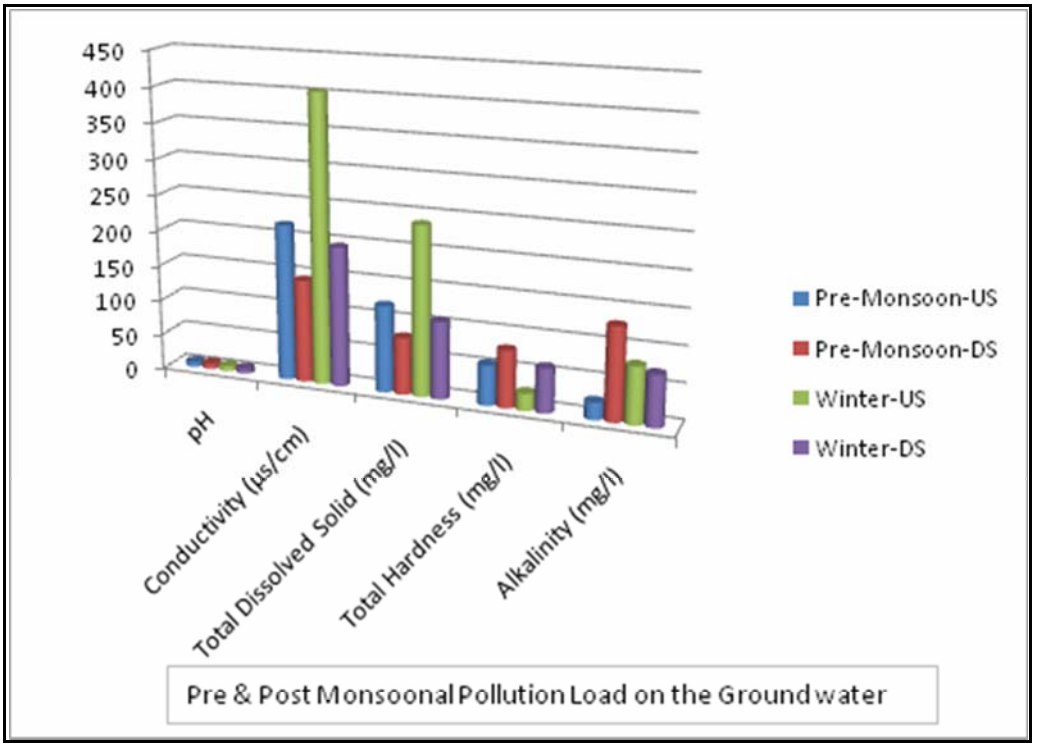


Figure-3.17: Groundwater Quality Comparison



3.8 SOIL QUALITY

3.8.1 Soil Sampling

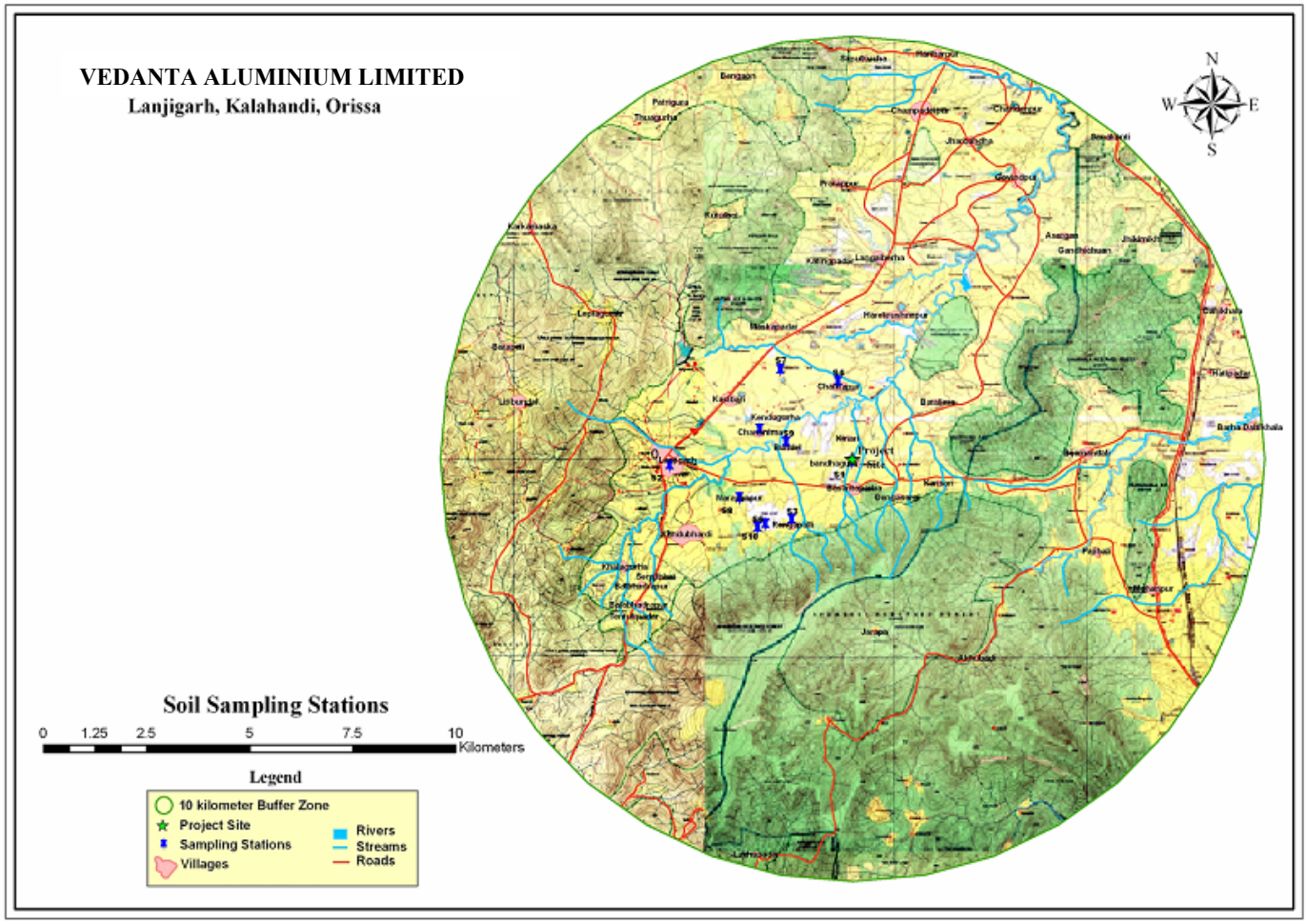
Samples of soil have been taken within 10 km radius of the study area for assessing environment and evaluate anticipated impact of the proposed project. Understanding the soil quality is essential for Environmental Impact Assessment study and to identify critical issues with a view to suggest appropriate mitigation measures for implementation. The sampling locations for soil are listed in **Table-3.31** below and depicted in **Figure 3.18**.

TABLE–3.31
SAMPLING LOCATIONS FOR SOIL

SR.NO.	CODE	LOCATION	DISTANCE FROM PLANT(KM)	DIRECTION
1	S.S.L.1	Plant Site		
2	S.S.L.2	Lanjigarh	4.0	W
3	S.S.L.3	Rengopali	2.0	S
4	S.S.L.4	Chhatrapur	1.6	N
5	S.S.L.5	Chananlima	1.7	WNW
6	S.S.L.6	Nead Redmud pond	1.5	S.W
7	S.S.L.7	Near Ash pond	4.0	NW
8	S.S.L.8	Process Water Lake	1.6	NW
9	S.S.L.9	Bundel	4.0	W
10.	S.S.L.10	Rehab colony	3.0	SW

The laboratory analysis results of the soil samples for all seasons are listed in **Tables-3.32, 3.33, 3.34** and **3.35** respectively**.**

Figure-3.18 Soil Sampling Locations



Source: Topo sheet no. 65M/6/NE

TABLE-3.32
SOIL ANALYSIS REPORT (PRE-MONSOON PERIOD)

SL. NO.	PARAMETERS	S.S.L.1	S.S.L.2	S.S.L.3	S.S.L.4	S.S.L.5	S.S.L 6	S.S.L 7	S.S.L 8	S.S.L 9	S.S.L 10
1.	SOIL TYPE	CLAYE SANDY	CLAYE SANDY	CLAYE SANDY	CLAYE SANDY	CLAYE SANDY	CLAYE SANDY	CLAYE SANDY	CLAYE SANDY	CLAYE SANDY	CLAYE SANDY
2.	COLOUR	YELLOWISH	REDISH	REDISH	YELLOWISH	REDISH	REDISH	YELLOWISH	YELLOWISH	YELLOWISH	YELLOWISH
3.	PH	7.12	6.76	7.24	6.52	6.84	6.54	6.54	6.97	7.02	7.12
4.	E.C ((µs/cm)	122.7	193.9	124.4	129.6	186.1	129.7	135.2	125.6	187.5	139.5
5.	BULK DENSITY (g/cc)	0.782	0.846	0.8746	0.8571	0.9248	0.856	0.8519	0.8472	0.9027	0.852
6.	SAND%	2.0	1.5	1.4	1.3	2.0	1.0	2.6	1.4	1.6	1.6
7.	SILT%	2.0	2.0	2.0	2.1	2.5	3.0	2.0	2.2	2.3	2.0
8.	CLAY%	96.0	96.5	96.6	96.7	95.4	96.0	95.4	96.4	96.1	96.4
9.	ORGANIC MATTER %	1.7	2	1.5	1.4	1.9	2	2.11	1.8	1.46	1.67
10.	AV. NITROGEN mg/kg	2.7	2.9	2.5	2.1	2.5	3.0	2.8	2.3	2.1	2.2
11.	AV. PHOSPHOROUS mg/kg	0.8	1.0	0.9	0.8	0.9	1.1	1.0	0.8	0.8	0.9
12.	AV. POTASSIUM mg/kg	0.6	0.5	0.6	0.4	0.5	0.6	0.4	0.5	0.6	0.6
13.	AV. MAGNESIUM mg/kg	2.59	2.76	2.42	2.71	2.72	2.82	2.64	2.37	2.56	2.62
14.	CHLORIDE mg/kg	40.6	158.4	42.4	52.6	123.3	167.6	158.5	124.6	50.8	67.5
15.	COPPER mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
16.	ZINC mg/kg	2.0	3.2	2.1	2.7	2.9	3.6.	3.4	3.1	2.5	2.8
17.	BORON mg/kg	0.05	0.07	0.08	0.06	0.07	0.08	0.06	0.04	0.05	0.07

TABLE-3.33
SOIL ANALYSIS REPORT (MONSOON PERIOD)

Sr.No.	Parameters	S.S.L.1	S.S.L.2	S.S.L.3	S.S.L.4	S.S.L.5	S.S.L 6	S.S.L 7	S.S.L 8	S.S.L 9	S.S.L 10
1	Soil Type	Claye Sandy	Claye Sandy	Claye Sandy	Claye Sandy	Claye Sandy	Claye Sandy	Claye Sandy	Claye Sandy	Claye Sandy	Claye Sandy
2	Colour	Yellowish	Reddish	Reddish	Yellowish	Reddish	Reddish	Yellowish	Yellowish	Yellowish	Yellowish
3	pH	7.25	6.98	7.45	6.84	7.13	6.89	6.81	7.08	7.24	7.35
4	E.C (µS/Cm)	104.8	185.9	111.7	119.5	192.7	135.7	123.6	119.6	191.5	132.7
5	Bulk Density (gm/cc)	1.017	1.109	1.084	1.123	1.095	1.074	1.159	1.079	1.106	1.147
6	Sand%	1.94	1.44	1.29	1.17	2.15	1.52	2.74	2.35	1.89	2.09
7	Silt%	2.14	1.78	1.74	1.87	2.05	2.12	1.82	2.06	2.11	1.91
8	Clay%	95.92	96.78	96.97	96.96	95.8	96.36	95.44	95.59	96	96
9	Organic Matter %	1.45	1.79	1.41	1.38	1.25	1.14	1.07	1.35	1.27	1.18
10	Av. Nitrogen(mg/kg)	2.28	2.54	2.34	2.26	2.47	2.84	2.64	2.52	2.31	2.42
11	Av. Phosphorous (mg/kg)	1.1	1.3	1.4	1.2	1.6	1.5	1.5	1.4	1.4	1.5
12	Av. Potassium (mg/kg)	0.9	0.8	0.87	0.72	0.82	0.94	0.72	0.91	0.96	0.98
13	Av. Magnesium (mg/kg)	2.39	2.56	2.22	2.55	2.54	2.64	2.48	2.09	2.24	2.28
14	Chloride(mg/kg)	38.8	142.8	38.8	48.8	111.9	157.8	148.7	134.8	46.4	62.8
15	Copper (mg/kg)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
16	Zinc (mg/kg)	1.98	2.86	1.94	2.26	1.94	3.12.	3.08	2.94	2.16	2.24
17	Boron(mg/kg)	0.04	0.06	0.05	0.04	0.05	0.06	0.07	0.05	0.05	0.07

TABLE-3.34
SOIL ANALYSIS REPORT (POST-MONSOON PERIOD)

SR.NO.	Parameters	S.S.L.1	S.S.L.2	S.S.L.3	S.S.L.4	S.S.L.5	S.S.L 6	S.S.L 7	S.S.L 8	S.S.L 9	S.S.L 10
1.	Soil Type	Claye Sandy	Claye Sandy	Claye Sandy	Claye Sandy	Claye Sandy	Claye Sandy	Claye Sandy	Claye Sandy	Claye Sandy	Claye Sandy
2.	Colour	Yellowish	Reddish	Reddish	Yellowish	Reddish	Reddish	Yellowish	Yellowish	Yellowish	Yellowish
3.	pH	6.98	6.67	7.24	6.42	6.85	6.62	6.13	6.74	7.02	7.09
4.	E.C (µS/Cm)	122.7	178.6	112.3	115.9	169.5	119.3	124.5	109.5	172.6	127.5
5.	Bulk Density (gm/cc)	1.004	1.105	1.084	1.114	1.083	1.008	1.025	1.047	1.112	1.135
6.	Sand%	1.85	1.48	1.34	1.28	1.87	1.05	2.48	1.29	1.58	1.47
7.	Silt%	1.7	1.5	1.8	2.4	2.8	2.7	2.4	2.5	2.1	1.9
8.	Clay%	92.4	95.2	91.9	92.5	94.3	94.3	92.5	96.4	96.3	96.5
9.	Organic Matter %	1.45	1.89	1.46	1.15	1.87	2.02	2.12	1.9	1.32	1.46
10.	Av. Nitrogen (mg/kg)	2.3	2.6	2.1	1.9	2.4	2.9	2.5	1.8	2.1	2.1
11.	Av. Phosphorous (mg/kg)	1.1	1.1	1.4	0.9	1.4	1.3	1.5	0.8	1.4	0.9
12.	Av. Potassium (mg/kg)	0.65	0.62	0.78	0.72	0.69	0.87	0.72	0.88	0.62	0.73
13.	Av. Magnesium (mg/kg)	2.38	2.56	2.53	2.71	2.54	2.82	2.48	2.63	2.56	2.54
14.	Chloride (mg/kg)	38.8	156.4	38.5	52.6	123.3	157.8	146.7	128.3	46.2	59.7
15.	Copper (mg/kg)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
16.	Zinc (mg/kg)	1.98	2.68	1.91	2.25	2.21	2.29	3.08	3.08	2.32	2.83
17.	Boron (mg/kg)	0.04	0.07	0.08	0.04	0.05	0.04	0.07	0.08	0.06	0.07

TABLE-3.35
SOIL ANALYSIS REPORT (WINTER PERIOD)

SR.NO.	Parameters	S.S.L.1	S.S.L.2	S.S.L.3	S.S.L.4	S.S.L.5	S.S.L 6	S.S.L 7	S.S.L 8	S.S.L 9	S.S.L 10
1.	Soil Type	Claye Sandy	Claye Sandy	Claye Sandy	Claye Sandy	Claye Sandy	Claye Sandy	Claye Sandy	Claye Sandy	Claye Sandy	Claye Sandy
2.	Colour	Yellowish	Reddish	Reddish	Yellowish	Reddish	Reddish	Yellowish	Yellowish	Yellowish	Yellowish
3.	pH	7.15	6.63	7.13	6.61	6.75	6.71	6.30	6.82	6.97	7.09
4.	E.C (µS/Cm)	127.6	183.5	118.2	122.3	172.8	128.4	131.1	114.9	180.3	133.5
5.	Bulk Density (gm/cc)	1.011	1.109	1.079	1.120	1.078	1.013	1.030	1.041	1.117	1.130
6.	Sand%	1.75	1.48	1.78	1.53	1.92	1.25	2.18	1.41	1.60	1.49
7.	Silt%	1.56	1.5	1.86	2.45	1.89	1.99	2.37	2.48	2.13	1.93
8.	Clay%	95.31	95.20	94.57	94.63	94.39	94.58	93.45	94.15	94.91	95.17
9.	Organic Matter %	1.38	1.82	1.79	1.39	1.80	2.18	2.20	1.96	1.36	1.41
10.	Av. Nitrogen (mg/kg)	2.2	2.45	2.6	2.2	2.7	3.1	2.8	2.1	2.4	2.4
11.	Av. Phosphorous (mg/kg)	1.1	1.1	1.5	1.1	1.5	1.4	1.6	0.9	1.5	1.1
12.	Av. Potassium (mg/kg)	0.71	0.70	0.83	0.80	0.75	0.93	0.79	0.92	0.70	0.78
13.	Av. Magnesium (mg/kg)	2.46	2.62	2.58	2.76	2.60	2.87	2.56	2.72	2.63	2.65
14.	Chloride (mg/kg)	42.3	160.2	43.4	59.5	128.1	162.6	152.7	133.8	54.9	65.0
15.	Copper (mg/kg)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
16.	Zinc (mg/kg)	1.23	2.72	2.95	2.37	2.38	2.41	3.12	3.10	2.37	2.90
17.	Boron (mg/kg)	0.04	0.07	0.07	0.05	0.06	0.04	0.07	0.06	0.07	0.08

Observations

It has been observed that the pH of the soil Quality ranges from 6.52-7.24 indicating the soil is Neutral in nature & good for cultivation. The Bulk density of soil ranges from 0.782 to 0.9248. The Electrical conductivity was observed to be in range of 122.7 -193.9 µs/cm, which is average for crop growth, with minimum 122.7 µs/cm observed at Plant Site and maximum of 193.9 µs/cm observed at Lanjigarh. Organic matter having the range between 1.4 – 2.11 indicate that the soil in the area contain sufficient quantity of organic carbon. The Nitrogen Values ranged between 2.1-3.0 mg/kg indicating that the soil contains good quantity of nitrogen that is considered as fertile. The phosphorus value ranging between 0.8-1.1 mg/kg indicating that the soil is having fair amount of phosphorous which is suitable for cultivation.

During monsoon period it has been observed that the pH of the soil quality ranged from 6.81-7.45 indicating the soil is Neutral in nature and is good for cultivation. The Bulk density of soil ranges between 1.017 to1.159 gm/cc. The Electrical conductivity was observed to be in the range of 104.8 -192.7 µs/cm, which is average for crops, with minimum 104.8 µs/cm observed at Plant Site and maximum of 192.7 µs/cm observed at Chanalima. Organic matter having the range 1.07 – 1.79% indicate that the soil in the area contain sufficient quantity of organic carbon. The Nitrogen values ranged between 2.26 -2.84 mg/kg indicating that the soil contains good quantity of nitrogen that is as general fertile. The phosphorus value ranging between 1.1- 1.5 mg/kg indicates that the soil is having fair amount of phosphorous which is suitable for cultivation.

During post-monsoon period it has been observed that the pH of the soil Quality ranged from 6.13-7.24 indicating the soil is Neutral in nature and is good for cultivation. Bulk density of soil ranges between 1.004 to 1.135 gm/cc. Electrical conductivity was observed to be in the range of 109.5 – 178.6 µs/cm, which is average for crops, with minimum 109.5 µs/cm observed at Process water Lake and maximum of 178.6 µs/cm observed at Langigarh. Organic matter having the range 1.15 – 2.12% indicate that soil in the area contain sufficient quantity of organic carbon. The Nitrogen values ranged between 1.8 -2.9 mg/kg indicating fertile soil. Phosphorus value ranging from 0.8 - 1.5 mg/kg indicating that soil is having fair amount of phosphorous which is suitable for cultivation.

Boron concentration is less than <0.1 mg/kg. Thus, the soil in study area having acceptable to agriculture. In the agriculture land, organic matter and phosphorus are sufficient to support good crop growth.

Overall soil quality of the area does not vary much within the whole buffer and core zone. Further the pH and nutrient content of the soil indicates that there is none or minimal effect due to the existing red mud pond and ash pond. This further indicates that there is no leakage or overflow from the red mud pond and ash pond to any land mass nearby. Therefore it may be inference that the proposed expansion will have none or minimal effect on soil pollution of the area and therefore any groundwater contamination as a subsequent result.

3.8.2 Geotechnical Summary

Subsoil in general is of good quality. Subsoil is mainly residual in origin and is characterised by very high shear strength and medium to low compressibility. Underlying the top very stiff to hard silty sandy clay layer, we have a residual soil. Below this, the weathered rock layer starts. With increase in depth, the weathering action becomes lesser and the rock turns hard.

The standing water level was struck close to the ground surface, at about 0.20m depth around BH-16A location. Again, in many bore holes, the SWL was not found. So, for foundation, placed at a depth of 1.50 to 4.50m may create problem in some cases. However, due to medium to high percentage of fine content and sticky nature of the subsoil, the percolation of water will be less and ordinary pumps, operated from surface, will be able to tackle the situation.

A list of the bore holes with the reduced level and standing water level are presented in a tabular form below in **Table-3.36** and the summarized bore well data for conductivity is presented in **Table- 3.37**.

Table-3.36: Bore well Details

Bore Hole No.	Co-ordinate (M)			Terminating Depth (M)	Standing Water Table (M)	Top of Rock below EGL (M)
	Northing	Easting	R.L.			
1A	9513.321	9306.950	432.079	15.50	Not Found	10.50
01	9850.429	9449.300	427.553	14.20	4.30	9.20
02	9987.613	9504.300	424.207	16.00	3.90	10.50
03	10175.702	9563.000	420.514	18.00	6.40	14.00
04	10303.136	9664.380	417.552	17.75	5.20	15.75

4A	10413.278	9766.207	417.022	20.50	6.00	16.20
4B	10544.003	9745.195	414.211	18.10	8.50	15.10
5A	9406.408	9447.140	435.729	10.00	2.40	6.50
05	9617.534	9576.390	434.112	8.50	Not Found	3.50
06	9771.811	9629.310	432.116	11.50	4.20	6.50
07	9915.306	9677.860	427.425	7.50	Not Found	2.50
08	10112.798	9752.460	421.584	3.25	Not Found	1.25
8A	10293.715	9842.580	413.907	18.00	4.60	16.00
8B	10480.504	9914.060	413.907	21.40	4.60	18.40
9A	9308.773	9620.800	439.592	17.10	3.90	12.10
09	9517.633	9746.920	435.633	18.80	4.30	13.80
10	9661.468	9781.000	431.125	12.50	2.95	10.45
11	9840.912	9858.660	426.016	6.50	0.60	4.50
12	10029.855	9934.610	423.969	13.85	Not Found	8.85
12A	10219.158	10000.500	418.143	20.05	4.70	--
12B	10366.515	10134.100	397.195	20.05	0.70	--
13A	9250.211	9811.830	444.381	16.00	6.85	13.00
13	9405.842	9922.950	440.070	19.30	4.45	14.30
14	9558.587	9952.190	435.709	20.00	4.50	15.00
15	9764.933	10043.400	429.943	16.20	3.70	11.70
16	9943.519	10120.800	425.272	25.05	1.40	--
16A	10126.987	10209.900	419.344	15.80	0.20	10.80
16B	10294.935	10280.400	414.574	13.50	1.15	8.50
16C	10448.669	10399.100	409.916	14.00	1.25	10.50
16D	10644.551	10480.300	405.781	13.10	1.50	10.10
17A	9219.109	10007.600	447.149	22.50	5.80	17.50
17	9362.260	10102.600	444.302	22.00	5.60	17.00
18	9576.096	10129.700	436.816	23.00	4.30	18.00
19	9733.676	10240.000	432.391	20.80	5.60	15.80
20	9897.848	10304.000	424.513	14.00	2.20	10.60
20A	10066.226	10400.600	421.844	20.00	3.40	15.00
20B	10219.357	10453.100	416.431	15.50	0.90	10.50
20C	10377.133	10570.300	412.152	14.00	1.50	9.00
20D	10550.484	10636.800	410.959	9.00	6.00	6.00
20E	10732.833	10725.000	408.445	15.50	3.90	12.00
21A	9265.218	10222.300	447.566	20.10	5.80	--
21	9375.659	10222.500	443.468	20.02	5.30	18.00
22	9548.245	10255.900	437.989	22.00	5.40	17.00
23	9676.925	10431.900	433.681	19.00	7.80	14.00
24	9853.920	10524.200	426.911	9.95	1.50	4.95
24A	10009.985	10612.600	421.836	15.20	Not Found	12.20
24B	10146.820	10677.100	421.729	7.00	0.60	4.00
24C	10310.461	10753.200	416.547	16.20	7.90	14.20
24D	10507.862	10807.300	414.098	17.65	5.80	12.65
24E	10692.016	10873.100	410.815	18.00	3.25	13.00

25A	9202.021	10421.600	459.567	18.50	Not Found	13.50
25	9313.911	10457.100	469.001	21.52	Not Found	16.50
26	9512.876	10422.132	445.954	14.00	Not Found	9.00
27	9587.390	10612.400	444.818	17.03	Not Found	12.00
28	9772.470	10721.800	437.014	20.00	7.90	15.00
28A	9918.318	10792.400	428.588	20.02	11.30	15.00
28B	10057.044	10856.800	423.154	16.50	6.80	11.50
28C	10201.640	10965.300	421.425	21.50	7.40	16.50
29A	9810.042	10977.731	428.830	20.00	Not Found	15.00
29B	9996.156	11054.054	424.197	22.50	Not Found	17.50
30A	9742.957	11160.368	427.729	13.00	1.25	8.00
30B	9927.557	11241.009	421.898	15.40	2.70	10.40
30C	10075.505	11357.310	422.892	20.02	2.90	--
31	9516.176	11333.826	431.813	15.50	0.80	10.50
31A	9663.329	11345.265	426.417	17.00	0.60	12.00
31B	9825.581	11426.425	428.809	11.00	2.95	6.00
31C	9998.960	11528.281	426.417	20.05	2.30	--
32A	9574.385	11524.477	434.363	18.50	Not Found	13.50
32B	9735.113	11608.769	433.647	9.05	3.95	4.05
33A	9528.460	11693.954	438.576	18.03	1.10	13.00
P	10154.411	10608.622	417.746	15.50	1.05	12.00

Six (6) nos. field permeability tests were conducted at bore holes inside the rock layer. The test results are presented below in **Table-3.37**. There were two representative bore wells namely 03 and 29B, which were dug near the Ash Pond and Redmud pond respectively to understand the behavior of pollutant transportation. Based on the permeability data and the nature of the soil (Clayey-sandy clay), it is apparent that the seepage will be higher with less slope stability for the pond conditioning. Therefore appropriate impermeable lining is been provided to arrest any seepage what-so-ever from these ponds and further the groundwater quality of the area indicated no increase in concentration (pH & Alkalinity) except for the seasonal variations.

Table-3.37: Bore well Data

Bore Hole No.	Top of Rock below EGL (M)	Depth of Test (m)	Coefficient of Permeability (cm/sec)
03	14.00	14.30 –15.50	8.91×10^{-3}
07	2.50	4.70 - 6.00	2.21×10^{-2}
16B	8.50	8.60 – 10.00	3.36×10^{-3}
24	4.95	5.00 - 6.45	9.40×10^{-3}
29B	17.50	17.70 – 19.00	4.02×10^{-3}
31B	6.00	8.40 – 10.00	1.28×10^{-2}

3.9 ECOLOGICAL ASSESSMENT

3.9.1 Flora and Fauna Studies

Introduction

An ecological survey of the study area was conducted particularly with reference to listing of species and assessment of the existing baseline ecological (Terrestrial and Aquatic ecosystem) conditions.

Objectives of Ecological Studies

The present study was undertaken with the following objectives:

- To assess the nature and distribution of vegetation in and around the plant site;
- To assess the distribution of animal life spectra;
- To understand the productivity of the water bodies;
- To assess the biodiversity and to understand the resource potential; and
- To ascertain migratory routes of fauna and possibility of breeding grounds.

Methodology Adopted for the Survey

To achieve the above objectives a detailed study of the area was undertaken in 10-km radius from the plant site and general area of 20-km radius. The different methods adopted were as follows:

Generation of primary data by undertaking systematic ecological studies in the area;

Discussion with local people so as to elicit information about local plants, animals and their uses; and Gathering data for ethnobiology.

The present report gives the review of published secondary data and the results of field sampling conducted.

Forest Blocks in Study Area

The list of forest blocks are presented in **Table-3.38**. Nearest forest block are Patragurha Reserved Forest on Northeast direction mainly composed of *Shorea robusta.* The vegetation map of the area is presented in **Figure 3.4** earlier.

TABLE-3.38: LIST OF FOREST BLOCKS IN 10 KM RADIUS

Sr. No.	Name of the Forest Block	Distance from Proposed Plant Location	Direction from Plant Site
1	Bori reserve forest	5.2	NW
2	Hatsal reserve forest	3.5	NW
3	Raula jhimiri reserve forest	5.2	WNW
4	Niyamgiri reserve forest	3.5	SW
5	Khambesi reserve forest	2.0	SW
6	Kudilima reserve forest	9.7	SE
7	Patra gurha reserve forest	6.4 (Rayagada district)	ESE
8	Batarilima reserve forest	2.3	E
9	Dahikhala reserve forest	2.5	E
10	Patragurha reserve forest	2.2 (Kalahandi district)	NE
11	Nimagiri reserve forest	9.0	S

Terrestrial Ecological Status:

Primary Survey

A preliminary survey was made in and around proposed plant site and nine locations were selected for detailed study. The selected locations are given in **Table-3.39.**

TABLE-3.39
DETAILS OF TERRESTRIAL ECOLOGICAL SAMPLING LOCATIONS

Station Code	Name of the Station	Distance from the Center of the Plant Site (km)	Direction w.r.t. Proposed Plant Site
TE-1	Lanjigarh village	4.0	W
TE-2	Kasibarhi village	3.5	NW
TE-3	Niyamgiri Vedanta nagar	2.5	SSW
TE-4	Balabadrapur village	6.2	SW
TE-5	Harikrishnapur village	3.8	NE
TE-6	Bijamendeli village	5.4	E
TE-7	Bhaliapadar village	11.0	SE
TE-8	Trilochanapur village	10.5	SW
TE-9	Hill Top(Mine area)	5.0	S

Primary data was generated through site visit, and sampling of species based on the Dept. of Environment & Forest publication of flora and fauna of the area. Primarily the visual assessment of the flora and fauna along with the identified species were recorded for the study purposes. Subsequently a general checklist of all plants encountered was prepared for the study area. This is meant to indicate the biodiversity for wild and cultivated plants. The plants so encountered were classified into life form spectrum according to the classification of Raunkiaer's classification of life form spectrum.

The bird population of migratory and local birds was determined by taking 10 random readings at every location. Observing mammals, amphibians and reptiles, noting their calls, droppings, burrows, pugmarks and other signs through physical observations were also carried out from the area for two twelve hour observation periods, (one during day time and the other during night time for terrestrial fauna).

Local inhabitants were also interviewed for usage of plants and animals and to gather the ethno-biological data.

Cryptogamic Vegetation

The area shows many algae, fungi, bryophytes and ferns. Algae are present in aquatic bodies or in marshy places. Fungi, particularly from ascomycetes and basidiomycetes are located on ground or epiphytically. Lichens of crustose, foliose and fruticose types are present on different substrates

Life Form Spectrum

Raunkiaer defined life forms as the sum of adaptations of plants to the climate. Braun-Blanquet (1951), whose system is adapted in this study, modified the Raunkiaer's system. The following five best of the ten classes created by Braun-Blanquet is present in the study area. The details of classification are presented in **Table-3.40.**

TABLE-3.40: CLASSIFICATION OF LIFE FORM SPECTRUM

Phanerophytes	These are trees, shrubs and climbers where the growing buds are located on the upright shoot much above the ground surface and they are the least protected.
Therophytes	These are plants which survive the adverse season in the forms of seeds. The plants produce flowers and seeds in the favourable season. They are annuals, predominantly found in extremes of dry, hot or cold conditions.
Hydrophytes	Water plants except plankton (free floating and submerged macrophytes.
Hemicryptophytes	This type of plant species is again predominantly present in cold climatic regions. Perenneting buds are present just under the surface soil and remain protected there. Mostly these are biennial or perennial herbs whose vegetative growth and aerial parts are conspicuous in warm seasons only. Buds may also be present at the soil surface but they are never exposed. They remain concealed under dead leaves and twigs
Geophytes	Plants, with pertaining parts buried in substratum such as bulb and rhizomes
Epiphytes	Parasitic plants

During field survey, maximum 451 numbers of plant species are studied and their analysis is presented in **Table-3.41.**

TABLE-3.41

CLASS WISE DISTRIBUTION OF PLANT SPECIES IN THE STUDY AREA

Type of Species	**Winter season and pre-monsoon seasons**	
	No.	**%**
Phanerophytes (P)	221	49.00
Therophytes (T)	134	29.71
Hydrophytes (H)	16	3.55
Hemicryptophytes (He)	50	11.09
Geophytes (G)	10	2.22
Epiphytes	20	4.43
Total	**451**	**100**

In the study area, maximum number of species are phanerophytes (49.00) followed by therophytes (29.71%). These classes are followed by hemicryptophytes

(11.09%) and epiphytes (4.43%). Geophytes and hydrophytes were found in very few numbers.

Presence of large number of phanerophytes (shrubs and trees) and therophytes (annuals or herbaceous vegetation) indicates semiarid to tropical vegetation structure.

Hemicryptophytes (predominantly grasses and sedges) were found to be significant in the area. These indicate fertile and wet soil in upper layer of soil profile. Hydrophytes were present in both the seasonal and perennial water bodies.

***Floristic Composition*- Plant site and surrounding area**

The major crops in the area are rice, jowar, maize and commercial crops of *Brassica nigra* and *Gossypium* sp. All these crops mainly depend on rains. The commonly observed plant species in and around the plant site are presented in **Table-3.42.**

TABLE-3.42
DETAILS OF DOMINANT PLANT SPECIES AROUND PLANT SITE

Name of the Plant Species	Local Name
Shorea robusta	Sal
Acacia Arabica	Babul
Acacia auriculaeformis	Akasia
Albizia odoratissima	Tinia
Albizia procera	Tentra, Dhal siris
Anogeissus latifolia	Dhaura
Bambusa arundanacea	Daba bans
Bauhinia malabarica	Koteli
Bauhinia racemosa	Ambalata
Bauhinia variegate	Kanchana
Boswellia serrata	Salai
Cassia fistula	Sunari
Cassia siamea	Chakunda
Mangifera indica	Am
Emblica officinalis	Anla
Euphorbia nivula	Sijju
Ficus hispida	Burgad
Terminalia arjuna	Kahun
Tamarindus indica	Imli
Terminalia chebula	Chebula

Name of the Plant Species	Local Name
Citronella sp	Cironella
Raufulfia serpertiana	sarpagandi
Androgarphis paniculata	Acanthaceae
Costus specieosus	Zingeberaceae
Crotalaria epunctata	Fabaceae
Curcuma angustifolia	Zingeberaceae
Curcuma aromatica	Zingeberaceae
Aregemone mexicana	Papaveraceae

Endangered Plants

Floristic studies were conducted during pre-monsoon season and winter in 2007-08 to know the presence of any endangered/threatened/endemic plant species in the plant site and surrounding 10 km radius. The study area did not record the presence of any critically threatened species. The records of Botanical Survey of India and Forest department also did not indicate presence of any endangered and or vulnerable species in this area.

Terrestrial Fauna and Ornithology

Details of National Park/Sanctuary

As per Ministry of Environment Notifications and local forest notifications reveals that no Wildlife sanctuaries, National parks/bio-spheres in 10-km radius from proposed plant site.

Primary Survey

Detailed field studies were conducted to identify faunal components in study area of 10 km radius from plant site and their conservation status as Wildlife Protection Act, 1972 are presented in **Table-3.43.** About 112 faunal components recorded/reported in 10 km radius from plant site, out of which, 7 belongs to Sch-I, 9 belongs to Sch-II, belongs to Sch-III and rest belongs to sch-IV as per Wildlife Protection Act,1972. Elephants, leopard and pythons are present in this area, which falls under Schedule-I of Wildlife Protection Act, 1972.

TABLE-3.43

FAUNA AND THEIR CONSERVATION STATUS FROM STUDY AREA (10 km radius)

Technical Name	English Name/ Local Name	Conservation status as per Wild Life Protection Act (1972)
Aves		
Milvus migrans	Common Kite	Sch-IV
Quills contronix	Grey quail	Sch-IV
Corvus corvus	Jungle crow	Sch-IV
Corvus splendens	House crow	Sch-IV
Turdoides striatus	White headed babler	Sch-IV
Aegithina tiphia	Iora	Sch-IV
Pycnonotus cafer	Red vented bulbul	Sch-IV
Pycnonotus jokokus	White browed Bulbul	Sch-IV
Saxicoloides fulicata	Indian robin	Sch-IV
Gallus gallus	Red Jungle fowl	Sch-IV
Columbus livibus	Rock Pigeon	Sch-IV
Bubo bubo	Indian great horned Owl	Sch-IV
Copsychus saularis	Magpie Robin	Sch-IV
Tchitrea paradisi	Paradise Fl ycatcher	Sch-IV
Tephrodornis pondiceraianus	Common Wood shrike	Sch-IV
Lalage sykesi	Black headed cochoo Shrike	Sch-IV
Artamus fuscus	Ashy Swallow Shrike	Sch-IV
Dicrurus macrocerus	Black Drongo	Sch-IV
Dicrurus longicaudatus	Grey Drongo	Sch-IV
Dissemurus paradiseus	Rackete tailed Drongo	Sch-IV
Oriolus oriolus	Indian Oriole	Sch-IV
Black Headed Oriole	Oriolus xanthornus	Sch-IV
Temenuchus pagodarum	Brahmny Myna	Sch-IV
Acridotheres tristicus	Common myna	Sch-IV
Ploceus philippines	Weaver bird	Sch-IV
Uroloncha striata	Spotted munia	Sch-IV
Passer domisticus	House Sparrow	Sch-IV
Redrumped Swallow	Hirundo daurica	Sch-IV
Motacilla cinerea	Grey wagtail	Sch-IV
Motacilla maderaspatensis	Large pied wagtail	Sch-IV
Cinnyris lotensis	Loten's sunbird	Sch-IV
Cinnyris asiatica	Purple Sunbird	Sch-IV
Brachypternus bengalensis	Malabar Golden acked wood	Sch-IV
Megalaima merulinus	Indian Cuckoo	Sch-IV
Hierococys varius	Common Hawk uckoo	Sch-IV

Technical Name	English Name/ Local Name	Conservation status as per Wild Life Protection Act (1972)
Eudynamis scolopaceus	Koel	Sch-IV
Centropus sinensis	Crow Pheasant	Sch-IV
Psittacula Krammeri	Rose ringed parakeet	Sch-IV
Coryllis vaeralis	Lorikeet	Sch-IV
Coracias benghalensis	Indian Roller	Sch-IV
Merops orinetalis	Common Bee Eater	Sch-IV
Merops leschenaulti	Chestnut headed Bee Eater	Sch-IV
Alcedo atthis	Common Kingfisher	Sch-IV
Halcyon smyrensis	White breasted kingfisher	Sch-IV
Microfus affinis	House swift	Sch-IV
Cyprirus parvus	Palm swift	Sch-IV
Caprimulgus asiaticus	Common Indian jar	Sch-IV
Tylo alba	Barn Owl	Sch-IV
Haliastur indus	Brahmny kite	Sch-IV
Milvus migrans	Pariah kite	Sch-IV
Circus aeruginosus	Marsh harrier	Sch-IV
Astur badius	Shikra	Sch-IV
Chalcophaps indica	Emerald Dove	Sch-IV
Lobvanella indicus	Redwattled Lapwing	Sch-IV
Lobpluvia malabaraica	Yellow wattled lapwing	Sch-IV
Anhinga melanogaster	Darter	Sch-IV
Egretta garzetta	Little Egret	Sch-IV
Bubulcus ibis	Cattle Egret	Sch-IV
Ardeola grayii	Pond Heron	Sch-IV
Anas querquedula	Gangney Teal	Sch-IV
Anas acuta	Common Teal	Sch-IV
Aythya feroma	White eyed Pochard	Sch-IV
Gallinula chlorpus	Moore hen	Sch-IV
Sterna albifrons	Indian River Tern	Sch-IV
Galerida malabarica	Malabar Crested Lark	Sch-IV
Reptiles		
Hemidactylus sp	House Lizard	Sch-IV
Calotes versicolor	Garden Lizard	Sch-IV
Chameleon zeylanicus	Lizard	Sch-IV
Varassnus benghalensis	Varanus	Part-II of Sch-II
Ptyas mucosus	Rat snake	Part-II of Sch-II
Naja naja	Cobra	Part-II of Sch-II
Hemibungarus sps	Indian coral snake	Sch-III
Bungarus candidus	Krait	Sch-III
Vipera russeli	Viper	Part-II of Sch-II
Python sp	Python	Part-II of Sch-I
Caloductyloides aureus	Golden Gecko	Part-II of Sch-I
Butterflies		
Triodes minos	Southern Birdwing	Sch-IV

Technical Name	English Name/ Local Name	Conservation status as per Wild Life Protection Act (1972)
Pachliopta hector	Crimson rose	Sch-IV
Papilo demoleus	Lime butterfly	Sch-IV
Graphium agamemnos	Tailed jay	Sch-IV
Papilo polymnstor	Blue mormon	Sch-IV
Junonia atlites	Grey pansey	Sch-IV
Juninia almana	Peacock pansey	Sch-IV
Neptis hylas	Common sailor	Sch-IV
Parantica aglea	Glassy tiger	Sch-IV
Amphibians		
Rana hexadactyla	Frog	Sch-IV
Rana tigrina	Bull frog	Sch-IV
Cocopus sps	Burrowing frog	Sch-IV
Mammals		
Lepus nigricollis	Hare	Sch-IV
Hyaena hyaena	Hyaena	Sch-III
Canis auries	Jackal	Part-II of Sch-II
Presbytis entellus	Langur	Part-II of Sch-II
Presbytis phayrei	Monkey	Part-I of Sch-I
Funambulus spp.	Squirrel	Sch-IV
Funambulus palmarum	Squirrel	Sch-IV
Sus sucrofa	Wild pig	Sch-III
Rattus norvegicus	Field mouse	Sch-IV
Herpestes edwardii	Common mongoose	Part-II of SCh-II
Bandicota indica	Bandicoot	Sch-IV
Bandicota bengalensis	Bandicoot	Sch-IV
Vulpus benghalensis	Wild fox	Part-II of Sch-II
Elephas maximus	Elephant	Part-I of Sch-I
Hysrix indica	Porcuppine	Sch-IV
Melsurus ursinus	Wild bear	Sch-III
Cervus unicolor	Sambhar	SCh-III
Axis axis	Deer	Sch-III
Panthera pardus	Leopard	Part-I of Sch-I
Manis crasssicaudata	Pangolin	Part-I of Sch-I
Bos gaurus	Bison	Part-I of sch-I
Cuon alpinus	Wild Dog	Part-II of Sch-II
Muntiacus muntajack	Barking Deer	Part-III

On comparison of the check list given in the Schedule-I of the Act and the list of wildlife recorded in the study area, it can be concluded that 7 species of schedule-I and 9 species of schedule II exist in the study area.

Wild Life Conservation

Flora and fauna data was collected from Forest Working Plans (1994-1999) of Rayagada and Kalahandi district. As per the Wild Life Act (1972), those animals which have been enlisted in the schedules of the Wildlife Act have been presented in the above table. The schedules are based on the species namely, rare, endangered, threatened, vulnerable etc. According to threat of extinction Schedule-I contains those species which need topmost priority, while II, III, IV and V have lesser degree of threat. Most of the avi-fauna are listed in Schedule–IV. As per the list of avi-faunal species, these are mostly local migrant species only. As per recent forest working plans and discussion with local forest officials, there are no migratory paths reported from the study area.

The following mitigation measures will be taken for protection of fauna in the study area:

- Educate the local people to develop awareness to protect the animals;
- Formulations of wild life protection committees in nearby villages to check the poaching and hunting;
- Protect and regulate the herbivorous animals in the forest area near to proposed mine area;
- Wild life patrolling committee would be formed to monitor the wild animals movement; and
- Develop thick green belt in and around the plant site with fruit bearing tree which will attract the avi-fauna in the study area and increase the aesthetic value of the area.

Aquatic Ecosystems

Introduction

Protecting the environment and making efficient use of natural resources are two of the most pressing demands in the present stage of social development. The task of preserving the purity of the atmosphere and water basins is of both national and global significance since there are no boundaries to the propagation of anthropogenic contaminants in the water. An essential pre requisite for the successful solution to these problems is to evaluate ecological impacts from the

baseline information and undertake effective management plan. So the objective of aquatic ecological study may be outlined as follows:

- To characterize water bodies like fresh waters;
- To understand their present biological status;
- To characterize water bodies with the help of biota;
- To understand the impact of proposed industrial and urbanization activities; and
- To suggest recommendations to counter adverse impacts, if any on the ecosystem.

To meet these objectives following methods were followed:

- Generating data by actual field sampling and analysis in these areas through field visits during study period;
- Discussion with local people to get the information for aquatic plants and aquatic animals; and
- Visit to local fishermen societies to study fish catch.

In order to get a clear picture and to assess the biological resources, two sampling locations were identified for Aquatic sampling. Samples were collected during the pre-monsoon season of 2007. The sampling locations are presented in **Table-3.44.** The respective sites are selected based on the density of vegetation, habitation and suggestions from locals.

Methodology Adopted for Aquatic Studies

Aquatic ecosystem close to the project area under investigation was considered for a detailed study. Water samples were considered for their physico-chemical characteristics. The details of aquatic ecological locations are presented in **Table-3.44.**

TABLE-3.44

DETAILS OF AQUATIC ECOLOGCAL SAMPLING LOCATIONS

Sr. No.	Code	Locations	Remarks
1	AE-1	River Vamsadhara near Lanjigarh village	Fresh water
2	AE-2	Nala near plant boundary	Fresh water

Biological Parameters

Plankton

Phytoplankton group reported from two locations are basillariophyceae, chlorophyceae, myxophyceae and euglenophyceae members. About 30 species of phytoplankton were reported from two locations. Density of phytoplankton group among the two locations was highest in lentic ecosystem (AE-2) and lowest in river Vamsadhara (AE-1). Dominance of *Bacillariophyceae* members followed by myxophyceae was observed in all the locations. The highest percentage of occurrence was *Synedra, Cymbellas sp of bacillariophyceae and Anabeana sp of* Myxophyceae and the lowest percentage was *Euglena sp* as observed during the study period. *Keratella monospina, Asplancha* and *Daphnia* are secondary dominant species in the area.

The list of plankton recorded in fresh water bodies in study during study period are presented in **Table-3.45.**

TABLE-3.45

LIST OF PLANKTONIC FLORA AND FAUNA FROM STUDY AREA

Phytoplankton	Zooplankton
Gyrosigma sp	*Keratella monospina*
Achananthes affinis	*Brachirous caudatus*
Gyrosigma accuminatus	*Asplancha brighwell*
Pandorina sp	*Colpidium colpoda*
Ankistrodesmus falcatus	*Daphnia sp*
Ankistrodesmus var.tumidus	*Ceriodaphnia reticulata*
Pediastrum boryanum	*Mesocyclops leuckarti*
Scenedesmus bijuga	*Mesocyclops hyalinus*
Melosira granulate	*Coleps hirsutus*
Cyclotella meneghiana	*Arcella sp*
Microcystis sp	*Actinophyros sp*
Navicula gracilis	*Asplancha sp*
Nitzschia gracilis	*Ceriodaphnia sp*
Chroococcus minutes	*Mesocyclops sp*
Spirulina princepes	-
Pinnularia braunii	-
Synedra tabulate	-
Amphora sp	-
Cymbella sp	-
Navicula radiosa	-
Chlorococcum sp	-
Pediastrum duplex	-
Pleurosigma sp	-
Facus sp	-
Euglena sp	-

Conclusions on Aquatic Ecology

Surface water samples were collected for biological analysis from two locations. Biological samples were analysed and estimated diversity index. Plankton diversity Index for phytoplankton and zooplankton varies from **2.59 to 3.02** and **2.35 to 2.65** respectively. The physico-chemical, biological parameters and diversity index reveals that the studied water bodies are slightly mesotrophic in nature. There was no study on fish or similar species in this area. However as plankton is an indicator of environment, it is apparent that due to mesotrophic distribution of planktons, the aquatic life is not yet polluted for any extinct criteria. It is been anticipated that without any surface water or groundwater contamination, the nearby aquatic ecosystem will be preserved in future even after the expansion project.

3.10 BASELINE SOCIO-ECONOMIC STATUS

The socioeconomic features around the plant site have been collected through primary and secondary data collection**.** The socioeconomic development is closely related to the growth of industrialization of the area. The balanced development of agriculture with the industry in that area will give rise to the development of the area. The setting up of Alumina refinery plant will promote growth of other ancillary industry and will definitely create additional employment potential of the area. The investment through industry will promote other activities like transportation, trade development and others. The local people will be benefited through trickledown effect. The district statistical handbook published by Directorate of Economic and Statistics, Orissa, Bhubaneswar and Census of India publication were referred to gather data on present baseline socioeconomic status of the area.

OBJECTIVE:

The main objectives are as follows:

i) To assess the impact of the project on agricultural situation;
ii) To examine the impact of the project on pattern of demand;
iii) To assess the in impact of the project on consumption pattern;
iv) To examine employment and income effects of the project;
v) To explore the possibility of local industrialization as an offshoot of the project;
vi) To examine the effect of the project on education status of the people in the study area; and
vii) To judge peoples perception regarding the project

3.10.1 DESCRIPTION OF STUDY AREA AND SOCIO-ECONOMIC PARAMETERS

The plant is situated at Lanjigarh in Kalahandi district of Orissa State. The plant site is about 5 km from Lanjigarh deposit and nearby villages are Bandagruha, Kapagruha, Basantapara and Sindhabahal. The plant is located on road connecting state highway SH-6 (Bhawanipatna - Rayagada) to Lanjigarh.

Niyamdangar forms a topographical high land in the area with an elevation of 1300 m above MSL. Niyamgiri plateau (1210m), Bamandeb dongar (1033 m) and Niyamgiri hill (1306 m) are the major elevated land features in the area. The valleys are mostly narrow and well dissected. The nearest district town is Bhawanipatna at about 65-km (by road). The nearest railway station is at Muniguda at a distance about 25.0 km (by road).

The present District of Kalahandi was in ancient time's part of South Kosala. It was a princely state. The princely state of Kalahandi was merged in Orissa along with other princely states on 1st November 1949. The district is endowed with a large no. of big and small rivers. The district is covered by two major river basins i.e. Mahanadi river basin and Godavari river basin. The Tel River is a major tributary of Mahanadi River. The Indravati River is a major tributary of Godavari River. Tel is the longest and most important river of the District. Amathaguda, Asurgarh, Ampani, Belkhandi, Udahandi, Junagarh, Karlapat, Lanjigarh, Mohangiri, Phurlijharan & Rabandarh are some of the visiting places of this district.

The proposed project is located in Lanjigarh CD Block. The socio-economic feature of Kalahandi district is presented in the **Table-3.46 & 3.47**.

Table: 3.46 Socio Economic Features

(Administrative Set Up, Respective District)

Number of Sub-Division	2
Number of Tehsils	7
Number of Municipality	1
Number of N.A.C.	5
Number of Blocks	18
Number of Police Station	11
Number of Gram Panchayat	273
No. of Inhabited Villages	2711
No. of Uninhabited Villages	153
Total Number of villages	2236
Total no.of Livestock population	22.70 lakhs
Number of tube-wells sunk (excluding sanitary wells)	5,121 nos

Source: District Primary Census Statistics of Rayagada and Kalahandi

Table-3.47: Socio Economic Features (Position of District in States Economy for Kalahandi District vis-a-vis Orissa), 2001 Census

Sl. No.	Item	Magnitude	
		Kalahandi	***Orissa State***
1.	Total Population (2001 census) in '000 numbers		
	Rural	1,235,275	31211
	Urban	100,219	5496
	Total	1,335,494	36707
2.	SC Population in '000 nos.	236,019	6082
3.	ST Population in 000 nos.	382,573	8145
4.	%ge of urban population	7.5	14.97
5.	Sex ratio (Female per 1000 male)	1,000	972
6.	Population Density (1991 census)	160	236
7.	Decennial Growth rate (1991-2001)	19.50	20.06
8.	Workers (in '000 numbers)		
	Total workers	620,950	14273
	Main workers.	382,050	9573
	Marginal Workers	23,900	4700
	Cultivators	183,984	4238
	Agricultural laborers	312,515	5001
9.	Literacy rates		
	Male	62.7	75.95
	Female	29.3	50.97
	Total	45.9	63.61

Source: Directorate of Economic and Statistics, Orissa, Bhubaneswar

3.10.2 Methodology

The methodology adopted for the study is based on review of secondary data such as the District Census statistics of Rayagada and Kalahandi districts, 2001 for the parameters of demography and occupational structure of people within the study area of 10-km radius around the proposed plant.

The sociological aspects of this study include human settlements, demography, social such as Scheduled castes and Scheduled Tribes and literacy levels besides infrastructure facilities available in the study area. The economic aspects include occupational structure of workers. The information on socio-economic aspects of the study area has been compiled from secondary sources, which mainly include Census data of 2001 Census, the latest census records available at the village level, besides other public agencies indicated in the above section. The salient features of the demographic and socio-economic aspects are described in the following sections. The socio-economic status of the study area is listed in **Table-3.48.**

Table 3.48: Socio-economic Status of the Study area

Lanjigarh CD Block **Source: District Census Handbook**

Sl. No.	Name of Village	Area of Village (in Ha)	No of House holds	Total Population	SC	ST	Sex Ratio	Workers				Literacy Rate (%)
								Total	Main Workers	Marginal Workers	Non Workers	
1	Balabhadrapur	94.70	102	458	87	136	991	265	126	139	193	34.5
2	Bandhguda	38.45	40	160	47	80	905	7	40	47	73	22.5
3	Basantpada	41.28	131	649	68	258	1016	277	101	176	372	94.2
4	Batelima	147.71	60	276	57	56	971	147	129	18	129	19.5
5	Belamba	64,75	34	176	24	152	1146	82	51	31	94	16.3
6	Bhatguda	157.42	90	394	18	223	990	189	123	66	205	42.2
7	Bilatipadar	122.62	51	197	2	68	858	81	63	18	116	48.4
8	Boringpadar	232.69	64	265	31	178	1103	107	58	49	158	15.1
9	Bundel	85.39	25	144	7	137	1182	62	28	34	82	23.7
10	Champadeipur	176.44	141	652	154	85	958	388	348	40	264	41.0
11	Chandanpur	308.37	121	550	235	54	1030	348	160	188	202	26.3
12	Chhatarpur	134.36	173	726	340	186	1039	444	270	174	282	40.0
13	Dengasargi	41.68	23	91	0	91	1116	33	1	32	58	6.0
14	Goipata	73.25	20	85	12	70	1024	46	23	23	39	17.6
15	Gopinathpur	212.06	104	498	183	35	1075	281	139	142	217	51.8
16	Harekrishnapur	222.58	145	702	6	183	1041	325	139	186	377	18.0
17	Lanjigarh	478.74	685	2913	839	471	932	1257	572	685	1656	45.2
18	Karkamaska	140.83	32	174	6	168	1260	121	31	90	53	1.3
19	Kutunipadar	250.50	56	221	13	131	1009	128	92	36	93	8.0
20	Niali	188.58	89	392	108	39	1142	228	88	140	164	51.9
21	Sindhibahal	69.61	50	218	79	139	1319	122	52	70	96	16.6
22	Betapara	211.65	52	207	56	107	1167	55	55	0	152	25.7

23	Dhaunrabhata	157.83	9	36	0	36	1400	25	13	12	1	3.3
24	Jamchuan	32.78	19	83	0	83	1184	47	47	0	36	1.5
25	Khalguda	162.28	2	13	0	13	857	4	2	2	9	10.0
26	Jagannathpur	400.64	164	725	308	354	1054	378	148	230	347	37.2
27	Ambaguda	29.54	12	69	0	69	971	44	37	7	25	6.0
28	Gandhani	88.63	7	38	0	38	1000	21	19	2	17	21.4
29	Damenjhula	157.02	31	155	0	155	1279	85	43	42	70	9.0
30	Ghodapokhari	148.12	30	150	55	95	1459	50	33	17	100	3.8
31	Padmathopa	158.64	86	344	344	0	944	200	99	101	144	24.2
32	Kashibadi	185.75	48	203	16	112	1030	122	46	76	81	19.0
33	Kenduguda	127.58	7	21	0	0	1100	14	9	5	7	11.1
34	Rengopali	165.11	53	210	33	176	1000	129	66	63	81	12.5
36	Kotabundel	21.04	8	36	0	35	1250	22	11	11	14	16.7
37	Barpali	38.85	15	61	33	28	906	39	2	37	22	0.0
38	Karlijodi	93.48	38	180	0	180	1195	120	40	47	73	22.5
39	Litibundel	82.15	55	276	85	191	1029	167	18	149	109	2.0
40	Bandhaguda	38.45	40	160	47	80	905	87	40	47	73	22.5
42	Panchakudi	167.54	29	114	0	86	1192	63	58	5	51	9.9
43	Pratibeda	60.70	41	150	16	0	1113	90	44	46	60	36.4
44	Kutrubandha	89.03	9	60	0	55	1000	35	17	18	25	23.1
45	Rajendrapr	87.82	80	317	134	167	1086	230	101	129	87	22.4
46	Sargiheju	152.16	32	141	0	11	1043	86	65	21	55	23.8
47	Saplukucha	159.04	33	144	0	144	1182	89	53	36	55	13.0
48	Banigaon	101.98	26	129	0	129	843	80	34	46	49	26.0
49	Bhatajhari	17.81	26	104	0	101	926	62	30	32	42	11.5
50	Netrei	153.38	7	33	0	33	941	19	2	17	14	0.0

3.10.3 Demography

As per the study conducted by IRMA, the overall economic condition has improved since the inception of the existing plant with reduction in unemployment ratio, improvement in drinking water conditions, and upbringing of schools for primary education. Thus it has been an upward trend in the socio-economic status of the people with the corporate social responsibility programs undertaken by VAL since its inception.

Socio-economic Analysis

Kalahandi is a district well known as Mahakantra (great forest) in ancient India. But now, it is no more than a wasteland. The people of this land, who were once self-sufficient and self contented with abundant forest produce and ample harvest, are now lacking the firewood and facing food problem. The land of Kalahandi, which was famous for paddy cultivation, is now depending upon external aid. Depending on food gathering and food process, the people of this region were self-sufficient. Their multi-village interdependent-economy shaped an integrated worldview in respect of their social, economic and ideological spheres. Kalahandi, also known as Karunda Mandal is the treasure of precious stones like karandam (Manik), Garnet (red stone), and Beruz Neelam (blue stone) etc. The more interesting fact is that since 1985 Kalahandi has been well-known for its misfortune being affected by acute drought, but merchants from distant places of our country and abroad have been arriving at Kalahandi to build up their good fortunes, exploiting the native soil for getting precious stones. On the other hand the native people of this land, being incapable of providing food to members of their poor family are leaving their motherland, migrating to other parts of the country.

Kalahandi is known for drought situation that has broken the economic backbone of the cultivators. The bulk of population, which constitutes the landless agricultural labourers, becomes unemployed due to suspension of all sorts of agricultural operations. Besides a long history of drought, the socio-economic traditions followed in the society are the main cause behind the class distinction among the people of Kalahandi. The fact that the agricultural products and the rural Kalahandi produce are being controlled by the urban businessmen is one of the causes of social class distinction. Moreover the custom of loan and mortgage current in the society are the major sources of exploitation. Along with the

drought the problem such as rural unemployment, non-industrialization, growth of population and rapid deforestation are some of the major problems of Kalahandi. Hence being gripped both by nature and men, the rural inhabitant of Kalahandi has found no other way of survival.

As a result either migrate or scout for wage employment opportunities are the only alternatives. Kalahandi district boasts of its rich natural resources, these are being degraded over a period of time. The degradation of natural resources has not only reduced the economic base of the district but also affected the environment adversely. The adverse impacts like change in climatic condition, increased floods, decreased productivity, water shortage, increased infant mortality and morbidity rate etc are some of the outcomes of continuing degradation. In the absence of proper measures to reduce the degradation of natural resources the problem will only aggravate.

The growth of industrial sectors and infrastructure developments in and around the agriculture dominant areas, villages and towns is bound to create its impact on the socio-economic aspects of the local population. The impacts may be positive or negative depending upon the developmental activity. To assess the impacts on the socio-economics of the local people, it is necessary to study the existing socio-economic status of the local population, which will be helpful for making efforts to further improve the quality of life in the area of study. To study the socio-economic aspects of people in the study area around the proposed plant, the required data has been collected from various secondary sources.

Demographic Aspects

i) Distribution of Population

As per 2001 census the study area consisted of 38465 persons. The distribution of population in the study area is shown in **Table-3.49**.

TABLE-3.49: DISTRIBUTION OF POPULATION IN GENERAL STUDY AREA

Particulars	General Study Area
No. of Households	9057
Male Population	18945
Female Population	19520
Total Population	38465
Average Household Size	4.25
Sex ratio	1030
Density of population/km^2	169.43

Source: District Primary Census Statistics of Rayagada and Kalahandi districts, 2001

The males and females constitute to about 49.25% and 50.75% in the study area.

ii) Average Household Size

The study area had an average family size of 4.25 persons per household in 2001. This is a moderate family when compared with other parts of the district.

iii) Population Density

The density of population of the study area with about 22703 ha area works out to about 169.43 persons per $km^{2.}$

iv) Sex Ratio

The configuration of male and female indicates that the males constitute to about 49.25% and females to 50.75% of the total population. The sex ratio i.e. the number of females per 1000 males indirectly reveals certain sociological aspects in relation with female births, infant mortality among female children and single person family structure, a resultant of migration of industrial workers. The study area on an average has 1030 females per 1000 males, which highlights that the females out number the males.

v) Social Structure

In the study area about 19.41% population belonged to scheduled castes (SC) and 42.77% to the scheduled tribes (ST) indicating that about 62.17% population in the study area belong to the socially weaker sections. The distribution of population in the study area by social structure is shown in **Table-3.50**

TABLE-3.50: DISTRIBUTION OF POPULATION BY SOCIAL STRUCTURE

Sr. No.	Particulars	Study Area Figures
1	Scheduled Castes	7465
2	% to Total Population	19.41
3	Scheduled Tribes	16450
4	% to Total Population	42.77
5	Total SC and ST	23915
6	% to Total Population	62.17
7	Other Castes	14550
8	% to Total Population	37.83

Source: District Primary Census Statistics of Rayagada and Kalahandi districts, 2001

3.10.4 Literacy Levels

The analysis of the literacy levels in the study area reveals a lower literacy rate in the study area. The study area experienced a low literacy rate of 25.23. % in 2001. The distribution of literates and literacy rates in the study area is given in **Table-3.51.**

TABLE-3.51: DISTRIBUTION OF LITERATES AND LITERACY RATES

Sr. No.	Particulars	Study Area Figures
1	Total Literates	9706
2	Average Literacy (%)	25.23
3	Male Literacy (%)	37.49
4	Female Literacy (%)	13.34
5	Male Literates	7102
6	% to Study area Literates	73.17
7	Female Literates	2604
8	% to Study area Literates	26.83

Source: District Primary Census Statistics of Rayagada and Kalahandi districts, 2001

The male literacy i.e. the percentage of literate males to the total males of the study area works out to be 37.49%. The female literacy rate, which is an important indicator for social change, is observed to be only 18.46% in the study area. This indicates there is a considerable need for sociological development in the region.

3.10.5 Availability of Infrastructure

The infrastructure and amenities available in the study area denotes the economic well being of the region. The study area as a whole possesses poor to moderate level of infrastructure facilities.

A review of infrastructure facilities available in the area has been done based on the information given in District Census Handbook. The Infrastructure facilities available in the study area are described in the subsequent sections.

1. Educational Facilities

The educational facilities are not evenly distributed in the area. It has a good level of educational facilities including 55 primary schools, 5 middle schools 2 high schools and 6 other educational institutions. Some smaller villages are devoid of

any educational facility. The available educational facilities and the educational status of the study area are given in **Table-3.52**.

TABLE-3.52: EDUCATIONAL FACILITIES

Sr. No.	Institution	Total
1	Primary Schools	55
2	Middle Schools	5
3	High Schools	2
4	Other Education Center	1

Source: District Primary Census Hand Book of Rayagada and Kalahandi districts

2. Health Services

Different types of health facilities available in the study area include primary health center, sub- center, dispensary, family planning canter, registered practitioners and a couple of health workers. The available health facilities in the rural areas of the study area are given in **Table-3.53.**

TABLE-3.53: HEALTH FACILITIES

Sr. No.	Type of Institution	Number of Institutions in Study Area
1	Primary Health Center	1
2	Sub-Center	1
3	Dispensaries	1
4	Registered Practitioners	1
5	Family Planning Centers	1
6	Others	1

Source: District Primary Census Hand Books of Rayagada and Kalahandi districts

3. Access to Drinking Water

Water supply in the study area is mainly from wells, tanks and tube-wells. Almost all villages fetch water from wells and tube wells. Considerable numbers of villages depend on village tanks and river for water.

4. Transport and Communication

The study area is served by rail and road transport facilities. As a whole, the study area has a poor level of communication network. About 11 villages of the study area have bus facility and one village has the railway station facility. About 28 villages have pucca approach roads while the remaining villages have

kachcha approach roads only. Additional access roads are been constructed by the Company for connectivity between rural and urban areas of the said district, with accessibility to the plant site.

With the business growing in-and-around Lanjigarh area, the local tele-communication infrastructure has expanded to various Wireless Providers within this area. The communication outlines are drawn in **Table-3.54.**

Table-3.54: COMMUNICATION

Length of Railway route	38 Kms.
Length of National Highway	129 Kms
Length of State Highway	255 kms.
Length of Major Dist. Road	282 Kms
Length of C.V.Rs.	269 Kms.
Length of other Dist. Road	111 Kms
Length of P.S. Roads	517 Kms.
Length of G.P. Roads	9955 Kms

5. Posts & Telegraphs

The study area had poor level of Post and Telegraphic services. Only 7 villages in the study area have post office facilities.

6. Electricity Supply

Most of the villages in the study area are electrified and electricity is supplied for domestic, agricultural and public lighting purposes.

7. Banking

Banking units of SBI with ATM Facility has been installed at Lanjigarh for public access and utilization.

3.10.6 Economic Profile

3.10.6.1 Agriculture

Over seventy percent of the population of Kalahandi district depends on Agriculture. The present cultivable area in the district is 3, 93,550 Ha and the respective crop areas and crop pattern are listed in **Table-3.55 and Table 3.56** respectively**.**

Table-3.55: Area under Different Crops

Area under different Crops		**Area in '000 Ha**	**Production (in '000 MT)**
Cereals	Autumn Rice	98	90
	Winter Rice	139	194
	Summer Rice	29	59
	Total Rice	266	342
	Jowar	1.17	0.55
	Bajra	0.04	0.02
	Maize	1.51	1.12
	Ragi	3.10	1.32
	Wheat	0.07	0.10
	Small Millets	0.45	0.17
	Total Cereals	**272.74**	**345.28**
Pulses	Mung	5.58	0.98
	Biri	5.06	0.68
	Kulthi	5.98	1.00
	Other Pulses	29.29	20.81
	Total Pulses	46.18	23.47
Total Food Grains		**318.12**	**368.75**

In Kalahandi district, paddy is the principal crop, which accounts for 69% of gross cropped area. The other important crops grown in the districts are pulses grown in 12% of the cropped area followed by oil seeds, which is grown in 5%, fiber in 4%, vegetable in 2% and other food crops like spices and condiments etc.

Table-3.56: Crop Patterns and their distribution

Area under different Crops		**Area in '000 Ha**	**Production in '000 MT**
Oil Seeds	Ground Nut	1.83	1.54
	Sesamum (Til)	2.60	0.27
	Mustard	0.54	0.06
	Lin seed	3.10	1.38
	Caster Seed	2.44	1.71
	Other Oil Seeds	8.54	3.36
Total Oil Seeds		**19.05**	**8.32**
Vegetables	Potato	Scarce	Scarce
	Onion	1.21	11.37
	Others	4.73	44.59
Total Vegetables		**5.94**	**55.96**
Cash Crops	Sugarcane	1.14	50.35
	Tobacco	0.43	0.11

Total Cash Crops		**1.57**	**50.46**
Condiments & Spices	Chilies	1.70	1.49
	Ginger	0.09	0.16
	Turmeric	0.11	0.25
	Other Spices	1.41	1.68
Total Condiments & Spices		**3.31**	**3.58**

Massive Waste Land

Massive cultivable wasteland is available and this wasteland with the help of land and water conservation measures can be turned into productive assets for livelihood. Hence efforts are required to initiate agri-horti-pisiculture practices along with micro-watershed projects through massive labor-intensive operations to transform the available wasteland into productive territories. This will also help the burgeoning landless and BPL families immensely. The hectare wise distribution of land for the whole area is listed in **Table 3.57**.

Table-3.57

Hectare-wise distribution of land

Agriculture	
Geographical Area	7920 Sq. KM
Normal rainfall	1378.20 mm
Actual rainfall (2000)	1291.80 mm
Total cultivated area	**3,93,550 Ha**
i) High Land	2,12,800 Ha.
ii) Medium Land	1,09,750 Ha.
iii) Low Land	71,000 Ha.
Total Paddy Land	**1,83,000 Ha**
i) High Land	49,809 Ha.
ii) Medium Land.	66,696 Ha
iii)Low Land	66,955 Ha.
Other Crop Area:	2,10,090 Ha

3.10.6.2 Occupational Structure

The occupational structure of residents in the study area is studied with reference to main workers, marginal workers and non-workers. The main workers include

10 categories of workers defined by the Census Department consisting of cultivators, agricultural laborers, those engaged in household industry and other than household industry and other services.

The marginal workers are those workers engaged in some work for a period of less than six months during the reference year prior to the census survey. The non-workers include those engaged in unpaid household duties, students, retired persons, dependents, beggars, vagrants etc.; institutional inmates or all other non-workers who do not fall under the above categories.

As per 2001 census records altogether the main workers works out to 29.59% of the total population. The marginal workers and non-workers constitute to 21.70% and 48.71% of the total population respectively. The occupational structure of the study area is shown in **Table-3.58.**

TABLE-3.58: OCCUPATIONAL STRUCTURE

Sr. No	Occupation	Study Area	
		No. of Workers	% to Population
1	Total Main Workers	11383	29.59
	Male	8302	21.58
	Female	3081	8.01
2	Marginal Workers	8348	21.70
	Male	2470	6.42
	Female	5878	15.28
3	Non-Workers	18734	48.71
	Male	8173	21.25
	Female	10561	27.46
Total Population		**38465**	**100.00**

Source: District Primary Census Statistics of Rayagada and Kalahandi, 2001

CHAPTER-4
IMPACT IDENTIFICATION

After screening and scoping the identification of potentially significant environmental impacts constitute one of the preliminary steps of Environmental Impact Assessment (EIA). There are three principal methods for identifying environmental effects and impacts; i.e checklists, matrices and flow diagram.

4.1 CHECKLISTS

Checklists are comprehensive lists of environmental effects and impact indicators designed to stimulate the analysts to think broadly about possible consequence of contemplated action.

4.2 MATRICES

Matrices typically employ a list of human action in addition to a list of impact indicators. The two are related in a matrix, which can be used to identify cause and affect relationships.

4.3 FLOW DIAGRAMS (NETWORK METHOD)

Flow diagrams are sometimes used to identify action-effect-impact relationship. The flow diagram permits the analysts to visualize the connection between action and impact. This method is best suited to single project assessments, and is not recommended for large regional actions.

The proposed Alumina refinery plant expansion project will take up the debottlenecking of the existing plant including that of pollution control equipment and incorporation of latest innovative design features in the expansion project to increase production, to improve productivity and to minimise the adverse impacts of the environment pollution. The environmental attributes that may be affected due to the construction and operation of the proposed project are:

- Air Environment
- Noise Environment
- Surface Water Environment
- Ground Water Environment
- Land environment
- Biological Environment

- Socio-Economic and Cultural Environment
- Infrastructure
- Aesthetics

The Construction, operation and future activities are considered to identify the possible impact. The matrix method has been chosen to list the potential impacts of the proposed project. The activities have been arranged in columns and the environmental attributes in the row of the matrix. The impact identification matrix is shown in the **Table - 4.1.** The impacts whether, beneficial or adverse have been analyzed in the Chapter-5 on prediction and evaluation of impacts.

Table - 4.1: Impact identification Matrix

ACTIVITY	CONSTRUCTION			OPERATION			POST OPERATION		
Attribute	Earth work	Mech. fabrication	Labour Force	Raw material handling & storage	Manufacturing process	Pollution control and Env. Mgt.	Industrialization	Transport	Urbanization
Air	–			–	–	+	–	–	–
Surface water Quality	–		–	–	–	+	–		–
Ground water quality	–			–	–	–	–		–
Water resources			–		–		–		–
Noise	–	–		–	–		–	–	–
Soil	–			–	–	–			
Land Use	–			–		–	–		–
Ecology	–					–	–		
Economic benefits	+	+	+		+		+	+	+
Employment	+	+	+	+	+		+	+	+
Infrastructure development	+			+			+	+	+
Peripheral social			+			+	+		+

development									
Health safety	–	–	–		–		–	–	+
Aesthetic	–			–	–		–	–	–
Displacement and rehabilitation	–			–			–		–

– **Negative or adverse Impact**

+ **Positive or beneficial Impact**

CHAPTER-5
IMPACT PREDICTION & EVALUATION

The description of the proposed project and the existing baseline status in the core as well as in the buffer zone has been dealt in detail in the earlier chapters. These information forms the basis of Environmental Impact Assessment (EIA) of the proposed project and the same is discussed in this chapter with prediction and evaluation of these impacts.

5.1 OBJECTIVE OF EIA

The objective of having an EIA for the proposed project under consideration is to identify the potential impacts on the site specific prevailing environmental setting and degree of impacts. This will enable to draw up an appropriate Environment Management Plan (EMP) to consider other alternatives so as to ensure that the proposed project activity does not impair the present environmental setting.

5.2 ENVIRONMENTAL IMPACTS DURING CONSTRUCTION

Construction activity will constitute excavation, civil construction and mechanical erection. Transport of various construction materials and stockpiling them will also be a major activity. These activities will be of transient nature and its impact on environment will be of significance during construction phase only. Several temporary measures will be taken during construction period to minimize the impact. The potential impact and probable source are summarized below in **Table- 5.1**

Table- 5.1: Potential Impacts with Probable Source

Discipline	Potential Impacts	Probable Source
Water Quality	Increase in suspended solids due to soil run-off during heavy precipitation	Soil Erosion
Air Quality	Increase in dust and NOx concentration	Heavy vehicular movement
Noise	Increase in noise level	Construction equipment
Terrestrial Ecology	Clearing of Vegetation	During construction
Aquatic Ecology	Impact on surface and ground water resources	No specific Impact is predicted

5.2.1 Impact on Ambient Air Quality

Civil work and erection of structures are to be undertaken during construction phase. These construction activities along with transportation of construction material shall generate dust. Welding of different structures also produces gases. But these dusts are inorganic in nature and are generated at ground level and due to the very nature of dust, it is not expected to be carried over to long distance to cause inconvenience to surrounding people. The impact on ambient air quality due to fugitive dust generated during construction period is not permanent in nature, and will cease with the completion of construction activity. The bulk of civil work is expected to be completed within 12 months. With the completion of construction phase, the impact on air quality due to fugitive dust will be minimized and this impact is reversible in nature. However, fugitive dust emissions will be controlled by sprinkling of water at all locations prone. Considering the meteorlogical data of the area VAL will construct its town ship in the leeword side of the proposed project.

5.2.2 Impact on Water Environment

Water requirement during construction activity will be met from the existing facility A lot of debris, and other solid waste are expected to be generated during construction period, and during monsoon with the surface runoff, the debris may be washed away to contribute suspended solids in nearby stream. This will be minimized through provision of temporary garland drains around the dumping site of debris. Again this is temporary in nature and shall be ceased with the completion of the project.

5.2.3 Impact on Noise & Soil Quality

The major sources of noise during the construction phase are vehicular traffic, construction equipment like dozers, scrapers, concrete mixers, cranes, generators, pumps, compressors, rock drills, pneumatic tools, saws, vibrators etc. The operation of these equipments will generate noise ranging between 70-85 dB (A). The noise produced during the construction will have significant impact on the existing ambient noise levels. The major work will be carried out during the daytime. The construction equipment may have high noise levels, which can affect the personnel, operating the machines. Use of proper personal protective

equipment will mitigate any significant impact of the noise generated by such equipment.

There won't be any toxic chemical or waste to be disposed off on ground either during construction or during operation. Therefore the observed soil quality will be protected in as-is condition for the said project after implementation.

5.2.4 Impact on Ecology

The proposed layout sites do not cover any area with thick vegetation and ecological sensitive area, thus the construction activity will have least impact on the ecology of the area. It will have no impact on the buffer zone. Due to zero discharge condition of the project, there would be no water contamination and hence degradation of the aquatic life.

5.2.5 Socio-Economic Impacts

The construction activity will help in infusing a lot of funds in the area and thus will generate some direct/indirect employment opportunity, infrastructure development and business opportunities. Socioeconomic conditions of the area will improve during construction phase of the project. The R & R package that is being given to project affected peoples is as per the R & R policy of Govt. of Orissa is been stricktly followed with intensive effort towards CSR activities and peripheral development, which has not only provided shelter and job, but has created a separate economic upliftment of the local community. The CSR report is enclosed in **Annexure-III** for detailed review.

5.3 POLLUTION POTENTIAL DURING OPERATIONAL PHASE

5.3.1 AIR POLLUTION

The plant processes like Grinding, Pre-desilication, Digestion, Calcination CPP etc are prone to air pollution. It may be observed that heat, dust, SO_2, CO and NO_X to the air environment is the prime pollution potential from the proposed project. However with suitable EMP it is possible to run the Refinery Plant & other process equipments without endangering the environment. The sources and types of air pollutant during operation phase are listed in **Table-5.2**.

Table No. 5.2: Sources and Type of air Pollution from the Proposed Project

Sr. No.	Unit	Emissions		
		SO_2 (kg/hr)	**NOx (kg/hr)**	**SPM (kg/hr)**
1	Calciner [from each stack]	575 (with 3.5% S)	37.5	7.8 (after ESP with 95% of efficiency)
2	Co-generation plant	1245 (with 0.5%S)	-	120 (after ESP with 95% efficiency)
3	Bauxite transport and crushing	-	-	Bauxite dust 3.2
4	Coal handling area	-	-	Coal dust 4.7
5	Lime handling area	-	-	Lime dust 0.68 based on the lime usage in T/T of Alumina production

5.3.2 WATER POLLUTION

Effluent from various units will be treated separately depending upon the effluent characteristics. Liquid effluents in alumina production are generated from number of units. There are five types of liquid effluents, namely:

1] Alkaline wastewater from various sources of the refinery plant
2] Cooling Tower and boiler Blow down;
3] DM Plant Regeneration;
4] Filter Back wash; and
5] Domestic sewage

5.3.3 SOLID WASTE

Red mud and ash are the two major solid wastes this plant generates. The proposed plant will generate 7.5 million tons of red mud and 0.86 million tons of ash every year based on the existing generation of solid waste per ton of finished product. While the ash will be slightly alkaline the red mud will be highly alkaline with the pH ranging around 12 and 14. Therefore disposal of red mud will require special method to be adopted so that it does not affect the ground and surface water. The solid waste inventory is listed illustrated in **Table 5.3**.

Table-5.3: Solid Waste Inventory

Solid Waste	Source of Solid Waste	Unit of Measure	Quantity for Existing Plant	Quantity for Expansion	Mode of Disposal
Red Mud	Settler & washer	MMTPA	1.28	7.5	Red Mud Pond via HCSD System
Ash	Coal Fired Boiler	MMTPA	0.23	0.86	It will be sold to down stream industries like cement, brick making and agriculture. The balance will be disposed off to ash pond using High Concentration Slurry Disposal (HCSD) system
MSW (Municipality Solid Waste)	Domestic	TPD	1.2	6.7	Composting Facility
Sewage Sludge	Domestic	Kg/day	14	60	The organic portion of solid generated in the STP will be used as manure in greenbelt development after composting.

5.4 IMPACT ASSESSMENT & PREDICTION DURING OPERATIONAL PHASE

With the expansion of the Alumina Refinery Plant along with Co-generation Power Plant, the impacts both beneficial and adverse are anticipated on Ambient Air

Quality, Noise level, Water, Land Use, Soil, Ecology and beneficial impacts on Socioeconomic Environment, which is dealt in detail in subsequent paragraphs. The anticipated environmental impacts are predicted in **Table-5.4**.

Table-5.4
ANTICIPATED ENVIRONMENTAL IMPACTS

Operation Impact	**Potential Negative Impacts**	**Probable Source**
Air Quality	Increase in SO_2, NO_x and SPM level in ambient air	Alumina Plant and Co-generation plant
	Increase in NO_x concentration	Alumina Plant and Co-generation plant
	Increase in SPM in ambient air	Vehicular traffic
		Coal, Bauxite & Lime handling area
Water Quality	Deterioration of surface water quality	Discharge from plant rejects, filter backwash, service water waste and effluents
Noise	Increase in noise levels in the plant area	Equipment in main plant and auxiliaries
Terrestrial Ecology	Impact on plant species	Emissions from stacks
Aquatic Ecology	Impact on aquatic species	Wastewater, if any, from Alumina plant, heat exchanger, cooling tower, power plant etc.
Demography and Socio-Economics	Strain on existing amenities like housing, water sources, sanitation, medical and infrastructure facilities	Influx of people (employees as well as contractor's employees/ Laborers)
Land environment	Depletion of cultivable area, if any	Land acquisition for red mud pond, ash pond and township

5.4.1 Impact on Air Environment

The impacts on air environment from the proposed expansion and debottlenecking of Alumina plant with coal based Co- generation plant depends on various factors like production capacity, plant configuration, process technology involved, type of raw material used, type of fuel used, in plant control measures adopted, operation and maintenance of the various units of the plant. Apart from these, there will be other activities associated e.g., transportation of raw material and finished products, storage facilities, and material handling within plant premises which may contribute to air pollution.

The coal based co- generation plant and calcination operations shall affect the air quality parameters like RPM, SPM, SO_2 and NO_x. The other process units like raw material crushing and other supporting services like storage and transportation will emit lot of dust in the form of RPM & SPM. Needless to say that adequate air pollution control measures will be taken up both at design and operational stage to conform to the emission parameters within the standard limit. The project proponent will take necessary action by providing closed containers for transportation of raw materials, by products and end products to avoid fugitive emission during transportation. Necessary dust scrubber and suppression facility will be provided at the unloading and loading points.

The impact on air quality due to emission from a single source or group of sources is evaluated by use of mathematical models. When the air pollutants enter into the atmosphere, they transport and diffuse in the atmosphere resulting in pollutant dilution. Air meteorology is important factor in pollution status evaluation. Air quality models are designed to simulate these processes mathematically, and relate emission of primary pollutants to the resulting down wind air. The model inputs are emission load and nature, meteorology and topographic features.

5.4.1.1 Plant Emissions

Stacks are major sources of air pollution from the proposed plant. Expansion Project is to be provided with necessary air pollution control devices like Electro Static Precipitators (ESP), bag filters, recuperators, dust catchers, etc to control dust and gases and also limit emission within the prescribed standard. Emission factors, air handling capacity of the proposed installation and emission norm have

been used to estimate amount of emission from the proposed plant with the height of emission. The emission inventory is prepared on the basics of following assumptions and calculations.

5.4.1.2 Emission Calculation

The detail calculation of the Stack emissions for the proposed expansion is listed in **Table 5.5**. The SO_2 and NOx calculations are based on the sulphur content of the fuel and the design parameters are derived from the project plan of the proposed expansion project of alumina refinery of VAL. While preparing the inventory of emission, the existing plant's emission has also been taken in to account though the same has already been addressed in the baseline data. The reason for taking this is because of the increase in the capacity of the equipment due to debottlenecking.

Table- 5.5

Emission Inventory in Air Pollution - Details of Stack and emissions data

Source	X-	Y-	Height (m)	Dia (m)	Temp. (^{0}C)	Velocity (m/s)	Flow (Nm^3/hr)	TSP (gm/sec)	SO2 (gm/sec)	NOx (gm/sec)	APC Equipment
PP(E)	10000	10000	145	3.0	145	23.2	385572	10.7	101.7	69.5	ESP
PP(P)	10120	9700	145	3.0	145	23.2	385572	10.7	101.7	69.5	ESP
Cal 1(E)	9457	10501	120	2.72	150	24	296048	8.2	93.6	16.4	ESP
Cal 2(E)	9481	10501	120	2.72	150	24	296048	8.2	93.6	16.4	ESP
Cal3(P)	9487	10501	120	2.72	150	24	296048	8.2	93.6	16.4	ESP
Cal4(P)	9514	10525	120	2.72	150	24	296048	8.2	93.6	16.4	ESP
Cal5(P)	9550	10525	120	2.72	150	24	296048	8.2	93.6	16.4	ESP

All the stacks will be provided with suitable port hole and platform for stack monitoring.

5.4.1.3 Air Quality Modeling and Prediction

The impacts of primary air pollutants on air quality due to emission from single source or a group of sources is evaluated by the use of mathematical models. The Industrial Source Complex- Short Term Version 3 (ISCST-3) is the state of the art model with USEPA, which is extensively used for predicting ground level concentration (GLC) of conservative pollutants from point, area and volume

sources. The impacts of conservative pollutants were predicted using this air quality model keeping in view the plain terrain at and around the ground site. ISCST-3 is an hour-by-hour steady state Gaussian Model.

For a steady state Gaussian plume the hourly concentration at downwind distance x (meters) and cross wind distance y (meters) is given by.

$$\text{Concentration} = \frac{QKVD}{2\pi U_s \sigma_y \sigma_z} \exp\left[-0.5(y/\sigma_y)^2\right]$$

Where

Q = pollutant emission rate (mass per unit time)

σ_Y, σ_z,= standard deviation of lateral and vertical concentration distribution (m)

Q= pollutant emission rate (mass per unit time)

U_S = mean wind speed at release height.

K= a scaling coefficient to convert calculated concentrations to desired unit

D= decay term

V= Vertical term

It may be noted that the vertical term includes the effect of source elevation, receptor elevation, plume rise, limited mixing in the vertical and gravitational settling and dry deposition of particulates.

The options used for short-term computations are:

- The plume rise is estimated by Briggs formula, but final rise is always limited to that of mixing layer;
- Stack tip down wash is not considered;
- Buoyancy induced dispersion is used to describe the increasing plume dispersion during the accession phase;
- Calms processing routine is used by default;
- Wind profile exponents are used by default, 'Irwin';
- Flat terrain is used for computations;
- It is assumed that the pollutants do not undergo any Physico-chemical transformations and there is no pollutant removal by dry deposition;
- Washout by rain is not considered; and
- Cartesian co-ordinate system has been used for computations.

The input data requirement of each source include data specific to the source and its type viz. point area or volume source. The source input requirement for running the program is the emission height location and strength.

The impact has been predicted over a 10Km x 10Km area with centre of the plant as centre. The receptors are defined with respect to 16 radial wind directions (N to NNW) and radial distance from centre. GLC have been calculated at every 500 m grids points to have better result. Predominant Wind directions are mainly from North to South, NE to SW and East to West.

The meteorological data input to the model is obtained as per wind rose diagram plotted as in **Figure 3.9**. Stability has been computed as per Turner's method and mixing height has been derived from the empirical formula as per CPCB guidelines.

Based on the data compiled above the air quality predictions were carried out for the Suspended Particulate Matter, SO_2 and NO_X, the important values are tabulated at the **Table 5.7.** The corresponding isopleths are presented in **Figure. 5.1, Figure. 5.2** and **Figure. 5.3** respectively**.** The five highest values as listed in **Table-5.6** is derived from the IST-III

Table 5.6 Predicted Incremental Value of GLCs for 5 highest values.

Rank	*Max.24 hr.Avg ($\mu g/m^3$) of Pollutants*		
	SPM	*NO_X*	*SO_2*
1	Rengopali- 2.65	Rengopali- 6.9	Rengopali-22.34
2	Rehab colony- 1.99	Rehab colony- 6.45	Rehab colony-8.93
3	Kasibari- 1.99	Lanjigarh-6.45	Lanjigarh-4.47
4	Mines area- 1.99	Kasibari- 4.31	Kasibari-8.93
5	Lanjigarh-1.99	Mines area- 4.31	Mines area-4.47

Figure 5.1: Isopleths of SPM

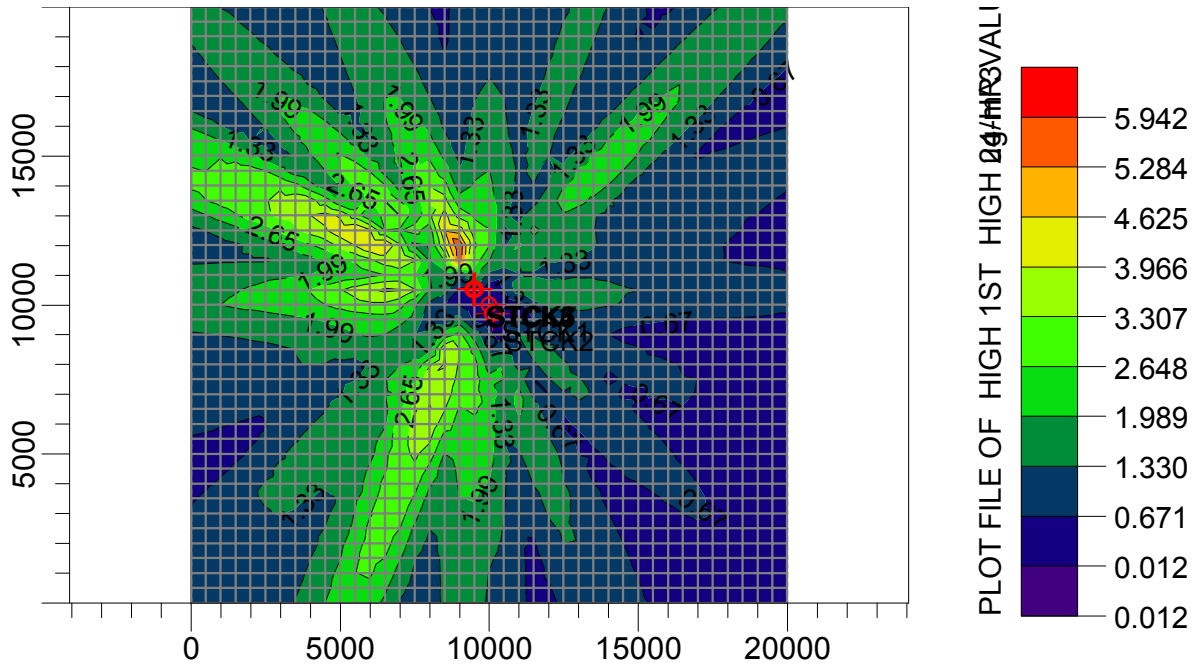


Figure 5.2: Isopleths of SO_2

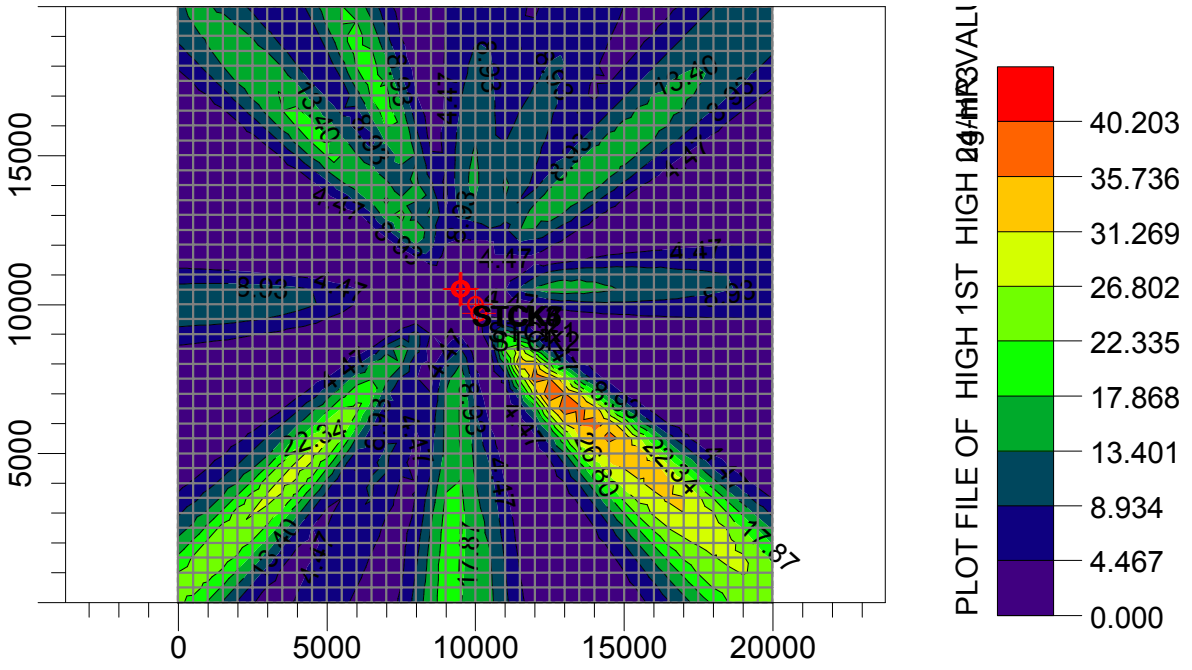


Figure 5.3: Isopleths of NO_X

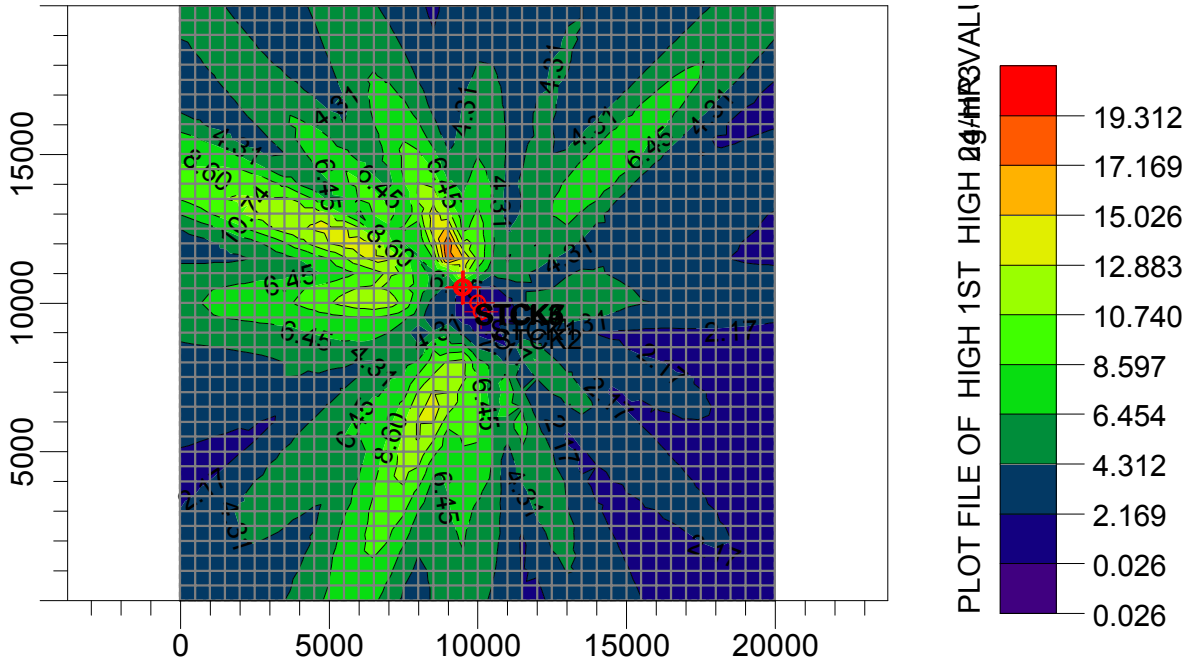


Table 5.7 Maximum Predicted GLCs Value at Rengopali

Pollution parameter	Baseline data in μg/ m^3	Max. predicted incremental values in μg/ m^3	Max. predicted values in μg/ m^3	Max. permissible value as per CPCB for residential area In μg/ m^3
SPM	187.2	2.65	189.85	200
SO_2	16.2	22.34	38.54	80
NO_X	25.1	6.9	32	80

Note: The base line data is considered from the winter season Ambient Air quality Data as in Table-3.12, due to the fact that winter will have maximum GLC for high air density.

5.4.2 Impact on Noise Environment

The operational noise quality will be due to the machinery operations in isolated areas, which can be dealt with individual source control.

Mathematical Model for Sound Wave Propagation during Operation

For an approximate estimation of dispersion of noise in the ambient from the source point, a standard mathematical model for sound wave propagation is used.

The sound pressure level generated by noise sources decreases with increasing distance from the source due to wave divergence.

An additional decrease in sound pressure level with distance from the source is expected due to atmospheric effect or its interaction with objects in the transmission path.

For hemispherical sound wave propagation through homogenous loss free medium, one can estimate noise levels at various locations, due to different sources using model based on first principles, as per the following equation:

$$Lp_2 = Lp_1 - 20 \text{ Log } (r_2 / r_{1)} \quad .... (1)$$

Where Lp_2 and Lp_1 are Sound Pressure Levels (SPLs) at points located at distances r_2 and r_1 from the source. The combined effect of all the sources then can be determined at various locations by logarithmic addition.

As a first approximation, one can assume that for all general population in the villages, every noise source in the plant is a point source. The average equivalent sound power level of such a point source can be estimated for different distances and directions from a hypothetical source by applying the following equation:

$$L_p = L_w - 20 \text{ Log } r - A_e - 8 \quad ....(2)$$

Where Lw is the sound power level of the source, L_p is the sound pressure level at a distance ' r ' and A_e is environmental attenuation factor. A combined noise level L_p (total) of all the sources at a particular place is given by:

$$L_p \text{ (total)} = 10 \text{ Log } (10^{(L_p1/10)} + 10^{(L_p2/10)} + ...)... (3)$$

Some of the sources of noise and the estimated levels are given in the following **Table-5.8**

TABLE-5.8

ESTIMATED NOISE LEVELS FROM THE PLANT

Sr. No.	Unit	Sound Level, dB(A)
1	Gas Suspension Calciner	
A	Blower Room	95-105
B	Oil heating Unit	80-85
2	Aluminium Plant	
A	Digestion Unit	90-95
B	Ball Mill	95-105
3	Compressor House	90-95
4	Crusher	90-95
5	Vacuum Pump	80-85
6	Cooling Water Pumps	85
7	Power Plant	
A	Steam Turbine	85-90
B	Boiler	85-90
C	Generator	80-85
8	Coal Handling Plant	
A	Transfer Points	79
B	Coal Crushing	73-79
9	Work Shops	65-75

5.4.2.1 Prediction of Noise Impacts

L_p (total) was calculated for all the units in the gas suspension calciner, aluminium plant (digestion units) and power plant. Predictions were carried out considering gas suspension calciner, aluminium plant and power plant as individual sources of noise generation.

It is evident from the analysis of the data that the noise drops to below 45 dB (A) level at 1-km distance from the plant.

- **Prediction of Impacts on Community**

Day and night sound pressure levels L_{dn} is often used to describe the community noise exposure, which includes 10 dB (A) night time penalty. The noise levels at a distance of 1-km and above would be less than 45 dB (A). Most of the human

settlements are at a distance greater than 1-km from the plant site. Hence, the impact on general population would be insignificant.

5.4.3 Impact on Water Environment

5.4.3.1 Impact on Water Resources

The water requirement for the proposed facility will be met from Tel river, which is at a distance of about 67-km. There will not be any tapping of groundwater during the operation of the refinery plant. No groundwater will be used during constructional period and hence there will not be any adverse impact on the groundwater resources.

The total requirement of treated water i.e. filtered water for the proposed alumina refinery, mines and drinking water requirement of plant, mines and township after expansion is expected to be 56,250 m^3/day after expansion and is proposed to be obtained from the same source.

The entire treated wastewater will be reused in the process. Thus, the impact on water resources is not likely to be significant. The water balance is given in **Figure-5.4**.

5.4.3.2 Impact on Water Quality

The sources of effluents from various units will be treated separately depending upon the effluent characteristics. Liquid effluents in alumina production are generated from number of units. There are five types of liquid effluents, namely:

1] Alkaline wastewater from various sources of the refinery plant
2] Cooling Tower and boiler Blow down;
3] DM Plant Regeneration;
4] Filter Back wash; and
5] Domestic sewage

5.4.3.3 Cooling Tower Blow down, DM Plant Regeneration and Filter Backwash

The process wastewater will be coming from Heat exchangers, evaporators (acidic wastewater), Cooling Tower Blow down (CTBD) and Laboratory effluent. Besides, there are alkaline effluents from different units and will be fully recycled within the plant. During monsoon, the effluent will be discharged only after necessary treatment meeting the standards.

5.4.3.4 Sanitary Wastewater

The sanitary wastewater will be treated in sewage treatment plant. The treated wastewater will be reused for greenbelt development or discharged during monsoon.

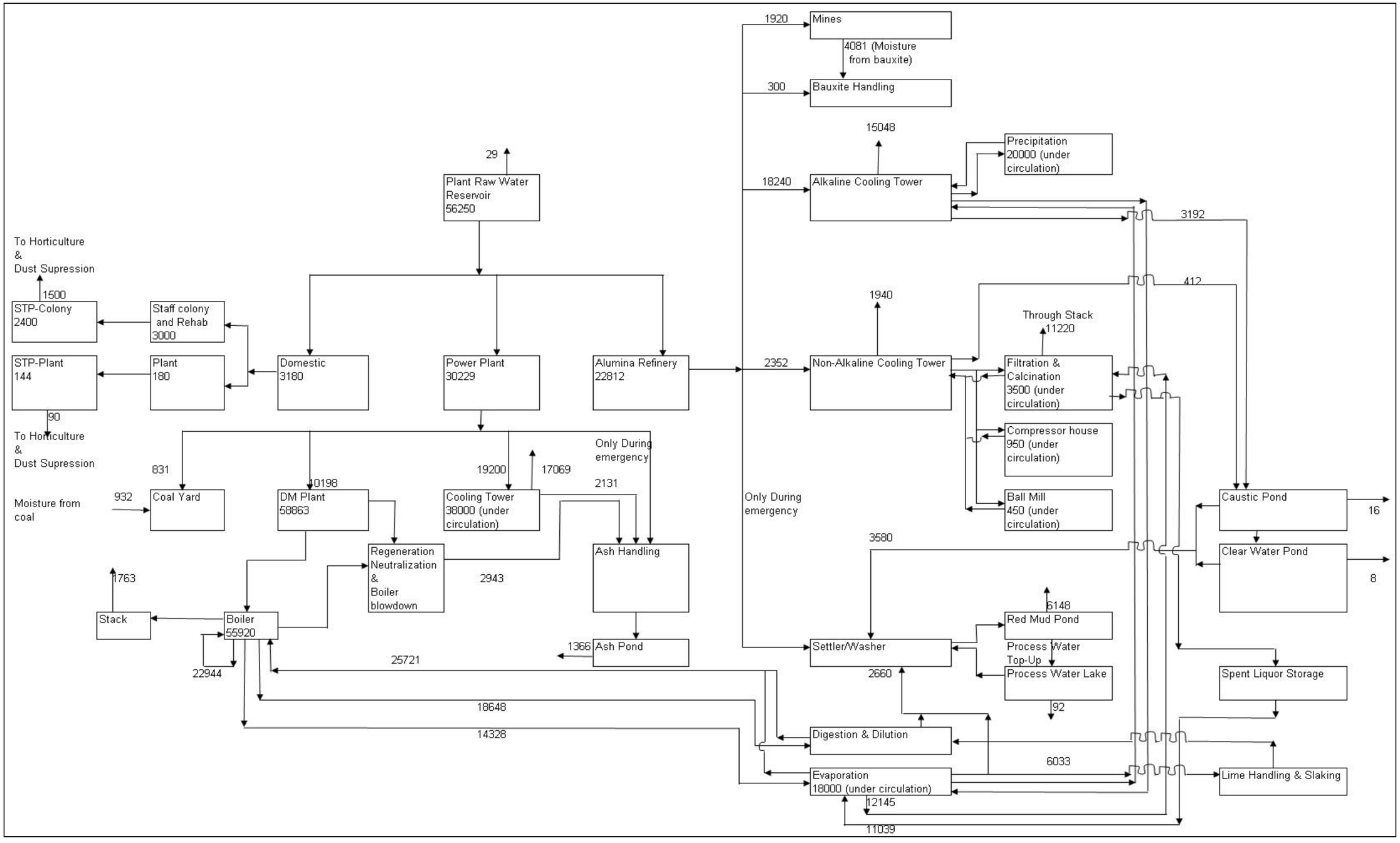
Thus, as explained above, the treatment scheme will meet all the necessary disposal standards prescribed by Orissa Pollution Control Board (OPCB) and Central Pollution Control Board (CPCB).

5.4.3.5 Impact due to Red Mud Pond and Ash Pond

The run-off from the red mud pond will be collected and stored in a holding pond, which is located near the toe of the mud storage area. The stored run-off will be used for sprinkling during dry season. To divert rainwater from outside the mud storage area, suitable garland drains will be provided. Similarly, the constituents of the red mud indicate less solubility of red mud with the water. It can be inferred that the leaching problem is likely to be minimal. Similarly, the overflow from the ash pond area will be recycled back to the ash slurry system.

Thus, the impact on surface and ground water quality from these areas will be minimized. The wells surrounding the red mud pond and ash pond will be monitored under post project monitoring. Based on the data generated during the study period it can be seen that there is no impact on the water environment due to the operation.

FIGURE-5.4: WATER BALANCE (m^3/day)



5.4.4 Impact of Solid Waste

The main solid waste generated is in the form of Red Mud and Ash originated from the Settler/Washer (of the refinery Unit) and co – generation plant respectively. These two major solid wastes are appropriately contained in the designated Red Mud Pond and Ash Pond designed for 15 years. The wastes generated are summarized below in **Tables 5.9 & 5.10**.

Table 5.9: Process Solid Waste

Solid Waste	Source of Solid Waste	Unit of Measure	Quantity	Mode of Disposal
Red Mud	Settler & washer	MMTPA	7.5	Red Mud Pond via HCSD System
Ash	Coal Fired Boiler	MMTPA	0.86	It will be sold to down stream industries like cement, brick making and agriculture. The balance will be disposed off to ash pond using High Concentration Slurry Disposal system
MSW (Municipality Solid Waste)	Domestic	TPD	6.7	Composting Facility
Sewage Sludge	Domestic	Kg/day	60	The organic portion of solid generated in the STP will be used as manure in greenbelt development after composting.

Table 5.10: Non Process Hazardous Waste

SL No	Name of Hazardous Waste	Existing generated per year (Approximate)	To be generated per year (Approximate)	Disposal Method to be adopted
1	Used oil	150 KL	280 KL	Selling to Registered Recyclers
2	Oily cotton waste	2000 Kg	8000 Kg	Fire in Boiler
3	Used oil filters	150 nos	280 nos	Sold to recycle agents
4	Used batteries	400 nos	900 nos	Buy Back System with the manufacturers
5	Spent Resins from DM Plant	4500 ltrs(with a period of 5 year)	10200 ltrs(with a period of 5 year)	Will be disposed in Engineering Landfills

5.4.5 Socio Economic Impacts

5.4.5.1 Sampling Design

It is rather obvious that nearby villages will have more impact (adverse or beneficial), therefore the study area was divided into three zones with 3 km, 5 km, 10 km radius with central point of the combined project site as the center to assess the socioeconomic impact of the project on the surrounding environment. The interview followed by the questionnaire method was followed to assess the people's perception of the project and also to assess the change in socioeconomic pattern due to setting up of the integrated steel plant. The sample of villages from each stratum as well as the respondents/households within each sampled village has been selected by two-stage stratified random sampling. On the first stage; villages from each stratum are selected and on the second stage; households/respondents are selected from sampled village by simple random sampling. Efforts are made to allocate sample of villages from each strata in proportion of their size. From each selected village, at least two respondents are selected randomly to account intra village variability among the respondents. The strata wise distribution of sampled respondents is given below in **Table 5.11**:

Table- 5.11: Strata wise distribution of sampled respondents

Strata with Radius (Km)	No. of households
3	10
3-5	15
5-10	15
Total	40

5.4.5.2 Composition of the Questionnaire

A detailed questionnaire was designed for this study to assess the impact of the project on the surrounding environment in terms of socioeconomic benefits likely to accrue from this project. The project objective was kept in the mind all along while designing the questionnaire. Households/respondents were interviewed with the structured questionnaire. The questionnaire consists of following major sections:

- Name, age and sex of the respondent.
- Composition and size of family
- Educational status

- Information and agricultural situation (land use, cropping pattern, productivity, net return etc.)
- Income and employment
- Information and family budget
- Consumption and saving
- Family health status
- Family asset base
- Respondents perception about the project

5.4.5.3 Methodology

The major methods used as tools of analysis in this study are as given below:

1. Regression

   Simple linear regression of the type

   $Y_i = a + b X_i + U_i + U j$ (Where, U is the stochastic error term having its usual properties) is considered. The model is fitted by Ordinary Least Square (OLS) to obtain estimated demand and consumption functions.

2. Fitted regression models is used to work out

   I) Elasticity of demand with respect to deposable income (e):

   E = dy/dx. x/y (In case of demand functions)

   ii) Marginal propensity to consume (MPC):

   MPC = dy/dx (In case of consumption functions)

Frequency distribution of peoples' perception, educational status, land holding etc.

5.4.5.4 Agricultural Situation

The present survey reveals that the majority population in study area belongs to urban communities and thus their economic is basically commercial in nature. Very small proportion (5%) of total population in study area, particularly people from villages are still dependent on agriculture. The productivity of crop patterns is listed in **Table 5.12**.

Table 5.12: Cropping Pattern and Productivity

Sl. No.	*Crop*	*Area (% of GCA)*	*Productivity (Qtl./Hectare)*
1	Paddy	36	15 T
2	Others	64	4 T

5.4.5.5 Employment and Income Effect

Direct Employment

There is a direct employment of 2500 people from local community based on the skill levels and income capacity. Most of these employees are trained in respective technical skills for the appropriate job within the plant.

Indirect Employment

Indirect employment ranges from outsourced agencies to the daily workers. In an average 10000 such workers will be engaged in various activities in indoor and outdoor facilities and is a mixture of highly skilled, skilled, semi-skilled and non-skilled workers.

5.4.5.6 Educational Status

The local educational levels will be raised with additional facilities provided to schools through various CSR programs, such as scholarships, awareness programs, child care facilities, sponsored sports and cultural events, self help groups and community participation in area developments.

5.4.5.7 Health Status

Discussion with the medical officers in Local Govt./Semi Govt. Health Centers, reveals the existence of following type of major disease in the study area. Installation of the plants may bring changes in this scenario. Health awareness among the villages may grow with the industrial development, especially regarding cleanliness. Community development organisers may play a lead role in this regard. The details are given in the **Table 5.13.**

Table-5.13 Health Status of the people in the study area

Program	Details	Area of Coverage
Mobile Health unit	Taking medical care to the door steps of the people	Covering 53 Villages
First to Reach	Providing emergency medical service	At Thuamul Rampur to 500 persons
Project Sushtha Parivar	Partnering with District Health Department	To all the peripheral villages
Health Awareness Camps	▪ Malaria, TB, AIDS, Sunstroke, Small Family Norms ▪ Coverage- 53 villages in the vicinity of industrial operation ▪ Use of IEC materials – audio/visual methods & street plays ▪ Partnership with District Health Department	To all the peripheral villages
Family Planning Operation Camp	▪ 150 eligible women underwent tubectomy ▪ Government Health Department is the partnering agency	Local Women Community
Pulse Polio Program	▪ Children in 0-5 years of age were administered polio drops ▪ 60 villages covered under 6 booths	All the children of 60 villages

5.4.5.8 Industrialization around the Alumina refinery

There is so far no other industry of any type located within a radius of 10 km from the proposed expansion site, other than the existing alumina refinery at the same premises.

5.5 EVALUATION OF IMPACTS

5.5.1 Introduction to Matrix Method

The identification and prediction of impacts on various environmental parameters is followed up by quantification of impacts. There are several methods available to quantify the environmental impacts. The Leopold matrix method is one of the most widely adopted and has been used for quantification of impacts for this study. The methodology involves first, the identification of activities, which occur during the two phases of the project and second their likely impacts on the environmental parameters.

Matrix Method*:*

In this method, the effect of various activities on the environment is ranked on a scale of 1 to 5 based on the order of increasing importance to arrive at the Parameter Importance Value (PIV).

The score of each parameter has been converted to a probability value and then recalculated by multiplying each value by a factor of 1,000 so that the sum of all the recalculated values becomes 1000. The values thus confirm to the units of the standard scale, generally used for evaluating the degree of impact on a set of project activities on total environment.

The matrix used for EIA consists of project activities on the X-axis and the environmental components likely to be effected by such activities on the Y-axis. The degree of impact upon the environmental components due to each anticipated project activity is graded as per the index scale given below:

SL. NO.	DEGREE OF IMPACT	IMPACT VALUE
1	Minimal	1-2
2	Moderate	3-4
3	Appreciable	5-6
4	Significant	7-8
5	Extreme	9-10

A (+) or (-) sign has been assigned to each value depending on its beneficial or detrimental effect. The environment impact has been framed with four major project activities as column in X-axis and 14 environmental components as rows in Y-axis. The PIV values for each row as determined in Table.4.9, is placed at the first column. An appropriate impact value based on judicious subjective assessment is assigned to each of the project activity. The impact score for each environmental component (SC1) has been calculated as under:

$$SCI = (PIV)i \sum_{J=i}^{n} Iij$$

Where is the impact value (on a scale of 1.0 to 10.0 positive or negative) due to the effect of a project activity (j) on the environmental component (i).
The n= total number of project activities.
The Total Impact Score (TIS) is arrived at as follows:

$$TIS = (PIV)I \sum_{I=1}^{n} SCi$$

Where m= total number of environmental components.

The Total Impact Score (TIS) is determined as per the procedure outlined above. The score has been evaluated against the following Assessment Value Index Scale. The Impact identification matrix is listed in **Table-5.14** and total impact score is given in **Table-5.15.**

Up to (-) 2000 : No appreciable impact on environment. Adverse impact is minimal.
(-) 2000 to (-) 4000 : Appreciable impact on environment but not injurious in general. Adequate mitigating measures are important.
(-) 4000 to (-) 6000 : Significant impact upon the environment. Major environmental control measures to be taken.

(-) 6000 to (-) 8000 : Major injuries impact on environment. Site selection to be considered
(-) 8000 and above : Alternative site to be considered.
Up to 2000 : Minimally beneficial.
Up to 4000 : Moderately beneficial.
Up to 6000 : Appreciably beneficial.
Up to 8000 : Significantly beneficial.
8000 and above : Extremely beneficial.

Table No. 5.14: Impact Identification Matrix (Calculation of PIV)

Environment Components	**Importance Rank**	**Weightage (W)**	**Parameters Importance Value (PIV)= W X 1000**
Ambient air Quality	4	0.10	95
Technology	4	0.10	95
Surface water Quality	2	0.05	48
Surface water resources	2	0.05	48
Ground water Quality	1	0.02	24
Noise Quality	2	0.05	48
Soil Quality	3	0.07	71
Land use pattern	3	0.07	71
Flora & Fauna	2	0.05	48
Aesthetics	3	0.07	71
Employment	4	0.10	95
Trade & Business	4	0.10	95
Human Health & Safety	2	0.05	48
Infrastructure Development	3	0.07	71
Social & Educational Development	2	0.05	48
Human displacement & resettlement	1	0.02	24
Total	42		App. 1000

Table 5.15: Total Impact Score (TIS) for Project activities without EMP

Environment Components	PIV	Land acquisition	Mechanical Work	Raw Material & Product Handling, Stores & Transportation	Plant Operation	Civic amenities	Total	TIS Score
Ambient air Quality	95		-3	-3	-4	-1	-11	-1045
Technology	95		+4	+2	+1	+1	+8	+760
Surface water Quality	48				-1	-2	-3	-144
Surface water Resources	48				-1	-2	-3	-144
Ground water Quality	24				-3	-1	-4	-96
Noise Quality	48		-2	-2	-1		-5	-240
Soil Quality	71		-1		-1	-1	-3	-213
Land use Pattern	71	+2	-1	-2		-1	-2	-142
Flora & Fauna	48	+1			-1		0	0
Aesthetics	71	+1	-1	-1	-2		-3	-213
Employment	95			+1	+2	+1	+4	+380
Trade & Business	95			+1	+1	+1	+3	+285
Human Health & Safety	48		-1	+1	-2	+1	-1	-48
Infrastructure Development	71			-1	2	+2	+3	+213
Social & Educational Development	48		-1	+1	-1	+1	0	0
Human displacement & resettlement	24				+3	+3	+6	+144
Total	1000	+4	-6	-3	-8	+2	-11	-503

CHAPTER-6
ENVIRONMENTAL MANAGEMENT PLAN

6.1 EMP AS A MANAGEMENT TOOL

The industrial development in the study area needs to be intertwined with judicious utilization of non-renewable resources of the study area and within the limits of permissible assimilative capacity. The assimilative capacity of the study area is the maximum amount of pollution load that can be discharged in the environment without affecting the designated use and is governed by dilution, dispersion, and removal due to physico-chemical and biological processes. The Environment Management Plan (EMP) is required to ensure sustainable development in the study area (10-km) of the proposed industry. Government, Regulating agencies like Pollution Control Board working in the region and more importantly the affected population of the study area need to extend their co-operation and contribution. The identification and quantification of impacts based on scientific and mathematical modeling has been presented in Chapter-5.

Environmental policy at industry level is yet to be defined formally. Standards are stipulated by various regulatory agencies to limit the emission of pollutants in air and water. Similarly, a mandatory practice is recommended for preparing an Environment statement each year in order to encourage the industries to allow efficient use of resources in their production processes and reduce the quantities of wastes per unit of product. This in itself is not sufficient since this does not provide an assurance that it's environmental performance not only meets, will continue to meet, legislative and policy requirements.

Hence, Environmental Management Systems (EMS) are suggested at the industry level for ensuring that the activities, products and services of the region conform to the carrying capacity (supportive and assimilative capacity) based issues. This is based on the Bureau of Indian Standard's Specification IS: 13967 (1993): Environmental Management Systems - Specification (equivalent to British Standard BS 7750). Since this is more in line with the quality systems, it is recommended that the proposed plant develop one as outlined in the following sub sections.

The EMS - its set-up, role and responsibilities - is given subsequently.

6.2 FORMATION OF AN ENVIRONMENTAL MANAGEMENT SYSTEM

The environmental management system to be formed by each industry will enable it to maximize its beneficial effects and minimize its adverse effects with emphasis on prevention. It should:

- Identify and evaluate the environmental effects arising from the industry's existing/proposed activities, products and services to determine those of significance;
- Identify and evaluate the environmental effects arising from incidents, accidents and potential emergency situations:
- Identify the relevant legislative and regulatory requirements:
- Enable priorities to be identified and pertinent environmental objectives and targets to be set:
- Facilitate planning, control, monitoring, auditing and review activities to ensure that the policy is complied with; and
- Allow periodic evaluation to suit changing circumstances so that it remains relevant.

6.3 IMPLEMENTATION OF AN ENVIRONMENTAL MANAGEMENT SYSTEM

Commitment

It is essential that the top management of the industry is committed to development of its activities in an environmentally sound manner and supports all efforts in achieving this objective.

Experience has shown that all attempts to change the processes and production methods which reduce/prevent wastes and inefficient use of resources ultimately result not only in environmentally sound practices but also better business returns.

Preparatory Environmental Review

An industry with no formal environmental management system first establishes its current position with regard to environment through a preparatory environmental review. This should cover four areas:

- Legislative and regulatory requirements;
- Evaluation and registration of significant parameters and their environmental impacts:
- Review of existing environmental management practices and procedures, and
- Assessment of feedback from investigation of previous environmental incidents and non-compliance with legislation, regulations or existing policies and procedures.

The resulting report should address:

- The nature and extent of problems and deficiencies;
- The priorities to be accorded to rectify them, and
- An improvement program designed to ensure that the personnel and material resources required are identified and made available.

Environmental Policy

The industry's management should actively initiate, develop and support the environmental policy, which is relevant to its activities, products and services and their environmental effects. Broadly this should:

- Be consistent with the occupational health and safety policy and other industrial policies (such as quality policy);
- Indicate which of the industrial activities are covered by the environmental management system;
- Be communicated and implemented at all levels of the industry; and
- Be available publicly.

Organization and Personnel

To facilities the implementation of the EMS, one of the most important aspects relate to the organization and personnel. The related issues are:

- Define and document the responsibility, authority and interrelations of key personnel involved in the implementation of the environmental policy, objectives and environmental management system;
- Identify the in-house verification requirements and procedures including resources and personnel;

- Appoint a Management Representative (MR)
- Communicate to employees at all levels the importance of compliance with the environmental policy, their role and responsibilities in achieving compliance, the potential consequences of departures from the specified procedures, and identify and provide appropriate training; and
- Establish and maintain procedures to ensure that contractors are made aware of the environmental management system requirements and provisions.

Environmental Effects

The industry should establish and maintain procedures for:

- Receiving, documenting and responding to internal as well as external communications concerning environmental aspects and management;
- Identifying, examining and evaluating the environmental effects of its activities under normal and abnormal/emergency situations (including risk assessment) and compiling significant effects in a register; and
- Recording all legislative, regulatory and other policy requirements and codes in a register.

Environmental Objectives and Targets

The objectives should be set with a view to realizing gradual and steady improvements in environmental performance through application of best available and economically viable technology.

The areas targeted for improvement should be those where improvements are most necessary to reduce risks (to environmental and industry) and liabilities. These should be identified through cost-benefit analysis wherever practicable and should be quantitative and achievable.

Environmental Management Program

The establishment of an environmental management programme is the key to compliance with the industry's environmental policy and achievement of the environmental objectives and targets.

It should designate the responsibility for achieving the targets at each level and the means thereof. It should deal with the actions required for the consequences of the

industries past activities as well as address the life cycle of developments of new products so as to effectively control adverse impacts.

Environmental Management Manual and Documentation

The documentation is intended to provide an adequate description of the environmental management system. The manual is expected to provide a reference to the implementation and maintenance of the system.

Operational Control

The management responsibilities should be defined to ensure that the control, verification, measurement and testing of environment parameters within the industry are adequately coordinated and effectively performed.

The control, verification, measurement and testing should be made through documented procedures and work instructions defining the manner of conducting activities, the absence of which can lead to violation of the environment policy.

In the event of non-compliance, procedures for investigation of the causative mechanism should be established and the factors reported for corrective actions.

Environment Management Records

The industry should establish and maintain a system of records to demonstrate compliance with the environmental management systems and the extent of achievement of the environmental objectives and targets. In addition the other records (legislative, audit and review reports), management records should address the following:

- Details of failure in compliance and corrective action;
- Details of indigents and corrective action;
- Details of complaints and follow-up action;
- Appropriate contractor and supplier information;
- Inspection and maintenance reports;
- Product identification and composition data;
- Monitoring data; and
- Environmental training records.

Environmental Management Audit

The management audits are to determine whether the activities are conforming to the environmental management systems and effective in implementing the environmental policy. They may be internal or external, but carried out impartially and effectively by a person properly trained for it. Broad knowledge of the environmental process and expertise in relevant discipline is also required. Appropriate audit programme and protocols should be established.

Environmental Statement

As a mandatory requirement under the Environment Protection Rules (1986) as amended through the Notification issued by the Ministry of Environment and Forests in April 1993, an Environmental Statement should be prepared annually. This should include the consumption of total resources (raw material and water per tonne of product), quantity and concentration of pollutants (air and water discharged, quantity of hazardous and solid waste generation, pollution abatement measures, conservation of natural resources and cost of production vis-a vis the investment on pollution abatement. This may be an internal or external audit, but carried out impartially and effectively by a person properly trained for it. Broad knowledge of the environmental process and expertise in relevant disciplines is also required.

The intention of this statement is:

- To identify the process /production areas where resources can be used more efficiently through a comparison with the figures of a similar industry (thereby reducing the consumption per unit of product);
- To determine the areas where waste generation can be minimized at source and through end of pipe treatment (thereby reducing the wastes generated and discharged per unit of product);
- Initiate a self-correcting/improvement system through an internal analysis to achieve cost reduction through choice of superior technology and more efficient practices.

Environmental Management Reviews

The senior management should periodically review the Environmental Management System (EMS) to ensure its suitability and effectiveness. The need for possible changes in the environmental policy and objectives for continuous improvement

should be ascertained and revisions made accordingly.

EMS based on the above objectives should be formulated and implemented at the industry level.

6.4 EMP AT DESIGN STAGE

The Management Action Plan aims at controlling pollution at the source level to the possible extent with the available and affordable technology followed by treatment measures before they are discharged.

The Environmental Management Plan also lists out all these strategies not only for the operational phase of the plant but also for the construction phase. The EMP is prepared keeping in view all possible strategies oriented towards waste minimization, waste treatment, waste disposal and residual attenuation for the proposed industry in a chronological sequence.

6.5 EMP DURING CONSTRUCTION PHASE

Constructional Phase	Potential Negative Impacts	Probable Source	Mitigative Measures	Remarks
Water Quality	Increase in suspended solids due to soil run-off during heavy precipitation	Soil Erosion	Temporary sedimentation Tank	--
Air Quality	Increase in dust and NOx concentration	Heavy vehicular movement	Regular sprinkling of water in the construction area.	The impact will be low as the main approach road will be tarried
Noise	Increase in noise level	Construction equipment	Equipment will be kept in good condition to keep the noise level within 85 dB (A)	Workers will be provided with necessary protective devices e.g. ear plug, ear-muffs
Terrestrial Ecology	Clearing of Vegetation	During construction	Plantation will be done during the start of the project	--
Aquatic Ecology	Impact on surface and ground water resources		Wastewater will be treated in STP	No significant impacts on aquatic life and water resources

6.6 EMP DURING OPERATIONAL PHASE

Operation Impact	Potential Negative Impacts	Probable Source	Mitigative Measures	Remarks
Air Quality	Increase in SO_2, NOx and SPM level in ambient air	Alumina Plant and Co-generation plant	One additional 120 m high stack for calciner and one more 145 m high stack for CGPP will be provided to ensure wider dispersal of pollutants.	Maximum incremental short term ground level concentration (GLC) of NOx and SO_2 due to operation of ESP will be within the permissible limits
	Increase in Nox concentration	Alumina Plant and Co-generation plant	Boilers will have in-built design for low NOx emission	--
	Increase in SPM in ambient air	Vehicular traffic	All motorable roads in the plant area will be paved to reduce dust emission	--
	Increase in SPM in ambient air	Coal & Lime handling area	Dry fog system and bag filters will be provided and water will be sprinkled regularly near dust generating areas	--
Water Quality	Deterioration of water quality of surface water	Discharge from plant rejects, filter backwash, service water waste and effluents	Wastewater will be completely recycled for various uses in the plant and no discharge of wastewater outside the premises is envisaged. During monsoon only excess treated water meeting norms will be discharged	--
Noise	Increase in noise levels in the plant area	Equipment in main plant and auxiliaries	Equipment will be designed to conform to noise levels prescribed by regulatory agencies. Provision of green belt and plantation would further help in attenuating noise	--

Operation Impact	Potential Negative Impacts	Probable Source	Mitigative Measures	Remarks
Terrestrial Ecology	Impact on plant species	Emissions from stacks	Emission will be controlled as well as dispersed through appropriate design	As emissions will be within limits, no active injury to the vegetation is expected
Aquatic Ecology	Impact on aquatic species	Wastewater, if any, from Alumina plant, heat exchanger, cooling tower, laboratory, power plant etc.	Wastewater will be completely recycled for various uses in the plant and no discharge of wastewater outside the premises is envisaged	As there is no discharge, no impact on aquatic environment is envisaged
Demography and Socio-Economics	Strain on existing amenities like housing, water sources and sanitation, medical and infrastructure facilities	Influx of expanded people of plant employees as well as contractor's employees/ Laborers	Existing township will be utilized	--
Land environment	Impact on land environment	Disposal of solid waste	High concentrated slurry disposal method will be followed for Red mud and ash.	--

6.6.1 Pollution Control Equipment

Various extaction and control system have been provided at different stages of the process. The list of equipment and facilities provided are detailed in **Table-6.1**.

Table 6.1 List of pollution control (PC) equipments for the total Project

Major Process	**Pollution Control Equipment**	**Purpose**	**Impact**
Bauxite crushing & Grinding	Dry Fog System	Dust Suppression	Air Pollution
	Water Sprinkling System for Dust suppression	Dust Suppression	Air Pollution
Predesillication	Sump pit		
Evaporation	Sump pit		
Digestion & Heat Recuperation System	Sump pit		
Settling	Sump pit		
Counter current Mud Washing & Mud Disposal	Red Mud Pond	For solid waste disposal and caustic recovery	Air Pollution during dry season
	Process water lake	Caustic recovery and reuse in the process	Water pollution
	Dirty Water Pond	Caustic recovery and reuse in the process	Water pollution
	Caustic Effluent drain	Collection of all caustic effluent	Contamination with soil and land
	Storm water drain	Collection of all storm water	Contamination with soil and land
Security Filtration			
Heat Interchange			
Precipitation	Sumps	Caustic recovery and reuse in the process	

Hydrate Classification	Sumps	Caustic recovery and reuse in the process	
Hydrate Seed thickening	Sumps	Caustic recovery and reuse in the process	
Fine seed wash	Sumps	Caustic recovery and reuse in the process	
Product Filtration, Hydrate washing & Storage			
Gas Suspension Calcination	Electro Static Precipitators	Alumina dust	Air Pollution
	Stack height		
	On Line gas monitoring System	Alumina dust	Air Pollution
Alumina Handling	Bag filter	Alumina dust	Air Pollution
Caustic Storage	Dyke wall and spill collection system	For spill protection	soil and water pollution
Cooling Tower	Reuse of Cooling water system		
Lime handling System	Wet scrubber	Dust collection system	
Power Plant			
Coal Unloading	Water Sprinkling System	Suppress the dusting due to material handling	Dust transmit through air in windy seasons to surrounding areas

Coal Storage	Fire Hydrant System	Suppress any kind of fire	Loss of Property & heat stress
Coal Crusher / Grinder	Dry Fog System	Suppress the suspended particles & dusting due to coal processing	Dusting all around the conveyors causing unsafe work environment for the persons working there
Coal Conveyer	Dry Fog System		
Coal fired Boiler	ESP with Chimney	Collect SPM from Flue Gas	Dust transmit through air in windy seasons
	Ash Pond	Reclaim water from Pond	Slurry overflow to nearby farming land. Air pollution in dry season
	HCSD system	Ash Slurry disposal	Dusting inside the work area causing unsafe work environment
Turbine	Noise and Heat control System	Turbine, Steam Pipelines Insulation & Exhaust Ventilators	Heat stress in the work area
Furnace Oil Storage	Dyke wall and spill collection system	Oil Sewage Pump House to collect leaked/waste oil	Oily sludge overflow to drain leading to nearby water source & pollution
D M plant	pH neutralization pit	1 for Acid & 1 for Alkali neutralization	Acid/Alkali sludge overflow to drain leading to nearby water source & pollution

	Use and diversion of neutralized water to ash slurry and clean water pond	For reuse	Loss of water & pollution
Cooling Tower	Reuse of Cooling water system	Recycling of water	Loss of water & pollution
Domestic effluent at plant	ST Plant	Treatment of liquid waste from Latrine, bathroom and canteen	Water Pollution
Domestic effluent at Colony	ST Plant		
Water Supply and Distribution	Water meter with totalizer at Tel River		Water cess payment
	Water meter for Process with totalizer for domestic		
	Water meter for Process with totalizer for process		
	Water meter for Process with totalizer for boiler (D M Plant)		
	Garland drain for refinery		
Environmental Monitoring			
	Sampling location for soil, water, air		
	Stack sampling point at CFB		
	Environment lab set up		
	Identification dug well sampling point		

	Observation well point - Bore well at red mud pond, process water lake,ash pond and dirty water pond		
	Stream flow measurement	To monitor the flow of water	
	AAQ station	Air quality	
	On Line pH monitoring and Neutralisation System before dirty water pond		
	On Line pH monitoring and Neutralisation System before clear water pond		
D G Set	Stack Height and Accoustic Measure		

6.7 SOLID WASTE MANAGEMENT

The solid waste generated will be red mud from the process, fly ash from boiler and sludge from ETP. The 1.0 MMTPA alumina refinery generates approximately 1.28 MMTPA of red mud, which is required to be disposed off. Similarly, after expansion the red mud generation will be reduced to 3.75 MMTPA from the existing calculation of 7.5 MMTPA. High Concentration Slurry Disposal (HCSD) or dry stacking technology shall be used for disposal of red mud in the proposed red mud pond of 890.34-ha area located at about 1.3 km in the Southern side.

Red Mud

There is no technically and economically viable and feasible solution available so far for the utilization of red mud. Worldwide, research is going on for finding application of red mud for miscellaneous uses. Some of these are listed below:

Red mud can replace a part of clay in brick manufacturing. Ceramic products are also an attractive proposition for red mud, since it contains most of the required ingredients.

Attempts are being made to use red mud as a landfill material as it is or after treatment in many countries. It is being treated as a material to be used for land reclamation from marshy lands or abandoned mines.

Use of red mud in making paints (because of iron oxide and titanium dioxide in it), as an adsorbent and catalyst are some of the fields where extensive researches are in progress.

It is expected that about approximately 3.75 MMTPA red mud will be generated from the expanded Alumina refinery by the improved technology in Calciner, which will be pumped to the red mud pond by the high concentrated slurry disposal system. In order to arrest leaching from the ponds to ground to the maximum extent, red mud pond will be suitably lined with PVC.

HCSD has been adopted to discharge red mud. To achieve the high concentration the digestion slurry is passed through high-rate thickeners (settlers and washers). The underflow of the last washing stage is pumped by a centrifugal booster pump to the inlet of a Positive Displacement Mud Disposal pump (GEHO pump). The

GEHO pump (2 nos., 1 W+1S) pump the residue through red mud discharge pipeline (350mm dia) to the red mud pond where it is distributed to a number of outflows. All solution runoff will flow to the lower most area at the north-west corner of the pond where it will either be pumped or gravity fed to Process Water Lake constructed to store the alkaline water. The water from Process Water Lake will finally be reclaimed to the plant for process use.

Design of Red Mud Pond

The basic design of residue storage area has been done by Worley, Australia which suggested three lined cells (Cell-A, B&C); a decant water dam and a process water lake which is in line with the CPCB and also addresses the local soil conditions. The disposal areas are to be constructed of earthen walls from locally obtained materials; the storage areas are to be lined / sealed against leakage to the environment. Under normal operation one of the three cells is to be supplied with thickened red mud for distribution along the cell perimeter. All solution runoff from the area would overflow through decant towers into the decant dam. The design of the facility also provided overflow spillways for emergency release of excess rain water under conditions in excess of the design rainfall event (one-in-one-hundred-year return period). The solution collected in the decant water dam would be either pumped or gravity fed to the process water lake.

The detail engineering was done by Indian Institute of Science, Bangalore. Keeping in line with the three residue storage areas, a decant water dam and a process water lake; M/s IISc gave the detail alignment of the ponds and construction details of earthen dykes. It suggested four cells- A, B, C & D (Decant Pond) and a Process Water Lake. M/s IISc also suggested 1.5 mm thickness HDPE lining in all the ponds. However, following the geotechnical tests conducted at red mud pond, it maintained that if the pond base is compacted to modified proctor condition (maximum dry density and OMC) the same would serve as impervious barrier/ lining.

In order to optimize the cost of construction, the design by M/s IISc was further reviewed by M/s Tailings Management System (TMS), Ontario, Canada. The following changes were suggested by M/s TMS in the overall design:

1. The intermediate dykes between cell- A & B and cell- C & D were to be removed and converted to only two cells namely east cell and west cell

respectively. The dyke heights proposed by IISc were altered and revised dyke heights were given by TMS (considering 3 to 3.5 % deposition slope of the residue).

2. The requirement of HDPE lining was waived for red mud pond, instead M/s TMS suggested a composite layer of native soil-bentonite mixture (2 % dry wt/dry wt, 200 mm thickness) and 300 mm native soil seal over it as lining. In Process Water Lake, however, it recommended that HDPE liner to be put as the caustic concentration of the liquid may increase significantly during prolonged periods of evaporation.

Final design is based on the features of both IISc & TMS. While the construction details and cross-section of dyke proposed by IISc have been followed, suggestions made by TMS to convert the four cells into east & west cell and sealing the red mud pond with bentonite-soil mixture have been worked out in the final execution. The construction of West Cell and Process Water Lake is now over and East Cell is going on. In this manual all the as built features, drawings and final dyke top levels of Red Mud Pond (West Cell) and Process Water Lake have been described.

Construction Guidelines

1 The containment dykes of the ponds have been made by local burrow materials located within the pond perimeter.
2 The earthen dykes have been made by layers of 250-300mm thickness compacted to required density under optimum moisture content.
3 The upstream as well as downstream slopes of the dykes are maintained at 2H: 1V. The top width of dykes is 5.0m.
4 Filter media has been provided on the base under the downstream portion of the embankment along with rock toe as specified in the drawing for releasing the hydraulic pressure generated in the dyke and ensuring stability of the dyke.
5 Pitched toe drains with filter have been provided throughout the length of the dyke at the downstream toe of the dyke as indicated in the drawing. Surface drains have been provided at every 40m interval along the downstream slope which runs into the toe drain.
6 Turfing with pad/doob grass has been provided along the downstream slope of the dyke.
7 WBM road of 110mm thickness and 3.75m width has been provided over the top of dykes with PCC Kerb stones embedded on the outer side of road

to channelize the rain water into the surface drains being provided along the downstream slope of dykes.

Sealing of Ponds

- Every precaution has been taken to seal the ponds against environment.
- The finished level of pond bottom has been kept at least 1.0m above the standing water level.
- In Red Mud Pond the base has been sealed using composite layer of native soil-bentonite mixture (2 % dry wt/dry wt, 200 mm thickness) and 300 mm native soil seal over it as outlined by M/s TMS. The upstream slope of dykes has been compacted to 95% Modified Proctor Compaction Density.
- A natural water reservoir is present outside the north-west corner portion of west-cell. So, looking at the risk associated, a catchment pond has been provided at the lowest portion of the region to collect the toe drain water from northern and western dyke, which will pumped back to the pond.
- The lower most region of the West Cell (north-west corner) where all the water of the pond is supposed to accumulate has been lined with HDPE (both base and slope) to make the surface completely impermeable.
- The entire base and slope of Process Water Lake has been lined with 1.5mm thickness HDPE with 500mm compact earth filling over it.
- A natural water reservoir is present outside the north-east corner portion of process Water Lake. So, looking at the risk associated, a catch-ment pond has been provided at the lowest portion of the region to collect the toe drain water from eastern, northern and western dyke, which will pumped back to the pond.

Design Parameters:

1 Red mud generation: 20500 TPD
2 Mud disposal method: HCSD (high concentration slurry disposal)
3 Mud concentration at pumping: 58-65% solid(w/w)
4 Specific gravity of red mud: 3.7 (as tested)
5 Slope to be maintained during mud deposition: 3-6%
6 Specific gravity of carrying water: 1.1
7 In situ mud concentration: 78-82%

PUMPING OF MUD (DAILY BASIS):

SOLID,TPD	LIQUID,TPD	%SOLID	PULP,TPD	PULP,M^3/D	SP.GR.
20500	14845	0.58	35345	19036	1.86

MUD AFTER DEPOSITION:

SOLID,TPD	LIQUID,TPD	%SOLID	PULP,TPD	PULP,M^3/D	SP.GR.
20500	5782	0.78	26282	10797	2.43

The annual mud deposition is 1038060 M^3 over an area of 8900 M SqM. This calculation is based on 3% mud deposition slope. However with 6% slope factor the life expectancy of the Red Mud Pond will increase by 2-3 years.

Fly Ash

The quantity of ash generated after expansion will be 2388 Tonnes/day. This will be pumped to the ash pond in high concentrated basis. The water will be recycled back to the plant for slurry preparation or for utilization after treatment. The assumptions for Ash Pond design is as per the criteria mentioned below:

- Mud disposal method: HCSD (High concentration slurry Disposal)
- Ash concentration at pumping: 60-65% solid(w/w)
- Specific gravity of ash: 2.7 (normal:2.1 to 3.0))
- Slope to be maintained during ash deposition: 3-10%
- Specific gravity of carrying water: 1.0
- In situ mud concentration: 80-82%
- Ash pond area (only pond a as pond b shall be used for water retention)

VOLUME, M^3	**POND A**	**POND B**
POND	1800000	3600000
ADDITIONAL @3%	1282166	2564332
ADDITIONAL @6%	2243750	4487500
ADDITIONAL @8%	2991720	5983440

For accommodating the generated ash disposal, the Pond A has a dimension of 850X600M (AVERAGE RADIUS: 350M), and the Pond B is proposed for a initial dimension of 1700X1200M (AVERAGE RADIUS: 350M) within the extra land of 314.37 ha. Generation of ash on daily basis is as per the specifications below:

PUMPING OF ASH (DAILY BASIS):

SOLID,TPD	LIQUID,TPD	%SOLID	PULP,TPD	PULP,M^3/D	SP.GR.
2388	1592	0.60	3980	2332	1.71

ASH AFTER DEPOSITION:					
SOLID,TPD	LIQUID,TPD	%SOLID	PULP,TPD	PULP,M^3/D	SP.GR.
2388	597	0.80	2985	1427	2.09

WATER AVAILABLE FOR RECIRCULATION:

HOURLY 83 M^3/hr

The total volume of ash generated in yearly basis is 18216858 M^3. This is planned to be accommodated within the two Ash Ponds of above design, however for future utilization of ash alternative solutions will be adopted along with advent of new technological solutions. The industry will take steps to utilize ash to a maximum extent by itself and provide all facilities to other users of ash as per direction of Government/OPCB. The industry proposes to encourage local small scale units and promote entrepreneurs for the utilization of ash generated in the plant. The potential users for ash (particularly fly ash) are manufacturers of fly ash brick and fly ash concrete blocks and cement plants. In addition, fly ash in hydrate and semi hardened form can also be used in land reclamation, bund construction or road sub base construction.

The various uses of fly ash is given below:

- Portland Pozzolana Cement (using fly ash as Pozzolana);
- Cement-Fly ash concrete and ready-mixed fly ash concrete;
- Precast fly ash concrete building units;
- Sintered fly ash light weight aggregate and concrete;
- Lime- fly ash cellular concrete;
- Cement/Lime/silicate bonded and clay-fly ash building bricks;
- Port land cement clinker;
- Oil-well cement and masonry cement;
- For road and air field pavement construction using;
- Lime fly ash concrete;
- Lean cement fly ash concrete;
- Cement fly ash concrete;
- Lime fly ash soil stabilization and lime fly ash bound macadam;
- As fill material in embankment construction;
- As filler material in bituminous concrete; and
- Insulating and semi insulating bricks.

Ash Disposal Alternatives

To minimize the ground water contamination and the extent of land occupied by the unproductive ash ponds, various other methods for disposal have to be worked out. Besides, all efforts should be done at all levels at many places to find out ways and means to utilize ash into value added products. The remaining of the total ash generated has to be disposed in the ash pond. The bulk of the ash can be disposed through following alternatives:

1. Land filling with proper cover of soil;
2. Construction of sub-base in cases such as roads, canal, railway line embankment, air ports, dykes, bunds etc.; and
3. Cement Industries

However, it is very clear that using ash in such a manner on one hand will certainly reduce the cost of material, but on the other hand the cost of transporting and handling the ash will slightly increase. Basically, construction of roads, canals, railways embankments etc. in the vicinity can be implemented as well as used in cement plants.

For disposal of solid waste generated from the proposed production facility, following specified disposal facility is under construction for the proposed plan period as shown in **Table 6.2**.

Table 6.2: Proposed Solid Waste Disposal Facilities

Particular	Area	Volume	Life
Ash pond A	3.57 Lakh m^2	18 Lakh m^3	12-13 years
Ash pond B	20.4 Lakh m^2	36 Lakh m^3	12-13 years
Red mud west cell Pond	2.8 Lakh m^2	32 Lakh m^3	3-4 years
Red mud East cell pond	89 Lakh m^2	104 Lakh m^3	9-10 years

The above capacities are designed with 75% capacitation of estimated solid waste generation by the plant. In actuality this is further been estimated for 15 years of holding capacity based on the compaction of the Redmud and Ash in their dump site.

6.8 WASTEWATER MANAGEMENT

The wastewater will be gereated from cooling towers in the CGPP and refinery. Besdes, domestic wastewater from canteen and employees wash area will also be generated. The recommended measures to minimize the impacts and conservation of fresh water are:

- Recycling of complete wastewater generated in cooling tower
- Treatment of wastewater for recycling in areas of use
- Provision of sewage treatment plant to treat domestic sewage from plant
- Utilization of treated domestic wastewater in greenbelt development and dust suppression
- Provision of separate storm water system to collect and store run-off water during monsoon and utilization of the same in the process to reduce the fresh water requirement

6.8.1 Water Treatment

The raw water will be processed in primary treatment chamber before storing in the designated reservoir.

6.8.2 Wastewater Treatment

The process wastewater is 100% recycled with zero discharge norms. (During monsoon treated waste water will be discharged) However the wastewater from domestic sources will be treated in FAB (360 KLD) process as a technology of waste water treatment. This is expected to have 85-87 % efficiency in treating the waste water.

6.8.3 Rain water harvesting

Rain water harvesting will be adopted in the township area and will be recharged to ground water by percolating method or by bore hole. This even is feasible after an appropriate study. As regards in plant the rain water will be collected and reused excess of any will be treated and discharged. As regards plant area the rainfall collected will be used at relevant area.

6.9 MEASURES FOR IMPROVEMENT OF ECOLOGY

The Local ecology is intended to be preserved as much as possible with retention of the existing species of plantation and further enhancing the density of plantation with the local species. This will be supervised by the plant operation team for sustainability of the species and improvement strategy.

6.9.1 Greenbelt Development

With rapid industrialization and consequent deleterious impact of pollutants on environment, values of environmental protection offered by trees are becoming clear. Trees are very much suitable for detecting, recognizing and monitoring air pollution effects. Monitoring of biological effects of air pollutant by the use of plants as indicators has been applied on local, regional and national scale. Trees function as sinks of air pollutants, besides their bio-esthetical values, owing to its large surface area.

The greenbelt development not only functions as foreground and background landscape features resulting in harmonizing and amalgamating the physical structures of the plant with surrounding environment, but also acts as pollution sink.

Thus, implementation of afforestation programme is of paramount importance. It will also check soil erosion, make the ecosystem more complex and functionally more stable and make the climate more conducive.

Total greenbelt in the project complex will cover one third of the total area. All the unused open spaces are intended to be used for greenbelt landscape development. The pathway-sidings and around residential complexes, a thick grassy land will be created to prevent erosion, and retain moisture content with less post sunset thermal radiation from bare ground. Also some selected variety of trees will be planted along the road sides for partial thermal capping and control of fugitive dust emissions from the said roadways. The slopes of the red mud pond and ash pond areas will be used for nursery development to establish the fact that these disposal facilities are segregative in nature and have no soil or surface water contaminations what-so-ever.

6.9.2 Criteria for selection of species

Species to be selected should fulfill the following specific requirements of the area. Tolerance to specific conditions or alternatively wide adaptability to eco-physiological conditions.

- Rapid growth
- Capacity to endure water stress and climate extremes after initial establishment:
- Differences in height and growth habits
- Pleasing appearance
- Providing shade
- Ability of fixing atmospheric Nitrogen
- Improving waste lands.

Some Additional Information about Plantation

To undertake plantation on site for different purposes, following steps will be taken:

- Raising of seedlings in nursery
- Preparation of pits and preparing them for transfer of seedlings
- After-care

Raising of seedlings in nursery

Seedlings will be raised in nurseries. Adequate number of surplus seedlings will be available considering 10% mortality in seedlings. Healthy seedlings to be ready for transfer to permanent location before rainy season.

Preparation of pits and preparing them for transfer of seedlings

Standard pit size would be 1 m x 1 m x 1 m
The distance between pits would vary depending on their location
The pits should be filled using:

- Good soil from nearby agricultural fields (3 parts)
- Farmyard manure (1 part)
- Rhizobium commercial preparation 1 kg/1000 kg
- BHC powder, if the soil inhabits white ants (Amount variable)
- The pits should be watered prior to plantation of seedlings.

Trees are the most important sinks for air pollution. Trees also absorb noise, act as barrier. It will improve the ecology and aesthetics of the area. They have major long-term impacts on soil quality and the ground water table.

6.10 HOUSEKEEPING

Appropriate measures will be taken under the direct guidance of the Environmental cell for appropriate housemanship and conditioned working environment to be maintained within the Plant premises.

6.11 SOCIO- ECONOMIC DEVELOPMENT

Vedanta aims to develop and manage a diverse portfolio of mining and metals business to provide attractive returns to its shareholders. It aims to achieve this in a socially and environmentally responsible manner and create value for the communities where it operates. Sustainable development principles are fundamental to VAL's approach. These principles require VAL to monitor and reduce social and environmental risks, to ensure efficient resource use, to minimize pollution, and to create partnership with the local communities.

To create partnerships with its local communities, VAL Lanjigarh under its Corporate Social Responsibility (CSR) has taken up initiatives on three-focus areas- Education, Health and Sanitation and Sustainable Livelihood. The purpose of the CSR is to bring qualitative improvements in the lives of the community residing in the vicinity of its activities in Lanjigarh area. In addition to this, VAL focuses on sports and youth development programmes, environment protection drives and executes infrastructure development projects. The activities being undertaken under each focus area are as follows:

(i) Education:

The PTGs are very backward, educationally. Their total literacy till today is leveled at less than 20 per cent. Their female literacy is alarming low, less than 10 per cent. Their children prefer to do, indoor and outdoor, works rather than going to schools. The incidence of never attending children and dropped out children is very high among the PTGs. Thus the CCD plan indicates educational development intervention by operating the existing 16 Nursery Schools with 16 local teachers having an intake capacity of 640 children for popularizing the goal of education among the PTG children in

the age group 3-6 year and promoting their educational ability so as to enable them to compete with other STs boys and girls for taking admission in the ST & SC Development Department Residential Educational Institutions. Besides, the core education programme will be setting up of an 'Educational Complex' in every Micro Project o take special educational (both formal and vocational) care for promotion of girls' education of the PTGs, and raise their literacy and awareness levels and skills and empower them, educationally, economically and socially. Besides, the task of teaching in Nursery Schools, the teachers will play the roles animators and account keepers of SHGs, coordinators and facilitators of different development works organizers of health camps and training and awareness programmes of the Micro Projects at villages.

(ii) Health and Nutrition:

The CCD plan reflects health measures through participation of tribal traditional medicine-men in development of herbarium as well as organization of health camps with Micro Projects – NGOs partnership in a select of central villages in every alternative month to extend clinical treatments of common diseases for all affected people and providing live saving medicines for the serious patients. This will check spreading the deadly malaria disease and malnutrition and help cure the people from diseases and save them from health disorders and deaths.

(iii) Infrastructure:

The development of infrastructure – village link roads and bridges/culverts, irrigation facilities, solar lights, educational and health and market, through cooperative (NFGCS) efforts, is essential for accelerating economic development of the PTG people. The CCD plan investment in village infrastructure will give impetus to economic activities, improve tribal skills, facilitates delivery of social services, generate additional employment and income. The Micro Project in the partnership with the ITDAs and Grampanchayats will have a vital role to play in the process of building up the infrastructure in Dongria Kondh villages.

(iv) Drinking Water and Irrigation:

By turn of 2012, the CCD plan initiative will ensure coverage of all the problem villages, where drinking water is scarce, with assess to safe drinking water by constructing cisterns, installing tube wells and stream based gravitational flow tap water projects, wherever they are feasible. The construction of check dams and Diversion Weirs and extending canals and water channels from the dam sites to the farms and fields will ensure potential flow irrigation facilities for the agro-horticulture operations during kharif and rabi seasons.

(v) Income Generation:

The CCD plan envisages development of land with stone bounding and plantation of fruit bearing trees, like citrus, mango, banana, lichi, yam and spices, such as turmeric and zinger (organic produce), cinnamon and black piper cultivation/intercropping in the hill farms of the Dongarias as the core income generating programme. It will be supplemented by rice cultivation in the small chunks of wetlands, agro-forestry-vocation based skill development trainings to youths and extension of market facilities by strengthening the existing cooperative organization (NGFGCS) and providing transport services for the people and goods. Most of the income generating programmes will be implemented through a group mode (Women SHGs). The schemes, like fruit and food processing and trading of agro-forest produce and their transporting will be implemented by the SHGs, and the NGFGCS will act as a federation of all the SHGs and help extend financial and marketing and transportation supports to them. This will arrest economic exploitations of the Dongaria Kondhs by the Doms.

Education:

In order to spark the desire for children's education amongst the rural community, VAL organizes awareness program and provides supports through Child Care Centers (CCC) and Education Guarantee Scheme Schools (EGSS) in the villages. Children of the age group between three and five and six and fourteen undergo pre-schooling education and primary education respectively in these centers. VAL has opened seven Child Care Centers in seven villages – one in each village wherein 302 children are enrolled. It also supports running one EGSS where 122

children are continuing their primary education. This school covers the students from three adjacent villages. All the students at the school get the mid day meal on every working day.

Health and Sanitation:

With a view to facilitate the community people to maintain better health status VAL runs a dispensary in the Rehabilitation Colony (i.e. Niyamgiri Vedanta Nagar), a First Aid Center in the plant and Rural Health Camps through its Mobile Health Unit. In the health camps, doctors do the general health check-ups and suggest medication to the patients. At the same time, the patients and their attendants coming to the health camps are made aware of the methods and benefits of sanitary and hygienic practices, and using mosquito nets to keep malarial fever away.VAL also lent its helping hands to about 14800 patients inflicted with Malaria, Diarrhea, Viral fever and Scabies through its Rural Medical Camps from December 2003 to November 2005.

Sustainable Livelihood

In view of the abundant natural resources available in the Lanjigarh area and the poor economic status of the community residing in the surrounding area of the plant site, VAL initiated a livelihood program. Having considered the low per capita income status in the area VAL identified some feasible enterprises catering to the needs of the area and facilitating income generation scope for the target people. Accordingly it has mobilized SHGs (Self Help Group) for rural women belong to BPL households (Below Poverty Line) and arranged income-generating activities for them. VAL has started 8 SHGs with 92 women members in Niyam Giri Vedanta Nagar and has also formed another 11 SHGs with 216 women in other villages. These SHG members have mobilized nearly Rs. 92 thousand savings. One SHG is producing Phenyl and another has gone in for spice making.

As means of livelihood 80 farmers from Chhatrapur and Lanjigarh villages have undergone training on better agriculture practices for paddy and vegetable cultivation. It also conducts soil-testing camps in the villages. In the last Soil Testing Camp 31 soil samples were tested and accordingly soil treatment measures were suggested to the farmers.

Sports and Youth Development

To promote sports spirit and strengthen the social cohesiveness VAL organizes sports and youth development program on regular basis. In persuance of the objective they promote volleyball, football, cultural programs and support youth clubs in order to activate participation in social work and community development initiatives. VAL has conducted two football matches and facilitated the village youths to form 10 youth clubs. Vedanta also participates in the cultural program of the villagers and supports their festivals.

Infrastructure Development

As it is well realized that development of infrastructures provides base to any development program for achieving its objective. VAL executed infrastructure development projects such as development of metal roads, pucca drains, installation of hand pumps for clean and safe drinking water, installation of street lights, construction of temples, the Dharani ghars, construction of school buildings etc.

Environment Protection

VAL since its inception has been conscious about the environment protection in and around its industrial operation. In pursuance of this, it organizes environment protection awareness camps and observes plantation week ensuring participation of the community and the employees. VAL has organized environment awareness camps in the villages and make the community aware of the importance of sapling plantation. Around 40000 saplings of various species like Karanj, Mango, Tamarind, Jackfruit, Ashok, Neem, Lemon, Jamun, etc which are locate in nature have been planted in rehabilitation colony and 60000 saplings were planted in plant area.

To draw a long term CSR strategy VAL decided to carry out a socio economic survey of villages which were situated within a 10 kilometer radius from the plant; villages situated on the both sides of a railway track linking the plant with Rayagada – Sambalpur railway line and villages situated in and around the proposed mining sites. Asian Institute for Sustainable Development, Ranchi was requested to carry out the survey in collaboration with Xavier Institute of Social Service, Ranchi. Survey covered 81 villages located in the above-mentioned area.

CHAPTER-7
RISK ASSESSMENT & DISASTER MANAGEMENT PLAN

7.1 ENVIRONMENTAL RISK MANAGEMENT

It is presumed that the proposed expansion of Alumina refinery would be designed and engineered with all possible safety measures and standard code of practices of engineering. In spite of this, there may be some design deficiency or due to operation and maintenance fault which may lead to accidental events causing damage to the life and property. This chapter presents an overview of environmental risks associated with the production facilities, suggested remedial measures and a model outline of the emergency preparedness plan.

7.2 OBJECTIVES

The objectives of environmental risk assessment are governed by the following, which excludes natural calamities:

1. To identify the potential hazardous areas so that necessary design safety measures can be adopted to minimize the probability of accidental events.
2. To identify the potential areas of environmental disaster, which can be prevented by proper design of the installations and its controlled operation.
3. To manage the emergency situation or a disastrous event, if any, from the plant operation.

Managing a disastrous event will obviously require prompt action by the operators and the crisis management personnel using all their available resources like alerting the people and other plant personnel remaining inside, deployment of fire fighting equipment, operation of emergency shut off valves, opening of the escape doors, rescue etc.

Minimizing the immediate consequences of a hazardous event include cordoning off, evacuation, medical assistance and giving correct information to the families of the affected persons and local public for avoiding rumors and panic.

Lastly, an expert committee is required to probe the cause of such events and the losses encountered and suggest remedial measures for implementation so that in future such events or similar events do not recur.

7.3 DEFINITION OF ENVIRONMENTAL RISKS

The following terms related to environmental risks are defined before reviewing the environmental risks:

- Harm: Damage to the person, property or environment.
- Hazard: Something with the potential to cause harm; this could be due to characteristics of material being processed or malfunctioning of the equipment. An environmental hazard is thus going to be a set of circumstances, which leads to the direct or indirect degradation of environment and damage to the life and property.
- Risk: The probability of the harm or a likelihood of harmful occurrence. Environmental risk is a measure of the potential threat to the environment, life and property.
- Consequence: Effect due to occurrence of the event, which may endanger the environment permanently or temporarily and or loss of life and property.
- Environmental: The consequence is so severe that it can extensively damage one or all.
- Disaster : The four components of the environment, namely, (i) Physico-chemical (ii) biological, (iii) human and (iv) aesthetics.

7.4 IDENTIFICATION OF HAZARDS

The hazards are attributable due to raw materials and chemicals used in steel making and the plant operation. A list of major raw materials used in the plant and the process units with their hazard potential is presented in **Table 7.1.**

Table 7.1- Hazardous Material Inventory

Chemicals	Existing Storage Capacity	Expansion Storage Capacity	Storage Capacity After Expansion
HFO	5600m^3	11000m^3	16600 m^3
Power Plant	100m^3	400m^3	500 m^3
Calcination	200m^3	250m^3	450 m^3
Caustic (as 48% NaOH)	10050m^3	10050m^3	20100 m^3
LDO	65m^3	20m^3	85 m^3
Power Plant	50m^3	0	50 m^3
Calcination	40m^3	20	60 m^3
Lime	2000 T	3000 T	5000 T
Sulphuric acid	60 T	70 T	130 T
Hydrochloric acid	100m^3	100m^3	200 m^3

7.5 ENVIRONMENTAL RISK EVALUATION

From environmental hazards point of view for the raw materials and consumable chemicals and processing of the same in various production units, relative risk potential analysis is made on the following three factors:

- Likelihood of occurrence
- Likelihood of detection
- Severity of consequences

Each of these factors is graded and compiled to determine the risk potential. The factors governing the determination of relative risk potentials are presented in the **Table 7.2.**

Table 7.2 – Determination of Risk Potential

Likely hood of occurrence		**Likelihood of detection**		**Severity of consequences**	
Criteria (A)	Rank	Criteria (B)	Rank	Criteria (C)	Rank
Very High	5	Very High	1	None	2
High	4	High	2	Minor	4
Moderate	3	Moderate	3	Low	6
Low	2	Low	4	Moderate	8
Very low	1	Very low	5	High	10

RISK POTENTIAL (RP) = (A+B) X C

Based on the above stated criteria for assessing the risk, each probable event has been evaluated by addressing several questions on the probability of event occurrence in the view of the in-built design features detection response, operational practice and its likely consequence. A summarized list of environmental risk potential for the likely events is presented in **Table 7.3**.

This evaluation has been done with the presumption of common events as observed from the past experience in the operation of an integrated iron and steel plant and best practicable designs for the proposed project. The present risk potential evaluation is primarily based on human errors or faulty operation or failure of the control systems.

Table 7.3: Environmental Risk Potential Evaluation

		Rank			
Sl No.	**Event**	**Likelihood of Occurrence**	**Likelihood of detection**	**Severity of Consequence**	**Risk Potential**
1	Fire at the coal Stockyard	Very low (1)	High (2)	High (10)	30
2	Fuel gas leaks from the Pipeline/valves	High (4)	Low (4)	High (10)	80
3	Collapsing of gas Holders	Very low (1)	High (2)	High (10)	30
4	Splashing of molten Metal and slag	Very low (1)	Very high (1)	High (10)	20
5	Uncontrolled dust emissions/failure of Emission control System	High (4)	Moderate (3)	Moderate (8)	56
6	Release of untreated Waste water	Low (2)	Very low (1)	High (10)	30
7	Occurrence of static Electricity /electric spark In the Mill Cellar Room	Very low (1)	Very low (5)	High (10)	60
8	Failure of gas Cleaning Plant/Fume Extraction System	Moderate (3)	Moderate (3)	Moderate (8)	48
9	Wet scrubbers Running dry	Low (2)	Moderate (3)	High (10)	50
10	Oil wastes/ oil sludge Handling	Low (2)	High (2)	Moderate (8)	32

7.6 RISK MANAGEMENT MEASURES

The Risk management measures for the proposed project activities require adoption of best safety practice at the respective construction zones within the Works boundary. In addition, the design and engineering of the proposed facilities would take into consideration of the proposed protection measures for air and water environment.

7.7 HAZOP STUDY

It is suggested to have HAZOP study for the fuel gas distribution network and propane handing facilities prior to commissioning for last minute corrections in the design of the systems from fail safe angle.

7.8 ELECTRICAL SAFETY

Adequately rated and quick response circuit breakers, aided by reliable and selectively digital or microprocessor based electro-magnetic protective relays would be incorporated in the electrical system design for the proposed project. The metering and instruments would be of proper accuracy class and scale dimensions. A centralized supervisory control of data acquisition (SCADA) system exists in the plant. The proposed facilities would require integration with this system.

7.9 ON SITE EMERGENCY PLAN

7.9.1 Organization

A central disaster control cell has been set up under the direct charge of the General Manager (EHS). He is the person nominated to declare any major emergency and would be in charge of all operations. In his absence, General Manager (Operation) would be in the charge. He will be supported by the other nominated members of cell, e.g., General Managers/ Asst. General Manager for plant operations and service agencies like steel melting shop and Mill Personnel, Security, fire fighting staff, medical officer, manager (safety) and manager (Pollution control).

7.9.2 Information Flow

The following guidelines will be observed by any person after noticing a gas leak or fire till help is made available from central disaster control room/shop level disaster control cell.

- Raising of alarm.
- Communication to the control room about the event.
- Communication to fire station for relief in case telephone is available, otherwise try to attract attention by any available means.
- Closing of doors, windows or ventilators of the room to prevent any contaminated air getting in.

7.9.3 Central Disaster Control Room

On receiving the call, the Disaster control room would immediately direct the different supporting service agencies as enumerated below:

- Security and administrative services: responsible for safety of the plant against trespassers, saboteurs any crowd, dissemination of information to Govt. authorities and in the neighbourhood.
- Safety service: responsible for implementation of safety measures at work place and occupational safety.
- Medical service responsible for providing medical care to the injured or the affected in an event of emergency.
- Stores: responsible for providing adequate number of tools, tackles and accessories for proper emergency control.
- Welfare and water supply: To ensure supply of fire fighting water requirement and provisions of power supply.

7.9.4 Shop Level Disaster Control Cell.

The controller at the shop level would take immediate charge of any emergent situation and would assume full responsibility regarding mobilization of resources guide and help service agencies in properly carrying out their assigned duties. The duties of the shop level controller are enumerated below:

- Assess the scale of emergency and decide, if any possibility of major emergency exists and inform the Central Control room, if necessary.
- Direct safe close down of plant or any operation, if necessary.
- Ensure key personnel are called in immediately and they start carrying out their assigned duties.
- Direct rescue and fire fighting operations from safe operations point of view.
- Control rehabilitation of affected areas and any victims on cessation of emergency.
- Ensure complete safety before restarting the plant / operation.

7.9.5 Contingency Plan

The contingency plan aimed at providing different services has been prepared based on the plant general layout, the available resources, and type of hazards. The various activities covered under the contingency plan are, Pre-emergency activities, Emergency times activities and Post emergency activities.

The various facilities that have been provided within the premises are, Security service, Fire fighting service, Medical service, Pollution control service, Public relation service, Telecommunication service, Transport service, Evacuation service and Welfare service.

7.9.6 Alarm System

An alarm system will be provided with a wailing type siren at a centralized place and actuators at the strategic locations in the plant. Adequate number of telephone will be provided in each unit at Shop Floor so that a person can either directly raise the alarm or ring up disaster control room from where the alarm can be raised directly. Public Address system will also be installed for quick communication in case of emergency.

7.9.7 Equipment Checks

All fire-fighting equipment like valves, fire hydrants, pumps, monitors, etc., will be checked weekly to detect defective parts and such parts would be immediately replaced.

7.9.8 Mock Drills

Mock drills will be conducted for training the personnels and to check the performance of men & equipments and also to keep them fit for any emergency.

- To extract persons from the debris of collapsed buildings / structure and save human lives.
- To hand over the extricated persons to first aid parties.
- To take immediate steps as may be necessary for the temporary supports or demolition of buildings and structures, the collapses of which is likely to endanger life or obstruct traffic.
- To cut off supplies of water, gas electricity to damaged buildings.

7.9.9 Medical Centre

The plant will be equipped with a separate Medical Center with necessary instrument medicines and trained manpower. The medical officer will maintain close liaison with different hospitals in the vicinity.

7.10 RESCUE AND REPAIR SERVICE

The rescue services will be provided depending upon nature of accidents is:
The trained rescue personnel will be provided with the equipment like, Self contained oxygen breathing apparatus, Blower type gas masks, Resuscitators, Petromax lamp, torches, Axe/hand saw, Bamboo ladder, Necessary safety appliances and first aid box.

7.10.1 Fire Fighting Organization and Procedures

- Overall control of the Fire fighting operations will rest with the senior most officers present at the scene of fire, who will be assisted by the operational and fire staff. Close coordination and planning for fire protection will be done between plant operaters and fire service.
- While turning out for fire calls, the fire staff will be guided to the correct location immediately on their arrival.
- In charge of the section at shop floor shall explain special risks involved and guide the in charge of the Fire fighting crew. He will, however, not interfere in the method of fire fighting operations.
- Fire drills would be held in each zone periodically under the directions of the fire officer.
- Fire sirens will be tested by sounding straight for one minute on every Monday at 9AM for SMS and on every Wednesday at 9AM for Main Gate.

7.10.2 Responsibilities of Fire Control Room operator

- To take correct message regarding location, type of fire etc. from the caller.
- To repeat the message.
- To inform fire fighting personnel on duty immediately for turn out by sounding the bell.
- To ask the pump house operator to maintain adequate head in the fire water line.
- To inform telephone exchange.

7.10.3 Responsibilities of Fire fighting personnel

- To report immediately at the scene of fire.
- To take instructions from fire officer.

7.10.4 Responsibilities of Fire officer

- To direct the deployment of fire fighting personnel and fire fighting appliances.
- To organize additional fire fighting crew, if required, depending upon gravity of the situation.
- To guide plant employees in Fire fighting.
- To coordinate between different groups of fire fighting personnel and team of trained workers from the Department.
- To control the spread of fire and rescue operation, if necessary.
- To extinguish the fire.
- To replenish the required fire fighting materials / equipment.
- To arrange relievers wherever necessary.
- To assess the situation and arrange additional help if necessary in co-ordination with disaster control room.
- All clear siren to be blown after the major fire emergency is over.

7.10.5 Responsibilities of security personnel at the manned gate

- To prevent entry of unauthorized persons.
- To keep the gate open for the entrance of emergency vehicles , officers and concerned staffs with fire fighting and allied operations.

7.10.6 Responsibilities of Medical officer during major fire

- To be available at the first- aid center for necessary medical advice.
- To depute one of the medical staff to the scene of fire to render any medical assistance required at the site.

7.10.7 Responsibilities of the Head of the Personal and Welfare Department during major fire

- To arrange the transport of the fire fighting personal with minimum loss of time from township in consultation with the fire control room/fire officer.
- To make arrangement for the refreshment meals for persons engaged in fire fighting.
- To inform the fire officer regarding the actions taken.

7.10.8 Responsibilities of Head of the Maintenance Dept. during major fire

To report to Fire Chief and render all help that may be required from maintenance dept.

7.10.9 Responsibilities of Head of the Electrical Maintenance Dept. during Major fire

To report to fire officer and render assistance to be required from Electrical department such as installation of equipment provision of temporary lighting.

7.10.10 Responsibilities of Head of the Materials procurement Dept. during Major fire

To arrange to manage the stores for emergency issue of materials. If the materials are not available in the stores or are likely to be exhausted during fire fighting operations he would arrange for the same from neighboring industries or other sources.

7.10.11 Mutual aid system

At times the possibility of a major emergency a situation out of control of plant authority cannot be ruled out. In such a case, the plant authority would declare it to be a major emergency and total control would be transferred to the district level office of contingency plan committee. Necessary help would also be sought from neighboring industries having necessary infrastructure for dealing with disaster.

CHAPTER-8
ENVIRONMENTAL MANAGEMENT SYSTEM & IMPLEMENTATION OF EMP

8.1 FORMATION OF AN ENVIRONMENTAL MANAGEMENT SYSTEM

The environmental management system to be formed by the industry will enable it to maximize its beneficial effects and minimize its adverse effects with emphasis on prevention. It shall:

- Identify and evaluate the environmental effects arising from the industry's existing/proposed activities, products and services to determine those of significance;
- Identify and evaluate the environmental effects arising from incidents, accidents and potential emergency situations:
- Identify the relevant legislative and regulatory requirements:
- Enable priorities to be identified and pertinent environmental objectives and targets to be identified and pertinent environmental objectives and targets to be set:
- Facilitate planning, control, monitoring, auditing and review activities to ensure that the policy is complied with.
- Allow periodic evaluation to suit changing circumstances so that it remains relevant.

8.2 IMPLEMENTATION OF AN ENVIRONMENTAL MANAGEMENT SYSTEM

8.2.1 Commitment

It is essential that the top management is committed for the development of its activities in an environmentally sound manner and supports all efforts in achieving this objective.

Experience has shown that all attempts to change the processes and production methods which reduce/ prevent wastes and inefficient use of resources ultimately result not only in environmentally sound practices but also better business returns.

8.2.2 Preparatory Environmental Review

An industry with no formal environmental management system first establishes its current position with regards to environment through a preparatory environmental review. This covers four areas:

- Legislative and regulatory requirements.
- Evaluation and registration of significant parameters and their environmental impacts.
- Review of existing environmental management practices and procedures.
- Assessment of feedback from investigation of previous environmental incidents and non-compliance with legislation, regulations or existing policies and procedures.

The resulting report should address:

- The nature and extent of problems and deficiencies
- The priorities to be accorded to rectify them

8.2.3 Environmental Policy

The industry's management should actively initiate, develop and support the environmental policy, which is relevant to its activities, products and services and their environmental effects. Broadly this should:

- Be consistent with the occupational health and safety policy and other industrial policies (such as quality policy);
- Indicate which of the industrial activities are covered by the environmental management system;
- Be communicated and implemented at all levels of the industry
- Be available publicly.

8.2.4 Organization and Personnel

To facilitate the implementation of the EMS, one of the most important aspects relate to the organization and personnel. The related issues are:

- Define and document the responsibility, authority and interrelations of key personnel involved in the implementation of the environmental policy, objectives and environmental management system;

- Identify the in-house verification requirements and procedures including resources and personnel;
- Appoint a Management Representative (MR);
- Communicate to employees at all levels the importance of compliance with the environmental policy, their role and responsibilities in achieving compliance, the potential consequences of departures from the specified procedures, identify and provide appropriate training
- Establish and maintain procedures to ensure that contractors are made aware of the environmental management system requirements and provisions.

8.2.5 Environmental Effects

The industry should establish and maintain procedures for:

- Receiving, documenting and responding to internal as well as external communications concerning environmental aspects and management
- Identifying, examining and evaluating the environmental effects of its activities under normal and abnormal/emergency situations (including risk assessment) and compiling significant effects in a register.
- Recording all legislative, regulatory and other policy requirements and codes in a register.

8.2.6 Environmental Objectives and Targets

The objectives should be set with a view to realizing gradual and steady improvements in environmental performance through application of best available and economically viable technology.

The areas targeted for improvement should be those where improvements are most necessary to reduce risks (to environment and industry) and liabilities. These should be identified through cost-benefit analysis wherever practicable and should be quantitative and achievable.

8.2.7 Environmental Management Program

The establishment of an Environmental Management Program is the key to compliance with the industry's environmental policy and achievement of the environmental objectives and targets.

It should designate the responsibility for achieving the targets at each level and the means thereof. It should deal with the actions required for the consequences of the industry's past activities as well as address the life cycle of developments of new products so as to effectively control adverse impacts.

8.2.8 Environmental Management Manual and Documentation

The documentation is intended to provide an adequate description of the environmental management system. The manual is expected to provide a reference to the implementation and maintenance of the system.

8.2.9 Operational Control

The management responsibilities should be defined to ensure that the control, verification, measurement and testing of environment parameters within the industry are adequately coordinated and effectively performed.

The control, verification, measurement and testing should be made through documented procedures and work instructions defining the manner of conducting activities, the absence of which can lead to violation of the environment policy.

In the event of non-compliance, procedures for investigation of the causative mechanism should be established and the factors reported for corrective actions.

8.2.10 Environment Management Records

The industry should establish and maintain a system of records to demonstrate compliance with the environmental management systems and the extent of achievement of the environmental objectives and targets. In addition the other records (legislative, audit and review reports), management records should address the following:

- Details of failure in compliance and corrective action;
- Details of indigents and corrective action;
- Details of complaints and follow-up action;
- Appropriate contractor and supplier information;
- Inspection and maintenance reports;
- Product identification and composition data;
- Monitoring data;
- Environmental training records**.**

8.3 ENVIRONMENTAL MANAGEMENT AUDIT

8.3.1 Environmental Statement

As a mandatory requirement under the Environment Protection Rules (1986) as amended through the Notification issued by the Ministry of Environment and Forests in April 1993, an Environmental Statement should be prepared annually. This should include the consumption of total resources (raw material and water per tonne of product), quantity and concentration of pollutants (air and water discharged, quantity of hazardous and solid waste generation, pollution abatement measures, conservation of natural resources and cost of production vis-à-vis the investment on pollution abatement. This may be internal or external audits, but carried out impartially and effectively by a person properly trained for it. Broad knowledge of the environmental process and expertise in relevant disciplines is also required.

The intention of this statement is:

- To identify the process/ production areas where resources can be used more efficiently through a comparison with the figures of a similar industry (thereby reducing the consumption per unit of product);
- To determine the areas where waste generation can be minimized at source and through end of pipe treatment (thereby reducing the wastes generated and discharged per unit of product);
- Initiate a self-correcting/improvement system through an internal analysis to achieve cost reduction through choice of superior technology and more efficient practices.

8.4 ENVIRONMENTAL MANAGEMENT REVIEWS

The senior management should periodically review the Environmental Management System (EMS) to ensure its suitability and effectiveness. The need for possible changes in the environmental policy and objectives for continuous improvement should be ascertained and revisions should made accordingly. EMS based on the above objectives should be formulated and implemented at the industry level.

It is recommended to have a full-fledged environmental monitoring cell supported by fully equipped environmental laboratory. The environmental monitoring cell should be headed by a Senior Level Environmental Engineer with adequate experience. He should be supported by following technical personnel:

- Senior chemist
- Ecologist/Horticulturist; and
- Adequate & permanent field staff

The department should be the nodal agency to co-ordinate and provide necessary services on environmental issues during construction and operation of the project. This group is responsible for implementation of environmental management plan, interaction with the environmental regulatory agencies, reviewing draft policy and planning. This department interacts with MoEF, Central Pollution Control Board (CPCB), State Pollution Control Board (SPCB) and other environment regulatory agencies.

8.5 IMPLEMENTATION OF EMP

The effective implementation of EMP will not only reduce pollution load & comply the regulatory requirement but also increase productivity & improve marketability of product.

8.5.1 Environmental Monitoring

The regular online and background monitoring of environmental parameters is essential for the successful implementation of EMP.

8.5.2 Environmental Laboratory

The environmental laboratory headed by manager (environmental lab) will co-ordinate all the environmental monitoring. He will be assisted by two chemist, three samplers and two helpers. The laboratory will be equipped with the state of the art instrument that would be required for monitoring the relevant parameters.
The main analytical instruments/ equipments will be :

- High volume sampler
- Stack monitoring kits
- Digital pH meter

- Conductivity/ TDS meter
- Nephelometer
- UV/VIS spectrophotometer
- Soxhelt apparatus to measure oil & grease
- Ammonia distillation apparatus
- BOD incubators

Besides adequate glassware & other laboratory equipment and chemicals will be in place.

8.5.3 EMP Cell

M/s. VAL will set up a full-fledged department of EHS (Environment, health and safety) to be managed by a general manager level executive.

The environmental management cell will be headed by a qualified senior executive who will deal with all the EMP related matters like environmental monitoring, environmental system, environmental performance, compliance requirement and liasioning with regulatory authority, safety & disaster management and occupation health. He will be assisted by manager (safety), doctor (health), manager (env. engg) & manager (env. monitoring). At the bottom safety officers, health workers and chemists will perform all day-to-day routine works.

8.5.4 EMP safety & disaster management

The safety cell will be managed by one manager (safety & DMP). Three safety officers will assist him. They will all be responsible for all safety work, records and liasioning with regulatory authorities. The VAL plans to implement OSHAS 18000.

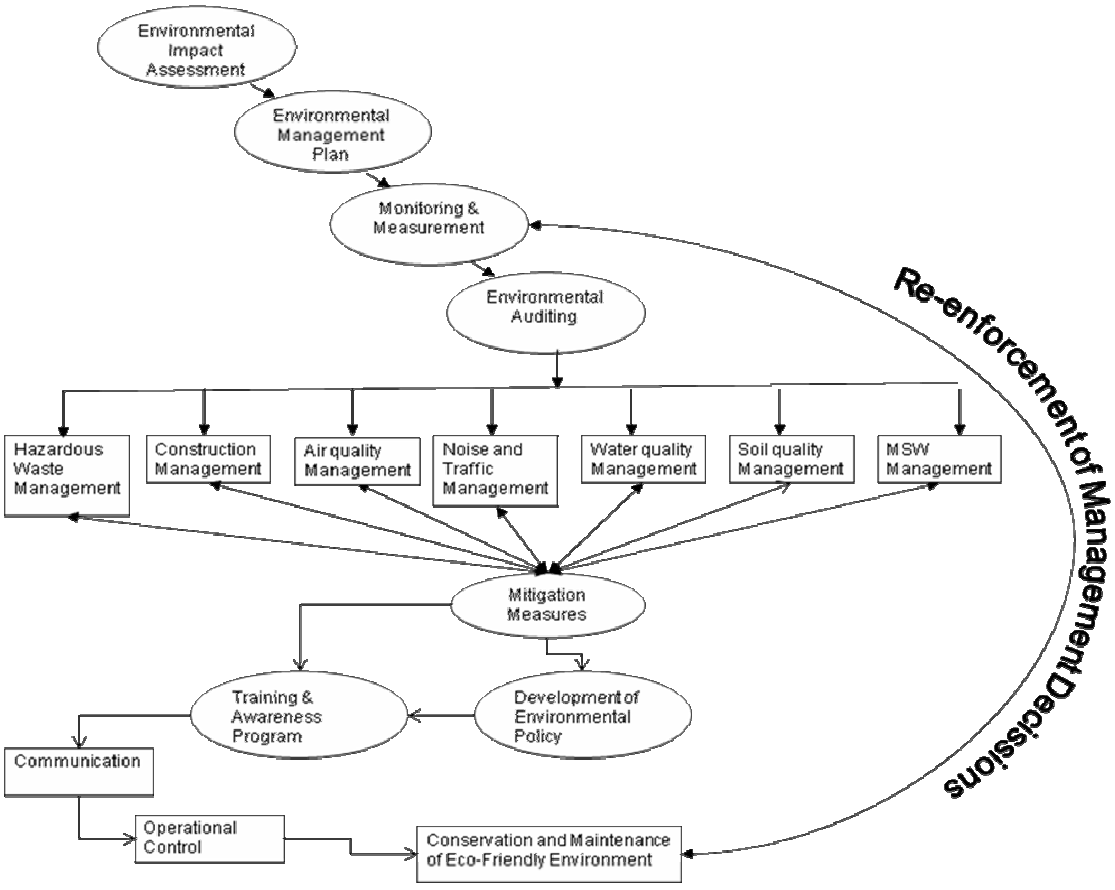
8.5.5 Occupational health

The factory employees are likely to suffer from various occupation related diseases. A doctor will co-ordinate all these cases and will address the same with the help of different health specialists.

8.6 COST OF EMP IMPLEMENTATION

Category	Investment So Far	Projected Investment
Instrument and Equipment (Capital Cost)	Rs. 1500 Cr	Rs. 2000 Cr
Maintenance/ Annum	Rs. 2.4 Cr	Rs. 4.0 Cr
CSR Activities / Annum	Rs. 3 Cr	Rs. 6 Cr
Training and Monitoring / Annum	Rs. 1.6 Cr	Rs. 2.5 Cr

Figure 8.1: Overview of the Environmental Management Plan



CHAPTER-9
PROJECT BENEFITS AND CONCLUSION

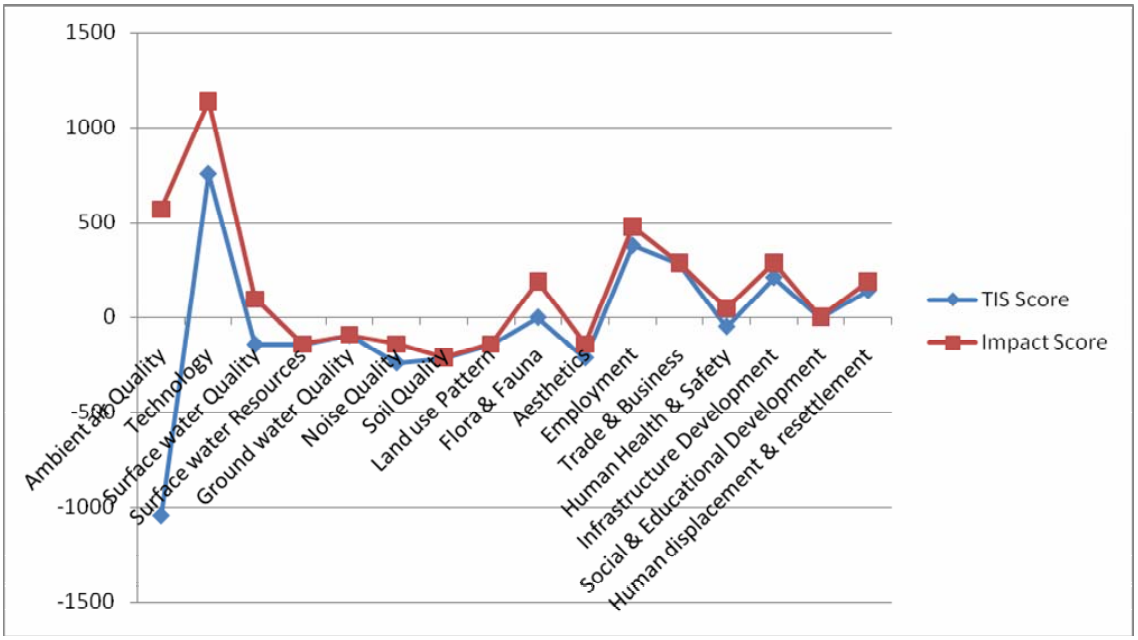
After due evaluation of Pros & Cons, the qualitative matrix is drawn for an overall impact assessment in a predictive model. The scores used in this matrix are based on the evaluation criteria as mentioned in Chapter 3/4.

Table-9.1: Total Impact Score (TIS) for Project activities with comprehensive EMP and project benefits

Environment Components	PIV	Civil Construction	Mechanical Work	Raw Material & Product Handling, Stores & Transportation	Plant Operation	Civic amenities	Total	Impact Score
Ambient air Quality	95	1		2	2	1	6	570
Technology	95	1	4	2	2	3	12	1140
Surface water Quality	48	2	1	1	-1	-1	2	96
Surface water Resources	48				-1	-2	-3	-144
Ground water Quality	24				-3	-1	-4	-96
Noise Quality	48	-1	-2	-2	-1		-6	-288
Soil Quality	71		-1		-1	-1	-3	-213
Land use Pattern	71	-1	-1	-1		-1	-4	-284
Flora & Fauna	48	1			-1	4	4	192
Aesthetics	71	-1	-1	-1	-2	2	-3	-213
Employment	95	2		1	3	1	7	665
Trade & Business	95			1	1	1	3	285
Human Health & Safety	48	1	-1	-1	-2	2	-1	-48

Infrastructure Development	71	1		-1	2	2	4	284
Social & Educational Development	48	1				3	4	192
Human displacement & resettlement	24	-1			-1	-1	-3	-72
Total	1000							2066

Figure-9.1: Comparison of PRE-POST EMP Scores



Note: TIS: Total Impact Score Before EMP; Impact Score: Total Impact Score After EMP

Conclusion

The total score of the impact on all the subjects as identified important for expansion project and changes from a negative score to a positive score. This change in the impact after implementation of EMP is due to appropriate installation of the pollution control equipments and taking care of the ecosystem with preservation and quality assurance. It is been observed that the air quality is the most important character in the assessment, with positive impact of employment, trade & business, health care, and eco-friendly technology been key players due to the proposed project. Although the air quality will have some impact on the environment, but considering the socio-economic importance of the project

and for a better interest of the State and locals, the project has sustainable environmental impact attaining the projected growth in economy and social welfare.

VAL since its inception has been conscious about the environment protection in and around its industrial operation. And in persuasion of this, it organizes environment protection awareness camps and observes plantation week ensuring participation of the community and the employees.

Annexure I

Status of Compliance of Environmental Clearance for Alumina Refinery Project

Sl no.	Special Conditions	Compliance
1	The Gaseous emissions from various process units shall conform to the standards prescribed from time to time. The SPCB may specify more stringent standards for the relevant parameters keeping in view the nature of the industry, its size and location. At no time the emission level shall go beyond the prescribed standards. In the event of any failure of any pollution control systems adopted by the unit, the respective unit shall not be restarted until the control measures are rectified to achieve the desired efficiency. Ambient air quality monitoring stations shall be set up in consultation with the Orissa Population Control Board. Data shall be regularly monitored and records maintained and report submitted to the Ministry/CPCB/SPCB once in six months.	Plant is now in operation. 10 number of AAQ monitoring station have been fixed in consultation with SPCB.
2	There shall be no discharge of process effluent. As reflected in the EIA/EMP report, proposed refinery shall be designed for zero process discharge. Extensive measures shall be undertaken for water reuse and recycling. The domestic waste water shall be treated in the sewage treatment plant and treated waste water conforming to the standards for land application shall be reused for green belt development.	Proposed refinery has been designed as per Zero Discharge Concept.Domestic waste water is being treated in STP.we have two STP of capacity 360KLD and 150KLD in out plant premiseses and in township respectively. Provision has been made to reuse the treated effluent water.
3	In-plant control measures for checking fugitive emissions from spillage/ raw materials handling etc. shall be provided. Fluoride emissions should be monitored from the existing pot room, proposed pot room and in the forage around the smelter complex. Further, dry scrubbing system to control the emissions from the pot lines should be provided. The fluoride emissions	In-plant control measures have been provided to control the figitive emissions. There will be no pot rooms in the existing Alumina Refinery Plant.

	shall not exceed 0.8 kg/t of aluminium produced.	
4	The calciner and boiler stacks shall be provided with electrostatic precipitator and continuous monitoring device for SO_2. Particulate emissions shall not exceed 150 mg/NM^3. The height of the stacks shall be as per the CPCB guidelines. The boiler and calciner stacks should be equipped with continuous monitoring device to check SPM emission levels. Low NO_X burners shall be installed to control the NO_X emissions.	Calciner and Boiler stacks have been provided with ESPs and online gas analyser has been installed for continous monitoring of gases. The stack height has been designed as per CPCB guidelines. Provision has been made for low NOx burner to control NOx emissions.
5	The company shall adopt dry disposal (High concentration slurry disposal) system for red mud and ash disposal. Monitoring of groundwater quality around the red mud and ash ponds shall be undertaken by providing piezometeric holes. A leachate study shall be undertaken and report submitted within six months of commissioning of the project. A plan shall be worked out for rehabilitation of red mud pond and ash pond as and when they are filled up. Efforts shall also be made to find out productive uses of red mud.	Dry disposal (High concentration slurry disposal) system for red mud and ash has been provided. 10 numbers of piezometeric holes had been provided around red mud and ash pond for monitoring of ground water quality.
6	Green belt of adequate width and density shall be provided to mitigate the effects of fugitive emission all around the plant. A minimum of 25% of the area shall be developed as green belt with local species in consultation with the DFO, as per CPCB's guidelines.	Plantation activities have been started within the premises of the plant.About 206000.00 sapling have been planted upto September 2007 and Balance area will be planted in phases.
7	Occupational health surveillance of the workers shall be done on a regular basis and records maintained as per the Factories Act.	It is being carried out.
8	All the recommendations of the Charter on Corporate Responsibility for Environmental Protection (CREP) for the aluminium sector shall be strictly implemented.	Red Mud is being disposed with High Concentration Slurry Disposal System as per CREP condition

9	The project authorities shall obtain necessary clearances for the stack of the Captive Power Plant from the Airports Authority of India.	Necessary clearance from Air Port Authority of India for the stacks of power plant has been obtained.
10	The company shall obtain necessary clearances for the linked mining component before operationalising the alumina refinery and the captive power plant.	Noted
Sl no.	**General Conditions**	
1	The project authorities shall strictly adhere to the stipulations made by the Orissa Pollution Control Board and the State government.	Noted for compliance.
2	No further expansion or modifications in the plant shall be carried out without prior approval of the Ministry of Environment and Forests.	Noted for compliance.
3	Adequate ambient air quality monitoring stations shall be established in the downward direction as well as where maximum ground level concentration of SPM, SO2 and Nox are anticipated in consultation with the State Pollution Control Board. Data on ambient air quality, fugitive emission and stack emissions shall be regularly submitted to this Ministry including its Regional Office at Bhubaneshwar and the State Pollution Control Board/ Central Pollution Control Board once in six months.	Same as Special Condition No 1
4	The overall noise levels in and around the plant area shall be kept well within the standards (85 dBA) by providing noise control measures including acoustic hoods, silencers, enclosures etc. on all sources of noise generation. The ambient noise levels shall conform to the standards prescribed under EPA Rules, 1989 viz. 75 dBA (daytime) and 70 dBA (night time).	During detailed engineering stage, care has been taken by providing suitable acoustic measures to contain noise level upto 85db(A) in frequented areas and to contain plant overall noise level of 75db(A) during daytime and 70db(A) during night time.

5	The company shall also comply with all the environmental protection measures and safeguards recommended in the EIA/EMP report. Further, the company shall earmark funds separately for improving socio-economy and ecology of the region.	It is being followed.
6	The project authorities shall provide adequate funds both recurring and non-recurring to implement the conditions stipulated by the Ministry of Environment and Forests as well as the State Government along with the implementation schedule for all the conditions stipulated herein. The funds so provided shall not be diverted for any other purposes.	All the conditions imposed by MOEF and SPCB have been completed and no fund has been diverted.
7	The Regional Office of this Ministry at Bhubaneshwar/central Pollution Control Board/State Pollution Control Board will monitor the stipulated conditions. A six monthly compliance report and the monitored data along with statistical interpretation shall be submitted to them regularly.	Noted for compliance.
8	The company shall inform the public that the project has been accorded environmental clearance by the Ministry and copies of the clearance letter are available with the State Pollution Control Board/Committee and may also be seen at website of the Ministry of Environment and Forests at http:/envfor.nic.in This shall be advertised within seven days from the state of issue of clearance letter, at least in two local newspapers that are widely circulated in the region of which one shall be in the vernacular language of the locality concerned and a copy of the same should be forwarded to the Regional Office.	The environmental clearance has been published in local newspaper "Sambad" dated 28-09-2004 and "Dharitri Oriya daily"
9	The project authorities shall inform the Regional Office as well as the Ministry, the date of financial closure and final approval of the project by the concerned authorities and the data of commencing the land development work.	The Project work commenced on 22-09-2004.

a.	The Ministry may revoke or suspend the clearance, if implementation of any of the above conditions is not satisfactory.	Noted.
b.	The Ministry reserves the right to stipulate additional conditions, if found necessary. The company in a time bound manner will implement these conditions.	Noted
c.	The above conditions will be enforced, Interalia under the provisions of the Water (Prevention & Control of Pollution) Act, 1974, the Air (Prevention & Control of Pollution) Act, 1981, the Environment (Protection) Act, 1986 and the Public Liability Insurance Act, 1991 along with their amendments and rules.	Noted for compliance.

Annexure II

Compliance to the guidelines of Corporate Responsibility for Environmental Protection (CREP) on Alumina Refinery

As per TOR condition

Sl. No.	Issues	Action Points	Targets	Compliances
1.	Red Mud	Phasing out Wet disposal	To achieve minimum 50% solids in red mud by Dec 2005	Red Mud disposal shall be carried out by High Concentration Slurry Disposal system where in mud concentration at pumping shall be 58-65% SOLID (W/W). Details are given in Section 6.7 of Chapter-6 of EIA Report
		Red Mud Utilisation	A proposal for practical utilization to be prepared by Aluminium Association of India within six months	Red mud pond is designed for at least 10 years capacity. The land availability structure of pond with specification details are given in Table-6.2 of Chapter-6 of EIA Report

Annexure -III

Corporate Social Responsibility Report (Vedanta Aluminium Limited, Lanjigarh)

Vedanta Aluminium Limited (VAL), Lanjigarh under its **Corporate Social Responsibility** has taken up initiatives based on **three-focus areas- Education, Health & Sanitation and Sustainable Livelihood,** for bringing about qualitative improvements in the lives of the community residing in the vicinity of its industrial operation in Lanjigarh area. In addition VAL focuses sports and youth development program, environment protection drives and executes infrastructure development projects.

In order to spark the desire for children's education amongst the rural community VAL organizes awareness program and supports Child Care Center run by Sterlite Foundation in the villages Education Guarantee Scheme School and Panchayat High School where children of the age group between three to five years; five and fourteen years and above undergo pre-schooling education, primary education and high school education respectively. Recently VAL has adopted 400 Anganwadi Centres under Sterlite BAL CHETNA project to strengthen the pre-schooling service of the centres and health care services with focus on reduction of Anemia.

The status of education initiatives is as under:

- Number of Child Care Center : 34
- Number of enrolled children in the centers : 1175
- Number of EGS school in Niyamgiri Vedanta Nagar : 01
- Number of enrolled children in the EGS School : 140
- Number of villages covered under EGS School : 03
- Mid-Day-Meal to the children in the Centers and EGS school : Every day
- Number of student in Panchayat High School, Chhatrapur : 168

EDUCATION & CHILD WELFARE

Focus Areas	Activities Taken Up Since 2003				
	2003-04	2004-05	2005-06	2006-07	2007-08
Education and Child Welfare		1 Childcare Centre	10 Childcare Centers	8 Child Care Centers	19 Child Care Centers
		1 EGS School		1 Panchayat high School	
Scholarships/ Sponsorship				Scholarship to Gajendra Majhi	• Vedanta Gyanashree Award • Vedanta Scholarship to 4 students of Panchayat High School
Sports and Culture/ Sponsorship			Kalahandi Utsava		
				State Level One Act Drama Competition	
		Children's Day			
		Independence Day			
					Predeshika Khel Kud Samaroh
					Surtarangini Football Tournament

Impact:

Business Need

- Facilitates smooth entry into the village and acts as catalyst for community support

Community

- Average class attendance of the children in Child Care Center : 96%
- Average class attendance of the students in the EGS school : 95%
- Average class attendance of the students in the EGS school : 85%
- Presence of the parents in the Parents Meet of the Center : 90%
- Presence of the parents in the Parents Meet of the EGS school : 92%

- The children recite Oriya and English rhymes and write small words and numerals in the respective scripts.
- The children attend the classes with washed uniforms.
- The children participate in the cultural program developing their personality.

SPORTS & CULTURE and ENVIRONMENT PROTECTION

To promote sports spirit and strengthen the social cohesiveness VAL organizes sports & culture and youth development program on regular basis. In persuasion of the objective we promote football games, cricket matches, cultural programs and support youth clubs for their active participation in social work and community development initiatives. This apart, we sensitize the community for environment protection and accordingly we ensuring the participation of the community. VAL has planted about 1,00,000 saplings in and around Plant site, Niyamgiri Vedanta Nagar and Avenue Plantation at Bhawanipatna.

Summary of the activities:

S. No.	Name of Villages/District/Town	Name of Program
1	Bhawanipatna	Kalahandi Utsav
2	Rayagada	Chaitiparv
3	Lanjigarh	Cricket Match, Football Match, Badminton game

Impact:

- Participation of youths in social activities has increased.
- Social cohesiveness has strengthened.

HEALTH & SANITATION

Focus Areas	Activities Taken Up Since 2003				
	2003-04	**2004-05**	**2005-06**	**2006-07**	**2007-08**
Health & Sanitation		Mobile Health Unit			
			Village Sanitation Drives		
			Take Home Ration Camps		
			Health Awareness Camp		
	Dispensary in Niyamgiri Vedanta Nagar				
					Family Welfare Programme (Project Sustha Pariwar)
					Flood Relief Camps

With a view to facilitating the community people to maintain better health status VAL runs dispensary in the Rehabilitation Colony i.e. Niyamgiri Vedanta Nagar, First Aid Center in the plant and organizes Rural Health Camps on regular basis through its MOBILE HEALTH UNIT. In the health camps our doctors do the general health check-ups and suggest medication to the patients. At the same time the patients and their attendants coming to the health camps are made aware of the methods and benefits of undergoing sanitary and hygienic practices, using mosquito nets to keep malarial fever away. This apart, we facilitate organizing Cataract Operation Camps to bring back the light to the eyes of people suffering from cataract and blindness. VAL organizes regular sanitation drive in the villages to generate awareness among the people about sanitation and hygienic practices to keep households and common places neat and clean. We conduct Family Welfare Awareness camps and Family Planning Operation camps to raise standard of living and enhance quality of life by adopting small family norm, safe sex practices, use of contraceptives etc under Public Private Partnership called Project Sustha Pariwar. We also extend need based health services like Flood Relief Camp and Health camps in flood affected areas.

The overview of our health initiatives is as below:

- Number of patients treated in the Dispensary (July 2004 to March 2008) :54292
- Number of patients treated in the First Aid Center (July2004 to March 2008) :36027
- Number of patients treated in the Rural Health Camps (July 2004 to November 2008) : 76025
- Identified most prevalent diseases : Malaria, Diarrhoea, Viral fever, Scabies
- Number of Tube wells Installed in Niyamgiri Vedanta Nagar : 08
- Total Number of Tube wells Installed : 55

Impact:

Business Need

- Facilitates smooth entry into the village and acts as catalyst for community support

Community

- Tentative decrease in the number of patients inflicted with malaria : 30%
- Decrease registered in the number of patients suffering with scabies : 25%
- Hike in the incidents of the mosquito nets use for malaria prevention : 30%
- Increase in the number of community women participating in sanitation drive : 80%
- Increase in the number of Community people participating in awareness drive : 40%

SUSTAINABLE LIVELIHOOD

Focus Areas	Activities Taken Up Since 2003				
	2003-04	2004-05	2005-06	2006-07	2007-08
Sustainable Livelihood			Vision Entrepreneurship		
				Sashya Shilpa Abhijan	
				Goatry	
				Leaf Plate Making	
					Soil Testing
					Pisciculture
					Mushroom
					Tailoring

In view of the enough natural resources available in the Lanjigarh area and the poor economic status of the community residing in the surrounding areas of the plant site VAL initiated the livelihood program. Having considered the low per capita income status in the area we identified some feasible enterprises catering to the needs of the area and facilitating income generation scope for the target people. Accordingly we organized rural women of BPL (Below Poverty Line Status) into Self-Help-Groups at par with 10-15 members per group. Then each group was imparted training on project proposal formulation, doing thrift saving and kicking-off income generating projects. Our effort in this direction has formed 35 SHG's. In addition to it we support agriculture and watershed development activities to increase the productivity of soil and thereby the volume of crop production under the Project Sashya Shilpa Abhijan. There are 65 farmers' SHGs in the villages growing cash crops. 750 acres of land has been brought under cultivation generating additional source of income for the farmers. There income level has increased due to proper market linkage. These farmers are provided training on Best Agricultural Practices, Organic Farming, Medicinal Plant Cultivation and recently also on horticulture. Besides this we have developed enterprises on phenyl making, leaf plate making, pisciculture, goatry etc

Summary of our sustainable livelihood initiatives:

- Number of women SHG's formed in five peripheral villages : 35
- Number of members of the thirty five SHG's : 365
- Total savings of the 35 SHG's : Rs.5,50,360.00
- Number of farmer's SHG : 65
- Number of Farmer's benefitted : 650
- Total savings of the 65 SHG's : Rs.7,43,000.00
- Number of Villagers benefitted through various enterprises: 158

Impact:

- SHG's women have developed the habit of thrift saving
- The culture of silence among women has broken.
- Women's self-confidence has strengthened.
- They participate in social activities.

INFRASTRUCTURE DEVELOPMENT

As is well realized that development of infrastructures provides base to any development program for achieving its objective. VAL executed infrastructure development projects like construction of roads, lanes, drains, temples, school building etc. to provide support base for other programmes. In the last six months one Champadeipur to Pokharibandh road, number of internal concrete road with drain and Chandani, Construction of School Buiding, banamali Sikhya Niketan, dahikhal etc. has been constructed by VAL for the benefit of the community. Apart from this dharni temple has been constructed and Child Care Centres have been renovated in villages like Khemdipadar, Kansari etc. Tube wells were also installed to provide drinking water to the villages. Approach road to the villages were also built to increase accessibility to the villages. So VAL executed infrastructure development projects during the year 2004-2008 which are as follows:

Focus Areas	**Activities Taken Up Since 2003**				
	2003-04	**2004-05**	**2005-06**	**2006-07**	**2007-08**
Infrastructure Development	House construction, Road development, Toilet construction, Water supply system, Community hall etc.				Construction of drain at A block NVN
	Child care centre,EGS school, Pond renovation, culverts & drain construction, Plantation(RAC)				Construction of sitting platform A block NVN
	Skill Development of DFs Expenses(RAC)				Construction of Dharni mandap,B block,NVN
	Creamatorium, Playground, EGS school platform concreting, toilets cleaning (Non RAC)				Construction of 2 nos.of tubewell platform,NVN
	Transect drain, road repair, drain construction, community hall kitchen, water tanks repair & tube well plat form repair(Non RAC)				Electrical Connection,NVN
	House repair, tubewell platform construction, hospital building, house roof repairing, Dharani temple construction & repairing, Rehabilitation colony maintainance work(Non RAC)				Construction of Dharni mandap,C block,NVN
	Tubewell platform repair, Maintainance work, drain construction, community hall repairing, house roof repairing etc.				Construction of 5 nos.of tubewell platform,NVN
	PAP management				Installation of DISH TV at Community Hall,NVN
					Cleaning of bushes,shrubs at NVN
					Cleaning of 12 nos. of houses at NVN
					Water proofing of 39 houses NVN
					Colouring of Dharni temple and Community hall,NVN
					Electrification job of 12 Quarters at NVN
					Construction of Drain at NVN
					Installation of Pre cast Cement gabbions

		Construction of internal concrete road,Nuapada,chandanpur
		Construction of internal concrete road,Chandanpur Basti,chandanpur
		Construction of concrete road,approach road,drain,borewell platform,SC pada,Bandhaguda
		Height raising of high school boundary wall,Chhatrapur
		Construction of internal concrete road,ST pada,Bandhaguda
		Construction of internal concrete road,Kadamguda
		Installation of tube well at Rengopali,Baterlima
		Construction of Drain,Basantapada
		Construction of internal concrete road,Harekrushnapur
		Sludge removal,Rengopali
		Tube well platform,Kendubardi
		Tube well platform,Sind bahal
		Tube well platform,Kapa guda
		Tube well platform,Kendubardi
		Tube well platform,Baterlima
		Tube well platform,Basanta pada
		Tube well platform, Chhatrapur
		Tube well platform, Chhatrapur

		Tube well platform, Rengopali
		Tube well platform, Jagannath Pur
		Tube well platform,Baterlima
		Construction of Drain,Mali pada,Balabhadrapur
		Construction of Interna Concrete road,Mali pada,Balabhadrapur
		Tube well platform,Kadamguda
		Renovation of Pharmacist quarter,lanjigarh
		Internal Concrete road,Raja Pada,Lanjigarh
		Tube well platform,Kansari
		Tube well platform, Chhatrapur
		Tube well platform,Kansari
		Tube well platform, Jagannathpur
		Tube well platform, Rasbundel
		Tube well platform,Bundel
		Tube well platform,Ashram pada,Lanjigarh
		Tube well platform,Ashram pada,Lanjigarh
		Tube well platform,Ashram pada,Lanjigarh
		Tube well platform,bazar chhak,Lanjigarh
		Construction of WBM road Baterlima-Niali

		Tube well platform,Bada Pada,Lanjigarh
		Construction of Tube well platform and drain,Chhatrapur
		Tube well platform,Bada Pada,Lanjigarh
		Repairing of Patharbhata nala cross bund,Lanjigarh
		Renovation of Lanjigarh high School Field Boundary wall
		Construction of concrete road with drain from pond curve to police barrack square,lanjigarh
		Renovation of Doctor's Quarter lanjigarh
		Repairing of damaged bridge,Trilochanpur
		Construction and fixing of Iron gate at Panchayat High School,Chhatrapur
		Construction of WBM road from Jodabandh-Chandanpur(1-500)mts.
		Construction of WBM road from Jodabandh-Chandanpur(501-1000)mts.
		Construction of drain Nangalbeda
		Construction of Concrete road at khamankhunti Village
		Construction of Computer Room for Saraswati Sishu Mandir,Ambadala
		Renovation of Baterlima Child Care centre
		Construction of concrete pavement with drain,Jagannathpur
		Construction of boundary wall and renovation of bathroom at kesinga mahavidyalaya Kesinga

		Construction of open bathroom and tubewell platform at Raghunathpur
		Repairing of Child care Centre at Raghunathpur
		Construction of drain alongwith platform border at Chhatrapur
		Construction of dharni Temple,chanalima
		Construction of earthen check dam,Chhatrapur
		Construction of Drain at Maskapadar
		Construction of Drain at Kendubardi
		Renovation work at Police Barrack,lanjgarh
		construction of sitting platform,Belamba
		Construction of Concrete pavement,Dahikhal
		Repair of Dahikhal Bridge
		Programme sponsored by VAL for cultural development& Kalahandi Utsav
		High Light mast at Bhawanipatna
		Traffic signaling system and road signals
		High Level bridge at Nangalbeda
		Construction of Concrete Pavement with mini drain at Kansari Village
		Construction of drain for irrigation purpose,Basantapada
		Repairing of culvert,Chanalima

		Sprinkling of water,ambodola
		Internal Concrete road,Bilatipadar
		Sports Kit,Bilatipadar
		Tent Material,Bilatipadar
		Bore well installation (2 nos.),Raghunathpur
		Bore well installation(2 nos.) Chandanpur
		Bore well installation(2 nos.),Nangalbeda
		Bore well installation (3 Nos.)& sanitary well,Malikukudaghar
		Bore well installation(3 nos.)& sanitary well,Chhatrapur
		Installation of 1 no. of bore well,chhatrapur

PART-II

BASIC DATA ABOUT PTGs

TO BE BASED ON THE BASE LINE SURVEY REPORT OF THE YEAR MARCH-2007

(DONGRIA KONDHA DEVELOPMENT AGENCY, KURLI (CHATIKANA), RAYAGADA DISTRICT, ORISSA)

Sl. No.	Name of the PTGs living in the State	Name of the village(s)/ Hamlet(s)	Name of the Tahasil	Name of the Block	Name of the District	Total population as per survey (Survey, 2007)			No. of HH	Whether pop Inc/ Dec/ Stable	* Literacy Rate (%) 2007
						8.6.1.1	M	F			
I	II	III	IV	V	VI	VII			VIII	IX	X
1. Dongria Kondh		**Kurli G.P.**									
1		Kurli	Bissam Cuttack	Bissam-Cuttack	Rayagada	168	78	90	38	Dec by 1	35.71
2		Mundaballi (H)				159	69	90	41	Dec by 12	9.43
3		Hutesi (H)				104	42	62	26	Inc by 6	9.61
4		Hundijali (H)				186	71	115	35	Inc by 17	2.15
5		Thuaguda (H)				42	19	23	9	Dec by 5	19.04
6		Khambesi (I)				458	203	255	110	Inc by 16	22.95
7		Kadraguma				149	69	80	27	Inc by 22	30.87
8		Kurubelipadar				26	13	13	6	Inc by 7	23.07
9		Bhatiguma				192	84	108	56	In by 56	11.97
10		Uparguma				150	50	100	37	Inc by 28	12.00
11		Jangjodi				131	61	70	41	Inc by 7	11.45
12		Radhanga				194	88	106	45	Inc by 11	7.73
13		Patalamba				73	29	44	20	Dec by 9	4.13
14		Arisakani				39	19	20	11	Inc by 3	2.50
15		Khajuri				320	136	184	71	Inc by 5	23.43
16		Gortali (H)				180	74	106	44	Inc by 17	6.6
17		Gondali				133	54	79	32	Inc by 8	19.54

Sl. No.	Name of the PTGs living in the State	Name of the village(s)/ Hamlet(s)	Name of the Tahasil	Name of the Block	Name of the District	Total population as per survey (Survey, 2007)			No. of HH	Whether pop Inc/ Dec/Stable	* Literacy Rate (%) 2007
						8.6.1.1	**M**	**F**			
I	**II**	**III**	**IV**	**V**	**VI**	**VII**			**VIII**	**IX**	**X**
18		D.Ranibandha				52	24	28	12	Inc by 7	9.61
19		Sagadi				62	26	36	14	Inc by 9	3.22
20		Lahunikhunti				26	11	15	7	Dec by 2	11.53
21		Hingabadi				107	49	58	32	Inc by 7	8.41
22		Bondili				155	56	99	32	Inc by 10	22.58
23		Kirida (H)				56	23	33	13	Stable	3.57
		Sub Total				**3125**	**1329**	**1796**	**749**	**Inc by 207**	
I	**II**	**III**	**IV**	**V**	**VI**	**VII**			**VIII**	**IX**	**X**
52		Penubali				-	-	-	-	Nil	
53		Gailanga (H)				11	4	7	2	Dec by 4	18.18
		Surudipai (H)				9	3	6	3	Newly set up	33.33
54		Gulugula				119	49	70	26	Inc by 12	2.52
55		Naringibadi (FV)				27	11	16	6	Dec by 10	3.70
56		Manda				35	15	20	9	Inc by 1	5.71
		Sub Total				**1996**	**837**	**1159**	**444**	**Inc by 19**	
		Sibapadar G.P.									
57		Batudi				72	31	41	18	Inc by 10	33.33
58		Kesarpadi				71	30	41	17	Inc by 1	33.80
59		Serkapadi				82	29	53	20	Inc by 7	42.68
60		Ankurbali				-	-	-	-	Nil	-
61		Jarpa (RF)				33	18	15	12	Inc by 4	0.00
62		Khambesi-II				100	43	57	29	Inc by 20	4.00
		Sub Total				**358**	**151**	**207**	**94**	**Inc by 42**	
		TOTAL				**6,036**	**2,553**	**3,483**	**1,430**	**Inc by (+8.35%)**	16.23

Reference: FV – Forest Village H – Hamlet G.P.- Grampanchayat

Note

- Population in 3 villages, like Kaliaripeth, Kirida, and Badabada is reported stable
- The highest number of population decreased (-12 persons) is reported from Kurli village (Sl. 1).
- The highest number of population increased (+ 56 persons) is reported from Bhatiguma village (Sl.No. 9)
- People at village Penubali deserted the village and move to the village Gailunga. Likewise, people of village Ankurbali deserted the village and stay at nearby village.
- On the whole no decline of population is reported on the total population of any GP.
- The total population of Micro Project has increased from 5,570 persons in 2001 (SCSTRTI:UBMS) to 6036 persons in 2007 (DKDA Survey) indicating a population growth of 8.35% during the period 2001-2007
- Out of total 62 villages/settlements, in 13 villages population has been decreased, in 46 villages increased, in 3 villages remain stable and departed in 2 villages, while one hamlet namely Surudipai has been newly set up taking 9 population in the revenue village Penubali (SL.No.52)

PART-II (cont.)

BASIC DATA ABOUT PTGs

TO BE BASED ON THE BASE LINE SURVEY REPORT OF THE YEAR MARCH-2007

(DONGRIA KONDHA DEVELOPMENT AGENCY, KURLI (CHATIKANA), RAYAGADA DISTRICT, ORISSA)

Brief profile of PTG (Basic features, life style, Educational status etc.)	**'Persistent health problem, if any'**	**Main Occupation and source (s) of Income**
XI	**XII**	**XIII**
Basic features & life style • Autochthons of the Niamgiri hill ranges in Rayagada district • Speak *Kui*, a Dravidian dialect. • Shifting cultivators and expert horticulturists. • Grow pineapples, banana, oranges, turmeric and a variety of cereals and pulses in their swiddens. • Have linear housing pattern in the Dravidian style. • Organized into strong territorial clan groups. • Follow clan exogamy and practice polygyny. • Girls' dormitory, *dashbeta* is functional. • Traditional labour cooperatives are operating. • Observe *meria* or *kedu* festival sacrificing buffaloes. • Worship earth goddess, *dharnipenu* and *Kateiwall* • Their community house is called *Sadar* one of the feuding tribes of India. **Literacy Rate 2001 2007 Rise** • Total literacy: 08.19% 16.23% 08.04% • Male literacy: 15.31% 30.27% 14.96% • Female literacy: 02.50% 06.02% 03.48%	• Endemic Malaria (Plasmodium falciparum) and malnutrition are the main health hazards • Villages are inaccessible, for which the Dongria Kondh fail to avail modern health care facilities down the hills • Stomach diseases such as diarrhea, dysentery and intestinal colic with flatulence • Skin diseases • Wound due to frequent clan feuds and its aggravation for lack of treatment	**Main Occupation**: • Shifting cultivation • Horticulture **Sources of income**: • Hill farm cultivation: pulses jhana, ragi etc. and legumes, like arhar, beans etc. Oil seeds, like caster, mustard, nizer, til etc. • Horticulture: Fruit orchards like Mango, jackfruit, banana, citrus, pineapple etc. and spices cultivation like turmeric, ginger, chilli, etc. • Minor forest collections, yam, hil broom, siali fibre and leaves, sal seeds and leaves, mahua flowers and seeds, tamarind, resin, gum etc.

NOTE:

(i) Information in column no. XI and XIII shall be given in bullet points only.

(ii) Village-wise concentration of PTGs shown in Majmuli/ Revenue maps.

PART-III

APPROACH OF THE STATE GOVERNMENT/UT ADMINISTRATION
IN BRIEF FOR THE DEVELOPMENT OF PTGs DURING XIth FIVE-YEAR PLAN
(To be based on basic data given in Part-II)
(DONGRIA KONDHA DEVELOPMENT AGENCY, KURLI (CHATIKANA),
RAYAGADA DISTRICT, ORISSA)

Aims and objectives

The CCD plan during the 11th plan period (2007-120 is an ambitious programme for the total development of the PTGs. It aims at improving infrastructure and providing basic amenities within easy reach in the habitat of the PTGs and generating additional employment and income of the PTG people with a view to reduce their poverty, raise literacy level, ensure health and food security and enhance their quality of life and conserve their culture. The basic approaches of the CCD plan are:

- Total development through an integrated approach by pulling resources from Central Govt and State Govt.,
- GO, Grampanchayats and NGO partnership to address the development needs of the PTG. The NGOs will be invited to extend their funds and functionaries for the PTG development programmes, principally on the IEC component,
- People's participation in development process will be encouraged through the involvement of traditional institution, like Labour Cooperatives, youth dormitory, SHGs etc.,
- Basic infrastructure will be created and amenities like health, education, drinking water, roads will be made available to the PTG people within their easy reach, and
- Shifting cultivation land will be developed as orchards with spice intercropping to protect environment and provide employment and income,
- Assistance for conservation and promotion of PTG traditions, like Labour Cooperative, cloth embroidery, horticulture, dance and songs and their up keeping,
- Social security will be ensured through the provision of fireproof houses, grain banks and coverage of all families under Janashree Bima Yojana.

Protection of traditional knowledge and culture

The agro forest based economic activities in the hills are difficult tasks that require coordination of people in a cooperative spirit. The practices of traditional 'labour cooperatives', working together for each other work, will be put as a development input in all the labour-based economic activities for accomplishing the difficult tasks, up in the hill farming. Therefore, the plan suggests strengthening of SHGs, traditional labour cooperatives, youth dormitories and construction of sadarghar/community house. Introduction of improve/high yielding varieties of fruits and roots as against the wild varieties under traditional horticulture programmes (jack fruit, mango and pineapple), retaining and extension of cultivation of organic spices (turmeric and zinger), organization of Scarf Embroidery Training for skill up gradation of girls and reorganization of dance and songs will be a host of innovative socio-economic activities for protection of traditional knowledge and culture of the PTG.

PART –IV

PROBLEMS OF PTGs AND PRIORITIES FOR THE XIth FIVE-YEAR PLAN

(DONGARIA KONDHA DEVELOPMENT AGENCY,KURLI(CHATIKANA),RAYAGADA DISTRICT ORISSA)

Sl. No.	**Name of PTGs living in the State /UT**	**Major Problems being faced by the particular PTG (Sector-wise, e.g. Health, Education, Income Generation, Culture, Housing, habitat, etc.)**	**Priorities of the State/UT for each PTG for the XIth plan period (To priorities out of Infrastructure/Roads/Education/ Health/Housing/ Drinking Water/Income Generation/Agri,development/Protection of traditions etc)**
I	**II**	**III**	**IV**
1	Dongaria Kondh	• **Health:** Endemic Malaria (Plasmodium falciparum) and malnutrition are the main health hazards • **Education:** Very low rate of literacy, and lack of development awareness • **Income Generation:** Shifting Cultivation resulting in deforestation, soil erosion, uneconomic harvest & eco-hazards, Undeveloped land for paddy cultivation, lack of irrigation • **Culture:** Socio-cultural practices like clan feuds, payment of high bride price, heavy drinking habits and expensive rites & rituals lead to deficit economy and indebtedness • and ultimately they become vulnerable to exploitation by the Domb neighbours and local money lenders • **Housing:** Lack of ventilation. Maintenance of thatch for want of piri, wild grass • **Habitat:** Depletion of forest and soil erosion adversely affecting the habitat's ecology and agro-forest based economy. Villages are inaccessible, for which the Dogria Kondh fail to get market prices for their produce, and fail to avail health care facilities down the hills.	• **Connectivity:** Construction of roads, culversts and small bridges • **Drinking Water:** Stream based gravitational flow pipe water and construction of cistern installation of tube wells • **Housing:** Construction of fireproof roof houses • **Irrigation and land development:** Check dams and water channel followed by stone bonding and land development • **Protection of Tradition:** • (i) ***Horticulture:*** Development of orchards (mango, banana, citrus, with pineapple and spices, turmeric + ginger, intercropping), • (ii) ***Art and caeft:*** Skill up gradation in embroidered cloth and • (iii) ***Organization of cultural troops:*** dance and songs • **Education:** Setting up of an Educational Complex and Running Nursery Schools • **Health:** Herbal garden – indigenous system of medicine and setting up of Mobile Health Unit/organization of health camps

Annexure -IV

Surface Water Quality of River Tel at Kesinga

Sl.No.	PARAMETERS	Upstream of Tel River At Kesinga	Downstream of Tel River at Kesinga
1	pH	7.7	7.3
2	Conductivity ((EC) microSiemens/cm)	114	120
3	TDS (mg/l)	250	264
4	DO (mg/l)	8.1	8.4
5	BOD_{5days} (mg/l)	1.2	1.2
6	COD (mg/l)	42	38
7	Chloride (mg/l)	12	12
8	Hardness (as $CaCo_3$ in mg/l)	86	88
9	TC (MPN/100ml)	1250	1250

Note: This sampling and analysis was carried out during Pre Monsoon Period in the Months of April-May'08 as per CPCB Guidelines.