Environmental Impact Assessment

for

350 (2 x 135 + 1 x 30 + 1 x 50) MW Coal & Middling Based Thermal Power Plant

at

Village- Kolam, Dist. Raigarh, Chhattisgarh

M/s Sarda Energy & Minerals Ltd.

Prepared by

ANACON LABORATORIES PVT. LTD.

Recognised by MoEF (GOI) Notifn. No. D.L.33004/99 Dt.24.10.2007

60, Bajiprabhu Nagar, Nagpur – 440 033

Ph. : (0712) 2242077, 9373287475 Fax : (0712) 2242077

Email : anaconngp@gmail.com, anacon_ngp@sancharnet.in,

Website : www.anacongarway.com

May, 2009

CONTENTS

LIST OF FIGURE

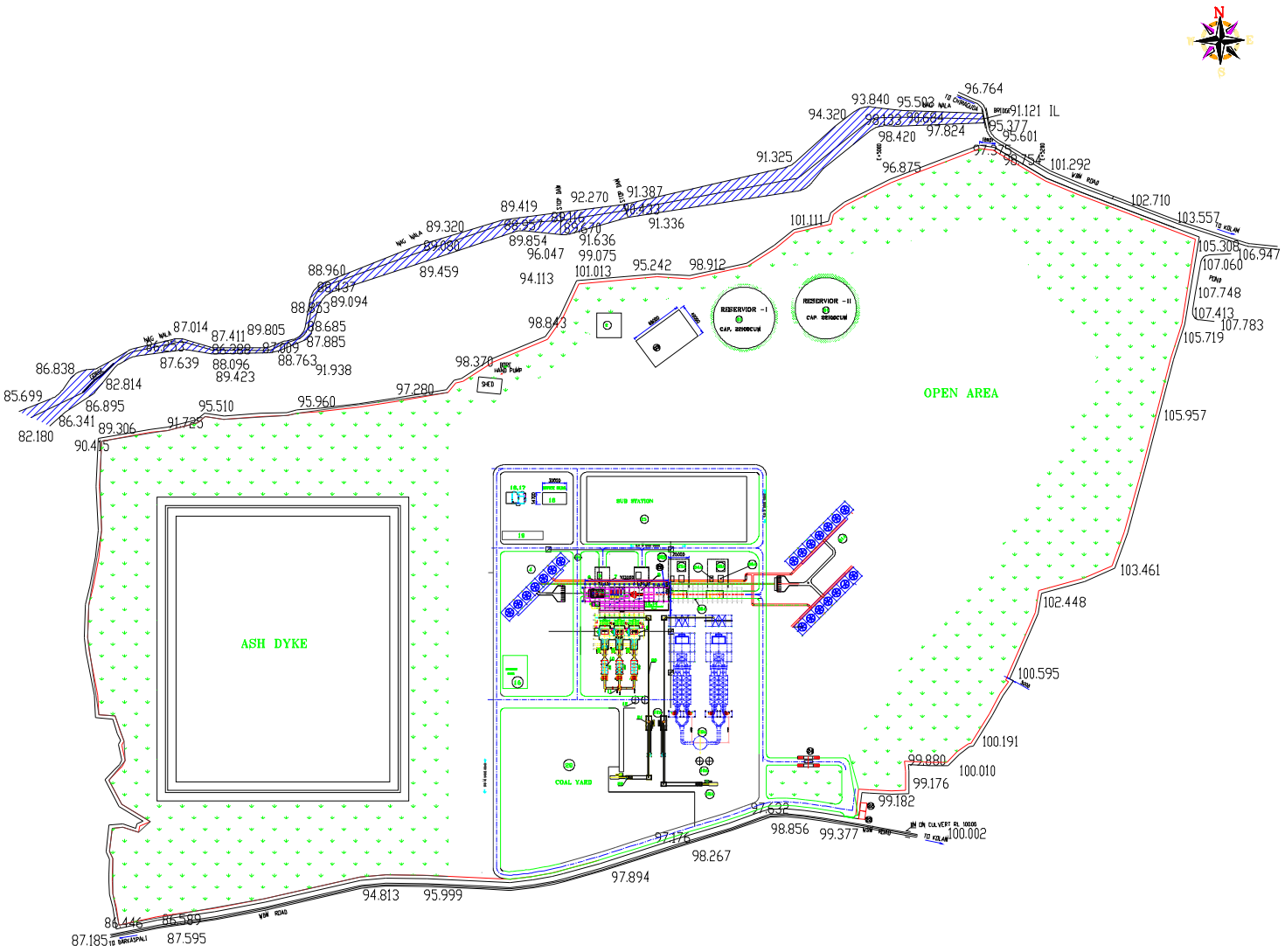
LIST OF TABLE

PLATES

Sr.	Items
1	**Plate 1 : Site Photographs**
2	**Fuel Transportation**

ANNEXURE

Sr.	Items
1	Terms of Reference (ToR)
2	Coordinates of the Plant Site
3	Water Allotment Application
4	Contour Map alongwith Site plan
5	Map Showing Core Zone Futures
6	Sampling and Analysis Method
7	Ambient Air Quality
8	Demographic Details
9	Emission Calculation and Metrological Data



PHASE-II(2X135MW)

NO	DESCRIPTION	NOS/ SIZE(mxm)
01A	COOLING TOWER 107.2x14.72	(2)
02A	TRANSFORMER YARD	36X25
03A	GENERATOR TRANSFORMER	(1)
04A	UNIT AUXILIARY TRANSFORMER	(1)
05A	STATION AUXILIARY TRANSFORMER	(1)
06A	T.G BUILDING WITH FUEL BUNKER	
07A	BOILER	(2)
08A	E.S.P	(2)
09A	CHIMNEY	(1 Nos.)
10A	ASH SILO	(2)ø9
11A	COAL CONVEYOR	
12A	CRUSHER HOUSE	(1)
13A	GRIZZLY HOPPER	(1)

TOTAL AREA=203 ACRE

AREA RESERVED FOR PLANTATION=66 ACRE

LEGENDS:- 1x30 MW+1x50MW PP

NO	DESCRIPTION	NOS/ SIZE(mxm)
01	RAW WATER STORAGE TANK	DIA75Mx5(2)
02	FIRE WATER PUMP HOUSE	30Mx30M
03	WATER TREATMENT PLANT	65Mx40M
04	COOLING TOWER	107.2x14.72
05	GENERATOR TRANSFORMER	(2)
06	UNIT AUXILIARY TRANSFORMER	(2)
07	STATION AUXILIARY TRANSFORMER	(2)
08	T.G BUILDING	102 x 16.6
09	BOILER (3X100TPH)	60X41
10	E.S.P	(3)16X7.86
11	CHIMNEY	1 No.
12	ASH SILO	(2)ø9
13	COMPRESSOR,WORK SHOP&DG ROOM	30x10.95
14	E&I LAB	
15	STORE ROOM	40x30
16	REST ROOM	(1)
17	CANTEEN (STAFFS/WORKERS)	30X30
18	ADMIN BUILDING	20x35
19	PARKING AREA(CAR/TWO WHEELER)	50x10
20	COAL CONVEYOR	
21	CRUSHER HOUSE	(1)
22	GRIZZLY HOPPER	(1)
23	SECURITY ROOM	10X8
24	WEIGH BRIDGE	(1)
25	SWITCH YARD	250X80
26	LT AUXILIARY TRANSFORMER	(3)
27	LIFT	
28	TIME OFFICE	
29	COAL YARD	

Figure 2.1
Layout Plan

NOTES

REV.	DATE	DESCRIPTIONS	APPD.

SARDA ENERGY & MINERALS LIMITED
INDUSTRIAL GROWTH CENTRE, SILTARA, RAIPUR

CAD.No. LAY-1	SCALE.	PROJ: KOLAM	EQUIP:
DESIGNED		TITLE: LAYOUT PLAN OF 350MW POWER PLANT AT KOLAM, RAIGARH (1x30+1x50+2x135)MW	
DRAWN	MAITY	19.01.09	
CHECKED	M.SHAH	DRG.No. SEML/KOL/ENV/001	REV.No. 1
APPROVED	R.T.L		

DO NOT SCALE THE DRAWING
ALL DIMENSIONS ARE IN mm.
IF IN DOUBT PLEASE ASK

Plate 1 : Site Photographs

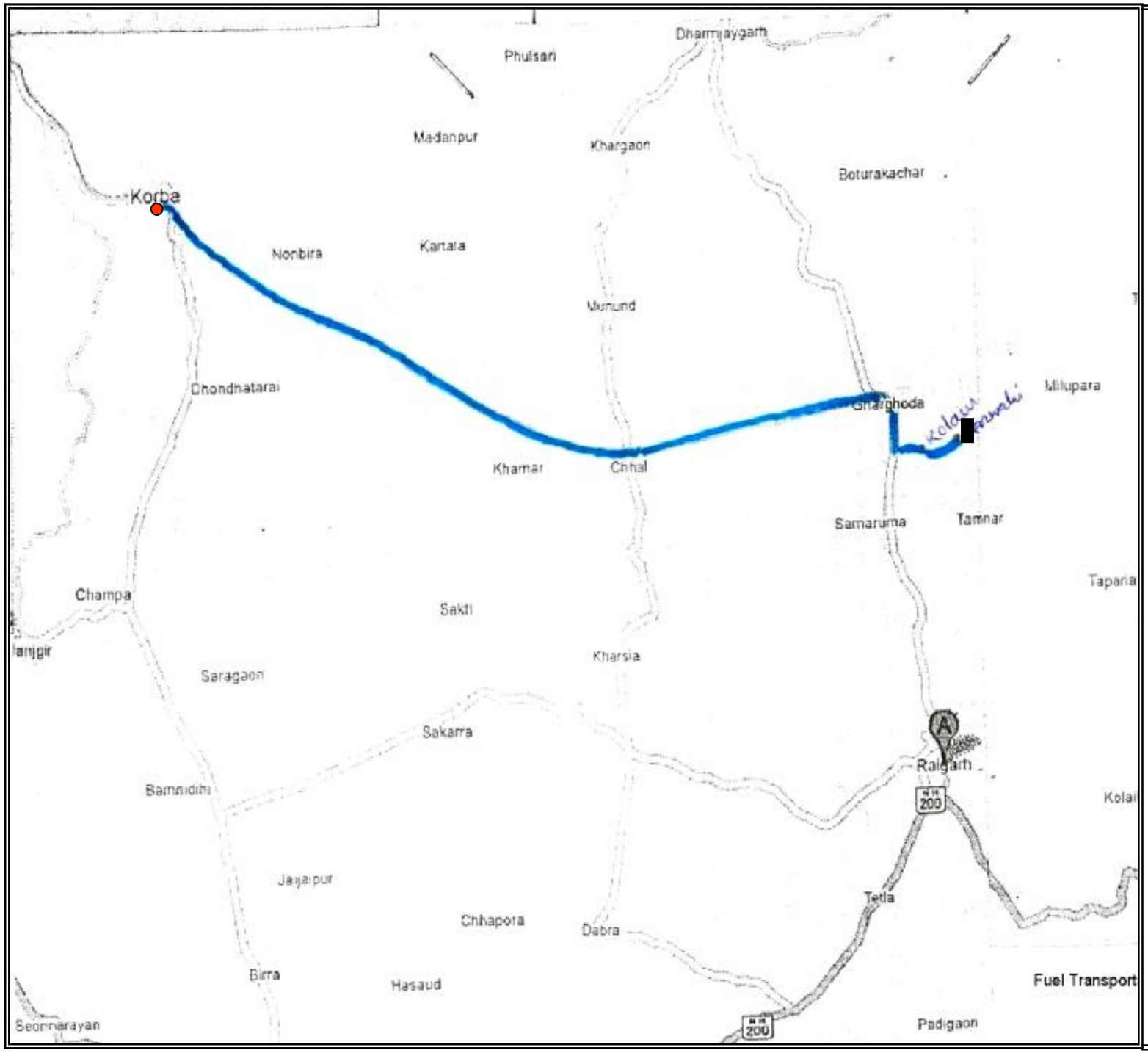


Plate No. 2

Project Location

Raw Coal Source

Fuel Transportation

Project Personals

Dr. D. G. Garway Dr. D. G. Kshirsagar Mr. S. D. Joshi Mr. S. Kothe Dr. S. K. Gadkari Mr. Vipin Kumar Mr. A.K. Singh	Mr. Sandeep G. Mr. Vijay Darokar Mr. Sandeep Patel Ms. Kavita Saygaonkar Ms. Pallavi Harkare Miss. Khushali Dharkar Miss. Leena Maundekar

Technical

Mr. S. M. Tripathi	Ms. Namrata Motghare

Secretarial Assistance

Mr. Dhananjay Datir	Mr. Prashant Pachpore

Annexure I

Terms of Reference

STATE LEVEL EXPERT APPRAISAL COMMITTEE
CHHATTISGARH
Government of India
Ministry of Environment and Forests

1-Tilak Nagar,
Shiv Mandir Chowk,
Main Road Avanti Vihar,
Raipur (C.G.)
E-mail: seiaacg@gmail.com
Website : www.seiaacg.org

No. 491 /SEAC-CG/ EC/TPP/RGH/34/09 Raipur, Date 13/02/2009

To,

M/s Sarda Energy & Minerals Limited
Industrial Growth Center,
Siltara, District- Raipur (CG)

Sub: Thermal Power Plant of capacity 350 MW (2x135 +1x30+1x50 MW) at Village – Kolam, Tehsil – Gharghoda, District - Raigarh (C.G.) by M/s Sarda Energy & Minerals Limited - Prescribing the TOR -Regarding

= 0 = 0 =

The undersigned is directed to refer to your communication no. SEML/ENV/R/682 dated 25/08/2008, no. SEML/ENV/R/1137 dated 01/12/2008, no. SEML/ENV/R/1258 dated 26/12/2008, no. SEML/ENV/R/1267 dated 27/12/2008 and no. SEML/ENV/R/1305 dated 06/01/2009 regarding the subject mentioned above.

The proposal is for setting up of a Thermal Power Plant of capacity 350 MW (2x135 +1x30+1x50 MW). The plant is proposed at Village – Kolam, Tehsil – Gharghoda, District - Raigarh (C.G.). The project proponent has procured about approximately 200 Acres (81 Ha) land for the proposed Coal based thermal power plant. The water requirement for the proposed power plant would be 1180 m^3/hr. Supply of water will be through Kelo River.

The State Level Expert Appraisal Committee, Chhattisgarh considered the project in 12th meeting held on 12th September 2008. As per decision taken in 12th meeting of SEAC, Chhattisgarh, project proponent made the presentation before SEAC, Chhattisgarh on 21st meeting on 29/12/2008. After submission of the requisite information and based on the consideration of the documents submitted, the presentation made by the project proponent and discussion held, the Committee decided that the proposed project should be considered as 'B1' category and prescribed the following Terms of Reference (TORs) for preparing draft EIA report for the above-mentioned project;

Source of Raw Coal:

- Linkage of coal/ assurance for supply of raw coal for power plant.
- The list of clients/ companies along with copy of agreement between project proponent and companies from whom the middling/rejects / coal fines to be procured for use in power plant.
- The mode of transport/conveyance of incoming coal/ middling/rejects / coal fines and outgoing ash etc. Transportation routes showing major

establishments including villages, schools/colleges, residential areas etc. to be given.

- The transportation of fuel and ash to cement plants through rail should be explored and proposal along with action plan to be submitted.
- The list of companies along with copy of agreement between project proponent and companies to whom the solid wastes (such as ash) to be supplied for disposal/sold:

Project Description:

- A brief description of the plant, the technology used and energy conservation;
- All the coordinates of the plant site with toposheet;
- Detailed material balance and water balance, break up of raw coal, middling/rejects / coal fines, break up of water requirement as per different activities in the power plant;
- Source of water supplied for use in power plant, sanction of the competent authority in the State Government;
- Examine close circuit system for 100% recycling and reuse of the treated effluent in the various operations or other uses such as irrigating the greenbelt within premises etc.;
- Optimization of COC for water conservation. Other water conservation measures proposed in the project should be incorporated;
- Examine the air cooled technology for water conservation at-least for 1x30+1x50 MW units;
- Examine zero effluent discharge conditions;
- Submission of sample test analysis raw coal/ middling/rejects / coal fines to be used – this includes grade of coal and other characteristics – ash, S and Hg level etc.

Description of the Environment:

- Study of alternative sites should also be submitted so as to justify the selected site from environmental angle.
- Study area should cover an area of 10 km radius around the proposed site;
- A study area map of the core zone and 10 km area of the buffer showing major topographical features such as land use, drainage, location of habitats, major construction including railways, highways, pipelines, major industries / mines and other polluting sources, which shall also indicate the migratory corridors of fauna, if any, and the areas where endangered fauna and plants of medicinal and economic importance found in the area;
- Contour map along with the site plan of the project and project land use area statement including land for project operations, such as coal handling plant, power plant, building infrastructure, effluent treatment plants, raw coal, middling/reject/coal fines stock yard, ash silo, colony, greenbelt, undisturbed area, natural topographical features (such as existing roads, drains/natural water bodies if any) to be left undisturbed, proposed diversion / re-channeling of natural drainage or water courses, if any;
- One complete season site specific meteorological data;
- Information regarding surface hydrology, water regime, hydrogeology and ground water regime;
- Information regarding drainage pattern of the study area;

- Topography of study area, clearly indicating, whether the site requires any filling? If so, details of filling, filling material, quantity of filling material required, filling material supply source and transportation etc. The filling material should be fly/bottom/pond ash of thermal power plants and dust/slag/accretion of steel plants etc;
- Location of any National Park, Wildlife Sanctuary, Reserve Forest, Protected Forest and Eco-sensitive zones, elephant/tiger reserve (existing as well as proposed), migratory routes, if any, within 10 km of the project site be specified and marked on the map duly authenticated by concerned Government department;
- Map showing the core zone delineating the agricultural land (irrigated and un-irrigated), uncultivable land (as defined in revenue records), forest areas (as per records), grazing land and waste land;
- Land use statement of the study area well as project area;
- Collection of one complete season (non-monsoon preferably winter season 2008) primary base line data (along-with dates of monitoring) on environmental quality such as air (RPM, SPM, SOx & NOx), noise, water (surface and ground water), soil;
- Include ground water monitoring near solid waste/ash dump zone;
- The monitoring be conducted as per Central Pollution Control Board's guidelines and parameters for water testing for both ground water as per ISI and surface water as per Central Pollution Control Board guidelines;
- Surface water, ground water, soil, noise and ambient air quality be monitored at-least at eight stations / locations around the proposed site. At-least one monitoring station in the upwind direction/downstream/non-impact non-polluting area as a control station;
- The location of the air monitoring stations decided after taking into consideration the predominant wind direction, population zone and sensitive receptors including Reserve Forests;
- Details of various facilities to be provided for the personnel involved in raw coal / middling/ rejects/ash transportation & handling in terms of parking, rest areas, canteen, sanitation, and effluents / pollution load from these activities;
- Details of infrastructure facilities such as sanitation, fuel, restroom, canteen etc. to be provided to the labour force including casual workers during construction as well as during operation phase. Effluents / pollution load from these activities be included;
- Details of workshop, if any, and treatment of workshop effluents;
- Occupational health issues, baseline data on the health of the population;

vironmental Impacts:

- Impacts of project, if any, in the land use, in particular agricultural land, forest land, grazing land, water bodies, drainage of the area and the surroundings;
- Impact of choice of the selected boiler technology for power plant and impact on air quality and waste generation (emission and effluents).
- Impacts of transportation covering the entire sequence of supply, transportation, handling, transfer and storage of raw coal, middling coal, rejects, coal fines and ash on air quality showing in a flow chart with the specific points of fugitive emissions generation;
- Impact of the project on local infrastructure of the area, such as road network. Examine whether existing roads are adequate to take care of

additional load of coal /middling rejects/coal fines transportation? Whether any additional infrastructure would need to be constructed and the agency responsible for the same with time frame?

- Prediction of impact of project on different environmental components inter-alia (1) air including noise, (2) water (surface and groundwater), (3) soil, (4) flora and fauna and (5) socio-economic. Also take into account the emission from the vehicle transportation and loading & unloading activities etc.;
- The details of input data and model used for air quality modeling. The air quality contours may be plotted on location map showing the location of project site, habitation nearby, sensitive receptors, if any. The wind roses should be shown on this map.

Mitigation Measures:

- Use of rejects, middling and coal fines from washery as fuel should be optimized in fuel mix, so as to use entire rejects, middling and coal fines from captive coal washery proposed at karwahi mine;
- Details of pollution control measures with respect to effluent treatment, air pollutants emission control, noise control and scientific & safe disposal of all solid wastes and ash;
- Specific pollution control and mitigative measures for the entire process, Specific pollution control / mitigative measures proposed to be put in place at every transfer and handling points;
- Coal stock yard (raw coal, middling coal, coal rejects and coal fines) be housed in closed sheds in pucca platform above ground level and ash in silo provided with wind shields / wind breaking walls; storage size and capacity of coal stock be decided in consultation with DGMS and Chhattisgarh Environment Conservation Board;
- Measures for occupational health and safety of the personnel and manpower for the project;
- Compliance to the standards (Fugitive emission standards, effluent discharge standards, noise level standards) prescribed for power plant by Ministry of Environment and Forests, Government of India / Central Pollution Control Board / Chhattisgarh Environment Conservation Board (which ever stringent);
- Ensure the particulate matter emission limited to 50 mg/Nm^3;
- Scheme for rainwater harvesting;
- Details along-with action plan for development of greenbelt in 33% land area with not less than 1500 trees per ha giving details of species, width of plantation, planting schedule etc;
- Details regarding sale/disposal of solid wastes /ash from the unit to miscellaneous purchasers (if any);
- Action plan for use of ash as per provisions of notification on use of fly ash;

Environmental Management Plan:

- The EIA-EMP report covering the impacts and management plan for the project specific activities on the environment of the region, and the environmental quality – air, water, noise, land, biotic community through collection of data and information, generation of data on impacts for a rated capacity;
- Detailed EMP to mitigate the adverse impacts due to project along-with item-wise cost of its implementation (capital and recurring);

- Disaster Management Plan and mitigative measures for disaster prevention and control;
- Risk assessment to be undertaken, based on the same, propose safeguard measures;
- Details along-with action plan and year wise funds to be allocated for eco-development/community welfare works including maintenance of roads in nearby villages/areas;

Additional Study:

- Public Hearing details covering the notices issued in the newspaper, proceedings/minutes of public hearing, the points raised by the general public and commitments made, in a tabular form. If the Public Hearing is in the regional language, provide an authenticated English translation of the same;
- Status of litigations/court cases filed/ pending against the project (all cased including environment) and / or any direction / order passed by any hon'ble court of law against the project, if so, details thereof;

The following general points should be noted:

- All documents should be properly indexed, page numbered.
- Period/date of data collection should be clearly indicated.
- Authenticated English translation of all material provided in regional languages.
- After the preparation of the draft (as per the generic structure prescribed in Appendix –III of the EIA Notification, 2006) covering the above mentioned TOR issues, the project proponent shall get the Public Hearing conducted and take further necessary action for obtaining environmental clearance in accordance with the procedure prescribed under the EIA Notification, 2006.
- The copy of the letter received from SEAC, Chhattisgarh on the TOR prescribed for the project should be attached as an annexure to the final EIA-EMP report. The compliance statement of TOR prescribed should also be incorporated.

In addition to the above, information on the following may also be incorporated in the EIA report.

1. Is the project intended to have CDM-intent?

(I) If not, then why?

(II) If yes, then

(a) Has PIN (Project Idea Note) {or PCN (Project Concept Note)} submitted to the 'NCA' (National CDM Authority) in the MoEF?

(b) It not, then by when is that expected?

(c) Has PDD (Project Design Document) been prepared?

(d) What is the "Carbon intensity" from your electricity generation projected (i.e. CO_2 Tons/MWH or Kg/KWH)

(e) Amount of CO_2 in Tons/year expected to be reduced from the baseline data available on the CEA's web-site (www.cea.nic.in)

Notwithstanding 1(I) above, data on (d) & (e) above to be worked out and reported.

The final EIA-EMP report to be submitted to SEIAA, Chhattisgarh must incorporate the issues in TOR and that raised in Public Hearing. The index of the final EIA-EMP report must indicate the specific chapter and page no. of the EIA-EMP report where the specific TOR prescribed by SEAC, Chhattisgarh and the issue raised in the Public Hearing have been incorporated.

(S.S. Bajaj)
Secretary
State Level Expert Appraisal Committee, Chhattisgarh
Raipur (C.G.)

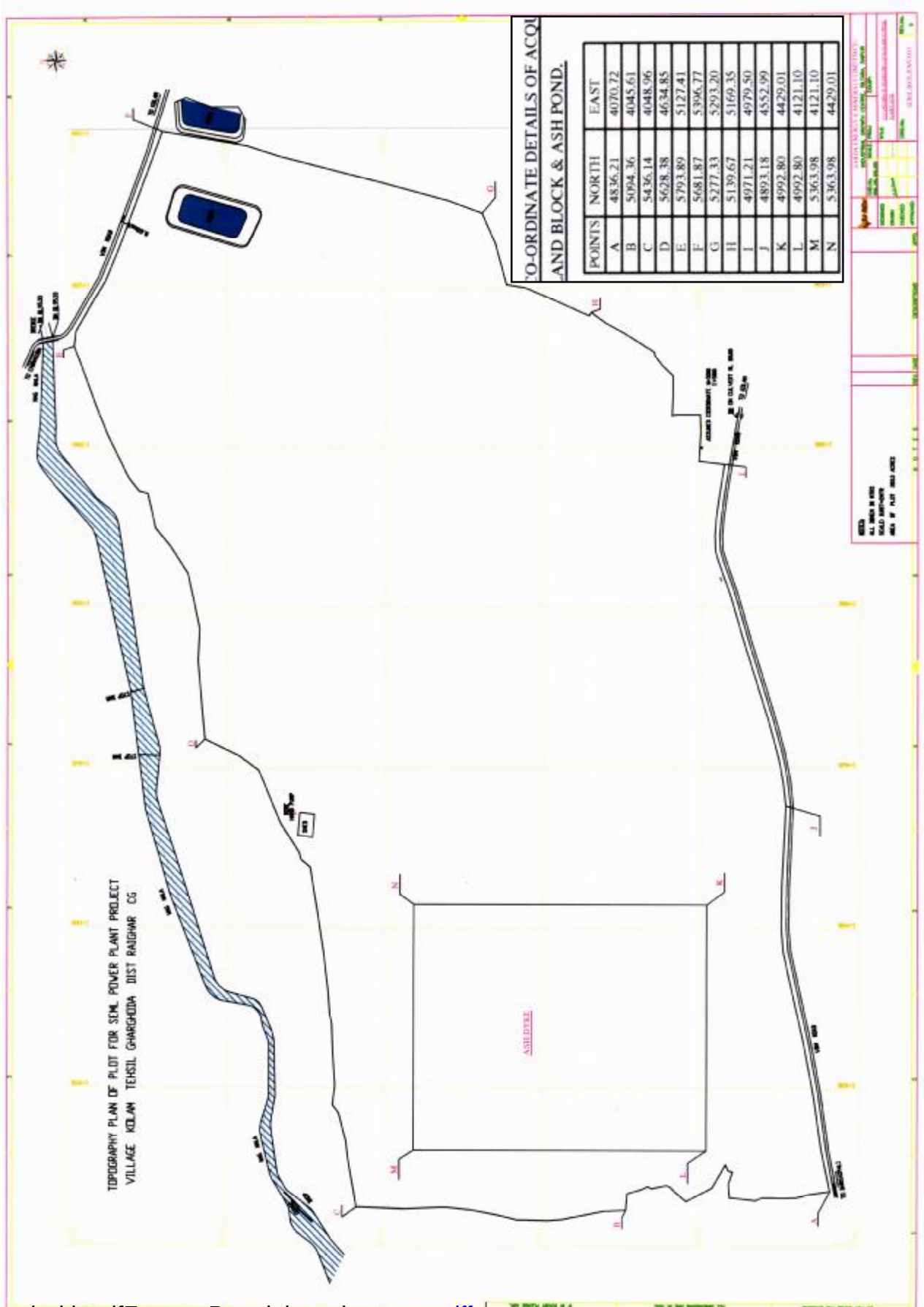
Endt. No. /SEAC-CG/ EC/TPP/RGH/34/09 Raipur, Date / /2009

Copy to:-

1. The Secretary, Department of Environment, Mantralaya Chhattisgarh, Raipur-492001
2. The Chairman, Chhattisgarh Environment Conservation Board, 1-Tilak Nagar, Shiv Mandir Chowk, Main Road Avanti Vihar, Raipur (C.G.)
3. The Chief Conservator of Forests (C) Regional Office (WZ), Ministry of Environment & Forests, Kendriya Paryavaran Bhawan, Link Road No.-3, E-5, Arera Colony, Bhopal.
4. Member Secretary, State Level Environment Impact Assessment Authority, Chhattisgarh. Please find enclosed herewith the original file for your further necessary action please.

(S.S. Bajaj)
Secretary
State Level Expert Appraisal Committee, Chhattisgarh
Raipur (C.G.)

Annexure-II
Coordinates of the Plant Site



Annexure –III

Water Allotment Application

Room :- Kasdol

SARDA ENERGY & MINERALS LIMITED

(FORMERLY RAIPUR ALLOYS & STEEL LTD.)

JMG HOUSE, PANCHSHEEL NAGAR, CIVIL LINES, RAIPUR – 492001 (CHHATTISGARH)
Phone No. 07721-264204 TO 264211, 403925 TO 927 Fax. 07721-264214 & 403924

SEML/L/S-KK/F- 126 /08/ 243 26.08.2008

To
The Secretary,
Water Resources Department
Govt. of Chhattisgarh
Mantralya, Raipur (C.G)

Sub: Revised application for allotment of Water for 2 x 135 MW Thermal Power Plant to be installed at Kasdol in Gharghoda Block, Dist. Raigarh (C.G).

Dear Sir,

We have applied earlier to the Convener, State Investment Promotion Board along with copy to your good office vide our letter no : SEML/L/S-KK/F- 126 /08/176 dated 16.05.2008, for allotment of Water for 2 x 135 MW Thermal Power Plant to be installed at Kasdol / Godhi in Gharghoda Block, Dist. Raigarh (C.G).

In our above application form, we have proposed the nearest source of water near Village Milupara at Sakta Stopdam on Kelo River. Now we are proposing to draw the water from same Kelo River at **Kasdol** and from **Gohridipa Anicut,** as the water availability at earlier site, in required quantity is doubtful. The later site is better from storage point of view.

The revised application for allotment of water of 8.91 MCM/ Annum is submitted herewith.

It is requested herewith to permit us, to draw the water for our requirement from Gohridipa Anicut and by constructing new intake well near Kasdol in place of our earlier proposed location of Milupara on Sakta Dam.

Thanking you,

For, Sarda Energy & Minerals Ltd.,

27/8/08

G.K. Chhanghani
Executive Director

Encl: (i) Revised Application form for sanction of allotment of water by WRD.
(ii) Location Map showing location of proposed plant and nearest source of water.
(iii) Feasibility Report of detailed assessment of required quantity of water.
(iv) Copy of M.O.U. Signed on 7/1/2005 with the C.G. Government.

M.V. 28/8/08

3 A, CENTRAL AVENUE, NAGPUR – 440018 PHONE NO. 0712 – 2727509 FAX - 2728207

Revised Application form for sanction of allotment of water by Water Resource Department

To,

The Secretary,
Water Resources Department,
Govt. of Chhattisgarh
Raipur (Chhattisgarh)

Sub: Application for water allotment for the Project 2 x 135 MW (80 % PLF) TPP.

Sir,

Our company is setting up a plant **2x135MW (80 % PLF) Thermal Power Plant** in the location explained below for which the water requirement of **8.91 MCM/Annum** shall be needed.

Details of the proposed project are given below :

1. Name of the company	: M/S Sarda Energy & Minerals Ltd.
2. Regd. No./Office Address with Tel./Fax No. etc.	: JMG House, Panchasheel Nagar Civil line, Raipur. C.G. 492001 Ph-0771-4283502-04 Fax-0771-2427072
3. Type of organization (Private/Public Ltd. Partnership etc.) and name of the product.	: Public Ltd. Company.
4. Location of the project :	
(i) Nearest village	: Kasdol & Godhi
(ii) Block	: Gharghoda
(iii) District	: Raigarh
5. Salient details of the project	: As enclosed
6. Proposed nearest source of water ..... (Location map be enclosed)	: Kelo River (Map enclosed) At Kasdol and Gohridipa Anicut
7. Required quantity of water	: 8.91 MCM/Annum.
8. Project Report regarding required water calculation	: Feasibility report enclosed
9. Position of M.O.U.	: M.O.U. Signed on 7/1/2005 with Govt of C.G.

Declaration

1. I/We certify that the information furnished is true to the best of my/our knowledge.
2. I/We agree to pay the water charges fixed by the Govt. for time to time and also agree to pay commitment charges if any
3. I/We agree to sign necessary M.O.U. / Agreement.

Place: Raipur

Signature:

Date: 26/08/08

Firm:

INSTRUCTION

Application form should be submitted in 3 copies.

List of enclosure to be appended along with the application.

1.Location Map showing location of proposed plant and nearest source of water.

2. Report of detailed assessment of required quantity of water (Plant / Unit wise)

3.Copy of M.O.U. with the Government.

छत्तीसगढ़ शासन

राज्य निवेश प्रोत्साहन बोर्ड

मंत्रालय के पास (रेणुका द्वार),शास्त्री चौक,
रायपुर छत्तीसगढ़.–492001
दूरभाष (0771)–4066351, 4066352, फैक्स–4066315, ई–मेल sipb.cg@nic.in

क्रमांक 185/एसआईपीबी/2007/ रायपुर, दिनांक /05/2008

प्रति,

प्रमुख सचिव,
छत्तीसगढ़ शासन,
जल संसाधन विभाग
मंत्रालय,रायपुर

विषय :– मेसर्स छत्तीसगढ़ इलेक्ट्रिसिटी कंपनी लि. (सारडा इनर्जी एण्ड मिनरल्स लि.) का जल आवंटन का आवेदन पत्र ।

निवेशक द्वारा शासन से दिनांक 07/01/2005 को पावर प्लाण्ट की स्थापना हेतु एम.ओ.यू. का निष्पादन किया गया है । निवेशक द्वारा अपने प्रस्तावित संयत्र ग्राम कसडोल एवं गोढ़ी जिला रायगढ़ के समीप केलो नदी से 8.91 एमसीएम जल प्रति वर्ष आवंटन हेतु आवेदन पत्र प्रस्तुत किया है । आवेदन मय सहपत्रो के आपकी ओर आवश्यक कार्यवाही हेतु सलंग्न प्रेषित है ।

छत्तीसगढ़ औद्योगिक निवेश प्रोत्साहन नियम – 2004 में उल्लेखित प्रावधान अन्तर्गत निर्धारित समय सीमा में आवेदन पर निर्णय लेने निवेदन है । कृपया संलग्न प्रारूप – 4 में अभिस्वीकृति भेजनें का कष्ट करें ।

(सचिव सह संयोजक द्वारा अनुमोदित)

सलंग्नः–उपरोक्तानुसार ।

(अनुराग पाँण्डेय)
सहायक संचालक
रायपुर, दिनांक 27 /05/2008

क्रमांक 185/एसआईपीबी/2008/582
प्रतिलिपि सूचनार्थ :–

संचालक, मेसर्स छत्तीसगढ़ इलेक्ट्रिसिटी कंपनी लि. (सारडा इनर्जी एण्ड मिनरल्स लि.) जेएमजी हाउस, पंथशील नगर, सिविल लाईन्स, रायपुर 492 001 (छत्तीसगढ़) ।

सहायक संचालक

MD\sipb\letters\ May- 2008\ (67)

छत्तीसगढ़ शासन

राज्य निवेश प्रोत्साहन बोर्ड

मंत्रालय के पास (रेणुका द्वार),शास्त्री चौक,
रायपुर छत्तीसगढ़.–492001
दूरभाष (0771)–4066351, 4066352, फैक्स–4066315, ई–मेल sipb.cg@nic.in

क्रमांक / 29 / एसआईपीबी / 2007 / 653 रायपुर, दिनांक 9 / 06 / 2008

प्रति,

प्रबंध संचालक,
मेसर्स सारडा इनर्जी एण्ड मिनरल्स लि.,
औद्योगिक क्षेत्र सिलतरा,
रायपुर (छत्तीसगढ़)

विषय :– अभिस्वीकृति की सूचना ।

महोदय,

उपरोक्त विषय में लेख है कि आपके द्वारा जल आवंटन के संबंध में इस कार्यालय में आवेदन प्रस्तुत किया गया था । आपका उक्त आवेदन जल संसाधन विभाग मंत्रालय, रायपुर को आवश्यक कार्यवाही हेतु प्रेषित किया गया है । जल संसाधन विभाग ने आपके आवेदन प्राप्ति की अभिस्वीकृति दी है, जिसकी एक प्रति आपकी ओर संलग्न प्रेषित है ।

धन्यवाद

संलग्न – उपरोक्तानुसार ।

भवदीय

09/06

(आनन्द कुमार श्रीवास्तव)
उप संचालक

MD\sipb\letters\ May- 2008\ (32)

FORM – IV
(See Rule – 5 (3))

(2)

The office of The P.Secy., GoCG, W.R. Deptt, Mantralaya, Raipur.

Acknowledges the receipt of Application No. SIPB / DIPC District 20...../.....29..... filed by M/s. Sarda Energy & Minerals Ltd. Address .....

.....for (Name of clearance) .....water allotment.....

.....

... through SIPB / ~~DIPC District~~ RAIPUR ..... Chhattisgarh on 03-06-2008

The time limit for disposal of application is 03/08/2008 03/09/2008
(Issued in duplicate).

Date 6-6-08

Place RAIPUR.

Signature Competent Authority / Authorized Representative

OFFICER ON SPECIAL DUTY
WATER RESOURCES DEPTT.
MANTHALAYA
RAIPUR (C. G.)

Telephone No. 0771-2221208

35

SARDA ENERGY & MINERALS LTD.
(Formerly Raipur Alloys & Steel Ltd.)

SARDA

SEML/L/S-KK/F-126/08/ 182

23rd May 2008

To
The Convener
State Promotion Control Board
Near Mantralaya, Renuka Dwar
Shastri Chowk
Raipur (C.G.)

Sub: Allotment of Water for 40 MW Captive Power Plant and 2.00 Million TPA Coal Washery to be Installed at Gharghoda Block, Dirstrict Raigarh (C.G.)

Ref : (i) Your letter No. 29/SIPB/2007/556 dated 22/05/2008.
(ii) Our application No. SEML/L/S-KK/F-126/08/177 dated 16/05/2008.

Dear Sir,

With reference to our application dated 16/05/2008 & your above referred letter, we are submitting herewith the revised application.

As you know, M/s Raipur Alloys & Steel Limited (Now Sarda Energy & Minerals Limited) has signed the MOU with Govt. of Chhattisgarh on 06/10/2006 for installation of various projects at Siltara Industrial Growth Centre, Siltara, Raipur.

As per M.O.U., we proposed for installation of 40 MW Captive Power Plant and 2.00 Million TPA Coal Washery at Siltara Industrial Growth Centre, Siltara, Raipur. The Commerce & Industries Dept., Govt. of Chhattisgarh vide their letter No. 783/205/07/W/6, dated 16/03/2007 has banned the installation of new Coal based Sponge Iron and Coal Based Power Plants at Siltara, Raipur.

In view of the fact mentioned above, we have selected the alternative site for installation of Captive Power Plant which we now propose to install adjacent to our Coal Mine at Raigarh.

We now propose for installation of 40 MW Captive Thermal Power Plant and 2.00 Million TPA Coal Washery at Gharghoda Block/Tehsil, District Raigarh (C.G.)

Contd.2.

www.seml.co.in

Industrial Growth Centre,
Siltara, RAIPUR - 493111(C.G.)
Ph. : 07721- 403925-29, 264205-9 & 14
Fax : 07721 - 264214/403924
E-mail : info@seml.co.in

We are enclosing herewith our application in prescribed format for allotment of 2.42 MCM/ Annum of water from Kelo River.

We now request you to please recommend our case for allotment of water as mentioned above.

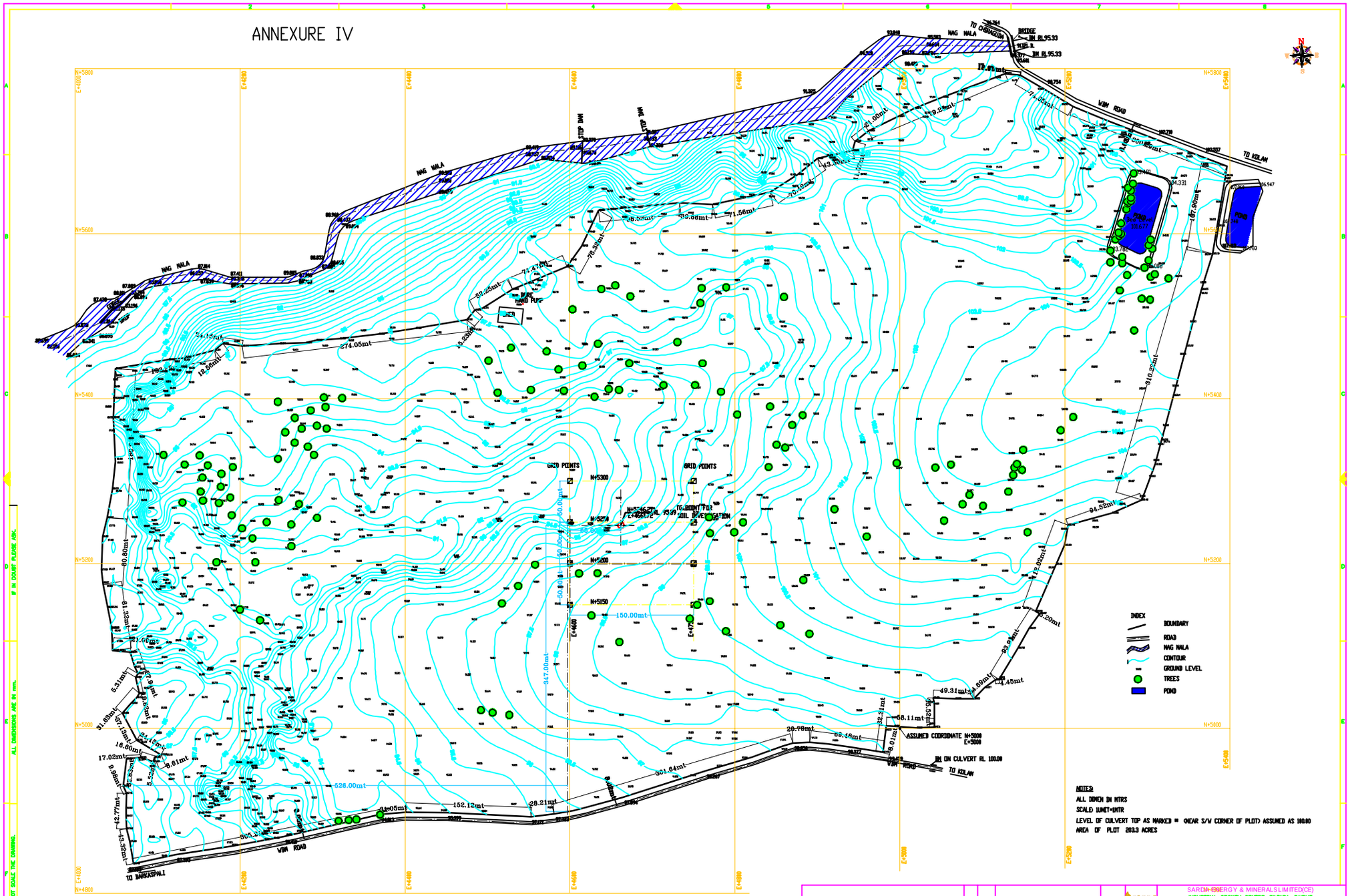
Thanking you.

Yours faithfully,
For Sarda Energy & Minerals Limited

(G.K. Chhanghani)
Executive Director

Encl : (i) Revised prescribed application for 40 MW TPP & 2.00 Million TPA Coal Washery. (4 Sets)
(ii) Revised Feasibility Report. (4 Sets)

NB: - Rest all enclosures were submitted with the application dated 16/05.2008.

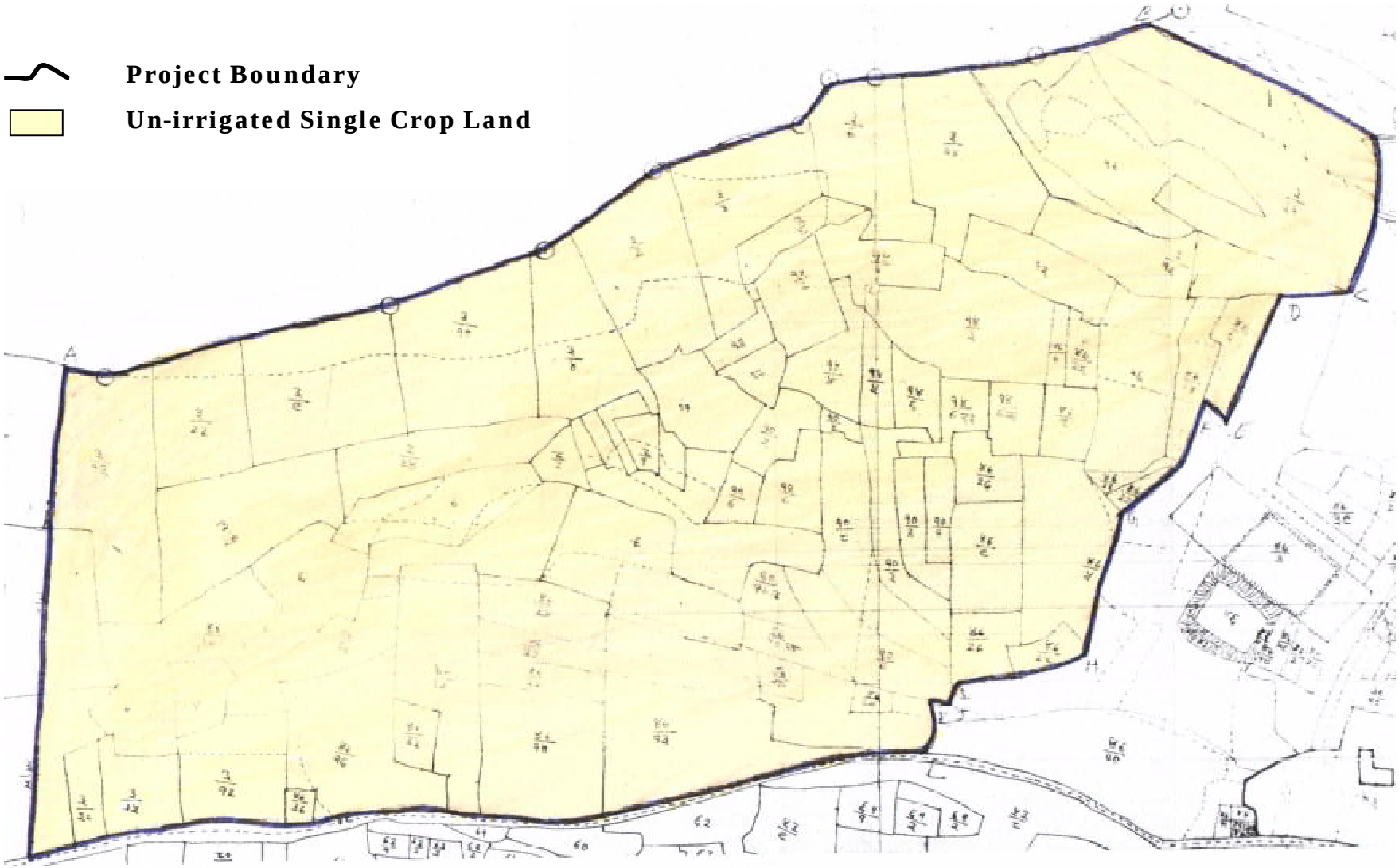


Annexure V

Landuse of Core Zone

Project Boundary

Un-irrigated Single Crop Land



Annexure VI

Sampling and Analysis Method

Table 1
LIST OF INSTRUMENTS USED FOR SAMPLING & ANALYSIS

Sr. No.	Instrument Name	Make	Model	Parameters
1	Respirable particulate sampler	Aero Vironment Engineers Inc.	RDS- 9000	RPM, SPM, SO_2, NOx
2.	Weather Technologies data acquisition system microprocessor system for automatic monitoring of weather parameters.	Weather technologies (India Pvt. Ltd., Pune)	WDL – 1002	Wind speed, direction, temperature, relative humidity, rain gauge & solar radiation.
3.	Spectrophotometer	Systronics	166	Spectrophotometric Methods.
4.	Inductive Coupled Plasma analyser(ICPA-AE 5)	Thermo Electronics UK	6300	Metal elements in air, water, soil samples.
5.	Gas Chromatograph	Ashco	Neon Pro	PAH, organic compounds.
6.	Sound level meter	Lutron, Taiwan	SL – 4001	Noise Monitoring
7.	pH Meter	Systronics	361	pH values in water and soil samples.
8.	Conductivity meter	Systronics	308	Conductivity measurement in water samples.
9.	Turbidity Meter	Systronics	132	Turbidity Measurement in water samples
10.	Flame Photometer	Systronics	128	Sodium Potassium in Water and Soil analysis.
11.	Ion-selective electrode meter	Thermo Electronics UK	Orion star	Specific Ions measurement in Water and Soil analysis.

AIR ENVIRONMENT

Table 2
MONITORED PARAMETERS AND FREQUENCY OF SAMPLING

Parameters	Sampling frequency
Suspended Particulate Matter	24 hourly sample twice a week for Three months
Respirable Particulate Matter	24 hourly sample twice a week for Three months
Sulphur dioxide ($So^{2)}$	24 hourly sample twice a week for Three months
Oxides of Nitrogen (NOx)	24 hourly sample twice a week for Three months
Carbon Monoxide (CO)	8 hourly samples for 24 hour twice a week for three months

Table 3
TECHNIQUES USED FOR AMBIENT AIR QUALITY MONITORING

Sr. No.	Parameter	Techniques	Technical Protocol	Minimum Detectable Limit (µg/m³)
1	Total Suspended Particulate Matter	Respirable Dust Sampler (Gravimetric Method)	IS - 5182 (Part – IV)	5.0
2	Respirable Particulate Matter	Respirable Dust Sampler (Gravimetric Method)	IS - 5182 (Part – IV)	5.0
3	Sulphur dioxide	Modified West and Gaeke Method	IS - 5182 (Part – II)	4.0
4	Oxide of Nitrogen	Jacob & Hochheiser Method	IS - 5182 (Part –VI)	4.0
5	Carbon Monoxide	Gas Chromatography Method	IS - 5182 (Part – X)	12.5

Table 4
SENSITIVITY OF METEOROLOGY MONITORING EQUIPMENT

Sr. No.	Sensor	Sensitivity
1	Wind Speed Sensor	+ 0.02 m/s
2	Wind Direction Sensor	+ 3 degrees
3	Temperature Sensor	+-0.2 ° C
4	Relative Humidity	+- 3%
5	Rain gauge	0.5mm
6	Solar radiation	4mV/KW/m²

Table 5
NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutant	Time Weighted Average	Concentration in Ambient Air (µg/ m³)		
		Industrial Area	Residential, Rural & Other Areas	Sensitive Areas
Sulphur dioxide (SO_2) (µg/ m³)	Annual Average *	80	60	15
	24 Hours **	120	80	30
Oxides of Nitrogen (NOx) (µg/ m³)	Annual Average *	80	60	15
	24 Hours **	120	80	30
Suspended Particulate Matter (SPM) (µg/ m³)	Annual Average *	360	140	70
	24 Hours **	500	200	100
Respiratble Particulate Matter (Size less than 10 microns) (µg/ m³)	Annual Average *	120	60	50
	24 Hours **	150	100	75
Lead (Pb) (µg/ m³)	Annual Average *	1.0	0.75	0.50
	24 Hours **	1.5	1.0	0.75

Carbon monoxide (CO) ($\mu g/m^3$)	8 Hours	5000	2000	1000
	1 Hour **	10000	4000	2000

Note:

* Annual arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval.

** 24 hourly/8 hourly values should be met 98% of the time in a year. However 2% of the time, it may exceed but not on two consecutive days.

WATER ENVIRONMENT

Table 6
STANDARD OPERATING PROCEDURES (SOP)
FOR WATER AND WASTEWATER SAMPLING AND ANALYSIS

Sr. No.	Parameter	Sample Collection	Sample Size	Storage / Preservation
1	pH	Grab sampling Polyurithane Plastic / glass container	50 ml	On site analysis
2	Electrical Conductivity	Grab sampling Polyurithane Plastic / glass container	50 ml	On site analysis
3	Total Suspended Solids (TSS)	Grab sampling Polyurithane Plastic / glass container	100 ml	Refrigeration, can be stored for 7 days
4	Total Dissolved Solids (TDS)	Grab sampling Polyurithane Plastic / glass container	100 ml	Refrigeration, can be stored for 7 days
5	COD	Grab sampling Polyurithane Plastic / glass container	100 ml	Add H_2SO_4 to pH <2, refrigeration; 28 days
6	Residual Chlorine	Grab sampling Polyurithane Plastic / glass container	50 ml	On site analysis
7	Hardness	Grab sampling Polyurithane Plastic / glass container	100 ml	Add HNO_3 to pH<2, refrigeration; 6 months
8	Chlorides	Grab sampling Polyurithane Plastic / glass container	50 ml	Not required; 28 days
9	Sulphates	Grab sampling Polyurithane Plastic / glass container	100 ml	Refrigeration; 28 days
10	Sodium, Potassium	Polyurithane Plastic / glass container	100 ml	Not required; 6 months
11	Nitrates	Polyurithane Plastic / glass container	100 ml	Refrigeration; 48 hrs
12	Fluorides	Polyurithane Plastic / glass container	100 ml	Not required; 28 days
13	Alkalinity	Polyurithane Plastic / glass container	100 ml	Refrigeration; 14 days

14	Ammonia	Polyurithane Plastic / glass container	100 ml	Add HNO_3 to pH<2, refrigeration; 28 days
15	Hexavalent Chromium, Cr^{+6}	Polyurithane Plastic / glass container rinse with 1 : 1 HNO_3	100 ml	Grab sample; refrigeration; 24 hrs
16	Heavy Metals (Hg, Cd, Cr, Cu, Fe, Zn, Pb, etc.)	Polyurithane Plastic / glass container 1 : 1 HNO_3	500 ml	Filter, Add HNO_3 to pH<2; Grab sample; 6 months

Source : Standard Methods for the Examination of Water and Wastewater, Published by APHA, AWWA, WEF 19th Edition, 1995.

Table 7
ANALYTICAL TECHNIQUES FOR WATER AND WASTEWATER SAMPLING AND ANALYSIS

Sr. No.	Parameter	Method
1	pH	APHA – 4500 – H^+
2	Colour	APHA – 2120 C
3	Odour	IS : 3025, Part- 4
4	Temperature	APHA – 2550 B
5	Dissolved Oxygen	APHA – 4500 O
6	BOD, 3 day @ 27° C	APHA – 5210 B
7	COD	APHA – 5220 C
8	Electrical Conductivity	APHA – 2510 B
9	Turbidity	APHA – 2130 B
10	Chlorides	APHA – 4500 CI
11	Fluorides	APHA – 4500 F
12	Phosphates	APHA – 4500 P
13	Cyanides	APHA – 4500 CN
14	NH_3-N	APHA – 4500 NH_3
15	Nitrate NO_3-N	APHA – 4500 NO_3
16	NO_2-N	APHA – 4500 NO_2
17	Phenolic Compounds	APHA – 5530 D
18	Total Dissolved Solids (TDS)	APHA – 2540 C
19	Total Suspended Solids (TSS)	APHA – 2540 D
20	Total Hardness	APHA – 2340 C
21	Sulphates as SO4	APHA – 4500 SO_4^{-2}
22	Arsenic	APHA – 3120 B/ APHA –3114 B/ APHA – 3500 AS
23	Calcium	APHA – 3120 B/ APHA –3500 CA
24	Magnesium	APHA – 3120 B/ APHA –3500 Mg
25	Sodium	APHA – 3120 B/ APHA –3500 Na
26	Potassium	APHA – 3120 B/ APHA –3500 K
27	Manganese	APHA – 3120 B/ APHA –3500 Mn
28	Barium	APHA – 3120 B/ APHA –3500 Ba
29	Mercury	APHA – 3120 B/ APHA –3500 Hg
30	Silver	APHA – 3120 B/ APHA –3500 Ag
31	Selenium	APHA – 3120 B/ APHA – 3114 B/ APHA – 3500 Se
32	Lead	APHA – 3120 B/ APHA –3500 Pb

33	Copper	APHA – 3120 B/ APHA –3500 Cu
34	Cadmium	APHA – 3120 B/ APHA –3500 Cd
35	Iron	APHA – 3120 B/ APHA –3500 Fe
36	Zinc	APHA – 3120 B/ APHA –3500 Zn
37	Nickel	APHA – 3120 B/ APHA –3500 Ni
38	Boron	APHA – 4500 B
39	Coliform Organisms	APHA – 9215 D
40	Total Organic Carbon	APHA – 5310 B
41	Oil and Grease	APHA – 5220 B
42	Pesticides	APHA – 6630 D
43	PAH	APHA – 6440 C
44	Alkalinity as CaCO3	APHA – 2320 B

Table 8
SURFACE WATER QUALITY STANDARD

Sr. No.	Parameter	Units	Class C of IS : 2296 Limits
1	pH	-	6.5 to 8.5
2	Colour	Hazen	300
3	Odour	mg/l	
4	Temperature	mg/l	
5	Dissolved Oxygen	mg/l	4 minimum
6	BOD, 3 day @ 27° C	mg/l	3
7	COD		
8	Electrical Conductivity	µS/cm	$
9	Turbidity		
10	Chlorides	mg/l	600
11	Fluorides	mg/l	1.5
12	Phosphates	mg/l	
13	Cyanides	mg/l	0.05
14	NH_3-N	mg/l	
15	Nitrate NO_3-N	mg/l	50
16	NO_2-N	mg/l	
17	Phenolic Compounds	mg/l	0.005
18	Total Dissolved Solids	mg/l	1500
19	Total Suspended Solids		
20	Total Hardness	mg/l	$
21	Sulphates as SO4	mg/l	

22	Arsenic	mg/l	0.2
23	Calcium	mg/l	$
24	Magnesium	mg/l	$
25	Sodium	mg/l	$
26	Potassium	mg/l	$
27	Manganese	mg/l	
28	Barium	mg/l	
29	Mercury	mg/l	$
30	Silver	mg/l	
31	Selenium	mg/l	0.05
32	Lead	mg/l	0.1
33	Copper	mg/l	1.5
34	Cadmium	mg/l	0.01
35	Iron	mg/l	50
36	Zinc	mg/l	15
37	Nickel	mg/l	
38	Boron	mg/l	
39	Coliform Organisms	MPN/100ml	5000
40	Total Organic Carbon	mg/l	
41	Oil and Grease	mg/l	0.1
42	Pesticides	mg/l	absent
43	PAH	mg/l	$
44	Alkalinity as CaCO3	mg/l	$
45	Chromium	mg/l	0.05
46	Aluminium	mg/l	$

$: Limits not specified.

Table 9

GROUND WATER QUALITY STANDARDS

Sr.	Parameter	Units	Limits of IS : 10500 : 1993
1	pH	-	6.5 to 8.5 (NR)
2	Color	Hazen	5 (25)
3	Taste	-	Agreeable
4	Odor	-	UO
5	Dissolved Oxygen	mg/l	4 minimum
6	Electrical Conductivity	µS/cm	$
7	Turbidity	NTU	5 (10)
8	Chlorides	mg/l	250 (1000)
9	Fluorides	mg/l	1.0(1.5)
10	Cyanides	mg/l	0.05 (NR)
11	Nitrate NO3-N	mg/l	45(NR)

12	Phenolic Compounds	mg/l	0.005
13	Total Dissolved Solids	mg/l	500 (2000)
14	Total Hardness	mg/l	300(600)
15	Sulphates as SO4	mg/l	200(400)
16	Arsenic	mg/l	0.01(NR)
17	Calcium	mg/l	75(200)
18	Magnesium	mg/l	30(100)
19	Sodium	mg/l	$
20	Potassium	mg/l	$
21	Manganese	mg/l	0.1(0.3)
22	Mercury	mg/l	0.001(NR)
23	Selenium	mg/l	0.01(NR)
24	Lead	mg/l	0.05(NR)
25	Copper	mg/l	0.05(1.5)
26	Cadmium	mg/l	0.01(NR)
27	Iron	mg/l	0.3(1.0)
28	Zinc	mg/l	5(15)
29	Boron	mg/l	1
30	E.coli	-	Absent
31	Coliform Organisms	MPN/100ml	10
32	Oil and Grease	mg/l	0.1
33	Pesticides	mg/l	absent
34	Alkalinity as CaCO3	mg/l	200(600)
35	Chromium	mg/l	0.05(NR)
36	Aluminium	mg/l	0.03 (0.2)
37	Phenolic Compounds	mg/l	0.001(0.002)
38	Anioionic Detergents	mg/l	0.2(1.0)
39	Mineral Oil	mg/l	0.01(0.03)

Note : $ Limits not specified, Ag : agreeable, UO : Un- objectionable.
(): Permissible limit in absence of alternative source.

Table 10
WASTE WATER DISCHARGE STANDARDS

Sr.	List of Parameter	Units	Standard
1	Color and Odor	--	All efforts should be made to remove colour
2	Suspended Solids	mg/l	200
3	Particle size of Suspended	--	Shall pass 850 micron IS sieve.
4	pH value	--	5.5 to 9.0
5	Temperature	°C	$
6	Oil and grease, Max.	mg/l	10.0
7	Total residual chlorine,	mg/l	$
8	Ammonical nitrogen (as	mg/l	$
9	Total Kjeldhal nitrogen	mg/l	$
10	Free ammonia (as NH3),	mg/l	$
11	Biochemical oxygen	mg/l	100.0
12	Chemical oxygen demand,	mg/l	$
13	Arsenic (as As), Max.	mg/l	0.2
14	Mercury (as Hg), Max.	mg/l	$
15	Lead (as Pb), Max.	mg/l	$
16	Cadmium (as Cd), Max.	mg/l	$
17	Hexavalent chromium (as	mg/l	$
18	Total chromium (as Cr),	mg/l	$
19	Copper (as Cu), Max.	mg/l	$
20	Zinc (as Zn), Max.	mg/l	$

21	Selenium (as Se), Max.	mg/l	$
22	Nickel (as Ni), Max.	mg/l	$
23	Cyanide (as CN), Max.	mg/l	0.2
24	Fluorides as F	mg/l	$
25	Dissolved phosphates (as	mg/l	$
26	Sulphides (as S), Max.	mg/l	$
27	Phenolic compounds (as	mg/l	$
28	Radioactive Materials	mg/1	$
	Alpha Emitters, Max.	mC/ml	10-7
	Beta Emitters, Max.	mC/ml	10-7
29	Bio-assay test	--	90% survival of fish after 96 hours in 100%
30	Manganese (as Mn)	mg/l	$
31	Iron (as Fe)	mg/l	$
32	Vanadium (as V)	mg/l	$
33	Nitrate nitrogen	mg/l	$

Note : 1. $ Limits not specified industries, operations or processes for which standards have been specified in Schedule of the Environment Protection Rules, 1989. **2.** These standards shall be applicable for other than those industries, operations or process

SOIL ENVIRONMENT

Table 11
ANALYTICAL TECHNIQUES FOR SOIL ANALYSIS

Sr. No.	Parameter	Method
1	Grain size distribution	Sieve analysis (D 422 – 63)
2	Textural classification	Chart developed by Public Roads Administration
3	Bulk density	Sand replacement, core cutter
4	Sodium absorption ratio	Flame colourimetric (D 1428-82)
5	pH	pH meter (D 1293-84)
6	Electrical conductivity	Conductivity meter (D 1125-82)
7	Nitrogen	Kjeldahl distillation (D 3590-84)
8	Phosphorus	Molybdenum blue, colourimetric (D 515-82)
9	Potassium	Flame photometric (D 1428-82)
10	Copper	AAS (D 1688-84)
11	Iron	AAS (D 1068-84)
12	Zinc	AAS (D 1691-84)
13	Boron	Surcumin, colourimetric (D 3082-79)
14	Chlorides	Argentometric (D 512-81 Rev 85)

Table 12
SOIL ANALYSIS PARAMETER AND UNIT

Sr. No.	Parameter	Units
1	pH (1 : 5 Aq. Extract)	---
2	Conductivity (1 : 5 Aq. Extract)	µ S/cm
3	Texture	---
4	Sand	%
5	Silt	%
6	Clay	%

7	Bulk Density	mg/cc
8	Exchangeable Calcium as Ca	mg/kg
9	Exchangeable Magnesium as Mg	mg/kg
10	Exchangeable Sodium as Na	mg/kg
11	Available Pottassium as K	Kg/ ha
12	Available Phosphorous as P	Kg/ ha
13	Available Nitrogen as N	Kg/ ha
14	Organic Matter	%
15	Organic Carbon	%
16	Water Soluble Chloride as Cl +	mg/kg
17	Water Soluble Sulphate as SO4	mg/kg
18	Sodium Absorption Ratio	---
19	Aluminium	%
20	Total Iron	%
21	Manganese	mg/kg
22	Zinc	mg/kg
23	Boron	mg/kg

Table 13
STANDARD SOIL CLASSIFICATION

Sr. No.	Soil Test	Classification
1	pH	< 4.5 Extremely acidic 4.51- 5.50 Very strongly acidic 5.51- 6.00 moderately acidic 6.01- 6.50 slightly acidic 6.51- 7.30 Neutral 7.31- 7.80 slightly alkaline 7.81- 8.50 moderately alkaline 8.51- 9.0 strongly alkaline 9.01 very strongly alkaline
2	Salinity Electrical Conductivity (µmhos/cm) (1ppm = 640 µmhos/cm)	Upto 1.00 Average 1.01-2.00 harmful to germination 2.01-3.00 harmful to crops (sensitive to salts)
3	Organic Carbon (%)	Upto 0.2 : very less 0.21-0.4 : less 0.41-0.5 medium, 0.51- 0.8: on an average sufficient >1.0 more than sufficient
4	Nitrogen (Kg/ha)	Upto 50 very less 51-100 less 101-150 good 151-300 Better >300 sufficient

5	Phosphorus (Kg/ha)	Upto 0.2 : very less 16-30 less 31-50 medium, 51-65 on an average sufficient 66-80 sufficient >80 more than sufficient
6	Potash (Kg/ha)	0-120 very less 120-180 less 181-240 medium, 241-300 average 301-360 Better >360 more than sufficient

NOISE ENVIRONMENT

Table 14
AMBIENT NOISE STANDARDS

Area Code	Category of Area	Noise Leverl dB (A) eg	
		Day time *	Night Time
A	Industrial Area	75	70
B	Commercial Area	65	55
C	Residential Area	55	45
D	Silence Zone **	50	40

Note : * day time is from 6 am to 10 pm.

** Silence zone is defined as area up to 100-m around premises of hospitals, educational institutions and courts. Use of vehicle horns, loud speakers and bursting of crackers are banned in these zones.

Table 15
STANDARD FOR OCCUPATIONAL EXPOSURE

Total Time of Exposure per Day in Hours (Continuous or Short term Exposure)	Sound Pressure Level in dB (A)
8	90
6	92
4	95
3	97
2	100
3/2	102
1	105
¾	107
½	110
¼	115

Never	>115

Note:

1. No exposure in excess of 115 dB (A) is to be permitted.
2. For any period of exposure falling in between any figure and the next higher or lower figure as indicated in column (1), the permissible level is to be determined by extrapolation on a proportionate scale.

Table 16
PROXIMATE ANALYSIS OF COAL CONSIDERED

Sr. No.	Parameter	Design Coal	Best Coal	Worst Coal
1	Design GCV, Kcal/kg	3650	4350	3000
2	Ash, %	40	35	48
3	Sulphur,%	0.6	0.4	0.9
4	Volatile matter, %	22	29	13
5	Fixed carbon, %	26	28	25
6	Moisture, %	12	8	14
7	Grindability, HGI	45	55	45

Table 17
TYPICAL CHARACTERISTICS OF HEAVY FUEL OIL

Sr. No.	Parameter	Characteristics (IS – 1953, Grade HV)
1	Total Sulphur content	4.5% (Max)
2	Gross Calorific Value	About 11,000
3	Flash Point (Min.)	66 Deg C
4	Ash Content by weight (Max.)	0.1%
5	Pour Point (Max.)	24°C(Max.)
6	Specific heat (kCal/kg.°C)	0.5

Annexure –VII

Ambient Air Quality
AAQ 1 : Kolam
(Period: Dec.-08 to Feb. 09)

Sr. No.	Date of sampling	TSPM	RPM	SO_2	NOx
1	02.12.08	145	46	6	7
2	03.12.08	132	42	7	8
3	08.12.08	121	39	7	8
4	09.12.08	125	40	8	9
5	17.12.08	131	42	9	10
6	18.12.08	142	45	10	12
7	25.12.08	137	44	9	10
8	26.12.08	140	45	9	11
9	03.01.09	150	48	8	9
10	04.01.09	154	49	8	9
11	09.01.09	127	41	8	9
12	10.01.09	139	44	9	9
13	16.01.09	142	45	7	8
14	17.01.09	135	43	6	7
15	24.01.09	147	47	7	8
16	25.01.09	151	48	6	8
17	01.02.09	149	48	7	7
18	02.02.09	142	45	6	8
19	08.02.09	153	49	7	8
20	09.02.09	126	40	6	8
21	16.02.09	138	44	7	9
22	17.02.09	141	45	7	10
23	25.02.09	143	46	6	9
24	26.02.09	147	47	6	8
Maximum		**154**	**49**	**10**	**12**
Minimum		**121**	**39**	**6**	**7**
Average		**140**	**45**	**7**	**9**
98^{th} %le		**153**	**49**	**10**	**12**

AAQ 2 : Chirmura
(Period: Dec.-08 to Feb. 09)

Sr. No.	Date of sampling	TSPM	RPM	SO_2	NOx
1	02.12.08	128	41	6	7
2	03.12.08	137	44	6	8
3	08.12.08	120	38	7	8
4	09.12.08	112	36	7	9
5	17.12.08	98	31	8	7
6	18.12.08	130	42	8	7
7	25.12.08	127	41	9	7
8	26.12.08	144	46	7	7
9	03.01.09	132	42	8	8
10	04.01.09	105	34	8	7
11	09.01.09	110	35	8	7
12	10.01.09	124	40	7	7
13	16.01.09	128	41	7	7
14	17.01.09	130	42	7	7
15	24.01.09	136	43	7	8
16	25.01.09	141	45	8	8
17	01.02.09	147	47	8	8
18	02.02.09	122	39	8	8
19	08.02.09	121	39	7	8
20	09.02.09	118	38	6	8
21	16.02.09	130	42	6	8
22	17.02.09	134	43	7	7
23	25.02.09	145	46	6	7
24	26.02.09	130	42	6	7
Maximum		**147**	**47**	**9**	**9**
Minimum		**98**	**31**	**6**	**7**
Average		**127**	**41**	**7**	**8**
98th %le		**143**	**46**	**9**	**9**

AAQ3 : Dolesara
(Period: Dec.-08 to Feb. 09)

Sr. No.	Date of sampling	SPM	RPM	SO_2	NOx
1	02.12.08	145	46	6	7
2	03.12.08	135	43	6	7
3	08.12.08	128	41	6	7
4	09.12.08	137	44	7	8
5	17.12.08	141	45	7	9
6	18.12.08	138	44	8	9
7	25.12.08	128	41	7	10
8	26.12.08	132	42	9	10
9	03.01.09	146	47	9	11
10	04.01.09	152	49	7	12
11	09.01.09	150	48	8	10
12	10.01.09	147	47	8	10
13	16.01.09	153	49	7	9
14	17.01.09	148	47	6	8
15	24.01.09	137	44	6	9
16	25.01.09	128	41	6	9
17	01.02.09	125	40	7	9
18	02.02.09	133	42	6	8
19	08.02.09	145	46	7	7
20	09.02.09	147	47	8	7
21	16.02.09	151	48	6	7
22	17.02.09	155	50	7	7
23	25.02.09	153	49	7	8
24	26.02.09	145	46	8	8
Maximum		**155**	**50**	**9**	**12**
Minimum		**125**	**40**	**6**	**7**
Average		**142**	**45**	**7**	**9**
98^{th} %le		**153**	**49**	**9**	**12**

AAQ 4: Rodopali
(Period: Dec.-08 to Feb. 09)

Sr. No.	Date of sampling	SPM	RPM	SO_2	NOx
1	02.12.08	120	38	6	7
2	03.12.08	137	44	7	7
3	08.12.08	150	48	8	8
4	09.12.08	148	47	8	7
5	17.12.08	132	42	9	9
6	18.12.08	145	46	10	11
7	25.12.08	137	44	7	11
8	26.12.08	156	50	7	9
9	03.01.09	144	46	7	8
10	04.01.09	138	44	8	8
11	09.01.09	147	47	8	9
12	10.01.09	128	41	9	9
13	16.01.09	137	42	9	8
14	17.01.09	140	45	7	8
15	24.01.09	147	47	8	7
16	25.01.09	144	46	9	7
17	01.02.09	152	49	8	8
18	02.02.09	138	44	6	9
19	08.02.09	145	46	6	9
20	09.02.09	155	50	6	8
21	16.02.09	141	45	7	9
22	17.02.09	139	44	6	8
23	25.02.09	146	47	7	9
24	26.02.09	151	48	8	8
Maximum		**156**	**50**	**10**	**11**
Minimum		**120**	**38**	**6**	**7**
Average		**142**	**45**	**8**	**8**
98^{th} %le		**154**	**49**	**10**	**11**

AAQ 5: Poto
(Period: Dec.-08 to Feb. 09)

Sr. No.	Date of sampling	SPM	RPM	SO_2	NOx
1	02.12.08	122	39	6	7
2	03.12.08	135	43	6	7
3	08.12.08	124	40	7	7
4	09.12.08	137	44	6	7
5	17.12.08	148	47	8	7
6	18.12.08	155	50	8	7
7	25.12.08	151	48	6	8
8	26.12.08	156	47	9	9
9	03.01.09	138	42	6	10
10	04.01.09	142	45	6	9
11	09.01.09	133	42	8	8
12	10.01.09	122	39	7	9
13	16.01.09	130	41	7	7
14	17.01.09	127	41	9	7
15	24.01.09	150	48	8	7
16	25.01.09	148	47	8	8
17	01.02.09	145	46	6	8
18	02.02.09	135	43	7	7
19	08.02.09	122	39	7	7
20	09.02.09	130	42	7	7
21	16.02.09	138	44	6	7
22	17.02.09	140	45	8	7
23	25.02.09	137	44	7	7
24	26.02.09	145	46	7	7
Maximum		**156**	**50**	**9**	**10**
Minimum		**122**	**39**	**6**	**7**
Average		**138**	**44**	**7**	**8**
98^{th} %le		**156**	**49**	**9**	**10**

AAQ6 : Jhankndarta
(Period: Dec.-08 to Feb. 09)

Sr. No.	Date of sampling	TSPM	RPM	SO_2	NOx
1	02.12.08	104	33	6	7
2	03.12.08	122	39	7	8
3	08.12.08	108	34	8	8
4	09.12.08	110	35	6	7
5	17.12.08	123	39	6	8
6	18.12.08	135	43	7	8
7	25.12.08	140	45	6	8
8	26.12.08	132	42	6	8
9	03.01.09	140	45	6	7
10	04.01.09	130	42	7	7
11	09.01.09	121	39	7	7
12	10.01.09	135	43	6	8
13	16.01.09	140	45	7	8
14	17.01.09	137	44	7	8
15	24.01.09	140	45	6	8
16	25.01.09	127	41	6	7
17	01.02.09	120	38	6	7
18	02.02.09	128	41	7	8
19	08.02.09	132	42	6	7
20	09.02.09	140	45	6	8
21	16.02.09	122	39	7	8
22	17.02.09	130	42	7	7
23	25.02.09	140	45	6	7
24	26.02.09	137	44	6	7
Maximum		**140**	**45**	**8**	**8**
Minimum		**104**	**33**	**6**	**7**
Average		**129**	**41**	**6**	**8**
98^{th} %le		**140**	**45**	**8**	**8**

AAQ7 : Auraimura
(Period: Dec.-08 to Feb. 09)

Sr. No.	Date of sampling	TSPM	RPM	SO_2	NOx
1	04.12.08	137	44	7	8
2	05.12.08	146	47	7	8
3	11.12.08	142	45	8	9
4	12.12.08	132	42	8	9
5	20.12.08	140	45	8	9
6	21.12.08	120	38	8	9
7	28.12.08	130	42	7	8
8	29.12.08	127	41	8	8
9	05.01.09	125	40	8	8
10	06.01.09	135	43	7	7
11	13.01.09	140	45	6	8
12	14.01.09	152	49	6	8
13	20.01.09	151	48	6	8
14	21.01.09	140	45	7	7
15	28.01.09	147	47	8	7
16	29.01.09	150	48	8	7
17	03.02.09	137	44	7	7
18	04.02.09	140	45	6	8
19	11.02.09	145	46	6	8
20	12.02.09	128	41	6	9
21	19.02.09	130	42	7	7
22	20.02.09	138	44	6	7
23	27.02.09	141	45	7	7
24	28.02.09	145	46	7	7
Maximum		**152**	**49**	**8**	**9**
Minimum		**120**	**38**	**6**	**7**
Average		**138**	**44**	**7**	**8**
98th %le		**152**	**48**	**8**	**9**

AAQ8 : Nawapara
(Period: Dec.-08 to Feb. 09)

Sr. No.	Date of sampling	SPM	RPM	SO_2	NOx
1	04.12.08	122	39	6	8
2	05.12.08	128	41	7	8
3	11.12.08	140	45	7	8
4	12.12.08	147	47	8	9
5	20.12.08	154	49	8	9
6	21.12.08	150	48	9	8
7	28.12.08	137	44	9	9
8	29.12.08	148	47	9	10
9	05.01.09	150	48	9	10
10	06.01.09	151	48	9	11
11	13.01.09	138	44	9	9
12	14.01.09	130	42	8	10
13	20.01.09	131	42	7	8
14	21.01.09	140	45	7	9
15	28.01.09	146	47	7	9
16	29.01.09	127	41	7	9
17	03.02.09	130	42	8	8
18	04.02.09	135	43	7	8
19	11.02.09	140	45	7	7
20	12.02.09	147	47	8	7
21	19.02.09	152	49	9	8
22	20.02.09	150	48	9	7
23	27.02.09	133	42	8	7
24	28.02.09	140	45	8	7
Maximum		**154**	**49**	**9**	**11**
Minimum		**122**	**39**	**6**	**7**
Average		**140**	**45**	**8**	**8**
98th %le		**153**	**49**	**9**	**11**

AAQ 9 : Manjhapard
(Period: Dec.-08 to Feb. 09)

Sr. No.	Date of sampling	TSPM	RPM	SO_2	NOx
1	04.12.08	126	40	6	7
2	05.12.08	130	42	6	7
3	11.12.08	133	42	7	8
4	12.12.08	141	45	7	8
5	20.12.08	146	47	7	8
6	21.12.08	150	48	6	8
7	28.12.08	155	50	6	7
8	29.12.08	143	46	6	7
9	05.01.09	132	42	8	6
10	06.01.09	136	43	9	10
11	13.01.09	140	45	7	10
12	14.01.09	147	47	7	9
13	20.01.09	143	46	7	8
14	21.01.09	150	48	8	8
15	28.01.09	151	48	9	8
16	29.01.09	120	38	7	7
17	03.02.09	130	42	7	7
18	04.02.09	120	38	8	8
19	11.02.09	118	38	8	8
20	12.02.09	130	42	6	7
21	19.02.09	124	40	7	8
22	20.02.09	122	39	7	8
23	27.02.09	135	43	7	8
24	28.02.09	124	39	6	8
Maximum		**155**	**50**	**9**	**10**
Minimum		**118**	**38**	**6**	**6**
Average		**135**	**43**	**7**	**8**
98th %le		**154**	**49**	**9**	**10**

Annexure VIII- Demographic Details

Sr. No.	District	Name of Taluka	Name of village	No. of Household	Total Population	Male	Female	SC Population	ST Population	Literates	Main Workers	Marginal Workers	Non Workers
1	Raigarh	Gharghoda	Bade Gumda	244	1215	602	613	100	424	728	710	26	479
2			Amlidih	234	1096	550	546	79	550	599	248	347	501
3			Chaidoria	86	377	175	202	23	193	213	68	185	124
4			Pandripani	62	288	137	151	0	268	183	50	29	209
5			Baihamuda	338	1556	779	777	98	1040	870	390	239	927
6			Bhalumar	156	736	361	375	70	183	475	190	1	545
7			Bhendra	322	1397	667	730	104	1030	899	750	94	553
8			Jhariyapali	172	747	390	357	72	250	424	215	168	364
9			Charbhantha	162	701	323	378	9	580	427	212	8	481
10			Jhankadarha	71	317	157	160	32	137	206	119	3	195
11			Kognara	147	605	297	308	44	545	413	166	16	423
12			Kanchanpur	383	1571	754	817	220	1091	831	636	303	632
13			Bahirkela	390	1817	870	947	46	1072	1202	818	308	691
14			Karichapar	71	332	163	169	0	302	140	166	3	163
15			Chheerbhauna	47	198	100	98	3	161	107	81	3	114
16			Teram	401	1667	803	864	347	896	940	639	201	827
17			Dhoram	201	904	453	451	38	748	589	428	79	397
18			Patrapali	130	558	278	280	106	416	394	218	109	231
19			Bijari	82	372	169	203	39	103	221	165	57	150
20			Rumkera	220	1017	507	510	124	795	547	561	35	421
21			Kantajhariya	83	360	171	189	28	295	233	63	99	198
22			Konpara	139	610	307	303	33	324	386	181	79	350
23			Kotarimal	194	853	429	424	93	505	558	391	0	462
24			Kathrapali	87	395	193	202	9	313	251	252	0	143
25			Kurmibhaona	115	492	251	241	29	332	325	188	66	238
26			Porda	265	1122	570	552	77	656	662	445	181	496

Sr. No.	District	Name of Taluka	Name of village	No. of Household	Total Population	Male	Female	SC Population	ST Population	Literates	Main Workers	Marginal Workers	Non Workers
27			Muskura	16	50	28	22	0	50	28	19	0	31
28			Salhepali	157	661	331	330	57	358	390	207	6	448
29			Ajijgarh	45	191	100	91	0	148	72	37	78	76
30			Kudhurmauha	40	161	78	83	0	159	64	70	26	65
31			Chimtapani	123	462	235	227	85	301	256	196	105	161
32			Chotiguda	269	1214	598	616	114	643	644	540	190	484
33			Tilaipali	97	394	195	199	18	139	280	181	49	164
34			Naya Rampur	85	351	177	174	26	325	206	140	66	145
35			Bamhanpali	41	150	78	72	5	114	65	33	22	95
36			Bichinara	146	633	308	325	110	481	265	221	130	282
37			Pelama	212	941	474	467	59	559	525	551	0	390
38			Uraba	247	1039	526	513	120	741	502	396	52	591
39			Hinjher	89	407	195	212	62	299	222	125	21	261
40			Jarhidih	62	292	156	136	3	203	194	103	13	176
41			Lalpur	83	400	210	190	32	255	296	172	16	212
42			Kharra	64	280	141	139	4	215	200	148	5	127
43			Maduadumar	45	204	98	106	27	15	143	33	35	136
44			Sakta	73	294	153	141	18	223	232	137	61	96
45			Bhalumuda	72	314	158	156	36	208	173	225	5	84
46			Dholnara	91	408	200	208	17	281	233	239	3	166
47			Bajarmuda	179	800	407	393	74	470	497	413	45	342
48			Karwahi	122	557	288	269	2	269	383	186	74	297
49			Khamahariya	121	531	264	267	62	198	407	140	126	265
50			Milupara	282	1165	573	592	78	784	704	378	120	667
51			Lamdarha	84	325	158	167	12	305	225	110	86	129
52			Kondkel	199	856	423	433	74	563	560	254	248	354
53			Aoraimuda	203	854	414	440	66	440	523	371	70	413
54			Nundarha	176	690	332	358	112	439	308	191	199	300

Sr. No.	District	Name of Taluka	Name of village	No. of Household	Total Population	Male	Female	SC Population	ST Population	Literates	Main Workers	Marginal Workers	Non Workers
55			Kerakhol	88	351	168	183	71	256	139	106	47	198
56			Chirramuda	145	588	293	295	44	438	332	213	35	340
57			Banai	265	1137	565	572	118	881	585	392	266	479
58			Rengalbahri	125	502	251	251	73	402	276	295	35	172
59			Barkaspali	140	635	316	319	164	162	399	316	0	319
60			Uttar Regaon	139	656	318	338	48	495	356	263	92	301
61			Kolam	103	427	223	204	54	188	258	187	56	184
62			Chitwahi	174	747	363	384	40	515	406	246	159	342
63			Dolesara	244	1061	513	548	216	408	677	187	166	708
64			Dakshin Regaon	63	334	168	166	0	126	228	72	53	209
65			Rodopali	158	688	351	337	89	430	445	304	96	288
66			Salihabhanttha	173	764	383	381	58	395	437	226	288	250
67			Deogarha	425	1945	949	996	242	1453	887	787	305	853
68			Patrapali	97	425	224	201	39	310	281	99	34	292
69			Barpali	248	1035	502	533	172	805	503	489	121	425
70			Mauhapali	145	670	326	344	39	461	338	373	53	244
71			Punjipathra	72	366	241	125	16	273	284	191	13	162
72			Samaruma	78	392	206	186	8	18	276	135	67	190
73			Padkipahri	81	352	174	178	0	220	244	92	63	197
74			Kasdol	292	1326	661	665	71	488	835	307	10	1009
75			Salihari	49	265	141	124	26	183	207	173	1	91
76			Kanta Jhariya	39	176	90	86	9	95	116	102	1	73
77			Ratrot	7	28	15	13	0	28	18	18	0	10
78			Amaghat	223	1018	490	528	45	878	552	193	289	536
79			Kachkoba	245	1056	519	537	186	584	456	258	279	519
80			Jarekela	224	1018	503	515	42	587	592	451	81	486
81			Nawapara	68	293	142	151	39	215	174	112	59	122

Sr. No.	District	Name of Taluka	Name of village	No. of Household	Total Population	Male	Female	SC Population	ST Population	Literates	Main Workers	Marginal Workers	Non Workers
82			Basanpali	216	991	459	532	84	197	638	266	310	415
83			Gorhi	389	1774	841	933	160	718	1200	272	434	1068
84			Tamnar	867	3974	1997	1977	158	994	2632	1109	300	2565
85			Budiya	200	960	480	480	27	488	690	363	111	486
86			Kunjemura	238	1054	539	515	76	528	585	380	161	513
87			Kosampali	64	279	146	133	16	143	163	119	77	83
88			Gare	150	741	368	373	44	438	476	373	75	293
89			Pata	273	1189	595	594	124	474	685	528	116	545
90			Mudagaon	119	520	245	275	33	339	342	246	68	206
91			Saraitola	112	564	272	292	84	367	360	178	119	267
92			Sarasmal	113	508	260	248	0	415	294	197	2	309
93			Tihli Rampur	107	448	221	227	24	213	330	8	266	174
94			Dongamauha	169	777	590	187	0	231	642	518	112	147
95			Baljor	72	304	146	158	10	261	219	170	13	121
96			Jhinku Bahal	134	599	294	305	66	189	430	169	98	332
97			Libara	276	1181	598	583	98	636	875	472	58	651
98			Jharna	298	1265	616	649	53	745	754	416	341	508
99			Raipara	93	466	229	237	21	246	295	147	6	313
100			Samkera	300	1491	726	765	242	621	1044	486	204	801
101			Mahloi	509	2292	1166	1126	316	1385	1068	720	442	1130
102			Deogaon	244	1079	525	554	134	441	624	101	511	467
			Total	**17278**	**76638**	**38162**	**38476**	**6775**	**43757**	**46067**	**27991**	**10983**	**37664**

Annexure –IX

Emission Calculation and Metrological Data

Volumetric Flow Rate = Area (m^2) x Velocity (m/s) x Temp. Correction Factor

Temperature Correction factor = (273+25) / (273 + Stack Temp. ^0C)

1. General Calculations

- ***Emission Rate Calculations***

$$Emission\ Rate\ (\frac{g}{s}) = Limit\ (mg/Nm^3)\ x\ Volumetric\ \ flow\ (Nm^3/s)\ x\ 10^{-3}$$

Particulate Matter (SPM) Emission Rate for Stack (80 MW)

The pollution load of particulate matter is calculated based on the standard of 50 mg/Nm^3. The emission rates for stack is calculated and an example is given below

$$Emission\ \ rate = 50\frac{mg}{Nm^3} \times 154.7\frac{Nm^3}{S} \times \frac{1}{1000} = 7.73\frac{g}{s}$$

Particulate Matter (SPM) Emission Rate for Stack (2x135 MW)

The pollution load of particulate matter is calculated based on the standard of 50 mg/Nm^3. The emission rates for stack is calculated and an example is given below

$$Emission\ \ rate = 50\frac{mg}{Nm^3} \times 315.6\frac{Nm^3}{S} \times \frac{1}{1000} = 15.8\frac{g}{s}$$

NOx Emission Rate for Stack (80 MW)

Coal Consumption	=	1745 TPD
NOx emission rate	=	4.5 kg/ton
NOx emission	=	1745 x 4.5
	=	7852.5 kg/day = 327.2 kg/hr
	=	90.88 g/sec say 91.0 g/sec

NOx Emission Rate for Stack (2x135 MW)

Coal Consumption	=	5890 TPD
NOx emission rate	=	4.5 kg/ton
NOx emission	=	5890 x 4.5
	=	26505 kg/day = 1104.37 kg/hr
	=	306.77 g/sec say 307 g/sec

SO_2 Emission form Stack (80 MW)

Coal consumption	=	1745 TPD
	=	72708.3 kg/hr
Sulphur Content in fuel	=	0.4%
Sulphur dioxide emission factor	=	(0.4/100) x (64/32) = 0.008
SO_2 emission rate	=	72708.3 x 0.008
	=	581.66 kg/ hr = **161.6 g/sec**

SO_2 Emission form Stack (2x135 MW)

Coal consumption	=	5890 TPD
	=	245416.6 kg/hr
Sulphur Content in fuel	=	0.4%
Sulphur dioxide emission factor	=	(0.4/100) x (64/32) = 0.008
SO_2 emission rate	=	245416.6 x 0.008
	=	1963.3 kg/ hr = **545.4g/sec**

Hourly Average Metrological Data at Site

Hours	Wind Direction (Degree)	Wind Speed (m/sec)	Temperature (^{0}K)	Stability Class	Mixing Height (Meter)
1	270	0.8	294.1	6	300
2	270	1.0	296.0	6	250
3	315	0.9	296.6	6	200
4	315	0.9	287.4	6	150
5	315	2.1	297.1	5	100
6	270	1.4	297.3	5	100
7	315	1.7	297.9	5	100
8	315	2.2	298.1	4	400
9	90	1.3	298.2	4	400
10	45	1.0	299.5	3	800
11	9	1.2	301.8	2	1000
12	315	1.6	303.6	2	1200
13	315	1.1	304.9	2	1200
14	9	1.1	305.6	1	1300
15	9	1.3	304.5	1	1500
16	9	1.0	301.4	2	1500
17	315	1.3	298.5	3	1400
18	315	0.8	298.4	4	1200
19	315	1.1	297.7	5	1100
20	270	1.2	296.8	5	800
21	9	1.0	296.5	5	600
22	9	1.1	295.4	6	500
23	8	1.0	294.5	6	500
24	9	1.0	294.6	6	400

Chapter 1

Introduction

1.1 Preamble

The Government of India's 5th National Power Plan has envisaged a total installed capacity of 2.12,000 MW as per the 16th Electric Power Survey, based on power demand. This capacity is to be achieved by the end of the 11th Plan, March 2012. The Government of India has projected a GDP growth rate of about 7.4% based on the 11th plan power capacity to be achieved. To achieve a target of higher than 10,000 MW per annum, huge investment in power sector is required and also the manufactures, contractors, vendors and supporting will need to increase their capacities to meet this target of power sector.

In view of the above backdrop M/s Sarda Energy & Minerals Ltd. (SEML) has decided to setup a coal & middling based Thermal Power Plant with a total capacity of 350 (2x135 + 1x30 + 1x50) MW in District Raigarh, Chhattisgarh. SEML has retained Anacon Laboratories Nagpur to undertake on Environmental Impact Assessment study and preparation of Environment Management Plan for the proposed 350 MW Thermal Power Plant for Environment Clearance from State Level Environment Impact Assessment Authority.

1.2 Profile of Project Proponent

Sarda Energy & Minerals Ltd. (Formaly Chhattisgarh Electricity Company Ltd.), incorporated on 23rd January 1998, is a Public Limited Company. Power has been the prime mover of growth in the Company. The Company had installed 20 MW coal based thermal power plant, which commenced operations in the year 2001. The Company also installed four ferro alloys furnaces of 9 MVA each for captive consumption and maximum realisation for the power generated. Gradually the capacity of power plant has been increased to 61.5 MW and one more Ferro Alloys furnaces of same capacity have been added

thereby increasing the capacity to 45 MVA, making us the second largest producer of manganese based Ferro Alloys in the country. The facilities are installed at Industrial Growth Centre, Siltara, Raipur over an area of about 70 acres.

Chhattisgarh Electricity Company Ltd. has got merged with Raipur Alloys & Steel Limited as per the orders of Hon'ble High Court of Chhattisgarh, Bilaspur dated 11th May, 2007 & the name of Raipur Alloys & Steel Limited has also been Changed to "Sarda Energy & Minerals Limited"(SEML) as per Fresh Certification of Incorporation dated 2nd August 2007.

Liberalization of economy by the Government, throwing open for manufacturing of Iron and Steel including mining of iron ore, coal and other related minerals to private entrepreneurs, provided an avenue for further growth in this segment to SEML. Company is a industrial house to set up a modern integrated steel plant at Siltara Industrial Estate, Raipur. The steel plant uses non-coking coal for sponge iron production of 79,200 TPA, further it has expanded to 4,60,000 TPA sponge iron production.

Initially for meeting its requirement for 79,200 TPA sponge iron, SEML obtained a mining lease for iron ore situated at Dongarbor in the Rajnandgaon District, to produce 2.0 lakhs TPA. After expansion of sponge iron plant to meet it's requirement of iron ore, the company has increased production capacity of Dongarbore Iron Ore Mine from 2.0 lakhs TPA to 15.0 lakhs TPA for extraction of iron ore in the year 2007.

Company has been allotted a captive coal block at Karwahi near Tamnar, District- Raigarh, Chhattisgarh State to produce 1.2 Million TPA coal. Company is proposed fopr installation of 1.1 Million TPA Integrated Steel Plant and 60 MW WHRB Power Plant at Siltara Industrial Growth Centre, Mandhar, Raipur.

1.3 Project Description

The power project includes Power house, Steam generator, Cooling tower, D.M. plant, Coal Storage facility and support infrastructure like Administrative Buildings, Water Reservoir, Water Treatment plant, Effluent Treatment Plant, Internal Roads, Drainage System etc. Green belt, Avenue Plantation and Lawns within the plant premises and other pollution control and safety systems, which will help to attenuate noise and dust emission.

1.3.1 Location

The site, admeasuring 81.0 ha of land for the proposed power plant has been identified at village Kolam, District Raigarh, Chhattisgarh, which is located within 22° 10' N latitude & 83° 25' 30" E longitude. Vicinity map of project site is presented in **Figure 1.1.** The environmental setting of the site are presented below:

Sr. No.	Particulars	Details
1	Latitude	22° 10' N
2	Longitude	83° 25' 30" E
3	Altitude	300 m above MSL
4	Toposheet	64 N/8,12
5	Seismicity	Area falls under least affected earthquakes zone II as per IS 1893 - 2002
6	Present land use	Single Crop Agricultural Land
7	Climatic condition (Annual Average)	Ambient Air temp 7°C to 48°C Avg. annual rainfall 1400 mm (IMD, Raigarh)
8	Nearest village	Kolam(1 Km, East)
9	Nearest towns	Ghargoda (8 km, West)
10	Nearest railway station	Raigarh (35 km)
11	Nearest airport	Raipur (250 km)
12	Streams / Rivers	Pajhar Nalla (0.5, km West)
13	Sanctuaries /National Parks/ Biospheres, etc.	Nil
14	Topography	Gently undulating and sloping toward west
15	Defense Installations	Nil
16	Historical Places	Nil

1.3.2 Site Selection

The proposed project site is situated at Village : Kolam, Tehsil : Gharghoda (Now Tamnar), District : Raigarh, Chhattisgarh State, 4.0 km away from SEML Captive Karwahi open cast coal mine near Tamnar, Raigarh. The 10-km radius map around the project site is presented in **Figure 1.2** and site photographs are presented as **Plate1.**

The following are the factors in favour of selection of site at village Kolam, Raigarh.

- Proximity and availability of raw material captively
- Proximity to the user industry
- Proximity to the source of fuel
- Availability of adequate water
- Availability of adequate land for locating the plant with approach roads
- Suitability of land from topography and geological aspects
- Proximity of National Highways & Transport of heavy equipments

1.4 EIA/EMP for Environment Clearance

As per the EIA Notification dated 14th September 2006 of MoEF, the proposed 350 MW thermal power plant requires prior environment clearance from Environment Impact Assessment Authority, Chhattisgarh. The proposed project falls under **Category** '**B**' Accordingly, Expert Appraisal Committee of Chhattisgarh considered the project at its meeting held on 29th December, 2008 and issued the TOR for presentation of EIA/EMP which is placed at **Annexure I**.

The draft EIA/EMP has been prepared incorporating the TOR conditions and point wise TOR conditions compliances are summarized below.

Sr. No	Scope as per TOR	Compliance/Report Reference
Source of Raw Coal		
1	Linkage of Coal/assurance for supply of raw coal for power plant.	Total Coal Requirement = 21.552 Lakhs TPA SEML Captive Coal Mine = 2.40 Lakhs TPA E-aucation (Balance) = 19.152 Lakhs TPA
2	The list of client/companies along with copy of agreement between project proponent and companies from whom the middling/rejects/coal fines to be procured for use in power plant	100% Middling & Reject from SEML's Coal Washery = 3.648 Lakhs TPA
3	The mode of transportation/conveyance of	Coal Transportation from SEML mines to Plant by Covered Belt Conveyor

	incoming coal/middling/rejects/coal fines and outgoing ash etc. transportation routes showing major establishments including villages, schools/colleges, residential areas etc. to be given.	Middling/Rejects from Captive Coal Washery to Plant = Covered Belt Conveyor Balance coal from E-auction (Korba, Chhal & Barod) by road. Fly Ash/Pond Ash = Closed Bulkers
4	The transportation of fuel and ash to cement plant through rail should be explored and proposal along with action plan to be submitted.	Transportation of Coal by covered belt conveyor from captive mine & balance coal will be met from E-auction from Korba, Chhal & Barod by road transportation. Hence, rail option is eliminated. Fly ash will be given to local industries within the radius of 50-100 km from project as per the fly ash notification. The close bulkers shall be used for transportation from environment consideration. Hence, rail transportation may not be feasible.
5	The list of companies along with copy of agreement between project proponent and companies to whom the solid wastes (such as ash) to be supplied for disposal/sold.	SEML has process to tie up with cement industries such as Lafarage Cement and Grasim Cement Plant for disposal of fly ash and will also used in filling of captive coal mine..
Project Description		
1	A brief description of the plant, the technology used and energy conservation.	Plant Description and Technology : Please refer **Chapter 2** Technology = **Sub head 2.5, Chapter 2** Energy Conservation = AFBC/CFBC Boilers will be used.
2	All coordinates of the plant site with toposheet.	All coordinates of the plant site is enclosed as **Annexure II.**
3	Detailed material balance and water balance, break up of raw coal, middling/rejects/coal fines, break up of water requirement as per different activities in the power plant.	Coal Quantity – 21.552 Lakhs TPA Middling Quantity – 3.648 Lakhs TPA Bottom Ash Quantity – 0.2 MTPA Fly Ash Quantity – 0.9 MTPA Water requirement and water balance are presented in **sub head 2.3.2 of Chapter 2.**
4	Source of water supplied for use in power plant, sanction of the competent authority in the State Government.	Water will be sourced from the Kelo river. Water allotment application is enclosed as **Annexure III.**
5	Examine close circuit system for 100% recycling and reuse of the treated effluent in the various operations or other uses such as irrigating the greenbelt within premises etc.	Zero discharge will be adopted. Detailed water balance and reuses of treated effluent are presented **in Figure 2.2 of Chapter 2.**
6	Optimization of COC for water conservation. Other water conservation measures proposed in the project should be incorporated.	COC 5 will be Maintained. Recycling, to achieve zero discharge
7	Examine the air cooled technology	Air cooled system will be explored to minimize

	for water conservation at least for 1x30 + 1x50 MW unit.	the water requirement for single 135 MW unit during designing.
8	Examine zero effluent discharge conditions.	205 m^3/hr wastewater will be treated in Effluent Treatment Plant and treated effluent will be utilized within the plant premises (Dust Suppuration for Road & Vehicle Washing, Ventilation, Coal Handling/Dust Suppuration, Greenbelt and Ash Handling etc.)
9	Submission of sample test analysis raw coal/middling/rejects/coal fines to be used-this includes grade of coal and other characteristics – ash, S and Hg level etc.	Details are presented in **Chapter 2, Sub head 2.3.3.1.**
Description of the Environment		
1	Study of alternative sites should also be submitted so as to justified the selected site from environmental angle.	Proposed site is suitable for power plant from all site selection criteria considerations i.e. Fuel requirement, water requirement and environmental point of view.
2	Study area should cover an area of 10 km radius around the proposed site.	Study area map covering 10 km radius around the project site is presented in **Figure 1.2 of Chapter 1**
3	A study area map of the core zone and 10 km area of the buffer showing major topographical features such as land use, drainage, location of habitats, major construction including railway, highway, pipelines, major industries/mines and other polluting sources, which shall also indicate the migratory corridors of fauna, if any, and the areas where endangered fauna and plants of medicinal and economic importance found in the area.	Study area map of core zone and buffer zone are attached as **Figure 1.2 of Chapter 1.**
4	Contour map along with the site plan of the project and project land use area statement including land for project operations, such as coal handling plant, power plant, building infrastructure, effluent treatment plants, raw coal, middling/reject/coal fine stock yards, ash silo, colony, greenbelt, undisturbed area, natural topography features (such as existing roads, drains/natural water bodies if any) to be left undisturbed, proposed diversion/re-channelling of natural drainage or water courses,	Site plan showing plant layout, natural topographical features and Contour map along with the site plan is enclosed as **Annexure –IV.**

	if any.	
5	One complete season site specific meteorological data.	Site specific meteorological data was collected for winter season (2008-09). Details are given in **Sub head 3.4.1 of Chapter 3**
6	Information regarding surface hydrology, water regime, hydrology and ground water regime,	Details are presented in **Chapter 3, Subhead 3.2.2 and 3.2.3.**
7	Information regarding drainage pattern of the study area.	Drainage map of the study area is presented in **Chapter 1, Figure 1.2.**
8	Topography of study area, clearly indicating, whether the site requires any filling? If so, details of filling, filling materials, quantity of filling materials required, filling materials supply sources and transportation etc. the filling material should fly/bottom/pond ash of thermal power plants and dust/slag/accretion of steel plants etc.	The study area is almost a flat terrain, hence does not require any filling.
9	Location of any national park, wildlife sanctuary, Reserve Forest, Protected forest and eco-sensitive zones, elephant/tiger reserve (existing as well as proposed), migratory routes, if any, within 10 km of the project site be specified and marked on the map duly authenticated by concerned Government department.	National Park – No Wildlife Sanctuary – No Reserve Forest – Silot RF Protected Forest – 8 Nos. Protected Forests Eco-sensitive Zones – No Elephant/Tiger Reserves – No Migratory Routes – No
10	Map showing core zone delineating the agricultural land (irrigation and un-irrigated), uncultivable land (as defined in revenue record), forest areas (as per records), grazing land and waste land.	Details are enclosed as **Annexure V**
11	Land use statement of the study area as well as project area.	Land use statement of the study area is given in **Chapter 3, Sub head 3.2.** Land use of Project Site – Single cropped unirrigated Land given in **Annexure V.**
12	Collection of one complete season (non-monsoon preferably winter season 2008) primary base line data (along with dates of monitoring) on environmental quality such as air (RPM, SPM, SO_2 & NOx), noise, water (Surface and ground water) Soil.	Details are presented in **Chapter 3, Subhead 3.4.3, 3.5 & 3.6.**
13	Include ground water monitoring near solid waste/ash dump zone.	Ground Water monitoring has been included in EMP.

14	The monitoring be conducted as per Central Pollution Control Board's guidelines and parameters for water testing for both ground water as per ISI and surface water as per Central Pollution Control Board Guidelines.	Ground water as well as surface water baseline monitoring has been conducted as per CPCB Guidelines and testing was conducted as per IS 10500 for ground water and IS 2296 for Surface water.
15	Surface water, ground water, soil, noise and ambient air quality be monitored at-least at eight stations/locations around the proposed site. At least one monitoring station in the upwind direction/downstream/non-impact non – polluting area as a control station	Details are as under: Surface water monitoring locations – 2 Nos Ground water monitoring locations – 6 Nos Soil monitoring locations – 9 Nos. Noise monitoring locations – 8 Nos. Air quality monitoring locations – 9 Nos
16	The location of the air monitoring stations decided after taking into consideration the pre dominate wind direction, population zone and sensitive receptors including Reserve forest.	The locations of the ambient monitoring stations were decided on the base of IMD wind rose for winter season and are shown in **Figure 3.4.1, Chapter 3**.
17	Details of various facilities to be provide for the personnel involving in raw coal/middling/rejects/ash transportation and handling in terms of parking, rest areas, canteens, sanitations, and effluent/pollution load from these activities.	Adequate parking, rest rooms, canteen and sanitation facility has been provided. **Refer Figure 2.1, Chapter 2.**
18	Details infrastructure facilities such as sanitation, fuel, restroom, canteen etc. to be provided to the labour force including casual workers during construction as well as during operation phase. Effluent/pollution load from these activities be included.	During operation phase canteen and sanitation facility will be provided to the labours. Sewage will be treated in STP.
19	Details of workshop, if any and treatment of workshop effluent.	No
20	Occupational health issues, baseline data on the health of the population.	Details are presented in **Chapter 6** of **EIA report .**
Environmental Impacts		
1	Impacts of the project, if any, in the land use, in particular agricultural land, forest land, grazing land, water bodies, drainage of the area and the surroundings.	Land under project is un-irrigated single cropped. There is no forest and grazing land involved in it. Adverse impact will be mitigated through pollution control measure given in EMP.
2	Impact of choice of the selected boiler technology for power plant	AFBC/CFBC boilers are selected for proposed power plant due to minimum pollutant

	and impact on air quality and waste generation (emission and effluent).	emissions considerations. Details are presented in **Chapter 2, Subhead 2.5.**
3	Impact of transpiration covering the entire sequence of supply, rejects, coal fines and ash on air quality showing in flow chart with the specific points of fugitive emissions generation.	193 nos. of trucks for raw coal and 68 nos. bulkers per day will be added into traffic due to fly ash handling. Impacts of transportation on environment are given in **Chapter 4, Sub head 4.3.4.** Traffic flow diagram is enclosed as **Plate 2.** Water sprinkling and adequate parking facility will be provided to control the fugitive emission.
4	Impacts of the project on local infrastructure of the area, such as road network. Examine whether existing roads are adequate to take care of additional load of coal/middling rejects/coal fines transportation? Whether any additional infrastructure would need to be constructed and the agency responsible for the same with time frame?	Adequate road is available for transportation of Raw coal and fly ash. Proper maintenance of local road will be done by SEML.
5	Prediction of impact of project on different environmental components inter-alia (1) air including noise, (2) water (surface and ground water), (3) Soil, (4) flora and fauna and (5) socio- economic. Also take into account the emission from the vehicle transportation and loading & unloading activities etc.	Prediction of impact on different environmental components are presented in **Chapter 4.** Air Environment: Maximum Incremental concentration of SPM, SO_2 & NOx will be 0.73, 21.4 & 12.0 $\mu g/m^3$ due to stack emissions. Noise Environment: The predicted incremental noise levels at the boundary of the plant are in the range 34 to 41 dB (A). Soil Environment: The ash pond will be developed as per the guidelines of MoEF with HDPL lining. Hence, insignificant adverse impact. Flora and Fauna: The impact on terrestrial ecology may be felt due to emission of gaseous pollutants like SO_2 TSPM and NOx, if mitigation measures are not taken as recommended in this report. Socio Economic Environment: The requirement of 700 skilled / unskilled persons will be met from nearby villages for construction and regular employment during the operational phase. Transportation: The traffic will include 68 bulkers and 193 nos. trucks. Hence, only heavy

		traffic is considered in assessing the impact of traffic. The maximum concentration occurs at 20 m from the edge of the road, and the concentration is about 2.3 µg/m^3 for NOx, which are well within the permissible limit
6	The details of inputs data and model used for air quality modelling. The air quality contours may be plotted on location map showing the location of project site, habitation nearby, sensitive receptors, if any, the wind roses should be shown on this map.	**All the details** of AAQ monitoring as well as the air quality modelling along with the relevant maps and figures **are given in Chapter 4, sub head 4.3.3** (Impact on Air Quality) of the EIA report. Air Quality – ISCST-3 Transportation – CL-4 Noise - Dhwani
Mitigation Measures		
1	Use of rejects, middling and coal fines from washery as fuel should be optimized in fuel mix, so as to use entire rejects, middling and coal fines from captive coal washery proposed at Karwahi mine.	100% Karwahi coal washery rejects will be utilized in power plant . The details are given in **Chapter 2, Sub head 2.3.3**
2	Details of pollution control measures with respect to effluent treatment, air pollutants emission control, noise control and scientific & safe disposal of all solid wastes and ash.	Details of pollution control measures are summarized in **Chapter 4.** v Water Pollution: **Sub head 4.3.6** v Air Pollution: **Sub head 4.3.5** v Noise Pollution: **Sub head 4.3.8** v Solid Waste: **Sub head 4.3.7**
3	Specific pollution control and mitigative measures for the entire process, specific pollution control/mitigative measure proposed to be put in place at every transfer and handling points.	Details of pollution control measures are summarized in **Chapter 4.** Water Pollution: **Sub head 4.3.6** Air Pollution: **Sub head 4.3.5** Noise Pollution: **Sub head 4.3.8** Solid Waste: **Sub head 4.3.7**
4	Coal stock yard (raw coal, middling coal, coal rejects and coal fines) be housed in closed sheds in pucca platform above ground level and ash in silo provided with wind shields/wind breaking walls, storage size and capacity of coal stock be decided in consultation with DGMS and Chhattisgarh Environment Conservation Board.	Coal stock yard (raw coal, middling coal, coal rejects and coal fines), and silo will be designed in consultation with DGMS and Chhattisgarh Environment Conservation Board
5	Measures for occupational health and safety of the of the personnel and manpower for the project.	Details are presented in **Chapter 6, Sub head 6.6.**
6	Compliance to standards, noise level standards) prescribed for power plant by Ministry of Environment and Forests, Government of India/Central	Compliance to standards, noise level standards) prescribed for power plant by Ministry of Environment and Forests, Government of India/Central pollution Control Board/Chhattisgarh Environmental

	pollution Control Board/Chhattisgarh Environmental Conservation Board (which ever stringent)	Conservation Board has be followed for preparation of EIA/EMP.
7	Ensure the particulate matter emission limited to 50 mg/Nm^3	Stacks particulate matter emissions will be controlled (below 50mg/Nm^3). Refer **Chapter 4, Subhead 4.3.5.**
8	Scheme for rain water harvesting	Details are presented in **Chapter 8, Sub head 8.2.4.1**
9	Details along with action plan for development of greenbelt in 33% land area with not less than 1500 tress per ha giving details of species, width of plantation, planting schedule etc.	33% area of total plant area will be developed as Greenbelt/Greencover. Detailed greenbelt /greencover plan is given in **Chapter 8, Sub head 8.2.5.1**
10	Details regarding sale/disposal of solid wastes/ash from the unit to miscellaneous purchasers (if any)	Fly ash will be utilized in cement plant and brick manufacturing units and filling of captive mine.
11	Action plan for use as per provisions of notification on use of fly ash.	Action plan for fly ash utilization is given in **Chapter 4, Subhead 4.3.7**
Environmental Management Plan		
1	The EIA-EMP report covering the impacts and management plan for the project specific activities on the environment of the region, and the environmental quality-air, water, noise, land biotic community through collection of data and information, generation of data on impacts for a rated capacity.	Detailed EMP is presented in **Chapter 8** of **EIA report.**
2	Detailed EMP to mitigate the adverse impacts due to project along with item wise cost of its implementation (capital and recurring)	Detailed EMP to mitigate the adverse impacts due to project along with item wise cost of its implementation (capital and recurring) is presented in **Chapter 8, Subhead 8.4.**
3	Disaster Management Plan and mitigative measures for disaster prevention and control.	Details are presented in **Chapter 6, Subhead 6.4.**
4	Risk assessment to be undertaken, based on the same, propose safe guard measures.	Details are presented in **Chapter 6, Sub head 6.1.**
5	Details along with action plan and year wise funds to be allocated for eco development/community welfare works including maintenance of roads in nearby villages/areas.	Budgetary provision for CSR activities is presented in **Chapter 8, Subhead 8.5.**
Additional Study		
1	Public hearing details covering the notices in the newspaper,	Public hearing to be completed as per guidelines.

	proceedings/minutes of public hearing, the points raised by the general public and commitments made, in a tabular form. If the public hearing is in the regional language, provide an authenticated English transition of the same.	
2	Status of litigations/court cases filed/pending against the project (all cased including environment) and/or any direction/order passed by any hon'ble court of law against the project, if so, details thereof.	No litigation is pending against the project.
General Points		
1	All documents should be properly indexed, page numbered.	All the documents have been properly referenced with index, page numbers and continuous page numbering.
2	Period/date of data collection should be clearly indicated.	Period and source has been accounted during the baseline data collection**.**
3	Authenticated English translation of all material provided in regional languages.	All the documents are prepared in English
4	After the preparation of the draft (as per the generic structure prescribed in Appendix – III of the EIA Notification, 2006) covering the above mentioned TOR issues, the project proponent shall get Public hearing conducted and take further necessary action for obtaining environmental clearance in accordance with the procedure prescribed under the EIA Notification, 2006.	In compliance of all points of TOR, draft EIA report has been prepared for submission to Chhattisgarh Environmental Conservation Board for necessary action.
5	The copy of the letter received from SEAC, Chhattisgarh on the TOR prescribed for the project should be attached as an annexure to the final EIA-EMP report. The compliance statement of TOR prescribed should also be incorporated.	Copy of TOR Letter and compliance are enclosed as **Annexure I**
In additional to the above, information on the following may also be incorporated in the EIA report		
1	Is the project intended to have CDM-intent? i) If not, then why? ii) If yes, then	Not Applicable
a	Has PIN (Project Idea Note) {or PCN (Project Concept Note)} submitted to the NCA (National CDM Authority) been prepared	NA

b	It not, then by when is that expected?	NA
c	Has PDD (Project Design Document) been prepared?	NA
d	What is the "carbon Intensity" from your electricity generation projected (i.e. CO_2 Tons/MWH or Kg/KWH)	NA
e	Amount of CO_2 in Tons/year expected to be reduced from the baseline data available on the CEA's Web-site (www.cea.nic.in)	NA

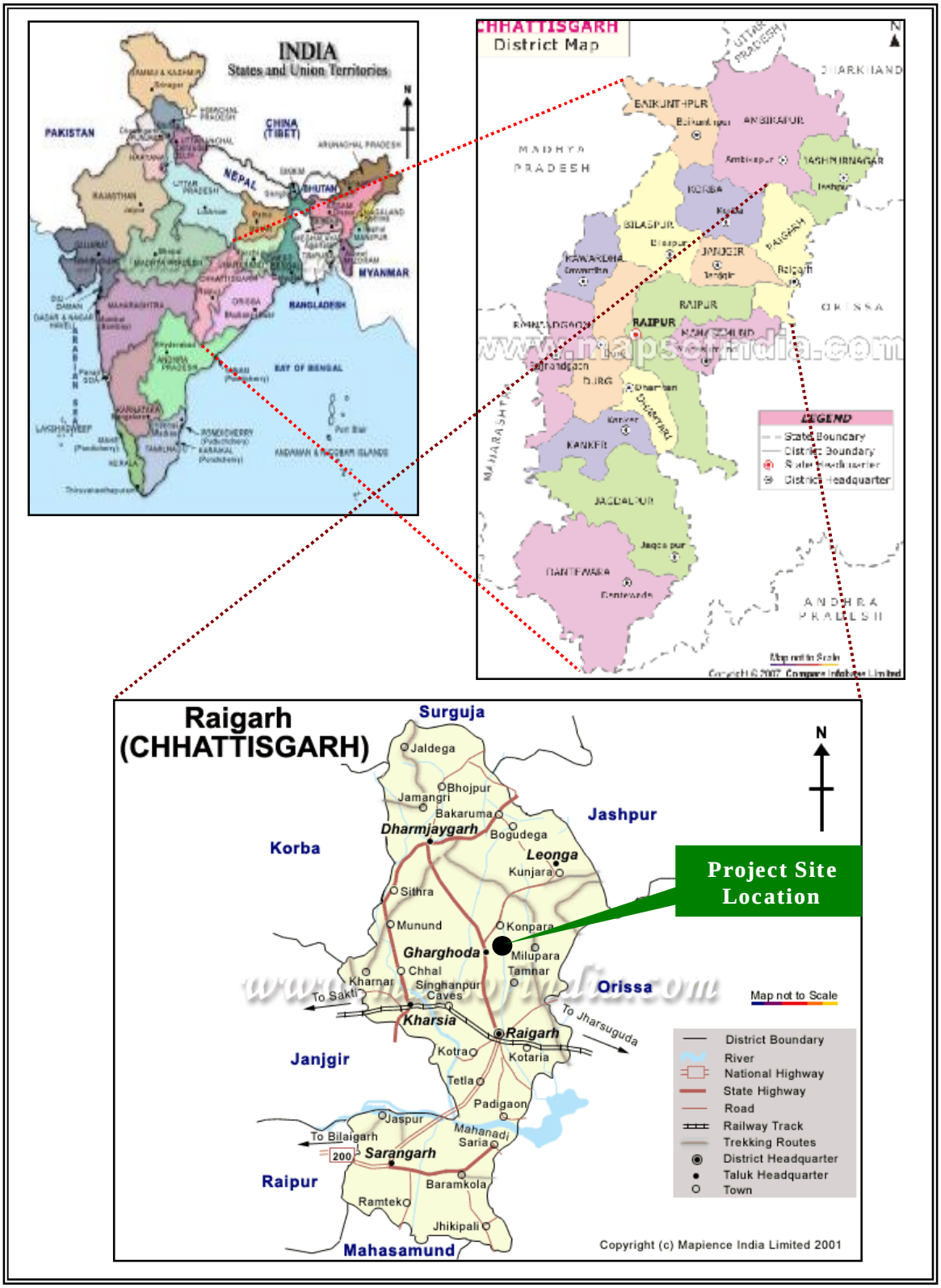


Figure 1.1
Index Map

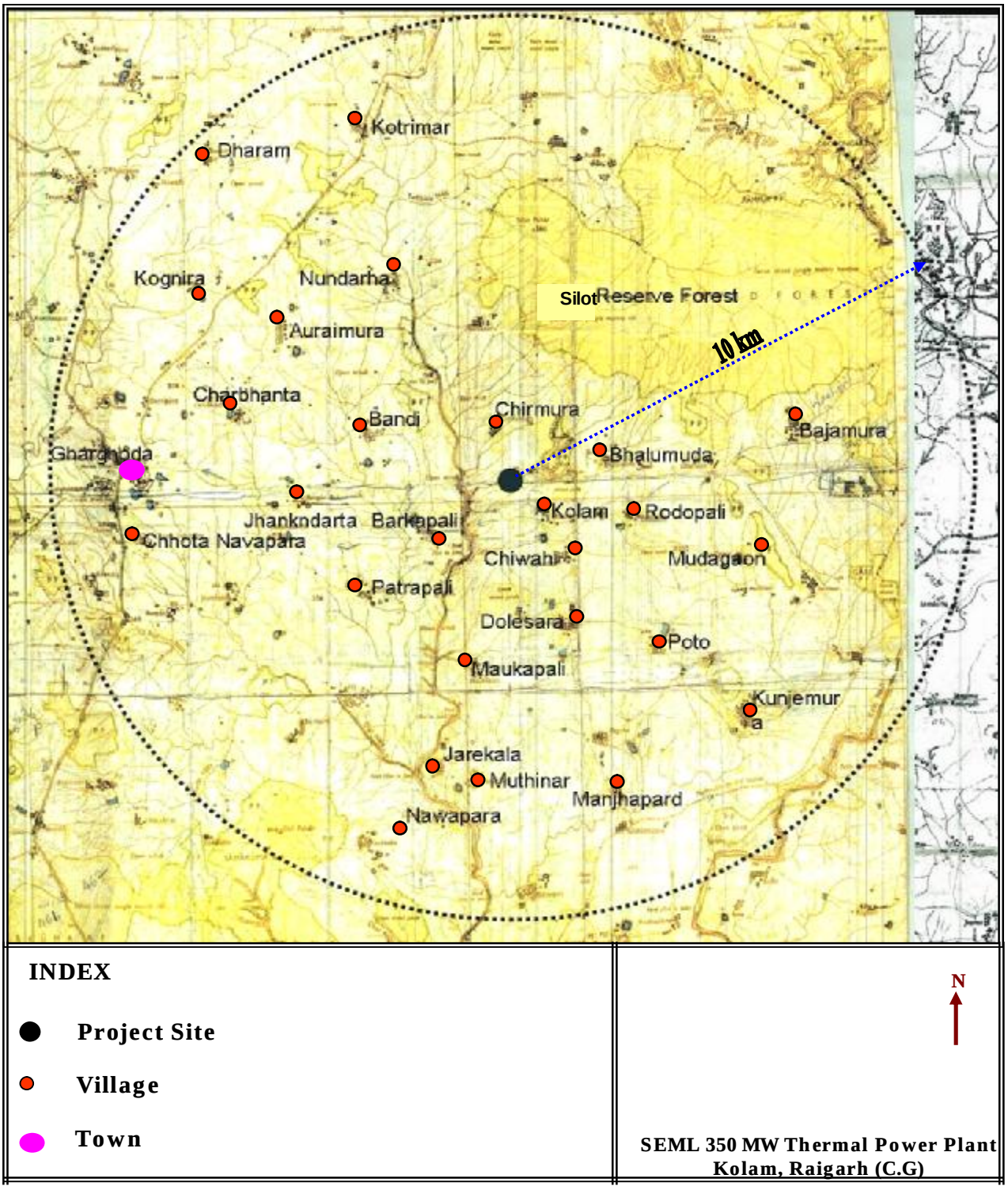


Figure 1.2

Study Area Map (10 Km Radius)

1.5 Environmental Monitoring Schedule

Field studies were conducted for a period of three months representing winter season (December 08 to February 09) to determine existing levels of various environmental attributes as outlined in **Table 1.2**.

Table 1.2
Environmental Attributes and Frequency of Monitoring

Sr. No.	Attributes	Parameters	Frequency
1	Ambient Air Quality	SPM, RPM, SO_2, and NO_x	24 hourly samples twice a week for three months at 9 locations. CO monitored as 8 hourly samples.
2	Meteorology	Surface Wind speed and direction, Temperature, Relative humidity and Rainfall	Surface Near Project site continuously for three months with hourly recording of data. Data also collected from secondary sources (IMD station at Raigarh). Upper air data trends were compiled from R. N. Gupta publication "Spatial Distribution of Mixing Depths over Indian Region" (CPCB Publication).
3	Water quality	Physical, Chemical and Bacteriological Parameters at 6 ground water and 2 surface water locations.	Grab samples were collected once during study period.
4	Ecology	Existing terrestrial and aquatic flora and fauna in 10-Km radius area.	Through field studies hourly once during EIA.
5	Noise levels	Noise levels in dB(A) at 8 locations.	At every location data monitored once during EIA study.
6	Land use	Trend of land use pattern for different categories	Based on data collected from secondary sources like Primary Census Abstracts of Census of India 2001
7	Geology	Geological history	Hydro-geological data based on data collected from secondary sources
8	Hydrology	Drainage area and pattern, nature of streams, aquifer	Based on data collected from secondary sources

Sr. No.	Attributes	Parameters	Frequency
		characteristics, recharge and discharge areas	
9	Socio-Economic aspects	Socio-economic characteristics: i.e. demographic structures, population dynamics, infrastructures resources, health status, economic resources.	Based on data collected from secondary sources like Primary Census Abstracts of Census of India 2001
10	Risk assessment and Disaster Management Plan	Identify areas where disaster can occur by fires and explosions and release of toxic substances	Risk assessment and modeling

Chapter 2

Project Description

2.1 Layout of the Plant

The site is more or less flat with minor undulations and is suitable for construction of foundation, buildings and heavy structures. The proposed plant will be developed in phase wise manner and layout is shown in **Figure-2.1.**

Layout of the power plant has been optimized considering the space requirements for steam turbine, boiler, coal handling system, coal yard, ash handling system, workshop, cooling water system, DG sets, switchyards, etc for the proposed 350 MW power plant.

All facilities in the plant area will be laid so as to minimize land requirement. The layout will also facilitate movement of workers and material handling between the various facilities, both during construction and operational phase.

2.2 Project Size

The details of proposed power plant are presented in **Table-2.1.**

Table-2.1
Technical Details of Proposed Power Plant

Sr. No.	Features	
1	Capacity	350 (2 x135, + 1x30, + 1x50) MW
2	Type of Boiler	CFBC & AFBC
3	Temperature	545 ^{0}C
4	Atmospheric Pollution Control System	Electrostatic Precipitators
5	Fuel	Coal and Middling
6	Source	Coal : Captive coal mines and coal linkage/E-auction. Middling: Captive coal washery
7	Steam Turbine Generator	Three Cylinder, Axial Flow

Source: Detailed Project Report

2.3 Basic Requirements for Proposed Project

2.3.1 Land Requirement

The present project requires 81.0-ha of land. The break-up of the land use for the project is given in **Table 2.2.** The layout plan of the proposed power plant is presented in **Figure-2.1**.

Table-2.2
Breakup of Land Use

Sr. No.	Description	Area (ha)
1	Power House Building	15.0
2	Ash Dyke	22.0
3	Coal Storage Yards and truck Tripling System Yard	5.5
4	Raw Water Reservoir (10 days Storage)	6.5
5	Office, Parking, Canteen and Service Building	1.0
6	Internal Roads	4.0
7	Greenbelt	27.0
Total		**81.0**

Source: Detailed Project Report

2.3.2 Water Requirement

The total maximum water requirement for the plant is about 1240 m^3/hr which will be drawn from Kelo River which will be stored in water reservoir. The detailed water requirement and wastewater generation of the proposed power plant is given in **Table-2.3** and also shown in **Figure-2.2.** Application for water is enclosed as **Annexure III.**

Table: 2.3
Water Balance

Sr. No.	Units	Water Quantity (Cum/hr)		
		Water Requirement	System Loss	Wastewater
1	Cooling Tower	1072	872	200
2	DM Water A) For steam generation B) For Potable	83	81	2
3	Service Water	25	22	3
Total		**1180**	**975**	**205**

- Withdrawal of river water will be 1240 m^3/hr, after considering loss due to desludging, evaporation etc. (1180+60 = 1240 m^3/hr)

- Air cooled system will be explored to minimize the water requirement for single 135 MW unit during designing.
- Zero discharge norms will be adopted.

2.3.3 Fuel Requirement

2.3.3.1 Coal

Coal and Middling consumption of the 350 MW power plants will be about 21.55 lakhs TPA and 3.648 lakhs TPA when plant would operate at a Plant load factor (PLF) of 85 %. Fuel details and sources are reported in **Table 2.4.** Coal will be sourced from Captive coal mines and coal linkage/E-auction. The expected range of coal and middling quality is reported in **Table-2.5.**

Table-2.4
Fuel Details & Sources

Sr. No.	Fuel	Quantity (Lakhs TPA)	Source
1	Coal	2.4	Captive Coal Mine at Karwahi
2	Coal	19.15	E-auction and SECL Linkage
3	Middling	3.648	Captive Coal Washery at Karwahi

Table-2.5
Expected Range of Coal Quality

Sr. No.	Parameters	Coal	Middling
1	Sulphur (%)	0.3-0.4	0.3-0.4
2	Moisture (%)	8-12	10-16
3	Ash (%)	40-45	50-55
4	Gross Calorific Values (GCV) kCal/kg	3000-3600	1400-2200
5	Grade	F	G

2.3.3.2 Fuel Oil

LDO will be used as start-up and coal flame stabilization during low load operation of the steam generator while firing coal. The LDO requirement will be about 4500 L per annum.

2.3.4 Manpower

It is estimated that the total requirement of manpower for the whole organization will be approximate 700. Department-wise /division-wise manpower is given below:

Designation	Total
Administration	20
Purchase	15
Finance	15
Operation – Engineers & Staff	440
Maintenance- Engineers & Staff	110
Technical Staff	100
Total	**700**

2.3.5 Transport Facilities

Coal will be transported from the linked mine to project site by Closed Conveyor belt and remaining part of fuel will be transported by Road.

2.3.6 Health and Sanitation Facilities

To ensure optimum hygienic conditions in the plant area, proper drainage network will be provided to avoid water logging and outflow. Adequate health related measures and a well equipped safety and environment department will be established to ensure clean and healthy environment.

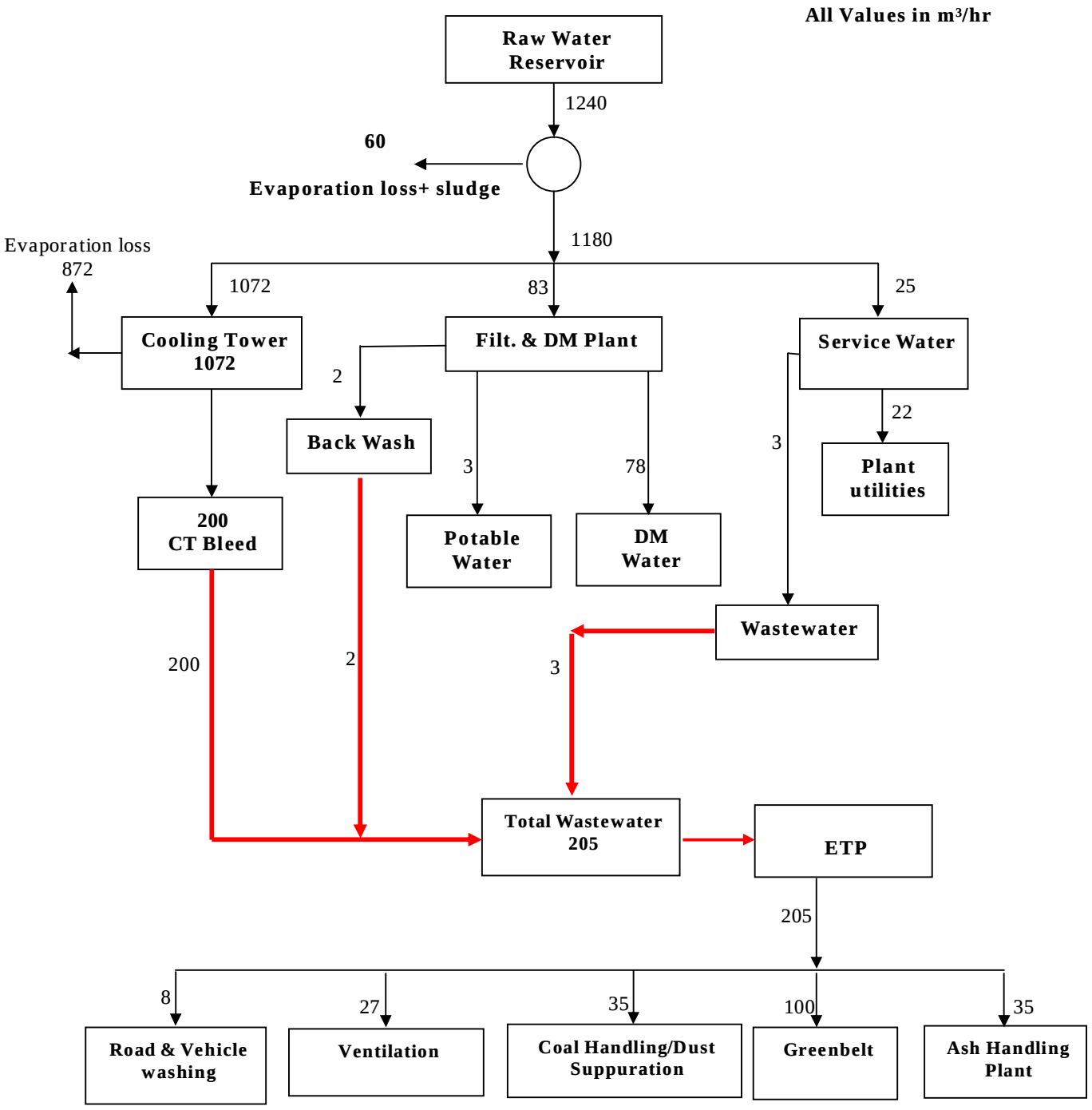


Figure 2.2
Water Balance Diagram

2.3.7 Utilities

In the proposed plant, various utilities will be provided for the smooth and efficient functioning of the plant. The proposed utilities are discussed in subsequent sections.

Cooling Tower

It is proposed to install 3 nos. cooling towers, one for each unit proposed 1x30 + 1x50 MW and one each for 1x135 MW capacity power plant. The cooling water will be collected in a RCC basin.

Water Treatment Plant

Raw water will be received in a raw water reservoir. The raw water reservoir will have an overall storage capacity of nearly 10 days raw water requirement. Raw water will be clarified to remove suspended solids and colloidal particles in clariflocculators. Clarified water would be supplied as make-up water in the cooling tower basin and filtration plant. Filtered water will be used for drinking, in air conditioning plant and DM plant feed.

Fire Protection System

An elaborate fire hydrant system covering all the buildings of the proposed power plant including coal stockyard would be provided. Part of the first stage treated output will be stored in a tank for further distribution to fire water storage tank and service water overhead tank.

In addition to the fire hydrant system, the following fire protection systems are proposed:

- Automatic High Velocity Water Spray (HVWS) system for the protection of generator, transformers, turbine, oil tanks, lube oil system equipments, unit auxiliary transformers
- Automatic Medium Velocity Water Spray (MVWS) system and foam system for fuel oil tanks;
- Automatic MVWS system for coal conveyors, cable galleries, etc.;

- Automatic sprinkler systems for certain select areas;
- Heavy duty portable or trolley mounted fire extinguishers for the protection of control rooms and portable fire extinguishers for different areas

Communication System

For effective communication in the plant, public address system, private automatic branch exchange system (EPABX), public address system with paging and party modes and P&T telephone system will be provided.

2.4 Schedule for Approval and Implementation

The project will be implemented in two phase:

Phase I - Year 2010 (1x30 + 1x50 MW)

Phase II - Year 2011 (2 x 135 MW)

2.5 Process Description & Equipment Details

2.5.1 Process

Chemical energy of coal is converted into thermal energy, then to mechanical energy and finally to electrical energy. Heat released from the coal is absorbed by water / steam tubes of the boiler to convert boiler feed water into steam at 520+/- 5 ^{0}C temp. & 88 bars pressure. Steam is expanded through turbine blades to rotate the turbine.

State-of-the- art technology has been considered for design of the proposed power plant. The process flow diagram is presented in **Figure-2.3**. The proposed thermal power plant consists of battery of two nos. of 135 MW, 30 MW & 50 MW steam turbines coupled with alternator. The total number of turbines to be installed will be four. The Steam will be made available from 5 Nos. AFBC/CFBC Boilers to the extent of about 1430 tones per hour.

Steam Turbine

Turbine Alternator Set	-	**Steam Turbine – 2 x 135 MW**
Make	-	It has been proposed to procure from Reputed manufacturers like M/s BHEL / ALSTOM / LMZ Etc. with the following specifications
Type	-	Three Cylinder, Axial Flow.
Steam Pressure	-	130.00 Kg/cm^2
Temperature	-	535 ^{o}C
Back Pressure	-	0.91 Kg/cm^2
RPM	-	3000
Alternator	-	02 Nos.
Type	-	Hydrogen Cooled
Rating	-	3 Phase, 50 Cycles at 0.8 P.F.
Voltage	-	14.5 + 0.5 KVolts
Speed	-	3000 RPM
Capacity	-	270 MW (2 x 135 MW)
TG Set Auxiliaries	-	Turbine Auxiliaries like condenser, feed re-generative system, CEPs, AOP, air ejectors, feed pumps, NGT, oil purifiers, oil coolers and associated piping and fittings will be procured from reputed manufacturers.
Turbine Alternator Set	-	**Steam Turbine – 1 x 30 MW**
Make	-	It has been proposed to procure from ALSTOM
Type	-	Single Cylinder, Axial Flow.

Steam Pressure	-	89 Kg/cm^2
Temperature	-	535 ^{o}C
Back Pressure	-	- 0.90 Kg/cm^2
RPM	-	3000
Alternator	-	01 Nos.
Type	-	Water Cooled
Rating	-	3 Phase, 50 Cycles at 0.8 P.F.
Voltage	-	11 $\pm$ 0.5 KV
Speed	-	3000 RPM
Capacity	-	30 MW
Turbine Alternator Set	-	**Steam Turbine – 1 x 50 MW**
Make	-	It has been proposed to procure from BHEL/SHANGHAI/NANZING /ALSTOM / LMZ / ANY Reputed make
Type	-	Single Cylinder, Axial Flow.
Steam Pressure	-	89 Kg/cm^2
Temperature	-	535 ^{o}C
Back Pressure	-	- 0.90 Kg/cm^2
RPM	-	3000
Alternator	-	01 Nos.
Type	-	Air Cooled
Rating	-	3 Phase, 50 Cycles at 0.8 P.F.

Voltage	-	13.5 ± 0.5 KV
Speed	-	3000 RPM
Capacity	-	50 MW
TG Set Auxiliaries	-	Turbine Auxiliaries like Condenser, feed re-generative system , CEPs, AOP, air ejectors, feed pumps, NGT, oil purifiers, oil Coolers and associated piping and fittings will be procured from reputed manufacturers.

Steam Generator

Coal Based

Boiler	-	**CFBC Boiler**
Make	-	Reputed make like CVPL / THERMAX/WAXI/HARBIN/SHANGHAI etc.
Capacity (Max)	-	550 TPH x 2 Nos.
Working Pressure (S/H Outlet)	-	135 Kg/cm^2
Temperature	-	545 ^{o}C
Type	-	Water Tube, Coal Fired Boiler
Auxiliary associated with Boiler	-	ID Fans, FD Fans, PA Fans, Electrical Feed Pumps, Air/Flue Gas Ducting, Ash Hoppers, Dense Phase Ash Handling System & associated piping & ducting.
Boiler	-	**AFBC / CFBC Boiler**
Make	-	Reputed make like CVPL / THERMAX/B&W.
Capacity (Max)	-	110 TPH x 3 Nos.
Working Pressure (S/H Outlet)	-	92 Kg/cm^2

Temperature	-	530 ± 10°C
Type	-	Water Tube, Coal Fired Boiler
Auxiliary associated with Boiler	-	ID Fans, FD Fans, PA Fans, Electrical Feed Pumps, Air/Flue Gas ducting, Ash Hoppers, Dense Phase Ash Handling System & associated piping & ducting.

The other utilities of plant consist of Coal Handling System, Cooling Tower, DM water plant, softener plant, ash-handling system etc. Each boiler will be connected with an ESP of 99.5% efficiency. The de-dusting system will be installed at various junction points to control the emission.

Electrostatic Precipitor

Make	-	Any reputed make like HAMON/THERMAX / RICCO

Specifications:

Gas Temperature (Optg/max.)	-	140 Deg. C
Gas Pressure	-	(-) 250 (mm WG) max.
Moisture content	-	10 % to 12 %
ESP Inlet Dust conc.	-	60 gm/Nm^3
ESP Outlet Dust emission	-	< 50 mg/Nm^3

Coal Handling System

The coal required for Power Plant is of size 0 - 6 mm for 1 x 30 MW & 1 x 50 MW and 0-10 mm for 2 x 135 MW power plant, whereas the coal received from the Mine & middling received from Washery is of size 10 mm or (-) 300 mm. Thus the coal received is required to be crushed and screened.

The coal received will be fed into ground hopper. This will be crushed and screened. 0 - 6 mm coal from the screen will be fed into travelling tripping trolley installed

on the coal bunkers and the oversized coal will be again fed for re-crushing to crusher. Travelling Tripper trolley installed above the Coal Bunker will facilitate uniform distribution of the coal into the bunkers. The Coal handling system consists of the following major equipments:

a] Ground Hopper
b] Impact Crusher
c] Vibrating Screen
d] Conveyor Belt
e] Travelling Tripper Trolley

Coal Yard

The coal required for the thermal power plant will be stored in a open yard. Floor of the yard will be concrete and there will be partition walls for proper stacking of the coal and it is proposed to construct shed for storing the coal for rainy season requirement.

Ash Handling System

For handling of fly ash of the steam generator, dense phase, pneumatic conveying system is provided. The ash collected in the hoppers located in economizer, air pre-heated sections of SG and ESP hoppers will be pneumatically conveyed and collected in a silo from where the ash will be disposed off by road trucks for brick manufacturing and selling to cement plants.

Compressed Air System

The compressed air is required for operation of control valves pneumatic cylinders, conveying of Ash through ash handling system.

Workshop

A mechanical workshop to meet maintenance services of the plant. A lathe, shaping machine, vertical drill, bending machine, punch press, shearing machine, welding transformer/rectifier, power hack-saw machine, hand grinders etc. are planned.

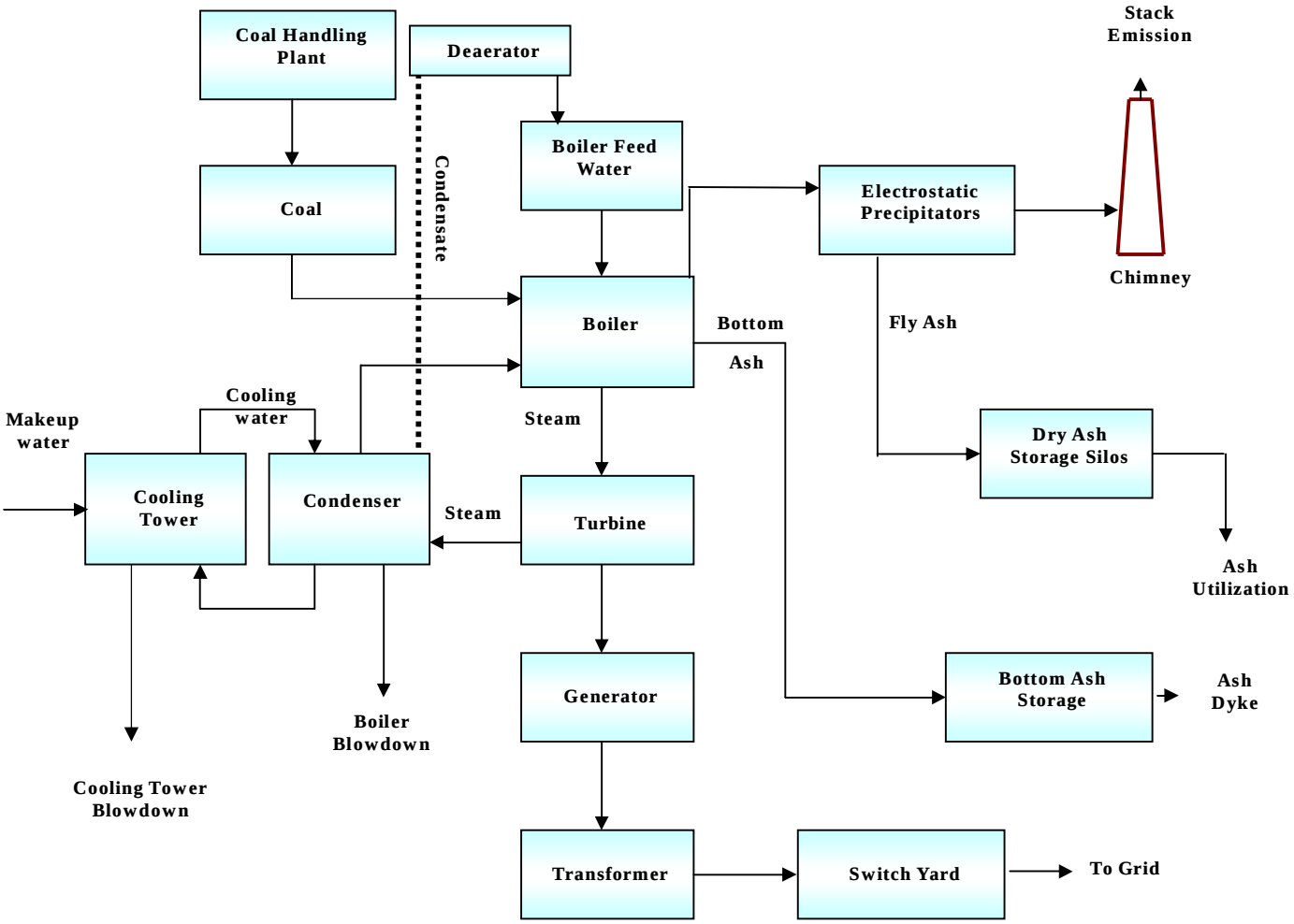


Figure : 2.3
Process Flow Diagram

2.6 Sources of Pollution

The various types of pollution from the proposed power plant are categorized under the following types:

- Air pollution
- Water pollution
- Solid waste
- Noise pollution

2.6.1 Air Pollution Load from Power Plant

The major pollutants emitting from the power plant stack will be SO_2, NOx and particulate matter. Plant equipment design and operation will ensure that SO_2 emissions are limited below the State PCB norms. Proper pollution control equipments will be installed to minimize the stack emissions within the stipulated/permissible limits prescribed by National Ambient Air Quality Standards.

The mitigation measures proposed in the plant are:

- Installation of ESPs of 99.5% efficiency to limit the SPM concentrations below 50 mg/Nm^3;
- Provision of two nos of stack with 110m, and 180m heights for wider dispersion of gaseous emissions;
- Provision of low NOx burners in the boilers;
- Dust extraction system at transfer points of conveyor system;
- Enclosure around Conveyor belt to prevent dust generation;
- Provision of water sprinkling system at material handling and storage yard;
- Asphalting of the roads within the plant area; and
- Developing of Greenbelt around the plant to arrest the fugitive emissions.

2.6.2 Wastewater

The wastewater sources from the proposed project will be from cooling tower, DM plant, Filter back wash water and sanitary waste.

Wastewater to be generated from the power plant will be treated in Effluent Treatment Plants to neutralise and remove oil & grease to limits prescribed by CPCB. Part of treated wastewater will be reused for greenbelt, dust suppression and other plant utilities. No waste water will be discharge out side the plant premises.

2.6.3 Solid Waste

Ash is the main solid waste generated in the coal based thermal power plant. The quantity of fly ash and bottom ash generated will be 2715 TPD and 679 TPD respectively.

Bottom ash will be disposed off by using slurry disposal system. Unutilized fly ash will also be disposed off in designated ash disposal area. Fly ash will be utilized in cement manufacturing and bricks.

2.6.4 Noise Pollution

Provision of acoustic enclosures is proposed to reduce the noise levels emanating from noise generating equipments and personal protection equipment will be provided to the workers. The wide greenbelt around the plant will attenuate the noise level dissemination out side the plant boundary.

Chapter 3

Description of the Environment

The baseline environmental quality data for various components of environment, viz. Air, Noise, Water, Land and Socio-economic were generated during December 2008 to February 2009 in the study area covering 10 km radius of the proposed power plant site. Other environmental data on flora and fauna, land-use pattern, forest etc were also generated through field surveys and also collected from State Govt. Departments and or secondary sources.

3.1 Environmental Monitoring Schedule for Baseline Data Collection

The methodology adopted is outlined below:

- Ø Conducting reconnaissance surveys for knowing the study area; and
- Ø Selecting sampling locations for conducting various environment baseline studies.
- Ø The sampling locations have been selected on the basis of the following:
- Ø Predominant wind directions recorded by the Indian Meteorological Department (IMD) Raigarh observatory
- Ø Existing topography
- Ø Drainage pattern and location of existing surface water bodies like lakes/ponds, rivers and streams
- Ø Location of villages/towns/sensitive areas
- Ø Sensitive receptors
- Ø Areas, which represent baseline conditions.
- Ø The field observations have been used to:
- Ø Assess the positive and negative impacts due to the proposed project.
- Ø Suggest appropriate mitigation measures for negating the adverse environmental impacts, if any
- Ø Suggesting post-project monitoring programme.
- Ø Field studies were conducted for a period of three months representing Winter season to determine baseline conditions of various environmental parameters.

All sampling and analysis methods for environmental parameters are enclosed as **Annexure VI.**

3.2 Land Environment

3.2.1 Landuse

The objectives of Landuse studies are:

- To determine the present Landuse pattern;
- To analyze the impacts on Landuse due to the proposed plant in the study area; and
- To give recommendations for optimizing the future Landuse pattern and associated impacts.

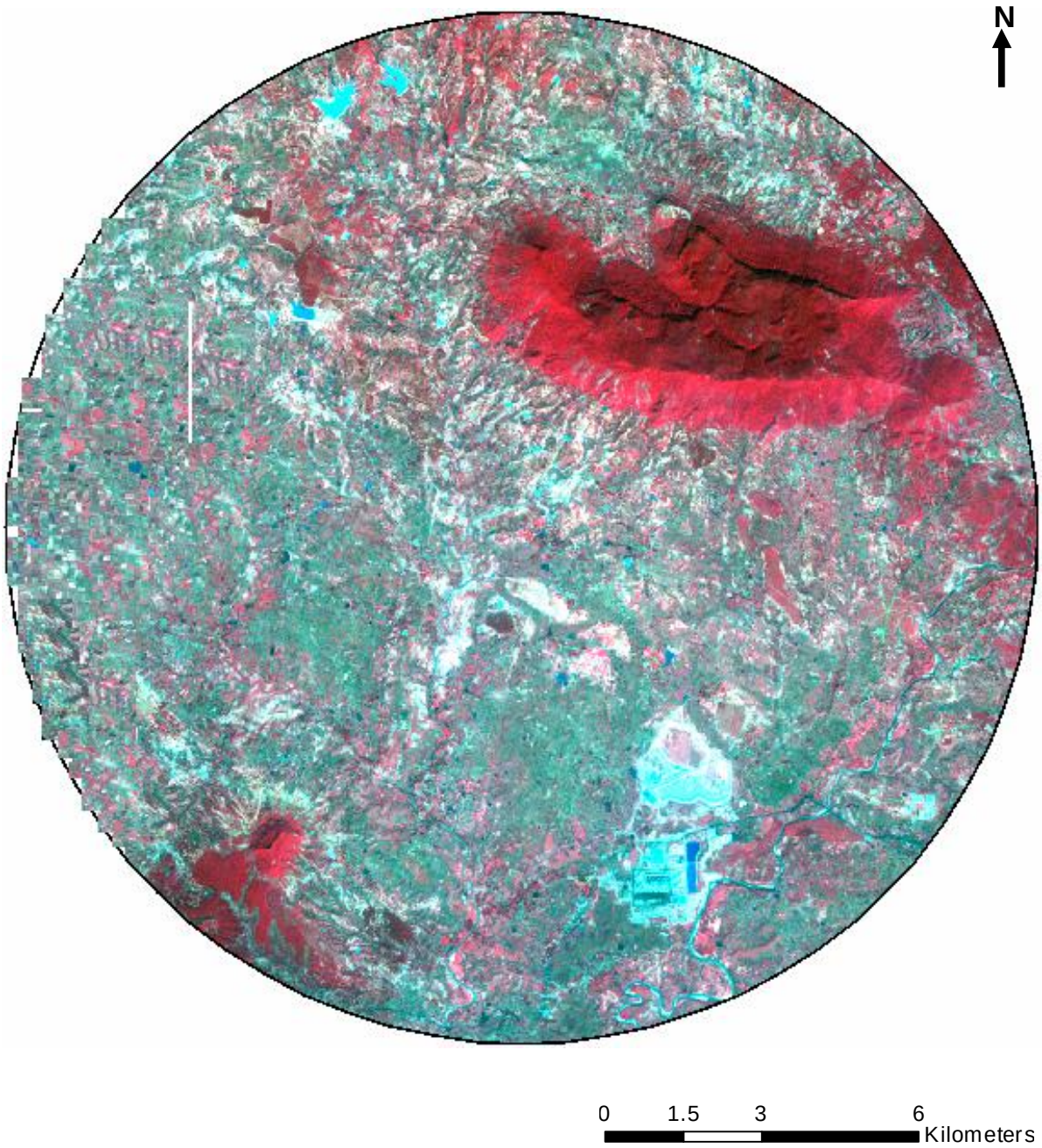
Data Used: In case of the present studies, following data were used -

(A) Precision Geocoded product of Indian Remote Sensing Satellite IRS – P 6, Sensor – LISS III, Acquired on 09/11/2007 (**Refer Figure 3.2.1)**,

(B) Survey of India Toposheets bearing nos. 64 N/8 and 12.

The following methodology was adopted in order to study the land use:

- Acquisition of satellite data.
- Preparation of base map from Survey of India toposheets.
- Data analysis using visual interpretation techniques.
- Ground truth studies or field checks.
- Finalization of the map.
- Digitization using heads up vectorisation method.
- Area calculation for statistics generation.



1. IRS P6, LISS

Figure 3.2.1
Satellite Imagery of Study Area Covering 10 km Radius around the Site

The satellite data was interpreted visually by using various interpretation keys like tone, colour, texture, structure and association to categorize different Landuse classes to their respective units. The different interpretation keys were cross-verified during ground studies to refine the mapping.

Landuse/ Land cover Details: The land use / land cover map of the study area (10 km radius) is given as **Figure 3.2.2**.

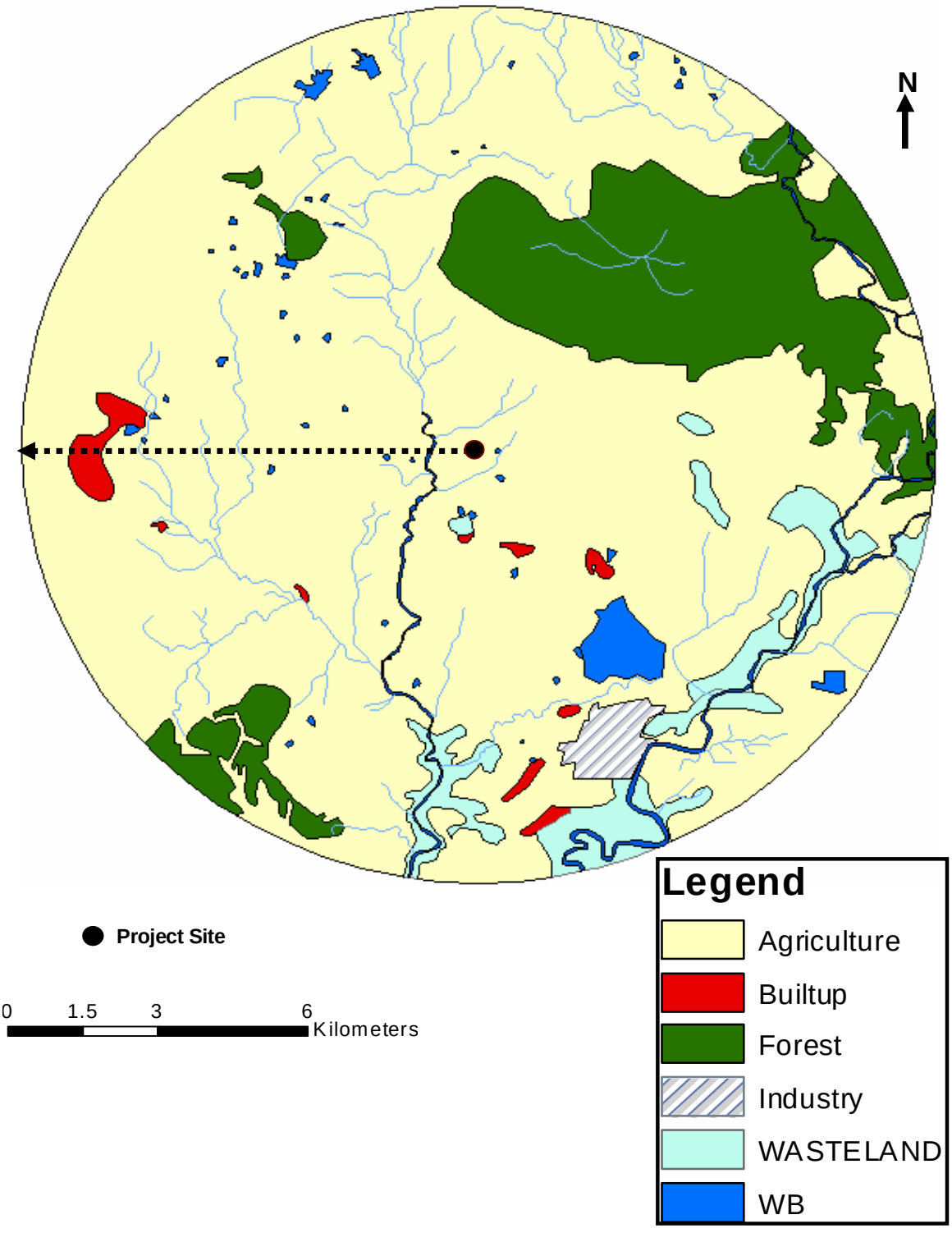


Figure 3.2.2
Landuse Map of 10 km Radius around the Proposed Power Plant

The following prominent landuse classes have been observed in the study area:

Agriculture: The principal feature observed within the entire study area (314 km^2) is the agricultural activity. It is spreads almost over 78% (244 km^2) of the land area. The agriculture in this area is rain fed as well as irrigated also. The farmers are harvesting the second crop by irrigating their lands with river water as well as groundwater drawn from the bore wells.

Forest: The forest forms a second largest landuse. It occupies nearly 14% (44.39 km^2) of the geographical area.

Wasteland: The next prominent land use is that of the wasteland, which covers about 4% (13.23 km^2) of the study area.

The other classes of less significance are that of waterbodies represented by the surface water tanks, river and nallas in the study area, covering almost 2% of the area, along with built up (0.94%) and industrial area (0.86%) respectively.

The landuse land cover details are described in **Table 3.2.1** below and also depicted as **Figure 3.2.3** Pie Diagram for the study area.

Table 3.2.1

Landuse / Land Cover Details of Study Area

Landuse	**Study Area (km^2)**	**PGA**
Agriculture	244.42	77.80%
Wasteland	13.23	4.21%
Industry	2.68	0.86%
Waterbodies	6.36	2.04%
Forest	44.39	14.15%
Built up	2.92	0.94%
Total	**314.00**	**100.00%**

(*** PGA – Percentage Geographical Area)

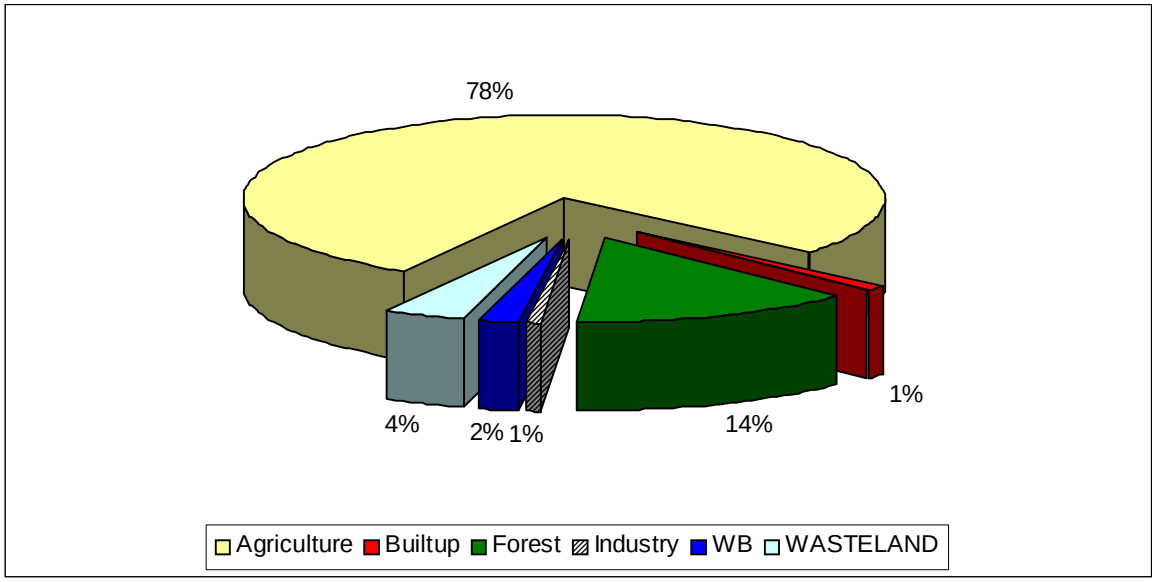


Figure 3.2.3 : Pie Diagram Showing Distribution of Landuse/land cover in Study Area

3.2.2 Geology and Hydrogeology

On the regional scale, Raigarh area falls in the eastern part of Chhattisgarh basin. The intra-cratonic Chattisgarh basin is located within the Central Indian Shield comprising of variety of rock types. The archean gneisses and schists are in juxtaposition with the Chhattisgarh sediments. The basement has been subjected to weathering and erosional processes for million of years. The sediments are therefore widespread. The meta- sediments with associated granites, gneisses etc. have contributed the formation of sediments. The principal rocks of the Chhattisgarh basin are granite, schist, quartzite, limestone, shale, sandstone, etc. with associated coal seams and laterite.

3.2.3 Hydrogeology

The study area occupies a gently sloping slightly undulating plain land. This area receives about 1500 mm rainfall annually. The rainfall is stored in the surface water tanks, which play a vital role in the groundwater recharge. The groundwater occurs both under phreatic i.e. water table aquifers tapped with the help of open dug wells as well as semi confined to confined aquifers tapped by means of bore wells. The dug wells are found to

range in depth from 8 to 12 m bgl. The pre monsoon static water level in this region is observed to be 8 to 10 m bgl. Few shallow dug wells are reported to go dry due to lowering of water table in summer.

The surrounding area shows predominance of borewells, which are used for irrigation as well as daily usage. These structures are installed with hand pumps as well as machines. They range in depth from 60 to 120 m bgl and deliver water @ 1 lps to 3 lps (lps – Liter per second). The borewells are found to be widely accepted water bearing structures than the dug wells. This area has been rated as "safe" by CGWB for utilization of groundwater.

3.2.4 Soil Characteristics

The soil quality assessment has been carried out. Nine locations were identified for collection of soil samples from the study area. The sampling locations are shown in **Figure-3.2.2** and their distances and bearings from project site are listed in **Table 3.2.2.**

Physical Characteristics of soil

Physical characteristics of soil are delineated through specific parameters viz. particle size distribution, bulk density, porosity, water holding capacity and texture are presented in **Table 3.2.3**

The bulk density of the soil in the study area ranged between 1.31 to 1.49 g/cc which indicates favorable physical condition for plant growth.

Soil porosity is a measure of air filled pore spaces giving information about movement of gases, inherent moisture, development of root systems and strength of soil. The porosity and water holding capacity of the soils are in the range of 33.65 % to 39.54 % and 34.21 % to 37.64% respectively. The soil in the impact zone has sandy loam structure with moderate water holding capacity.

Table 3.2.2
Locations for Collection of Soil Samples

Sr. No.	Sampling Locations	Direction	Aerial Distance (Km) with respect to plant
1.	Kolam	SE	1.4
2.	Chirmura	N	1.6
3.	Dolesara	S	3.5
4.	Rodopali	ESE	4.0
5.	Poto	SE	5.5
6.	Jhankndarta	WSW	5.5
7.	Auraimura	NW	6.5
8.	Nawapara	SSW	8.5
9.	Manjhapard	SSE	9.0

Table-3.2.3
Physical Properties of Soil

Sr. No.	Location	Bulk Density g/cc	Porosity %	Water Holding Capacity %	Particle Size Distribution		
					Sand %	Silt %	Clay %
1	Kolam	1.31	36.07	37.33	60.7	18.5	20.8
2	Chirmura	1.38	35.54	34.35	57.3	20.22	22.48
3	Dolesara	1.35	33.65	36.62	55.2	22.05	22.75
4	Rodopali	1.49	37.05	35.11	57.8	20.68	21.52
5	Poto	1.47	39.16	37.64	65.75	15.85	18.40
6	Jhankndarta	1.42	36.50	36.80	54.73	20.60	24.67
7	Auraimura	1.37	39.54	37.20	52.27	23.32	24.41
8	Nawapara	1.34	38.04	36.54	57.8	18.68	25.52
9	Manjhapard	1.43	34.70	34.21	56.46	19.01	24.53

Chemical Characteristics of soil

Data collected for chemical characteristics of soils through selected parameters viz. pH, EC, soluble cations and anions, organic content and fertility status are presented in **Table 3.2.4** and **Table 3.2.5.**

pH is an important parameter indicative of alkaline or acidic nature of soil. It greatly affects the microbial population as well as solubility of metal ions and regulates nutrient availability. Variation in the pH of the soil in the study area is found to be neutral (6.35 to 7.45), thus conducive for growth of plant.

Electrical conductivity, a measure of soluble salts in the soil is in the range of 0.164 mmhos/cm to 0.350 mmhos/cm. The important cations in the soil are calcium and magnesium whose concentrations range from 0.0025 to 0.0067 % and 0.0017 to 0.0038 % respectively. Chlorides are in the range of 0.0028 to 0.0071%.

Organic matter present in soil influences its physical and chemical properties and is responsible for stability of soil aggregates. Organic matter and nitrogen are found in the range of 1.52 – 2.32 % kg/ha and 270 – 486 kg/ha. This shows that soil is moderately good in organic and nutrient contents. The relationship of CEC with productivity and absorptivity are presented in **Table-3.2.6** and **Table-3.2.7**

Table 3.2.4
Chemical Characteristics of Soil in Study Area

Sr. No.	Location	pH	EC (mmhos)	Org. C	Cl	SO_4	Ca	Mg	CEC Meq./ 100gm
				%					
1	Kolam	6.36	0.250	1.52	0.0028	0.0020	0.0038	0.0020	24.48
2	Chirmura	6.81	0.187	1.27	0.0042	0.0037	0.0065	0.0033	23.56
3	Dolesara	7.42	0.164	1.43	0.0053	0.0044	0.0067	0.0031	24.52
4	Rodopali	6.73	0.321	1.34	0.0055	0.0043	0.0025	0.0038	23.45
5	Poto	6.70	0.350	1.54	0.0067	0.0027	0.0054	0.0018	23.09
6	Jhankndart	7.45	0.261	1.19	0.0071	0.0041	0.0037	0.0029	23.15
7	Auraimura	6.72	0.172	1.14	0.0062	0.0038	0.0038	0.0017	21.77
8	Nawapara	7.10	0.168	1.16	0.0050	0.0024	0.0044	0.0028	23.62
9	Manjhapard	6.35	0.175	1.22	0.0065	0.0035	0.0057	0.0032	23.47

Table 3.2.5
Fertility Status

Sr. No.	Location	Organic matter (%)	N (kg/ha)	P_2O_5 (kg/ha)	K_2O (kg/ha)
1.	Kolam	2.22	365	36	118
2.	Chirmura	2.17	345	42	132
3.	Dolesara	1.79	270	34	127
4.	Rodopali	2.05	312	30	124
5.	Poto	2.18	486	31	145
6.	Jhankndarta	2.06	387	37	137
7.	Auraimura	1.52	304	32	128
8.	Nawapara	2.32	356	42	145
9.	Manjhapard	2.28	389	38	138
-	Level in poor soil	0.5	< 280	< 23	< 133
-	Level in moderate soil	< 0.5 – 0.75	280-560	23-57	133 –337
-	Level in fertile soil	> 0.75	> 560	> 57	> 337

Table-3.2.6
Relationship of CEC with Productivity

S. No.	CEC Range (meq/100g)	Productivity	Location (Sr. No.)
1	< 10	Very Low	-
2	10 – 20	Low	-
3	20 – 50	Moderate	1 to 9
4	> 50	High	-

Table-3.2.7
Relationship of CEC with Absorptivity

S. No.	CEC Range (meq/100g)	Absorptivity	Location (Sr. No.)
1	<10	Low	-
2	10 – 20	Moderate	-
3	20 – 30	Moderately high	1 to 9
4	30 – 40	High	-

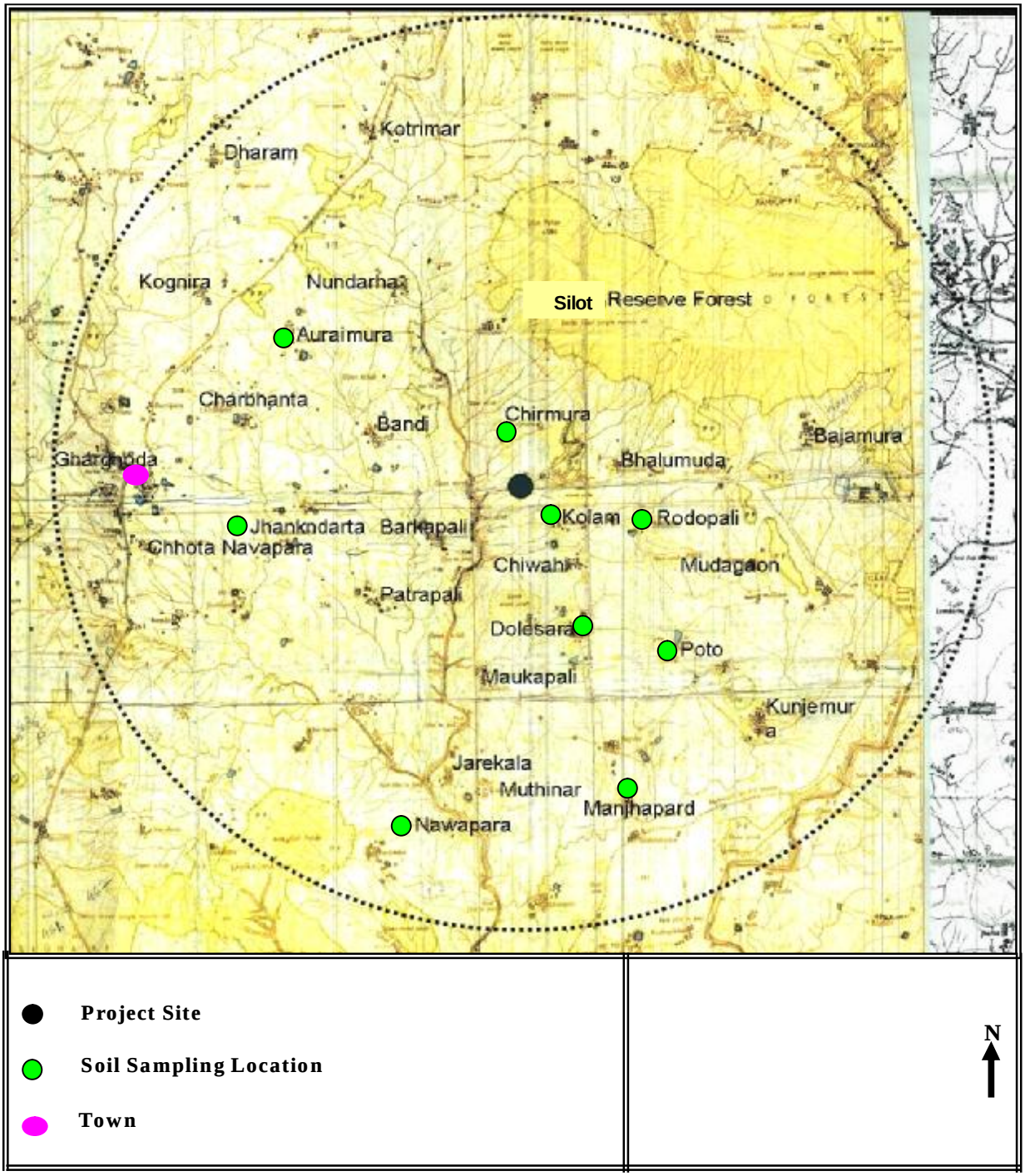


Figure 3.2.4
Soil Sampling Location

3.3 Ecological Studies

Introduction

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

Objectives of Ecological Studies

The present study was undertaken with the following objectives:

1 To assess the nature and distribution of vegetation in and around the project site

2 To assess the distribution of animal life spectra; and

3 To ascertain migratory routes of fauna and possibility of breeding grounds, if any.

Methodology Adopted for the survey

To achieve the above objectives, study of the area was undertaken in 10 km radius area with the proposed project site as its center. The different methods adopted were as follows:

- Compilation of secondary data with respect to the study area from published literature and Government agencies.
- 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 usages of local plants.

The present report gives the review of published secondary data and the results of field sampling conducted during winter season 2008-09.

Review of Secondary Published Data

From records of Botanical Survey of India

Floral Structure

The Chhattisgarh plains has long been cultivated and at present only small patches of degraded tropical dry deciduous forests have been left, if at all. It is rather more characterized by scattered stunted and crooked trees and shrubs of *Butea monosperma, Lagerstroemia parviflora, Albizia spp., Acacia leucophloea*, A. *nilotica spp. Indica* Mangifera *indica. Terminalia spp., Ficus racemosea*. F. *benghalensis. F.* Religiosa, *Azadirachta indica, Pithecellobium dulce, Syzygium cumini, Mitragyna parvifolia, Aegle marmelos, Diospyros melanoxylon, Bauhinia spp., Calotropis spp., Caesalpinia bonduc, Ipomea carnea* and *Mimosa himalayana* with several climbers like *Ziziphus oenoplia, Celastrus* patina, *Ipomea spp., Atylosua scarabaeoides* and *Cissampelos pareira*. Particular mention may be made of the *Mahua* trees, *Madhuca longifolia* var. *latifolia*, which are considered sacred and stay unlopped. In addition, *Albizia spp., Dalbergia sissoo, Ddelonix regia, Cassia* fistula, *Peltophorum pterocarpum, Pongamia pinnata*, Eucalyptus hybrids and *Pterocarpus marsupium* are frequently planted on the roadsides. The grounds flora, during rainy and post rainy season, consists of several annual or perennial species of grasses, sedges and other herbs and creepers, but by the middle of winter it is completely grazed and presents a bare desolate spectre. Mention may be made of two Epiphytic orchids, Vandal tessellate and V. testacea which grow freely on *Mangifera indica, Butea monosperma, Madhuca longifolia var latifolia, Diospyros melanoxylon* and *Terminalia spp*. The former with large brown banded flowers immediately catches the eye.

Tropical Moist Deciduous Forests

A good development of these forests with a fair amount of sal can be observed in the reserved forests. It has tall trees of *Shorea, robusta, terminalia spp. Pterocarpus marsupium, Dalbergia panigulata, Adina ccordifolia, Stereospermum chelonoides, Schleichera oleosa, Garuga pinnata, Lannea coromandelica, Bombax ceiba, Soymida febrifuga* and *boswellia serrata,* and smaller trees like *lagestroemia parviflora, briedelia squamosa, mallotus philippensis, diospyros melonxylon, Anogeissus latifolia, Buchanania lanzan, Gmelina arbored, Antidesma ghaesembill, Ficus spp., Grewia tiliifolia* and Cassia

fistula and Shrubs like *Breynia vitisidaea, Embelia tsjeriam –Cottam, Chloroxylon Swietenia, Holarrhena antidysenterica, Casearia graveolens, Helicteris isora, Semecarpus anacardium, Ochna obtusata, Indigofera cassioides, Woodfordia fruticosa* and species of *Leela* and *Desmodium*. The common in Chatisgarh bamboo, Dendrocalamum strictus, forms dense thickets. The conspicuous climbers and ramblers in these forests are *Millettia extensa*, smilax *zeylanica*, bauhinia *vahlii, olax scandens, combretum roxburghii, Ventilago denticulate, lchnocarpus frutescens, dioscorea pentaphylla*, D. *puber*, D. *opppsitifolia* and D. *bulbifera*.

The undergrowth in dense forests is often sparse, and not much varied. The common species are *Eranthemum* purpurascens, *Perilepta edgeworthiana, Nelsonia canescens, Phoenix acaulis, Chlorophytum tuberosum, globba racemosa*, G. *bulbifera, Curcuma spp., Zingiber spp., Tacca leontopetaloides, Carex speciosa*, and a few ground orchids like *Eulophia spp*. *Habenaria spp., Geodorum densiflorum*, and *Peristylus spp*. The edges of the forests have a very luxurious growth of numerous annual and perennial species of Cleome, *Desmodium, Alysicarpus, tephrosia, Crotalaria, Blumea, cynoglossum, Barleria, leucas, Phyllanthus, Euphorbia, Pupalia, Aerva, Commelina, Cyanotis* and sedges and grasses. The species diversity and undergrowth in forests with high proportion of Shorea robusta is comparatively poorer than in the mixed forests. Sal is generally absent on hill slopes.

Tropical Dry Deciduous Forests

These are found in comparatively drier areas, generally in and around the Chhattisgarh plains. Though not always conspicuously different from the moist deciduous forests, since transitionary stages are not uncommon, dry deciduous forests are dominated by *Legerstroemia parviflora, Butea monosperma, Diospyros melanoxylon, Albizia spp., Anogeissus latifolia, Terminalia spp., Aegle marmelos, Acacia catechu*, A. *torta*, A. *pennata, Cordia oblique, Emblica officinalis, Madhuca longifolia* var. *latifoia, Bauhinia spp., Nyctanthes arbor trists, Ziziphus mauritiana*, Z. *xylopyrus, Helicteres isora, Lannea coromandelica* and *Boswella serrata*. The shrubby layer is usually formed of *Holarrhena antidysenterica, Grewia* hirsute, Mimosa *himalayana, Flaccurtia indica, Capparis zeylanica, Kirganelia reticulate, Securinega virosa, Casearia elliptica, woodfordia fruitocs, Clerodendrum serratum* and *Solanum anguivi*. The common climbers are *Ziziphus oenoplia, Smilax zeylanica, Celastrus paniculatus, Ampelocissus latifolius*, A. *tomentosa, Asparagus*

racemosus, Hemidesmus indicus and *Ichnocarpus frutescens.* A few other climbers like *Rhynchosia minima, Atylosia scarabaeoides, Ipomoea spp, Mukia maderaspatana, Diplocyclus palmatus, Cryptolepis buchananii* and *Pergularia daemia* become more common in open forest pockets or its margins. *Hyptis suaveolens, Anisomeles indica, Alysicarpus spp., Tephrosia purpurea, Plectranthus mollis, Cassia tora, Pavetta tomentosa*, species of *Indigofera, Crotalaria, Leucas*, Euphorbia and a large variety of grasses and sedges are common along forests margins.

Teminalia arjuna and *Syzygium heynaenum* are commonly found along banks of the rivers and streams. While the former is also found elsewhere, the latter is very specific in its habitat. Bushes of *Tamarix ericoides* and *rotula aquatica* are frequent in river beds.

The rock boulders in the dry uplands bear in their crevices only a few species like *Polycarpaea aurea, P. corymbosa, Indigofera astragalina, I. glabra, Cassia absus, Anisochilus carnosus, Trichurus monosoniae, Anthraxon prinodes, Chrysopogon verticillatus, Digitaria stricta, Dimeria ornithopoda, Perotis indica* and *Pogonatherum crinitum.*

Forests Blocks in Study Area

There are around 9 forests blocks which includes protected, reserved and open. The list of forests blocks and their distances from plant site are presented in **Table 3.3.1**. The forest blocks are mainly consists of *Salai, Tendu, Bija, Saja, Char Ganja, Dhauwra, Harra* and *Dhobin.*

Table 3.3.1
List of Forest Blocks within 10 Km Radius

Sr. No.	Forests Block
1	Silot Reserve Forest
2	Protected forests near village Bhalumuda
3	Protected forests near village Bajamura
4	Protected forests near village Rodapali
5	Protected forests near village Mudagaon
6	Gare protected forest
7	Protected forest near village Kognira
8	Protected forest near village Nundarha
9	Protected forest near village Dharam

Terrestrial Ecological Status: Primary Survey

A preliminary survey was made and four locations were selected for detailed study within 10 kms radius of the proposed plant. The selected locations are given in **Table 3.3.2** and depicted in **Figure 3.3.1**.

Table 3.3.2
Details of the Terrestrial Ecological Sampling Locations

Code	Location	Direction (w.r.t plant site)	Distance from project site (km)
TE-1	Kolam village	SE	1.4
TE-2	Bajamura village	ENE	7.0
TE-3	Mudagaon village	ESE	5.2
TE-4	Patrapai village	SW	4.0

The primary data was generated through:

1. Preparing a general checklist of all plants encountered in the study area. This would indicate the biodiversity for wild and cultivated plants.

2. Phytosociological studies by using list count quadrate method for woody and herbaceous flora in forest areas and only herbaceous flora in ambient air quality monitoring locations. Sufficient number of quadrates of 100m^2 size was adopted for study, which is based on the area species curve. The number of quadrates depended on actual field requirements.

3. Herbaceous and woody flora was studied by taking 10 and 20 quadrates at each location having 100m^2

4. Determining the bird population of migratory and local birds by taking 10 random readings at every location; and

5. Observing mammals, amphibians and reptiles, noting their calls, droppings, burrows, pugmarks and other signs;

Local inhabitants were interviewed for usages of plants and presence of animals and to get ethnobiological data.

Floristic Composition-Primary Survey

Floristic Richness

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 (Lichens *Ascomycetes* and *Basidiomycetes* could be observed near hilly terrain). Bryophytes occur in wet areas and occasionally on barks of trees and old walls of houses. The commonly observed bryophytes in this area are *Funaria sp* and *polypodum sp*. Fern flora of the study area is insignificant. The aquatic weeds *Hydrilla sp, Chara sp, Salvinia, Nymphea* was predominant in small ponds in agricultural fields.

Life Form Spectrum

Raunkiaer defined life forms as the sum of adaptations of plants to climate. Braun-Blanquet (1951), whose system is adopted in this study, modified the Raunkiaer's system. Following five of the ten classes created by Braun-Blanquet is present in the study area.

Phanerophytes	: Shrubs and trees
Therophytes	: Annuals including ferns
Hydrophytes	: Water plants except plankton
Hemicryptophytes	: Plants with perennial shoots and buds close to surface
Geophytes	: Plants with perennating parts buried in substratum

Life form spectrum is a reflection of plant community. A plant community is governed by several factors like climatic, edaphic, topographic and biotic. Even local variations in environment affect components of plant community.

In the study area, maximum number of species are *phaenrophytes* (42.2%) followed by *therophytes* (39.0%). These classes are followed by *hemicryptophytes* (13.4%) and hydrophytes. Geophytes 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.

Plant Diversity

For better understanding of plant diversity, following different indices were estimated based on the phytosociological studies carried at four locations. The findings are presented in **Table 3.3.3**.

Table 3.3.3
Floristic Richness and Species Diversity Index

Code	Name of the area	Diversity index for herbaceous plants	Diversity index for woody plants
TE-1	Kolam village	2.45	2.12
TE-2	Bajamura village	2.78	2.24
TE-3	Mudagaon village	2.91	2.35
TE-4	Patrapai village	2.81	2.34

Observations

The Shannon-weaver Index for all four sampling locations is observed to be in the range of 2.45-2.91 for herbaceous species and 2.12-2.35 for woody species. The highest index is observed at TE-3 location, which indicates more species diversity. The lowest index is observed at TE-1, which indicates less species diversity.

Endangered Plants

The study area did not record the presence at any critically threatened species. The records of botanical survey of India and Forest department also did not indicate presence of any endangered or rare and vulnerable plant species in this area.

Terrestrial Fauna

National Park/Sanctuary

As per forest records, there are no sanctuaries or national park, Tiger reserves, elephant reserves, Biospheres, conservation reserves and community reserves in 15 km radius from proposed power plant site.

Primary Survey

To collect Primary data field studies were conducted. The secondary data was collected through interaction with local forest officials and recordes. The details are presented in **Table 3.3.4**.

Table 3.3.4
Fauna and their Conservation Status in the Study Area

Sr. No.	Technical Name	English Name/Local Name	Conservation status as per Wildlife Protection Act (1972)
	Aves		
1	*Targos calvus*	King vulture*	Sch-IV
2	*Milyus migrans*	Common kite	Sch-IV
3	*Corvus corvus*	Jungle crow	Sch-IV
4	*Corvus splendens*	House crow	Sch-IV
5	*Turdoides striatus*	White headed babler	Sch-IV
6	*Aegithina tiphia*	Lara*	Sch-IV
7	*Pycnonotus cafer*	Red vented bulbul	Sch-IV
8	*Pycnonotus jokokus*	White browed bulbul	Sch-IV
9	*Saxicoloides fulicata*	Indian robin*	Sch-IV
10	*Gallus gallus*	Red jungle fowl	Sch-IV
11	*Columbus livibus*	Rock pigeon	Sch-IV
12	*Bubo bubo*	Indian great horned owl*	Sch-IV
13	*Copsychus saularis*	Magpie robin	Sch-IV
14	*Oriolus oriolus*	Indian oriole	Sch-IV
15	*Oriolus xanthornus*	Black headed oriole	Sch-IV
16	*Temenuches pagodarum*	Brahmny myna	Sch-IV
17	*Acridotheres tristicus*	Common myna	Sch-IV
18	*Ploceus phillippines*	Weaver bird	Sch-IV
19	*Uroloncha striata*	Spotted munja	Sch-IV
20	*Passer domisticus*	House sparrow	Sch-IV
21	*Cinnyris lotensis*	Loten's sunbird	Sch-IV
22	*Cinnyris asiatica*	Purple sunbird	Sch-IV

Sr. No.	Technical Name	English Name/Local Name	Conservation status as per Wildlife Protection Act (1972)
23	*Brachypternus bengolensis*	Malabar golden acked wood	Sch-IV
24	*Megalaima merulinus*	Indian cuckoo	Sch-IV
25	*Eudynamis scolopaceus*	Koel	Sch-IV
26	*Centropus sinensis*	Crow pheasant	Sch-IV
27	*Psittacula krammeri*	Rose ringed parakeet	Sch-IV
28	*Coryllis vaeralis*	Lorikeet	Sch-IV
29	*Coracias benghalensis*	Indian roller	Sch-IV
30	*Merops orinetalis*	Common bee eater	Sch-IV
31	*Merops leschenaulti*	Chestnut headed bee eater	Sch-IV
32	*Alcedo atthis*	Common kingfisher	Sch-IV
33	*Microfus affinis*	House swift	Sch-IV
34	*Caprimulgus asiaticus*	Common Indian jar	Sch-IV
35	*Tylo alba*	Barn owl	Sch-IV
36	*Haliastur Indus*	Brahmny kite	Sch-IV
37	*Milvus migrans*	Pariah kite	Sch-IV
38	*Anhinga melanogaster*	Darter	Sch-IV
39	*Egretta garzetta*	Little egret	Sch-IV
40	*Bubulcus ibis*	Cattle egret	Sch-IV
41	*Ardeola grayii*	Pond heron	Sch-IV
42	*Anas acuta*	Common teal	Sch-IV
43	*Aythya feroma*	White eyed pochard	Sch-IV
44	*Pavo cristatus*	Peacock	Part-III of Sch-IV
	Reptiles		
45	*Calotes versicolor*	Common garden lizard	Sch-IV
46	*Chameleon zeylanicus (Laurenti)*	Indian chamaeleon	Sch-IV
47	*Varanus benegalensis*	Monitor lizard	Part-II of Sch-II
48	*Lycodon spp.*	Wolf snake	Part-II of Sch-II
49	*Boiga spp.*	Cat snake	Sch-IV
50	*Bangarus spp.*	Krait	Sch-IV
51	*Naja naja*	Indian cobra	Part-IV
	Butterflies		
52	*Pachliopta hector lin.*	Crimson rose	Sch-IV
53	*Papilio demoleus lin.*	Lime butterfly	Sch-IV
54	*Junoria almana lin.*	Peacock pansy	Sch-IV
55	*Hypolimnas bolina lin*	Great eggfly	Sch-IV
56	*Euploea core cramer*	Common crow	Sch-IV
57	*Neptis hylas moore*	Cinnib sailor	Sch-IV
58	*Eurema hecabe lin.*	Common grass yellow	Sch-IV
69	*Catopsilia sp.*	Emigrant	Sch-IV
60	*Leptosia nina (Fabricius)*	Psyche	Sch-IV
	Amphibians		

Sr. No.	Technical Name	English Name/Local Name	Conservation status as per Wildlife Protection Act (1972)
61	*Rana tigrina*	Bull frog	Sch-IV
62	*Hyla goeldii*	Tree frog	Sch-IV
63	*Bufo malanosticus*	Bufo	Sch-IV
	Mammals		
64	*Bandicota indica*	Bandicoot	Sch-IV
65	*Bandicota bengalensis*	Bandicoot	Sch-IV
66	*Rhinolopus spp.*	Bat	Sch-IV
67	*Hipposiderus spp.*	Bat	Sch-IV
68	*Melursus ursinus*	Bear	Sch-III
69	*Bosephalus tragocamelus*	Blue bull or nilgai*	Sch-III
70	*Axix axis*	Cheetal	Sch-III
71	*Rattus norvegicus*	Field mouse	Sch-V
72	*Lepus nigricollis*	Hare	Sch-IV
73	*Rattus rattus*	House rat	Sch-V
74	*Hyaena hyaena*	Hyaena*	Sch-III
75	*Canis auries*	Jackal	Part-II of Sch-II
76	*Presbytis entellus*	Langur	Part-II of Sch-II
77	*Mucaca mulata*	Monkey	Part-II of Sch-II
78	*Rattus sp.*	Rat	Sch-V
79	*Funambulus spp.*	Squirrel	Sch-IV
80	*Funambulus palmarum*	Squirrel	Sch-IV
81	*Vulpus benghalensis*	Wild fox	Part-I of Sch-II
82	*Sus sucrofa*	Wild pig*	Sch-III

*** Not observed during field studies**

On comparison of the check list given in the Schedule-I of the Act and the list of Wildlife recorded in the study area. 82 animal species were recorded/reported from study area during study period, out of which 6 species belong to Sch-II, 5 species belongs to Sch-III and rest of the species belongs to Sch-IV and Sch-V as per **Wildlife Protection Act, 1972**.

Aquatic Ecosystems

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 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 undertaken effective management plan. So the objective of aquatic ecological study may be outlined as follows:

1 To characterize water bodies like fresh waters;

2 To understand their present biological status;

3 To characterize water bodies with the help of biota;

4 To understand the impact of proposed industrial and urbanization activities; and

5 To suggest recommendations to counter adverse impacts, if any on the ecosystem.

In order to get a clear picture and to assess the various parameters of water, two sampling locations were identified for sampling. Samples were collected during study period. The sampling locations are presented in **Table 3.3.5.**

Table 3.3.5
Details of Aquatic Sampling Locations

Sr. No.	Code	Location	Remarks
1	AE-1	Down stream of Pajhar nala	Fresh water
2	AE-2	Down stream of Kelo river	Fresh water

Methodology Adopted for Aquatic Studies

Two water samples for plankton study were collected in winter season from surface water of downstream of river Kelo and Pajhar nala. The samples were collected at a depth of 0.30 m from surface of the water. The samples were collected in one-liter capacity polyethylene cans and the samples were fixed with 4% buffered formaline solution. For the measurement of frequencies of various forms of phytoplankton and zooplankton, one drop of the sediment plankton was mounted on a micro slide and as many as 10 different microscope fields situated at more or less even distances from each other were examined and the number of importance counted **(Lackey method, 17 edition, APHA, AWWA 1992)**. The plankton forms were identified upto species level and Shanon Weaver's Index was calculated.

Aquatic Fauna

The field studies indicate that the aquatic fauna consisting of crustaceans, aquatic insects, fishes, amphibians, reptiles and birds and are listed in **Table 3.3.6**. The observed planktonic flora and fauna are presented in **Table 3.3.7**.

Table 3.3.6
Aquatic Fauna from Study Area

Sr. No.	Name of the Species	Lotic Water bodies
1	*Dytiscus sp*	Observed
2	*Nepa sp*	Observed
3	*Ranatra sp*	Observed
4	*Notpterus notopterus*	Observed
5	*Esomus darnucus*	Observed
6	*Labeo rohita*	Observed
7	*Labeo catla*	Observed
8	*Cirrhinus mrigula*	Observed
9	*Mysticus vittatus*	Observed
10	*Clarias batrachus*	Observed
11	*Channa striatus*	Observed
12	*Rana-cynophyctis*	Observed
13	*Phalacrocorax carbo*	Observed
14	*Bubulcus ibis*	Observed
15	*Egretta garzetta*	Observed
16	*Ardea cinerea*	Observed
17	*Alcedo athinis*	Observed
18	*Dendrocygna javanica*	Observed

Table 3.3.7
List of Observed Planktonic Flora and Fauna

Phytoplankton	Zooplankton
Anabaena sp	*Arcella*
Oscillatoria sp	*Keratella sp*
Microcystis sp	*Asplancha sp*
Chrococcus sp	*Brachionus sp*
Scenedesmus sp	*Daphnia sp*
Scenedesmus bijuga	*Cerodaphnia sp*
Pediastrum sp	*Cyclops sp*
Ankistrodesmus sp	*Mesocyclops sp*
Oocystis sp	*Cypris sp*
Crucigenai sp.	
Euglena sp	
Phacus sp	
Cosmarium sp	
Clostrium sp	
Navicula sphaerophora	
Synedra ulna	
Navicula rhyncocephala	
Gomphonema sp	

Conclusions of Aquatic Ecology

Surface water samples were collected from two surface water sources for analysis of biological parameters. *Basillariophycean, Chlorophyceaen, Myxophyceaen, Rotifers* and *Cladocerans* are predominant in the studied water bodies. Plankton diversity index for phytoplankton and zooplankton varies from 2.56 to 2.85 and 2.16 to 2.52. Physico-chemical, biological parameters and diversity index reveals that the studied water bodies are slightly mesotrophic in nature.

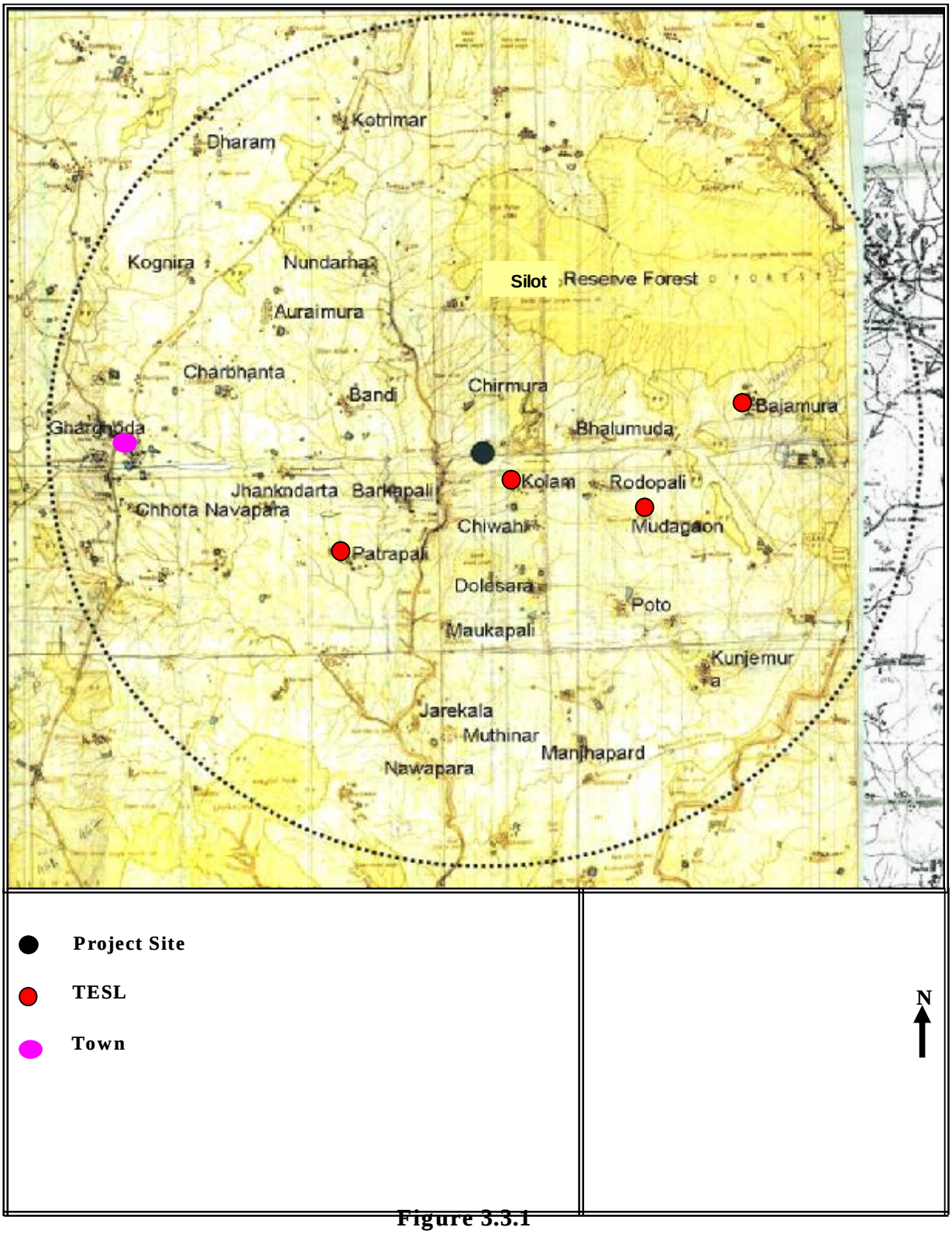


Figure 3.3.1
Terrestrial Ecological Sampling Locations

3.4 Air Environment

3.4.1 Meteorology

The meteorological data recorded during the monitoring period is very useful for proper interpretation of the baseline information as well as input for air quality prediction models. Historical data on meteorological parameters will also play an important role in identifying the general meteorological regime of the region.

The year is broadly divided into four seasons, as per CPCB:

- Winter season : December to February
- Summer season : March to May
- Monsoon season : June to September
- Post-monsoon season : October to November

Methodology

On-site monitoring was undertaken for various meteorological parameters as per BIS and IMD guidelines to generate the site-specific data. The generated data was then compared with the meteorological data obtained from IMD.

Methodology of Data Generation

The automatic meteorological data recording instrument was installed on top of a building near to the project site to record wind speed, direction, relative humidity and temperature. Cloud cover was recorded by visual observation. Rainfall was monitored by rain gauge.

Hourly average, minimum and maximum values of wind speed, direction, relative humidity, rainfall, and temperature were recorded continuously at this station during December 2008 to February 2009.

Sources of Information

Secondary information on meteorological conditions has been collected from the nearest IMD station at Raigarh .

India Meteorological Department has been monitoring surface observations at Raigarh since 1891. Pressure, temperature, relative humidity, rainfall, wind speed and direction are measured twice a day viz., at 0830 and 1730 hr. The wind speed and direction data of IMD, Raigarh station has been obtained for the past available 30 years.

Synthesis of Data on Climatic Conditions

3.4.2 Analysis of the Data Recorded at IMD- Raigarh

1) Temperature

The winter season starts from December and continues till the end of February. December is the coldest month with the maximum temperature at 28.2°C with the minimum temperature at 13.2°C. Both the day and night temperatures increase rapidly during the onset of pre-monsoon season from March to May. During pre-monsoon season, the maximum temperature (May) is observed at 42.6°C with the minimum temperature at 28°C. The mean maximum temperature in the monsoon season was observed to be 31.6°C whereas the mean minimum temperature was observed to be 24.6°C. By end of September with the onset of post-monsoon, day temperatures decrease slightly with the mean maximum temperature at 32.4°C. The monthly variations of temperatures are presented in **Table 3.4.1.**

2) Relative Humidity

The average relative humidity is observed around 20% to 41% during pre-monsoon period. In the monsoon period the relative humidity ranges between 50% to 86%. During the post-monsoon season, the mean humidity is observed between 47% to 71%. During winter season, the mean humidity is observed between 30% to 62%. The monthly mean variations in relative humidity are presented in **Table-3.4.1.**

3) Atmospheric Pressure

The atmospheric pressure is observed in the range of 965.6 to 986.0 mb. The maximum pressure (986.0 mb) is observed during the winter season, in the month of December. It can be observed from the data that not many variations are observed in the average atmospheric pressure levels. The pressure levels are found to be fairly constant over the region.

4) Rainfall

The total average annual rainfall based on the IMD data is 1552 mm. The monsoon generally sets in during the first week of June. About 83.4% of the rainfall is received during the monsoon. The rainfall gradually decreases after August. The maximum numbers of rainy days are observed in the month of July. Annual and monthly variations of rainfall are presented in **Table-3.4.1**.

5) Cloud Cover

During the winter and the pre-monsoon seasons, it was observed that the sky is generally very clear. In the pre-monsoon season, generally light clouds were observed in the evenings, with clear mornings. During monsoon season, both in the mornings and evenings the sky was observed to be generally cloudy.

6) Wind Speed/Direction

The wind rose (IMD data based) for the study period representing Winter season are shown in **Figure-3.4.1** and presented in **Table-3.4.2.**

Table-3.4.1
Climatological Data for IMD, Raigarh

Month	Temperature (°C)		Relative Humidity (%)		Rain-fall (mm)
	Max	Min	Max	Min	Mean
January	28.3	13.3	61	40	11.2
February	31.6	16.0	53	30	15.7
March	36.0	20.4	41	23	2.4
April	40.3	25.1	38	20	13.8
May	42.6	28.0	40	21	17.5
June	38.0	27.1	63	50	199.0
July	31.6	24.7	85	76	453.8
August	31.1	24.7	86	78	494.5
September	32.2	24.5	81	73	287.2
October	32.4	22.0	71	59	49.1
November	30.3	17.1	61	47	3.7
December	28.2	13.2	62	44	4.1

Table-3.4.2
Summary of the Meteorological data
Generated at Site (Winter Season 2008-09)

Months	Temperature (°C)		Relative Humidity (%)		Monthly Rainfall (mm)
	Max	Min	Max	Min.	
Dec.08	26.1	13.2	61	34	0
Jan 09	25.4	11.6	65	33	0
Feb 09	29.2	14.3	68	36	0

The windrose for the study period representing Winter season drawn from IMD data is shown in **Figure-3.4.2**.

1 The predominant wind direction and wind speed observed at the project site during the study period were NW, N and W for 13.7.%, 12.1% and 7.9% of the total time, whereas average predominant wind direction and wind speed as recorded by IMD, Raigarh during the Winter season are N (53%), NW 9.6 % and followed by calm, conditions 30.3% during 8:30 hrs. and N (23%), NW (15.3%) & W (11.6%) with clam conditions (40%) during 17:30 hrs.

2 The minimum and maximum temperatures recorded at the project site during study period were 29.2°C and 11.6 °C, whereas the maximum and minimum values recorded by IMD, Raigarh are 33.0°C and 12.7°C respectively;

The relative humidity recorded at the project site was in the range of 33% and 77% . As per data recorded by IMD, Raigarh it ranged between 31% and 82 %.

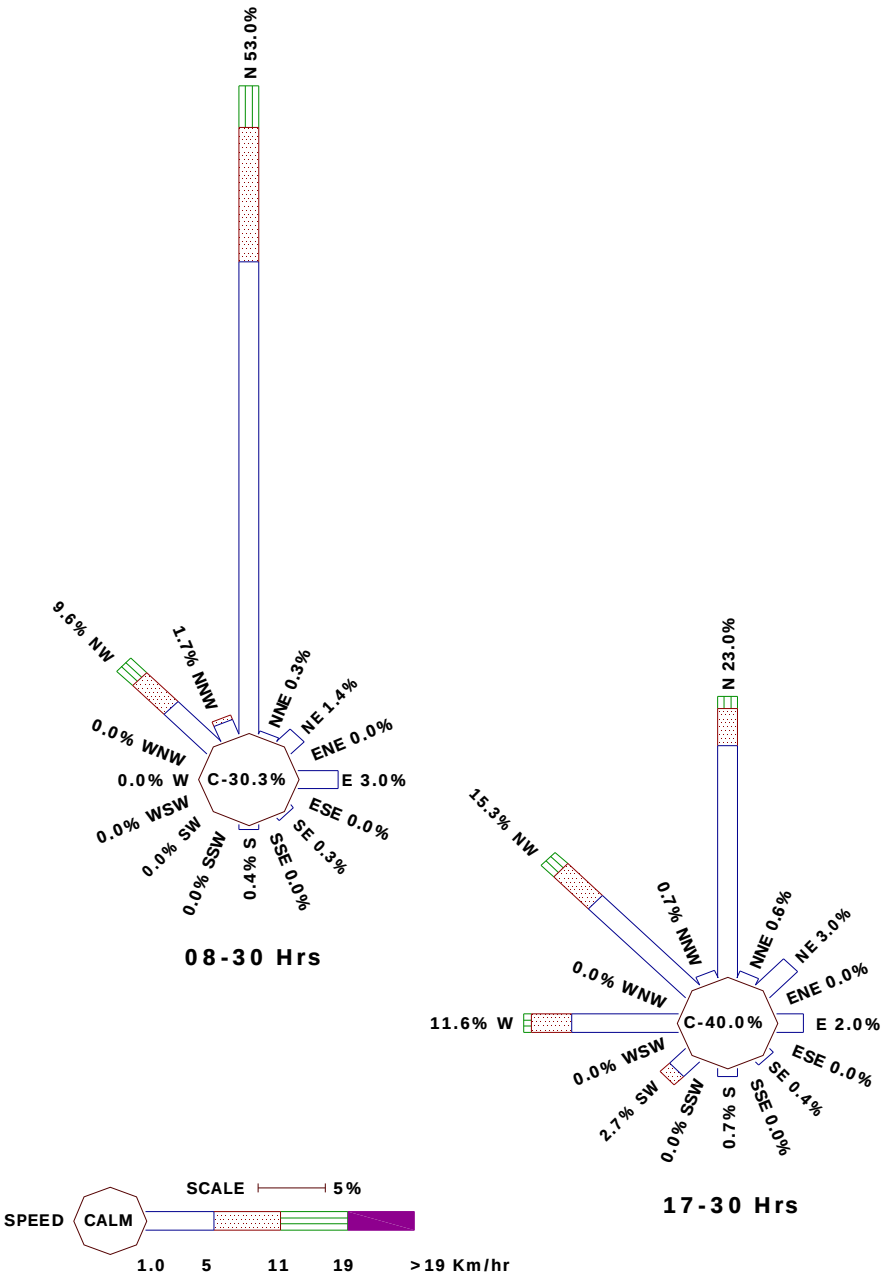


Figure-3.4.1
Windrose - IMD Raigarh (Winter Season)

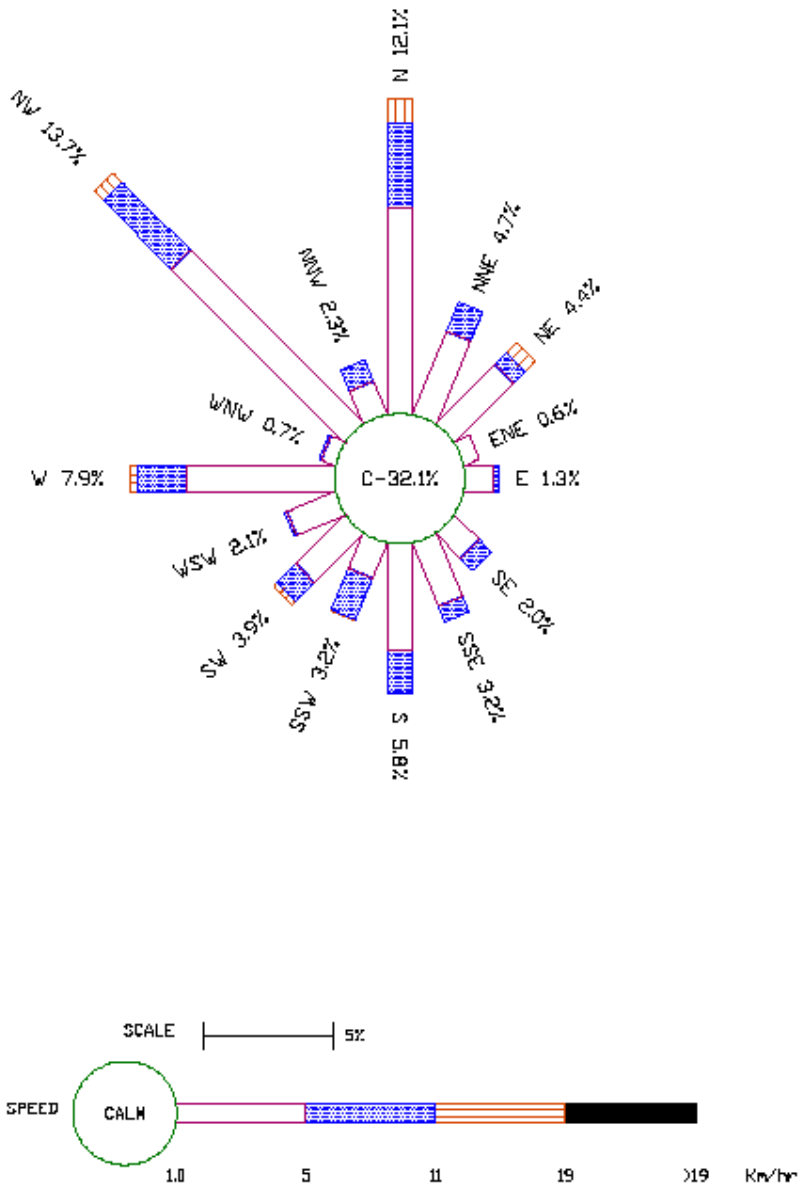


Figure-3.4.2
Windrose at Site (Winter Season 2008-09)

3.4.3 Baseline Ambient Air Quality Status

The various sources of air pollution in the region are industries and vehicular traffic. The prime objective of the baseline air quality study (10-km radius) was to assess the existing air quality of the area to form baseline information. The study area represents mostly rural environment.

The regional climatological data (Source: IMD Raigarh, 30 years average), was used as a guideline to know the predominant wind direction during study period . Ambient air monitoring was carried out at nine locations. The details about sampling locations are depicted in **Figure-3.4.3** and presented in **Table-3.4.3**. The locations were identified keeping in view predominant wind directions prevailing during study period, sensitive receptors and human settlements. The levels of Suspended Particulate Matter (SPM), Respirable Particulate Matter (RPM), Sulphur Dioxide (SO_2), Oxides of Nitrogen (NO_X) and Carbon monoxide (CO) were monitored for establishing the baseline status. SPM and RPM was collected with the help of particulate sampler as 24 hourly average by drawing air through the cyclone at the rate of 1.0 -1.5 m^3/min through glass fiber filter paper over which particulats less than 10 µ gets deposited and the bigger particals from 10 to 100 µ are collected into the cup provided at the bottom of the sampler. The dust deposited over the filter paper is measured as RPM and the sum of the dust deposited over filter paper and in the cup is measured as SPM which is analyzed by gravimetric method. Due to the high suction of the air, the vaccum is created into the hopper which is utilised for sampling SO_2 and NO_X which is measured by wet chemical method and were analyzed by colorimetricaly.

The status of ambient air quality within the study area monitored for December 2008 to February 2009 is presented in **Table 3.4.4**. and **Annexure VII**.

98^{th} percentile, average, minimum and maximum values have been computed from the observed raw data for all the AAQ monitoring stations.

Observations of Primary Data

The minimum and maximum concentrations for TSPM were recorded as 98 µg/m^3 and 156 µg/m^3 respectively. The maximum concentration was recorded at Rodopoli and Poto and minimum concentration was recorded at Chirmura. The average concentrations were ranged between 127 to 142 µg/m^3.

The minimum and maximum concentrations for RPM were recorded as 31 µg/m^3 and 50 µg/m^3 respectively. The maximum concentration was recorded at Sr. no. 3,4,5 & 9 and the minimum concentration was recorded at Chirmura. The average concentrations were ranged between 41 to 45 µg/m^3.

The minimum and maximum SO_2 concentrations were recorded as 6 µg/m^3 and 10 µg/m^3 respectively. The average concentrations were ranged between 6 to 8 µg/m^3.

The maximum NOx concentration was recorded as 12 µg/m^3 at Sr. no. 1 & 3. The average concentrations were ranged in between 8.0 µg/m^3 and 9.0 µg/m^3.

CO levels were recorded < 100 µg/m^3.

The concentration of the above fine criteria pollutants were observed well within the limits promulgated by CPCB for Residential, rural and other areas.

Table 3.4.3
Details of Ambient Air Quality Monitoring Locations

Sr. No.	Station Code	Locations	Direction (w,r.t. plant)	Aerial Distance (Km w.r.t. plant)
1	A1	Kolam	SE	1.4
2	A2	Chirmura	N	1.6
3	A3	Dolesara	S	3.5
4	A4	Rodopali	ESE	4.0
5	A5	Poto	SE	5.5
6	A6	Jhankndarta	WSW	5.5
7	A7	Auraimura	NW	6.5
8	A8	Nawapara	SSW	8.5
9	A9	Manjhapard	SSE	9.0

Table-3.4.4
Summary of Ambient Air Quality Results
(Period: Dec 2008 – Feb 2009)

Sr. No	Location	TSPM (µg/m³)				RPM (µg/m³)			
		Min	Max	Avg	98th %le	Min	Max	Avg	98th %le
1.	Kolam	121	154	140	153	39	49	45	49
2.	Chirmura	98	147	127	143	31	47	41	46
3.	Dolesara	125	155	142	153	40	50	45	49
4.	Rodopali	120	156	142	154	38	50	45	49
5.	Poto	122	156	138	156	39	50	44	49
6.	Jhankndarta	104	140	129	140	33	45	41	45
7.	Auraimura	120	152	138	152	38	49	44	48
8.	Nawapara	122	154	140	153	39	49	45	49
9.	Manjhapard	118	155	135	154	38	50	43	49

Table 3.4.4 (cont..)
Summary of Ambient Air Quality Results

Sr. No.	Location	SO_2 (µg/m³)				NOx (µg/m³)			
		Min	Max	Avg	98th %le	Min	Max	Avg	98th %le
1.	Kolam	6	10	7	10	7	12	9	12
2.	Chirmura	6	9	7	9	7	9	8	9
3.	Dolesara	6	9	7	9	7	12	9	12
4.	Rodopali	6	10	8	10	7	11	8	11
5.	Poto	6	9	7	9	7	10	8	10
6.	Jhankndarta	6	8	6	8	7	8	8	8
7.	Auraimura	6	8	7	8	7	9	8	9
8.	Nawapara	6	9	8	9	7	11	8	11
9.	Manjhapard	6	9	7	9	6	10	8	10

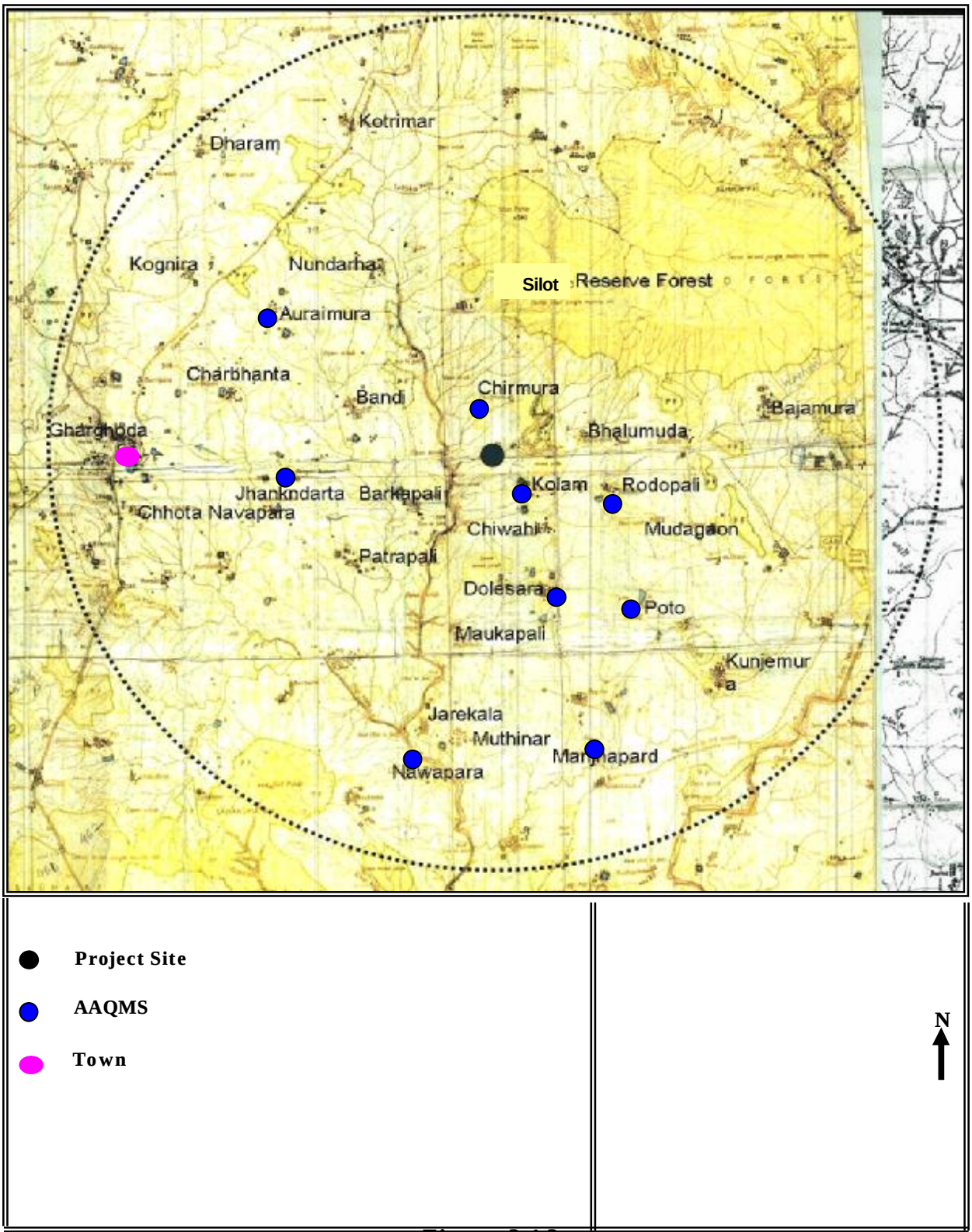


Figure-3.4.3
Ambient Air Quality Monitoring Locations

3.5 Noise Environment

A preliminary reconnaissance survey was undertaken to identify the major noise generating sources in the area. Eight locations were identified based on the activities in the village area, traffic and sensitive areas like hospitals and schools. The noise monitoring locations are shown in **Figure-3.5.1**.

Method of Monitoring

Sound Pressure Level (SPL) were measured at eight locations; one reading for every hour was taken for 24 hours. The day noise levels were monitored during 6 am to 10 pm and night levels during 10 pm to 6 am at all the monitoring locations within the study area.

Presentation of Results

The results are tabulated in **Table-3.5.1**.

a) Day Time Noise Levels (L_{day})

The day time noise levels at all locations were observed to be well within the prescribed limit of 55 dB (A). The noise levels ranged between 47.7 dB(A) to 53.0 dB (A).

b) Night Time Noise Levels (L_{night})

The night time noise levels at all locations were observed to be on lower side as compared to prescribed limit of 45 dB (A). The noise levels ranged between 39.0 dB (A) to 43.9 dB (A).

Table 3.5.1
Noise Levels in the Study Area

Sr. No.	Location	L_{10}	L_{50}	L_{90}	L_{eq}	L_{day} dB (A)	L_{night} dB (A)	L_{dn}
1	Kolam	50.6	49.4	42.6	50.5	48.8	42.9	50.8
2	Chirmura	51.3	46.2	43.7	47.2	49.5	43.5	52.3
3	Rodopali	54.2	47.1	42.3	49.5	53.0	43.4	53.2
4	Poto	50.7	47.2	38.2	49.8	49.9	39.0	49.6
5	Charbhanta	52.4	48.2	40.1	50.7	50.6	41.2	50.8
6	Jhankndarta	51.6	46.2	39.6	49.7	50.2	41.8	50.3
7	Nawapara	50.3	47.1	40.7	48.6	48.5	41.8	50.0
8	Manjhapard	49.5	46.2	42.7	47.0	47.7	43.9	51.5

CPCB Standards: Industrial area Day Time 75 dBA, Night Time 70 dBA
Residential area Day Time 55 dBA, Night Time 45 dBA

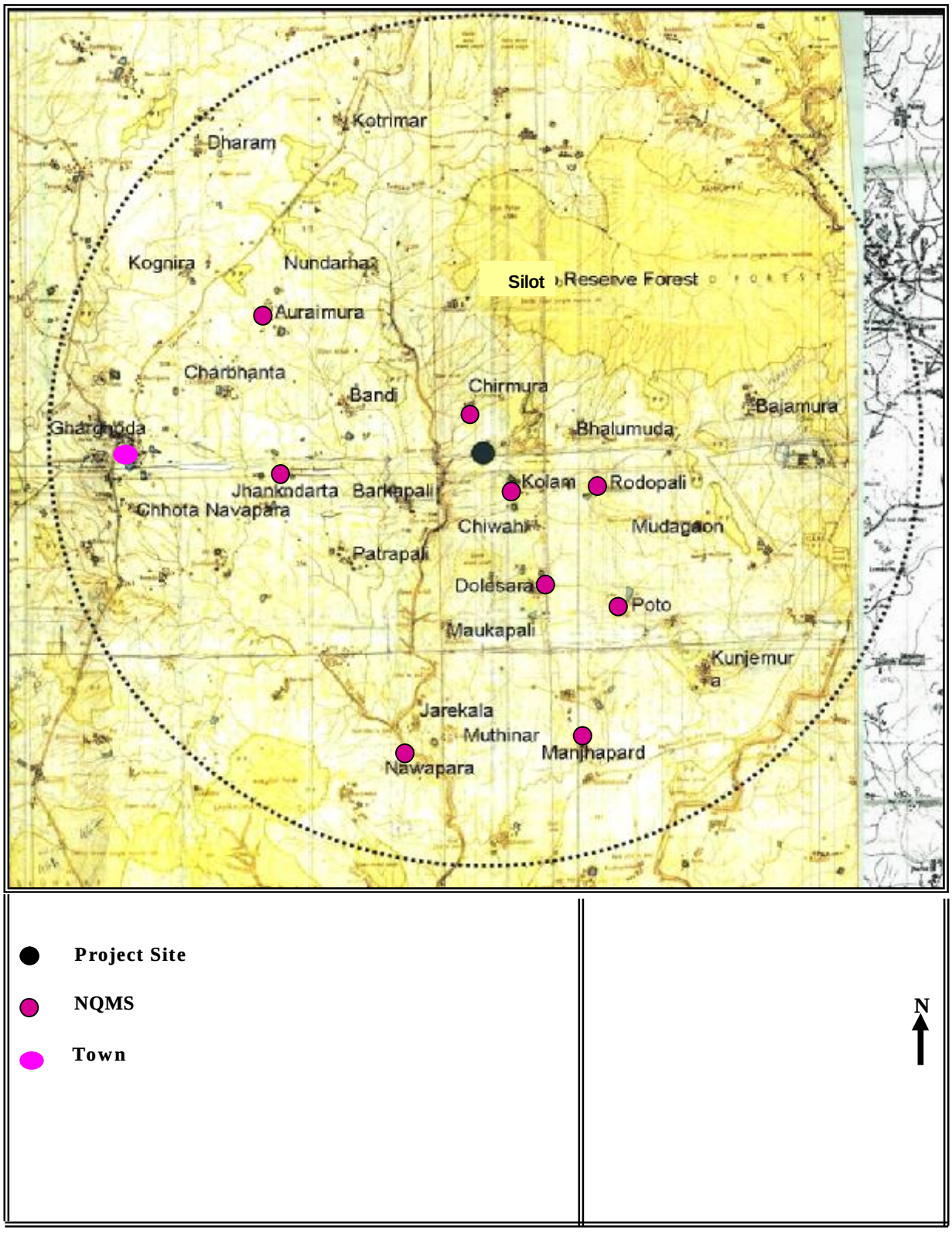


Figure-3.5.1
Noise Monitoring Locations

3.6 Water Quality

The impacts on water environment form inherent part of development and operation of thermal power projects in two ways, i.e. stress on water resources (continuous drawl of large quantities of water) and the pollution impacts due to discharge of effluents. These impacts may be related to either or both; surface and groundwater resources in the project area depending on the specific situation. To address these issues, it is necessary to take a stock of available water resources in project area with respect to their existing quality as well as their supportive capacity to represent the baseline status of water environment as part of impact assessment study for a proposed thermal power plant.

The existing water resources, both surface and groundwater with respective significance were identified through reconnaissance within the study area (10 km radial distance) around project site. These locations were selected to assess the existing status of water quantity in impact zone. Water sample analysis with respect to physico-chemical and bacteriological parameters having relevance to public health and aesthetic significance were selected to assess the water quality status with special attention to raw water resource for proposed project and the receiving water body for the treated effluent. The standard methods prescribed for surface and groundwater samples as well as the analytical methods prescribed for individual parameters were followed in this study.

Baseline Data

The existing status of groundwater and surface water quality was assessed by identifying 6 ground water (Bore wells) samples in different villages and 2 surface water samples as depicted in **Figure-3.6.1** and listed in **Table-3.6.1**. The physico-chemical characteristics of surface, bacteriological analysis of surface water and groundwater samples collected are presented in **Table 3.6.2** , **Table-3.6.3** and **Table 3.6.4**.

It has been observed that all the physico-chemical parameters and heavy metals of water samples from surface and ground water are below the stipulated drinking water standards.

Table 3.6.1
Details of Water Sampling Locations

Code	Location	Direction	Distance (km)
		w.r.t. Project Site	
Surface Water			
SW1	Kelo river	SE	9.5
SW2	Pajhar nalla	W	0.5
Ground Water			
GW1	Chirmura	N	1.6
GW2	Bhalmuda	ENE	2.6
GW3	Mudagaon	ESE	5.2
GW4	Kunjemur	SE	7.8
GW5	Patrapai	SW	4.0
GW6	Charbhanta	WNW	6.5

Table 3.6.2
Surface Water Quality

Sr. No	Parameters	SW 1 Kelo river	SW 2 Pajhar nalla	IS : 2296 Class 'C'
1	pH Value	7.5	6.8	6.8 to 8.5
2	Electrical Conductivity at 25^0C	177	197	-
3	Turbidity NTU	5.3	7.3	-
4	Total Dissolved Solids (TDS)	95.29	162	1500
5	Total Hardness ($CaCO_3$)	43.93	82	-
6	Iron (as Fe) Dissolved Fe	0.48	0.7	50
7	Chlorides (as Cl)	6.83	124	600
8	Calcium (as Ca)	13.52	16.2	-
9	Magnesium (as Mg)	2.43	3.8	-
10	Sulphate (as SO_4)	13.52	26.3	-
11	Nitrates (as NO_3)	<0.1	0.15	50
12	Fluoride (as F)	0.1	0.17	1.5
13	Total Alkalinity	46.3	52.3	-
14	Total Coliform	<16	< 16	5000 (MPN/100ml)
15	Mercury as (Hg)	BDL	BDL	-
16	Arsenic as (As)	BDL	BDL	0.2
17	Lead as (Pb)	BDL	BDL	0.1
18	Chromium as (Cr^{6+})	BDL	BDL	0.05
19	Dissolved Oxygen		-	> 4.0
20	COD	40.89	34.27	-

Note: All analytical results are in mg/lit except pH, Ec, Turbidity
- : Limits not specified

Table 3.6.3
Bacteriological Quality
(Surface Water)

Sr. No.	Sampling Source	Total Coliform (CFU / 100 ml)
1.	Kelo river	<16
2.	Pajhar nalla	<16

Table 3.6.4
Water Quality: Ground Water

Sr. No.	Parameters	Concentration			IS : 10500
		Chirmura (BW)	Bhalmuda (BW)	Mudagaon (BW)	
1	pH Value	6.1	6.2	6.4	6.5 to 8.5
2	Turbidity NTU	10.2	5.4	3.7	5 (10)
3	Electrical Conductivity at 25^0C	147	177	168	-
4	Total Dissolved Solids (TDS)	96	97.3	102	500 (2000)
5	Total Hardness ($CaCO_3$)	52	47	57	300 (600)
6	Iron (as Fe) Dissolved Fe	0.87	0.78	0.85	0.3 (1.0)
7	Chlorides (as Cl)	10.6	8.2	7.9	250 (1000)
8	Calcium (as Ca)	16.2	14.3	20.2	75 (200)
9	Magnesium (as Mg)	3.42	2.7	3.1	30 (100)
10	Sulphate (as SO_4)	1.7	2.2	1.6	200 (400)
11	Nitrates (as NO_3)	1.12	1.17	1.12	45
12	Fluoride (as F)	0.1	0.12	0.17	1.0 (1.5)
13	Total Alkalinity	47	52.6	51.2	200 (600)
14	Copper as(Cu)	BDL	BDL	BDL	0.05 (1.5)
15	Manganese as (Mn)	BDL	BDL	BDL	0.1 (0.3)
16	Mercury as (Hg)	BDL	BDL	BDL	0.001
17	Cadmium as (Cd)	BDL	BDL	BDL	0.01
18	Selenium as (Se)	BDL	BDL	BDL	0.01
19	Arsenic as (As)	BDL	BDL	BDL	0.01
20	Lead as (Pb)	BDL	BDL	BDL	0.05
21	Zinc as (Zn)	BDL	BDL	BDL	5 (15)
22	Chromium as (Cr)	BDL	BDL	BDL	0.05
23	Aluminum as (Al)	BDL	BDL	BDL	0.03 (0.2)
24	Boron as (B)	BDL	BDL	BDL	1

Note: All analytical results are in mg/lit except pH, EC and Turbidity
BW: Bore well

Table 3.6.4 contd...
Water Quality: Ground Water

Sr. No.	Parameters	Concentration			IS: 10500
		Kunjemur (BW)	Patrapai (BW)	Charbhanta (BW)	
1	pH Value	6.2	6.6	7.6	6.5 to 8.5
2	Turbidity NTU	6.8	5.2	7.2	5 (10)
3	Electrical Conductivity at 25^0C	142	156	148	-
4	Total Dissolved Solids (TDS)	45	62	66	500 (2000)
5	Total Hardness ($CaCO_3$)	45	62	66	300 (600)
6	Iron (as Fe) Dissolved Fe	0.34	0.42	0.51	0.3 (1.0)
7	Chlorides (as Cl)	4.6	12.3	13.7	250 (1000)
8	Calcium (as Ca)	24.2	18.2	17.2	75 (200)
9	Magnesium (as Mg)	2.8	3.2	4.1	30 (100)
10	Sulphate (as SO_4)	2.4	3.1	3.7	200 (400)
11	Nitrates (as NO_3)	1.3	1.2	1.17	45
12	Fluoride (as F)	0.18	0.12	0.16	1.0 (1.5)
13	Total Alkalinity	44.3	45.6	42.3	200 (600)
14	Copper as(Cu)	BDL	BDL	BDL	0.05 (1.5)
15	Manganese as (Mn)	BDL	BDL	BDL	0.1 (0.3)
16	Mercury as (Hg)	BDL	BDL	BDL	0.001
17	Cadmium as (Cd)	BDL	BDL	BDL	0.01
18	Selenium as (Se)	BDL	BDL	BDL	0.01
19	Arsenic as (As)	BDL	BDL	BDL	0.01
20	Lead as (Pb)	BDL	BDL	BDL	0.05
21	Zinc as (Zn)	BDL	BDL	BDL	5 (15)
22	Chromium as (Cr)	BDL	BDL	BDL	0.05
23	Aluminium as (Al)	BDL	BDL	BDL	0.03 (0.2)
24	Boron as (B)	BDL	BDL	BDL	1

Note: All analytical results are in mg/lit except pH, EC and Turbidity
BW: Bore well

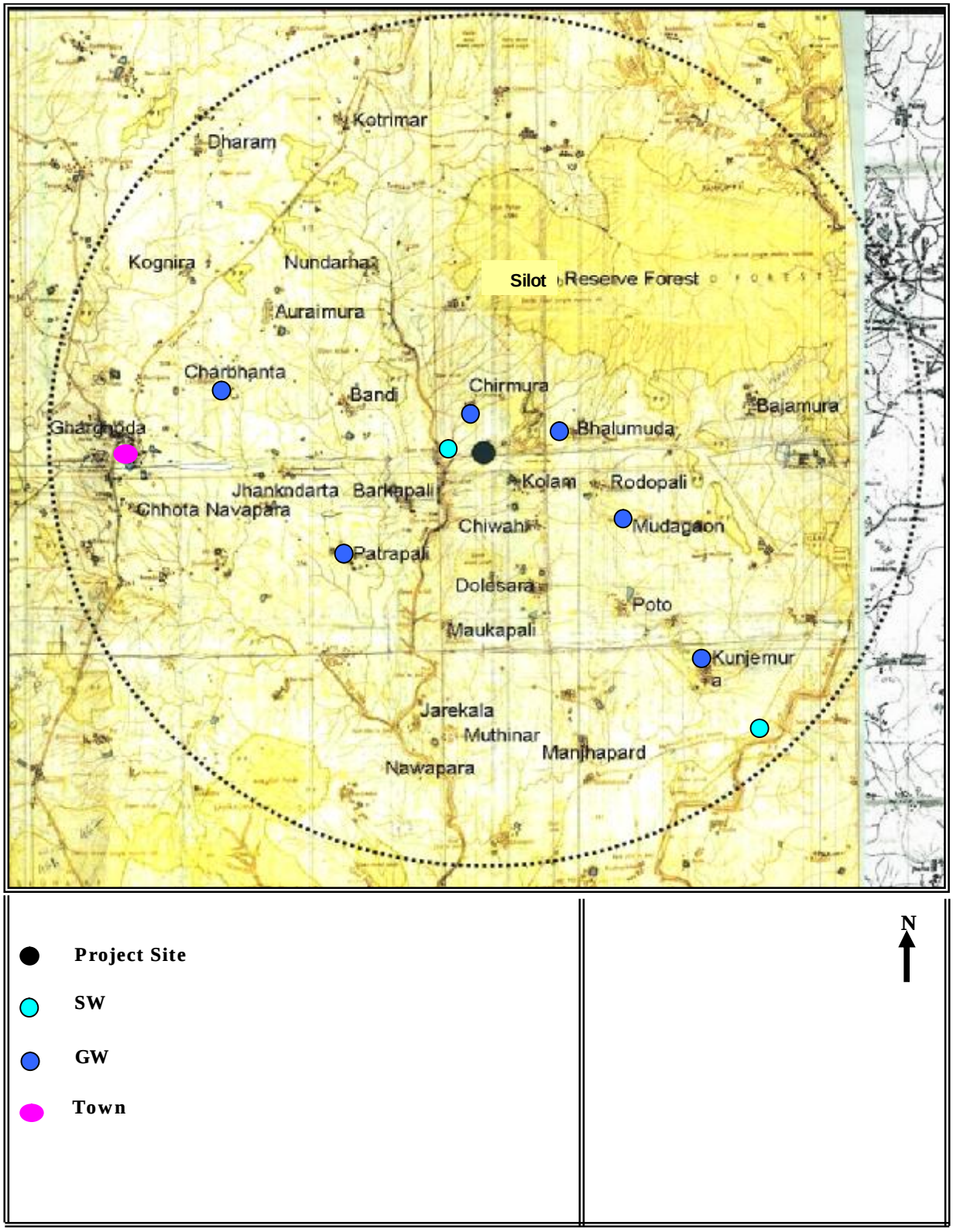


Figure 3.6.1
Water Sampling Locations

3.7 Socio-economic Survey

The growth of industrial sectors and infrastructure developments in and around the agriculture dominant areas, villages and towns are 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-economic status 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 study area. To study the socio-economic aspects of people in the study area around the proposed project site, the required data has been collected from various secondary sources and supplemented by the primary data generated through the process of a limited door to door socio-economic survey.

3.7.1 Methodology adopted for the Study

The methodology adopted for the study is based on the review of secondary data, such as District Census Statistical Handbooks-2001 and the records of National Informatics Center, New Delhi, for the parameters of demography, occupational structure of people within the general study area of 10-km radius around the proposed project site.

3.7.2 Review of Demographic and Socio-Economic Profile - 2001

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 village wise demographic data as per 2001 census is presented in **Annexure-VIII**. The salient features of the demographic and socio-economic details are described in the following sections.

3.7.3 Demography

Distribution of Population

As per 2001 census, the study area consists of 76638 persons. The distribution of population in the study area is given in **Table-3.7.1**. The males and females constitute 49.8% and 50.2% of the study area population respectively.

Table 3.7.1
Distribution of Population

Particulars	Within 10 km Radius Area of Proposed Plant Site
No. of Households	17278
Male Population	38162
Female Population	38476
Total Population	76638
Average Household Size	4.4
Male %	49.8%
Female%	50.2%

Average Household Size

The average household size of the study area is 4.4 persons. The low family size could be attributed to a high degree of urbanization with migration of people with higher literacy levels who generally opt for smaller family size and family welfare measures.

Sex Ratio

The configuration of male and female indicates that the males constitute to about 49.8% and females to 50.2% of the total population as per 2001 census records. 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 1008 females per 1000 males as per 2001 census.

Social Structure

As per 2001 census, the percentage of scheduled caste population is 8.8% within 10-km radius study area. The percentage of Schedule tribe population is 57.0%. The distribution of population by social structure is given in **Table-3.7.2**.

Table 3.7.2
Distribution of Population by Social Structure

Particulars	Within 10 km Radius Area of Proposed Plant Site
Schedule Caste Population	6775
% To the total population	8.8%
Schedule Tribes Population	43757
% To the total population	57.0%
Total SC and ST population	50532
% To total population	65.8%
Other castes population	26106
% To total population	34.2%
Total Population	**76638**

Literacy Levels

The study area experiences an average literacy rate of 60.1%. The distribution of literate and literacy rate in the study area is given in **Table-3.7.3**.

Table 3.7.3
Distribution of Literate and Literacy Rates

Particulars	Within 10 km Radius Area of Proposed Plant Site
Total literate	46067
Average literacy (%)	60.1%
Total population	**76638**

3.7.4 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 labourers, those engaged in live-stock, forestry, fishing, mining and quarrying; manufacturing, processing and repairs in household industry; and other than household industry, construction, trade and commerce, transport and communication 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 be 36.5% of the total population. The marginal workers and non-workers constitute to 14.4% and 49.1% of the total population respectively. The distribution of workers by occupation indicates that the non-workers are the predominant population. The occupational structure of the study area is shown in **Table-3.7.4**.

Table 3.7.4
Occupational Structure

Particulars	**Within 10 km Radius Area of Proposed Plant Site**
Total main workers	27991
% To population of study area	36.5%
Marginal workers	10983
% To population study area	14.4%
Non-workers	37664
% To population study area	49.1%
Total Population in Study area	**76638**

Chapter 4

Anticipated Environmental Impacts and Mitigation Measures

4.1 Identification of Impacts

This chapter presents identification and appraisal of various anticipated impacts of the proposed power plant. The environmental impacts can be categorized as either primary or secondary. Primary impacts are those, which are attributed directly to the project and secondary impacts are those, which are indirectly induced.

The environmental impacts have been assessed assuming that the pollution due to the existing activities in the area where project is planned has already been covered under the present environmental scenario established by the monitored baseline data. Various likely impacts during the construction and operation phase on the environment parameters have been studied to estimate the impact on the environment and are described below.

4.2 Mitigation Measures during Construction Phase

This includes the activities related to leveling of site, construction of structures proposed for the plant and installation of equipments.

4.2.1 Impact on Landuse

The total project area is of 81.0 hectare. It is proposed to develop adequate greenbelt to cover 27.0 ha of the plant area. Clearing of shrubs at some locations is required during construction phase. The plantation will be in about 33% of the total project area, which will, not only improve aesthetic aspects but will also compensate the vegetation loss, which may take place during the construction period.

4.2.2 Impact on Soil

The soil at the project site is predominantly sandy. The sub-strata of this area is not rocky and as such no blasting is envisaged for either leveling or during foundation work since the site is plain and needs very little grading, filling and leveling. The

construction activities will result in loss of topsoil to some extent in the plant area and waste disposal area. The topsoil requires proper handling like separate stacking so that it can be used for green belt development. No significant adverse impact on soil in the surrounding area is anticipated, only temporary impact will be observed due to the construction activities.

4.2.2.1 Mitigation Measures Proposed for Land Environment

The following measures will be adopted:

- After completion of the construction phase, the surplus earth shall be utilized to fill up the low lying areas, the rubble will be cleared and all un-built surfaces will be reinstated;
- The top soil from the excavated areas will be re-used for the plantation;
- Green belt development and related activities will be taken up so that plantation grows to adequate height by the time of plant commissioning. Thus, green belt will be effective in containing the fugitive emissions during operation, if any;
- Local and fast growing plant species will be selected for plantation.
- Entire plant area will be aesthetically landscaped and as much as feasible natural gradient will be maintained;
- There will be minimum concreting of the top surfaces so that there is a scope for maximum ground water recharge due to rainfall; and
- Plantation outside the plant premises, in the near by villages will also be encouraged by supplying free saplings to the villagers as a part of CSR activity.

4.2.3 Impact on Air Quality

During construction phase, dust will be the main pollutant, which will be generated from the site development activities and vehicular movement on the road. Further, concentration of NO_x and CO may also slightly increase due to increased vehicular traffic movement. However, change in ambient concentrations of air quality

will be insignificant. As most of the construction equipment will be mobile, the emissions are likely to be fugitive. The dust generated will also be fugitive in nature, which can be controlled by sprinkling of water. The impacts will be localized in nature and the areas out side the project boundary are not likely to have any significant adverse impact.

4.2.3.1 Air Pollution Management

There will not be any major leveling operations required as the plant site is having a gradual gradient. Hence, no significant excavation of the area except for the purpose of foundations is envisaged. However, during dry weather conditions, it is necessary to control the dust generated by excavation and transportation activities. This will be achieved by regular water sprinkling. Ambient air levels of SO_2 and NOx are expected to increase due to operation of construction machinery such as bulldozers, pay loaders, trucks etc. These levels are expected to be insignificant as these machines will be operated intermittently. More over most of the items are movable. Hence, there will not be any concentration of emissions at any single point. It will be ensured that both gasoline and diesel powered construction vehicles are properly maintained to minimize smoke in the exhaust emissions.

Additional recommendations include the following:

- Sprinkling of water at regular intervals preferably using truck-mounted sprinklers along the roads and work zone areas;
- Electrical power shall be made available near to the site. Attempts to be made to utilize the electrically powered machinery to the extent possible to minimize the emissions of SO_2 and NOx.

4.2.4 Impact on Water Resources and Quality

The water requirement during peak construction period will be about 200 m^3/day, which will be drawn from nearest water reservoir/ River.

The wastewater generation during the construction period will be from the sanitary units provided to the workers. This waste will be treated in STP. Hence, there will not be any impact on the water regime due to discharge of treated wastewater.

4.2.4.1 Water Quality Mitigation Measures

The earth work (cutting and filling) will be avoided during rainy season and will be completed during winter and summer seasons. Stone pitching on the slopes and construction of concrete drains for storm water to minimize soil erosion in the area will be undertaken. Settling pond is planned for storage and recycling of surface water for use in the plant area. Also development of green belt in and around plant will be taken up during the monsoon season. In-plant roads will be concreted. Soil binding and fast growing vegetation will be grown within the plant premises to arrest the soil erosion.

4.2.5 Impact on Noise Levels

The major sources of noise during the construction phase are vehicular traffic, construction equipment like dozers, scrapers, concrete mixers, cranes, pumps, compressors, pneumatic tools, saws, vibrators etc. The operation of these equipments will generate noise ranging between 85-90 dB (A) near the source. These noise levels will be generated within the plant boundary and will be temporary in nature.

4.2.5.1 Noise Levels Mitigation

Equipments will be maintained appropriately to keep the noise level within 85 dB(A). Wherever possible, equipment will be provided with silencers and mufflers. High noise producing construction activities will be restricted to day time only. Greenbelt will be developed from construction stage. Further, workers working in high noise areas will be provided with necessary protective devices e.g. ear plug, ear-muffs etc.

4.2.6 Impact on Ecology

The proposed site is devoid of any major vegetation. A good green belt will be developed within the plant premises will result in the positive shift in the ecological status of the area.

4.2.6.1 Mitigation Measures

Local and fast growing plant species will be planted under greenbelt development programme to enhance green cover in the area as per CPCB guidelines.

4.2.7 Demography and Socio-Economics

It has been brought out during the socio-economic survey that non-workers constitute about 49.1% of the total population in 10 km radius of the proposed project site. Some of them will be offered employment in the proposed project during construction activities. The peak labour force required during the construction period is estimated to be about 300 per day and preference will be given to local labouers particularly unskilled labours. The total employees of power plant during operation period are estimated to be around 700 persons.

In addition to the opportunity of getting employment as construction labourers, the local population would also have employment opportunities based on the educational qualification like petty commercial establishments, small contracts / sub-contracts and supply of construction materials for buildings and ancillary infrastructures etc. Consequently, this will contribute to economic upliftment of the area.

- Local people will be given preference for employment;
- All the applicable guidelines under the relevant Acts and Rules related to labour welfare and safety will be implemented during the construction work;
- The contractor shall be advised to provide fire wood/kerosene / LPG to the workers to prevent damage to trees; and
- The construction site will be secured with fencing and will have guarded entry points.

4.2.8 Storage of Hazardous Material

The hazardous materials used during construction may include petrol, diesel, welding gas and paints. These materials will be stored and handled carefully under applicable safety guidelines.

Some of the precautions of storage include the following:

- Dyked enclosures will be provided so as to contain complete contents of the largest tank;

- Diesel and other fuels will be stored in separate dyke enclosures;
- Tanks having sufficient diameter shall be separated by fire insulating walls from other storage tanks; and
- The distance between the storage tanks shall be at least half their height.

4.2.9 Facilities to be provided by the Labour Contractor

The contractor shall be asked to provide following facilities to construction work force:

First Aid

At work place, First Aid facilities will be maintained at a readily accessible place where necessary appliances including sterilized cotton wool etc. will be available. Ambulance facilities will be kept ready available at workplace to take injured person to the nearest hospital.

A reasonably equipped dispensary will be established for the use of workers as well as local population.

Potable Water

Sufficient supply of drinking water will be provided from the filtered water storage tank.

Sanitary Facility

Within the vicinity of work place, latrines and urinals will be provided at accessible places. These will be cleaned at least twice during working hours and kept in a good sanitary condition. The contractor will conform to sanitary requirement of local medical and health authorities at all times.

Canteen

A canteen on a moderate scale will be provided.

Security

SEML will provide necessary security to work force in co-ordination with State authorities.

4.3 Impacts during Operational Phase and Mitigation Measures

For the purpose of impact assessment during the operational phase, the following components have been considered although some of these will be overlapping:

- Land use;
- Topography and climate;
- Air quality;
- Water resources and quality;
- Noise levels;
- Soil quality
- Terrestrial ecology;
- Aquatic ecology;
- Traffic load;
- Demography and socio-economics; and
- Infrastructural facilities.

4.3.1 Impact on Landuse

SEML acquired 81.0 hectares of land for the proposed project. It is proposed to develop adequate greenbelt to cover about 27.0 ha of the plant area. The development of green belt in and around the project site is expected to mitigate the impact due to ground cover clearing for erecting the proposed plant. Adequate rainwater harvesting measures will be implemented to utilize the storm water inside plant premises.

4.3.2 Topography and Climate

The proposed project site is fairly flat with shrubs present at some places. There will not be much cutting and felling of trees required for the proposed project. The structures such as industrial buildings, stacks, waste disposal facilities etc. will be constructed. There will not be any tall structures except stacks.

4.3.3 Impact on Air Quality

The sources of air pollution in the process due to the proposed facilities have been identified and quantified. Particulate matter, Sulphur dioxide (SO_2) and Oxides of Nitrogen (NOx) emissions will be the main pollutants. The incremental ground level concentrations from the proposed facilities have been estimated by dispersion modeling.

Details of Mathematical Modeling

Industrial Source Complex Short-Term (ISCST3) dispersion model based on steady state Gaussian plume dispersion model, designed for multiple point sources for short term has been used for predicting the ground level concentrations. The computations deal with major pollutants like Sulphur dioxide and Suspended Particulate Matter and Oxides of Nitrogen.

Model options used for computations

The options used for short-term computations are:

- The plume rise is estimated by Briggs formulae, but the final rise is always limited to that of the mixing layer;
- Stack tip down wash is not considered;
- Buoyancy induced dispersion is used to describe the increasing plume dispersion during the ascension 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 that there is no pollutant removal by dry deposition;
- Washout by rain is not considered; and
- Cartesian co-ordinate system has been used for computations.

Meteorological Input Data to the Model

The hourly meteorological data recorded at site is converted to the mean hourly meteorological data as specified by CPCB and the same has been used in the model. In absence of site specific mixing depths, mixing depths published in "Spatial Distribution of hourly Mixing Depths over Indian Region" by Mr. R.N. Gupta have been used.

Model Input Data

The air pollution modeling carried out represents the worst case scenario. During the normal operating conditions, the pollutant concentration will be much less than the worst case scenario projected in the following paragraphs. The pollutants considered for modeling include sulphur dioxide, suspended particulate matter, Oxides of Nitrogen. The details of the stack and emissions envisaged from the proposed plant are given in **Table-4.1.** The details of emission calculations and hourly average meteorological data are enclosed as **Annexure IX.**

Presentation of Results

The simulations were done to evaluate SPM, SO_2, and NO_X likely to be contributed by the proposed plant. For the short term simulations, the concentrations were estimated around the site in 10-km radius covering 16 directions. The incremental concentrations are estimated for winter season.

Table-4.1
Details of Stack Emissions

Sr. No.	Particulars	Unit	Stack (50 MW + 30 MW Unit)	Stack (2x135 MW)
1	Height	m	110	180
2	Diameter	m	3.5	5.0
3	Stack Temp.	^{0}C	135	135
4	Fuel Requirement	TPD	1745	5890
5	Velocity	m/s	22	22
6	Volumetric Flow Rate	Nm^3/sec	154.7	315.6
Proposed Emission				
A	SPM	mg/Nm^3	50	50
		g/sec	7.73	15.8
B	SO_2 (Sulphur Content 0.4%)	g/sec	161.6	545.4
C	NOx (4.5 kg/ton)	g/sec	91.0	307.0

Resultant Concentrations after Implementation of the 350 MW Thermal power Plant

The maximum incremental GLCs due to the proposed project for SPM, SO_2 and NOx are superimposed over the maximum baseline SPM, SO_2 and NOx concentrations recorded during the study period in the south direction to arrive at the likely resultant concentrations. The isopleths for pollutants SPM, SO_2 and NOx are presented in **Figure 4.1** to **4.3.**

The resultants and incremental concentrations of SPM, SO_2 and NOx are shown in the **Table 4.2.** The predicted GLCs are potentially insignificant and the resultant values are well below the prescribed limit for residential and rural zone.

Table 4.2
Resultant GLC'S of Pollutants

All values in **µg/m^3**

Sr. No.	Parameters	Distance/ Direction	Baseline Conc.	Incremental Conc.	Resultant Conc.
1	SPM	2.0 km/SE	156	0.73	156.73
2	SO_2	2.0 km/SE	10	21.4	31.4
3	NOx	2.0 km/SE	12	12.0	24.0

Maximum Permissible Value SPM: 200µg/m^3 (CBCB Standards)
SO_2: 80µg/m^3 (CBCB Standards)
NO_x: 80µg/m^3 (CBCB Standards)

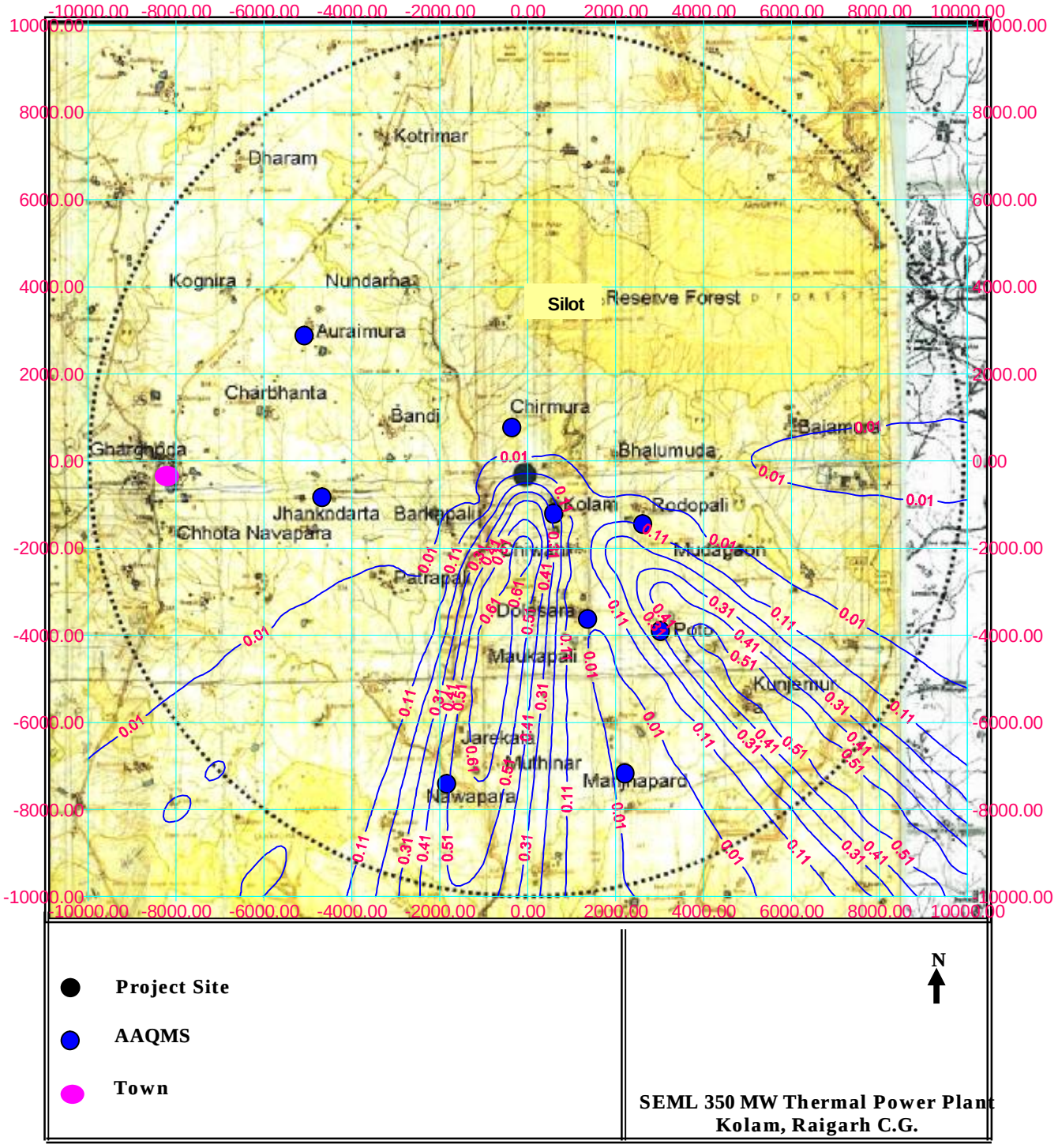


Figure-4.1
Short Term 24 Hourly Incremental GLCs of SPM

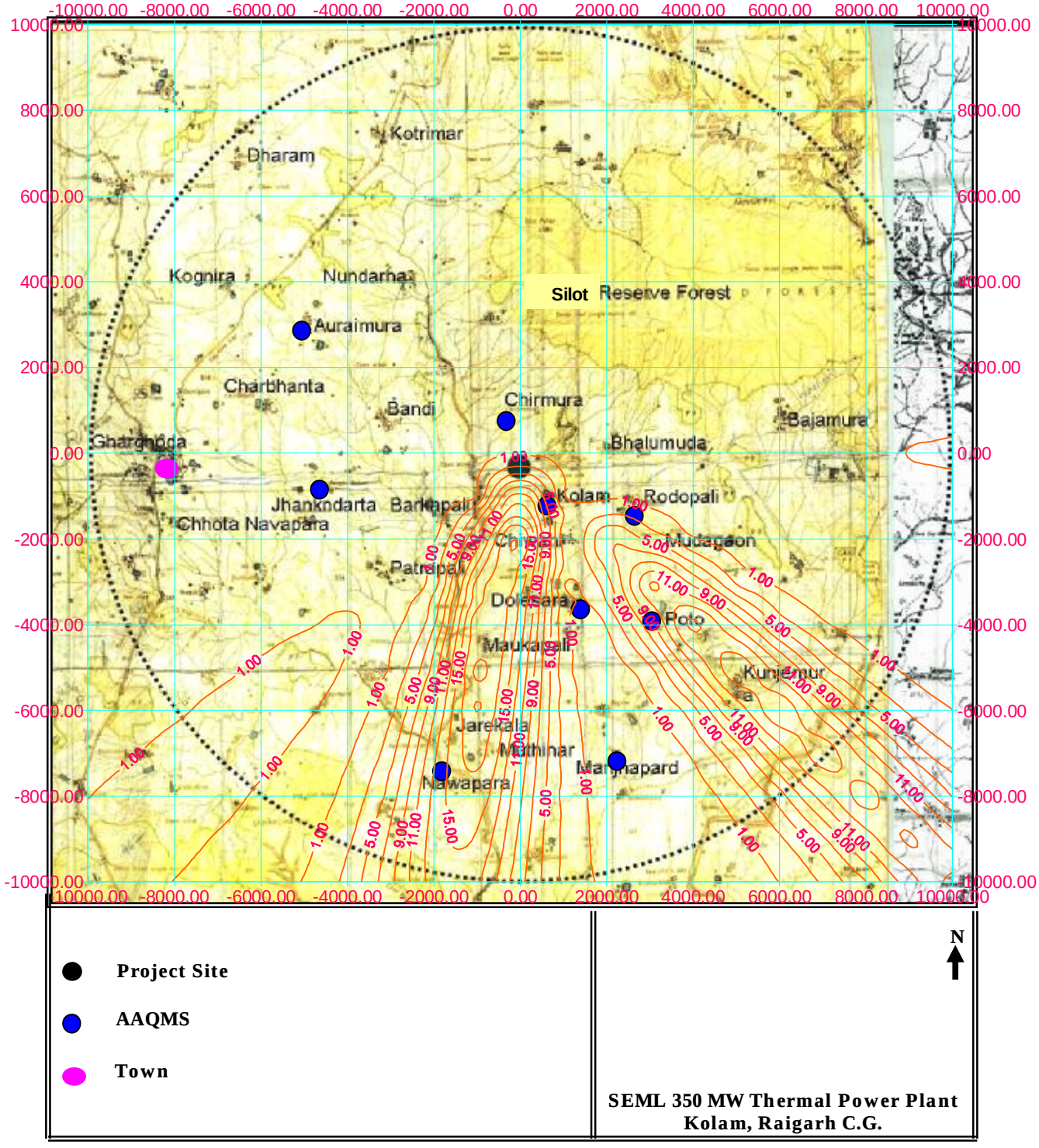


Figure-4.2
Short Term 24 Hourly Incremental GLCs of SO_2

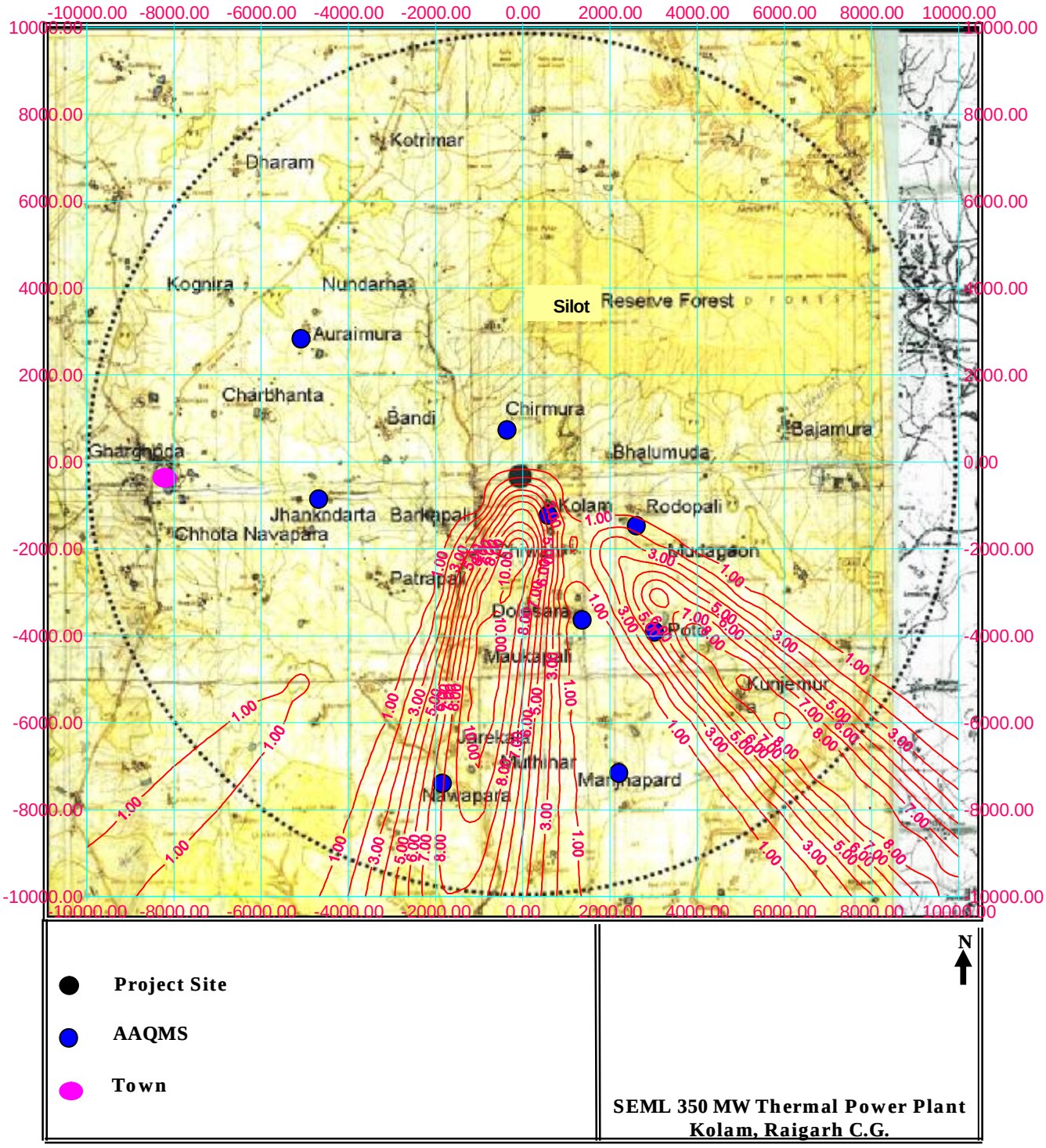


Figure-4.3
Short Term 24 Hourly Incremental GLCs of NOx

4.3.4 Impact of Traffic on Air Quality

After implementation of proposed plant, there will be increase in traffic flow on nearest road due to movement of bulkars carrying ash of proposed plant. The extent of these impacts, at any given time, will depend upon (i) the rate of vehicular emission within a given stretch of the road and (ii) the prevailing meteorological conditions. The impacts will have strong temporal dependence as both of these factors vary with time. The temporal dependence would have diurnal, seasonal as well as long term components.

The air quality predictions have been carried out for line source by using the air quality model CALINE-4 developed by California Department of Transportation. The model is based on Gaussian diffusion equation and uses a mixing zone concept to characterize pollutant dispersion over the roadway. The model has been extensively tested for its predictive capability for traffic related air quality impacts. Given the source strength, meteorology, site geometry and site characteristics, the model can reliably predict pollutant concentrations for receptors located within 150 m of the roadway, the most important region for estimating the impacts due to the low elevation emissions.

Proposed Traffic

The proposed additional traffic mainly includes trucks and bulkars, which are used to transport raw coal and flyash. Hence, only heavy traffic is considered in assessing the impact of traffic. The proposed truck traffic due to proposed activity is considered in assessing the impact on surrounding area. The total proposed traffic details are given in **Table-4.3.**

Table-4.3
Proposed Additional Traffic due to the project

Material	Quantity (TPD)	Capacity of trucks carrying material (Tonnes)	Number of daily trucks
Raw Coal	5803	30	193
Flyash	2715	40	68

The additional traffic due to proposed power plant will be 261 trucks per day.

Emission Factors

The emission standards for Indian vehicles as proposed by the Indian Institute of Petroleum (IIP) have been used to provide the emission factors for the different vehicle types. Emission factors after accounting for the vehicle speeds are as specified in **Table-4.4.**

Table-4.4
Emission Factors

All values are in gm/km/vehicle*

Trucks/Buses		Cars		Two & Three Wheelers	
CO	**NOx**	**CO**	**NOx**	**CO**	**NOx**
10.67	18.97	2.72	0.970	4.0	1.5

Note: To be multiplied by 1.6 for converting into gm/mile for use in CALINE4.

Meteorological Data

Air quality scenarios were developed for worst case stability classes using the wind speeds. The meteorological data considered for the modeling studies is given below in **Table-4.5**.

Table-4.5
Meteorological Data Considered for Modeling

Stability Class	Wind Speed (m/sec)
A	1.0
B	2.0
C	3.0
D	5.0
E	2.0
F	2.0

Details of Road

For model computations Right of Way (ROW) of 20-m has been considered for perusal of violations of standards and accordingly receptor locations have been chosen to account for its location with respect to edge of ROW.

Results and Discussions for Traffic Impact

The general observation reveals that the maximum concentration occurs at 20-m from the edge of the road, and the incremental concentration is about 2.3 µg/m^3 for NOx which are well within the permissible limit.

4.3.5 Air Pollution Management

4.3.5.1 Reducing Air Pollution in Proposed Power Plant

Major pollutants envisaged from the proposed power plant are Particulate Matter, Sulphur dioxide and Oxides of Nitrogen. The baseline ambient air quality levels in the project area are within the permissible limits as specified by regulating agency. The following methods of abatement will be employed for the air pollution control.

- Particulate matter will be controlled below 50 mg/Nm^3 by providing efficient Electrostatic Precipitators (ESPs);
- Further, two stacks of 110-m and 180 m heights will be provided for adequate dispersion of sulphur dioxide;
- Emission of NOx will be controlled by designing low NOx burners;
- Adequate dust suppression system like fog type and water spray system shall be installed in the material handling system / transfer points;
- Green belt shall be provided around the plant area. Plantation along the internal roads in the plant premises will also be undertaken;
- All the internal roads shall be concreted / asphalted to reduce the fugitive dust due to vehicular movement; and
- Water spraying will be practiced frequently at coal stockyard.

4.3.5.2 Stack Gas Monitoring

The emissions from the stacks shall be regularly monitored for exit concentration of Sulphur dioxide, Nitrogen oxides and SPM. Sampling ports shall be provided in the stacks according to CPCB guidelines.

4.3.6 Impact on Water Resources and Water Quality

Impact on Water Resources

The water requirement for the proposed plant will be about 1240 m^3/hr, which will be met from Kelo River. Necessary permissions will be obtained from the concerned authorities. There will be not any impact on the water resources as no wastewater will be discharged outside the factory premises.

Impact on Water Quality

The water balance and wastewater streams have been described in **Chapter 2**. The amount of the wastewater generated will be 205 m^3/hr. This wastewater will be having quality which confirms to the discharge standards and will be utilized within the plant for process, cooling and greenbelt purposes. No effluent will be discharged outside the proposed plant premises. Hence, there will be no impact on the water regime due to the effluents from the proposed unit.

Storm water from Plant drains during Monsoon

Storm water recharge pits will be provided in the plant. These pits retain the storm water during monsoon season. In addition, these ponds also serve as buffer storage for any spillages, overflows and washings from different sections of the plant. This volume will be adequate for the proposed facilities which will be connected through additional plant drains. The run-off collected in these ponds will be recycled to the extent possible. Discharge, if any during monsoon period will be after complying with the permissible standard.

Mitigation / Management Measures

- The wastewater will be treated and reused for greenbelt development;
- The plant shall be operated on the zero discharge concept and no wastewater will be discharged out side the plant

4.3.7 Impact of Solid Wastes

The main solid waste from the proposed Power Plant will be ash (Fly ash and Bottom ash). The ash generation of about 3394 TPD. Out of this, the bottom ash will be about 20% of the total bottom ash generated i.e. 679 TPD and the fly ash will be about 2715 TPD. It is proposed to utilize 100% of the fly ash generated. During emergency the

ash will be disposed off safely in ash pond area to avoid environmental hazards. All efforts, however, will be made to utilize fly ash for various purposes. Unused fly ash will be disposed off in the ash pond. To control fugitive dust emission from the ash pond area water sprinkling would be done. After the ash pond is abandoned, its area will be reclaimed through tree plantation.

Ash Utilization and Management

The fly ash can be used for the manufacture of cement. It can also be utilized in mass concrete / construction. Ash can also be used for a number of other purposes such as:

- Brick preparation
- Soil stabilization
- As a filler layer under road pavements

The fly ash utilization and Management Plan are presented below:

Particular	1st Year	2nd Year	3rd Year	4th Year	5th Year
Total Ash	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**
Use in brick plant	0.01	0.01	0.01	0.02	0.02
Fly ash use in micro nutrition as fertilizers	0.01	0.01	0.01	0.01	0.01
Use in clay brick 50% total production	0.02	0.02	0.02	0.02	0.02
Road development in surrounding area	0.03	0.03	0.03	0.04	0.04
Use of Pozzolnic Material cement	0.4	0.55	0.65	0.75	0.81
Total fly ash consumption	**0.47**	**0.62**	**0.72**	**0.84**	**0.9**
% of use of flyash	**52.2**	**68.9**	**80**	**93.3**	**100**
Surplus Ash	**0.43**	**0.28**	**0.18**	**0.06**	**0**
Total Surplus ash before 100% utilization	**0.95**				

Note: Actual fly ash utilization may vary depending on demand. However, 100% utilization is planned from 5th year onwards.

4.3.8 Impact on Noise Levels

The noise levels at the source for these units will be in the range of 65-85 dB (A), which will get attenuated with increase in distance from its sources.

Mathematical Model for Sound Wave Propagation during Operational phase

For an approximate estimation of dispersion of noise in the ambient air 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:

$$L_{p2} = L_{p1} - 20\log\left(\frac{r_2}{r_1}\right) \quad (1)$$

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 the following equation.

$$L_{p(total)} = 10\log\left(10^{(L_{p1}/10)} + 10^{(L_{p2}/10)} + 10^{(L_{p3}/10)} \ldots\ldots\right) \quad (2)$$

Where, L_{p1}, L_{p2}, L_{p3} are noise pressure levels at a point due to different sources. The details of the model are as follows:

- Maximum number of sources is limited to 200;
- Noise levels can be predicted at any distance specified from the source;
- Co-ordinates of the sources in meters;
- Maximum and Minimum levels are calculated by the model;
- Output of the model in the form of isopleths; and
- Environmental attenuation factors and machine corrections have not been incorporated in the model but corrections are made for the measured L_{eq} levels.

The major noise generating sources from the proposed plant are listed in **Table 4.6.** These are considered as input to the noise model.

Table-4.6

Noise Generating Sources in plant

Sr. No.	Source	Maximum Noise Level dB(A)
1	Cooling tower	65.0-70.0
2	Air compressor	80.0-85.0
3	Transformer	70.0-75.0
4	Boiler	80.0-85.0

Presentation of Results

The modeling exercise results are discussed below and are represented through contours in **Figure 4.4**.

Prediction of Impacts

The predicted incremental noise levels at the boundary of the plant are in the range 34 to 41 dB (A).

Impact on Work zone

The equipment with significant continuous noise levels are turbine unit, cooling tower, air compressor, transformer and boiler. However, impacts on the working personnel are not expected to be significant on account of the high level of automation of these plant equipment, which means that workers will be exposed for short duration only that too intermittently. In addition to that personnel protective equipment like ear plugs will be provided to the workers working in the high noise zones.

4.3.8.1 Noise Pollution Management

As per model results, the incremental noise levels due to the proposed plant will be in the range of 34 dB (A) to 41 dB (A) at 400 m from the source. The ambient noise levels in the region are within permissible limits and are envisaged to be within the permissible limits even after commissioning of the proposed facilities.

The measured noise level produced by any equipment will not exceed 85 dB(A) at a distance of 1.0-m from its source in any direction under any load condition. The noise produced in valves and piping associated with handling compressible and incompressible fluids will be attenuated to 75 dB(A) at a distance of 1.0 m from the source by adopting low noise trims baffle plate silencers / line silencers acoustic lagging (insulation) thick-walled pipe work depending upon the requirement.

Safety valves will be provided on the steam drum and its number and capacity will conform to the code requirements. From safety relief valves, noise levels will not exceed 95 dB(A) for one-quarter hour or less per day.

Noise Control at the Community Level

Ambient noise levels out the plant boundary will not get effected due to the plant operation.

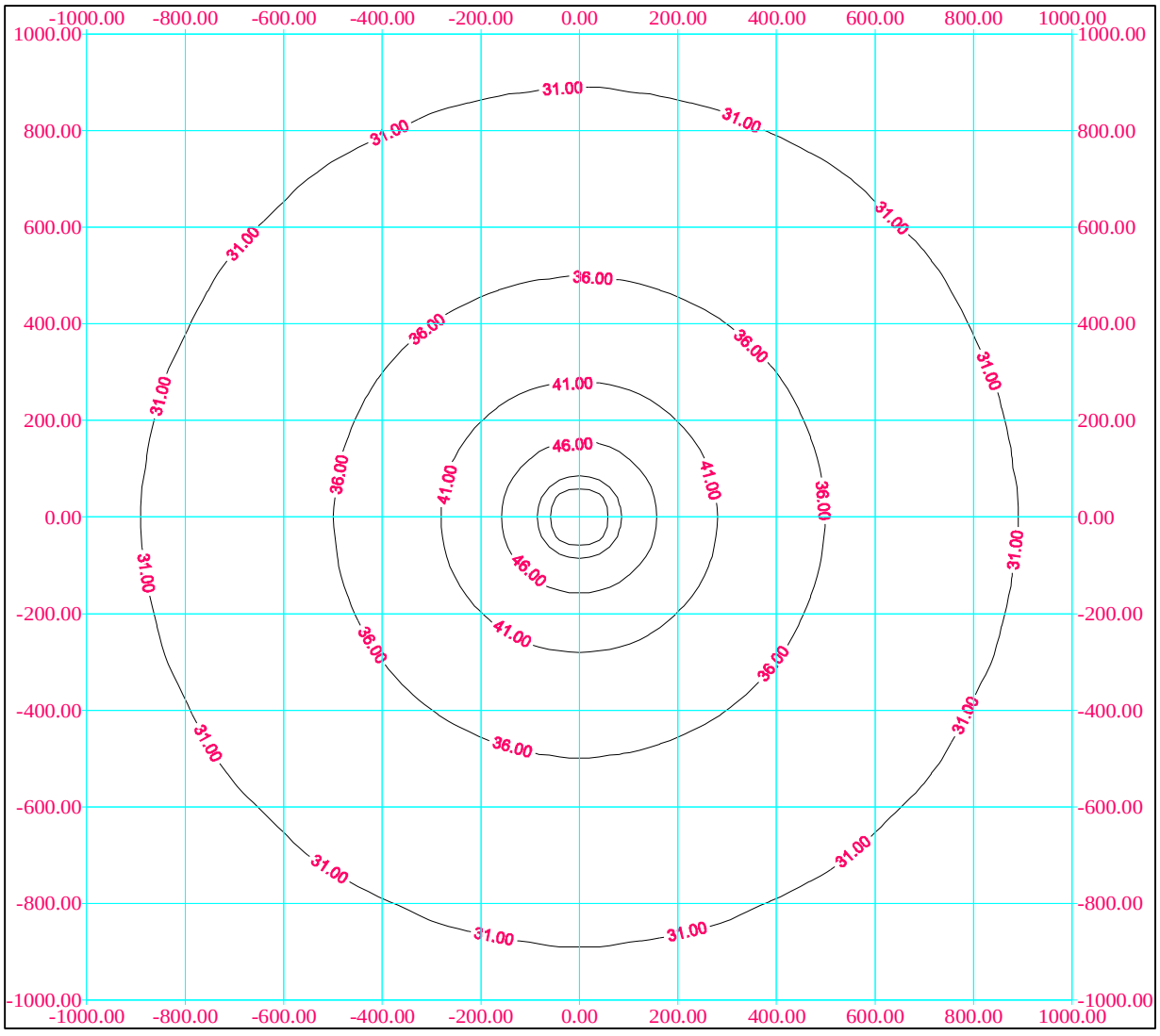


Figure-4.4
Noise Dispersion Contour

4.3.9 Impact on Soil

No chemical process is involved in the proposed project. As such, there will not be any soil contamination. Ash will be the main solid waste, which will be properly collected and stored in silos and in ash pond until its end users are identified.

4.3.10 Impact on Ecology

Impacts on Terrestrial Ecology - Operational Phase

The impact on terrestrial ecology may be felt due to emission of gaseous pollutants like SO_2, SPM and NOx, if mitigation measures are not taken as recommended in this report.

Presentation of Modeling Results

The simulations were done to predict concentrations of SO_2, NOx and SPM that are likely to be contributed by the proposed plant. The concentration of these pollutants predicted, were found to be below the permissible limit of CPCB and hence impacts will be insignificant.

Impact on Aquatic Ecology

The unit will be operating on zero effluent discharge principle. There is no perennial nallas or stream present in the study area; as such no impact on aquatic ecology is anticipated.

4.3.11 Impact on Socio-Economics

Impacts on Employment Generation

The requirement of 700 skilled / unskilled persons will be met from nearby villages during construction phase, in addition to some regular employment during the operational phase. The project will help in generation of significant indirect employment. This will have positive socio-economic development in the region. There will be in general upliftment of standard of living of the people in the region.

4.4 Indirect Impacts

4.4.1 Impacts on Public Health and Safety

Effective implementation of measures suggested for pollution control will ensure safety and health of the public in the study area.

Chapter 5

Environmental Monitoring Programme

5.1 Environmental Monitoring

The environmental monitoring is important to assess performance of pollution control equipments installed at the project site. The sampling and analysis of environmental attributes including monitoring locations will be as per the guidelines of the Central Pollution Control Board.

- Environmental monitoring will be conducted on regular basis by SEML to assess the pollution level in and around the project area.

The attributes, which require regular monitoring, are specified underneath:

- Air quality;
- Water and wastewater quality;
- Noise levels;
- Soil quality;
- Afforestation and
- Socio Economic aspects and community development
- A comprehensive monitoring program is suggested in **Table-5.1**.

Table-5.1
Monitoring Schedule for Environmental Parameters

Sr. No.	Particulars		Monitoring Frequency	Method of Sampling	Parameter
I	**Air Pollution & Meteorology**				
	A	**Stack Monitoring**			
	1	Main Stack		Online	Particulate matter
	B	**Air Quality Monitoring**			
	1	Six locations in and around the plant	Once in month	24 hr continuously-HVS	SPM, RPM, SO_2, NO_x

Sr. No.	Particulars		Monitoring Frequency	Method of Sampling	Parameter
	2	Work zone monitoring	Twice in a month	High volume sampler	do
	C	**Fugitive Emissions**			
		Raw material handling, feed area, and other areas specified by SPCB	Twice in a month	8-hour basis with High Volume Sampler	SPM & RPM
II	**Water and Wastewater Quality**				
	A	**Water Quality**			
	1	Ground Water	Once in a season	Grab	Parameters specified under IS:2296 (Class C) and IS:10500
	B	**Industrial Effluents**			
		Treated wastewater, if to be discharged out side the plant during monsoon	Once in 15 days	24 hr composite	pH, SS, and O& G
III	**Ambient Noise Levels**				
	1	On the Plant Boundary at three locations	Once in three months	24 hr continuous with one hr interval	Noise levels in dB(A)
	2.	Surrounding Area	Once in each season for ambient noise levels	24 hr continuous with one hr interval	Noise levels in dB(A)
IV	**Soil Quality**				
		In and around the plant	Once in Pre-Monsoon and Post Monsoon season	Grab	Physio-chemical parameters and metals

5.2 Monitoring Methods & Data Analysis of Environmental Monitoring

All environmental monitoring and relevant operational data will be stored in a relational database. This will enable efficient retrieval and storage and interpretation of the data. Regular data extracts and interpretive reports will be sent to the regulator.

5.2.1 Air Quality Monitoring and Data Analysis

5.2.1.1 Stack Monitoring

The emissions from all the stacks shall be monitored regularly. The exit gas temperature, velocity and pollutant concentrations shall be measured. Any unacceptable deviation from the design values shall be thoroughly examined and appropriate action shall be taken. Air blowers shall be checked for any drop in exit gas velocity.

5.2.1.2 Workspace Monitoring

The concentration of air borne pollutants in the workspace/work zone environment shall be monitored periodically. If concentrations higher than threshold limit values are observed, the source of fugitive emissions shall be identified and necessary measures taken. Methane and non-methane hydrocarbons shall be monitored in oil storage area once in a season. If the levels are high suitable measures as detailed in EMP shall be initiated.

5.2.1.3 Ambient Air Quality Monitoring

The ground level concentrations of SPM, SO_2 and NOx in the ambient air shall be monitored at regular intervals. Any abnormal rise shall be investigated to identify the causes and appropriate action shall be initiated. Greenbelt shall be developed for minimizing dust propagation. The ambient air quality data should be transferred and processed in a centralized computer facility equipped with required software. Trend and statistical analysis should be done.

5.2.2 Water and Wastewater Quality Monitoring and Data Analysis

To ensure a strict control over the water consumption, flow meters shall be installed for all major inlets. All leakages and excess shall be identified and rectified. In addition, periodic water audits shall be conducted to explore further possibilities for water conservation.

5.2.2.1 Monitoring of Wastewater Streams

All the wastewater streams in the project area shall be regularly analyzed for flow rate and physical and chemical characteristics. Such analysis is carried out for wastewater at the source of generation, at the point of entry into the wastewater treatment plant and at the point of final discharge. These data shall be properly documented and compared against the design values for any necessary corrective action.

5.2.2.2 Monitoring of Groundwater

The monitoring of groundwater is the most important tool to test the efficiency of ash pond performance. This is indispensable as it provides detection of the presence of waste constituents in groundwater in case of leachate migration. In this programme, water samples are taken at a predetermined interval and analysed for specific pollutant expected to be in the leachate. For early detection of leachate migration, if any, it is suggested to construct Piezometers around the ash pond site.

In addition to Piezometers, monitoring wells should be installed to a depth of at least 3-m below the maximum historic groundwater depth. Based on assumptions and data about the characterstics of leachate to be generated, approximate permeability of soils in the zone of aeration and direction and velocities of groundwater flow, the maximum probable aerial extent of contaminant migration can be estimated as a basis for establishing the position of monitoring wells.

A minimum of two ground monitoring wells should be typically installed at ash disposal facility : one up-gradient well and one down-gradient well. It is suggested to collect water samples and analyse. Records of analysis should be maintained.

5.2.3 Noise Levels

Noise levels in the work zone environment such as boiler house, cooling tower area, DG house shall be monitored. The frequency shall be once in three months in the work zone. Similarly, ambient noise levels near habitations shall also be monitored once in three months. Audiometric tests should be conducted periodically for the employees working close to the high noise sources.

5.3 Reporting Schedules of the Monitoring Data

It is proposed that voluntary reporting of environmental performance with reference to the EMP should be undertaken.

The environmental monitoring cell shall co-ordinate all monitoring programmes at site and data thus generated shall be regularly furnished to the State regulatory agencies.

The frequency of reporting shall be on six monthly basis to the local state PCB officials and to Regional office of MoEF. The Environmental Audit reports shall be prepared for the entire year of operations and shall be regularly submitted to regulatory authorities.

5.4 Infrastructure for Monitoring of Environmental Protection Measures

A well-equipped laboratory with consumable items shall be provided for monitoring of environmental parameters in the site. Alternatively, monitoring can be outsourced to a recognized reputed laboratory.

The following equipment and consumable items shall be made available in the site for environmental monitoring or alternatively the monitoring can be outsourced by engaging a reputed authorized environmental laboratory.

5.4.1 Air Quality and Meteorology

High volume samplers, Stack monitoring kit, Personal Dust sampler, Central Weather Monitoring Station, Spectrophotometer (visible range), Single pan balance, Flame photometer, Relevant Chemicals as per IS : 5182.

5.4.2 Water and Wastewater Quality

The sampling shall be done as per the standard procedures laid down by IS : 2488. The equipments and consumables required are :

BOD incubator, COD reflex set-up, Refrigerator, Oven, Stop watch, Thermometer, pH meter, Distilled water plant, Pipette box, Titration set, Dissolve oxygen analyzer, Relevant chemicals.

5.4.3 Noise Levels

Noise monitoring shall be done utilizing an integrating sound level meter to record noises levels in different scales like A- weighting with slow and fast response options.

Chapter 6

Additional Studies

6.1 Risk Assessment

Hazard analysis involves the identification and quantification of the various hazards (unsafe conditions) that exist in the plant. On the other hand, risk analysis deals with the identification and quantification of risks, the plant equipment and personnel are exposed to, due to accidents resulting from the hazards present in the plant.

Risk analysis follows an extensive hazard analysis. It involves the identification and assessment of risks the neighboring populations are exposed to as a result of hazards present. This requires a thorough knowledge of failure probability, credible accident scenario, vulnerability of population etc. Much of this information is difficult to get or generate. Consequently, the risk analysis is often confined to maximum credible accident studies.

In the sections below, the identification of various hazards, probable risks in the Power plant after de-bottlenecking project, maximum credible accident analysis, consequence analysis are addressed which gives a broad identification of risks involved in the plant. Based on the risk estimation for fuel and chemical storage, Disaster Management Plan (DMP) has been prepared.

6.1.1 Approaches to the Study

Risk involves the occurrence or potential occurrence of some accidents consisting of an event or sequence of events. The risk assessment study covers the following:

- Identification of potential hazard areas;
- Identification of representative failure cases;
- Visualization of the resulting scenarios in terms of fire (thermal radiation) and explosion;

- Assess the overall damage potential of the identified hazardous events and the impact zones from the accidental scenarios;
- Assess the overall suitability of the site from hazard minimization and disaster mitigation points of view;
- Furnish specific recommendations on the minimization of the worst accident possibilities; and
- Preparation of broad Disaster Management Plan (DMP), On-site and Off-site Emergency Plan, which includes Occupational and Health Safety Plan.

6.1.2 Hazard Identification

Identification and cost effective control of accidents involving chemicals and process. A classical definition of hazard states that hazard is in fact the characteristic of system/plant/process that presents potential for an accident. Hence, all the components of a system/plant/process need to be thoroughly examined to assess their potential for initiating or propagating an unplanned event/sequence of events, which can be termed as an accident. The following two methods for hazard identification have been employed in the study:

- Identification of major hazardous units based on Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989 of Government of India (GOI Rules, 1989); and
- Identification of hazardous units and segments of plants and storage units based on relative ranking technique, viz. Fire-Explosion and Toxicity Index (FE&TI). Quantification of hazards in power plant is of primary significance in the analysis,

6.1.2.1 Classification of Major Hazardous Units

Hazardous substances may be classified into three main classes namely Flammable substances, unstable substances and Toxic substances. Flammable substances require interaction with air for their hazard to be realized. Under certain circumstances the vapours arising from flammable substances when mixed with air may be explosive, specially in confined spaces. However, if present in sufficient quantity such clouds may explode in open air also. Unstable substances are liquids or solids, which

may decompose with such violence so as to give rise to blast waves. Finally, toxic substances are dangerous and cause substantial damage to life when released into the atmosphere. The ratings for a large number of chemicals based on flammability, reactivity and toxicity have been given in NFPA Codes 49 and 345 M. No additional storages are proposed for fuel and chemicals. The storage facilities planned for the projects under implementation will be utilized in the proposed project. The fuel and chemical storage in the plant are given in **Table-6.1.**

Table-6.1
Category wise Schedule of Storage Tanks

Sr. No.	Material	No. of Tanks	Design Capacity (Total)	Classification
1	LDO	Single	4.5 KL	Flammable

6.1.3 Identification of Major Hazard Installations Based on GOI Rules, 1989

Following accidents in the chemical industry in India over a few decades, a specific legislation covering major hazard activities has been enforced by Govt. of India in 1989 in conjunction with Environment Protection Act, 1986. This is referred here as GOI rules 1989. For the purpose of identifying major hazard installations the rules employ certain criteria based on toxic, flammable and explosive properties of chemicals.

6.1.4 Analysis of Units of Different Processes

A systematic analysis of the fuels/chemicals and their quantities of storage has been carried out, to determine threshold quantities as notified by GOI Rules, 1989 and the applicable rules are identified. Applicability of storage rules is summarized in **Table-6.2.**

Table-6.2
Applicability of GOI rules to fuel/chemical storage

Sr. No.	Chemical/Fuel	Listed in Schedule	Total Quantity	Threshold Quantity (T) for Application of Rules	
				5,7-9,13-15	10-12
1	LDO	3 (1)	4.5 KL	25 MT	200 MT

6.1.5 Fire Explosion and Toxicity Index (FE&TI) Approach

Fire, Explosion and Toxicity Indexing (FE & TI) is a rapid ranking method for identifying the degree of hazard. The application of FE & TI would help to make a quick

assessment of the nature and quantification of the hazard in these areas. However, this does not provide precise information. Respective Material Factor (RMF), General Hazard Factors (GHF), Special Process Hazard Factors (SPHF) are computed using standard procedure of awarding penalties based on storage, handling and reaction parameters. Before hazard indexing can be applied, the installation in question should be subdivided into logical, independent elements or units. In general, a unit can logically be characterized by the nature of the process that takes place in it. In some cases, the unit may consist of a plant element separated from the other elements by space or by protective walls. A plant element may also be an apparatus, instrument, section or system that can cause a specific hazard. For each separate plant process, which contains flammable or toxic substances, a fire and explosion index F and/or a toxicity index T may be determined in a manner derived from the method for determining a fire and explosion index developed by the Dow Chemical Company.

6.1.5.1 FE and TI Methodology

Dow's Fire and Explosion Index (F and EI) is a product of Material Factor (MF) and hazard factor (F3) while MF represents the flammability and reactivity of the substances, the hazard factor (F3), is itself a product of General Process Hazards (GPH) and special process hazards (SPH). An accurate plot plan of the plant, a process flow sheet and Fire and Explosion Index and Hazard Classification Guide published by Dow Chemical Company are required to estimate the FE & TI of any process plant or a storage unit.

6.1.5.2 Computations and Evaluation of Fire and Explosion Index

The Fire and Explosion Index (F and EI) is calculated from the following formula:

The degree of hazard potential is identified based on the numerical value of F&EI as per the criteria given below:

F&EI Range	Degree of Hazard
0-60	Light
61-96	Moderate
97-127	Intermediate

128-158	Heavy
159-up	Severe

6.1.5.3 Toxicity Index (TI)

The toxicity index is primarily based on the index figures for health hazards established by the NFPA in codes NFPA 704, NFPA 49 and NFPA 345.

6.1.5.4 Classification of Hazard Categories

By comparing the indices F&EI and TI, the unit in question is classified into one of the following three categories established for the purpose **(Table-6.3)**.

Table-6.3
Fire explosion and Toxicity Index

Category	Fire and Explosion Index (F&EI)	Toxicity Index (TI)
I	F&EI < 65	TI < 6
II	65 < or = F&EI < 95	6 < or = TI < 10
III	F&EI > or = 95	TI > or = 10

Certain basic minimum preventive and protective measures are recommended for the three hazard categories.

6.1.5.5 Results of FE and TI for Storage/Process Units

Based on the GOI Rules 1989, the hazardous fuels and chemicals used by the power plant were identified. Fire and Explosion are the likely hazards, which may occur due to the fuel and chemical storage. Hence, Fire and Explosion index has been calculated for in plant storage. Detailed estimates of FE&TI are given in **Table-6.4.**

Table-6.4
Fire Explosion and Toxicity index for Storage Facilities

Sr. No.	Chemical/ Fuel	Total Quantity (KL)	F&EI	Category
1	LDO	4.5	1.1	Light

6.2 Visualization of MCA Scenarios

6.2.1 Introduction

A Maximum Credible Accident (MCA) can be characterized, as an accident with a maximum damage potential, which is still believed to be probable.

MCA analysis does not include quantification of the probability of occurrence of an accident. Moreover, since it is not possible to indicate exactly a level of probability that is still believed to be credible, the selection of MCA is somewhat arbitrary. In practice, the selection of accident scenarios representative for an MCA-Analysis is done on the basis of engineering judgment and expertise in the field of risk analysis studies, especially accident analysis.

As an initial step in this study, a selection has been made of the processing and storage units and activities, which are believed to represent the highest level of risk for the surroundings in terms of damage distances. For this selection the following factors have been taken into account:

- Type of compound viz. flammable or toxic;
- Quantity of material present in a unit or involved in an activity; and
- Process or storage conditions such as temperature, pressure, flow, mixing and presence of incompatible materials.

In addition to the above factors the location of a unit or activity with respect to adjacent activities is taken into consideration to account for the potential escalation of an accident. This phenomenon is known as the domino effect. The units and activities, which have been selected on the basis of the above factors are summarized, accident scenarios are established in hazard Identification studies, while effect and damage calculations are carried out in Maximum Credible Accident Analysis studies.

6.2.2 Methodology

Following steps are employed for visualization of MCA scenarios:

- Chemical inventory analysis;
- Identification of hazardous processes in individual units;
- Identification of chemical release and accident scenarios;
- Analysis of past accidents of similar nature to establish credibility to identified scenarios; and
- Short listing of MCA Scenarios.

6.2.3 Common Causes of Accidents

Based on the analysis of past accident information, common causes of major chemical plant accidents are identified as:

- Poor house keeping;
- Improper use of tools, equipment, facilities;
- Unsafe or defective equipment facilities;
- Lack of proper procedures;
- Improvising unsafe procedures;
- Failure to follow prescribed procedures;
- Jobs not understood;
- Lack of awareness of hazards involved;
- Lack of proper tools, equipment, facilities;
- Lack of guides and safety devices; and
- Lack of protective equipment and clothing.

6.2.4 Failures of Human Systems

An assessment of past chemical accidents reveals human factor to be the cause for over 60% of the accidents while the rest are due to other plant component failures. This percentage will increase if major accidents alone are considered for analysis. Major causes of human failures reported are due to:

- Stress induced by poor equipment design, unfavorable environmental conditions, fatigue, etc.
- Lack of training in safety and loss prevention;
- Indecision in critical situations; and
- Inexperienced staff being employed in hazardous situations.

Often, human errors are not analyzed while accident reporting and accident reports only provide information about equipment and/or component failures. Hence, a great deal of uncertainty surrounds analysis of failure of human systems and consequent damages.

6.2.5 Short Listing of MCA Scenarios

Based on the storage quantities and properties of the chemicals, the hazard identification has been done and given as follows for carrying out MCA analysis studies.

- Vapour Cloud Explosion due to vessel rupture;
- Pool fire due to rupture / leakage and accumulation;
- Toxic dispersion due to gas/vapour leaks or pool evaporation; and
- General fire hazards.

6.2.6 Conclusion

Results of FE&TI analysis show that the storage of LDO falls into Light category of fire and explosion index with a Nil toxicity index.

6.3 Hazard Assessment and Evaluation

6.3.1 Introduction

Preliminary hazards analysis is based on the philosophy "PREVENTION IS BETTER THAN CURE". How safe are the operations? Safety is relative and implies freedom from danger or injury. But there is always some element of danger or risk in anything we do or build. When a chemical process facility is considered safe? This calls for identification of hazards, quantification of risk and further suggests hazard mitigating measures, if necessary.

The purpose of the preliminary hazards analysis is to identify early in the design process the potential hazards associated with, or inherent in a process design, thus eliminating costly and time consuming delays caused by design changes made later. This also eliminates potential hazard points at design stage itself.

Hence, preliminary hazard analysis is more relevant when a plant is at design/construction stage. This technique, applied early in the project life cycle, helps to eliminate hazards and thus to avoid costly design modifications later. This analysis fortifies the proposed process design by incorporating additional safety factors into the design criteria.

6.3.2 Methodology

An assessment of the conceptual design is conducted for the purpose of identifying and examining hazards related to feed stock materials, major process components, utility and support systems, environmental factors, proposed operations, facilities, and safeguards.

6.3.3 Preliminary Hazard Analysis (PHA)

A preliminary hazard analysis is carried out initially to identify the major hazards associated with storages and the processes of the plant. This is followed by consequence analysis to quantify these hazards. Finally, the vulnerable zones are plotted for which risk reducing measures are deduced and implemented. Preliminary hazard analysis for storage areas and whole plant are presented in **Table-6.5** and **Table-6.6**.

Table-6.5
Preliminary Hazard Analysis for Storage Areas

Unit	Capacity	Hazard Identified
LDO	4.5 KL	Fire/Explosion

Table-6.6
Preliminary Hazard Analysis for the Whole Plant in General

PHA Category	Description of Plausible Hazard	Recommendation	Provision
Environmental factors	If there is any leakage and eventuality of source of ignition.	--	All electrical fittings and cables are provided as per the specified standards. All motor starters are flame proof.
	Highly inflammable nature of the chemicals may cause fire hazard in the storage facility.	A well designed fire protection including protein foam, dry powder, CO_2 extinguisher should be provided.	Fire extinguisher of small size and big size are provided at all potential fire hazard places. In addition to the above, fire hydrant network is also provided.

6.3.4 Maximum Credible Accident Analysis (MCAA)

Hazardous substances may be released as a result of failures or catastrophes, causing possible damage to the surrounding area. This section deals with the question of

how the consequences of the release of such substances and the damage to the surrounding area can be determined by means of models.

It is intended to give an insight into how the physical effects resulting from the release of hazardous substances can be calculated by means of models and how vulnerability models can be used to translate the physical effects in terms of injuries and damage to exposed population and environment. A disastrous situation is general due to outcome of fire, explosion or toxic hazards in addition to other natural causes, which eventually lead to loss of life, property and ecological imbalance.

Major hazards posed by flammable storage can be identified taking recourse to MCA analysis. MCA analysis encompasses certain techniques to identify the hazards and calculate the consequent effects in terms of damage distances of heat radiation, toxic releases, etc. A host of probable or potential accidents of the major units in the complex arising due to use, storage and handling of the hazardous materials are examined to establish their credibility. Depending upon the effective hazardous attributes and their impact on the event, the maximum effect on the surrounding environment and the respective damage caused can be assessed. The MCA analysis involves ordering and ranking of various sections in terms of potential vulnerability. Inventory analysis and fire, explosion and toxicity index (FE&TI) are the two techniques employed for hazard identification process.

In the plant fuel storage area mainly poses flammable and explosion hazards due to unwanted release of fuels. Consequence analysis is basically a study of quantitative analysis of hazards due to various failure scenarios. It is that part of risk analysis, which considers failure cases and the damage caused by these failure cases. It is done in order to form and opinion on potentially serious hazardous outcome of accidents and their possible consequences. The reason and purpose of consequence analysis are many folds like:

- Part of Risk Assessment;
- Plant Layout/Code Requirements;
- Protection of other plants;
- Protection of the public;
- Emergency Planning; and

- Design Criteria (e.g. loading on Control Room).

The results of consequence analysis are useful for getting information about all known and unknown effects that are of importance when some failure scenario occurs in the plant and also to get information as how to deal with the possible catastrophic events. It also gives the workers in the plant and people living in the vicinity of the area, an understanding of their personal situation.

Selected Failure Cases

The failure cases that are selected for study are indicated in **Table-6.6**. The purpose of this listing is to examine consequences of such failure individually or in combination. It will be seen from the list that failure cases related to storage of LDO has been identified.

6.3.4.1 Damage Criteria

The fuel storage and unloading at the storage facility may lead to fire and explosion hazards. The damage criteria due to an accidental release of any hydrocarbon arise from fire and explosion. The vapors of these fuels are not toxic and hence no effects of toxicity are expected.

Tank fire would occur if the radiation intensity is high on the peripheral surface of the tank leading to increase in internal tank pressure. Pool fire would occur when fuels collected in the dyke due to leakage gets ignited.

Fire Damage

A flammable liquid in a pool will burn with a large turbulent diffusion flame. This releases heat based on the heat of combustion and the burning rate of the liquid. A part of the heat is radiated while the rest is convicted away by rising hot air and combustion products. The radiations can heat the contents of a nearby storage or process unit to above its ignition temperature and thus result in a spread of fire. The radiations can also cause severe burns or fatalities of workers or fire fighters located within a certain distance. Hence, it will be important to know beforehand the damage potential of a flammable liquid pool likely to be created due to leakage or catastrophic failure of a storage or process vessel. This will help to decide the location of other

storage/process vessels, decide the type of protective clothing the workers/fire fighters need, the duration of time for which they can be in the zone, the fire extinguishing measures needed and the protection methods needed for the nearby storage/process vessels. **Table-6.7** and **Table-6.8** tabulate the damage effect on equipment and people due to thermal radiation intensity.

Table-6.7
Damage due to Incident Radiation Intensities

Sr. No.	Incident Radiation (kW/m2)	Type of Damage Intensity	
		Damage to Equipment	Damage to People
1	37.5	Damage to process equipment	100% lethality in 1 min. 1% lethality in 10 sec.
2	25.0	Minimum energy required to ignite wood at indefinitely long exposure without a flame	50% Lethality in 1 min. Significant injury in 10 sec.
3	19.0	Maximum thermal radiation intensity allowed on thermally unprotected adjoining equipment	--
4	12.5	Minimum energy to ignite with a flame; melts plastic tubing	1% lethality in 1 min.
5	4.5	--	Causes pain if duration is longer than 20 sec, however blistering is un-likely (First degree burns)
6	1.6	--	Causes no discomfort on long exposures

Source: Techniques for Assessing Industrial Hazards by World Bank.

The effect of incident radiation intensity and exposure time on lethality is given in **Table 6.8.**

Table-6.8
Radiation Exposure and Lethality

Radiation Intensity (kW/m^2)	Exposure Time (seconds)	Lethality (%)	Degree of Burns
1.6	--	0	No Discomfort even after long exposure
4.5	20	0	1 st
4.5	50	0	1 st
8.0	20	0	1 st
8.0	50	<1	3 rd
8.0	60	<1	3 rd
12.0	20	<1	2 nd
12.0	50	8	3 rd
12.5	--	1	--
25.0	--	50	--
37.5	--	100	--

6.3.5 Scenarios Considered for MCA Analysis

6.3.5.1 Fuel Storage

The details of storages are given **Table-6.1.** In case of fuel released in the area catching fire, a steady state fire will ensue. Failures in pipeline may occur due to corrosion and mechanical defect. Failure of pipeline due to external interference is not considered as this area is licensed area and all the work within this area is closely supervised with trained personnel.

6.3.5.2 Modeling Scenarios

Based on the storage and consumption of various fuels and chemicals the following failure scenarios for the proposed power plant have been identified for MCA analysis and the scenarios are discussed in **Tables-6.9.**

Table-6.9
Scenarios Considered for MCA Analysis

Sr. No.	Fuel/Chemical	Total Quantity	Pool Fire
1	Failure of LDO tank	4.5 KL	*

Note: * Scenarios Considered

6.3.5.3 Methodology

A perusal of **Table-6.9** indicates that major material storage is either flammable liquids or gases under pressure. Fires could occur due to presence of ignition source at or near the source of leak or could occur due to flashback upon ignition of the traveling vapor cloud. Tank fires may be occurring due to the following:

- Ignition if rim seal leak leading to rim seal fire and escalating to full-fledged tank fire. Lighting is a major source of ignition of tank fires; and
- Overflow from tank leading to spillage, vapour cloud formation and its subsequent ignition, which flashes back to the tank leading to tank fire. The chance of overflow should be less unless operator has grossly erred in receiving LDO into the same tank. Spillage due to overflow may result in a dyke fire if ignition occurs after sufficiently long period.

For the present study, the scenarios under consideration assume that the peak level of radiation intensity will not occur suddenly. Based on the past experience, it is found that 20-30 minutes time will be required before a tank fire grows to full size. For radiation calculations, pool fire has been considered. From the above considerations, the criteria of 4.5 kW/m^2 have been selected to judge acceptability of the scenarios. The assumptions for calculations are:

- It is not continuous exposure;
- It is assumed that No fire detection and mitigation measures are initiated;
- There is not enough time available for warning the public and initiating emergency action;
- Secondary fire at public road and building is not likely to happen;
- The effect of smoke on reduction of source radiation intensity has not been considered; therefore hazard distances calculated tend to be conservative; and
- Shielding effect of intervening trees or other structures has not been considered. No lethality is expected from this level of intensity although burn injury takes place depending on time of exposure.

6.3.5.4 Properties of Fuels Considered For Modeling Scenarios

The chemical data for various fuels used for modeling is tabulated in **Table 6.10** and is compiled from various sources reported in the literature.

Table-6.10
Properties of Fuels Considered for Modeling

Sr. No.	Fuel	Molecular Weight kg/kg.mol	Boiling Point ^oF	Density Kg/m^3
1	LDO	114.24	400	840

6.3.6 Model Computations

Results and Discussion - Pool Fire

The results of MCA analysis are tabulated indicating the distances for various damages identified by the damage criteria, as explained earlier. Calculations are done for radiation intensities levels of 37.5, 25, 12.5, 4.5 and 1.6 kW/m^2, which are presented in **Table-6.11** for different scenarios. The distances computed for various scenarios are given in meters and are from the center of the pool fire.

Table-6.11
Occurrence of Various Radiation Intensities- Pool Fire

Particular	Radiation Intensities (kW/m²)/Distances (m)					
	37.5	**25.0**	**19.0**	**12.5**	**4.5**	**1.6**
Failure of Single LDO tank (4.5KL)	2.2	2.7	3.2	4.1	7.3	13.1

Pool Fire Due to Failure of LDO Storage tank (4.5KL)

The maximum quantity of storage of LDO will be 4.5 KL. The most credible failure is the rupture of the largest pipe connecting the storage tank. As the worst case, it is assumed that the entire contents leak out into the dyke forming a pool, which may catch fire on finding a source of ignition.

A perusal of the above table clearly indicates that 37.5 kW/m² (100% lethality) occurs within the radius of the pool which is computed at 2.2 m in case of LDO tank on pool fire. This vulnerable zone will damage all equipment falling within the pool radius.

The threshold limit for 50% and 1% lethality is 25.0 and 19.0 kW/m². Similarly, the threshold limit for first degree burns is 4.5 kW/m², this vulnerable zone in which the thermal fluxes above the threshold limit for first degree is restricted to 7.3 m in case of LDO tank on pool fire.

Effect of Thermal Radiation on Population

A perusal of **Table-6.7** clearly indicates that 1.6 kW/m² represents the safe radiation intensity for human population even for long exposures. Hence, pool fire and fireball modeling has been done for all the scenarios and the distance for 1.6 kW/m² has been computed. The results of safe distance for pool fire and fireball are presented in **Table-6.12.**

Table-6.12
Occurrence of Safe Radiation Intensity

Sr. No.	Fuel/Chemical	Total Quantity	Pool fire
			1.6 kW/m² Radiation intensity distances (m)
1	Failure of LDO tank	4.5 KL	13.1

6.4 Disaster Management Plan

6.4.1 Disasters

A disaster is a catastrophic situation in which suddenly, people are plunged into helplessness and suffering, as a result, need protection, clothing, shelter, medical and social care and other necessities of life.

Disasters can be divided into two main groups. In the first, disasters resulting from natural phenomena like earthquakes, volcanic eruptions, storm surges, cyclones, tropical storms, floods, avalanches, landslides, forest fires etc. The second group includes disastrous events occasioned by man, or man's impact upon the environment. Examples are armed conflict, industrial accidents, radiation accidents, factory fires, explosions and escape of toxic gases or chemical substances, river pollution, mining or other structural collapses, air, sea, rail and road transport accidents and can reach catastrophic dimensions in terms of human loss.

There can be no set criteria for assessing the gravity of a disaster in the abstract since this depends to a large extent on the physical, economic and social environment in which it occurs. What would be considered a major disaster in a developing country, ill equipped to cope with the problems involved, may not mean more than a temporary emergency elsewhere. However, all disaster brings in their wake similar consequences that call for immediate action, whether at the local, national or international level, for the rescue and relief of the victims. This includes the search for the dead and injured and removal of debris and social care, the provision of temporary shelter to the homeless, food, clothing and medical supplies, and the rapid re-establishment of essential services.

6.4.2 Objectives of Disaster Management Plan (DMP)

The Disaster Management Plan is aimed to ensure safety of life, protection of environment, protection of installation, restoration of production and salvage operations in this same order of priorities. For effective implementation of the Disaster Management Plan, it will be widely circulated and personnel training given through rehearsals/drills.

The Disaster Management Plan would reflect the probable, consequential severalties of the undesired event due to deteriorating conditions or through 'Knock on'

effects. Further the management should be able to demonstrate that their assessment of the consequences uses good supporting evidence and is based on currently available and reliable information, incident data from internal and external sources and if necessary the reports of out side agencies.

To tackle the consequences of a major emergency inside the factory or immediate vicinity of the factory, a Disaster Management Plan has to be formulated and this planned emergency document is called “Disaster Management Plan”.

The objective of the Industrial Disaster Management Plan is to make use of the combine resources of the plant and the outside services to achieve the following:

- Effect the rescue and medical treatment of casualties;
- Safeguard other people;
- Minimize damage to property and the environment;
- Initially contain and ultimately bring the incident under control;
- Identify any dead;
- Provide for needs of relatives;
- Provide authoritative information to the news media;
- Secure the safe rehabilitation of affected area; and
- Preserve relevant records and equipment for the subsequent inquiry into the cause and circumstances of the Emergency.

In effect, it is to optimize operational efficiency to rescue rehabilitation and render medical help and to restore normalcy.

6.5 Emergencies

6.5.1 General, Industrial, Emergencies

The emergencies that could be envisaged in the plant and tank farm are as follows:

- Fires at Tank farm unloading platform;
- Slow isolated fires;

- Fast spreading fires;
- Structural failures;
- Contamination of food/water;
- Sabotage/Social disorder and
- Chemical storage tank failures

6.5.2 Specific Emergencies Anticipated

Fire and Explosion

Fire consequences can be disastrous, since they involve quantities of fuel either stored or in dynamic inventory in pipelines or in nearby areas. Toxic releases can affect persons working around. Preliminary hazard analysis has provided a basis for consequences estimation. Estimation can be made by using various pool fire, tank fire consequence calculations.

During the study of Risk Assessment, the natures of damages are worked out and probability of occurrence of such hazards is also drawn up. Therefore, the risk assessment report is to be essentially studied in conjunction with disaster management plan.

6.5.3 Emergency Organization

It is recommended to setup an Emergency Organization. A senior executive who has control over the affairs of the plant would be heading the Emergency Organization. He would be designated as Site Controller. As per the General Organization chart, would be designated as the Incident Controller. In the case of stores, utilities, open areas, which are not under the control of the Production Heads, Senior Executive responsible for maintenance of utilities would be designated as Incident Controller. All the Incident Controllers would be reporting to the Site Controller.

Each Incident Controller, for himself organizes a team responsible for controlling the incidence with the personnel under his control. Shift Incharge would be

the reporting officer, who would bring the incidence to the notice of the Incidence Controller and Site Controller.

Emergency Coordinators would be appointed who would undertake the responsibilities like fire fighting, rescue, rehabilitation, transport and provide essential and support services. For this purposes, Security Incharge, Personnel Department, Essential services personnel would be engaged. All these personnel would be designated as Key personnel.

In each shift, electrical supervisor, electrical fitters, pump house Incharge, and other maintenance staff would be drafted for emergency operations. In the event of power or communication system failure, some of the staff members in the office/plant offices would be drafted and their services would be utilized as messengers for quick passing of communications. All these personnel would be declared as essential personnel.

6.5.3.1 Emergency Communication

Whoever notices an emergency situation such as fire, growth of fire, leakage etc. would inform his immediate superior and Emergency Control Center. The person on duty in the Emergency Control Centre would appraise the Site Controller. Site Controller verifies the situation from the Incident Controller of that area or the Shift In-charge and takes a decision about an impending On Site Emergency. This would be communicated to all the Incident Controllers, Emergency Coordinators. Simultaneously, the emergency warning system would be activated on the instructions of the Site Controller.

6.5.3.2 Emergency Responsibilities

The responsibilities of the key personnel are appended below:

Site Controller

On receiving information about emergency he would rush to Emergency Control Center and take charge of ECC and the situation.

- Assesses the magnitude of the situation on the advice of incident Controller and decides;

- Whether the effected area needs to be evacuated;
- Whether personnel who are at assembly points need to be evacuated; declares emergency and orders for operation of emergency siren;
- Organizes announcement by public address system about location of emergency;
- Assesses which areas are likely to be affected, or need to be evacuated or are to be alerted;
- Maintains a continuous review of possible development and assesses the situation in consultation with Incident Controller and other Key Personnel as to whether shutting down the plant or any section of the plant is required and if evacuation of persons is needed;
- Directs personnel for Rescue, rehabilitation, transport, fire, brigade, medical and other designated mutual support systems locally available, for meeting emergencies;
- Controls evacuation of affected areas, if the situation is likely to go out of control or effects are likely to go beyond the premises of the factory, informs to District Emergency Authority, Police, Hospital and seeks their intervention and help;
- Informs Inspector of Factories, Deputy Chief Inspector of Factories, PCB and other statutory authorities;
- Gives a public statement in necessary;
- Keeps record of chronological events and prepares an investigation report and preserves evidence; and
- On completion of on Site Emergency and restoration of normalcy, declares all clear and orders for all clear warning.

Incident Controller

- Assembles the incident control team;
- Directs operations within the affected areas with the priorities for safety to personnel, minimize damage to the plant, property and environment and minimize the loss of materials;

- Directs the shutting down and evacuation of plant and areas likely to be adversely affected by the emergency;
- Ensures that all key personnel help is sought;
- Provides advice and information to the Fire and Security Officer and the Local Fire Services as and when they arrive;
- Ensures that all non-essential workers/staff of the affected areas evacuated to the appropriate assembly points, and the areas are searched for causalities;
- Has regard to the need for preservation of evidence so as to facilitate any inquiry into the causes and circumstances, which caused or escalated the emergency;
- Co-ordinates with emergency services at the site;
- Provides tools and safety equipment to the team members;
- Keeps in touch with the team and advise them regarding the method of control to be used; and
- Keeps the Site Controller of Emergency informed of the progress being made

Emergency Coordinator - Rescue, Fire Fighting

- On knowing about emergency, rushes to ECC;
- Helps the incident Controller in containment of the emergency;
- Ensures fire pumps in operating conditions and instructs pump house operator to ready for any emergency with standby arrangement;
- Guides the fire fighting crew i.e. firemen, trained plant personnel and security staff;
- Organizes shifting the fire fighting facilities to the emergency site, if required;
- Takes guidance of the Incident Controller for fire fighting as well as assesses the requirements of outside help;
- Arranges to control the traffic at the gate and the incident area;
- Directs the security staff to the incident site to take part in the emergency operations under his guidance and supervision;

- Evacuates the people in the plant or in the nearby areas as advised by Site Controller;
- Searches for casualties and arranges proper aid for them;
- Assembles search and evacuation team;
- Arranges for safety equipment for the members of this team;
- Decides which paths the evacuated workers should follow; and
- Maintains law and order in the area, and if necessary seeks the help of police.

Emergency Coordinator-Medical, Mutual Aid, Rehabilitation, Transport and Communication

- In the event of failure of electric supply and thereby internal telephone, sets up communication point and establishes contact with the Emergency Control Center (ECC);
- Organizes medical treatment to the injured and if necessary will shift the injured to nearby hospitals;
- Mobilizes extra medical help from outside, if necessary;
- Keeps a list of qualified first aiders of the factory and seek their assistance;
- Maintains first aid and medical emergency requirements;
- Makes sure that all safety equipment are made available to the emergency team;
- Assists Site Controller with necessary data and coordinate the emergency activities;
- Assists Site Controller in updating emergency plan, organizing mock drills verification of inventory of emergency facilities and furnishing report to the Site Controller;
- Maintains liaison with civil Administration;
- Ensure availability of canteen facilities and maintenance of rehabilitation center;
- He will be in liaison with Site Controller/Incident Controller;
- Ensure transportation facility;

- Ensures availability of necessary cash for rescue/rehabilitation and emergency expenditure;
- Controls rehabilitation of affected areas on discontinuation of emergency; and
- Makes available diesel/petrol for transport vehicles engaged in emergency operation.

Emergency Coordinator - Essential Services

- He would assist Site controller and Incident Controller;
- Maintains essential services like Diesel Generator, Water, Fire Water, Compressed Air/Instrument Air, power supply for lighting;
- He would plan alternate facilities in the event of power failure, to maintain essential services such as lighting, refrigeration plant etc;
- He would organize separate electrical connections for all utilities and emergency services so that in the event of emergency or fires, essential services and utilities are not affected;
- Gives necessary instructions regarding emergency electrical supply, isolation of certain sections etc. to shift In-charge and electricians; and
- Ensures availability of adequate quantities of protective equipment and other emergency materials, spares etc.

General Responsibilities of Employees during an Emergency

During an emergency, especially it becomes more enhanced and pronounced when an emergency warning is raised, the workers if they are In-charge of process equipment should adopt safe and emergency shut down and attend any prescribed duty as essential employee. If no such responsibilities assigned, he should adopt a safe course to assembly point and await instructions. He should not resort to spread panic. On the other hand, he must assist emergency personnel towards objectives of DMP.

6.5.4 Emergency Facilities

6.5.4.1 Emergency Control Center (ECC)

For the time being Office Block is identified as Emergency Control Center. It would have external Telephone, Fax, Telex facility. All the Site Controller/Incident Controller Officers, Senior Personnel would be located here. Also, it would be an elevated place. Various other materials that are to be maintained in the Emergency Control Center are:

The following information and equipment are to be provided at the Emergency Control Center (ECC).

- Intercom, telephone
- P & T telephone
- Self contained breathing apparatus
- Fire suit/gas tight goggles/gloves/helmets
- Hand tools, wind direction/velocities indications
- Public address megaphone, hand bell, telephone directories
- (internal, P&T) factory layout, site plan
- Emergency lamp/torch light/batteries
- Plan indicating locations of hazard inventories, plant control room, sources of safety equipment, work road plan, assembly points, rescue location vulnerable zones, escape routes.
- Hazard chart
- Emergency shut-down procedures
- Nominal roll of employees
- List of key personnel, list of essential employees, list of Emergency Co-ordinators
- Duties of key personnel
- Address with telephone numbers and key personnel, emergency coordinator, essential employees.

- Important address and telephone numbers including Government agencies, neighboring industries and sources of help, out side experts, chemical fact sheets, population details around the factory.

6.5.4.2 Assembly Point

Number of assembly points, depending upon the plant location would be identified wherein employees who are not directly connected with the disaster management would be assembled for safety and rescue. Emergency breathing apparatus, minimum facilities like water etc. would be organized.

6.5.4.3 Emergency Power Supply

Plant facilities would be connected to Diesel Generator and would be placed in auto mode. Thus water pumps, plants lighting and emergency control center, administrative building and other auxiliary services are connected to emergency power supply. In all the blocks flame proof type emergency lamps would be provided.

6.5.4.4 Fire Fighting Facilities

First Aid Fire fighting equipment suitable for emergency should be maintained in each and at Bulk Storage of LDO. This would be as per statutory requirements as well as per TAC Regulations. However, fire hydrant line covering major areas would be laid. It would be maintained as 6 kg/sq.cm pressure. Fire alarms would be located in the bulk storage areas.

6.5.4.5 Location of Wind Sock

On the top of the Administration block, top of each production blocks, wind socks would be installed to indicate direction of wind for emergency escape.

6.5.4.6 Emergency Medical Facilities

Stretchers, gas masks and general first aid materials for dealing with chemical burns, and inhalations, fire burns etc. would be maintained in the medical center as well as in the emergency control room. Private medical practitioners help would be sought. Government hospital would be approached for emergency help.

Apart from plant first aid facilities, external facilities would be augmented. Names of Medical Personnel. Medical facilities in the surrounding area and near towns would be prepared and updated. Necessary specific medicines and antidotes for emergency treatment of Burns Patients and for those affected by toxicity would be maintained.

Breathing apparatus and other emergency medical equipment would be provided and maintained. The help of nearby industrial management in this regard would take on mutual support basis.

6.5.4.7 Ambulance

An ambulance with driver availability in all the shifts, emergency shift vehicle would be ensured and maintained to transport the injured or affected persons. A Number of persons would be trained in first aid so that, in every shift first aid personnel would be available.

6.5.5 Emergency Actions

6.5.5.1 Emergency Warning

Communication of emergency would be made familiar to the personnel inside the plant and people outside. An emergency warning system would be established.

6.5.5.2 Emergency Shutdown

There are number of actions which are to be initiated to help deal with hazardous conditions, when a tank is on fire. The suggested actions are:

- Stop feed;
- Dilute contents;
- Remove heat;
- Deluge with water; and
- Transfer contents

Whether a given method is appropriate depends on the particular case. Cessation of agitation may be the best action in some instances but not in others. Stopping of the feed may require the provision of by pass arrangements.

Methods of removing additional heat include removal through the normal cooling arrangements or use of an emergency cooling system. Cooling facilities which use vapouring liquid may be particularly effective, since a large increase in vaporization can be obtained by dropping pressure.

6.5.5.3 Evacuation of Personnel

There could be more number of persons in the storage area and other areas in the vicinity. The area would have adequate number of exits, stair cases. In the event of an emergency, unconnected personnel have to escape to assembly point. Operators have to take emergency shutdown procedure and escape. Time Office maintains a copy of deployment of employees in each shift, at ECC. If necessary, persons can be evacuated by rescue teams.

6.5.5.4 All Clear Signal

Also, at the end of an emergency, after discussing with Incident Controllers and Emergency Co-ordinators, the Site Controller orders an all clear signal. When it becomes essential the Site Controller communicates to the District Emergency Authority, Police, and Fire Service personnel regarding help required or development of the situation into an Off-Site Emergency.

6.5.6 General

6.5.6.1 Employee Information

During an emergency, employees would be warned by raising siren in specific pattern. Employees would be given training of escape routes, taking shelter, protecting from harmful effects. Employees would be provided with information related to fire hazards, antidotes and first aid measures. Those who would designate as key personnel and essential employees should be given training to emergency response.

6.5.6.2 Public Information and Warning

The industrial disaster effects related to this plant may mostly be confined to the plant area. The detailed risk analysis has indicated that the pool fire effects would not be felt outside. However, as an abundant precaution, the information related to chemicals in use would be furnished to District Emergency Authority for necessary dissemination to general public and for any use during an off site emergency.

6.5.6.3 Coordination with Local Authorities

Keeping in view of the nature of emergency, two levels of coordination are proposed. In the case of an On Site Emergency (OSE), resources within the organization would be mobilized and in the event extreme emergency local authorities help should be sought.

In the event of an emergency developing into an off site emergency, local authority and District Emergency Authority (normally the Collector) would be appraised and under his supervision, the Off Site Disaster Management Plant would be exercised. For this purpose, the facilities that are available locally, i.e. medical, transport, personnel, temporary accommodation, voluntary organizations etc. would be kept on record. Necessary rehearsals and training in the form of mock drills should be organized.

6.5.6.4 Mutual Aid

Mutual aid in the form of technical personnel, runners, helpers special protective equipment, transport vehicles, communication facility etc. should be sought from the neighboring industrial management.

6.5.6.5 Mock Drills

Emergency preparedness is an important on that of planning in Industrial Disaster Management. Personnel would be trained suitably and prepared mentally and physically in emergency response through carefully planned, simulated procedures. Similarly, the key personnel and essential personnel should be trained in the operations.

6.5.6.6 Important Information

Once the Plant starts manufacturing products, important information such as names and addresses of key personnel, essential employees, medical personnel out side the plant, transporter's address, address of those connected with Off Site Emergency such as Police, Local Authorities, Fire Services, District Emergency Authority should be prepared and maintained.

6.5.7 Off-Site Emergency Preparedness Plan

The task of preparing the Off-Site Emergency Plan lies with the district collector, however the off-site plan will be prepared with the help of the local district authorities. The proposed plan will be based on the following guidelines.

6.5.7.1 Introduction

Off-site emergency plan follows the on-site emergency plan. When the consequences of an emergency situation go beyond the plant boundaries, it becomes an off-site emergency. Off-site emergency is essentially the responsibility of the public administration. However, the factory management will provide the public administration with the technical information relating to the nature, quantum and probable consequences on the neighboring population.

The off-site plan in detail will be based on those events which are most likely to occur, but other less likely events which have severe consequence will also be considered. Incidents which have very severe consequences yet have a small probability of occurrence will also be considered during the preparation of the plan. However, the key feature of a good off-site emergency plan is flexibility in its application to emergencies other than those specifically included in the formation of the plan.

The roles of the various parties who will be involved in the implementation of an off-site plan are described below. Depending on local arrangements, the responsibility for the off-site plan will be either rest with the works management or, with the local authority. Either way, the plan will identify an emergency co-ordinating officer, who would take the overall command of the off-site activities. As with the on-site plan, an emergency control center will be setup within which the emergency co-ordinating office can operate.

An early decision will be required in many cases on the advice to be given to people living "within range" of the accident - in particular whether they should be evacuated or told to go indoors. In the latter case, the decision can regularly be reviewed in the event of an escalation of the incident. Consideration of evacuation may include the following factors.

- In the case of a major fire but without explosion risk (e.g an oil storage tank), only houses close to the fire are likely to need evacuation, although a severe smoke hazard may require this to be reviewed periodically;
- If a fire is escalating and in turn threatening a store of hazardous material, it might be necessary to evacuate people nearby, but only if there is time; if insufficient time exists, people should be advised to stay indoors and shield themselves from the fire.

6.5.7.2 Aspects to be considered in the Off-Site Emergency Plan

The main aspects, which will be included in the emergency plan, are:

Organization

Details of command structure, warning systems, implementation procedures, emergency control centers.

Names and appointments of incident controller, site main controller, their deputies and other key personnel.

Communications

Identification of personnel involved, communication center, call signs, network, lists of telephone numbers.

Specialized Knowledge

Details of specialist bodies, firms and people upon whom it may be necessary to call i.e. those with specialized chemical knowledge, laboratories.

Voluntary Organizations

Details of organizers, telephone numbers, resources etc

Chemical Information

Details of the hazardous substances stored or procedure on each site and a summary of the risk associated with them.

Meteorological Information

Arrangements for obtaining details of weather conditions prevailing at the time and weather forecasts.

Humanitarian Arrangements

Transport, evacuation centers, emergency feeding, treatment of injured, first aid, ambulances, temporary mortuaries.

Public Information

Arrangements for dealing with the media press office; informing relatives, etc.

Assessment

Arrangements for: (a) collecting information on the causes of the emergency; (b) reviewing the efficiency and effectiveness of all aspects of the emergency plan.

6.5.7.3 Role of the Emergency Co-ordinating Officer

The various emergency services will be co-ordinated by an emergency coordinating officer (ECO), who will be designated by the District Collector. The ECO will liase closely with the site main controller. Again depending on local arrangements, for very severe incidents with major or prolonged off-site consequences, the external control will be passed to a senior local authority administrator or even an administrator appointed by the central or state government.

6.5.7.4 Role of the Local Authority

The duty to prepare the off-site plan lies with the local authorities. The emergency planning officer (EPO) appointed will carry out his duty in preparing for a whole range of different emergencies within the local authority area. The EPO will liase with the works, to obtain the information to provide the basis for the plan. This liaison will ensure that the plan is continually kept up-to-date.

It will be the responsibility of the EPO to ensure that all those organizations which will be involved off site in handling the emergency, know of their role and are able to accept it by having for example, sufficient staff and appropriate equipment to cover their particular responsibilities. Rehearsals for off-site plans will be organized by the EPO.

6.5.7.5 Role of Police

Formal duties of the police during an emergency include protecting life and property and controlling traffic movements.

Their functions will include controlling bystanders evacuating the public, identifying the dead and dealing with casualties, and informing relatives of death or injury.

6.5.7.6 Role of Fire Authorities

The control of a fire will be normally the responsibility of the senior fire brigade officer who would take over the handling of the fire from the site incident controller on arrival at the site. The senior fire brigade officer will also have a similar responsibility for other events, such as explosions. Fire authorities in the region will be apprised about the location of all stores of flammable materials, water and foam supply points, and fire-fighting equipment. They will be involved in on-site emergency rehearsals both as participants and on occasions, as observes of exercises involving only site personnel.

6.5.7.7 Role of Health Authorities

Health authorities, including doctors, surgeons, hospitals, ambulances, and so on, will have a vital part to play following a major accident, and they will form an integral part of the emergency plan.

For major fires, injuries will be the result of the effects of thermal radiation to a varying degree, and the knowledge and experience to handle this in all but extreme cases may be generally available in most hospitals.

Major off-site incidents are likely to require medical equipment and facilities additional to those available locally, and a medical "mutual aid "scheme should exist to enable the assistance of neighboring authorities to be obtained in the event of an emergency.

6.5.7.8 Role of Government Safety Authority

Factory Inspectors of the region may like to satisfy themselves that the organization responsible for producing the off-site plan has made adequate arrangements for handling emergencies of all types including major emergencies. They may wish to see well documented producers and evidence of exercise undertaken to test the plan.

In the event of an accident, local arrangements regarding the role of the factory inspector will apply. These may vary from keeping a watching brief to a close involvement in advising on operations.

6.6 Occupational Health and Safety

Large industries, in general, and chemical plants in particular where multifarious activities are involved during construction, erection, testing, commissioning, operation & maintenance, the men, materials and machines are the basic inputs. Along with the boons, the industrialization generally brings several problems like occupational health and safety.

6.6.1 Occupational Health

Occupational health needs attention both during construction & erection and operation & maintenance phases. However, the problem varies both in magnitude and variety in the above phases.

Construction & Erection

The occupational health problems envisaged at this stage can mainly be due to constructional accident and noise.

To overcome these hazards, in addition to arrangements to reduce it within TLV's personal protective devices should also be supplied to workers.

Operation and Maintenance

The problem of occupational health, in the operation and maintenance phase is due to Respirable dust and noise. With suitable engineering controls the exposures can be reduced to less than TLV limits and proper personnel protective devices should be given to employees.

The working personnel should be given the following appropriate personnel protective devices.

Industrial Safety Helmet

- Crash Helmets
- Zero power plain goggles with cut type filters on both ends.
- Zero power goggles with cut type filters on both sides and blue colour glasses
- Chemical goggles
- Welders equipment for eye & face protection
- Cylindrical type earplug
- Ear muffs
- Dust masks
- Canister Gas mask
- Self contained breathing apparatus
- Leather apron
- Aluminized fiber glass fix proximity suit with hood and gloves
- Boiler suit
- Safety belt/lime man's safety belt
- Leather hand gloves
- Asbestos hand gloves
- Acid/Alkali proof rubberized hand gloves

- Canvas cum leather hand gloves with leather palm
- Lead hand glove
- Electrically tested electrical resistance hand gloves
- Industrial safety shoes with steel toe
- Rubber boots (alkali resistant)
- Electrical safety shoes without steel toe and gum boots

Full fledged hospital facilities should be made available round the clock for attending emergency arising out of accidents, if any. All working personnel should be medically examined at least once in every year and at the end of his term of employment. This is in addition to the pre-employment medical examination.

6.6.2 Safety Plan

Safety of both men and materials during construction and operation phases is of concern. The preparedness of an industry for the occurrence of possible disasters is known as emergency plan. The disaster in the plant is possible due to leakage of hazardous chemicals, collapse of structures and fire/explosion etc.

Keeping in view the safety requirement during construction, operation and maintenance phases, power plant has formulated safety policy with the following regulations:

- To allocate sufficient resources to maintain safe and healthy conditions at work;
- To take steps to ensure that all known safety factors are taken into account in the design, construction, operation and maintenance of plants, machinery and equipment;
- To ensure that adequate safety instruction are given to all employees;
- To provide wherever necessary protective equipment, safety appliances and clothing, and to ensure their proper use;
- To inform employees about materials equipment or processes used in their work which are known to be potentially hazardous to health or safety;

- To keep all operations and methods of work under regular review for making necessary changes from the point of view of safety in the light of experience and upto date knowledge;
- To provide appropriate facilities for fist aid and prompt treatment of injuries and illness at work;
- To provide appropriate instruction, training, retraining and supervision to employees in health and safety, first aid and to ensure that adequate publicity is given to these matters;
- To ensure proper implementation of fire prevention methods and an appropriate fire fighting service together with training facilities for personnel involved in this service;
- To organize collection, analysis and presentation of data on accident, sickness and incident involving personnel injury or injury to health with a view to taking corrective, remedial and preventive action;
- To promote through the established machinery, joint consultation in health and safety matters to ensure effective participation by all employees;
- To publish/notify regulations, instruction and notices in the common language of employees;
- To prepare separate safety rules for each types of occupation/processes involved in a project; and
- To ensure regular safety inspection by a competent person at suitable intervals of all buildings, equipment, work places and operations.

6.6.3 Safety Organization

Construction & Erection Phase

A qualified and experienced safety officer will be appointed. The responsibilities of the safety officers include identification of the hazardous conditions and unsafe acts of workers and advice on corrective actions, conduct safety audit, organize training programs and provide professional expert advice on various issues related to occupational safety and health. He is also responsible to ensure compliance of works Safety Rules/Statutory Provisions.

In addition to employment of safety officer by power plant every contractor, who employs more than 70 workers, should also employ one safety officer to ensure safety of the workers, in accordance with the conditions of contract.

Operation & Maintenance Phase

When the construction is completed the posting of safety officers should be in accordance with the requirement of Factories Act and their duties and responsibilities should be as defined thereof.

6.6.4 Safety Circle

In order to fully develop the capabilities of the employees in identification of hazardous processes and improving safety and health, safety circles would be constituted in each area of work. The circle would consist of 5-6 employees from that area. The circle normally should meet for about an hour every week.

6.6.5 Safety Training

A full fledged training center will be set up. Safety training will be provided by the Safety Officer with the assistance of faculty members called from Corporate Center, Professional Safety Institutions and Universities. In addition to regular employees, limited contractor labours are also provided safety training.

To create safety awareness safety films will be shown to workers and leaflets etc. will be distributed.

Some precautions and remedial measures proposed to be adopted to prevent fires are:

- Compartmentation of cable galleries, use of proper sealing techniques of cable passages and crevices in all directions would help in localizing and identifying the area of occurrence of fire as well as ensure effective automatic and manual fire fighting operations;
- Spread of fire in horizontal direction would be checked by providing fire stops for cable shafts;

- Reliable and dependable type of fire detection system with proper zoning and interlocks for alarms are effective protection methods for conveyor galleries;
- House keeping of high standard helps in eliminating the causes of fire and regular fire watching system strengthens fire prevention and fire fighting; and
- Proper fire watching by all concerned would be ensured.

Chapter 7

Project Benefits

The proposed 350 MW Power plant will result in improvement of infrastructure as well as upliftment of social structure in the area. The people residing in the nearby areas will be benefited directly and indirectly. It is anticipated that the proposed power plant will provide benefits for the locals in two phases i.e. during construction phase as well as during operational stage of the plant.

7.1 Construction Phase

Employment

The major benefit due to the proposed project will be in the sphere of generating employment for about 700 persons in that area. The proposed project will benefit local population.

7.2 Operational Phase

7.2.1 Community Services

SEML will employ local people to the extent possible for avoiding creation of additional infrastructure. SEML will develop medical facilities for catering to the needs of the project personnel. These facilities will also be extended to the local community in due course.

7.2.2 Education

SEML will initiate action for social upliftment in the area like female education and vocational training. Financial support will also be extended to strength education infrastructure in the region.

7.2.3 Employment

The manpower requirements for the operational phase of the Power Plant will be about 700 people. In addition, there will be an indirect employment for skilled/ semi skilled

people during project life.

All attempts will be made to employ suitable, locally available, skilled personnel from the study area. In case of non-availability of skilled persons, people will be employed from out side the study area.

7.2.4 Transportation

There will also be small increase in the vehicular traffic due to passenger transport. This increase in traffic will not have any consequence to warrant special mention. One should expect that the increased passenger load in the sector would prompt the state government to start new and frequent public transport services to this area, bringing upliftment to the whole locality.

7.2.5 Other Benefits

SEML is equally conscious for the all round socio-economic development and is committed to raise the quality of life and social well being of communities where it operates. Its CSR initiatives have been prioritized on local needs, which focus on Health, Education, Infrastructure Development and Environment Conservation.

Chapter 8

Environmental Management Plan

Environmental Management Plan (EMP) discusses various pollution control measures envisaged for mitigating environmental impacts identified and assessed in the earlier chapters of this report. EMP also includes institutional set-up for implementation of various measures, plantation programme, action plan for ash utilization and post-project environmental monitoring plan.

While implementing the project, M/s SEML will follow guidelines specified by CPCB under the Corporate Responsibility for Environmental Protection (CREP) for thermal power plants. The following environmental management plan has been recommended for construction and operational phases:

8.1 Construction Phase

The following control measures are recommended to mitigate the probable adverse impacts:

- Site for construction workers camp shall be clearly demarcated to prevent occupational hazards. Ensure provision for necessary basic needs and infrastructure facilities such as water supply, sanitary facilities, temporary housing, domestic fuel etc.
- At the site of construction, where petroleum powered equipment is used and temporary storage of petroleum products (highly inflammable) is done, may cause fire hazard. Necessary care shall be taken as per the safety norms.
- Diesel operated construction machinery; vehicles etc. at project site shall be properly maintained to minimize exhaust emissions as well as noise.
- Though the effect of noise on the nearby inhabitants due to construction activity will be negligible, noise prone activities shall be restricted to the day time.
- Accidental spill of oils from construction equipment and storage sites shall be prevented.

- Tree plantation shall be undertaken at the time of development of the project site, so that they grow to considerable height by the time of commissioning of the proposed project.
- As soon as construction is over, surplus of excavated soil shall be utilized to fill up low lying areas, rubbish needs to be cleared and all surfaces be reinstated.
- Falling of matured trees shall be avoided.

8.2 Operational Phase

During the normal operation phase of the proposed power plant, environmental impacts were predicted and found to be marginal on air, land and socio-economic components and insignificant on noise and water. The following mitigation measures are recommended for various environmental components:

8.2.1 Ash Evacuation System

The ash disposal system shall be adopted where the ash and bottom ash will be collected in silo. Suitable vendors shall be identified for its commercial use.

The function of the ash Handling Plant is to remove coarse ash from all boiler economizer, air heater and dust extraction plant hoppers and transport it to the storage silo(s). This shall be carried out by either a combination vacuum-pressure pneumatic system or by direct pressure pneumatic system.

Nearly 20% of the total ash is bottom ash. The function of the furnace bottom ash handling system is to extract the ash from bottom of the boiler on a continuous or intermittent basis.

The design of the furnace bottom ash extraction system shall conform with the relevant requirements of IS 8633: 1977 “Technical Requirements for Location of Boiler Installations and Boiler Houses” as well as any recognized International Standards.

Storage Silos

The silos shall be fitted with suitable equipment to load dry ash into bulkers so that the same may be transported to ash utilization plant as and when required. Ash storage silos capacity shall be sufficient to store.

The silos shall be of cylindrical RCC/steel plates fitted with access doors, pressure relief vents and remote level indicators; venting arrangement etc. The silos shall be designed for mass flow and the discharge shall ensure an even flow of dust to the dry loading or conditioning equipment. The silos shall be supported such that there is headroom below for Bulkers. There shall be an intermediate floor for housing the slurry forming devices; unloaders; dry dust loading spout equipment; fluidizing blowers and heaters etc.

The silo shall be of proven flat bottom type fitted with radical air sliders; hoods and related arrangements. Each silo shall be fitted with vent filters sized to meet emission standards. The fitters shall be cleaned automatically on load by pulse-jet system.

8.2.1.1 Action Plan for Ash Disposal Site

The conditions for the disposal of the ash from proposed Thermal Power Plant and action plan for full utilization for ash within a period of 5 years.

Design volume of the ash disposal site

Total Ash Generation = 3394 T/day

$$\text{Volume of Waste} = \frac{\text{Total Quantity of Waste (T)}}{\text{Density of Waste (Tons/m}^3\text{)}}$$

$$= \frac{3394}{1.50} = 2262.6\ m^3/day$$

$$= 2262.6 \times 365 \text{ days} = 825849 m^3/year$$

For 5 years = $825849 \times 5 \text{ years} = 4129245\ m^3$

Area required for 5 years for the depth of 18 meters

$$= \frac{4129245}{18} = 229402.5 m^2$$

Area required (Ha.) for storage of ash for 5 years is 22.9 ha.

8.2.1.2 Ash Utilization/Management

Legal Framework

The management of ash generated by coal-fired power plants is governed by the Ministry of Environment and Forests' Ash Content Notification (1997) and Disposal of Fly Ash Notification (1999).

1. Disposal of Fly Ash Notification (1999)

The main objective of this notification is to conserve topsoil, protect the environment, and prevent the dumping and disposal of fly ash discharged from lignite-based power plants. The salient feature of this notification is that no person within a radius of 50 km from a coal- or lignite-based power plant shall manufacture clay bricks or tiles with mixing in ash to constitute at least 25% of their weight.

2. For thermal power plants, the utilization of fly ash is governed by the following requirements:

- Every coal- or lignite-based power plant shall make available ash for at least 10 years from the date of publication of this notification without any payment or any other consideration, for the purpose of manufacturing ash-based products such as cement, concrete blocks, bricks, panels, or any other material, or for the construction of roads, embankments, dams, dykes, or for any other construction activity.
- Every coal- or lignite-based thermal power plant seeking environmental clearance needs to submit an action plan for utilizing at least 30% of the ash generated in the first 3 years of operation and 100% by the 9th year.
- Fly ash generated from the proposed power plant will be commercially utilized, to the extent possible, in one or more of the following industries: (i) cement, (ii) brick, (iii) fly ash aggregate, (iv) road making and paving, (v) agriculture, (vi) back filling and filling of abandoned mines, and (vii) any other industry that is technically feasible. Apart from these uses, fly ash can be used for the construction of an ash-pond dyke, reclamation of low-lying areas, mine fills, and such agricultural applications as soil conditioner and fertilizer.

Bottom ash, which normally contains more unburned carbon and clinkers, is not

suitable for conversion into useful products and will be disposed to the ash disposal area. The following strategies will be adopted to ensure full fly ash utilization in brick and cement block manufacturing:

- Fly ash will be supplied through the silos to brick and cement block factories.
- Basic technology, as well as initial expert advice for using fly ash in making bricks and cement blocks, will be provided to local brick and cement block makers free of charge.
- Seminars and workshops will be organized at the expense of the Company to create market awareness for fly ash bricks and cement blocks in large cities.
- The company will use fly ash building materials in the construction of its various facilities to instill confidence in local people regarding fly ash building materials.
- As the major constraint in spreading the adoption of fly ash building materials is the unreliability of fly ash supply to widely dispersed brick and cement block industries, the state government can provide valuable assistance by creating depots near large consumption centers under its auspices.

The company proposes to manufacture ash-based products such as cement, concrete blocks, bricks, panels or any other material for the use of ash in construction activity such as in road laying, embankments or use as landfill to reclaim low lying areas including back filling in abandoned mines or pitheads or for any other use shall be carried out in accordance with certification and guidelines laid-down by the Bureau of Indian Standards, Indian Bureau of Mines, Indian Roads Congress, Central Building Research Institute, Roorkee, Central Road Research Institute, in New Delhi, Building Material and Technology Promotion Council, New Delhi, Central Public Works Department, State Public Works Departments and other Central and State Government Agencies.

SEML is in the process of discussions with various cement manufacturers in the vicinity of the proposed power station. The MOU shall be appended along with the final EIA report. The company shall also adhere to the comprehensive Guidelines for the use of Flyash and disposal issued by the Secretary MoP and also the Notification issued by MoEF in this respect.

8.2.2 Air Environment

Coal based thermal power plant will emit particulate matter, sulphur dioxide, oxides of nitrogen, carbon monoxide, heat, etc.

Pollutants from Flue Gases

The flue gases from the boiler exhausted into the atmosphere carry with them considerable quantities of pollutants such as SPM, SO_2, NOx, CO and HC etc. The adverse impact of these pollutants on the environment will be contained within the permissible limits, essentially by adopting the following measures.

- § Boiler of circulating fluidized bed combustion type of firing to reap the inherent advantages of very low liberation of NOx in the furnace.
- § Providing special high efficiency equipment viz. electrostatic precipitator at boiler outlet for extracting the dust pollutant from flue gas for achieving the dust concentration at the outlet of chimney as low as 50 mg/N cu. m.
- § Providing a sufficiently tall chimney to disperse the flue gases over a wide area. Thereby the ground level concentrations of SO_2 emitted by the power plant will be kept within permissible limits.

Air Emission Control Measures

Suspended Particulate Matter (SPM)

The concentration of dust (ash) in the flue gas at the outlet of stack would be about 50 milligram/Nm^3. The boiler would be provided with an electrostatic precipitator (ESP). Electrostatic precipitator (ESP) of efficiency > 99.5% so as to restrict the GLC within the prescribed limit will be installed for the stack emissions, the CO content will be negligible and NO_X content would be minimal.

Sulphur Di-Oxide (SO_2)

SO_2 as per Central Pollution Control Board: < 80 µg/m^3 (annual average)

It is proposed to install Two RCC stacks of 110 meters and 180 meters height each enclosing two independent flues one for 1 X 30 + 1 X 50 MW and one for 2 X 135 MW (350 MW) This will ensure SO_2 dispersion within acceptable limits.

Nitrogen Oxides (NOx)

The GLC to meet ambient air quality : < 80 µg/gm^3 (annual average)

As per the Central Pollution Control Board: < 120 µg/m^3 (24 hrs basis)

Low NO_X burners shall be installed to meet above limits.

8.2.3 Noise Environment

- Manufacturers and suppliers of machine/equipment like compressors, turbines, generators will be selected to ensure that these machine /equipment meet the desired noise/vibration standards by providing noise absorbing material for enclosures or using appropriate design/technology for fabricating/assembling machines.
- The operator's cabins (control rooms) shall be properly (acoustically) insulated with special doors and observation windows.
- The operators working in the high-noise areas like compressor houses, blowers, generators, feed pumps, steam generation plant, turbo-generator area shall be provided with ear-muffs/ear-plugs.
- Acoustic laggings and silencers shall be provided in equipment wherever necessary.
- The compressed air station shall be provided with suction side silencers. Ventilation fans shall generally be installed in enclosed premises.
- Supply ducts and grills on the ventilation and air conditioning system shall be suitably sized for minimum noise level.
- The silencers and mufflers of the individual machines shall be regularly checked.

8.2.4 Water Environment

Wastewater Management

Demineralization (DM) Plant effluent and boiler blow down shall be collected in a neutralizing pit where the acidic and alkaline effluents will neutralize each other. If required, lime dosing for final pH adjustment shall be followed. This shall be pumped and

mixed with other effluents in the guard pond. The entire treated waste water shall be recycled and reused.

The necessary design parameters, material of construction for cooling system including cooling towers shall be selected in such way that they are able to utilize water from clarifier. Provision for oil/grease separators shall be made to skim oil / grease, if any in the wastewater. Zero effluent discharge shall be practiced by recycling the waste water for dust suppression, plantation etc.

The following mitigation measures are recommended to minimize the impacts on water environment:

- The treated effluents from all streams shall be stored in a guard pond.
- The heat cycle makeup requirement for thermal power plant shall be met from dimineralized water.
- The sanitary wastewater will be treated in packaged STP and treated water will be used for plantation.

8.2.4.1 Details of Rain Water Harvesting Scheme

Groundwater Recharge with Rain Water Harvesting

There will be generation of surface run-off from the proposed plant facility during monsoon season. The run-off will be of two types i.e. run-off from the pervious area of the facility site and run-off from the built-up area of the facility.

Run-off from the Built-up Areas

The run-off from the paved surfaces of the proposed facility will be routed through a carefully designed storm water drainage network and collected in storm water collection sump and excess rainwater will be discharged to bore wells constructed on these internal drains.

The run-off from the pervious area will be routed directly to the rainwater harvesting structures constructed at suitable locations as per the contours. For augmenting the ground water resources in the proposed plant, number of rainwater harvesting pits will be constructed and the internal drains where excess rain water flowing in drain will be

diverted to these pits. These structures will facilitate percolation of water into the ground and thus augmenting the groundwater sources. The roof top water will be routed to the storm drains. This will result in increase in groundwater tables and to some extent the improvement of ground water quality.

The size and the locations of rainwater harvesting pits will be decided during detailed engineering of the project. Run off from the proposed project site (81 ha) is calculated using rational formula:

- Area (A) = 810000 m^2
- Rainfall Intensity (I) = 1.4 m (average)
- Run-off coefficient = 0.6
- Total yield of water from 81 ha. = 680400 m^3

The harvested water will be recharged in ground water through recharge pits.

8.2.5 Land Environment

8.2.5.1 Greenbelt Development Plan

The main objective of the green belt is to provide a buffer between the sources of pollution and the surrounding areas. The green belt helps to capture the fugitive emissions and attenuate the noise apart from improving the aesthetics quality of the region. A 20 – 25 m wide greenbelt shall be developed along the periphery of the plant and in all open areas. Avenue plantation shall also be developed as per the standard norms.

Approximately 1500 trees per Ha will be planted in consultation with the local Forest Department. A tentative list of plants suggested for green belt development is presented in **Table 8.1**.

The general guidelines for development of greenbelt are:

- Trees growing up to 5 m or more shall be planted along the plant premises and along the road sides
- Planting of trees shall be undertaken in rows.
- Open areas inside the plant boundary shall be covered with grass lawns.

- For adsorption of dust and gaseous pollutants the following types of plants have been considered,:

i. Fast growing

ii. Thick canopy cover

iii. Longer duration of foliage.

iv. Adequate height and spread of crown

v. Big leaves (long and board laminar surfaces) supported by firm petioles.

vi. Large number of stomata apertures. (Large leaf area index)

vii. Perennial and evergreen

viii. Abundance of surfaces on bark and foliage through roughness of bark, epidermal outgrowth on petioles, abundance of auxiliary hairs, hairs or scales on laminar surfaces and protected stomata (by wax, arches, rings, hairs, etc.)

The choice of plants includes shrubs that grow 1 to 2 m high and trees of 3 to 5m heights. It shall be ensured that the foliage area density in vertical is almost uniform by intermixing the trees and shrubs. Since safety during transport is a major consideration, shrubs in traffic islands and along road dividers shall be short enough to be below the eye-level of motorists.

The species identified for greenbelt development shall be planted using pitting technique. The pit size shall be either 45 cm X 45 cm X 45 cm or 60 cm X 60 cm X 60 cm .Bigger pit size shall be preferred. Soil used for filling the pit shall be mixed well with decomposed farm yard manure or sewage sludge at the rate of 2.5 kg (on dry weight basis) and 3.6 kg (on dry weight basis) for 45 cm X 45 cm X 45 cm and 60 cm X 60 cm X 60 cm respectively. The filling of soil shall be completed at least 5-10 days before actual plantation.

Table-8.1
Recommended Plant Species for Greenbelt

Sr. No.	Types of Plants	Botanical Name	Common Name
1	Large Size Trees	*Azadirachta indica (Meliaceae)*	Neem
2	Large Size Trees	*Syzygium cumini (Myrtaceae)*	Jamun
3	Large Size Trees	*Terminalia arjuna (Combretaceae)*	Arjun
4	Medium Size Trees	*Acacia nilotica (Mimoseae)*	Babul
5	Medium Size Trees	*Bombax cieba*	Semul
6	Medium Size Trees	*Delonix regia (Leguminosae)*	Gold Mohur,
7	Medium Size Trees	*Diospyros melanoxylon (Ebenaceae)*	Tendu
8	Medium Size Trees	*Emblica officinalis (Euphorbiaceae)*	Amla
9	Medium Size Trees	*Saraca indica (Caesalpinaceae)*	Asoka
10	Small Trees/Shrubs	*Zizyphus mauratiana (Rhamnaceae)*	Ber
11	Grasses	*Bambusa arundinacea (Graminae)*	Bamboo
12	Grasses	*Cymbopogon martini (Graminae)*	Gingergrass
13	Grasses	*Cynodon dactylon (Graminae)*	Doob
14	Grasses	*Dactyloctcnium cristarum (Graminae)*	Marka
15	Grasses	*Eulaliopsis binata (Graminae)*	Bagai Ghas

8.2.6 Socio-economic Environment

In order to take care of the likely impacts of the proposed project and to minimize the apprehensions of the local people an effective EMP has been prepared as under:

- Communication with the local community shall be institutionalized and done on a regular basis by project authority to provide an opportunity for discussion.
- Project authorities will undertake regular environmental awareness programs on environmental management measures being undertaken for improving their quality of life.
- To mitigate the strain on existing infrastructure, adequate provision of basic amenities viz. education, health, transport etc. shall be made considering the immigrating population and the work force in the area.
- Job opportunities are the most demanding factor, the local people having suitable skill shall be considered for employment.
- For social welfare activities to be undertaken by the project authorities, collaboration shall be sought with the local administration, gram panchayat, block development office etc. for better co-ordination.

8.3 Institutional Arrangements for Environment Protection and Conservation

Environmental management cell, will be established for the plants, which will be supervised and controlled by an independent plant Manager supported by a team of technically qualified personnel apart from other operating staff. Organization structure is presented in **Figure 8.1**.

It will be the responsibility of this department to supervise the monitoring of environmental attributes viz. ambient air quality, water and effluent quality, noise level either departmentally or by appointing external agencies wherever necessary. In case the monitored results of environmental pollution are found to exceed the allowable limits, the Environmental Management Cell will suggest remedial measures and get them implemented.

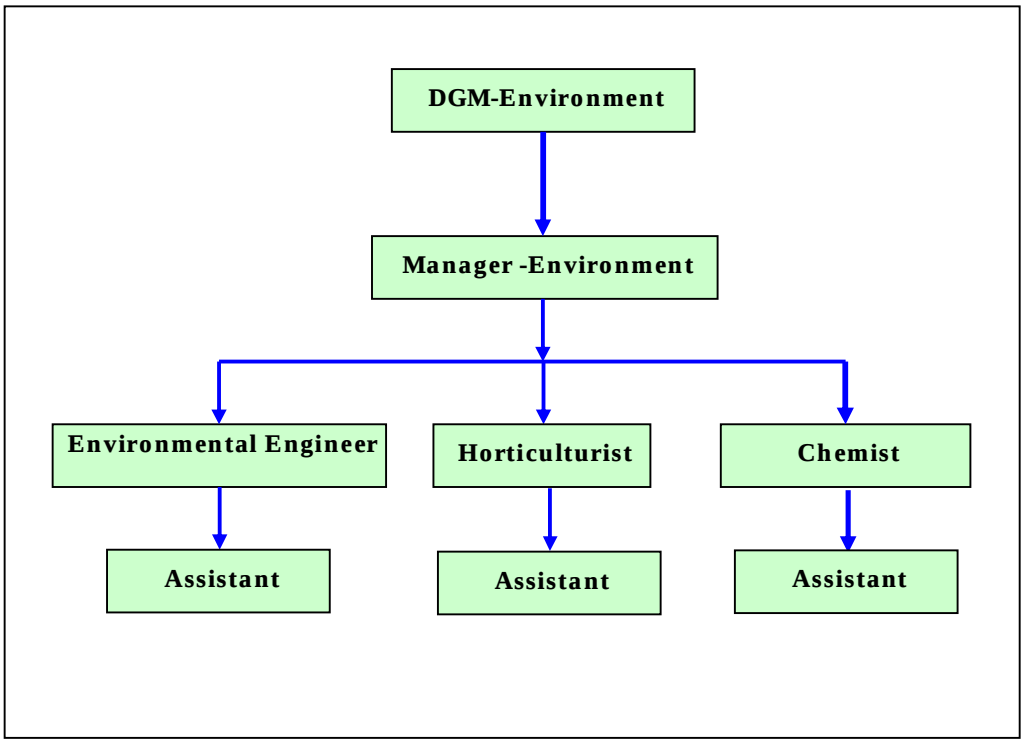


Figure 8.1
Organization Structure of Environment Management

8.4 Budgetary Provision for Environmental Measures

An adequate budgetary provision of Rs.112 Crores during construction and Rs. 10.0 Crores during operation has been made for implementation of Environmental Management Plan.

Pollution control Equipment	**Capital Cost** (in crores)	**Recurring Cost (Annual)** (in Crores)
Air pollution Control System	90.0	9.0
Wastewater Treatment System	5.0	0.3
Solid Waste Management	10.0	0.2
Tree Plantation	2.0	0.15
Monitoring	2.0	0.2
Rain water harvesting project	3.0	0.15
Total	**112**	**10.0**

8.5 Corporate Social Responsibility

Being a corporate citizen the company has the responsibility of contributing to the welfare of the society in which it operates. The company will organise various awareness programmes for its employee and the general public of the area where it operates to ensure a better, sustainable way of life for the weaker sections of society. The proposed expenditure for CSR activities are presented in **Table-8.2**.

Table-8.2
Budgetary Provision for CSR Activity

Particular	**Capital Cost** (in Lakh)
Education	10
Health Care	5
Community Development	5
Total	**20**

Chapter 9

Summary & Conclusion

9.1 Introduction

Sarda Energy & Minerals Limited proposes thermal power plant at village Kolam, Tamnar, District Raigarh, Chhattisgarh. The site admeasuring 81.0 ha is located at latitude 22° 10' N & longitude 83° 25' 30" E . The plant location has been selected based on the availability of fuel, water and facilities for power evacuation.

9.2 Project Description

The details of the proposed project are presented in **Table-9.1.**

Table-9.1
Details of Project

Sr. No.	Project	Details
1	Land Requirement	81 ha
2	Green Belt Area	27 ha
3	Cost of the Project	Rs. 1400 Crores
4	Water Requirement	1240 m^3/hr
5	Raw Material	Coal: 2.15 MTPA Washery Reject : 0.36 MTPA
6	Man Power	700
Technical Features		
7	Capacity	350 MW (1x30 MW + 1x50 MW +2x135 MW)

9.3 Description of Environment

Air Environment

Results of ambient air quality indicate that concentrations of SPM, RPM, SO_2, NOx and CO are well within the prescribed standards.

SPM - 98 to 156 µg/m^3.

RPM - 31 to 50 µg/m^3.

SO_2 - 6 to 10 µg/m^3

NOx - 6 - 12 µg/m^3.

Noise Environment

The noise levels in the study area are within the prescribed standards. Noise levels ranges from 47.7 dB(A) to 53.0 dB (A) during day time and 39.0 dB (A) to 43.9 dB (A) in the night time.

Water Environment

It has been observed that all the physico-chemical parameters and heavy metals of water samples from surface and ground water are below the stipulated drinking water standards. Refer **Table 3.5.2** and **Table-3.5.3** in **Chapter 3**.

Land Environment

About 77.8% of the total study area is agricultural land, 4.21% cultivable waste, and only 14.15% forest land.

The bulk density of the soil in the study area ranges between 1.31 to 1.49 g/cc. pH are in the range of 6.35 to 7.45. Organic carbon and nitrogen are in the range of 1.52 – 2.32% and 270 – 486 kg/ha.

Flora & Fauna

Core Zone

Most of the area of the proposed power plant covered by cultivation. About 1/3rd portion of the area is covered by waste Land unfit for cultivation and without tree cover, indicating degraded soil conditions.

Buffer Zone

No wild animals except langoors, monkeys, hare, jungle cat and rarely a deer species are seen in the study area.

There is no National Park, Sanctuary, Elephant or Tiger Reserve within 10 km radius around the project site. No migratory route of wild animals has been reported.

9.4 Anticipated Environmental Impacts and Mitigation

Land Environment

The proposed project site is fairly flat with shrubs present at some places. There will not be much cutting and filling required for the proposed project. The additional structures such as industrial buildings, stack, waste disposal facilities etc. will be constructed. There will not be any tall structures except stack.

The plant site is of 81 ha. Clearing of shrubs at some locations is required during construction phase. It is proposed to carry out plantation in about 33% of the total project area, which will not only nullify the impact due to vegetation loss during the construction phase but will also improve aesthetic aspects.

Combustion of coal will result in fly ash and bottom ash generation. A part of ash will be stored in Silos at the project site and remaining will be disposed of in an ash pond in slurry form. Efforts will be made to identify suitable end users to ensure 100% fly ash utilization.

Air Environment

Particulate Matter, Sulphur Dioxide and Oxides of Nitrogen are the main pollutants from the proposed plant. ESP of high efficiency (99.5 %) will be installed to limit particulate emissions to 50 mg/Nm^3. Two nos of stacks of 110 m and 180 m high will be provided for adequate dispersal of SO_2. Emissions of NO_x will be controlled by providing low NO_x burners.

ISCST3 dispersal model has been used to predict GLC's. Isopleths are given in **Figure 4.1 to 4.3 in Chapter 4**. The predicted resultant concentrations indicate that SPM, SO_2 and NO_x will be below prescribed standard for residential and rural areas.

Water Environment

The water requirement for the proposed plant is about 1240 m^3/hr, which will be met from Kelo River. 205 m^3/hr of wastewater will be generated, which will be recycled and reused for Cooling Tower, dust suppression, ash handling, plantation etc. There will be no impact on the water regime due to the effluents from the proposed unit.

Adequate rainwater harvesting measures will be implemented to utilize the storm water inside plant premises.

Noise Environment

Modeling results indicate that the incremental noise levels will be in the range of 34 dB(A) to 41 dB(A) at 400 m from the source. Adequate noise control methods will be adopted.

Ecology

No impact on terrestrial ecology will be felt due to emissions of pollutants like SPM, SO_2 and NOx, if mitigation measures are taken as recommended in this report.

9.5 Environmental Management Plan

Pollution control measures for mitigating environmental impacts identified in Chapter 4 include the following:

- Dust suppression / extraction system at the fuel handling area.
- Bottom ash will be collected in wet form. Fly ash will be collected in dry form in silos. Beyond the silo storage capacity, ash will be stored in ash pond in slurry form.
- Fly ash will be used for brick making, cement manufacturing etc. End users for fly ash utilization will be identified.
- Two nos of Stacks with 110m and 180 m high will be provided for proper SO_2 dispersion.
- High efficiency ESP [99.5%]
- Low NOx burners.
- Neutralization of DM plant effluent.
- Induce draft cooling tower with COC of 5.
- Zero effluent discharge will be practiced by recycling and reuse of treated wastewater in ash handling, green belt development, dust suppression etc.
- Separate collection of storm water and development of rain water harvesting

- Sanitation wastewater – Packaged STP.
- Roads within the plant will be black topped / concreted.
- Workers working in high noise areas will be provided ear plugs / muffs.
- Vehicles movement in the plant area will be regulated to avoid traffic congestion.
- Use of high pressure horn will be prohibited.
- 33% of the entire project area will be developed as green belt using native plant species.

9.6 Conclusion

The potential environmental, social and economic impacts have been assessed. The proposed power plant has certain level of marginal impacts on the local environment. With effective implementation of proposed environment management plan, these effects will be insignificant. Implementation of the project has beneficial impact in terms of providing direct and indirect employment opportunities. This will be a positive socio-economic development in the region. Quality of life of the people will improve. No displacement of people from the project site is involved.

With commitment and dedication, SEML will commission the coal based 350 MW power plant with modern equipment. Recommendations made in the CREP for the power project will be implemented. SEML also under take various community welfare measures for the uplifment of villages surrounding the plant.

Chapter 10

Disclosure of Consultants

Anacon is an established Environmental Consultancy firm with basic infrastructural facilities and man power. We are rendering our services in this field to various industries since last 13 years. We are group of experienced Ex. Scientists from the Government Institutions like IBM, NEERI & GSI and our Laboratory is empanelled by Maharashtra Pollution Control Board & MoEF, New Delhi for carrying out environmental Studies. We have prepared the EIA reports for various industries, which includes Steel, Power, Distilleries, Textile and Pharmaceutical. We have worked in the States of Assam, Chhattisgarh, Madhya Pradesh & Maharashtra. Our esteemed client groups include many large scale industries from private as well as the Public Sector Units. National Productivity Council, BALCO, MECON, TATA STEEL, LAFARGE, GRASIM, Ultra Tech Cement Ltd., RAYMONDS, LUPIN, Ranbaxy, GAIL, Seagram & Sagar Distilleries and Sponge Iron are our major clients.

We have successfully carried out the monitoring of Air, Water & Wastewater, Noise, Hazardous Waste & Land Environment for the EIA of various industries. We have also carried land use and land cover studies based on the satellite imageries.

Our operations are spread in six different states in Central India region with branches at Raipur, Korba, Ranchi, Bhopal and Delhi

Credentials of Testing Lab

Our laboratory is registered with following Govt. departments for providing technical services in the field of environment. The registration numbers are as follows;

1. MoEF Notification No. D.L.-33004/99 dt.24.10.2007–Recognized as “A” Grade lab under EPA. moef.gov.in/legis/env/so1811e.pdf
2. MPCB No.WP/Lab-Regn/B/1856 Dt.18.08.1993
3. MPPCB Bhopal No.9485 Dt.27.08.2001

4. Mah. Govt. WQM 2003/PK26 (2) PP12 Dt.1.9.2004 – Drinking water quality monitoring
5. Mah. Govt. JSP 2004/PK3715 PP11Dt.28.04.2004 – Hydrogeological survey
6. RQP/NGP/328/2005/B Dated: - 01.02.2005 – Indian Bureau of mines for preparation of mine plan
7. MPCB/EPD/PL/EMPL/18/07 dt.23.02.2007

For the organizational statutory requirement the registration numbers are as follows;

1. Company Law Board Regn. No11-114169 Dt.25.03.98
2. Provident Fund Regn. No. MH – 63074 Dt. 15.06.2001
3. Professional tax Regn. No. PT/R/4/6/27/1496 Dt. 11.01.199
4. Service Tax Regn.No.ST– 2301/NAG – Dn – I/STS/2001 STC NO. AADCA 0435B ST001
5. Income Tax - PAN No. AADCA0435B TAN No.NGPA0148C

Services Offered

Air (Monitoring / Survey / Modeling etc., Pl. specify)	Yes - Stack and Ambient Air Quality Monitoring, Survey / Modeling as per MoEF requirements. Specific gas monitoring like HC, CO, O_2, CO_2 using state of art microprocessor based portable kits.
Water : Surface, sea, inland & ground water (Monitoring / Survey / Modeling etc., Pl. specify) Geohydrological Survey	Yes - Monitoring of Water Environment in EIA projects, hydrogeological survey and water shed development.
Soil (Analysis, Remediation, Salt water intrusions, Water Harvesting etc)	Yes – Monitoring of land environment in EIA projects.
Plant (Effect of pollution, Treatment Technologies, Pollution Indicators etc.)	Yes - The effect of pollutant from various industrial sectors has been evaluated in terrestrial ecology of EIA project.
Assessment & impact studies on Biodiversity (Flora and Fauna)	Yes – Studies on biodiversity has been reported in EIA projects.
Municipal Solid Wastes (Analysis, Management – Handling, Storage, Transportation, Treatment and Disposal, Site Identification, remediation, Development/ Evaluation of Technology	Yes National Productivity Council is utilizing our services for monitoring and analysis of solid waste samples, which includes sampling and analysis of solid waste samples. **Anacon** lab can undertake the consultancy project on solid waste management for municipal corporation, resorts and

etc.)	newly developed cities. Preparation of detailed feasibility report is an expertise of **Anacon** lab.
Hazardous Wastes (Quantification, Site Assessment, Designing / Monitoring of Treatment Facilities, Technology Assessment etc., Pl. specify)	Yes – The project on development of landfill site including Engineering design, Hydrogeological studies and Environmental quality in respect of the Air, Water and Soil have been successfully completed for Force Motors (Bajaj Tempo), Kinetic Motors and Pratibha Syntex, Pithampur, Indore (MP)
Noise (Monitoring/Survey, Modeling etc)	Yes – The monitoring of the Noise Environment in the Impact zone of the industries and inplant have been carried out by **Anacon** Lab. For 32 EIA study.
Bio-Medical Wastes (Quantification, Site Assessment, Designing / Monitoring of Treatment Facilities Tech. Assessment etc., Pl. pecify)	Yes – The survey of Hospital waste management have been carried out in few cases.
Hazardous Chemicals (Site assessment, Inspection of Storages, Major Accident Hazards, Preparation/assessment of Safety Report, risk assessment/ Onsite/offsite Emergency Plan preparation etc.)	Yes – The storage of the hazardous chemicals have been assessed in respect of fugitive emissions and risk assessment for Pharmaceutical Industries at Lupin, Mandideep, Bhopal (M.P.). Four dumping sites developed maxi cap 8000 Tons for BALCO, Korba, Chhattisgarh.
Plastic Wastes (Management, recycling/reuse technology evaluation etc.)	Yes – On the similar line of solid waste management, studies on the plastic waste management could be undertaken by **Anacon** Laboratories Pvt. Ltd.
Electronic Waste (Management, recycling/reuse, technology evaluation etc.)	No
Environmental Education/Awareness (Projects approved/ grants received /campaigns carried out etc.)	Yes - Conducted Workshop at Raipur on 14.2.04 Theme - Latest Trends in Mining Technical and Legislative requirements, 67 participants attended. ; Conducted several Environment Awareness programs for PCB on different topics and also at Educational institutions/P.G. Departments. College students along with HOD have visited Anacon Laboratories Pvt. Ltd., for Educational tour. Anacon Laboratories Pvt. Ltd., has participated as a Key participant at CII seminar in the field of mining industries at Raipur Dt.22.03.06.
Environmental Impact Assessment (EIAs carried out/ sector wise expertise in EIA/ clearances obtained from MoEF/ State Government etc)	Yes - Successfully completed 65 EIA studies and 24 EIA presented before MoEF & env clearance is granted; remaining 41 presented at State level & the env clearance is granted.
Environmental Audit/s (Details of the audits conducted along with client list and Purposes of such audits)	Yes
Energy Audits / Water Audits (Expertise available, list of the clients and details on such audits)	Yes - Energy Audit for L & T Hirmi, Raipur on STP to conserve energy. In this exercise saving of the 40 % energy is suggested.

Environmental Planning & Management (Projects undertaken/ expertise for actual field implementation of the EMP)	Yes - The special efforts have been put up by Anacon for Seagram Distilleries Pvt. Ltd., and Sagar Industries & Distilleries Pvt. Ltd., Nashik for planning and implementation of EMP. Other projects also have been executed on Environmental Planning and Management.
Others (R&D Projects) (State briefly the other activities of your organization and the success Stories, if any)	Yes – 1.Conducted feasibility studies for pyrite recovery plant for 1000 TPD Cap for GHCL Lignite mine to reduce Sulphur from 7 % to 2 % 2. Identification of route cause for river bed drying (300 m width) for Lafarge, Raipur

Facilities

Anacon offer vide range of services in indoor and outdoor monitoring and analytical characterization in the field of Environment. Further, it is ably supported by highly skilled and experienced team of professionals in the fields of Science, Engineering, Ecology, Meteorology, Social Planning, Geo & Hydro-geology, and Environmental Planning.

Besides the regular monitoring equipment such as Respirable Dust Samplers, Automatic Weather Monitoring Stations, Stack Monitoring Kits, Personal Samplers, Noise Meters, Portable Water Kits etc, the other major specialized equipment include:

Anacon Laboratories has established analytical laboratory with sophisticated instrument such as Thermo iCAP 6300 ICP UK make – OES Radial View Spectrometer with Standard Gas System for analysis of heavy metals and the instruments required for the analysis of drinking water quality (32 parameters as per IS 10500), waste water & Hazardous waste. + Gas Chromatograph.

Anacon Laboratories has established the facilities for Ambient Air Quality by using US Make Meteorological Station and High Volume Sampler. Stack Monitoring is also undertaken. The methodology for estimation of SO_2, NOx and SPM has been established along with project specific pollutant.

Quality Systems

The laboratory have applied to NABL (ISO 17025) in May 2008 for water (32 parameters) and pre-assessment is over. Final certificate has been issued on 09/01/2009.

Achievements

The laboratory recognized under Environment Protection (EP) Act by GOI in 2007, Environment Division with its best mind power and industrial knowledge competency that allows it to compare with the best in the business.