Environment and Social Impact Assessment

6x660 MW Sasan Ultra Mega Power Project

At Singrauli

Madhya Pradesh

Prepared by

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Table of Content

List of Tables

List of Figures

Abbreviations Used

ACW	Auxiliary Cooling Water
AIChE	American Institute of Chemical Engineers
APHA	American Public Health Association
AWWA	American Water Works Association
BOD	Bio-chemical Oxygen Demand
BOO	Build, Own and Operate
CEA	Central Electricity Authority
CEA	Central Electricity Authority
CEIA	Comprehensive Environment Impact Assessment
CGWB	Central Ground Water Board
CHP	Coal Handling Plant
CMB	Central Monitoring Basin
CO_2	Carbon Di-oxide
COC	Cycle of Concentration
COD	Commercial Operation Date
COD	Chemical Oxygen Demand
CPCB	Central Pollution Control Board
CW	Cooling Water
CWC	Central Water Commission
DB	Dependants' Benefit
DCP	Dry Powder
Dy	Deputy
EA	Environment Assessment
EAC	Expert Appraisal Committee
ECW	Equipment Cooling Water
EHS	Environment, Health and Safety
EIA	Environment Impact Assessment
EII	Environmental Impact Index
EMP	Environment Management Plan
EPA	Environment Protection Agency
EPC	Engineering, Procurement and Construction
EPS	Electrical Power Survey
ER	Eastern Region
ESI	Employees State Insurance
ESIA	Environment and Social Impact Assessment
ESMMP	Environment and Social Management and Monitoring plan
ESP	Electrostatic Precipitator
FCC	False Color Composition

FPIC	Free Prior and Informed Consultation
GBPS	Govind Ballabh Pant Sagar
GCV	Gross Calorific Value
GHG	Green House Gases
GLC	Ground Level Concentration
GoI	Govt. of India
GoMP	Govt. of Madhya Pradesh
GWh	Giga Watt Hour
HCSD	High Concentration Slurry Disposal
HFO	High Fuel Oil
HH	House-holds
HP	High Pressure
hPa	Hectopascals
IEC	Important Environmental Components
IFC	International Finance Corporation
ILO	International Labour Organization
IMD	Indian Meteorological Department
IS	Indian Standards
ISCST3	Source Complex Short-term Model 3
ISH	Intermediate Surge Hopper
KL	Kilo Liter
LA	Land Acquisition
LDO	Light Diesel Oil
LFL	Lower Flammable Limit
LP	Low Pressure
MB	Maternity Benefit
mg/l	Milligram per Liter
MLA	Member of Legislative Assembly
mm	Millimeter
MoEF	Ministry of Environment & Forests
MoP	Ministry of Power
MP	Member of Parliament
MPPCB	Madhya Pradesh Pollution Control Board
MSDS	Material Safety Data Sheet
MSIHC	Manufacture, Storage & Import of Hazardous Chemicals Rules
MW	Mega Watt
NAAQS	National Ambient Air Quality Standard
NER	North-eastern Region
NFPA	National Fire Protection Association
NGO	Non-Govt. Organisation

NIO	National Institute of Oceanography
NOC	No objection Certificate
NO_X	Oxides of Nitrogen
NR	Northern Region
NRRP	National Rehabilitation & Resettlement Policy
OBC	Other Backward Class
OHS	Occupational Health Service
OSHA	Occupational Safety and Health Administration
PAA	Project Approving Agency
PAF	Project Affected Family
PAH	Project Affected Household
PAP	Project Affected Person
PFC	Power Finance Corporation
PGCIL	Power Grid Corporation of India Ltd.
PIC	Public Information Centre
PIV	Parameter Important Value
PLF	Plant Load Factor
PPAH	Pollution Prevention and abatement Handbook
PPE	Personnel Protection Equipment
PT	Primary Treatment
R&R	Rehabilitation and Resettlement
RCC	Reinforced Concrete Cement
RPII	Relative Parameter Importance Indices
RSPM	Respirable Particulate Matter
SB	Sickness benefit
SC	Schedule Caste
SEAC	State Expert Appraisal Committee
SEIAA	State-level Environment Impact Assessment Authority
SHR	Station Heat Rate
SMPV	Static & Mobile Pressure Vessels
SO_2	Sulphur Di-oxide
SOP	Standard Operating Procedures
SPCB	State Pollution Control Board
SPL	Sasan Power Limited
SPM	Suspended Particulate Matter
SR	Southern Region
ST	Schedule Tribe
TAC	Tariff Advisory Committee
TERI	The Energy and Resource Institute
UFL	Upper Flammable Limit

UMPP	Ultra Mega Power Project
UN	United Nations
UNEP	United Nations Environment Programme
UPS	Unrestricted Power Supply
US	United State
WEII	Weighted Environmental Impact Index
WHO	World Health Organisation
WPCF	Water Pollution Control Federation
WPR	Work Participation Rate
WR	Western Region
$\mu g/m^3$	Micro-grams per cubic meter

Executive Summary

EXECUTIVE SUMMARY

1.1 PROJECT OVERVIEW

India is a severely power deficit country. The current peak deficit is 11% & energy deficit is also 11% in Northern Region. The peak deficit is 19% and energy deficit is 16% in Western Region. At the end of 11th Plan (i.e. 2012) the peak deficit and energy deficit in Northern Region is expected to be 21% and 7% respectively and in Western Region is expected to be 3% and 13% respectively. At the end of 12th Plan (i.e. 2017) peak deficit is expected to be 7%.

The per capita electricity consumption in India is 704 kWh which is less than one fourth of world average (3163 kWh). 40% of India's population does not have access to power. Hence there is a need for setting up large scale power projects expeditiously to meet the power requirements of the country. Supply of competitively priced power is critical for the economic development of the country.

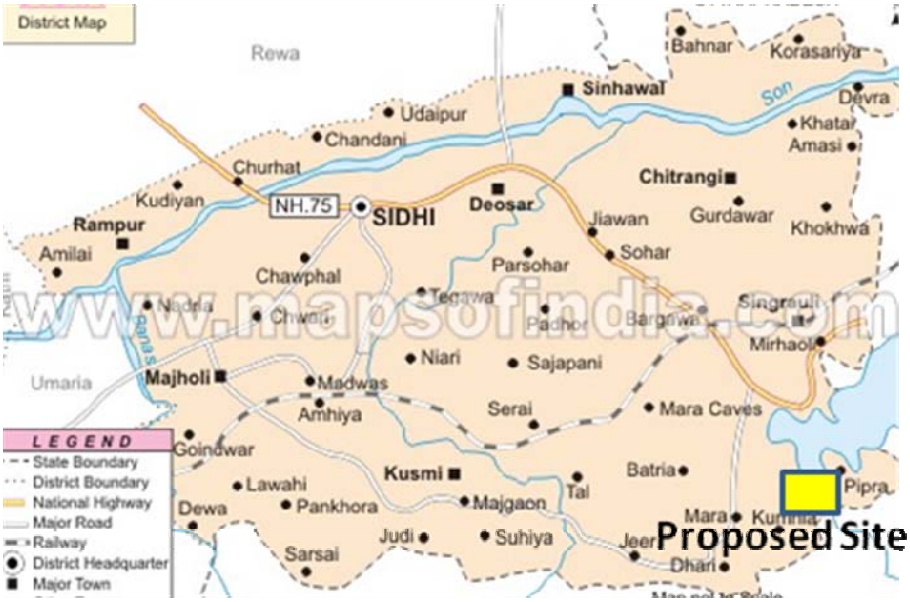
Sasan Ultra Mega Power Project (UMPP) is a Government of India's (GOI) initiative for building large scale power projects in India. As per the UMPP scheme, each UMPP is initially developed through a Special Purpose Company (SPC) which is a wholly owned subsidiary of Power Finance Corporation (PFC), Government of India undertaking. The SPC is responsible for activities like site selection, obtaining coal mines wherever applicable, acquiring land, obtaining various clearances & approvals. Thereafter, PFC carries out an International Competitive Bidding process & awards the SPC to successful bidder quoting lowest levelised tariff.

Sasan Power Ltd (SPL) is the SPC established by PFC to develop the Sasan UMPP. The project has been allotted three captive coal mines namely Moher, Moher Amlohri Extn & Chhatrasal. SPL was handed over to Reliance Power Ltd which emerged as the lowest bidder in terms of levelised tariff for Sasan UMPP & is being developed on Build, Own & Operate (BOO) basis. Sasan UMPP is 3960 MW pit-head coal based power project. The project will supply power at an extremely competitive levelised tariff of Rs 1.196/kWh (US Cents 2.6/kWh) which would benefit 35 crore population in the seven states where power would be supplied from the project.

SPL had carried out a Comprehensive Environmental Impact Assessment (CEIA) for the period March 2006 to February 2007. Based on Rapid EIA a formal public consultation process with the local population was specifically held for the project on June 17, 2006 according to MoEF guidelines. The project has been awarded the environmental clearance on November 23, 2006 by Ministry of Environment and Forests (MoEF), Government of India (GoI) based on recommendation of the Expert Appraisal Committee (EAC). The EAC comprises of eminent environment & social scientists & experts from MoEF, Central Pollution Control Board (CPCB), Ministry of Water Resources, Wildlife Institute of India and other government and quasi government organizations. Forest clearance for power plant area has been obtained from MoEF on April 16, 2009. No Objection Certificate (NOC) from Madhya Pradesh Pollution Control Board (MPPCB) dated July 6, 2006 has also been obtained. Environmental norms in India are very stringent for large power projects and follow International standards.

Executive Summary

This part gives a summary of the project details, impact assessment and mitigation measures taken up for the purpose of the study



1.2 SITE KEY FEATURES

The power plant is located near village Sasan in Singrauli (earlier Sidhi) District of Madhya Pradesh State. The site is near to the Govind Ballabh Pant Sagar, and would get its water supply from this reservoir. Captive coal mines will provide enhanced reliability of fuel supply.

The project will be developed in a total area of 3,341 acres of land (For Main Plant area, Ash Dyke and Township). The land acquisition for the project is being pursued through State Government of Madhya Pradesh as per the provisions of the Land Acquisition Act, 1896 and approved Rehabilitation and Resettlement Policy specially designed for the project.

Site Key Features

Project Site	Village: Sasan, Taluka- Waidhan, Dist: Singrauli (Earlier Sidhi)
Latitude	23° 57' 56" N
Longitude	82° 37' 30" E
Total villages / Households in Study Area (10 kms radius from centre of project site)	166 villages / 43201 Households
Connectivity:	
Nearest town	Waidhan (12 Km.)
Nearest Railway Station	Shakti Nagar Railway Station (18 Km.)
Nearest Airport	Varanasi (250 Km)
Access roads	NH-75 (10 Km Approx.) and the site is well connected through village road.

1.2.1 Objective of the study

The Environmental Impact Assessment (EIA) documentation for the Sasan UMPP was conducted in 2006 and was designed to meet the regulatory requirements of the Ministry of Environment & Forests (MoEF), Government of India. The Project received Environmental Clearance from MoEF in November 2006.

The Environment & Social Impact Assessment (ESIA) has now been revised and updated to meet the requirements of the International Finance Corporation (IFC)'s Performance

Standards for Social and Environmental Sustainability and Environmental, Health and Safety (EHS) guidelines This revised and updated ESIA is based on an update of social surveys, consultations, impact identification and evaluation and recommendations on environmental and social mitigation and management plan.

1.3 LEGAL AND REGULATORY REQUIREMENTS

Sasan UMPP is governed by various legislative rules and regulations set by Madhya Pradesh Pollution Control Board (MPPCB) and Ministry of Environment and Forests (MoEF), Govt. of India including guidelines of Central Pollution Control Board (CPCB) as applicable. The Project has obtained Environmental Clearance and Forest Clearance from MoEF for diversion of forest-land in power plant area.

The ESIA report has been structured to meet the documentation requirements of applicable national and international regulations and standards including Performance Standards on Social and Environmental Sustainability and General Environmental, Health and Safety (EHS) guidelines of IFC.

1.4 PROJECT DESCRIPTION

1.4.1 The Project

Sasan UMPP has a capacity of 3960 MW. Generated electricity will be supplied to fourteen distribution companies in seven states namely Madhya Pradesh, Uttar Pradesh, Delhi, Rajasthan, Punjab, Haryana, Uttaranchal with total population of about 35 Crores.

1.4.2 Technology

The 6x660 MW power plant will comprise of super critical boilers, steam turbines and hydrogen cooled generators. The steam generators have been designed for satisfactory and continuous operation with available range of coal characteristics.

1.4.3 Benefits of supercritical Technology

- Improvement in power plant efficiency
- Reduction in coal consumption
- Reduction in Green house gases
- Reduction in requirement of Ash dyke land & Consumptive water.
- Less start up time of the boiler.

1.4.4 Land

Land required for proposed Sasan UMPP is about 3341 acres, which includes main plant, ash disposal area, green belt, approach roads, water intake corridor and ash pipeline etc.

The main plant area comes in Sidhi Khurd and Sidhi Kalan villages which is about 2035 acres. Ash pond area, which is about 811 acres, will be located near to South-eastern side of main power plant in Harrhawa and Jhanjitola Villages. The residential colony will be constructed in Tiyara village over 449 acres.

The land acquisition for the project is being pursued through Govt. of Madhya Pradesh (GoMP) as per the provisions of the Land Acquisition Act, 1896 and approved Rehabilitation and Resettlement Policy designed for the project.

1.4.5 Fuel

Coal requirement envisaged for the proposed project is 14.99 MTPA at 90% PLF & 4445 kCal/kg. Coal for the Sasan project would be sourced from captive mines in Singrauli coal fields. Coal will be transported to project site through over land conveyor system.

1.4.6 Water

The water source for the proposed plant is Govind Ballabh Pant reservoir. Water Resources Department of Madhya Pradesh Government & Central Water Commission of GOI have allocated 150 cusecs of water from the reservoir which is sufficient to meet the power plant requirement.

1.4.7 Project Cost

Total cost of the project including captive coal mine cost and cost of pollution control equipment is estimated to be Rs. 20,000 crores (Rupees Twenty thousand crores only).

1.5 BASELINE ENVIRONMENT STATUS

Base-line data for the project area was collected for various environmental parameters including air, water, soil, land-use, noise, flora-fauna and socio-economic status to determine quality of the prevailing environmental settings. The study was conducted by Desein Private Limited, Consulting Engineers during three seasons (Summer, Post-monsoon and Winter) from March, 2006 to February, 2007.

The baseline environmental quality of the study area of 10 km radius from the proposed project has been identified through network method. Also 25-km radius around the project site has been covered for general area of study.

1.5.1 Sensitive Receptor

No major eco-system and biosphere have been identified within the study area as per the MoEF guidance manual.

1.5.2 Land-use

The project area consists of 1745 Acres of private land, which includes settlements and single crop agriculture land. The details of the area required for the plant are given below.

Land Owner-ship Status (in Acres)

Use of Land	Private Land	Govt. Land	Forest Land	Total
Plant Area	932	310	793	2035
Township	174	275	-	449
Ash disposal	602	209	-	811
Road from colony to plant	25	9	-	34
Corridor Ash Pipe	3	0.25	-	3
Intake Water Pipeline	9		-	9
Total	**1745**	**803**	**793**	**3341**

1.5.3 Soil Quality

The soils in the general study area are red soils dotted with clayey soils. The fertility of soils in general is poor. The soil texture shows varying proportions of silt and sands. The clay portion ranges from 3.4 to 6.5% by mass in summer season. No significant changes in texture of the soils samples were observed during study period.

The soil characteristics of the area are influenced by existing drainage pattern with soil erosion as the main feature of the landscape. As a result, the nutrient status is found to be lower in most of the cases.

1.5.4 Meteorological Conditions

1.5.4.1 Climate

The climate of the region is humid and tropical with four seasons, delineated as per IMD classifications.

1.5.4.2 Micro-meteorology

Measured temperature during monsoon, post-monsoon and winter seasons normally varies from 27.0 to 33.5°C, 19.0 to 31.7 °C and 11.8 to 26.5 °C respectively. The relative humidity of the area is high.

Light winds are common during early morning hours, whereas day and night time averages range from 1.9 to 8.7 km/hr in summer, 3.1 to 7.3 km/hr in monsoon, 1.5 to 5.3 km/hr during post-monsoon and 1.6 to 6.1 in winters.

The predominant wind direction in summer and monsoon is west whereas north is the predominant wind direction in post-monsoon and winter seasons.

1.5.5 Ambient Air Quality

The observed Ambient Air Quality generally meets the applicable norms. The sources of particulates are varied, fugitive and not related to any industrial emission, except at Waidhan, which is affected by emissions from multiple sources.

1.5.6 Water

1.5.6.1 Water Use

Surface Water

The region falls in the Ganga system. The Son is the major river which flows towards the NE through the northern part of the district and is drained by the rivers Banas, Gopad and Rihand / Rehar.

Rihand / Rehar River flows through eastern part of the study area. Rising from the hills of Surguja, it maintains a general north-easterly course and meets the Son in Bihar. The river has a dam in its downstream creating Govind Ballabh Pant Sagar reservoir with a large spread area falling in Uttar Pradesh and Madhya Pradesh.

The general area serves as catchment for watersheds and run-off water resources. The rainfall received in the area is moderate. The existing rivers, reservoir and wells are the main water sources utilized for irrigation and household purpose. The principal uses of stored water are in irrigation, hydel power generation, domestic uses including water supply for drinking purpose and existing thermal power plants.

Ground Water

The groundwater resource is limited and is primarily used for drinking and agricultural purposes. Because of the absence of water supply system in rural areas dependence on ground water is high. The groundwater aquifers are smaller in capacity and used extensively in rural areas.

1.5.6.2 Water Quality

Surface Water

To assess the baseline quality of Surface water, samples were collected from 3 locations. Dissolved solids in the surface water samples, are lower in concentration whereas

suspended solids are relatively higher in summer season which can be attributed to rainy days during study period.

Mineral contents of the samples are generally influenced by the sampling locations. Nutrient loads in terms of nitrate and phosphate are lower. The COD and BOD values are also lower. Heavy metal concentrations are insignificant in all the tested samples.

Ground Water

Ten Groundwater samples were collected. Samples show significant variation in quality, due mainly to variation in geology. The nutrient load is lesser and heavy metals as analyzed are within limits. The water is generally potable and used for domestic purpose in rural areas.

1.5.7 Noise Level

The noise level of the study area is well within the prescribed standards for residential areas. However, some higher values of noise have been recorded at Waidhan which may be due to road traffic and commercial activities in the town.

1.5.8 Ecology

A reconnaissance survey has been conducted to draw the present ecological status of the area. The biological components of general study area are highly degraded with low to medium biological diversity. The wildlife of the area is not represented by any major species.

1.5.9 Socio-economic

In total 166 villages of Singrauli Tehsil fall within ten (10) km of core zone in addition to five (5) villages which will house the main plant area, ash dyke, auxiliaries and other supporting facilities including infrastructure.

The influence area has a population of 2.5 lakhs with 45712 household with annual average growth rate of 3.7%. The existing high growth rate in the area is ascribed to ongoing industrial activities mainly in power and mining sectors.

The gender ratio of the project impact area is 960, which is higher than the national average of 933.

Approximately 820 Project Affected Families (PAF) losing home stead are expected to get affected due the proposed project.

1.6 PUBLIC CONSULTATION & DISCLOSURE OF INFORMATION

During the Public Consultation, SPL responded to concerns raised by stakeholders and measures have been taken to incorporate these concerns into project design and implementation.

The following sequences of activities were undertaken:

- May, 2006: Initial public meetings were organized with the affected community in accordance with Sec 5 of Land Acquisition Act for objection regarding land acquisition;
- May, 2006: R&R Survey have been conducted by the Consultant in guidance of SPL
- Project Information Centre has been opened in Harrahawa Village to provide the information for villagers about the project impact and mitigation measures proposed;
- June, 2006: Public Hearing for the project has been conducted on the basis EIA documented submitted to State Pollution Control Board as per the guidelines of Ministry of Environment & Forests, Govt. of India
  (The Hindi Translated Version of EIA document was disclosed to the general public in District Administration Office)

- September, 2008: Compensation amount was finalized by the Government and released to the revenue office
- December, 2008: A Grievance Redressal Camp was organized by SPL on 28th December, 2008 to resolve the issue of PAPs.
- 'The Energy and Research Institute (TERI)', an Non Government Organization (NGO) involved in welfare of the people is assisting the District Administration & project company in R&R issues. They are also interacting with Project Affected People and resolving their apprehensions.
- The ESIA report covers IFC specified requirements to the extent of their applicability to the Project.

1.7 IMPACT ASSESSMENT

1.7.1 Impact Assessment Process

The Environmental and Social impacts of the Sasan UMPP have been studied in detail. The Environmental & Social Impact Assessment (ESIA) documentation provides the details of the work carried out and recommends necessary actions and commitments to minimise, mitigate and monitor potential adverse impacts. The ESIA process included following considerations:

- Complying with legal requirements and IFC's performance standards for environmental and social sustainability;
- Ensuring Public Consultation and Disclosure Process; and

1.7.2 Key Project Impacts

1.7.2.1 Impacts on Land Use

The land required for the Project would result in long term change of its land-use. Prior to construction, land will be developed through leveling and grading. Present land use of the selected site is mainly infertile, un-irrigated single-cropped agriculture land with scrub forests and scattered settlements. As required by Forest Department to improve the forest cover and animal food value in the surrounding forest area and create water holes, shelter and food for wildlife, compensatory afforestation has been proposed over an area of 1586 acres. An amount of about Rs 15 crores has been deposited.

During operation phase, the landscape of the area under the various project components is expected to be improved due to projects initiatives of greenbelt development & rain water harvesting.

1.7.2.2 Impacts on Soil Quality

Most of the impacts of coal-based power plant project on soil are restricted to the construction phase, which will get stabilized during operational phase.

In the proposed project activity, waste-water generated will be treated suitably before discharge. The sanitary and other waste-water will be treated suitably and will be reused for green belt development activities.

The soil conditions of the project site would be allowed to stabilize during operation after the impacts of the construction phase. The topsoil in non-built up areas would be restored and such portions of the site would be subjected to plantations, which would help in bonding of the soil, thus increasing its strength.

1.7.2.3 Impacts on Hydrogeology

The project site falls in the safe category area as per ground water resource consideration. Thus no significant impact will take place due to extraction of ground water during construction. Also, rainwater harvesting is envisaged in consultation of the Central Ground Water Board.

1.7.2.4 Impacts on Drainage Pattern

No major changes in drainage pattern of the area are expected as no drainage is being realigned or diverted due to the proposed project. However, efforts will be made by SPL to improve the water sheds of the area.

1.7.2.5 Impacts on Water Quality

The construction personnel, housed in temporary settlements, discharge some amount of domestic wastewater. The main pollutants are organic components and microorganisms with the potential to cause contamination of water quality. To address potential impacts on water quality, disinfected latrines (e.g., through regular liming) is being used as main component of the sanitation system.

The effluents generated from the power plant during operations will be collected stream-wise for various treatments as envisaged in the wastewater treatment scheme. The treated effluent meeting the discharge standards will be released and thus no impact on the surface water is envisaged. The wastewater recovery, as practiced, will considerably reduce the impact on the surface water quality.

Groundwater is not envisaged to be drawn during operation and adequate treatments will be provided to the effluents in lined basins.

1.7.2.6 Impacts on Air Quality

The main source of emission during the construction phase is the movement of equipment and vehicles at site. Equipment deployed during the construction phase is also likely to result in marginal increase in the levels of SO_2, NO_X, and particulate matter. The impact is reversible, marginal and temporary in nature.

There is possibility of impacts on ambient air quality during operation phase of the Project due to combustion of coal in power generation process. The maximum monitored background ambient air quality values were found to be 22.3, 27.5 and 188.2 µg/m^3 for SO_2, NO_X and SPM respectively. The maximum resultant concentrations of the study area are likely to be 73.8 µg/m^3 for SO_2, 53.8 µg/m^3 for NO_X and 188.9 µg/m^3 for SPM. It was found that 24 hr concentrations of all pollutants would be well within limits for rural and settlement areas.
The CO_2 intensity of the project is 829.4 grams CO_2/kWh which is within the limits prescribed by International Funding Agencies.

1.7.2.7 Impacts on Noise Quality

The study area is likely to experience increase in ambient noise level due to heavy construction traffic for loading and unloading, fabrication and handling of equipments and material. The areas affected are those close to the site. To minimize the impact on nearby communities, construction schedule have been optimized.

Also the cumulative impact from different stationary noise sources in the operation phase of the proposed project has been predicted by using wave equation. Since the ambient noise is

higher than predicted levels therefore, due to the masking effect increase in noise level is not expected.

1.7.2.8 Impacts on Ecology

Forest land falling in plant area is classified as degraded forest and there are hardly any trees. The forest to be removed for the project contains mixed type of forest with 20 to 40% tree cover as per the Forest Working Plan. However, compensatory afforestation is being implemented over 1586 acres at a cost of Rs 15 Crs. Further the effects of air emissions on nearby vegetation and croplands are not likely to be injurious and noticeable as the pollutants concentrations are expected to be well within the prescribed standards.

1.7.2.9 Impact on Health & Sanitation

Health risk includes potential disease hazards due to lack of hygienic / sanitation (water supply and human waste disposal), vector and water borne diseases. Potential health risks would also grow if left unchecked. Mitigation measures like proper sanitary health care and human waste disposal facilities have been implemented. The Project is also providing health care facilities for the communities around the Project site through Mobile Clinic with doctors and Primary Health Centre has been constructed in R&R Colony of project.

1.7.2.10 Traffic Volume

Traffic congestion on nearby highways / roads may take place due to heavy vehicular movement during the construction phase of all the units of SUMPP, which may cause temporary public inconvenience. SPL would widen & strengthen the Road as per requirement.

1.7.3 Socio-economic Impact

1.7.3.1 R&R Issue

The Project has acquired land mainly from five villages of Sidhi Khurd, Sidhi Kalan, Jhanjitola, Harrahawa and Tiyara in Tehsil Waidhan, District Singrauli. The major impacts of the Project would be loss of property & livelihood. The estimated Project Affected Families (PAFs) losing homesteads is 820. However, Resettlement and Rehabilitation of the affected villages in a satisfactory manner will help mitigate the impact of displacement and loss of livelihood. Sasan Power Limited on its part will take special care to provide a long term sustainable compensation package (already approved by Govt.) to project affected persons based on the State & Central Government guidelines.

1.7.3.2 Change in Socio-economic Condition

Employment: The project will give priority to the host population in employing based on skills. Even indirect job opportunities will be created outside the project boundary. Many people will find employment in service sector and marketing of day-to-day needs viz. poultry and other agricultural products.

Development of Infrastructure: As the project and consequent activities are expected to generate additional employment and income opportunities for the local population, market expansion supported by infrastructural development will foster economic growth in the area. Flow of reliable and adequate power from the plant will not only enhance growth in the region, but will also bring about a change in energy consumption pattern.

1.7.3.3 Labour Influence

During construction activities, there will be a sizeable influx of labour population Labour colony is being constructed to house such labourers. This will have an effect on social

fabrics of the areas surrounding the project. However, this impact is envisaged to be insignificant due to the following reasons:

- Priority will be given to local labour, therefore less impact on resources.
- Temporary labour colonies will be situated within the plant boundary.
- It will be only a temporary change (restricted to construction period). After construction phase, the areas acquired by labor colonies shall be reverted back as per the requirement of the plant / green belt / afforestation.

1.7.4 Cumulative Impact due to Associated Facilities

The major industries in the vicinity of Sasan UMPP are Singrauli Thermal Power Plant and Vindhyanchal thermal power plant. No new industries are proposed to be established within 15 kms radius from the project site. However, the impact of operational activities of Singrauli STPP and Vindhyachal STPP is already considered in baseline environment conditions.

Impact from Water Pipeline Corridor

Make up water shall be drawn from Rihand reservoir. Water will be supplied through pipes following ground profile. No land acquisition is involved in water pipe line corridor. The land for the pipe corridor shall be taken on ROW basis. The impact on erection of this line is temporary in nature due to digging, back filling and temporary disturbance. There is no permanent or long term impact. Suitable road crossings/culverts shall be provided for movement of people. Therefore, minimal change on the local environment is expected due to the water corridor

Impact from Ash Corridor

The Ash from the Plant will be collected in dry form and will utilized. The unutlised ash has been envisaged to be transported in slurry form, and will be disposed off by means of a set of slurry pumps to ash dump area. In order to reduce the fugitive emission due to ash handling system, the disposal of ash to the ash dump area is envisaged in wet (slurry) form. The land requirement for the ash pipeline corridor is estimated to only 3.42 acres. Therefore, minimal impact due to ash corridor is envisaged.

Impact from Coal Transportation

Coal from mines will be transported to plant through overland conveyor route. Fugitive emission will not take place due to closed conveyor system. Also no congestion on the local transportation is envisaged due to proposed overland conveyor system. Approx. 73 acres of land will required for the belt coal conveyor system. The route of the coal conveyor system has been finalized on the basis of minimum disturbance especially to agriculture and habitats.

1.7.5 Impact on Cultural Resources

There are no specific cultural heritage sites in and around the project area. Also there are no tangible properties or natural features that would be considered cultural heritage site. Impact Area (10 km radius from the project site) doesn't have any endangered species and critical habitats.

Most of the construction labourers are on contractual basis. Separate labour camps will be built within the plant premises for the construction laborers. Therefore, conflict of the migrating labour with local, is not likely to take place during the construction phase.

Regular check and measures will be done through supervisors so that construction labour does not interfere with the local inhabitants for their cultural values.

1.7.6 Key Project Benefits

Sasan Ultra Mega Power Project is a project of national importance and would benefit 35 crore people across 7 states of India. In addition to the rehabilitation and compensation package for the directly affected persons, SPL is committed to provide community developmental benefits in a sustainable manner to the whole region. The key benefits anticipated from the project are:

- Increased electricity availability;
- Increased investment and national income;
- Increased employment opportunities to the local people;
- Improved infrastructure and educational facilities in the near-by villages.
- Development of supporting Small Scale Industries
- Reduced electricity cost

SPL would implement mitigation measures and undertaking specific action plans developed as part of Environment and Social Management Plan (ESMP). The contractors selected for the project construction would also be made aware of their responsibility for implementing day-to-day, construction-related environmental mitigation and monitoring measures as specified in the Environment & Social Management Plan.

1.8 ALTERNATIVES

The present site was selected based on water availability, proximity to coal mines, minimal R&R issue, low agricultural productivity, least impact on existing drainage system, absence of sensitive location in the vicinity and proximity to load centres in both northern & western region.

For the present plant super-critical technology will be used, which is more efficient and environment friendly. This will result in low coal consumption and water requirement. The indirect impact such as reduction in maintenance cost, auxiliary power consumption, ash dyke land and environmental benefits such as reduction in green house gases; water requirements, etc. are additional to the above.

1.9 RISK ASSESSMENT

Risk likely to pose threat to man, environment or property include transport, storage; handling and usage of fuels (Coal & LDO/ HFO), chlorine and hydrogen. Precautionary measures to be taken for preventing any hazards due to these materials.

All equipment vulnerable to explosion or fire would be designed to relevant IS codes and statutory regulations.

Specific care will be taken with respect to handling and storage of hazardous chemicals. Regular mock drills will be carried out to enact accident scenarios with reports sent to the top management. Workers at project site will be provided with personal protective equipment like safety shoes, helmets, ear muff, etc.

Suitable fire protection system comprising hydrants and spray systems will be provided for fire protection during operation phase of the project. Fire extinguishers shall be tested periodically and will always be kept in operational mode.

Surrounding population (including all strata of society) shall be made aware of safety precautions to be taken in case of any mishap in plant.

1.10 ENVIRONMENAL AND SOCIAL MANAGEMENT PLAN (ESMP)

The ESMP provides a delivery mechanism to address potential adverse impacts and implement standards of good practice to mitigate the same.

1.10.1 Standards and Guidelines

Besides the compliance with the stipulated conditions under various permits (approvals, clearances and licenses) obtained for construction and operation of the Project, SPL would also comply with regulatory provisions and applicable standards.

Environmental and Social Management System and its set up, role and responsibilities will be based on the requirement as per ISO 14000 certification. The company is also committed to pursue Occupational Health and Safety Assessment System OHSAS 18001 to be certified by national and international certifying agencies.

1.10.2 Environmental Management Plan

The Environment Management Plan (EMP) outlines the environmental management system that will be implemented during the detailed design and construction works of the project for minimization of deleterious effects and implementation of enhancement measures. The EMP monitors and manages environmental aspects and issues during operation phase by:

- Identifying potential environmental impacts;
- Recommending mitigation measures for the negative impacts;
- Identifying opportunities for enhancement measures;
- Providing an organizational framework for operating Environment Management System and other functions of the project by assigning roles and responsibilities for environmental monitoring and management;
- Formulating Environmental Management Plan, which specify mitigation, monitoring activities.

1.11 CLEAN DEVELOPMENT MECHANISM (CDM)

The project activity aims at reducing Green House Gas (GHG) emission by setting up 6 x 660 MW coal based Super-critical Thermal Power Plant at Sasan, District- Singrauli in the state of Madhya Pradesh, India.

1.11.1 Reduction in GHG emissions due to Proposed Project Activity

The Project would employ latest advanced class super-critical technology resulting in a) higher plant efficiency; b) lower Greenhouse Gas (GHG) emissions, so that there is considerably lesser environmental impact. The Project is the greenest coal based power plant in the region. The Project would consume approximately 1.5 million tons of coal less per year compared to the sub-critical plants of comparable size. As a result, net GHG emission is estimated to be lesser by 14% in comparison to the sub-critical technology based generation plant of similar capacity to generate the equivalent electricity.

By deploying the super-critical technology, Sasan Project would abate CO2 emissions by approximately 60 Million Tonnes over the the life of the Project. This would enable the project to earn Certified Emission Reductions (CERs) / Carbon Credits during the initial 10 years life time of the Project. As the project achieves sustainable development goals of GoI, Sasan Power has secured Host country approval from Ministry of Environment & Forests, GoI on February 06, 2009.

Eligibility for CERS under UNFCCC CDM

Clean Development Mechanism - Executive Board's (CDM-EB) Approved Consolidated Methodology - 13 (ACM-0013) allow super-critical technology based generation projects to generate CERs, provided the projects meets the criterion established for baseline identification. Established criterion for the selection of baseline takes into accounts several factors inter-alia include:

- Percentage electricity generation contributed by each of the fossil fuel sources.
- Net efficiency of generation technology in project vis-à-vis baseline scenarios

Electricity generated in India, in-excess of 60% is produced by sub-critical technology using sub-bituminous coal as fuel. Integrated Energy Policy and National Electricity Policy utilization of sub-bituminous coal for electricity generation in India. Under such conditions, sub-bituminous coal will continue to remain as baseline fuel at least till year 2030.

Although India has a coal based generation capacity of 72,807 MW (2008-09), efforts to introduce higher efficiency super-critical technology could not be achieved for reasons associated with inefficient and regulated markets, policy-level impediments, lack of manufacturing capacity amongst others. As a result, no super-critical technology power plant was commissioned in India, although it has reached a level of maturity worldwide. According to Thermal Performance Review – 2007-08, published by CEA, indicates the weighted average net efficiency of sub-critical generation units commissioned in India at 31.8% and the highest net efficiency achived by sub-critical technology as 34.07%.

Considering highest net efficiency achieved by sub-critical technology as baseline efficiency, Implementation of super-critical technology deployed would increase the efficiency of generation by 3.1% to 37.2%.

Such increased efficiency would allow Sasan Power to abate 60 Million Tonnes of CO_2 over the life of the Project.

Clean Development Mechanism (CDM)

As a result of higher efficiency generation, Sasan Power would consume approximately 1.5 million tons per year lesser coal compared to the sub-critical plant of comparable size, which in turn would reduce GHG emissions by 14%.

As per ex-ante estimates, Sasan Power would generate 2.2 CERs per annum during the initial 10 years of registration.

1.12 MANAGEMENT ACTION PLAN

1.12.1 Construction Labour Management Plan

Human Resources Policy will specify the terms of employment and working conditions under SPL. These include procedures for hiring and recruiting, probation, training, performance review, promotion, insurance, salary and compensation, resignation, lay-off and retrenchment, leave and vacation, and superannuation, which follow Indian labour law.

Labour Colony

Following facilities are recommended for the labour camps:

- Electricity and ventilation system, water supply and community latrines with semi-permanent structures for their workers

- Water, disinfected before consumption.
- Commissioning of community latrines and septic tanks

Fuel Arrangement for Construction Labour

During construction of the project, a large number of people will be working in the project area. The necessary fuel wood requirement will be met though supply of fossil fuel to avoid encroachment on forest area during construction. In order that influx of labourers in the project area does not lead to deforestation, necessary arrangements have been made by SPL with its contractors for alternate fuels.

Labour camp Demobilisation

On completion of the works, all temporary structures will be cleared away, all rubbish cleared, excreta or other disposal pits or trenches filled in and effectively sealed off and the site left clean and tidy, to the entire satisfaction of the project engineer.

The construction labourers will be compensated suitably as per the government norms. Care will be taken to ensure that all facilities such as health care, education for children of the labourers are provided as per applicable norms.

1.12.2 Health Management for Construction Labour and People in the Vicinity

Regarding monitoring of diseases corresponding to labour influx, regular health status monitoring of labours and its surrounding population is being carried out with the mobile health care facilities already developed and operated by SPL in this area.
Health Centre with doctor and health personnel (nurses, compounders etc) will be provided with mobile dispensary, indoor bed facility, emergency operating and recuperating facilities. Health centre would be staffed with suitably qualify Medical Officers, Compounders, Lab Technologist, Epidemiologist.

1.12.3 Inspections, monitoring and auditing

Inspection and monitoring of the Project activities vis-à-vis the suggested mitigation measures will minimize adverse impacts and increase effectiveness of environmental and social areas. Through the process of inspection, monitoring and auditing, SPL will ensure that all the contractors comply with the requirements of stipulated conditions under various permits as well as suggested mitigations for Project related activities.

Internal and external monitoring is proposed in the Project. Internal monitoring of the ESMP implementation will be the responsibility of a special Monitoring & Evaluation cell within SPL. The internal and external monitoring and evaluation will be an ongoing process and will continue even after the construction activities of the Project are over.

The Project will also comply and monitor conditions (of MoEF) under Forest Clearance and Environmental Clearance.

1.12.4 ESMP Monitoring & Auditing

An independent process would be established to evaluate the functioning of the Grievance Redressal cell & Implementation of Regulatory Norms specified by CPCB / MoEF and International funding agencies as per applicable norms.

1.12.5 Reporting, Review and Communication

SPL will ensure external reporting of environmental and social performance through Environment, Health & Safety (EHS) Cell. External reporting includes reporting of status of compliance of conditions stipulated under various permits as well as reporting of environmental statement under the provisions of Environment (Protection) Act, 1986 and

amendments. Project will ensure reporting of responses against any complaints or notices issued by regulatory agencies or other stakeholders.

To ensure effective implementation of the ESMP, the inspections and audit findings will be communicated internally by EHS to all concerned departments for effective implementation of suggested mitigation measures of their Project component.

1.12.6 Documentation and Record Keeping

The Project will maintain proper documentation for effective implementation of the ESMP.

1.12.7 Organization, Roles & Responsibilities

A separate Environment Management Cell comprising of a team of experienced and qualified personnel reporting to a Project Director / Head will be formed. He / She will be assisted by well trained staffs comprising of environmental and safety specialists.

Staff will be trained for environment control measures like air, water quality monitoring, solid waste management, noise abatement etc. Staff would also be trained to operate ESP and other pollution control equipment at optimum efficiency.

1.12.8 Training of Project Personnel & Contractors

Regular job specific training and EHS induction training needs will be imparted to project personnel and contractors engaged for the Project activities. Specific training will also be imparted to undertake the required ESMP management actions and monitoring activities. The Project will ensure that proper training is provided to all team members of Environment Management Cell.

1.12.9 Rehabilitation Action Plan

Resettlement and Rehabilitation of the affected villages in a satisfactory manner is necessary for smooth project operation. Sasan Power Limited on its part will take special care to provide a special package of compensation (already approved by Govt.) to project affected persons based on the Central & State Government guidelines

1.12.9.1 Compensation / Benefits to Displaced Families

As per approved R&R Policy, displaced families will be provided the following compensation (apart from compensation legally due under Land Acquisition Act depending on category of the family/ person).

Rehabilitation Entitlements

Category of DF	Rehabilitation Entitlements (One time payment)
Families whose land is acquired	• Families of small & marginal farmers to get Rs 15,000 for 1 year as rehabilitation allowance • Other land owner families to get Rs 7,500 for 1 year as rehabilitation allowance
Landless families, who do not own any farm land	• Rs 15,000 for 1 year as rehabilitation allowance. • Rs 7,500 to other landless families.
SC/ST displaced families	• Rs 15,000 for 1 year as rehabilitation allowance
Families whose house is being acquired	• Families have the options to take plot and/or house and/or cash compensation in lieu thereof • Free transportation facility for each displaced family within 25 km., Shifting Charges Rs. 1000 for each eligible displaced family. Dismantling Charge as applicable. • Residential plot of 60' x 90' is being provided together with a ready to use house.

Compensation is being provided on the basis of present market value as defined by Land Acquisition Act, 1894. In addition to this as per approved R&R policy, displaced families are being provided the compensation on replacement value (apart from the compensation legally due under LA Act) depending on category of the family / person.

1.12.10 Old age Pension

Every displaced person above 60 years of age will be given pension of Rs. 1000/month. This pension will be separate from the govt. pension.

1.12.10.1 Education Stipend

In addition to rehabilitation allowance education stipend ranging from Rs 150 to Rs 300 per month per student will also be provided by the SPL to school going children. SPL has tie-up with DAV School, one of the leading schools in India. About 600 Children have been admitted to School.

1.12.10.2 R & R Colony Facilities Provided to Affected People

To minimize inconvenience to affected families, SPL has constructed a R&R colony with all basic amenities to resettle the affected families. SPL is providing ready to move-in houses on 5400 sq ft residential plot. The house has been constructed with all basic amenities such as sanitary toilet, kitchen, smokeless chulha, electrical fitting, etc. A health centre has also been setup in the colony to provide free medical treatment and medicines. The R&R colony will also have following amenities

- School & Playgrounds
- Marketplace
- Panchayat Bhawan
- Herd Land
- Religious place
- Library
- Roads, drinking water and sanitation facilities
- Electrification – internal & external

1.12.11 Community Development Plan (CDP)

To build a good rapport with the local communities, it is essential to engage the local community along with village level institutions in an ongoing process of consultations and discussions.

1.12.11.1 Community Development

Focus group discussions were held with the community members-separate discussions with women, Gram Panchayats, men, elderly people- to understand their apprehensions and expectations from the project.

The specific components of the CDP include:

- Stakeholder consultations to identify the programmes and processes, as well as the community's willingness and ability to contribute to the same;
- **Trust Building measures**: Small and low cost initiatives to generate support for the CDP and to meet immediate needs of the village;
- Development of village specific micro plans, through Participatory Rural Appraisal (PRA) methods and training of the village community to develop micro plans;
- Monitoring and evaluation of the CDP

1.12.12 Grievance Redressal Mechanism

A Grievance Redressal Cell (GRC) has been established at the Project office. The cell has representation from SPL, local administration, civil society and the Project Affected Families.

The GRC will look into complaints and concerns about ownership disputes, inheritance of assets, distribution of compensation among heirs, missing affected assets and persons in the census, etc. The procedure will be based on consensus, seek to resolve the issues quickly in order to expedite the receipt of compensation, without resorting to expensive and time-consuming legal actions.

In addition to the above, if there are any grievances related to environmental management issues in the project area, the GR cell will record these grievances and suggestions and pass it on to the relevant authorities for necessary action and follow-up.

1.12.13 Bio-diversity Management

The species of trees will be native and will provide habitat for birds and also provide food for wild animals. The green belt will also control dust pollution and mitigate noise in addition to increasing vegetative cover. Also the following mitigation measures are proposed to reduce the load of tree felling and also improve the ecology of the region.

- Compensatory afforestation will be undertaken on approximate area of 1586 acres at a cost of about Rs.15 crores. This will fulfill the requirement of forest cover and animal food value in the adjoining area.
- To create a sense of belonging and love for nature and wildlife in the adjoining villages by arranging awareness programmes.
- To improve the socio economic condition of the villagers by providing them with skill and finance for diary, poultry, vegetable cultivation, horticulture, farm forestry, tailoring, small business etc.
- Spraying of water to reduce dust pollution.
- Green belt will be developed to control dust pollution and mitigate noise in addition to increasing vegetative cover.

1.12.14 Disaster Management Plan

Approved on-site disaster management and off-site emergency plans, commands communication and controls will be implemented. Adequate provisions like emergency response, response organization, response plan, material safety data sheet, command & control, capabilities, transportation, medical facilities, mitigation measures, training, education, public awareness emergency plan review etc. to control any disaster situation will be made available.

1.12.15 Mitigation Measures

In addition to the above mentioned management action plan, SPL will ensure compliance of the mitigation measures in accordance with a well documented audit & monitoring plan with defined responsibilities.

1.13 CONCLUSION

The power plant will improve power supply in the region in an environment friendly manner and would bring long term sustainable benefits for the local population by generating employment opportunities and improvement in infrastructure facilities. The negative effects will be offset by specific mitigation measures. The overall effects of the project will be beneficial.

Chapter 1
Introduction

CHAPTER 1. INTRODUCTION

1.1 INTRODUCTION

India is a severely power deficit country. The current peak deficit is 11% & energy deficit is also 11% in Northern Region. The peak deficit is 19% and energy deficit is 16% in Western Region. At the end of 11th Plan (i.e. 2012) the peak deficit and energy deficit in Northern Region is expected to be 21% and 7% respectively and in Western Region is expected to be 3% and 13% respectively. At the end of 12th Plan (i.e. 2017) peak deficit is expected to be 7%.

The per capita electricity consumption in India is 704 kWh which is less than one fourth of world average (3163 kWh). 40% of India's population does not have access to power. There is a need for competitively priced power for the economic development of the country.

The Government of India has envisaged capacity addition of 100,000 MW with an aim to achieve power for all by 2012. To achieve this target, development of large capacity power projects will be necessary. Ministry of Power (MoP) Central Electricity Authority (CEA) and Power Finance Corporation (PFC) are working together for the development of Ultra Mega Projects under tariff based competitive route, each of approx. 4000 MW capacity. Special Purpose Company (SPC) wholly owned by Power Finance Corporation (PFC), a GoI undertaking, have been set up to facilitate tie-up of inputs, clearances and linkages for these projects.

The pit-head power station offers options for low tariff coal based thermal power stations for supplying power to meet ever growing demand of power through existing / future transmission network.

One of the sites identified in consultation with Government of Madhya Pradesh for pit-head UMPP is located at Sasan village, Singrauli Tehsil in District Singrauli (earlier Sidhi) of Madhya Pradesh. For the development work of Sasan Project, the Sasan Power Limited - a SPC has been established.

1.2 PROJECT STATUS

Sasan Ultra Mega Power Project (UMPP) was initially developed through a SPC called Sasan Power Limited (SPL), a wholly owned subsidiary of Power Finance Corporation (PFC). Reliance Power Limited (Reliance Power) emerged as the lowest bidder in terms of levelized tariff for the Sasan UMPP. SPL is presently a wholly owned subsidiary of Reliance Power and is being developed on Build, Own and Operate (BOO) basis. Sasan UMPP is a pit-head coal based power project of 3960 MW capacity. The project has been allotted three captive coal mines namely Moher, Moher Amlohri Extn & Chhatrasal in Singrauli coal field. The project will supply power at an extremely competitive levelised tariff of Rs 1.196/kWh (US Cents 2.6/kWh) which would benefit 35 crore population in the seven states where power would be supplied from the project.

This project falls under Category 'A' based on spatial extent of potential impacts on human health and manmade and natural resources. All projects or activities included as Category 'A', require prior environmental clearance from the Central Government in the MoEF on the recommendations of an Expert Appraisal Committee constituted by Central Government for the purposes of this notification. Accordingly this project has been accorded Environment Clearance

SPL had carried out a Comprehensive Environmental Impact Assessment (CEIA) for the period March 2006 to February 2007including a formal public consultation process with the local population specifically held for the project on June 17, 2006. The project has been awarded the environmental clearance on November 23, 2006 by Ministry of Environment

Chapter-1: Introduction
This chapter gives brief outline of the project and its proponent, description of the nature, size, and location of the project and its importance, scope of the ESIA study

and Forests (MoEF), Government of India (GoI) based on recommendation of the Expert Appraisal Committee (EAC). The EAC comprises of eminent environment & social scientists & experts from MoEF, Central Pollution Control Board (CPCB), Ministry of Water Resources, Wildlife Institute of India and other government and quasi government organizations. No Objection Certificate (NOC) from Madhya Pradesh Pollution Control Board (MPPCB) dated July 6, 2006 has also been obtained.

Environmental norms in India are very stringent for large power projects and follow International standards

Out of the total site area, 320.93 ha of forest land has been diverted for the project. Forest clearance for power plant area has been obtained from MoEF on April 16, 2009 with a condition of compensatory afforestation for double the degraded forest area i.e., 642 ha. As required by Forest Department to improve the forest cover and animal food value in the surrounding forest area and create water holes, shelter and food for wildlife, compensatory afforestation will be implemented over an area of 1586 acres at a cost of Rs 15 Crs.

Coal for project will be sourced from captive coal mines in Singrauli Coal Field. These coal blocks are already allocated to SPL. Separate EIA studies have been conducted for the captive coal blocks.

This report has been prepared on the basis of data sourced from EIA document prepared for the Environment Clearance Purpose by M/s Desein Private Limited, the consulting Engineers.

1.3 KEY FEATURES OF SITE

The proposed power plant will be located near village Sasan in Singrauli (earlier Sidhi) District of Madhya Pradesh State (**Figure 1.1**). The site is in close proximity to the Govind Ballabh Pant Sagar, making water perennially available for the power plant. Captive coal mines will provide enhanced reliability of fuel supply.

The project will be developed in a total area of 3,341 acres of land. The land acquisition for the project is being pursued through State Government of Madhya Pradesh as per the provisions of the Land Acquisition Act, 1896 and approved Rehabilitation and Resettlement Policy designed for the project.

TABLE 1.1 – SITE KEY FEATURES

Project Site	Village: Sasan, Taluka: Waidhan, Dist: Singrauli
Latitude	23° 57’ 56” N
Longitude	82° 37’ 30” E
Total villages / Households in Study Area (10 kms radius from centre of project site)	166 villages / 43201 Households
Connectivity	
Nearest town	Waidhan (12 Km.)
Nearest Railway Station	Shakti Nagar Railway Station (18 Km.)
Nearest Airport	Varanasi (250 Km)
Access roads	NH-75 (10 Km Approx.) and the site is well connected through village road.

The area receives an annual rainfall of about 1133 mm. The wind speeds are mostly observed in the range of 1.6 to 6.5 km/hr and calm condition is significant. The west followed by west north-west is predominant wind directions in the study area. Sidhi region experiences annual average wind speed as high as 3.6 km/hr. The temperature in various months fluctuates in the range of 8.1ºC and 42.0ºC.

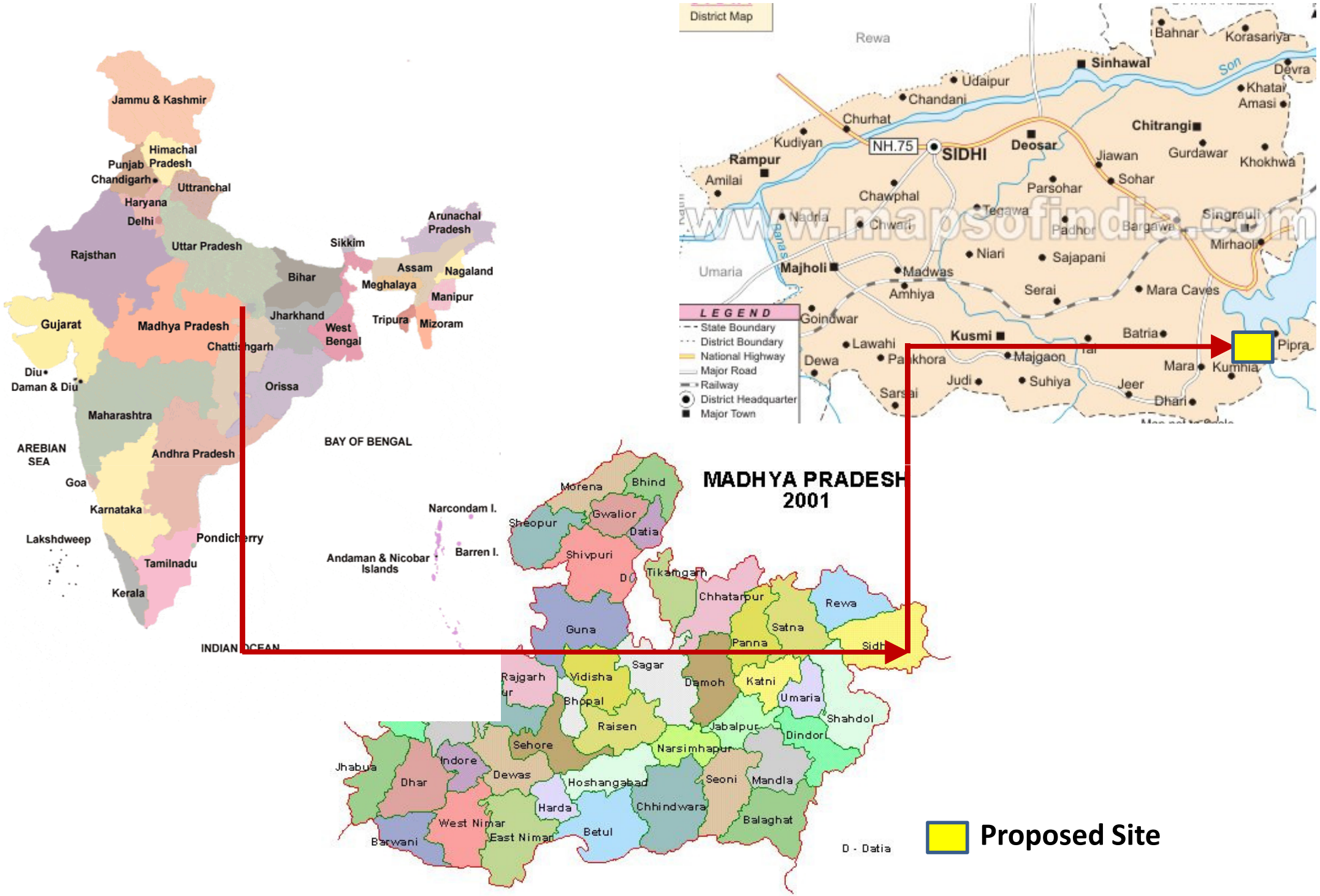


Fig 1.1- Location Map

1.4 PROJECT JUSTIFICATION

3960 MW Sasan Ultra Mega Power Project is a project of national importance and would benefit 35 crore peoples across 7 states of India. The project would supply power to utilities in northern & western region of India which have substantial power deficit.

1.4.1 Demand Estimation (11th and 12th Plan)

The demand scenario has been prepared as per publication of Electrical Power Survey (EPS-17) published by CEA and is presented below in **Table 1.2**.

TABLE 1.2- DEMAND PROJECTIONS UP-TO 2012 UNDER EPS

Region	Peak Demand (MW)	Energy Requirement (MU)
NR	48137	294841
WR	47108	294860
SR	40367	253443
ER	19088	111802
NER	2537	13329
Islands	88	384
All-India	157325	968659

Source: 17th Electricity Power Survey

TABLE 1.3- DEMAND PROJECTIONS UP-TO 2017 UNDER EPS

Region	Peak Demand (MW)	Energy Requirement (MU)
NR	66583	411513
WR	64349	409805
SR	60433	380068
ER	28401	168942
NER	3760	21143
Islands	136	595
All-India	223662	1392066

Source: 17th Electricity Power Survey

1.4.2 Supply Estimation (11th Plan)

a) Actual demand & supply position in 2009-10 is presented in **Table 1.4** below.

TABLE 1.4- DEMAND AND SUPPLY POSITION (2009-10)

Region	Energy (MU)			Peak (MW)		
	Requirement	Availability	Surplus/Deficit	Demand	Met	Surplus/Deficit
NR	227104	201951	-25153 (-11.1%)	33034	29504	-3530 (-10.7%)
WR	254475	213715	-40760 (-16.0%)	37240	30153	7087 (-19.0%)
SR	204012	188794	-15218 (-7.5%)	28958	26245	-2713 (-9.4%)
ER	82041	78444	-3597 (-4.4%)	12901	11789	-1112 (-8.6%)
NER	9407	8134	-1273 (-13.5%)	1820	1358	-462 (25.4%)

Source: CEA, Load generation balance report, 2009-10

It is observed from above that for period 2009-10 the Peak & Energy deficit in Northern Region is 11% and 11% respectively and in western region is 19% and 16% respectively.

b) Capacity Addition during 11th Plan

The expected addition in the country during 11th Plan is 78427 MW from under Construction and New Projects. The capacity addition data has been considered based on the recent assessment by CEA on demand projection and generation planning.

TABLE 1.5- ESTIMATION WITH THE ADDITION OF 78427 MW AND ENHANCED PERFORMANCE IN 11TH PLAN

Region	Installed Capacity (end of 10th Plan) (MW)	Capacity at the end of 11th Plan		Availability at the end of 11th Plan	
		Addition (MW)	Total (MW)	Energy [Column (4)*0.55*8.760] (MU)	Peak [Column (4)*0.7] (MW)
NR	36,359	20,628	56,987	274,565	39,891
WR	38,913	20,747	59,660	287,442	41,762
SR	37,561	14,920	52,481	252,853	36,737
ER	16,900	17,871	34,771	167,527	24,340
NER	2,514	4,261	6,775	32,642	4,743
ISLAND	81	-	81	390	57
TOTAL	132,328	78,427	210,755	1,015,420	147,529

Source: CEA Monthly Review of Power Sector

1.4.3 Demand & Supply Scenario at the End of 11th Plan

Demand & Supply Scenario at the end of 11th Plan with the addition of 78427 MW and enhanced performance in 11th Plan has been worked out and presented in **Table 1.6**.

TABLE 1.6- DEMAND & SUPPLY SCENARIO AT THE END OF 11TH PLAN

Region	Availability - end of 11th Plan		Demand (as Per 17th EPS Forecast)			
	Energy (MU)	Peak (MW)	Energy (MU)	Deficit / Surplus (%)	Peak (MW)	Deficit / Surplus (%)
NR	274,565	39,891	294,841	-7.38%	48,137	-20.67%
WR	287,442	41,762	294,860	-2.58%	47,108	-12.80%
SR	252,853	36,737	253,443	-0.23%	40,367	-9.88%
ER	167,527	24,340	111,802	33.26%	19,088	21.58%
NER	32,642	4,743	13,329	59.17%	2,537	46.51%
Islands	390	57	384	1.60%	88	-55.20%
All-India	1,015,420	147,529	968,659	4.61%	157,325	-6.64%

Source: CEA 17th Electric Power survey report

As can be observed from table above, there is significant energy & peak deficit in Northern Region (NR) and Western Region (WR) at the end of 11th plan i.e. 2012

1.4.4 Supply Estimation- 12th Plan

The expected addition during 12th Plan is 86,500 MW from New projects. The above capacity addition data has been considered based on the recent assessment by CEA on demand projection and generation planning.

TABLE 1.7- ESTIMATION WITH THE ADDITION OF 86500 MW AND ENHANCED PERFORMANCE IN 12TH PLAN

Capacity at the end of 11th Plan	Capacity at the end of 12th Plan		Availability at the end of 12th Plan	
Total (MW)	Addition (MW)	Total (MW)	Energy [Column (3)*0.55*8760] (MU)	Peak [Column (3)*0.7] (MW)
210,755	86,500	297,255	1,432,175	208,079

Source: CEA National Electricity Plan

1.4.5 Demand & Supply Scenario at the End of 12th Plan

Demand & Supply Scenario at the end of 12th Plan with the addition of 86500 MW is presented in **Table 1.8**.

TABLE 1.8- DEMAND & SUPPLY SCENARIO AT THE END OF 12TH PLAN

Region	Availability at the end of 12th Plan		Demand (as Per 17th EPS Forecast)			
	Energy (MU)	Peak (MW)	Energy (MU)	Deficit/ Surplus (%)	Peak (MW)	Deficit/ Surplus (%)
All-India	1,432,175	208,079	1392066	(+) 2.8	223662	(-) 7.5

Source: CEA 17th Electric Power survey report

It can be seen from the **Table 1.8** above that there is peak deficit of 7.5% in the country at the end of 12th Plan. Also from **Table 1.6**, it is seen that Northern and Western Regions would face both energy and peak power shortages.

The National Electricity Policy has set up the goal of adding new generation capacity to not only eliminate energy and peaking shortages but to have a spinning reserve of 5% in the system. Considering the above scenario, Sasan Ultra Mega Power Project is, therefore, justified from the demand supply consideration.

1.5 OBJECTIVE OF THE STUDY

The main objectives of Environment and Social Impact Assessment (ESIA) developed in consultation with Sasan Power Limited are as follows:

- Baseline information about the environmental, social, and economic conditions in the project area; to determine the existing status and post project scenario in respect of these parameters.
- Identify potential impacts of the project and the characteristic, magnitude and distribution of the impacts;
- Compile information on potential mitigation measures to minimize the impact including mitigation costs; so as to incorporate the same in Environment and Social Management Plan.
- Carry analysis of alternatives for the project at most beneficial in terms of social and environmental parameters.
- Formulating and implementing Sustainable Environmental Management and Monitoring Action Plan

1.6 PURPOSE OF THE STUDY

This report is prepared to update the Comprehensive Environmental Impact Assessment (CEIA) for the plant configuration of 6 x 660 MW Super Critical technology based power project & to comply with the requirements of IFC's Performance Standard & Equator Principles.

1.7 METHODOLOGIES AND APPROACH OF EIA

Construction of a thermal power plant exceeding capacity of 50 MW requires compliance with the procedure for approval of projects as per the Ministry of Environment and Forests (MoEF) EIA Notification 14th September, 2006.

Establishment of thermal power projects of this magnitude requires the submission of an Environmental Impact Assessment (EIA) report to the Ministry of Environment and Forests (MoEF). The MoEF is the Project Approving Agency (PAA) for such projects. The Environmental Impact Assessment has been conducted in accordance with the Terms of Reference recommended by the MoEF and in line with the requirements of the International Financial Institutions. The ESIA has been conducted to comply with Environment procedure and Guidelines of the Export–Import Bank of the United States and the associated Performance Standards and Guidelines on Social and Environmental Sustainability of International Finance Corporation; April 2006 (IFC).

The EIA study which was conducted by Desein Pvt Ltd in 2006 has examined the compliance of the project to the applicable National Standards, laws and regulations and required mitigation measures and an Environmental & Social Management and Implementation Plan have also been proposed.

The experts on relevant subject fields were engaged for the EIA study. Intensive interactions were held with the community who are directly or indirectly affected by the project activities. The community interactions were established by means of structured group meetings, individual interviews and awareness programmes in accordance with International Finance Corporation guidelines. All consultations were free of external manipulation, interference or intimidation. The consultations were conducted in the local language.

Various environment and social parameters were identified and examined as per standard methods. The details of the method of collection of data for different parameters are given in the baseline chapter. The parameters considered for the study and the frequency are given in **Table 1.9**.

TABLE 1.9: ENVIRONMENTAL ATTRIBUTES AND PARAMETERS

S. No.	Attributes	Parameters	Frequency
1.	Ambient Air Quality	SPM, RSPM, SO_2, NO_X,	24 hourly samples twice a week for three seasons at 6 locations.
2.	Meteorology	Wind speed and direction, Temperature, Relative humidity and Rainfall	Near Project site continuous for with hourly recording and from secondary sources of IMD station at Sidhi**.**
3.	Water quality	Physical, Chemical and Bacteriological parameters at 10 ground water and 3 surface water locations.	Samples were collected once during each season.
4.	Ecology	Existing terrestrial and aquatic flora and fauna within 10-Km radius circle.	Secondary data was collected from the Government department.
5.	Noise levels	Noise levels in dB(A) at 10 locations.	At every location data monitored twice during EIA study.
6.	Soil Characteristic	Soil quality at 12 locations	Once during each season
7.	Land use	Trend of land use change for different categories	Based on Survey of India Topo-sheet and Satellite imagery
8.	Socio-Economic aspects	Socio-economic features, labour force characteristics, boom town effects	Based on secondary sources data like primary census abstracts of census of India 2001.
9.	R&R Study	Household Surveys and Focused Group Discussion	Separate R & R study conducted
10.	Hydrology	Drainage area and pattern, nature of streams, aquifer characteristics, recharge and discharge areas	Based on data collected from secondary sources as well as sample well data of the study area
11.	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

1.8 STRUCTURE OF REPORT

The ESIA report has been structured as per Environment Procedure and guidelines of the Export-Import Bank of US and requirements of International Finance Corporation. The report

Chapter-1: Introduction
This chapter gives brief outline of the project and its proponent, description of the nature, size, and location of the project and its importance, scope of the ESIA study

consists of nine chapters (including the present chapter) and the contents of the remaining chapters are briefly described in this section.

Chapter 2: Legal Policies and Institutional Framework: This chapter presents legal provisions and describes the emission standards set by the Ministry of Environment and Forests (MoEF) for Coal-based Thermal Power Plant in general and specific to Sasan UMPP. The chapter also consist a legal review of national environmental and social (including labour) laws and policies as well as the relevant national and international standards and guidelines. Compliance status of Environmental Clearance by MoEF, NOC by MPPCB etc is also included.

Chapter 3: Project Description: This chapter provides information related to various feature of the proposed power plant including power generation process, fuel type and quantity, utilities, water and power requirement and other proposed infrastructure facilities. It also provides the glimpse of project schedule for approval and implementation. The chapter briefly describes the proposed project including off-site facilities like water pipeline, coal conveyor, township, as corridor, etc.

Chapter 4: Baseline Status: This chapter presents the methodology and findings of the field studies covering physical, biological and socio economic environments, carried out to ascertain the baseline environmental condition of the study area. It includes the information regarding micro-meteorology, water environment, air environment, soil environment and ecological environment and the socio-economic baseline settings of the study area.

Chapter 5: Public Consultation and Information Disclosure: This section describes (i) objectives of community consultation; (ii) consultation with project affected communities in a structured and culturally appropriate manner; (iii) discussion with the affected villagers; (iv) Public Consultation & Information; (v) disclosure field consultation; (vi) lists milestones in public involvement (e.g., dates, attendance, topics of public meetings); (vii) grievance redress framework; (viii) public hearing's opinions & compliance; (ix) monitoring and reporting; (x) major feedbacks received from beneficiaries, local officials, community leaders.

Chapter 6: Anticipated Environmental & Social Impact: This chapter provides details of the environmental impact assessment of the project during construction and operational phase. It expresses the impacts of the proposed project on the various components of environment. The mathematical modeling exercise pertaining to prediction of ground level concentration of air pollutants have been also been dealt in this chapter. Mitigation measures are suggested along with the impact prediction. This section also presents a brief outline of impact and respective management plan to address socio-economic conditions.

Chapter 7: Analysis of Alternatives: This chapter describes systematic comparisons of feasible alternatives for the proposed project site, technology, and operational alternatives. Alternatives have been compared in terms of their potential environmental impacts, suitability under local conditions, and institutional training and monitoring requirements. Economic values have been attached wherever feasible and the basis for the selected alternative has been stated.

Chapter 8: Risk Assessment: This chapter provides information regarding the activities associated with the project likely to pose a risk to man, environment or property. Such activities include transport, storage, handling and usage of fuels (coal and LDO), hazardous chemicals, acids and alkali. Computation of risk assessment has been covered in this chapter. It also provides details regarding precautionary measure to be taken.

Chapter 9: Environment & Social Management and Monitoring Plan: This chapter deals with the management plan incorporating recommendations to mitigate the adverse impact likely to occur on environmental parameters during construction and operation phase of the power plant. Post project monitoring and organization structure for environment management have been also provided in the chapter.

Chapter-1: Introduction

This chapter gives brief outline of the project and its proponent, description of the nature, size, and location of the project and its importance, scope of the ESIA study

The chapter also provides information about on-site disaster management describing the on-site and off-site emergencies, commands and controls. Chapter describes the emergency response capabilities, training and education as also mock drills, including the mitigation measures to be taken at the time of an eventually.

Chapter 2

Legal Policy and Institutional Framework

CHAPTER 2. LEGAL POLICY & INSTITUTIONAL FRAMEWORK

2.1 INTRODUCTION

The emerging environmental scenario calls for attention on conservation and judicious use of natural resources. There is a need to integrate the environmental consequences of the development activities and for planning suitable measures in order to ensure sustainable development of a region. The environmental considerations in any developmental process have become necessary for achieving sustainable development. To achieve such goals the basic principles to be adopted are:

- To enhance the quality of environment in and around the project area by adopting proper measures for conservation of natural resources;
- Prevention of adverse environmental and social impact to the maximum possible extent; and
- To mitigate the possible adverse environmental and socio-economic impact on the project-affected areas

The following sections describe provisions of relevant laws applicable to thermal power projects in general and specific to Sasan UMPP.

2.2 PROCESS FOR OBTAINING ENVIRONMENT CLEARANCE

According to the categorization mentioned in the MoEF Notification this project is grouped under Category A. Therefore while categorizing this Project most important aspects which may impact the project in a significant manner have been described in details in various Chapters of the ESIA Document.

As mentioned, the notification requires prior environmental clearance from the Central Government or by State Level Environment Impact Assessment Authority, duly constituted by Central Government. For this the following detailed procedures and regulations are involved.

As per the Notification of the Ministry of Environment and Forest (MoEF) published on 14th September 2006, certain changes, including restrictions and prohibitions on new projects or on the expansion or modernization of existing projects or activities based on their potential environmental impacts has been made with reference to the earlier notification of 27th January 1994. This entails capacity addition with change in process and/ or technology undertaken in any part of India. The new process requires prior environment clearance from Central Government or by the State-level Environment Impact Assessment Authority (SEIAA), duly constituted by the Central Government.

In the Notification a detailed procedure is mentioned to obtain the required Environment Clearance. As per the procedure, anybody who desires to undertake any project activities shall have to apply to the concerned authority of Central Government or SEIAA after identification of the prospective site for the project or activities to which the application relates. There are different categories mentioned in the Notification according to which the Environment Clearance is granted either by Central Government Authority or State Government Authority and accordingly Environment Clearance procedures are specified and processed. After a scrutiny of the concerned application form (Form 1) the, Expert Appraisal Committee (EAC) or State Level Expert Appraisal Committee (SEAC) determine detailed and comprehensive Terms of Reference (TOR) addressing all relevant environmental concerns for the preparation of an Environment Impact Assessment (EIA)

Report on the basis of information furnished in the application form including the Terms Of Reference proposed by the applicant. This may also include a site visit by a sub-group of EAC or SEAC concerned, if considered necessary. After the determination of ToR, an EIA report is required to be prepared and submitted to the concerned authority.

Detailed process for obtaining Environmental Clearance from the Ministry of Environment & Forest, Government of India is described in the following paragraphs.

2.2.1 Selection of Categories of Project

All projects and activities are broadly categorized as Category A and Category B based on spatial extent of potential impacts on human health and manmade and natural resources. Categorically they will get the environment clearance from the following:

- All projects or activities included as Category A, shall require prior environmental clearance from MoEF in the Central Government on the recommendations of an Expert Appraisal Committee to be constituted by Central Government for the purposes of this notification
- All projects or activities included as Category B projects will require prior environmental clearance from the State/Union Territory Environment Impact Assessment Authority (SEIAA) constituted by the Central Government. The SEIAA shall base its decision on the recommendations of a State/Union Territory level Expert Appraisal Committee to be constituted as per the notification. In the absence of a duly constituted SEIAA, a Category B project shall be treated as a Category A projects.

2.2.2 Stages in Prior Environment Clearance (EC) Process for New Project

The environmental clearance process for new projects will comprise of a maximum of four stages all of which may not apply to particular cases as set forth below. These four stages in sequential order are as follows:

Stage 1: Screening: It refers to the definite assignment of environmental category to projects or activities where the same is not completely specified. In case of Category 'B' projects scrutiny of application at State level to categorize project in 'B1' or 'B2' is done. The B2 projects do not require EIA Reports.

Stage 2: Scoping: It refers to the process where EAC or SEAC determines detailed and comprehensive TOR for the EIA report and can also include site visits by the committee if required.

Stage 3: Public Consultation: It refers to the process by which concern of local people and other stakeholders are ascertained and their views taken regarding the project. The Public Consultation takes part in two steps: Public hearing and written responses. The public hearing is conducted under State Pollution Control Board in a location close to the site of the project. In the hearing, the stakeholders discuss about the project and express their views regarding the project.

Stage 4: Appraisal: This refers to detailed scrutiny by EAC or SEAC of the application and EIA report to make categorical recommendations to the regulatory authority.

2.2.3 Grant or Rejection of Prior Environment Clearance

- The regulatory authority shall consider the recommendations of EAC or SEAC and convey its decision to the applicant within 120 days of the receipt of the complete application.
- Regulatory authority to accept the recommendations or disagree within 60 days.
- EAC or SEAC to consider the observations of regulatory authority and furnish its views in other 60 days.
- Regulatory authority to convey final decision within 30 days.

- Proponent to go ahead with EC as per EAC or SEAC in case no communication is received from the regulatory body.

2.3 DETAILED FRAMEWORK OF THE ENVIRONMENT IMPACT ASSESSMENT (EIA) PROCESS OF IFC & EP

2.3.1 The Performance Standards of the IFC

The IFC Performance Standards apply to private sector projects and provide project participants with instruments to structure, design, construct and manage the operations of projects in an environmentally and socially acceptable manner, while providing measures to avoid or mitigate adverse environmental and social impacts resulting from the projects. These Performance Standards are intended to focus on outcomes rather than process, thereby stressing the implementation of sound environmental and social management systems that achieve desired outcomes, including the mitigation of adverse impacts.

There are eight IFC Performance Standards:

- Social & Environmental Assessment and Management Systems
- Labor and Working Conditions
- Pollution Prevention and Abatement
- Community Health and Safety
- Land Acquisition and Involuntary Resettlement
- Biodiversity Conservation and Sustainable Natural Resource Management
- Indigenous Peoples
- Cultural Heritage

Performance Standard #1: Social & Environmental Assessment and Management Systems

Objectives:

- Identify and assess environmental and social impacts in the project's area of influence.
- Avoid, minimize, mitigate or compensate for adverse impacts
- Ensure that affected communities are engaged on issues that may affect them
- Promote improved environmental and social performance through effective management systems

Major Requirements:

- Conduct an Environmental and Social Impact Assessment (ESIA or EIA) of the project, appropriate to the nature of the project's environmental and social risks and potential impacts, to include issues identified in Performance Standards 2 to 8.
- Establish Environmental and Social Management Plans commensurate with the findings of the ESIA and consultation with affected communities.
- Establish Action Plans where specific mitigation measures and actions are required for the project to comply with applicable laws, regulations and the requirements of these Performance Standards.
- Provide organizational capacity and contractor / employee training to enable project to achieve continuous environmental and social performance
- Establish and maintain a timely process of community engagement, including a grievance mechanism, focusing on disclosure of information and consultation with local communities affected by project risks or adverse impacts that is free from

external manipulation, interference or coercion to ensure relevant and understandable access to project information.

- Establish procedures to monitor and measure the effectiveness of the environmental and social management program, including internal reporting of the program's effectiveness to the project's senior management, disclosure of Action Plans (including material changes to such Plans) to affected communities, and external reporting to affected communities on the results of Action Plans, commensurate with the concerns of the affected communities.

Performance Standard #2: Labor and Working Conditions

Objectives:

- Establish, maintain and improve the worker-management relationship
- Promote fair treatment and equal opportunity for workers, in compliance with national laws
- Protect workforce by addressing child labor and forced labor
- Promote safe working conditions and protect / promote the health of workers

Major Requirements:

- Establishment of a Human Resources Policy consistent with the requirements of this Standard that informs employees of their rights under national labor and employment laws
- Document and communicate to all employees conditions and terms of employment
- Respect collective bargaining agreements with worker organizations and provide reasonable conditions and terms of employment that, at a minimum, comply with national law, and enable alternative means for worker expression of grievances where national law restricts worker organizations
- Practice non-discrimination and equal opportunity in making employment decisions
- Provide a mechanism for workers to raise workplace concerns
- Protect the workforce from forced labor and illegal or economically exploitative child labor
- Provide workers with a safe and healthy work environment, taking into account risks inherent to the particular project sector.

Performance Standard #3: Pollution Prevention and Abatement

Objectives:

- Avoid or minimize pollution from project activities to avoid or minimize adverse impacts on the environment and human health
- Promote the reduction of emissions that may contribute to climate change

Major Requirements:

- Consider ambient conditions over the project cycle and apply pollution prevention and control technologies & practices that are best suited to avoid, minimize or reduce adverse impacts on human health and the environment, consistent with good industry practice
- Avoid, or where unavoidable, control the intensity of the release of pollutants, and include measures to control their accidental release.

- Avoid or minimize the generation of hazardous waste, and where such generation is unavoidable recover and reuse to the extent possible or treat, destroy or dispose of it in an environmentally sound manner.
- Avoid, or where unavoidable, minimize or control the release of hazardous wastes. Avoid the manufacture, trade or use of chemicals or hazardous materials subject to international bans or phase-outs.
- Establish plans and make preparations to respond to process upset, accidental and emergency situations in a manner appropriate to the operational risks and the need to prevent potential negative consequences.
- Refer to the Environmental Health and Safety Guidelines (EHS) of the IFC that is appropriate to the project sector to evaluate and select pollution prevention and control techniques and to determine emission and effluent levels that are normally acceptable to the project. If, due to specific project circumstances, alternative levels that deviate from the EHS or host Country levels are selected, a full and detailed justification for any proposed alternatives is required.
- Address adverse project impacts on existing ambient conditions such as land use, proximity to ecologically sensitive or protected areas, the capacity of the air and water to absorb incremental pollutants while remaining at an acceptable level, and the potential for cumulative impacts with uncertain consequences. In addition, promote strategies to avoid or minimize the release of pollutants and improve ambient conditions when project produces significant emissions in an already degraded area.
- Promote the reduction of project-related greenhouse gas emissions in a manner appropriate to the nature and scale of the project operations and impact. Annually quantify and monitor GHG emissions, and evaluate options to reduce or offset project related GHG emissions.
- Formulate and implement an integrated pest management program for pest management activities, including selection of pesticides that are low in human toxicity and design of an application regime to minimize damage to natural enemies and prevent the development of resistance in pests.

Performance Standard #4: Community Health & Safety

Objectives:

- Avoid or minimize the risks to, and impacts on, the health and safety of the local community over the project life cycle, from both routine and non-routine circumstances.
- Ensure that the safeguarding of personnel and property is carried out in a legitimate manner that avoids or minimizes risks to the community's safety and security.

Major Requirements:

- Evaluate risks and impacts of the project to the health and safety of affected communities, from design through decommissioning and establish preventive measures to address them in a manner commensurate with the identified risks and impacts.
- Disclose Action Plans and other relevant information to affected communities and government agencies to enable them to understand the risks and impacts while engaging them on this matter on an ongoing basis.
- Design, construct, operate and decommission the project's structural elements in accordance with good international industry practice with particular consideration to

exposure to natural hazards. In cases of dams or ash ponds situated in high-risk locations, engage an independent expert to conduct a review of the structure design early in the project stage. Take measures to ensure safety and prevent accidents when moving equipment on public roads.

- Prevent or minimize the potential for community exposure to hazardous materials that may be released by the project, and exercise commercially reasonable efforts to control the safety of hazardous raw materials and the transportation and disposal of wastes.
- Avoid or minimize the exacerbation of impacts caused by natural hazards, such as landslides or floods from land use changes due to project activities. Avoid or minimize impacts of project activities on soil, water and other natural resources in use by the affected communities.
- Prevent or minimize the potential for community exposure to water-borne, water-related, or vector-borne disease and other communicable diseases resulting from project activities or associated with the influx of project labor. Where specific diseases are endemic in communities in the project area, explore opportunities to improve environmental conditions that could reduce their incidence.
- Assist the community in preparing to respond effectively to emergency situations. Where local governments lack the capacity to respond effectively, assume an active role in preparing for and responding to project related emergencies. Document emergency procedures and responsibilities and disclose in the Action Plan.
- Assess risks to those within and outside the project site posed by arrangements with employees or contractors providing security to safeguard personnel and property. Investigate security forces to ensure they are not implicated in past abuses; provide them with adequate training with respect to conduct towards project workers and the local community.
- Investigate any credible allegations of unlawful or abusive acts of security personnel, take action to prevent recurrence, and report unlawful and abusive acts to public authorities when appropriate.

Performance Standard #5: Land Acquisition and Involuntary Resettlement

Objectives:

- Avoid or minimize involuntary resettlement whenever feasible by exploring alternative project designs.
- Mitigate adverse social and economic impacts by providing compensation for loss of assets at replacement cost and ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation and informed participation of those affected.
- Improve or at least restore livelihoods and living standards of displaced persons.
- Improve living conditions among displaced persons through provision of adequate housing with security of tenure at resettlement sites.

Major Requirements:

- Consider feasible alternative project designs to avoid or at least minimize physical or economic displacement while balancing environmental, social and financial costs and benefits.
- Offer displaced persons and communities compensation for loss of assets at full replacement cost and assistance to improve or at least restore their living standards or livelihoods. Compensation standards will be transparent and

consistent within the project. If land based, or where land is collectively owned, offer land-based compensation where feasible, and provide opportunities to displaced persons and communities to derive appropriate development benefits from the project.

- Following full disclosure, consult with and facilitate the informed participation of affected persons and communities in decision making processes related to resettlement. Consultation during implementation, monitoring and evaluation of compensation payment and resettlement will continue to achieve outcomes consistent with objectives.
- Establish a grievance mechanism to receive and address specific concerns about compensation and relocation raised by displaced persons or members of host communities, including a recourse mechanism to resolve disputes in an impartial manner.
- Where involuntary resettlement is unavoidable, carry out a census with socio-economic baseline data to identify persons who will be displaced, determine eligibility for compensation and assistance, and discourage inflow of people ineligible for these benefits. In the absence of local government procedures, establish a cut-off date for eligibility, and document and disseminate through the project area information regarding the cut-off date.
- Develop a Resettlement Action Plan for acquisition of land through the exercise of eminent domain or through negotiated settlements involving physical displacement of people that is based on a Social and Environmental Assessment regardless of the number of people affected
- For negotiated settlements involving economic displacement, develop procedures to offer affected people and communities' compensation and other assistance
- In the case of physical displacement, offer displaced persons choices among feasible resettlement options, including adequate housing or cash compensation where appropriate prior to relocation, and provide relocation assistance suited to the needs of each group, with particular attention to the poor and vulnerable. New resettlement sites will offer improved living conditions.
- In the case of displacement of persons having no recognizable legal right or claim to the land they occupy, offer them a choice of options for adequate housing with security of tenure enabling them to resettle legally without the subsequent risk of forced eviction. Provide these persons with compensation for occupied structures and other improvements to the land at full replacement provided they occupy the land prior to the eligibility cutoff date.
- In the case of physical displacement of communities of indigenous peoples from their communally held traditional or customary lands under use, meet the applicable requirements of this Standard as well as those of Performance Standard 7.
- Compensate persons facing loss of income or livelihood (economic displacement) regardless of whether they are physically displaced in accordance with the requirements
- In the case of host government-managed resettlement, collaborate with the responsible government agency

Performance Standard #6: Biodiversity Conservation and Sustainable Natural Resource Management

Objectives:

- Protect and conserve biodiversity

- Promote sustainable management and the use of natural resources through the adoption of practices that integrate conservation needs and development priorities

Major Requirements:

- Assess the significance of project impacts on all levels of biodiversity as an integral part of the ESIA process, taking into account the differing values attached to biodiversity by specific stakeholders, and identify impacts on ecosystem services. The assessment will focus on the major threats to biodiversity, which include habitat destruction and invasive species. Retain qualified and experienced external experts to assist in conducting the Assessment
- In areas of modified habitat, exercise care to minimize conversion or degradation of such habitat while identifying opportunities to enhance habitat and protect and conserve biodiversity as part of operations.
- In areas of natural habitat, the project will not significantly convert or degrade such habitat unless there are no technical and financially feasible alternatives, or unless the overall benefits of the project outweigh the costs, including those to the environment and biodiversity and unless conversion or degradation is appropriately mitigated.
- In areas of natural habitat, mitigation measures will be designed to achieve no net loss of biodiversity where feasible and may include post-operation restoration of habitats offsets of losses through the creation of ecologically comparable areas managed for biodiversity, and/or compensation to direct users of biodiversity.
- In areas of critical habitat no project activities will be implemented unless there are no measurable adverse impacts on the ability of the critical habitat to support the established population of critically endangered or endangered species, and activities result in no reduction in the population of any such species, and mitigation measures are taken to address lesser impacts.
- In addition to the requirements noted above for critical habitat, where the project is located in a legally protected area, consult protected area sponsors and managers, local communities and other key stakeholders on the proposed project, proceed in a manner consistent with the defined area management plans, and implement additional programs, as appropriate, to promote and enhance the conservation aims of the protected areas.
- Do not intentionally introduce any new alien species unless this is carried out in accordance with the existing regulatory framework for such introduction or is subject to a risk assessment (as part of the ESIA) to determine the potential for invasive behavior. Do not deliberately introduce any alien species having a high risk of invasive behavior or of any known invasive species, while exercising diligence to prevent accidental introductions.
- Manage renewable natural resources in a sustainable manner, and where possible, demonstrate the sustainable management of the resources through an appropriate system of independent certification.
- Projects involved in natural forest harvesting or plantation development will not cause any conversion or degradation of critical habitat. Locate such plantation projects on un-forested land or land already converted. Also, ensure that all natural forests and plantations are independently certified as meeting performance standards compatible with internationally accepted principles and criteria for sustainable forest management. If it is determined that the operation does not yet meet the requirements of such an independent forest certification system, develop and adhere to a time-bound, phased action plan for achieving such certification.

- Projects involved in the production and harvesting of fish populations or other aquatic species must demonstrate that their activities are being undertaken in a sustainable manner, through application of an internationally accepted system of independent certification or through appropriate studies carried out in conjunction with the ESIA.

Performance Standard #7: Indigenous Peoples

Objectives:

- Ensure that the process fosters full respect for the dignity, human rights, aspirations, cultures and natural resource-based livelihoods of indigenous peoples.
- Avoid adverse impacts of projects on communities of indigenous peoples or when avoidance is not feasible, minimize, mitigate or compensate for such impacts, while providing opportunities for development benefits in a culturally appropriate manner.
- Establish and maintain an ongoing relationship with indigenous peoples affected by a project throughout the life of the project.
- Foster good faith negotiation based on informed participation with indigenous peoples when projects are located on traditional or customary lands under use by those peoples.
- Respect and preserve the culture, knowledge and practices of indigenous peoples.

Major Requirements:

- Identify, through the ESIA process, all communities of indigenous peoples who may be affected by the project within the project's area of influence as well as the nature and degree of the expected (though unavoidable) social, cultural and environmental impacts on them.
- If unavoidable, minimize, mitigate or compensate for identified impacts in a culturally appropriate manner. Develop proposed action with informed participation and contained in a time-bound Indigenous Peoples Development Plan, or a broader community development action plan with separate components for indigenous peoples.
- Establish an ongoing relationship with the affected communities of indigenous peoples from early design through the life of the project. In projects with adverse impacts on such peoples, the consultation process will ensure their free, prior and informed consultation and facilitate their informed participation on matters directly affecting them, such as proposed mitigation measures, the sharing of development benefits and implementation issues. The process of engagement will be culturally appropriate and commensurate with the risks and potential impacts to the indigenous peoples, and will include involvement of indigenous peoples' representative bodies (councils of elders, etc.), will include both women and men of various age groups as culturally appropriate, will provide sufficient time for collective decision-making by the peoples, will facilitate the peoples' expression of views, concerns and proposals in the language of their choice, without manipulation or coercion, and will ensure that the project grievance mechanism is culturally appropriate and accessible for the indigenous peoples.
- Seek to identify through the process of free, prior and informed consultation, opportunities for culturally appropriate development benefits, commensurate with the degree of project impacts with the aim of improving their standard of living and fostering the long-term sustainability of the natural resource on which they depend.
- Consider feasible alternative project designs to avoid any relocation of indigenous peoples from their community held traditional or customary lands under use. If such

relocation is unavoidable, the client will not proceed with the project unless it enters into a good faith negotiation with the affected communities of indigenous peoples and documents their informed participation and the successful outcome of negotiations. (Any relocation will be consistent with the Resettlement Planning and Implementation requirements of Performance Standard #5, and the relocated indigenous peoples should be able to return to their traditional or customary lands should the reasons for their relocation cease to exist.

Performance Standard #8: Cultural Heritage

Objectives:

- Protect cultural heritage from the adverse impacts of project activities and support its preservation
- Promote the equitable sharing of benefits from the use of cultural heritage in business activities

Major Requirements:

- Comply with relevant national law on protection of cultural heritage, including national law implementing the host country's obligations under the Convention Concerning the Protection of the World Cultural and Natural Heritage and other relevant international laws, and protect and support cultural heritage by undertaking internationally recognized practices for the protection, field-based study and documentation of cultural heritage. Retain qualified experts to assist in the ESIA where required, based on the requirements which follow.
- The project site selections and design will be undertaken to avoid significant damage to cultural heritage. Where the project location is expected to be within an area where cultural heritage is found, either during construction or during operations, chance find procedures must be established through the ESIA. Findings will not be disturbed until an assessment by a competent specialist is made and actions are identified consistent with the requirements of this Performance Standard.
- Where a project may affect cultural heritage, consult with affected communities who use, or have used within living memory, the cultural heritage for longstanding cultural purposes to identify cultural heritage of importance, and incorporate into the decision-making process the views of the affected communities. Consultation will also extend to relevant national or local regulatory agencies entrusted with the protection of cultural heritage.
- No removal of cultural heritage is permitted unless there are no technically or financially feasible alternatives or the overall benefits of the project outweigh the anticipated cultural heritage loss. Any removal of cultural heritage will be conducted by the best available technique.
- In the case of critical heritage (internationally recognized heritage of communities who use, or have used within living memory, the cultural heritage for long standing cultural purposes) such heritage will not be significantly altered, damaged or removed. In exceptional cases, where a project may significantly damage such heritage and the damage or loss may endanger the cultural or economic survival of communities within the host country, consult with the affected communities, conduct good faith negotiation and document the successful outcome. Any other impacts on such heritage must be appropriately mitigated with informed participation of the affected communities.
- In the case of legally protected cultural heritage where the project is located within a legally protected area or defined buffer zone, in addition to the requirements

stated above for critical cultural heritage, the project will comply with defined national or local cultural heritage regulations of the protected area management plans; consultation will be undertaken with area sponsors and manager, local communities and other key stakeholders on the proposed project, and additional programs will be implemented to promote and enhance the conservation aims of the protected area.

2.3.2 Equator Principles

The Equator Principles state that adopting financial institutions will provide loans directly to projects only under the following circumstances:

- **Scope:** The Principles apply to projects over 10 million US dollars.
- **Principle 1: Review and Categorization:** The risk of the project is categorized in accordance with internal guidelines based on the environmental and social screening criteria of the IFC. Projects are classified, relating to social or environmental impacts, in Category A (significant impacts), Category B (limited impacts) and Category C (minimal or no impacts).
- **Principle 2: Social and Environmental Assessment:** For all medium or high risk projects (Category A and B projects), Project Proponents have to complete an Environmental Assessment, the preparation of which must meet certain requirements and satisfactorily address key environmental and social issues.
- **Principle 3: Applicable Social and Environmental Standards:** The Environmental Assessment report addresses baseline environmental and social conditions, requirements under host country laws and regulations, applicable international treaties and agreements, sustainable development and use of renewable natural resources, protection of human health, cultural properties, and biodiversity, including endangered species and sensitive ecosystems, use of dangerous substances, major hazards, occupational health and safety, fire prevention and life safety, socio-economic impacts, land acquisition and land use, involuntary resettlement, impacts on indigenous peoples and communities, cumulative impacts of existing projects, the proposed project, and anticipated future projects, participation of affected parties in the design, review and implementation of the project, consideration of feasible environmentally and socially preferable alternatives, efficient production, delivery and use of energy, pollution prevention and waste minimization, pollution controls (liquid effluents and air emissions) and solid and chemical waste management.
- **Principle 4: Action Plan and Management System:** Based on the Environmental Assessment, Equator banks then make agreements with their clients on how they mitigate, monitor and manage those risks through a 'Social Environmental Management Plan'.
- **Principle 5: Consultation and Disclosure:** For risky projects, the borrower consults with stakeholders (NGOs and project affected groups) and provides them with information on the risks of the project. The borrower has to consult the project affected communities in a structured and culturally appropriate manner. The process will ensure free, prior and informed consultation for affected communities.
- **Principle 6: Grievance Mechanism:** The borrower will establish a grievance mechanism as part of the management system.
- **Principle 7: Independent Review:** For the Assessment, Assessment Plan and consultation process.

- **Principle 8: Covenants:** Incorporation of covenants linked to compliance. Compliance with the plan is required in the covenant. If the borrower doesn't comply with the agreed terms, the bank will take corrective action, which if unsuccessful, could ultimately result in the bank canceling the loan and demanding immediate repayment.
- **Principle 9: Independent Monitoring and Reporting:** Over the life of the loan, in Category A and, if necessary in Category B, an independent expert is consulted.
- **Principle 10: EPFI Reporting:** Each EPFI commits to report publicly at least annually about its Equator Principles implementation processes and experience.

Equator Principles Financial Institutions (EEPIs) are required to categorize Projects according to the magnitude of its potential impacts based on the environmental and social screening criteria of IFC. Projects are designated as Category A, B or C when it represents, respectively, a high, medium or low level of risk as per the following:

Category A: Projects with potential significant adverse social or environmental impacts that is diverse, irreversible or unprecedented;

Category B: Projects with potential limited adverse social or environmental impacts that are few in number, site-specific, largely reversible, and readily addressed through mitigation measures; or

Category C: Projects with minimal or no adverse social or environmental impacts.

2.4 IMPORTANT ENVIRONMENT LEGISLATION

The environmental regulations, legislations and policy guidelines and control that may impact the project are the governed by various Government agencies. The principal environmental regulatory agency in India is Ministry of Environment and Forest (MoEF), Delhi. MoEF formulates environmental policies/standards/guidelines and also accords environmental clearances. The relevant standards, which are of significance to the proposed project, are discussed in the section below.

The important environmental legislations related to a Thermal Power Plant are given in **Table 2.1**.

TABLE 2.1- KEY ENVIRONMENT LEGISLATION

Name	Scope and Objectives	Key Areas	Operational Agencies/ Key Players
Water (Prevention and Control of Pollution) Act 1974	To provide for the prevention and control of water pollution and enhancing quality of water	Control of Sewage and industrial effluent discharges	Central and State Pollution Control Boards
Air (Prevention and Control of Pollution) Act 1981	To provide for the prevention and control of air pollution	Controls emission and air pollutants	Central and State Pollution Control Boards
Forest Conservation Act 1980	To halt rapid deforestation and environmental degradation	Restriction on de-reservation and using forests for non-forest purpose	Central Government
Environment Protection Act 1986 Environment	To provide for the protection and improvement of	An umbrella Legislation; supplements	Central Government, nodal agencies MoEF, can delegate powers to

Name	Scope and Objectives	Key Areas	Operational Agencies/ Key Players
Protection Rules 1989	environment	pollution laws	department of environment
Forest (Conservation) Rules 1981	To provide for the protection and improvement of the forests	A legislation to protect forests and forest products	Central Government, nodal agencies MoEF, can delegate powers to Department of Forest
Noise Pollution (Prevention & Control) Rules 2000	To control and take measures for abatement of noise and ensure that the level does not cross specified standards	Noise in urban area and around industrial sites	Central Government, nodal agencies MoEF, State governments
Hazardous Wastes (Management And Handling) Rules, 1989	To the adequate handling of hazardous materials or wastes	Hazardous waste generated from the industrial activity	Central Government, Nodal Agencies MoEF, CPCB
Public Liability Insurance Act, 1991	To provide for public liability- insurance for the purpose of providing immediate relief to the persons affected by accident occurring while handling any hazardous substance and for matters connected therewith or incidental thereto	To provide public liability insurance during risk material handling	Central Government, Nodal Agencies MoEF, State Govt.

2.5 NATIONAL ENVIRONMENT AND POLLUTION STANDARDS

2.5.1 Ambient Air Quality Standards

The standards of the air quality are set at a level necessary for an adequate margin of safety, to protect the public health, vegetation and property. The Ambient Air Quality standards have been notified by the Ministry of Environment and Forests (vide Gazette Notification dated 16th Nov 2009). The standards are given in **Table 2.2**.

TABLE 2.2- NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutant	Time	Concentration in µg/mg^3 Industrial, Residential, Rural & other areas	Ecologically Sensitive area (Notified by Central Govt.)
Sulphur Dioxide (µg/m^3)	Annual Avg.* 24 hours**	50 80	20 80
Oxides of Nitrogen (µg/m^3)	Annual Avg. 24 hours	40 80	30 80
PM10 (µg/m^3)	Annual Avg. 24 hours	60 100	60 100
PM2.5 (µg/m^3)	Annual Avg. 24 hours	40 60	40 60
Ozone (µg/m^3)	8 hours** 1 hour**	100 180	100 180
Lead (µg/m^3)	Annual Avg. 24 hours	0.50 1.00	0.5 1.00

Pollutant	Time	Concentration in µg/mg^3 Industrial, Residential, Rural & other areas	Ecologically Sensitive area (Notified by Central Govt.)
Carbon Monoxide (mg/m^3)	8 hours 1 hour	2 4	2 4
Ammonia (NH3) (µg/m^3)	Annual Avg. 24 hours	100 400	100 400

Source: Gazette of India Notification, dated 16th Nov, 2009

* Annual Arithmetic Means of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals

** 24 hourly or 8 hourly or 01 hourly monitored values, as applicable shall be complied with 98% of the time in a year. 2% of the time they may exceed the limits but not on two consecutive days of monitoring

TABLE 2.3- AMBIENT AIR QUALITY STANDARDS IN RESPECT OF NOISE

Category of Area Zone	Limits in dB(A) Leq*	
	Day Time	Night Time
Industrial Area	75	70
Commercial Area	65	55
Residential Area	55	45
Silence Zone	50	40

Source: Pollution Control Acts Rule and Notifications issued there under by Central Pollution Control Board (Gazette Notfication dtd 14th Feb 2000.

Note:- *1. Day time shall mean from 6.00 a.m. to 10.00 p.m.*
2. Night time shall mean from 10.00 p.m. to 6.00 a.m.
3. Silence zone is an area comprising not less than 100 meters around hospitals, educational institutions, courts, religious, places or any other area which is declared as such by the competent authority
4. Mixed categories of area may be declared as one of the four above mentioned categories by the competent authority.

2.5.2 Effluent Discharge Standards

For the purpose of protecting and improving the quality of the environment and preventing and abating environmental pollution, the standard for discharge of environmental pollutants from the industries, operations and processes are stipulated under Environmental Protection Rules 1993. The general standards for discharge effluent in surface water bodies are given in **Table 2.4.**

TABLE 2.4- EFFLUENT DISCHARGE STANDARDS

S No	Parameters	Unit	Standards	
			Discharge into inland surface waters	Land for Irrigation
1.	Colour and Odour	-	Efforts should be made to remove colour & unpleasant odour	Efforts should be made to remove colour & unpleasant odour
2.	Suspended Solids	mg/l	100	200
3.	Particle size of suspended solids	-	Shall pass 850 micron IS sieve	NS
4.	pH value	-	5.5 to 9.0	5.5 to 9.0
5.	Temperature (Max)	˚C	Shall not exceed 5˚C above the receiving water temperature	NS
6.	Oil and Grease (Max)	mg/l	10.0	10.0
7.	Total residual Chlorine (Max)	mg/l	1.0	NS
8.	Ammonical Nitrogen (Max)	mg/l	50.0	NS
9.	Total Kjeldah Nitrogen (Max)	mg/l	100	NS
10.	Free Ammonia (as in NH_3)	mg/l	5.0	NS
11.	Biochemical Oxygen Demand: 5 days	mg/l	30.0	100

S No	Parameters	Unit	Standards	
			Discharge into inland surface waters	Land for Irrigation
	at 20˚C Max			
12.	Chemical Oxygen Demand Max	mg/l	250	NS
13.	Arsenic (as As) Max	mg/l	0.2	0.2
14.	Mercury (as Hg) Max	mg/l	0.01	NS
15.	Lead (as Pb) Max	mg/l	0.1	NS
16.	Cadmium (as Cd) Max	mg/l	2.0	NS
17.	Hexavalent Chromium (as Cr^{+6}) Max	mg/l	0.1	NS
18.	Total Chromium (as Cr) Max	mg/l	2.0	NS
19.	Copper (as Cu) Max	mg/l	3.0	NS
20.	Zinc (as Zn) Max	mg/l	5.0	NS
21.	Selenium (as Sn) Max	mg/l	0.05	NS
22.	Nickel (as Ni) Max	mg/l	3.0	NS
23.	Cyanide (as Cn) Max	mg/l	0.2	0.2
24.	Fluorides (as F) Max	mg/l	2.0	NS
25.	Dissolved phosphates (as P) Max	mg/l	5.0	NS
26.	Sulphides (as S) Max	mg/l	2.0	NS
27.	Phenolic compounds (as C_6H_5OH) max	mg/l	1.0	NS
28.	Radioactive materials: α Emitters Max B Emitters Max	µcurie/ ml	 10^{-7} 10^{-7}	 10^{-7} 10^{-7}
29.	Bio-assay Test	-	90% survival of fish after 96 hours in 100% effluent	90% survival of fish after 96 hrs in 100% effluent
30.	Manganese (as Mn)	mg/l	2.0	NS
31.	Iron (as Fe)	mg/l	3.0	NS
32.	Vanadium (as V)	mg/l	0.2	NS
33.	Nitrate Nitrogen	mg/l	10.0	NS

Source: Pollution Control Acts Rule &Notifications issued there under, page No.460-463 by Central Pollution Control Board (gazette notification dated 19th May 200

2.5.3 Standards Applicable for Thermal Power Plant

The standard applicable for emission of liquid effluents, particulate matter and the standards of other parameters during operation from Thermal Power Plant are mentioned in **Table 2.5** to **Table 2.7** respectively.

A. Standards for Liquid Effluents

TABLE 2.5- STANDARDS FOR LIQUID EFFLUENTS

Source	Parameter	Concentration not to exceed, mg/l (except for pH & Temp.)
Condenser Cooling Water (once through higher cooling system)	PH Temperature Free available chlorine	6.5 to 8.5 Not more than 5^0C than the higher intake 0.5
Boiler Blow-down	Suspended solids Oil & grease Copper (Total) Iron (Total)	100 20 1.0 1.0
Cooling Tower blow-down	Free available Chlorine Zinc Chromium (Total) Phosphate	0.5 1.0 0.2 5.0

Source	Parameter	Concentration not to exceed, mg/l (except for pH & Temp.)
	Other corrosion inhibiting material	Limit to be established on case by case basis by CPCB in case of UT and State Boards in case of states
Ash pond effluent	PH Suspended solids Oil & grease	6.5 to 8.5 100 20

Source: Pollution Control acts, rules, Notification issued there under. Published by Central Pollution Control Board, Series PCLS/02/2006: January, 2006 p. 344 * Limit has been revised, please see new limit at Sr. No. 66C of the document Source: EPA Notification [S.O. 844(E), dt 19th Nov; 1996]

B. Standard for the Emission of Particulate Matter

TABLE 2.6- THERMAL POWER PLANTS: EMISSION STANDARDS

Generation Capacity	Pollutant	Emission limit
Generation capacity 210 MW or more	Particulate matter	150 mg/Nm^3
Generation capacity less than 210 MW	Particulate matter	350 mg/Nm^3

Source: Pollution Control Acts, rules, Notification issued there under. Published by Central Pollution Control Board, Series PCLS/02/2006: January, 2006 p. 356
Depending upon the requirement of local situation, such as protected area, the State Pollution Control Boards and other implementing agencies under the Environment (Protection) Act, 1986, may prescribe a limit of 150 mg/Nm3, irrespective of generation capacity of the plant.

C. Standard Height of Stack Emission and the limit of discharge

TABLE 2.7- THERMAL POWER PLANTS - STACK HEIGHT/LIMITS

Generation Capacity	Stack Height (Metres)
500 MW and above	275
200 MW/210 MW and above - less than 500 MW	220
Less than 200 MW/210 MW	H= 14 $Q^{0.3}$ where Q is emission rate of SO2 in kg/hr, and H is Stack height in metres.

Source: Pollution Control acts, rules, Notification issued there under. Published by Central Pollution Control Board, Series PCLS/02/2006: January, 2006 p. 359; (2) EPA Notification [G.S.R. 742(E), dt. 30th Aug; 1990]

D. Temperature Limit for Discharge of Condenser Cooling Water from Thermal Power Plants is mentioned in the following:

- New thermal power plants commissioned after June 1, 1999: New thermal power plants, which will be using water from rivers/lakes/reservoirs, shall install cooling towers irrespective of location and capacity.

E. Disposal of Fly Ash Notification (1999)

The main objective of which is to conserve the topsoil, protect the environment and prevent the dumping and disposal of fly ash discharged from lignite-based power plants. The salient features of the notification are:

Ash Utilization S.O. 2804(E), 3rd Nov 2009

"FLY ASH" means and includes all categories or groups of coal or lignite ash generated at the thermal power plant such as Electrostatic Precipitator (ESP) ash, dry fly ash, bottom ash, pond ash and mound ash.

Salient Points:

1. Building Materials, Roads or flyover embankments, Embankment, Compaction and Reclamation with in hundred kilometers around the Thermal Power Projects shall be fly ash based products.
2. Chief Engineer (Design) or Engineer-in-Chief of the concerned agency or organization of all construction agencies of Central or State or Local Government and private or

public sector to furnish the non-availability of fly ash from thermal power plants in sufficient quantities as certified by the power plants, within 100 km of the site if not adhered to the stipulation.

3. Thermal Power Plants : Constitution of a dispute settlement committee which shall include the General Manager of the thermal power plant and a representative of the relevant Construction and fly ash Brick Manufacturing Industry Association / Body, as the case may be at Power Plant
4. TPP to submit "Annual Implementation Report" (for period 1st April to 31st March) providing information on compliance of provision to SPCB / CPCB / RO, MoEF and also in the Annual report of the agency.
5. Pond ash to made available free of any charge on "as is where basis"
6. At least 20% of dry ESP fly ash shall be made available free of charge to units manufacturing fly ash or clay-fly ash bricks, blocks and tiles on a priority basis over other users.

Minimum Fly Ash Content for building materials or products to qualify as "fly ash based products" category shall be as given in below.

TABLE 2.8- FLY ASH CONTENT IN BUILDING PRODUCTS

S. No.	Building Materials or Products	Minimum % of fly ash by weight
1.	Fly ash bricks, blocks, tiles, etc. made with fly ash, lime, gypsum, sand, stone dust, cement, etc. (without clay).	50% of total raw material.
2.	Paving blocks, paving tiles, checker tiles, mosaic tiles, roofing sheets, pre-cast elements, etc. wherein cement is used as binder.	Usage of PPC (IS1489:Part-1) or PSC (IS-455) or 15% of OPC (IS-269/8112/12269) content.
3.	Cement.	15% of total raw materials.
4.	Clay based building materials such as bricks, blocks, tiles, etc.	25% of total raw materials.
5.	Concrete, mortar and plaster.	Usage of PPC (IS1489:Part-1) or PSC (IS-455) or 15% of OPC (IS-269/8112/12269) content.

Old and Existing Stations: units in operation before 3rd November, 2009 to achieve the target of fly ash utilization as per the tables given below.

TABLE 2.9- GUIDELINES FOR ASH UTILISATION FOR OLD AND EXISTING POWER STATIONS

Percentage Utilization of Fly Ash	Year from the date of issue of notification
At least 50% of fly ash generation	One year.
At least 60% of fly ash generation	Two years
At least 75% of fly ash generation	Three years
At least 90% fly ash generation	Four years
100% fly ash generation	Five years

New Stations commissioned after 3rd November, 2009 to achieve the target of fly ash utilization as per table given below.

TABLE 2.10- GUIDELINES FOR ASH UTILISATION FOR NEW POWER STATIONS

Fly ash utilization level	Years from the date of commissioning
At least 50% of fly ash generation	One year
At least 70% of fly ash generation	Two years
At least 90% of fly ash generation	Three years
100% of fly ash generation	Four Years

The unutilized fly ash in relation to the target during a year, if any, shall be utilized within next two years in addition to the targets stipulated for these years. The unutilized fly ash accumulated during first three years (the difference between the generation and utilization target) shall be utilized progressively over next five years in addition to 100% utilization of current generation of fly ash.";

F. The Batteries (Management and Handling) Rules, 2001

The MOEF has issued final Batteries (M&H) Rules, 2001 and its subsequent amendments 4th May, 2010 to control the hazards associated with the backyard smelting and unauthorized reprocessing of lead acid batteries.

Manufacturers/ Assemblers/ Re-conditioners/ Importers/ Recyclers/ Auctioneers/ Users/ bulk Consumers are required to submit half yearly returns to the SPCB who have been designated as the Prescribed Authority. The forms have been designed in such a manner as to enable easy verification of responsibilities fixed for every one under the rules.

The amendment dtd 4th May 2010 clarifies " bulk consumer-means a consumer such as the Departments of Central Government like Railway Defence, Telecom, Posts and Telegraph, the Departments of State Government, the Undertakings, Boards and other agencies or companies who purchase hundred or more than hundred batteries per annum;".

G. Hazardous Waste Rule

There are several legislation that directly or indirectly deal with hazardous waste. The relevant legislation are the Factories Act, 1948, the Public Liability Insurance Act, 1991, the National Environment Tribunal Act, 1995 and some notifications under the Environmental Protection Act of 1986. A brief description of each of these is given below.

Under the EPA 1986, the MoEF has issued several notifications to tackle the problem of hazardous waste management. These include:

- **Hazardous Wastes (Management and Handling) Rules, 1989**, which brought out a guide for manufacture, storage and import of hazardous chemicals and for management of hazardous wastes.
- **Biomedical Waste (Management and Handling) Rules, 1998**, were formulated along parallel lines, for proper disposal, segregation, transport etc. of infectious wastes.
- **Municipal Wastes (Management and Handling) Rules, 2000**, whose aim was to enable municipalities to dispose municipal solid waste in a scientific manner.

2.6 INTERNATIONAL FINANCE CORPORATION STANDARDS FOR THERMAL POWER PLANT

These standards in general are applicable to air, noise and water Environment.

2.6.1 Emission Standards of Thermal Power Plant

US Exim Bank Environmental Guidelines

US Exim Bank has formulated Environmental procedures and Guidelines (14th August, 2008) and supplementary guidelines (9th March, 2010). Annexure – G is part of above supplementary guidelines. This categorizes project based on carbon intensity and expects Project Proponent to adopt verifiable measures, to reduce Green House Gas Emissions (CO_2) and limit the same to 850 gm of CO_2 per kWh or less.

World Bank Guidelines

World Bank stipulates emission standards based on Air shed type (Good, Moderate and poor) and size of unit and type of fuel fired.

GOI Emission standards

Ministry of Environment and Forests stipulates emission standards for Particulate matter depending on capacity of the boiler and stipulates Stack height for wider dispersal of pollutants like SO_2 and NO_X. Further, it envisages space for FGD in units of 500MW and above for retrofitting if required.

TABLE 2.11- COMPARISON OF EMISSION STANDARDS

Environmental Aspect	GOI Regulations	IFC Guidelines	World Bank Guidelines
SO_2 Emissions	No Standards for Coal Based power plants Stack Height of 275 m	850 mg/Nm^3	2000 mg/Nm^3
NO_X Emissions	No Standards for Coal Based power plants	510 mg/Nm^3	750 mg/Nm^3
SPM Emissions	150 mg/Nm^3 as per Notification 100 mg/Nm^3 as per CREP	50 mg/Nm^3	50 mg/Nm^3
CO_2 Emissions	No Limit	850 gm/KWhr (Max)#	

#: Annexure – G part of supplementary guidelines categorizes project based on carbon intensity and expects Project Proponent to adopt verifiable measures to reduce Green House Gas Emissions (CO_2) and limit the same to 850 gm of CO_2 per kWh or less.

2.6.2 Ambient Air Quality Standards

Ministry of environment and Forests identifies two categories as air quality namely- Sensitive and Industrial, Residential, Rural & Other Areas under National Ambient Air Quality standards. USEXIM has No Specific Standards. However, WHO guidelines presented in **Table 2.12** are to be used only for carrying out an environment assessment in the absence of local ambient standards. However, depeding on compliance Areas are divided in to two categories namely - Non Degraded Area and Degraded Area. World Bank categories of air shed in to three such as Good, Moderate and Poor. India has its own NAAQS, so this is only to be considered as guideline for Indian conditions.

TABLE 2.12- COMPARISON OF AMBIENT AIR QUALITY STANDARDS ON 24 HOURLY BASIS

Parameter	India (µg/m^3)	World Bank (µg/m^3)	WHO (µg/m^3)	EU (µg/m^3)
SO_2	80	150	125	80-120
NO_X	80	150	200 (1hr)	200
SPM	200##	150		
PM10	100		150-230	150
PM2.5	60			

##: Omitted in the Revised NAAQS notification.
Source: IFC EHS Guidelines, April 30, 2007

2.6.3 Effluent Standards Applicable for Thermal Power Plant

The effluent levels presented in **Table 2.13** (for the applicable parameters) should be achieved daily without dilution.

TABLE 2.13- STANDARDS FOR EFFLUENTS FROM THERMAL POWER PLANTS

Parameters	GOI Standards	World Bank Standards
	Thermal Power Plant Specific Standards	
Condenser Cooling Water		
pH	6.5 - 8.5	6-9
Temperature	Cooling towers for inland stations	<3°C %
Free Available Chlorine (mg/l)	0.5	N.S.
Total Residual Chlorine* (mg/l)	N.S.	0.2
Boiler Blowdown		
Suspended Solids (mg/l)	100	50
Oil & Grease (mg/l)	20	10
Copper (total) (mg/l)	1.0	0.5
Iron (total) (mg/l)	1.0	1.0
Cooling Tower Blowdown		
Free Available Chlorine (mg/l)	0.5	NS
Total Residual Chlorine* (mg/l)	N.S.	0.2
Zn (mg/l)	1.0	1.0
Cr (total) (mg/l)	0.2	0.5
PO4 (mg/l)	5.0	NS
Ash Pond Effluent		
pH	6.5 - 8.5	6-9
Suspended Solids (mg/l)	100	50
Oil & Grease (mg/l)	10	10

Source: PPAH, World Bank Group, Effective July 1998

2.6.4 Standards Applicable for Ambient Noise

As mentioned in PPAH document of World Bank Group, Noise abatement measures should achieve either the levels given below in **Table 2.14** or a maximum increase in background levels of 3 decibels (measured on the A scale) [dB(A)].

TABLE 2.14: AMBIENT NOISE STANDARDS

Receptor	Maximum allowable Leq (hourly measurement) in dB(A)	
	Day (07:00-22:00)	Night (22:00-07:00)
Residential, Institutional, Educational	55	45
Industrial, Commercial	70	70

Source: PPAH, World Bank Group, Effective July 1998

2.7 INDIAN LABOUR LAWS

All the workmen of the company are required to be governed by the relevant Indian Labour laws, which are stated below:

2.7.1 Workmen's Compensation Act, 1923

The Workmen's Compensation Act, 1923 is one of the important social security legislations. It aims at providing financial protection to workmen and their dependants in case of accidental injury by means of payment of compensation by the employers.

Main Provisions and Scope of the Act

Under the Act, the State Governments are empowered to appoint Commissioners for Workmen's Compensation for (i) settlement of disputed claims, (ii) disposal of cases of injuries involving death, and (iii) revision of periodical payments. Sub-section (3) of Section 2 of the Act, empowers the State Governments to extend the scope of the Act to any class of persons whose occupations are considered hazardous after giving three months notice to be published in the Official Gazette. Similarly, under Section 3(3) of the Act, the State Governments are also empowered to add any other disease to the list mentioned in Parts A and B of Schedule – II and the Central Government in case of employment specified in Part C of Schedule III of the Act.

Compensation

In case of death and Permanent total disablement the minimum amount of compensation fixed is Rs. 80,000 and Rs. 90,000 respectively. The existing wage ceiling for computation of maximum amount of compensation is Rs. 4000. The maximum amount of compensation payable is Rs. 4.56 lakh in the case of death and Rs. 5.48 lakh in the case of permanent total disablement.

2.7.2 The Trade Unions Act, 1926

The Trade Unions Act, 1926 provides for registration of trade unions (including association of employers) with a view to render lawful organization of labour to enable collective bargaining. The Act also confers on a registered trade union certain protection and privileges.

2.7.3 Payment of Wages Act, 1936

Every employer shall be responsible for the payment to persons employed by him of all wages required to be paid under this Act:

Provided that in the case of persons employed (otherwise than by a contractor) –

- In factories if a person has been named as the manager of the factory under clause (f) of sub-section (1) of section 7 of the Factories Act 1948 (63 of 1948) ;
- In industrial or other establishments if there is a person responsible to the employer for the supervision and control of the industrial or other establishments;
- Upon railways (otherwise than in factories) if the employer is the railway administration and the railway administration has nominated a person in this behalf for the local area concerned.

The person so named the person so responsible to the employer or the person so nominated as the case may be shall also be responsible for such payment.

2.7.4 The Industrial Disputes Act, 1947

The objective of the Industrial Disputes Act is to secure industrial peace and harmony by providing machinery and procedure for the investigation and settlement of industrial disputes by negotiations.

The Act also lays down

- The provision for payment of compensation to the Workman on account of closure or lay off or retrenchment.
- The procedure for prior permission of appropriate Government for laying off or retrenching the workers or closing down industrial establishments
- Unfair labour practices on part of an employer or a trade union or workers.

2.7.5 Factories Act, 1948

The Factories Act, is a social legislation, which has been enacted for occupational safety, health and welfare of workers at work places. This legislation is being enforced by technical officers i.e. Inspectors of Factories, Dy. Chief Inspectors of Factories who work under the control of the Chief Inspector of Factories.

2.7.6 Minimum Wages Act, 1948

The object of the Act is to prevent exploitation of labour, prevent employment of sweated labour in the interests of general public and so in prescribing minimum wage rates, the capacity of the employer need not be taken into account.

2.7.7 Employees State Insurance Act, 1948

Employees State Insurance (ESI) Scheme for India is an integrated social security act tailored to provide Social protection to workers and their dependents, in the organised sector, in contingencies, such as Sickness, Maternity and Death or Disablement due to an employment injury or Occupational hazard.

Main Provisions

- Every factory or establishment to which this Act applies shall be registered within such time and in such manner as may be specified in the regulations made in this behalf.
- It provided for an integrated need based social insurance scheme that would protect the interest of workers in contingencies such as sickness, maternity, temporary or permanent physical disablement, death due to employment injury resulting in loss of wages or earning capacity.
- It also provided for six social security benefits:-
  - Medical Benefit
  - Sickness Benefit (SB)
  - Maternity Benefit (MB)
  - Disablement Benefit
  - Dependants' Benefit(DB)
  - Funeral Expenses

2.7.8 Employees Provident Fund and Miscellaneous Provisions Act, 1952

The Employees' Provident Funds and Miscellaneous Provisions Act, 1952 applies to every factory engaged in any industry specified in Schedule - I of the Act and in which 20 or more persons are employed and to other establishments like road motor transport establishments, hotels, restaurant cinema theatres, hospitals etc. as notified by Central Government in the Official Gazette.

The Act provides for the institution of compulsory Provident Fund, Pension Fund and Deposit Linked insurance Fund for the benefit of the employees in factories and other establishments.

2.7.9 The Maternity Benefits Act, 1961

Objective

The Maternity Benefit Act aims to regulate the employment of women in certain establishments for certain periods before and after child-birth and to provide for maternity benefits including maternity leave, wages, bonus, nursing breaks etc.

Prohibited Period of Employment or Work

The employment of women, or work by women in any establishment during the six weeks following the day of delivery or miscarriage

Payment of Maternity Benefit

Every woman shall be entitled to, and her employer shall be liable for, the payment of maternity benefit at the rate of average daily wage for the period of her actual absence, and any period of her actual absence, and any period immediately following the date of delivery and including the actual day for her delivery. In addition to the maternity benefit, every woman shall also be entitled to receive a medical bonus of Rs. 250/- if no prenatal confinement and post natal care is provided free of charge.

Eligibility for Maternity Benefit

A woman shall be entitled to maternity benefit only if she has actually worked in an establishment of the employer for a period of not less than eighty days in the twelve months immediately preceding the date of her expected delivery

Maximum Period of Maternity Benefit:

Maximum twelve weeks of, which not more than six weeks shall proceed the date of her expected delivery

2.7.10 Personal Injuries (Emergency Provisions) Act, 1962

An Act to make provision for the grant of relief in respect of certain personal injuries sustained during the period of the Emergency.

2.7.11 The Payment of Bonus Act, 1965

An Act to provide for the payment of Bonus to persons employed in certain establishments and for matters connected therewith

Main Provisions

- Subject to other provisions: — Minimum bonus shall be 8.33% of salary/wages earned or Rs. 100 whichever is higher.
- If allocable surplus exceeds the amount of minimum bonus, then bonus shall be payable at higher rate subject to a maximum 20% of salary/wages.
- Computation of bonus is to be worked out as per Schedule I to IV of the Act.

Penal Provisions

- Imprisonment up to 6 months and or fine up to RS 1000/-.

2.7.12 Contract Labour (Regulation and Abolition) Act, 1970

An Act to regulate the employment of contract labour in certain establishments and to provide for its abolition in certain circumstances and for matters connected therewith.

Responsibilities

The Act enjoins joint and several responsibilities on the Principal Employer and the Contractor. The Principal Employer should ensure that the Contractor does the following:

- Pays the wages as determined by the Government, if any, or;
- Pays the wages as may be fixed by the Commissioner of Labour.
- In their absence pays fair wages to contract labourer.
- Provides the following facilities:

- Canteen (if employing 100 or more workmen in one place) and if the work is likely to last for 6 months or more.
- Rest rooms where the workmen are required to halt at night and the work is likely to last for 3 months or more.
- Requisite number of latrines and urinals - separate for men and women.
- Drinking water.
- Washing.
- First Aid.
- Crèche

- Maintains various registers and records, displays notices, abstracts of the Acts, Rules etc.
- Issues employment card to his workmen, etc.

Checklist for Principal Employer

- Registration of the Establishment.
- Display of the following notices rate of wages, hours of work, wage period, date of payment of wages, date of payment of unpaid wages and name and address of the inspector having jurisdiction.
- Maintenance and Preservation of Register of Contractor.
- Filing of Return of Commencement and Completion of the Contract.
- Filing of Annual Return.
- Supervising the responsibilities of Contractor to avoid enjoining of the liabilities.
- Ensure provision that facilities of Canteen, Drinking Water, Washing, Rest Room, Latrines and Urinals, First Aid, Crèche are provided by the Contractor.

2.7.13 The Payment of Gratuity Act, 1972

The Act provides for the payment of gratuity to workers employed in every factory, shop & establishments or educational institution employing 10 or more persons on any day of the preceding 12 months. A shop or establishment to which the Act has become applicable shall continue to be governed by the Act even if the number of persons employed falls bellows 10 at any subsequent stage.

All the employees irrespective of status or salary are entitled to the payment of gratuity on completion of 5 years of service. In case of death or disablement there is no minimum eligibility period. The amount of gratuity payable shall be at the rate of 17 days wages based on the rate of wages last drawn, for every completed year of service. The maximum amount of gratuity payable is Rs. 10,00,000/-.

2.7.14 The Child Labour (Prohibition and Regulation) Act, 1986

Objective of the Legislation

It is an Act to prohibit the engagement of children in certain employments and to regulate the conditions of work of children in certain other employments. The act defines a child as a person who has not completed his fourteenth year of age.

Prohibition of Work for Child Labour

No child is permitted to work in any the occupations set forth in Part A of the Schedule or any workshop wherein any of the processes set forth in Part B of the Schedule is carried on. The above prohibition does not apply to any workshop wherein any process is carried

on by the occupier with the aid of his family or to any school established by, or receiving assistance or recognition from, Government.

2.7.15 Public Liability Insurance Act, 1991

An Act to provide for public liability- insurance for the purpose of providing immediate relief to the persons affected by accident occurring while handling any hazardous substance and for matters connected therewith or incidental thereto.

2.8 INTERNATIONAL TREATIES

Indian Environmental and Social planning are also governed by the different International treaties and agreement signed and agreed by the Govt of India, which are broadly as follows:

TABLE 2.15: INTERNATIONAL AGREEMENT AND COMMITMENT TO ENVIRONMENTAL CONCERNS

Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat (2 February, 1971) as amended	Provides the intergovernmental framework for international co-operation for the conservation and wise use of wetland habitat and species.
Convention Concerning the Protection of the World Cultural and Natural Heritage (Paris, 12 November, 1972)	Protect cultural monuments and natural sites within their territory that are recognized to be of such outstanding universal value that safeguarding them concern humanity as a whole.
Convention on International Trade in Endangered Species in Wild Fauna and Flora (Washington, 3 March, 1973)	To ensure, through international co-operation, that the international trade in specimens of species of wild fauna and flora does not threaten the conservation status of the species concerned.
Bonn Convention on the Conservation of Migratory Species of Wild Animals (Bonn, 23 June, 1979)	To conserve migratory species by Parties restricting harvests, conserving habitat and controlling other adverse factors. Sustainable utilization is an implicit goal.
The International Tropical Timber Agreement (Geneva, 18 November, 1983)	To promote the management of tropical forests on a sustainable basis and to provide a framework for co-operation between production and consuming member states in the tropical timber industry.
International Undertaking on Plant Genetic Resources (Rome, 23 November, 1983) as supplemented	To ensure that plant genetic resources are preserved, particularly cultivated varieties of plants, plants or varieties which have been in cultivation in the past, primitive versions of cultivated plants, wild relatives of such plants and certain special genetic stocks and restrict destructive impact of development activities to conserve plant varieties which are threatened with extinction as a result of deforestation (especially in tropical areas) or changes in agricultural practices
Vienna Convention for the Protection of the Ozone Layer (Vienna, 22 March, 1988) and Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal, 16 September 1987)	To protect the ozone layer by taking precautionary measures to control equitably total global emissions of substances that deplete it, with the ultimate objective of their elimination on the basis of developments in scientific knowledge, taking into account

	technical and economic considerations and bearing in mind the developmental needs of developing countries.
Convention on Early Notification of a Nuclear Accident (hereafter Notification Convention), and Convention on Assistance in the Case of a Nuclear Accident or a Radiological Emergency (hereafter Assistance Convention), (Vienna, 26 September, 1986)	Provide information as early as possible in order to minimize the trans -boundary environmental, health and economic consequences of a nuclear accident.
The Convention concerning Protection against Hazards of Poisoning Arising from Benzene (ILO Convention 136, Geneva, 23 June, 1971) (hereafter, Benzene Convention, 1971);	It contains 13 substantive articles providing, inter-alia, that whenever harmless or less harmful substitute products are available, ratifying States should use such substitutes instead of benzene.
The International Convention on Civil Liability for Oil Pollution Damage, Brussels 1969 (CLC)	To apportion the liability of oil pollution on the owner of oil tanker.

Basic Rights of workers are governed by number of international conventions negotiated through the International Labour Organization (ILO) and the United Nations (UN), which are broadly as follows:

- ILO Convention 87 on Freedom of Association and Protection of Right to Organize
- ILO Convention 98 on the Right to Organize and Collective Bargaining
- ILO Convention 29 on Forced Labor
- ILO Convention 105 on the Abolition of Forced Labor
- ILO Convention 138 on Minimum Age (of Employment)
- ILO Convention 182 on the Worst Forms of Child Labor
- ILO Convention 100 on Equal Remuneration
- ILO Convention 111 on Discrimination (Employment and Occupation)
- United Nations Convention on the Rights of the Child, Article 32.1

2.9 NATIONAL AND LOCAL ENFORCEMENT AUTHORITIES

2.9.1 Ministry of Environment & Forests (MoEF), Govt. of India

The Ministry of Environment & Forests is the nodal agency in the administrative structure of the Central Government, for the planning, promotion, co-ordination and overseeing the implementation of environmental and forestry programmes. The Ministry is also the Nodal agency in the country for the United Nations Environment Programme (UNEP).

The principal activities undertaken by Ministry of Environment & Forests consist of conservation & survey of flora, fauna, forests and Wildlife, prevention & control of pollution, afforestation & regeneration of degraded areas and protection of environment, in the frame work of legislations.

The main tools utilized for this include surveys, impact assessment, control of pollution, regeneration programmes, support to organizations, research to solve solutions and training to augment the requisite manpower, collection and dissemination of environmental information and creation of environmental awareness among all sectors of the country's population.

The organizational structure of the Ministry covers number of Divisions, Directorate, Board, Subordinate Offices, Autonomous Institutions, and Public Sector Undertakings.

2.9.2 Central Pollution Control Board (CPCB) and State Pollution Control Board (SPCB)

The Central Pollution Control Board (CPCB) and State Pollution Control Boards (SPCB)/ Pollution Control Committees (PCC) are set up under the provisions of the Water (Prevention & Control of Pollution) Act, 1974. Their main functions under this Act are to promote cleanliness of streams and wells in the country.

In 1981, the Air (Prevention & Control of Pollution) Act was passed by Parliament. The new Act permitted the functions of the Act to be carried out by the SPCBs already constituted under the Water Act, 1974.

The CPCB is to coordinate activities of SPCBs/PCCs at national level, besides performing other functions as laid down in the Water and Air Acts.

In 1986, the Environment (Protection) Act was promulgated. This Act has wider coverage of several aspects of environment protection. The CPCB and the SPCBs/PCCs are expected to perform additional functions under this Act as well. Ordinarily, this would have called for a review of the performance of the CPCB and SPCBs/PCCs; and consequent to that, their reorganization to cope with the tasks to be performed in the wake of legislation promulgated from time to time.

After the Environment Protection Act in 1986 came the Hazardous Wastes (Handling and Management) Rules in 1989; the Manufacture, Storage, and Import of Hazardous Chemical Rules, 1989; the Public Liability Insurance Act, 1991; Rules for the Manufacture, Use, Import, Export and Storage of Hazardous Micro Organisms, Genetically Engineered Organisms or Cells; Rules governing Noise Pollution; Rules concerning Plastic Usage; the Biomedical Waste Rules; Rules relating to Municipal Solid Waste Management, etc.

Overall, CPCB and SPCBs/PCCs are essentially scientific/technical organizations having responsibilities for the prevention and control of pollution and related programmes in the country.

The overall responsibilities of CPCB, SPCB at National Level and Municipal Authorities, District Magistrate etc. at district level are summarized in **Table 2.16**.

TABLE 2.16: RESPONSIBILITY MATRIX OF THE COMPETENT AUTHORITIES

S No	Responsibilities	Responsible Agencies / Authorities
1.	• Ensuring that municipal solid wastes to be handled as per rules. • Seeking authorization from State Pollution Control Board (SPCB) for setting up waste processing and disposal facility including landfills. • Furnishing annual report.	**Municipal Authorities**
2.	• Overall responsibility for the enforcement of the provisions of the rules in the metropolitan cities. • Overall responsibility for the enforcement of the provisions of the rules within the territorial limits of their jurisdiction.	**State Government** **1. Secretary In-Charge of Department of Urban Development** **2. District Magistrates / Deputy Commissioner**
3.	• Monitor the compliance of the standards regarding ground water, ambient air leachate quality and the compost quality • Issuance of authorization to the municipal authority, stipulating compliance criteria and standards.	**State Pollution Control Board (SPCB)**

S No	Responsibilities	Responsible Agencies / Authorities
	• Prepare and submit to the CPCB an annual report with regard to the implementation of the rules.	
4.	• Co-ordinate with State Boards and Committees regarding implementation and review of standards and guidelines and compilation of monitoring data. • Prepare consolidated annual review report on management of municipal solid wastes for forwarding it to Central Government along with its recommendations. • Laying down standards on waste processing/ effluent disposal technologies including approval of technology.	**Central Pollution Control Board (CPCB)**

2.10 EHS (ENVIRONMENT, HEALTH & SAFETY) POLICY

Well-established Corporate Occupational Health and Safety measures will be applied and strictly implemented, and all National labor laws and applicable International Labour Organization conventions on workplace conditions will be followed . Regulations related to occupational Health and Safety management will be issued and strictly enforced. All personnel will receive training in Occupational Health and Safety practices. Safety drills will be carried out periodically. Safety manuals or handbooks will be prepared as required.

The safety manual to be used during the construction period is already in place. Environment Management System ISO 14001:2004 and occupational Health & Safety management system OHSAS 18001:2007 certification for the site already obtained.

The company believes that good Health, Safety and Environmental performance is an integral part of efficient and profitable business management and these matters rank equally in importance with other management responsibilities and that success in these areas depends in the involvement and commitment of everyone in the organization.

As a consequence to the Company's overall commitment to preserve Health, Safety, and a Sound Environment the company has a responsibility to:

- Provide and maintain healthy and safe working conditions, equipment and systems of work for all employees.
- Ensure the protection of the health and safety of people who may be affected by its operations e.g. contractors, visitors, customers and the general public.
- Prevent, or if that is not practicable, minimize and make safe releases to air, water and land of substances which could adversely affect human health or the environment.
- Reduce waste and source by careful use of materials, energy and other resources and maximize recycling opportunities.
- Set targets for improving health and safety at work and environmental protection, carry out regular assessments and report annually on performance.
- Ensure that each of its locations adopts policies and commitments which also describe the local organization and arrangements for putting them into practice.

The Company regards Health, Safety and Environmental matters as mainstream management responsibilities.

- Executive and the line managers at all levels within the company are directly responsible through the normal management structure for Health, Safety and Environmental matters in the operations under their control.
- All employees have a responsibility to take reasonable care of themselves and others while at work and to participate positively in the task of preserving workplace health and safety and a sound environment.

2.11 COMPLIANCE STATUS

Sasan Power Limited is complying to all the conditions as directed by MoEF in Environment Clearance. SPL will adhere to these conditions in future as well. The detailed compliance status of Environment Clearance is given in Table 2.17.

Project : Sasan Ultra Mega Power Project
MOEF Ref. : J-13011/15/2006-IA.II(T) dated Nov 23, 06 and
J – 13011/15/2006-IA-II(T) dated Jul 21, 09

TABLE 2.17: COMPLIANCE REPORT OF ENVIRONMENTAL CLEARANCE

S. No.	Stipulation	Compliance Status as of June 2010
I	All conditions stipulated by Madhya Pradesh Pollution control Board vide their letter no S688/TS/MPPCB/2006 dated July 6, 06 shall be strictly implemented.	Will be complied.
II	The proposed configuration of the project (5x800) could be changed provided that the total capacity of the power plant shall not exceed 4000 MW and that no individual unit shall be less than 500 MW.	Will be complied
III	The total land requirement shall not exceed 3723 acres for all the activities/facilities of the power project put together.	Land requirement for power project is 3341 acres as per the status given below. • Private Land: 1745 acres. Final award approved by GoMP for 1708 acres balance in under process. • Government Land: 803 acresOrder for possession issued by GoMP for 560 acres. Order awaited for balance • Forest Land: 793 acres – Final forest clearance obtained.
V	The land requirement which has been reduced from that proposed originally shall be reconciled at the stage of issue of notification for land acquisition under section 6.	The land acquisition is being carried out as per Sec 6 notification.
VI	R&R in sufficient detail shall be finalized before award of the project and a copy of the detailed R&R shall be submitted to MOEF within three months of issue of this letter or before award of the project.	R&R plan submitted to MOEF on Aug 8, 06 by PFC. R&R plan submitted by SPL to GoMP on Feb 16, 08 and R&R compensation package notified by District Collector vide public notice on Sep 9, 08 and same is being implemented.
VII	The PAPs losing their homesteads or a major	A R&R colony with all the basic

S. No.	Stipulation	Compliance Status as of June 2010
	portion of the land shall not be ousted from the land till they are settled in the alternate sites.	facilities like school, temple, hospital, market place, Panchayat bhavan etc has been constructed for persons affected by Land Acquisition. Project Affected Persons are being shifted to R&R Colony.
VIII	A Committee under the auspices of the district administration with representatives of the PAPs, local Panchayats and representatives of NGOs and the project proponent shall be constituted to monitor the implementation of the R&R plan.	R&R plan is being implemented by District Collector, supported by Sasan Power Limited and TERI.
IX	Ancient Shiva temple shall be outside the plant boundary and access to the temple shall be provided by project authorities	Complied.
IX	Ash and Sulphur of the coal to be used in the project shall not exceed 34% and 0.5 % respectively	Noted for compliance. Will be ensured during O & M Phase.
X	Two bi flue and one single flue stacks of 275 m height each shall be provided with continuous online monitoring equipments. Exit velocity of 25 m/sec shall be maintained	This condition amended vide MOEF's letter no. J – 13011/15/2006-IA-II (T) dated July 21, 09. "Two tri-flue stacks of 275 m height each shall be provided with continuous online monitoring equipments for SOx, NOx and Particulate matter. Exit velocity of flue gases shall not be less than 25 m/s. Mercury emissions from stack may also be monitored on quarterly basis." Amended condition will be complied.
XI	High efficiency electrostatic Precipitator (ESP) with efficiency not less than 99.9% shall be installed to ensure that the particulate emission does not exceed 50 mg/Nm3	Will be complied.
XII	Space provision shall be made for Flue Gas De-sulphuristion (FGD) unit, if required at a later stage.	Space provision has been kept in the layout for FGD, if required at a later stage.
XIII	Low NOx burners shall be provided	Will be complied.
XIV	Adequate dust extraction system such as bag filters and water spray system in dusty areas such as coal and ash handling areas, transfer areas and other vulnerable areas shall be provided.	Fugitive dust will be controlled by regular sprinkling of water in coal, ash handling and other vulnerable areas of the plant.
XV	Fly ash shall be collected in dry form only and ash generated shall be used in a phased manner as per provisions of the notification on fly ash utilization issued by Ministry in September, 1999 and its amendment. By end of 9th year full fly ash utilization should be ensured. Unutilized ash shall be disposed off in the ash pond in the form of High	Fly ash disposal / utilization plan submitted to DFO Singrauli as part of Stage I Forest Clearance compliance on Feb 26, 09. This condition amended by EAC vide minutes of 67th meeting held

S. No.	Stipulation	Compliance Status as of June 2010
	Concentration slurry.	on March 19-20, 2010 which states that ; "The Committee deliberated the matter in detail and felt that the justification provided by the project proponent demands merits as there is difficulty in the availability of pumps for conveying 38% Ash slurry. Accordingly the Committee agreed to the request of the project proponent to adopt medium slurry Concentration of 25-28% for Ash disposal." Amended stipulation will be compiled with
XVI	Ash pond shall be lined with LDPE lining. Adequate safety measures shall also be implemented to protect the ash pond bund from getting breached.	This condition amended by EAC vide minutes of 67th meeting held on March 19-20, 2010 which states that ; "The project proponent made a detailed presentation in support of their request that the lining of Ash pond is not required. However the Committee after detailed discussion decided that suitably well designed lining using LDPE/HDPE or anyother suitable impermeable material like puddle clay shall be provided." Amended stipulation will be compiled with
XVII	Rain water harvesting shall be practiced. A detailed scheme for rain water harvesting to recharge the ground water aquifer shall be prepared in consultation with Central Ground Water Authority/ State Ground Water Board and a copy of the same shall be submitted within three months to the Ministry.	The recommendations of the approved report of CGWB have been noted and shall be complied with.
XVIII	The treated effluents confirming to the prescribed standards shall be re-circulated and reused within the plant. There shall be no discharge outside the plant boundary	This condition is amended vide MOEF's letter no. J – 13011/15/2006-IA-II (T) dated July 21, 09, "Discharge of effluents from the power plant may be permitted with condition that the quality of effluents should be as per prescribed norms and should meet the water quality of the receiving body at discharge point and discharge quantity should not exceed 5% of the total consumption of water except in

S. No.	Stipulation	Compliance Status as of June 2010
		monsoon" Amended condition will be complied
XIX	Regular Monitoring of ground water in and around the ash pond area including heavy metals (Hg, Cr, As, Pb) shall be carried out, records maintained and six monthly reports shall be furnished to the Regional Office of this Ministry. The data so obtained should be compared with the baseline data so as to ensure that the groundwater quality is not adversely affected due to the project	Will be complied with
XX	A 200 m wide greenbelt will be developed on the western side of the plant area; total area under greenbelt in the plant site will be 474.14 acres which does not include greenbelt area in ash pond and town ship. In addition, a green belt of 50 m width will be developed all around the ash pond.	Noted for compliance.
XXI	First Aid and sanitation arrangements shall be made for drivers and other contract workers during construction phase.	First aid and sanitation arrangements are already provided
XXII	Noise levels emanating from turbines shall be so controlled such that the noise in the work zone shall be limited to 75 dBA. For people working in high noise area, requisite personal protective equipment like earplugs/ear muffs etc. shall be provided. Workers engaged in noisy areas such as turbine area, air compressors etc. shall be periodically examined to maintain audiometric record and for treatment for any hearing loss including shifting to non noisy/ less noisy area	Will be complied.
XXIII	Regular monitoring of the ambient air quality shall be carried out in and around the power plant and records maintained. The location of the monitoring stations and frequency of monitoring shall be decided in consultation with SPCB. Periodic reports shall be submitted to the regional office of this Ministry.	Regular monitoring of ambient air quality will be carried out in and around the power plant once the project commences commercial operation and records will be maintained. The monitoring stations and frequency of monitoring shall be decided in consultation with SPCB prior to commencement of commercial operation. Periodic reports shall be submitted to the Regional office of MOEF.
XXIV	The project proponent shall advertise in at least two local newspapers widely circulated in the region around the project, one of which shall be in the vernacular language of the locality concerned, informing that the project has been accorded environmental clearance and copies of clearance letters are available with the State Pollution Control Board/ Committee and may also be seen at Website of the Ministry of Environment and Forests at http://www.envfor.nic.in.	Complied. The notice has been published in the following newspapers. • Danik Bhaskar dt.13.12.2006 • Nav Bharat Times dt.13.12.2006

S. No.	Stipulation	Compliance Status as of June 2010
XXV	A separate environment monitoring cell with suitable qualified staff should be set up for implementation of the stipulated environmental safeguards.	Will be complied once the project in commercial operation.
XXVI	The project proponent shall also submit six monthly reports on the status of compliance of the stipulated EC conditions including results of monitored data (both in hard copies as well by e-mail) to the respective Regional Office of MOEF, the respective Zonal Office of CPCB and the SPCB	Will be complied.
XXVII	Regional Office of the Ministry of Environment and Forests located at Bhopal will monitor the implementation of the stipulated conditions. A complete set of documents including Environmental Impact Assessment Report and Environmental Management Plan along with the additional information submitted from time to time shall be forwarded to the Regional Office for their use during monitoring.	Complied.
XXVIII	Separate funds should be allocated for implementation of environmental protection measures along with item-wise break up. This cost should be included as part of the project cost. The funds earmarked for the environment protection measures should not be diverted for other purposes and year wise expenditure should be reported to this Ministry.	Will be complied.
XXIX	Full cooperation should be extended to the Scientists / Officers from the Ministry/Regional Office of the Ministry at Bhopal / the CPCB / the SPCB who would be monitoring the compliance of environmental status.	Will be Complied
Following are additional conditions as per MoEF's letter no. J – 13011/15/2006-IA-II (T) dated July 21, 09		
XXX	A sewage treatment plant shall be provided and the treated sewage shall be used for raising greenbelt/ plantation.	A centralized STP has been envisaged for SASAN UMPP and the influents received from various collection points are aerobically treated in the centralized STP, The finally treated Sewage has the following characteristics: BOD < 30mg/l COD< 250mg/l TSS<100mg/l Oil& Grease <10mg/l The above parameter meets the stipulated MOEF norms in all respects. The effluent is then transferred to Guard Pond for further reuse in Plant/ Gardening.

S. No.	Stipulation	Compliance Status as of June 2010
XXXI	Adequate safety measures shall be provided in the plant area to check/minimize spontaneous fires in coal yard, especially during summer season.	Will be complied during O & M Phase
XXXII	Storage facilities for auxiliary liquid fuel such as LDO and/ HFO/LSHS shall be made in the plant area in consultation with the Dept. of Explosives, Nagpur. Sulphur content in the liquid fuel will not exceed 0.5%. Disaster Management Plan shall be prepared to meet any eventuality in case of an accident taking place due to storage of oil.	Will be complied.
XXXIII	Adequate funds shall be allocated for undertaking CSR Activities	Will be complied. Facilities like Temple, School, Health Centre, Panchayat Bhavan and Market Place are in operation.
XXXIV	First aid and sanitation arrangements shall be made for the drivers and other contract workers during construction phase.	Being complied. First aid and sanitation arrangements are provided.
XXXV	Provision shall be made for the housing of construction labour within the site with all necessary infrastructure and facilities such as fuel for cooking, mobile toilets, mobile STP, safe drinking water, medical health care, crèche etc. The housing may be in the form of temporary structures to be removed after the completion of the project.	Two block of Labour colony has been completed with all necessary infrastructure and facilities.
XXXVI	A copy of the clearance letter shall be sent by the proponent to concerned Panchayat, Zila Parisad/ Municipal Corporation, urban local Body and the local NGO, if any, from whom suggestions/ representations, if any, were received while processing the proposal. The clearance letter shall also be put on the website of the Company by the proponent.	Copy of clearance sent to concerned Authorities. Other condition being complied.
XXXVII	The proponent shall upload the status of compliance of the stipulated EC conditions, including results of monitored data on their website and shall update the same periodically. It shall simultaneously be sent to the Regional office of MOEF, the respective Zonal office of CPCB and the SPCB. The criteria pollutant levels namely; SPM, RSPM, SO2 and NOX (ambient levels as well as stack emissions) shall be monitored and displayed at a convenient location near the main gate of the company in the public domain	Being complied.
XXXVIII	The environment statement for each financial year ending 31st March in Form – V as is mandated to be submitted by the project proponent to the concerned State Pollution Control Board as prescribed under the Environment (Protection) Rules, 1986 as amended subsequently, shall also be put on the website of the company along with the status of compliance of EC conditions and shall	Will be complied during O & M Phase

S. No.	Stipulation	Compliance Status as of June 2010
	also be sent to the respective Regional Offices of MOEF by e – mail.	
XXXIX	The project authorities shall inform the Regional Office as well as the Ministry regarding the date of financial closure and final approval of the project by the concerned authorities and the dates of start of land development work and commissioning of plant.	Financing agreements executed on Apr 21, 09.

Chapter 3

Project Description

CHAPTER 3. PROJECT DESCRIPTION

3.1 INTRODUCTION

The Sasan Ultra Mega Power Project has a capacity of 3960 MW. Generated electricity will be supplied to fourteen distribution companies in seven states namely Madhya Pradesh, Uttar Pradesh, Delhi, Rajasthan, Punjab, Haryana, Uttaranchal having a total population of about 35 Crores.

3.2 PROJECT LOCATION AND ACCESS

The proposed power plant site is located around 23°57'56" N latitude and 82°37'30" E longitude near Sasan village in Singrauli District of Madhya Pradesh. The site is well connected by a road from Waidhan town. National NH-75 is passing at a distance 10 Km from the project site. The nearest Railway Station (Shaktinagar) is located at about eighteen (18) km from the project site. The nearest airport is Varanasi, which is about 250 kms from the site. The location map of the project site is enclosed as **Figure 1.1**.

The present site was selected after considering two more possible sites available in the area. The Central Electricity Authority (CEA) had earlier carried out site selection for locating suitable pit-head thermal power plant in the region. The detailed comparative analysis of alternate site is given in Chapter 7 of this SEIA Report.

3.3 PROJECT CONFIGURATION

The 6x660 MW power plant will comprise of super critical boilers, steam turbines and hydrogen cooled generators. The condensate extraction and boiler feed water heaters with other essential equipment for single reheat regenerating system will be provided.

3.4 BASIC REQUIREMENTS

3.4.1 Land

The land requirement for Sasan UMPP is about 3341 acres, which includes main plant, ash disposal area, green belt, approach roads, water intake corridor and ash pipeline etc. The general layout of the proposed power project is shown in **Figure 3.1** and area break-up details are given in **Table 3.1**.

The main plant area comes in Sidhi Khurd and Sidhi Kalan villages which is about 2035 acres. Ash pond area, which is about 811 acres, will be located near to south-eastern side of main power plant in Harrhawa and Jhanjitola villages. Around 449 acres of land is required for the staff colony (Township) and will be constructed in Tiyara village. The land requirement for coal conveyor is 73 acres.

TABLE 3.1- AREA BREAK-UP DETAILS

Particulars	Area in Acres
Main Plant including Green Belt	2035
Township	449
Ash Disposal Area	811
Approach Road, Ash Pipeline and Raw water intake corridors	46
Total	**3341**

The land acquisition for the project is being pursued through Govt. of Madhya Pradesh (GoMP) as per the provisions of the Land Acquisition Act, 1896 and Approved Rehabilitation and Resettlement Policy designed for the project.

Chapter-3: Project Description

This Chapter describes the process and technology involved in power generation process of proposed plant. It also give the details of proposed infrastructure facilities and pollution control systems.

PAGE FOR LAYOUT
(To be inserted from another file)

GoMP has issued notification under Section 4 (i) on 18th August, 2006 for acquisition of land in 5 villages of District Singrauli for the power plant area, ash disposal area and township area. Further, GoMP has issued notification under Section 6 on 10th August, 2007 to confirm land requirement for the project. An agreement under Section 41 of LA Act has been entered into by SPL with GoMP on 11 July 2007 for private land. Final award under Section 11 for private land has been approved for all 5 villages (Includes Plant Area, Township & Ash Disposal) and mutation of 794 acres is completed in Plant area, Township and ash disposal. Mutation of Balance land is in progress. Possession obtained for 560 acres of Government Land in Plant Area, Township & Ash Disposal. Also, possession of 363 acres obtained in Forest Land.

Based on available revenue records and existing maps, a land ownership map was developed for the impacted area and details of the same are given in **Table 3.2**.

TABLE 3.2- LAND OWNER-SHIP STATUS

Use of Land	Private Land	Govt. Land	Forest Land	Total
Plant Area	932	310	793	2035
Township	174	275	-	449
Ash disposal	602	209	-	811
Road from colony to plant	25	9	-	34
Corridor Ash Pipe	3	0.25	-	3
Intake Water Pipeline	9		-	9
Total	1745	803	793	3341

Note: All values are in Acres

3.4.2 Fuel

Coal requirement envisaged for the proposed project is 14.99 million tonnes per annum. Coal for the Sasan project would be sourced from captive mines allocated to the project in Singrauli coal fields. Coal will be transported to site through conveyor system. The likely coal quality parameters is given in **Table 3.3**

TABLE 3.3- COAL ANALYSIS

Particulars	Parameters
Ash	27.54%
Total Moisture	9.0%
GCV (kcal/kg)	4445

Fuel oil system including Heavy Fuel Oil (HFO) and Light Diesel Oil (LDO) will be used for boiler start-up as well as for flame stabilization during low load operation. For the storage of HFO, three storage tanks each having 2500 KL capacity will be provided along with a dyke of 3 m height to prevent oil spillage in case of an accident. In addition, two LDO storage tank of 1250 KL capacity will also be provided. The analysis of HFO and LDO are given in **Table 3.4 & Table 3.5** respectively.

TABLE 3.4- HFO ANALYSIS DATA

Parameter	Unit	Value
Acidity, Inorganic	-	Nil
Ash	% by mass, (Max)	0.1
Pour Point	^{o}C	6 (winter) – 18 (summer)
Flash Point (A bel)	^{o}C (Min)	66
Sediments	% by mass. (Max.)	0.25
Sulphur	Total % by mass, (Max.)	4.5
Water content	% by volume, (Max)	1.0

Water content	% by volume, (Max)	1.0

TABLE 3.5- LDO ANALYSIS DATA

Parameter	Unit	Value
Acidity, Inorganic	-	Nil
Ash	% by mass, (Max)	0.02
Pour Point	^{o}C	12 (winter) – 21 (summer)
Flash Point (A bel)	^{o}C (Min)	66
Sediments	% by mass. (Max.)	0.10
Water content	% by volume, (Max)	0.25

3.4.3 Water

The source of water for the project is Govind Ballabh Pant Sagar reservoir at a distance of about 25 km from the plant site. The reservoir's capacity is adequate for meeting the water requirement even during lean season. Water Resources Department of Madhya Pradesh Government & Central Water Commission (CWC) of GOI has allocated 0.109 MAF (~150 cusecs) of water from the reservoir**.**

Total Make-up water requirement for this project would be about 15000m^3/hr. The water balance for the project is enclosed as **Figure 3.2a** and in the **Table 3.6.**

TABLE 3.6- COMPONENT-WISE WATER REQUIREMENT

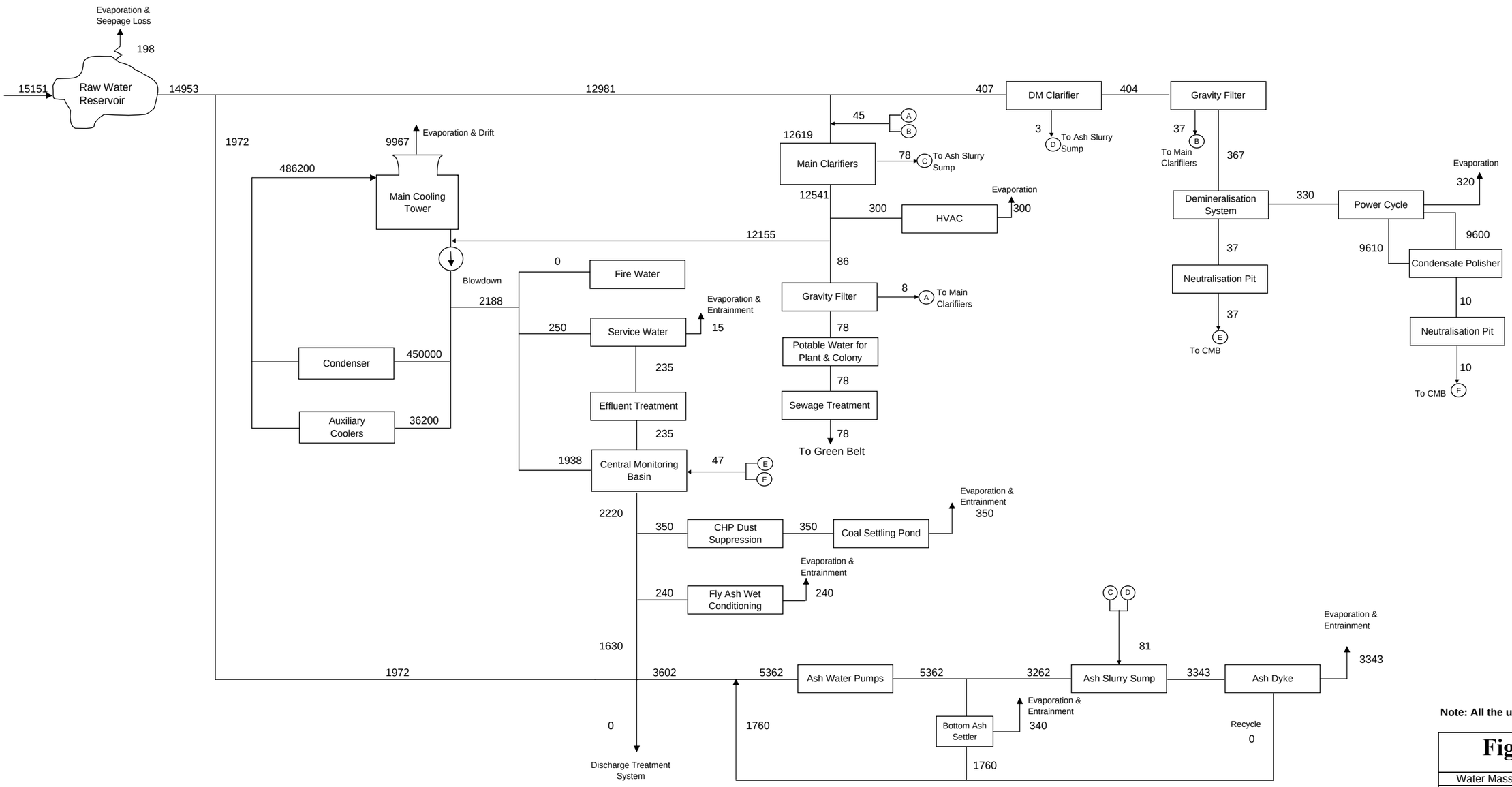
Component	Water Requirement (cum/hr)
Filtered Water Requirement (367+78=445)	
DM Water Requirement	
Make-up water in power cycle	308
Auxiliary cooling water make-up	10
H2 Plant make-up	2
Condensate polishing unit	10
Neutralization Waste	37
Total Feed to DM plant	367
Plant potable water needs	78
Clarified Water Requirement (12734)	
Cooling tower make-up	12155
Air Conditioning and ventilation	300
Miscellaneous including Sludge & Seepage losses	279
Service water, CHP dust suppression and Green belt	From Blow down water
Raw Water requirement (1972)	
Ash handling plant Makeup	1972
Total (445+12734+1972)	**15151 (Say 15000)**

SPL will make efforts to conserve water by applying principles of "Reduce, Reuse and Recycle" during operation phase. With ash water recycling and optimization efforts, the envisaged water balance diagram would be as shown in **Figure 3.2b**.

3.4.4 Project Cost

The total indicative cost of the project including coal mines & cost of pollution control equipment is about INR 20,000 Crores.

Water Balance for 6 X 660 MW Sasan Ultra Mega Power Project



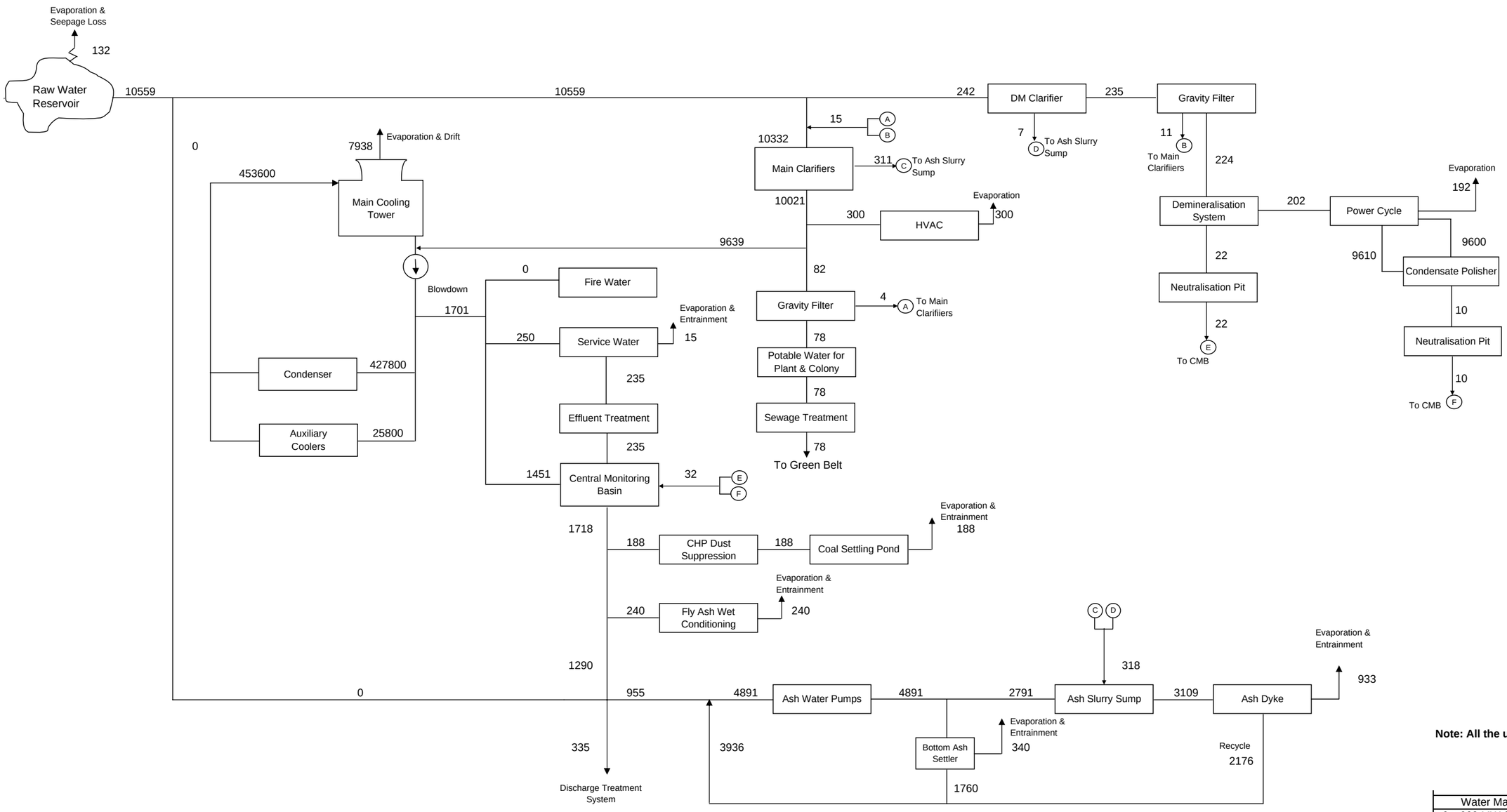
Note: All the units are in m3/h

Figure 3.2a

Water Mass Balance (With out Recycle)			
6 x 660 MW Sasan Ultra Mega Power Project			
JP		PP	VG
Drawn	Checked	Reviewed	Approved
Drawing No:REL-SUMPP-NEM-116-I-001-R 2			

Water Balance for 6 X 660 MW Sasan Ultra Mega Power Project

Figure 3.2b



Note: All the units are in m3/h

Water Mass Balance (With Recycle)			
6 x 660 MW Sasan Ultra Mega Power Project			
JP		PP	VG
Drawn	Checked	Reviewed	Approved
Drawing No:REL-SUMPP-NEM-116-I-002-R 2			

3.5 PLANT WATER SYSTEM

3.5.1 Make-up Water System

The raw water shall be drawn from the intake location & pumped to the raw water storage reservoir located inside the plant.

3.5.2 Circulating Water System

For the re-circulating type CW system, it is proposed to supply clarified water as make-up. The clarified water shall be pumped by clarified water make up pumps from the water pre-treatment plant to the cold water channel. Water from cold water channel will enter the CW pump house through bar screens/trash racks at low velocity to filter out debris. Stop log Gates shall be provided after the screens to facilitate maintenance.

The total water requirement for the condenser is estimated to be about 75000 m^3/hr per unit. Based on Environment Clearance as per MoEF, it is proposed to adopt COC of 5 in CW system. To avoid scaling necessary treatment shall be provided.

3.5.3 Auxiliary Cooling Water System

It is proposed to combine the ACW system with CW System, to cater to water requirement of 6x660 MW units and station auxiliaries. The Auxiliary cooling water pumps, located at TG building shall take tap off from CW supply headers before the condenser and the return water from the circuit would be led to the Cooling towers through the CW return header.

3.5.4 Equipment Cooling Water (ECW) System

Closed circuit cooling water system would be adopted for unit auxiliaries of steam generator and turbine generator. DM water would be used in primary cooling water circuit for cooling of various auxiliaries which in turn shall be cooled in a secondary circuit by auxiliary cooling water through a set of plate type heat exchangers. The secondary circuit cooling water would be tapped from the ACW pump discharge header and the return water from the circuit would be led to ACW return header. It is proposed to have common Plate heat exchangers for TG & SG auxiliaries.

3.5.5 Chemical Dosing System

Chorine dosing system is envisaged, to prevent/minimize growth of algae and to maintain alkalinity level respectively in the CW system.

3.5.6 Fire Fighting System

The fire fighting system will be designed by incorporating the recommendations of the **TAC (INDIA)/IS: 3034 & NFPA- 850.** The fire fighting system will consist of hydrant system, high velocity water spray system and Automatic deluge (medium velocity water spray) system covering all area of the plant.

The following protection systems are envisaged:

- Hydrant system for complete power plant covering main plant building, boiler area, turbine and its auxiliaries, coal handling plant, all pump houses and miscellaneous buildings of the plant. The system shall be complete with piping, valves, instrumentation, hoses, nozzles, hose boxes/stations etc.
- Automatic Foam injection system for fuel oil / storage tanks consisting of foam concentrate tanks, foam pumps, in-line inductors, valves, piping & instrumentation etc.
- Automatic high velocity water spray system for all transformers located in transformer yard and those of rating 10MVA and above located within the boundary

limits of plant, main and unit turbine oil tanks and purifier, turbine oil/lube oil piping (zoned) in turbine area, generator seal oil system, lube oil system for turbine driven boiler feed pumps, boiler burner fronts etc. This system shall consist of QB detectors, deluge valves, valves, piping & instrumentation.

- Automatic medium velocity water spray system for cable vaults and cable galleries of main plant, switchyard control room and ESP control room consisting of smoke detectors, linear heat sensing cable detectors, deluge valves, isolation valves, piping, instrumentation, etc.
- Automatic medium velocity water spray system for coal conveyors, coal galleries, transfer points consisting of QB detectors, linear heat sensing cables, deluge valves, nozzles, piping, instrumentation, etc.
- Automatic medium velocity water spray system for un-insulated fuel oil tanks storing fuel oil having flash point 65^{o} C and below consisting of QB detectors, deluge valves, nozzles, piping, instrumentation, etc.
- For protection of central control room, equipment room, computer room and UPS using Inert Gas extinguishing system as per NFPA-2001 would be opted.
- Fire detection and alarm system - A computerized analogue, addressable type Fire detection and Alarm system shall be provided to cover the complete power plant. Following types of fire detection shall be employed.
  - Multi-sensor type smoke detection system.
  - Photo electric type smoke detection system.
  - Combination of both multi-sensor type and photo electric type smoke detection systems.
  - Linear heat sensing cable detector for coal conveyors and cable galleries.
  - Quartzoid bulb heat detection system for coal conveyors, transformers, oil facilities etc.
  - Infra red type heat detectors (for selected coal conveyors).
  - Probe type detectors for fuel oil tanks.
- Portable and mobile fire extinguishers, such as pressurized water type, carbon-dioxide type, foam type, dry chemical powder type, will be located at strategic locations throughout the plant.
- Required Fire Tenders/Engines of water type, DCP type/Foam type, trailer pump with fire jeep etc shall be provided in the fire station.
- Fire water storage tanks and fire water pumps would be provided. Capacity of storage tanks and pumps shall be based on TAC requirement. Required booster pumps for Hydrant and Spray System shall be provided wherever required.
- For the above fire water pumping station, automatic pressurization system consisting of jockey pumps shall be provided.
- Complete Instrumentation and Control System for the entire fire detection and protection system shall be provided for safe operation of the complete system.

3.6 WASTE WATER TREATMENT AND DISPOSAL SYSTEM

3.6.1 WASTE WATER

Wastewater is any water that is contaminated by anthropogenic / industrial processes with solids, temperature, chemicals and other impurities.

The various sources of waste water from a power plant include:

- Oily waste water (Power house/Fuel oil unloading /Transformer yard area)
- Cooling Tower Blow Down
- ESP area wastewater
- DM plant regeneration waste (neutralized)
- Pre treatment Clarifier sludge
- Condensate polishing unit neutralized effluent
- CHP Dust Suppression effluent and Coal pile area run off
- Ash Silo area effluent
- Sewage water

3.6.2 PLANT EFFLUENT & DOMESTIC SEWAGE CHARACTERISTICS

The characteristics of Plant effluent and domestic sewage are given in **Table 3.7 & 3.8** respectively.

TABLE 3.7- PLANT EFFLUENT CHARACTERISTICS

Source	Characteristics
Cooling water	Marginal increase in temperature and dissolved solids
Service wastewater	High concentration of suspended solids, dissolved solids, oil and grease
Boiler blow-down	High quality water with slight increase in Fe, Cu; variation in Ph
Demineraliser regeneration and pre treatment plant waste	Wide variation in pH prior to neutralization. Dissolved solids will be around 7-8 times of input concentration
Plant Domestic Waste and Sanitary Waste	pH : 6.5-8.0; BOD : <300 mg/l; SS : < 350 mg/l
Colony Domestic Waste & Sanitary Waste	pH : 6.5-8.0; BOD : <300 mg/l; SS : < 350 mg/l

TABLE 3.8- DOMESTIC SEWAGE CHARACTERISTICS

Parameters	Unit	Characteristics	
		Raw Sewage	Treated Sewage
BOD	mg/l	300	100
Suspended Solids	mg/l	350	200
pH	-	6.5 – 8.0	6.5 - 8.0

3.6.3 WASTE WATER TREATMENT CONSIDERATIONS

Waste Water Treatment is the process of removing contaminants from wastewater. It includes physical, chemical, and biological processes to remove the contaminants. Effluent Treatment Plants treat the waste waters to reduce the potential for pollution. Effective effluent management and control helps in

- Reduction of operating costs
- Compliance with legislation.
- Uphold company's public image.

3.6.4 WASTE WATER TREATMENT METHODS

- Suspended Solids, small solid particles which remain in suspension in water as a colloid or due to the motion of the water, are removed by
  - Micro straining
  - Coagulation and flocculation
  - Filtration
- Dissolved solids, both organic and inorganic are purified by
  - Ion exchange
  - Reverse osmosis
  - Electro dialysis
  - Removal of nitrogen
- Phosphate removal can be done by
  - Chemical treatment (adding lime- Ca(OH)2 & alum- Al2(SO4)3)
  - Biological treatment(by aeration)
- Removal of dissolved organic compounds
  - Adsorption (Activated carbon filter)
  - Sludge treatment and disposal (gravity settling and floatation)
  - Disinfection (Chlorination)

3.6.5 SASAN WASTE WATER TREATMENT FACILITIES

- **Oily Waste Water**
  - **Fuel Oil unloading area & pump house building**

    Oily waste from FO / LDO Unloading area & pump house building is transferred to fuel oil area waste retention pit and pumped to OWS (Oil Water Separator). Separated oil from OWS goes to slop oil tank and clear water from OWS is pumped to ASPH (Ash Slurry pump house
  - **Power House Area**

    ESP pre settling pits having oil skimming arrangement (belt type oil skimmer) and from there this waste along with the ESP floor washing/rainfall runoff are pumped to flocculation tanks (having oil skimming arrangement) and inclined surface settlers for further treatment. Finally the treated effluent is pumped to guard pond.
  - **Transformer yard area**

    Transformer yard oily waste in the event of fire and bursting of transformer causing loss of containment of transformer oil, spilled oil is collected in common oil pit(s) for a cluster of transformers. Residual oil and water mixture (after emergency) and oily effluents that may get accumulated over a long period encompassing rainwater and leakage oil (under normal condition) is disposed through the OWS (oil water separator) in controlled manner.
  - For this, two (2) portable electric (dewatering) pumps are provided under the ETP package. Common transformer oil pits are kept empty at all the times by pumping out collected rain water.

- **Mill Reject System Quenching**

Effluent is transferred to nearby surface drain and finally led to ESP pre-settling pit for further treatment.

- **DM plant regeneration Waste**

Acid / alkali is dosed in the neutralization pit for pH correction of the regeneration waste and sent to the Guard Pond. Since the effluent is to be received in several batches so pumps of desired capacity and head is provided to transfer neutralization waste from the pit to the Guard Pond.

- **Condensate Polishing Unit Regeneration Waste & condensate drains from Boiler Area**

Acid / alkali dosed in the CPU Neutralization Pit for pH correction of the regeneration waste sent to the Guard Pond. Since the effluent is to be received in several batches, so Pumps at desired capacity and head is provided to transfer neutralized waste from the pit to the Guard Pond.

- **Water Pre-Treatment Sludge treatment**

The sludge generated from WPT clarifiers is collected in Common Sludge Sump. All these wastes are basically rich in suspended solid content. From Clarifiers Sludge Sump and Common Sludge Sump, sludge is pumped to Ash Slurry pump sump from where it is transported to the ash pond. It is to be noted that Clarifier sludge sump, Sludge Disposal Pump is under Water Pre-Treatment Plant Package.

- **ESP and Boiler Area waste water treatment**

Wastewater in ESP Area, TG/ Boiler area, Transformer yard leakage/spilled washing waste is generated due to various equipment drains & service water wastes. The effluent is pumped to a Pre-Settling pit (in twin compartment) having common sump. Effluent transfer Pumps are installed to transfer this effluent for further treatment in flocculation tanks and inclined surface settlers. Oil skimmer arrangement is provided in the pre-settling pit to remove the oily waste from power house area and transformer yard. Finally the treated effluent is transferred to Guard Pond.

- **CHP dust suppression effluent and Coal pile area run off**

During dry period of the year dust suppression (DS) system in coal handling plant(in Coal Pile Area and Coal Conveyer building) by way of sprinkling of water (with recovered water from Twin Settling pond and is also have a provision of suppression with guard pond water) is provided. To ensure effective dust suppression some excess DS water is provided in the design. Some portion of the DS water is absorbed in crushed coal, some are percolated to the ground and some evaporated. The remaining part comes as runoff. This naturally needs treatment i.e. suspended coal particles removed before discharge. During monsoon rainfall runoff from the open coal stockpile is considered effluent, as this carries suspended coal particles. The wastewater is pumped through a settling pond and the supernatant is pumped back for the CHP dust suppression.

- **Air pre-heater wash and fire fighting wastewater**

This is an irregular wastewater stream. This wastewater is generated only in case of a rare special maintenance phase and it is diverted to nearby surface flow drain leading to ESP Pre-settling pit for further treatment.

- **Cooling tower Blow down**

Cooling Tower Blow Down is done to maintain the level of dissolved solids in the Circulating Cooling Water. This effluent contains dissolved solids and chemicals / biocides used for prevention of scale formation / corrosion / bio fouling.

- **Guard Pond / Central Monitoring Basin (CMB)**

A Guard Pond has been conceived to act as an equalization basin for all treated and untreated effluents. It is estimated that up to 2500 m3/hr (in peak flow condition) of

effluent flows to the Guard Pond. The Guard Pond has a capacity of 5000 m3 catering for around 2 hours of detention period in twin compartments with one hour detention period of each compartment. Provision is kept for PH correction in Guard Pond. From Guard Pond water is pumped by means of Three (3) nos. Guard Pond Transfer Pumps. One (1) no. to be under operation and One (1) no. as standby and One (1) no. as maintenance standby. The pumps meet the requirement of water for CHP dust suppression, fly ash silo and ash water pump house.

3.7 COAL HANDLING SYSTEM

The capacity of the CHP has been worked out to meet the peak daily coal requirement of six units of 660 MW. The overall operating hours of the coal handling plant expected around 14 hours spread over two shifts per day leaving third shift exclusively for routine inspection and maintenance.

The coal handling plant shall be of three stages, each stage shall be of about 2000 TPH rated capacity belt conveyors along with facilities for receiving, unloading, crushing and conveying the crushed coal to boiler bunkers and stacking/reclaiming the coal to/from crushed coal stockyards.

When coal bunkers of the units will be full, crushed coal from crusher house will be transported to the crushed coal storage yard by stacker/reclaimer together with reversible yard conveyors. The coal bunkers (above the pulverizer / feeders) for each unit will have aggregate 12-16 hours storage capacity.

Rail mounted, travelling stacker-reclaimers, bucket wheel type are proposed for coal stockyard management. Coal stockyards proposed shall have crushed coal storage equivalent to 15 days coal consumption.

Dust suppression and service water system shall be provided throughout the coal handling plant. A centralized main CHP control room (PLC based) shall be provided to control and monitor the operations of the entire coal handling system.

3.8 ASH HANDLING SYSTEM

The ash handling system of each unit will be designed to meet the following requirements.

3.8.1 Bottom Ash Handling System

Each unit shall be provided with refractory lined, water impounded steel- fabricated bottom ash hopper having a hold up volume to store bottom ash generated preferably for a period of eight (8) hours.

BA hopper shall have multiple V sections. Under each V-Section, there shall be outlets fitted with a feed gate, clinker grinder, feed sump, jet pump and a set of piping and valves designed for removal of the ash in slurry form to the common slurry sump through pipes.

3.8.2 Coarse Ash Handling System

From economizer hoppers of each unit, coarse ash will flow with the help of flushing apparatus to respective unit bottom ash hopper through adequately sized sloping pipe duly assisted by jets (nozzles) placed at strategic locations for easy slurry flow. From air heater hoppers of each unit, coarse ash will flow with the help of feeder ejector to respective unit coarse ash tank through adequately sized sloping pipe duly assisted by jets (nozzles) placed at strategic locations and on the tank for easy slurry flow. The coarse ash slurry will be transported to the common slurry sump through ejector pumps installed for the purpose.

3.8.3 Fly Ash Handling System

Fly ash shall be collected in Electrostatic Precipitator (ESP). Accumulation in stack hopper will be only traces and not being considered for ash handling system design. Ash from all the ESP hoppers will be transported pneumatically under vacuum to Intermediate surge hopper (ISH)/ Combination Filter separator cum buffer Hoppers provided for each unit. The feeding of fly ash from filter separator/ISH to pressure conveying stream shall be made through air lock vessels which will be provided with 100% standby units.

There will be a wet disposal system wherein ash from the hopper can be fully diverted to the Wetting unit and then to the air separator/ collector tank for each unit. In the wetting unit slurry will be formed under the injection of HP water and from the separator, air will be suitably vented out and slurry will be drained. It is further to clarify that either the Silo Bye -Pass (Wet) mode will be operated or Dry mode system up to Storage Silo shall be operated.

3.8.4 Ash Disposal System

The ash will be utilized as per MoEF guidelines and any unutilized ash will be disposed off in ash dyke. The fly ash handling system capacity will be about 790 T for 90% of total ash. This ash will be disposed in 6 hours for the ash collected in 8 hours. However, the system will operate continuously.

3.8.5 Ash Disposal Water System

The water required for ash disposal will be tapped from cooling towers blow down and routed to the ash water slump. The pumps required for ash disposal viz. HP water pumps, LP water pumps, refractory cooling water pumps, seal water pump etc. will be provided. At least 50% capacity of pumps will be standby.

3.9 TOWNSHIP WORKS

About 1600 nos. dwelling units are proposed to be constructed for the project. Permanent Township for the project would be set up over 449 acres.

The details of the residential and non-residential facilities proposed to be created are as follows:

Residential Buildings

Type 'A'	6 nos.
Type 'B'	45 nos.
Type 'C'	176 nos.
Type 'D'	174 nos
Type 'E'	342 nos.
Type 'F'	696 nos.
Hostel	120 Rooms & 24 Studio apartments
Guest House	30 Deluxe Rooms & 10 Deluxe suites
Total	**1623**

Non-Residential Buildings

School, shopping complex, Bank, hospital (30 beds), post office, Store, Restaurant, Super Market, Multi purpose Rooms, Library, Cafeteria, etc. will also be provided in the Township.

3.10 POWER EVACUATION

As per the Power Purchase Agreement signed by Sasan Power Ltd with the Procurers, the Procurers are responsible for evacuating power from the project. The Procurers have signed an agreement with Power Grid Corporation of India Ltd (PGCIL) for setting up the transmission network for Sasan UMPP.

Power evacuation from sasan umpp is planned at 765 kv and 400 kv level. The power generated will be stepped up to 765 kv through suitably rated generator transformer.

Power is evacuated through: There are 3 single circuit lines at 765 kv level:

- 2 single circuit lines of 765/400 kv to the PGCL substation at Satna .
- One single circuit DC line to vindhyachal pooling station of PGCIL

Transmission system consists of

- ACSR Bersimis conductor for these 765 kV transmission lines.
- 765 kV and 400 kV levels is done through ICTs(1000 MVA 765/400 kV).
- For meeting the requirements of 132 kV transmission lines to coal mine and 33 kV transmission lines for water intake system2 nos of 400/132/33kV transformers are provided.

3.11 WATER INTAKE SYSTEM

Central Water Commission, Irrigation Planning (N) Directorate, vide letter no. 9/2/11/2005/IP (N)/ 560 dated 27.07.2006, has granted water allocation of 0.109 MAF (i.e. ~ 15,000 m^3/hr) for Sasan UMPP. Approval of Water Resource Department has also been obtained. Govind Ballabh Pant Sagar Reservoir (Rihand reservoir) has been identified as the source of water for Sasan UMPP.

Raw water shall be drawn from an intake location at southwest of the Rihand reservoir to a RCC canal of raw water pump house located on shore through underground pipeline. The water will be pumped to the raw water storage reservoir inside the power plant area, located at a distance of about 25 Km from the intake pump house site. Maximum quantity of water to be drawn for the power plant would be 15,000 m^3/hr. The pipeline will be routed on the north of Rihand reservoir crossing the Mayar River to the plant.

3.12 OVER LAND COAL CONVEYOR

For this project Coal is linked from Moher and Moher Amlori extension captive coal mines that lie to the north of the Power Plant site at a distance of 20 kms. For transportation of the coal from mines to the power plant, a single flight overland coal conveyor is proposed. Since it is a single flight conveyor from mines to the power plan, there are no transfer points along the route of conveyor.

Because of no transfer point in between the conveyor, there shall not be any dust generation and spillage. All the gantries shall have continuous roof and side sheeting and the floor will be totally covered, preventing possible spillage on to the ground.

The coal corridor is 50 m wide and 20 km long, from mines to the power plant , passing through Amhlori, Nougarh, Dhatura Barwa, Bilounji Bhatwa, Pachore, Hirwah, Kam, Gadharkhurd and Sidhikurd villages.

The alignment of the Overland coal conveyor passes through the submergence land in between Hirwah, Kam and Gadahara Khurd villages for a distance of approx 3.5 kms and crosses Mayar River at Kam village. For crossing over the river and water spread

areas, required clearances shall be ensured for the structures at top and both the edges corresponding to maximum flood level and water spread.

Chapter 4

Baseline Environment Status

CHAPTER 4. BASELINE STATUS

A. BASELINE ENVIRONMENT STATUS

4.1 LOCATION OF THE PROJECT

The project area is located near the villages Sasan, Sidhi-Kalan, Sidhi Khurd, Harrhawa, Tiyara and Jhanjhi-tola in Singrauli Tehsil of Sidhi District of Madhya Pradesh. GBPS/Rihand reservoir is situated to the North East of the project area. The site is located North of NH-75 and is approachable from Rihand through 6 Km long single lane village road. Nearest major town Waidhan is at a distance of about 12 Km. Nearest rail head is Shakti Nagar Railway Station (18Kms).

Sasan Ultra Mega Power Project site is about 250 km from Varanasi Airport in Uttar Pradesh State. The project site is remote from sensitive spots as national parks; wildlife sanctuaries; biosphere reserves; historical and cultural sites; defense installations; and places of historical, religious, or cultural importance. The surrounding areas within a 10 km radius have several rural communities. No significant vegetation or wildlife is disturbed due to the project, though it involves acquisition of degraded forest. There is no protected area within 25 km radius of the project site.

4.2 BACK GROUND OF THE STUDY

In order to predict anticipated environment impact of any project, it is necessary to obtain information of the existing conditions. The assessment of baseline environment and the anticipated impacts are the basis for preparation of the environmental management plan. Base line data was collected for various environmental parameters including air, water, land, flora-fauna and socio-economic status to determine quality of the prevailing environmental settings. The baseline study was conducted by Desein Private Limited, Consulting Engineer for one year from March 2006 to February 2007.

4.3 METHODS AND TECHNIQUES ADOPTED

For collecting the base-line data during the study period, a field office was established at Waidhan town. For sampling and collection of soil and water, monitoring of air quality and noise level and other field data. The baseline environmental quality of the study area of 10 km radius from the proposed project was identified through network method. Also 25 km radius around the project site was covered for general area of study.

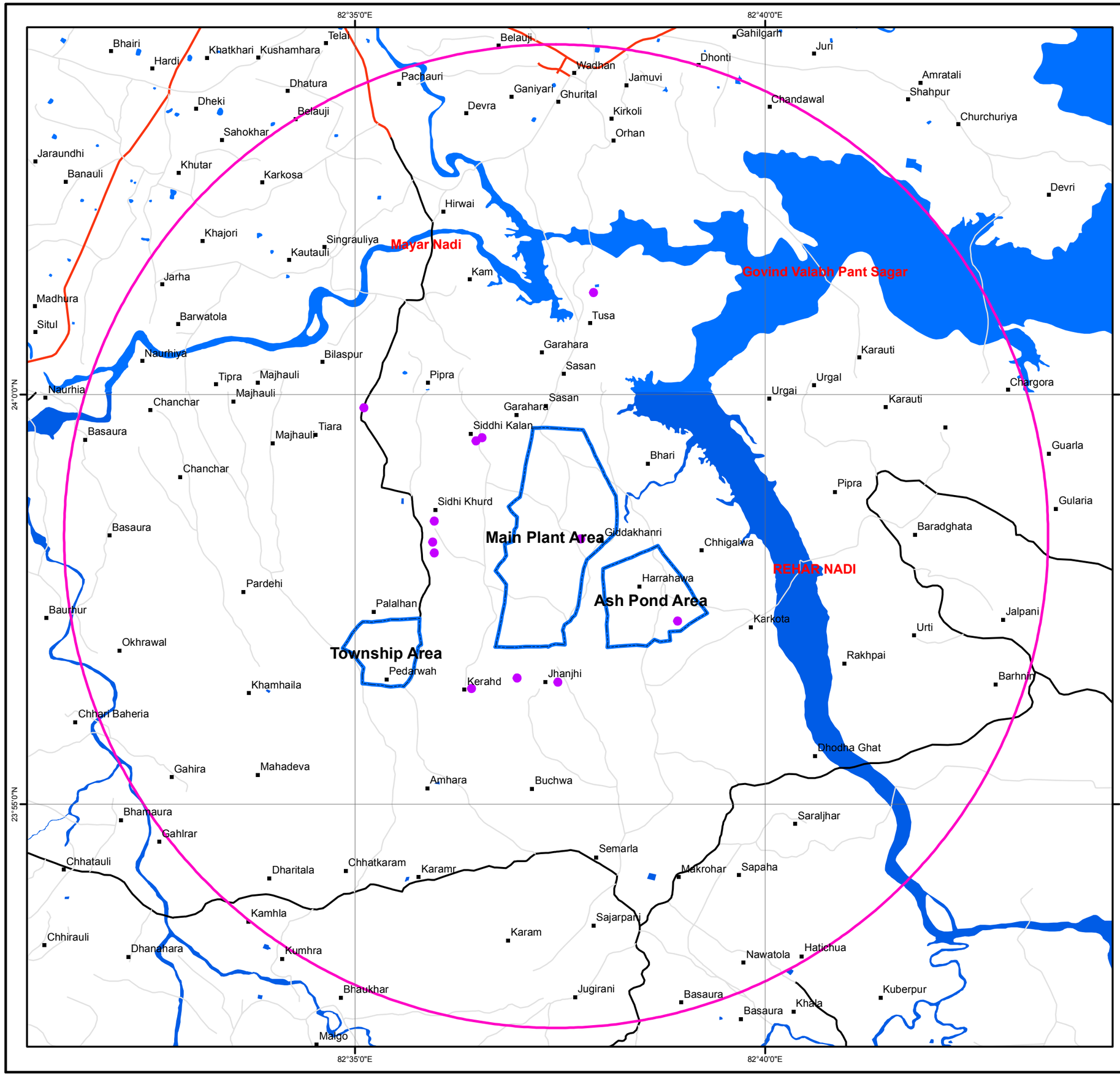
The monitoring locations and the description of monitoring techniques for collection baseline data collected is given in the sections below.

4.3.1 Soil

The various soils existing in the area were identified through reconnaissance survey and samples were collected on the basis of type of soil, existing land-use pattern and proposed plant layout including ash pond location. The samples were collected from 12 different locations, the details of which are given in **Table 4.1**. The locations of the soil samples are also shown in **Figure 4.1**.

Random soil samples were collected by 'Auger' up to depth of 15 cm and homogenized. The homogenized samples were then packed in polythene bags and sealed with proper remarks. The sealed samples were then sent to the laboratory for physico-chemical analysis.

SOIL SAMPLING LOCATION AROUND SUMPP



Legend

- Soil Sampling Location
- 10 Km Buffer From Plant
- Project Boundary

Base Layers

- Settlement
- Metalled Road
- Unmetalled Road
- Others
- Rail Network
- Waterbody

Fig 4.1

TABLE 4.1- SOIL SAMPLING LOCATIONS

Location	Location Code	Direction	Distance (km)	Land Type
Sidhi Kalan	S1	N	4	Agricultural Land
Tiyara	S2	WNW	2.5	Waste Land
Mohanban	S3	WNW	1	Reserve Forest
Jhanjhi Tola	S4	N	1	Semi Agricultural Land
Sidhi Kalan	S5	ENE	1.5	Forest Land
Sidhi Khurd	S6	S	0.5	Semi Agricultural Land
Gidhakhadi	S7	E	0.5	Agricultural Land
Harrahawa	S8	E	2	Waste Land
Karkotta	S9	ESE	3	Semi Agricultural Land
Sidhi Khurd	S10	ESE	6	Forest Land
Sidhi Khurd	S11	SSE	4	Waste Land
Tusa	S12	SW	6	Agricultural Land

0 1.5 3 6 Km

EPC-GIS, Noida
Dt:10 June 2010

TABLE 4.1- SOIL SAMPLING LOCATIONS

Location	Location Code	Distance (km)	Direction	Land Type
Sidhi Kalan	S1	4.0	N	Agricultural Land
Tiyara	S2	2.5	WNW	Waste Land
Mohanban	S3	1.0	WNW	Reserve Forest
Jhanjhi Tola	S4	1.0	N	Semi Agricultural Land
Sidhi Kalan	S5	1.5	ENE	Forest Land
Sidhi Khurd	S6	0.5	S	Semi Agricultural Land
Gidhakhadi	S7	0.5	E	Agricultural Land
Harrahawa	S8	2.0	E	Waste Land- Ash Pond
Karkotta	S9	3.0	ESE	Semi Agricultural Land
Sidhi Khurd	S10	6.0	ESE	Forest Land
Sidhi Khurd	S11	4.0	SSE	Waste Land
Tusa	S12	6.0	SW	Agricultural Land

4.3.2 Micro-meteorological Station

Onsite micro-meteorological data was generated by using an automatic weather station with sensors installed at 10 m heights. The station was set up on the rooftop of a house in Sasan village. The period for observation was from the summer of 2006 to winter of 2006-07. Wind speed, wind direction, dry and wet bulb temperature, relative humidity and general weather conditions were recorded throughout the study period in the automated data logger.

4.3.3 Ambient Air Quality

In order to assess the Ambient Air Quality (AAQ), samples were collected by installation of High Volume Sampler (with RSPM facility) at six different locations in study area. They were analyzed for primary air pollutants to work out the existing status of air quality.

Ambient Air Quality Monitoring (AAQM) Stations were selected based on the criteria used for designing the network. The location (relative direction and distance) of these stations with respect to the project site are given in **Figure 4.2** and details of the stations are described in **Table 4.2.**

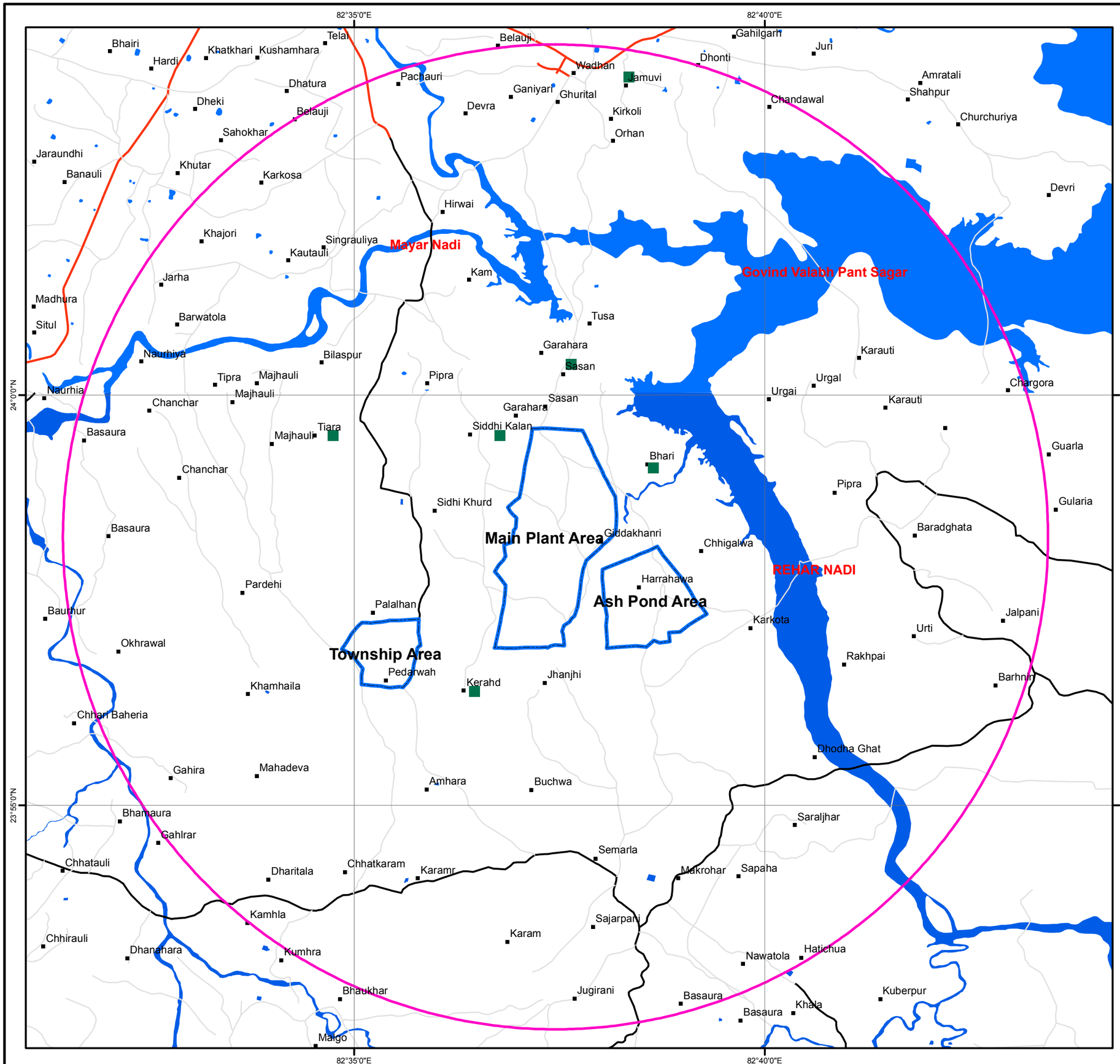
TABLE 4.2- AMBIENT AIR QUALITY MONITORING LOCATION

Location	Location Code	Direction	Distance (km)	Land-use Category
Near Site (Sidhi Kalan)	AQ1	W	1.0	Rural
Waidhan	AQ2	N	9.5	Urban
Sasan	AQ3	N	3.0	Rural
Tiyara	AQ4	NW	5.0	Rural
Bhari (Near Harrhawa)	AQ5	E	2.5	Rural
Keraha (Near Amhara)	AQ6	SW	5.0	Near R.F

For air sampling respirable dust samplers with separate attachments for gaseous sampling were operated twice a week at each location representing the sampling station. The sampling duration of the pollutants was eight (8) hours in consecutive manner within twenty-four (24) hour period. In order to obtain the background concentration, averaging of three consecutive samples of respective pollutants was done to arrive at twenty-four (24) hour average concentration.

The collected samples were analyzed as per procedures laid down in the Indian Standards and as per CPCB prescribed methods. For RPM and SPM, gravimetric detection method

AMBIENT AIR QUALITY MONITORING LOCATION



Legend

- Air Quality
- 10 Km Buffer From Plant
- Project Boundary

Base Layers

- Settlement
- Metalled Road
- Unmetalled Road
- Others
- Rail Network
- Waterbody

Fig 4.2

Table 4.2- Ambient Air Quality Monitoring Location

Location	Location Code	Direction	Distance (km)	Land-use Category
Near Site	AQ1	W	1	Rural
Waidhan	AQ2	N	9.5	Urban
Sasan	AQ3	N	3	Rural
Tiyara	AQ4	NW	5	Rural
Bhari (Near	AQ5	E	2.5	Rural
Keraha	AQ6	SW	5	Near R.F

0 1.5 3 6 Km

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(IS:5182-Part IV) and for SO_2 and NO_X IS:5182-Part-II and Part-VI were followed. The details are given in **Table 4.3**.

TABLE 4.3: TECHNIQUES USED FOR AMBIENT AIR QUALITY MONITORING

Parameter	Technique	Technical Protocol
Suspended Particulate Matter	Respirable Dust Sampler (Gravimetric method)	IS-5182 (Part-IV)
Respirable Particulate Matter	Respirable Dust Sampler (Gravimetric method)	IS-5182 (Part-IV)
Sulphur Dioxide	West and Gaeke	IS-5182 (Part-II)
Oxides of Nitrogen	Jacob and Hochheiser	IS-5182 (Part-VI)

The heavy metals present in ambient particulates were separately analyzed using AAS during summer season. Particulate mercury (Hg), lead (Pb) and fluoride (F) were tested at Waidhan station as the location lies in the proximity of industries.

4.3.4 Water Quality

Surface water samples were collected from 3 different locations during the study period. Ten groundwater samples were collected from tube wells and hand-pumps located in the villages near the project site. Water sampling location details are provided in **Table 4.4**, and depicted in **Figure 4.3**.

TABLE 4.4- WATER SAMPLING LOCATIONS

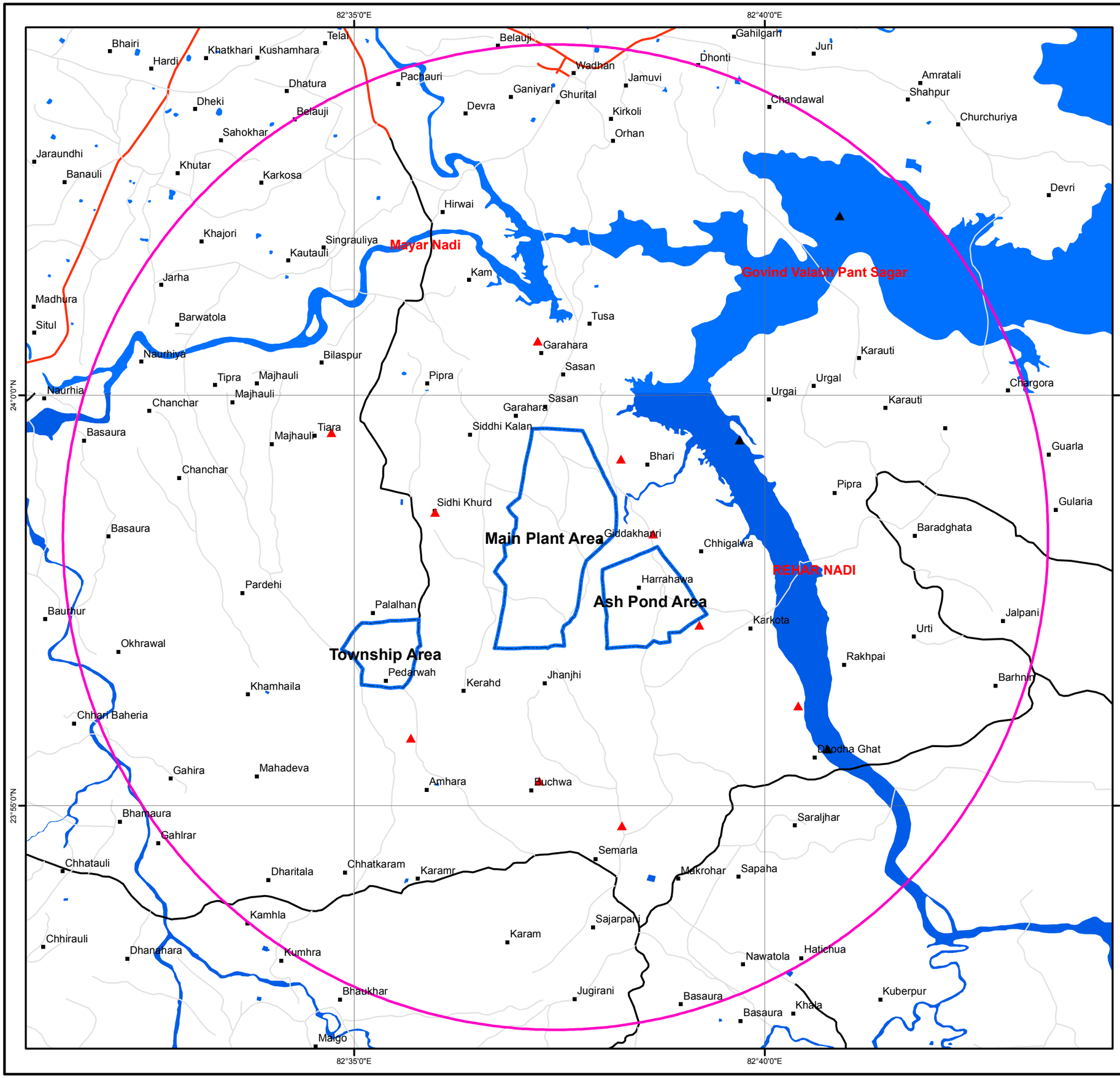
Location	Location Code	Distance (km)	Direction
Surface Water Sampling Location			
Near Karkota (Rehar River)	SW1	7.0	ESE
Near Bhari (Rehar River)	SW2	4.5	ENE
Govind Ballabh Pant Sagar	SW3	8.0	NE
Groundwater Sampling Location			
Near Tiyara	GW1	3.5	NW
Sidhi Khurd	GW2	2.0	NW
Garhara	GW3	4.0	N
Near Site	GW4	1.7	NE
Giddhakhari	GW5	2.0	SE
Harrahawa	GW6	3.5	SE
Karkota	GW7	6.0	SE
Jhanjhi Tola	GW8	4.5	SSE
Near Jhanjhi	GW9	5.0	S
Pedrawah (Near R.F. Mohanban)	GW10	5.5	SSW

Water samples were collected on monthly basis during the study period and analyzed for selected physico-chemical and biological parameters. Samples were collected, preserved and analyzed as per methods given in Standard Methods for the Examination of Water and Waste Water (APHA, AWWA and WPCF).

4.3.5 Noise Levels

CEL-383 sound level meter was used for measuring the noise levels. This instrument measures sound pressure level (SPL), maximum sound pressure level (max) and equivalent continuous noise level (Leq). Noise monitoring location details are provided in **Table 4.5** and indicated in **Figure 4.4**.

WATER SAMPLING LOCATIONS



Legend

- Water Sample
- Ground Water Sample
- 10 Km Buffer From Plant
- Project Boundary

Base Layers

- Settlement
- Metalled Road
- Unmetalled Road
- Others
- Rail Network
- Waterbody

Fig 4.3

Table 4.4- Water Sampling Locations

Location	Location Code	Direction	Distance (km)
Surface Water Sampling Location			
Near Karkota (Rehar River)	SW1	ESE	7
Near Bhari (Rehar River)	SW2	ENE	4.5
Govind Ballabh Pant Sagar	SW3	NE	8
Groundwater Sampling Location			
Near Tiyara	GW1	NW	3.5
Sidhi Khurd	GW2	NW	2
Garhara	GW3	N	4
Near Site	GW4	NE	1.7
Giddhakhari	GW5	SE	2
Harrahawa	GW6	SE	3.5
Karkota	GW7	SE	6
Jhanjhi Tola	GW8	SSE	4.5
Near Jhanjhi	GW9	S	5
Pedrawah (Near R.F. Mohanban)	GW10	SSW	5.5

0 1.5 3 6 Km

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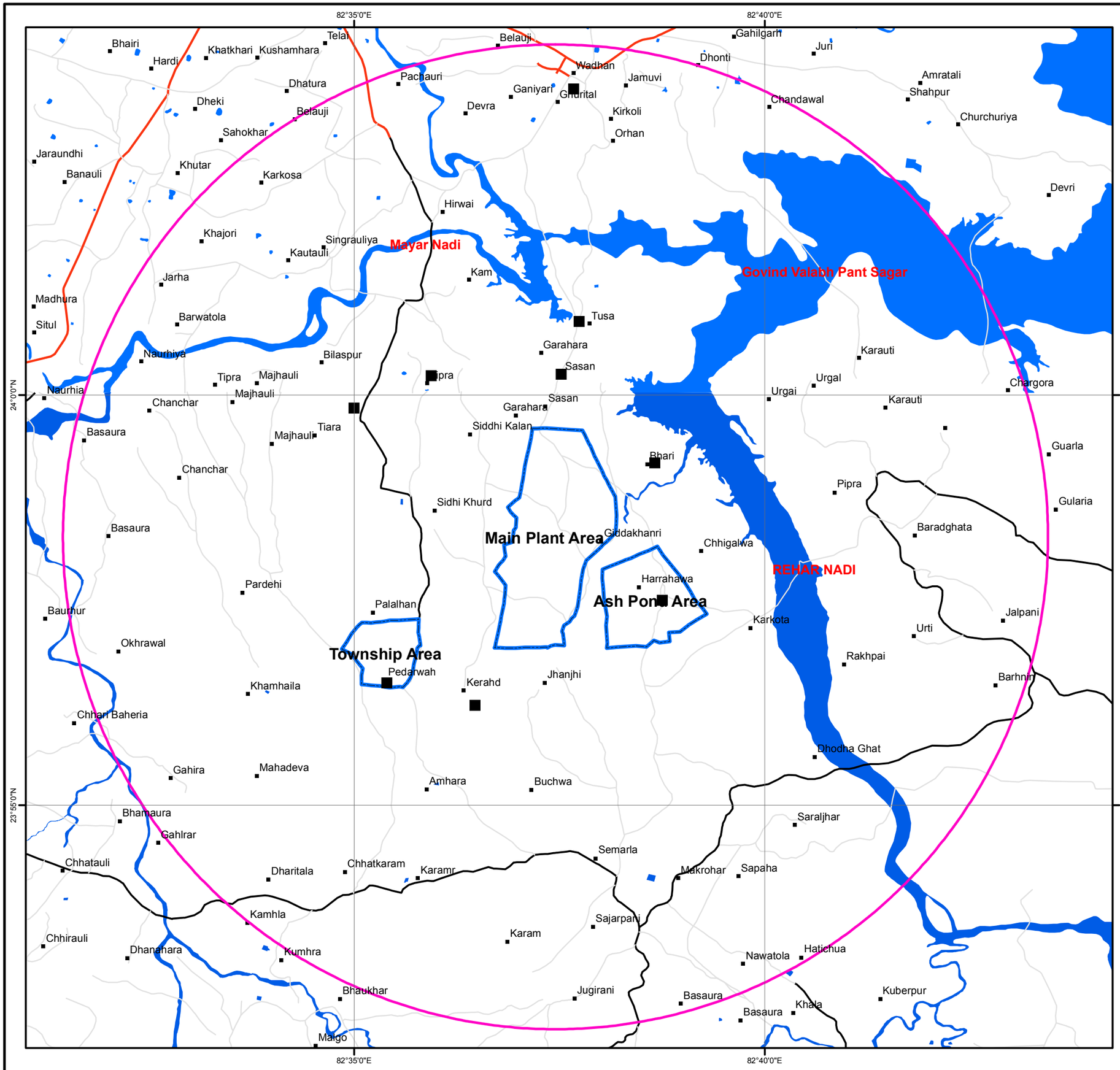
NOISE MONITORING LOCATION



Legend

- Noise Monitoring Location
- 10 Km Buffer From Plant
- Project Boundary

Base Layers

- Settlement
- Metalled Road
- Unmetalled Road
- Others
- Rail Network
- Waterbody

Fig 4.4

Table 4.5- Noise Monitoring Locations

Sampling Location	Direction	Distance (km)	Land-use Category
Project Site	-	-	Rural
Waidhan	N	9.5	Residential / Commercial
Sasan	N	3.5	Residential/Rural
Tiyara	NW	5	Residential/Rural
Tusa	NE	5	Residential/Rural
Keraha (Near RF)	SW	4	R.F/Sensitive
Pedarwah	SW	4.5	Residential / Rural
Harrhawa	SE	2.5	Residential/Rural
Pipra	NW	3.5	Residential/Rural
Bhari	E	2.5	Residential/Rural

0 1.5 3 6 Km

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TABLE 4.5- NOISE MONITORING LOCATIONS

Sampling Location	Direction	Distance (km)	Category
Project Site	-	-	Rural
Waidhan	N	9.5	Residential / Commercial
Sasan	N	3.5	Residential/Rural
Tiyara	NW	5.0	Residential/Rural
Tusa	NE	5.0	Residential/Rural
Keraha (Near RF)	SW	4.0	R.F/Sensitive
Pedarwah	SW	4.5	Residential / Rural
Harrhawa	SE	2.5	Residential/Rural
Pipra	NW	3.5	Residential/Rural
Bhari	E	2.5	Residential/Rural

4.3.6 Traffic Survey

Traffic Survey was conducted in three points in and around the town of Waidhan and near the project site. 24 hour survey was conducted once a week for summer and winter seasons. During the survey, vehicles were categorized into three groups;

- Light vehicles including two and three wheelers,
- Medium-size vehicles and
- Heavy vehicles with four or more wheels respectively

4.3.7 Ecological Survey

Inventory of flora and fauna species was made by a team of ecologist during the site visit and collected data from Forest Division East Sidhi.

The investigation of terrestrial ecosystem was carried out at ten (10) locations using 30 x 30 m^2 quadrates for the evaluation of phyto-sociological characteristics of woody species and twenty (20) locations using 50 x 50 cm^2 quadrates for the herbaceous flora.

4.3.8 Socio-economic Status

Socio-economic data was collected from field studies and secondary sources like Census of India 2001. Primary R&R Survey was also conducted to find-out the present status of the socio-economic condition of the project affected Households.

4.4 SENSITIVE RECEPTORS

Except Waidhan and some scattered villages habitation, no major settlement / town is located within the 25 kms radius from the project site. As per the MoEF guidance manual, no major eco-system and biosphere have been identified within the periphery of the project site. The study area does not have any features having historical and archaeological importance **(Table 4.6).**

TABLE 4.6- SUMMARY OF SENSITIVE RECEPTORS WITHIN 25 KMS RADIUS

S. No.	Features	Presence in the Study Area
1.	National Park / Wildlife Sanctuary	No
2.	Tiger/ Elephant Reserve/ Turtle Nesting Ground	No
3.	Core Zone of Biosphere Reserve	No
4.	Lakes / Reservoir / Dams	Govind Ballabh Pant Sagar – 12 kms
5.	Stream / Rivers	Rehar River- 4 kms, Mayar River- 10 kms

S. No.	Features	Presence in the Study Area
6.	Estuary / Sea	No
7.	Mangroves	No
8.	Mountains / Hills	No
9.	Notified Archaeological Sites	No
10.	Any other Archaeological Sites	No
11.	Defense Installation	No
12.	Airports	Varanasi Airport is 250 kms from site
13.	Railway Station	Shakti Nagar- 18 kms
14.	National / State Highways	National Highway-75 is 10 kms

4.5 LAND AND PHYSICAL ENVIRONMENT

4.5.1 Project Site

PFC had identified a potential site for development of Sasan Ultra Mega Power Project near Sasan Village, Singrauli district, in Madhya Pradesh. The proposed location has been chosen keeping in view of the social and environmental issues like least disturbance on local habitation, minimum impact on the forest land and less impact on drainage pattern were also considered for site selection. The layout map of the proposed power plant is presented in **Figure 3.1.**

The proposed power plant site is located around 23°57'56" N latitude and 82°37'30" E longitude near Sasan village in Singrauli District of Madhya Pradesh. The site is well connected by road from Waidhan town. National NH-75 is passing at a distance 10 Km from the project site. The nearest Railway Station (Shaktinagar) is located about eighteen (18) km from the project site. The nearest airport is Varanasi, which is about 250 kms from the site. The location map of the project site is enclosed as **Figure 1.1**.

Present land use of the selected site is mainly infertile and single crop agriculture land with scrub forest and settlements.

4.5.2 Physiography

In the study area, terrain is dominated by river basin. The territories are rugged with sediment burdens carried away by various streams. The landscape has alluvium depositions and murrum toppings.

Rehar River flows through the south-eastern plain. Rising from the hills of Sarguja it maintains a general north – easterly course and meets the River Sone in Jharkhand. The river has a dam built on the downstream. On the upstream side, resulting reservoir has submerged the plain upto a few kms from Waidhan, both in Uttar Pradesh and Madhya Pradesh. Kanchan and Mayar rivers unite a few kilometers south of Singrauli (Waidhan) before joining the Govind Ballabh Pant reservoir.

The plant area is located on high plateau with Gabaiya and Garra streams on eastern and western side of the plant area.

4.5.3 Geology

4.5.3.1 Project Site

The site for plant area and ash pond area extend over geological complex, mainly constituting of granite gneiss and schistose rocks with profuse intrusion of quartz reefs. The basement of the project area comprises undifferentiated gneisses gradational into schistose and phyllite faces. This older basement underwent regional granitization during Archean-Proterozonic transition. This phase ended with profuse intrusion of quartz reef, quartz veins and pegmatite veins. Western blank of the proposed site shows basic intrusive rocks of

dolerite nature extending through dark biotite schistose and gneissic rocks into western granitic ridge.

Bundelkhand gneissic complex, granite, quartz reel, dolerite dyke, Amgaon group, Gopad-banas metamorphic Complex and other undifferentiated gneisses, older enclaves within granitoids : gneisses, granulites and granitoids.

Thus the site consists of Archean – Proterozoic basement interacting with geo-morphological processes to develop sub-parallel ridge lineaments. These lineaments control the surface and sub-surface water movements in the proposed site.

The litholog obtained from bore holes of the plant site show the following succession from top downward : unsorted soils / colluvial – 1.0 m, compacted silt – 3.5 m - 12.5 m, granitic / granitiod rock – 2.0m – 3.5 m, quartziferous horizon 1 – 2 m, dark platy rock (migmatitic / hybrid) – 0.5 m. Hornbland – muscorite schist – 1.5 – 2.5 m and granitic – gneisses further downward basement.

4.5.3.2 Regional

Geologically the northern most part of the district is formed of Vindhyans, the middle portion of Archaeans and the southern part of the Gondwana formations. Study areas falls in the southern part of the district.

The Gondwanas are characterized by low rolling dips and present the structure of a broad basin closing towards west. The northern contact of the Gondwanas with Archaeans is faulted. There are a few exposures of coal and they are mostly restricted to the Raniganj formation.

The general succession of the different rock types in the Sidhi region are provided in **Table 4.7** in their order of superposition.

TABLE 4.7- GEOLOGY OF THE STUDY AREA

Recent	:	Alluvium and laterite
Upper Triassi	:	Mahadeva – Ferruginous sandstone and cherty clays
Upper Permian	:	Unconfirmity
Middle Permian	:	Raniganj- Calcarious sandstone, carbonaceous shale and coal seams
Lower Permian Gondwanas	:	Barren Measure – Flaggy sandstone, shale and clays
Upper carboniferous	:	Barakar – Felspathic sandstone, shale and clays. Talchir- Boulder beds, shale and sandstone.
		Unconformity
Purana Lower Vindhyans (Semriseries)	:	Kheinjua stage – Olive green shales porcelanite stage – shale interbedded with porcellanites, tuffs and limestones.
		Basal Stage – Conglomerate and quartzite.
		Unconformity
Sidhi Series	:	Orthoquartzite phyllite containing lenses of conglomerate. Banded – heamatite quartzite
		Unconformity
Archaeans Older Metamorphics	:	Quartz – sericite schist Basic schists-homblende – Chlorite – Basic schist, talcchlorite schist, talc tremolite schist, etc. epidosite etc.

4.5.4 Land-use Pattern

4.5.4.1 Project Site

Land Use as per Government Record

Land utilization data collected from secondary sources viz, land records, block level reports, etc shows (**Table 4.8**) that out of total land in the project impact area (constitutes total area in the villages from which part of land is acquired for the project), 66 % of the land is utilized for cultivation (irrigated and un-irrigated area). However, out of total of the impact villages only 17% is irrigated land.

TABLE 4.8: LAND-USE CLASSIFICATION IN PROJECT IMPACT AREA (IN ACRES)

S. No.	Village Name	Forest Area	Irrigated Area	Un-irrigated Area	Cultivable Waste	Area not Available for Cultivation
1.	Siddhi Khurd	0.0	145.8	1954.6	37.1	358.3
2.	Siddhi Kalan	793.4	378.1	990.9	612.8	207.6
3.	Harrahawa	0.0	521.4	1655.6	709.2	108.7
4.	Jhanjhi Tola	0.0	163.1	617.8	306.4	93.9
5.	Tiyara	0.0	1069.9	1485.1	1025.5	491.7
Total Area		773.4 (5%)	2278.3 (17%)	6703.8 (49%)	2690.9 (20%)	1260.2 (9%)

Source: Primary Census Abstract, Census of India, Madhya Pradesh, 2001

Land Use of the Site as per Ownership

Module-wise breakup of land requirement as per final award approved by Govt. of Madhya Pradesh (GoMP) is given below.

TABLE 4.9: MODULE WISE BREAK-UP OF LAND REQUIRED (IN ACRES)

Use of Land	Village Name	Land Type			Forest land	Total
		Pvt.	Govt.	Total		
Power Plant Area	Siddhi Khurd	797	243	1040	793	1833
	Siddhi Kala	135	67	202	-	202
Ash Disposal	Harrhawa	578	200	778	-	778
	Jhanjhi tola	24	9	33	-	33
Township	Tiyara	174	275	449	-	449
Total		**1708**	**794**	**2502**	**793**	**3295**

4.5.4.2 Study Area (25 kms Radius)

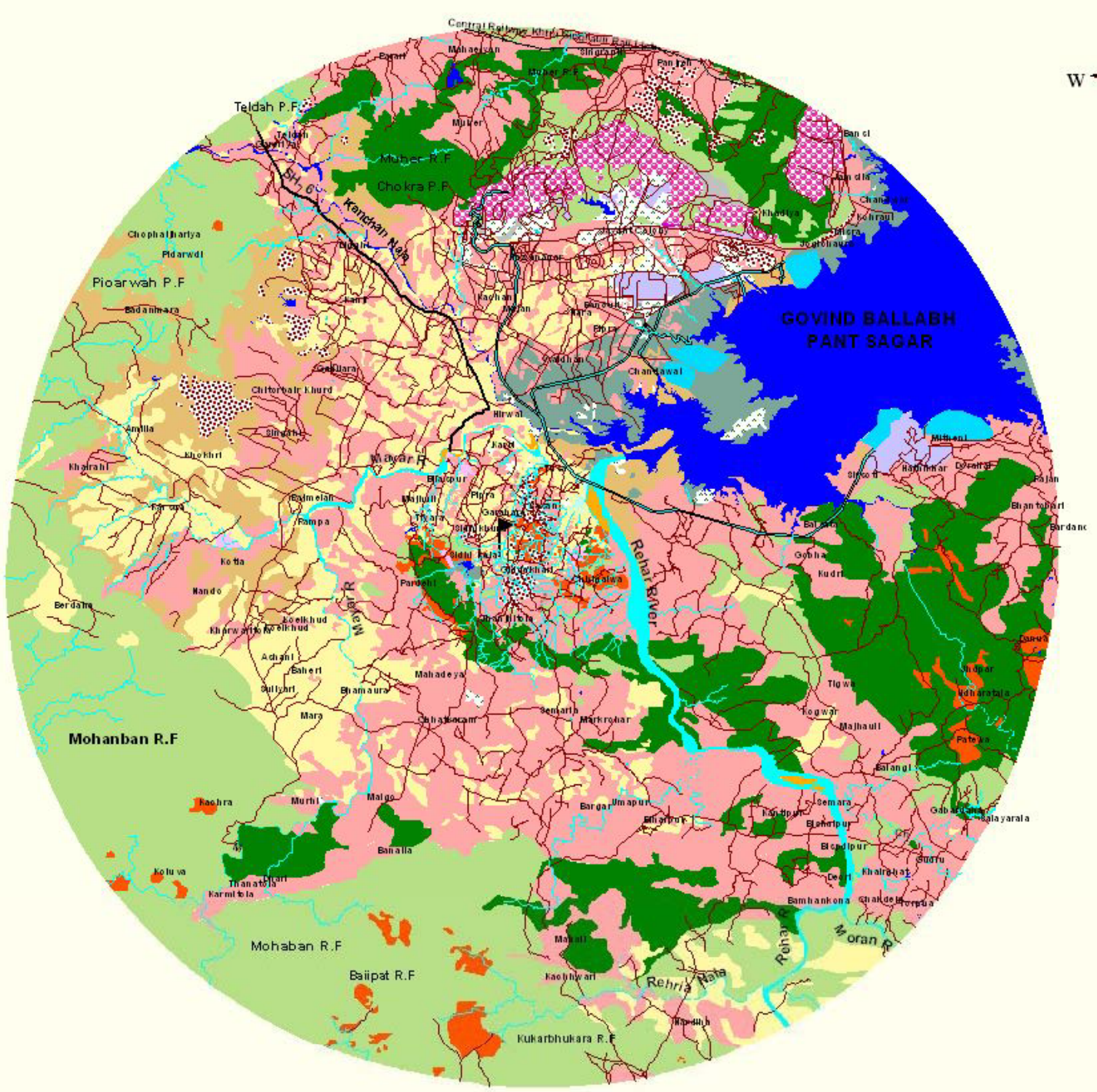
The term land use used in the report means both land use and land cover. The land use of the study area was carried out by utilizing three principal sources, namely, (i) Survey of India topo-sheet of 1:50,000 scale; (ii) Satellites imagery data without any cloud cover; and (iii) ground validation for interpretation of the FCC imagery.

Table 4.10 describes distribution of land area in km^2 and their respective percentages and land-use map is given as **Figure 4.5**.

TABLE 4.10- LAND-USE CLASSIFICATION WITHIN 25 KMS RADIUS

Land Use Category	Area (Sq. Km.)	Percentage of Study Area
Cropped Land	237.7	12.1
Vegetation	22.3	1.1
Mining Area	32.6	1.7
Forest		

LAND USE WITHIN THE 25 KM OF PROPOSED SITE



INDEX

LAND USE CATEGORIES

- Crop Land
- Vegetation

FOREST:

- Degraded Forest
- Dense Forest

BUILT - UP LAND:

- Industrial Area
- Open Space
- Settlement
- Settlement within forest

WETLANDS:

- Waterlogged area
- Marshy/ Swampy Land

WASTELANDS:

- Barren Rocky Area
- Gullied Land
- Land without scrub
- Mining/ Industrial Waste

WATERBODIES:

- Char
- Ponds / Tanks
- Reservoirs
- River
- Mining
- State Highway
- Canal
- Railway
- Road Network

Figure- 4.5

1:250000

0 4 8 12 16 Kilometers

SOURCES :

i) Satellite Images : IRS P6 LISS-IV , Nov 2005
ii) SOI Topographical Sheets
iii) District Planning Map Series, NATMO,1998
iv) Wasteland Atlas of India, 2000

Land Use Category	Area (Sq. Km.)	Percentage of Study Area
Degraded Forest	475.7	24.2
Dense Forest	249.7	12.7
Built-Up Land		
Industrial Area	13.3	0.7
Open Space	0.2	0.0
Settlement	552.9	28.2
Settlement within forest	29.8	1.5
Wetland		
Waterlogged area	0.7	0.0
Marshy/ Swampy Land	63.5	3.2
Waste Land		
Barren Rocky Area	79.7	4.1
Gullied Land	2	0.1
Land without scrub	24.5	1.2
Mining/ Industrial Waste	3.3	0.2
Water Bodies		
Ponds / Tanks	13.1	0.7
Reservoirs	141.8	7.2
River	21.5	1.1
Total	**1964.3**	**100.0**

Cropland: Only 12.1% of the study area falls under crop land. Croplands are observed randomly around the proposed site. However the area is distinctly dotted with such land uses. The patches get larger with the increase in distance from the site.

Settlement: Settlements constitutes around 28% of total area. Settlements comprise of the town of Waidhan and scattered villages settlements and its hamlets.

Mining Area: In the northern part major mining blocks are located. Mining is one of the major land-use prominent in the region and covers 36.28 sq km of total area.

Dense Forest: An elongated patch of dense forest is running south of the site and covers about 12.7% of study area. It gets thicker eastward towards Chhattisgarh. The following forest fall under this category

- Muher Reserve Forest
- Chokra Protected Forest

Degraded Forest: About 24% of area fall under degraded forest and is a prominent feature of the area. However western part of the areas has large expanse of degraded forests. The Reserve Forests and Protected Forests as given below falls in this category of:

- Mohanban Reserve Forest
- Kukarbhukara Reserve Forest
- Pidarwah Protected Forest
- Balipat Reserve Forest

Vegetation: In the study area, vegetation is mostly observed towards Singrauli industrial area and Govind Ballabh Pant Sagar. Vegetation is a general term for the plant life of a region; it refers to the ground cover provided by plants, and is, by far, the most abundant biotic element of the biosphere. They are juxtaposed with northern mining beds as well. However the percentage of such land use is limited to 1.1%.

Land without scrub: This is one of the most prominent uses around the proposed power plant site. Near by villages are having small lands under this category. Scrub" consists of low shrubs, mixed with grasses, herbs, and geophytes. Scrublands may be either naturally occurring or the result of human activity. They may mature into vegetation type in a particular region and remain stable over time, or a transitional community that occurs temporarily as the result of a disturbance, such as a major fire. The lands without scrubs are those lands which in spite of being wastelands lacks scrubs.

Gullied lands: The study area has discrete occurrences of such lands. A gully is a landform created by running water eroding sharply into a hillside.

Barren & Rocky: Barren and rocky lands are also observed near the site and constitute 4.1% of the total area. Most of such land is observed in the western part of study area.

Water-bodies: The reservoir of Govind Ballabh Sagar is one of main feature of land use of the study area and covers 7.2% of study area. Other major rivers in the area are Mayar and Rehar River. There are not many static surface water bodies, artificial or natural, in the district except the Govind Sagar. Though some tanks have been constructed in the area but most of them dry up during the summer season.

Marshy lands: Huge patches of marshy lands (3.2%) are observed on the western parts of Govind Sagar. A marsh is a type of wetland, featuring grasses, rushes, reeds, typhas, sedges, cat tails, and other herbaceous plants (possibly with low-growing woody plants) in a context of shallow water. A marsh is different from a swamp, which is dominated by trees rather than grasses and low herbs. The water of a marsh can be fresh, brackish, or saline.

Waterlogged area: There are four prominent patches of water logged areas which are observed near the man-made lake of Govind Sagar in which two are in west coast and remaining two in east bank of the Sagar.

The study area is known as the Energy Capital of India and is surrounded by industries. However, no new plant / mine / industry activity have been started from last 3-4 years. The lists of industrial activity found in 25 kms radius are listed in **Table 4.11.** The industries cover about 0.7% land of the total study area.

TABLE 4.11- LIST OF INDUSTRIAL ACTIVITIES WITHIN 25 KMS RADIUS

Name of the Industrial Activity	Distance from the Project Site (kms)
Singrauli TPP	21.0
Vindyachal TPP	20.5
NCL Coal Blocks	18.0
Proposed Mahan STPP	22.0
Proposed Muher Coal Mine	22.0

4.5.5 Soil Quality

The soils in the study area are generally red soils dotted with clayey soils. The fertility of soils in general is poor. The top soil samples collected from various locations under major land-use categories in study area were tested for physico-chemical characteristics. **Tables 4.12** and **4.13** provide physical and chemical characteristics of tested soils in summer and winter season respectively.

The soil texture shows varying proportions of silt and sands. No significant changes in texture of the soils samples observed during study period.

Chemically these soils are generally neutral in nature with soluble salts in terms of electrical conductivity higher in Tusa and Sidhi Kalan soils than in other soils. Soil samples collected

from Tiyara, Harrahawa and Karkota show variations in pH values with acidic soils in some cases.

Particle size distribution of the soil samples suggests that wasteland is covered by sandy loam and loamy sand soil. Semi-agricultural land is also covered by sandy loam soil but with relatively lesser percentage of sands. Agricultural land is mostly covered by silty loam soils.

The nutrient and organic matter contents are lower in all the tested soils. However, agricultural and forest soils have slightly higher nutrient concentrations. The tested soil samples share common characteristics without showing striking differences in terms of both physical and chemical parameters.

The soil characteristics of the area are influenced by existing drainage pattern with soil erosion as the main feature of the landscape. As a result, the nutrient status is found to be lower in most of the cases.

TABLE 4.12- SOIL CHARACTERISTICS (SUMMER)*

S. No	Parameter	Unit	Soil Sampling Locations											
			S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
1	Soil Texture													
	a. Gravel	%	9.45	7.35	7.9	3.5	7	5.25	3.65	0.1	0.3	1.25	4.5	4.3
	b. Sand	%	35.8	40.3	45.2	58.6	56.6	63.6	43.8	72.9	45.8	59.9	55.3	27.2
	c. Silt	%	50.7	48.4	43	34.4	33.3	28.7	46	24.8	50.1	35.4	36.5	63.3
	d. Clay	%	4.05	4	3.7	3.5	3.2	2.5	4	2.25	3.9	3.5	3.8	5.2
2	pH (1:2.5 susp.)	--	6.37	4.9	5.48	5.75	0	5.57	7.85	5.72	6.2	6.64	7.37	6.4
3	Conductivity (1:2.5 susp.)	µmhos/cm	218	60	45	72	77	80	220	47	82	90	116	120
4	Organic Matter	%	1.43	0.74	0.75	0.9	0.95	0.89	1.51	0.74	0.59	0.45	1.04	0.98
5	Sodium as Na	%	0.65	0.95	0.91	1.04	0.81	0.66	0.46	0.87	0.59	0.56	0.61	0.75
6	Potassium as K	%	0.48	0.92	0.59	0.79	0.88	1.07	0.75	0.86	0.79	0.8	0.83	0.58
7	Calcium as Ca	%	1.56	0.74	0.01	1.32	0.4	0.79	0.32	2.23	0.54	0.45	0.93	0.67
8	Chloride as Cl	%	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
9	Sulphate as SO_4	%	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
10	Carbonate as $CaCO_3$	%	1.56	1.04	0.78	1.56	0.52	0.52	2.08	0.26	1.82	1.04	1.58	1.3
11	Nitrogen as N	meq/100 gm	44.1	34.9	19.7	45.5	25.7	48.1	51.4	36.2	48.1	36.2	45.5	63.9
12	Phosphorus as PO_4	%	0.01	0.016	0.004	0.008	0.018	0.018	0.024	0.021	0.033	0.01	0.01	0.01
13	Cadmium as Cd	%	0.002	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.002	0.002
14	Copper as Cu	%	0.006	0.013	0.005	0.004	BDL	BDL	0.004	0.004	0.003	0.003	0.004	0.004
15	Chromium as Cr	%	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
16	Nickel as Ni	%	0.02	0.016	0.016	0.015	0.073	0.011	0.008	0.011	0.009	0.015	0.011	0.017
17	Lead as Pb	%	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
18	Zinc as Zn	%	0.017	0.01	0.013	0.014	0.014	0.005	0.006	0.042	0.012	0.009	0.009	0.009
19	Arsenic as As	%	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
20	Water Holding Capacity	%	16.8	16.5	17.9	19.5	17.2	19.1	18	20.7	19.2	16.5	18.2	22.8
21	Cation Exchange Capacity	meq/100 gm	55.8	15.8	7.07	20.7	18.9	19.9	34	12.5	25.3	19.6	26.2	25.8

S. No	Parameter	Unit	Soil Sampling Locations S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
22	Sodium Absorption Ratio	--	0.46	0.67	1.05	0.75	1.07	0.91	0.97	0.77	0.97	0.99	0.77	1.09

: For description please refer to Table 4.1

TABLE 4.13- SOIL CHARACTERISTICS (WINTER)

S. No	Parameter	Unit	Soil Sampling Locations S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
1	Soil Texture													
	a. Gravel	%	3	0.1	2.9	1.4	0.8	0.75	3.7	0.15	0.95	0.4	6.6	1.8
	b. Sand	%	31.4	65.7	49	52.7	55.8	54.7	42.6	64	70.6	40.2	46.1	23.7
	c. Silt	%	60	30	44	41.8	40	41	47	31	25	55	42	68
	d. Clay	%	5.55	4.2	4.1	4	3.35	3.55	6.65	4.8	3.45	4.4	5.25	6.5
2	pH (1:2.5 susp.)	--	7.14	5.24	7.8	5.96	6.32	6.02	8.38	5.1	5.72	6.32	6.33	7.88
3	Conductivity (1:2.5 susp.)	µmhos/cm	151	48	159	84	58	59	128	56	32	74	72	171
4	Organic Matter	%	0.78	0.68	0.81	0.73	0.84	0.89	0.76	0.73	0.6	0.89	0.44	0.81
5	Sodium as Na	%	0.71	0.98	0.87	0.93	0.76	0.69	0.45	0.81	0.62	0.58	0.52	0.64
6	Potassium as K	%	1.49	0.61	1.19	1.13	1.29	1.38	0.97	1.28	0.89	0.91	0.44	0.96
7	Calcium as Ca	%	1.4	0.79	0.02	1.19	0.43	0.83	0.29	1.91	0.59	0.41	0.81	0.78
8	Chloride as Cl	%	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	0.02	<0.01	<0.01
9	Sulphate as SO_4	%	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
10	Carbonate as $CaCO_3$	%	1.6	1.09	0.82	1.39	0.57	0.54	1.97	0.21	1.59	0.92	1.37	1.26
11	Nitrogen as N	meq/100 gm	39.2	33.1	18.3	47.3	23.7	48.9	49.3	34.9	46.3	34.9	43.8	65.7
12	Phosphorus as PO_4	%	0.004	0.018	0.19	0.017	0.017	0.033	0.013	0.24	0.028	0.017	0.011	0.01
13	Cadmium as Cd	%	0.003	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.003	0.03
14	Copper as Cu	%	0.004	0.011	0.007	0.006	BDL	BDL	0.003	0.006	0.002	0.004	0.006	0.03
15	Chromium as Cr	%	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
16	Nickel as Ni	%	0.03	0.02	0.02	0.01	0.08	0.02	0.01	0.02	0.01	0.01	0.01	0.01
17	Lead as Pb	%	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
18	Zinc as Zn	%	0.02	0.02	0.02	BDL	0.01	0.01	0.01	0.05	0.01	0.01	0.01	0.01
19	Arsenic as As	%	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
20	Water Holding Capacity	%	17.3	15.6	16.3	17.6	16.1	18.2	16.3	18.9	17.8	14.9	17.3	19.6
21	Cation Exchange Capacity	meq/100 gm	54.2	14.3	6.1	18.4	17.4	20.3	32.6	11.5	24.1	18.2	24.3	23.6
22	Sodium Absorption Ratio	--	0.49	0.71	0.98	0.81	0.95	0.84	0.84	0.74	0.86	0.83	0.69	1.12

4.6 METEOROLOGICAL CONDITION

Meteorological description of the area is based on both short and long-term data. The short-term data was generated near project site location and long-term data was collected from the nearest India Meteorological Department (IMD) observatory, located at Sidhi. Site-specific meteorology plays an important role in deciding the transportation and diffusion pattern of air pollutants and is considered in dispersion modelling.

4.6.1 Climate

The climate of the region is humid and tropical with four (4) seasons, delineated as per IMD classifications, characterized by the following:

- December to February is moderately cold with predominantly westerly winds.
- March to May is summer season; the atmosphere heats up and mercury records an upward trend. Both westerly and northwesterly winds predominate.
- Monsoon from June to September is characterized by heavy rainfall with easterly winds.
- Post-monsoon period occurring during October and November is characterized by westerly winds.

4.6.1.1 Temperature

Temperature is generally high showing relatively large difference between daily minimum and daily maximum temperatures during summer. The temperature starts rising significantly from March with scorching conditions in April, May and June the hottest months. With the onset of monsoon by the second week of June, temperature decreases.

From November the temperature starts decreasing and reaches minimum during January, which is the coldest month. During monsoon months diurnal variation in temperature is the minimum **(Table 4.14)**. **Figure 4.6** presents monthly average, maximum and minimum temperatures.

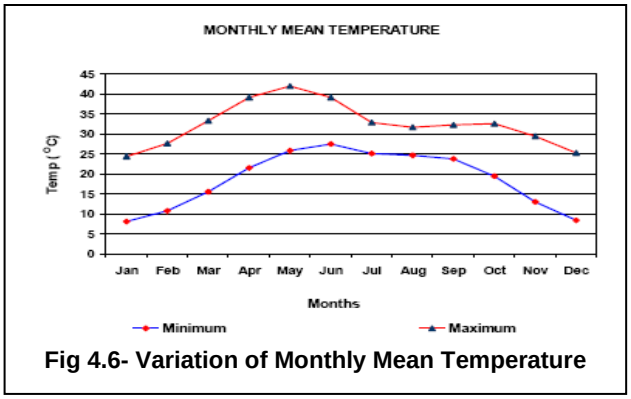


Fig 4.6- Variation of Monthly Mean Temperature

4.6.1.2 Relative Humidity

The area experiences a relatively higher relative humidity, which can be attributed to Govind Sagar and forest cover. Minimum humidity has been recorded in May (23%) followed by April (24%) as provided in **Table 4.14**. Maximum humidity has been recorded in August (85%) followed by July (83%) as shown in **Figure 4.7**.

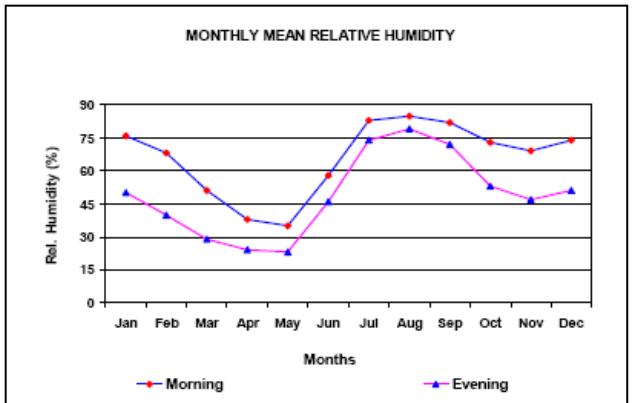


Fig 4.7- Variation of Monthly Mean Humidity

4.6.1.3 Wind Speed and Direction

Annual wind-roses plotted on the basis of long-term data shows westerly as prevailing wind direction. (**Figure 4.8 & 4.9**)

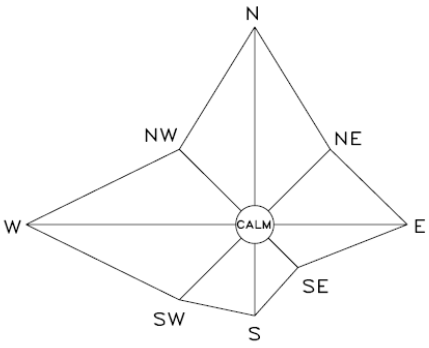


Fig 4.8- Annual Wind-rose (Morning 8:30 IST)

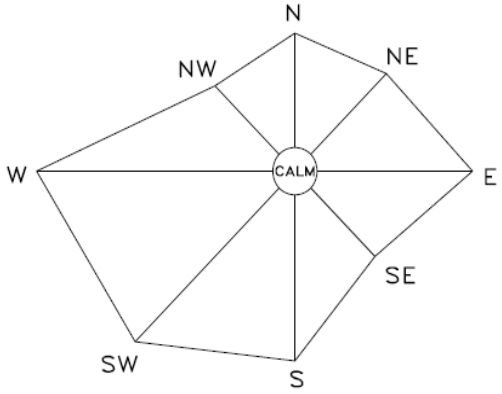


Fig 4.9- Annual Wind-rose (Morning 17:30 IST)

4.6.1.4 Cloud Cover

Monthly average cloud amounts are provided in **Table 4.14**. The cloud cover during July to September is higher, but during December month the same is minimum.

4.6.1.5 Rainfall

The southwest monsoon sets in June and continues till September. During rainy season about 89% of annual rainfall is received **(Figure 4.10).**

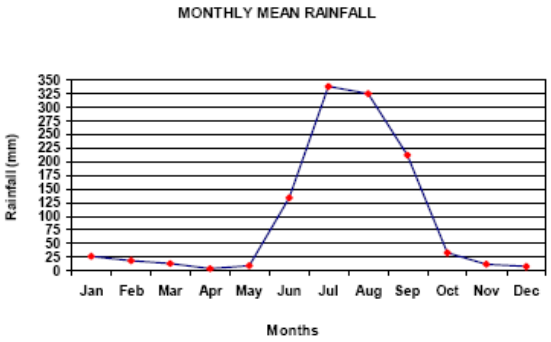


Fig 4.10- Variation of Monthly Mean Rainfall

Annual rainfall received in the area is about 1133 mm; the maximum rainfall (338.2 mm) is received during July followed by August (325.2 mm). The heaviest rainfall recorded in a day was 189.8 mm (16 July, 1980).

4.6.1.6 Vapour Pressure

Monthly average morning and evening vapour pressures are given in **Table 4.14**. Maximum pressure is recorded during August (31.0 hPa) and minimum pressure is recorded during January (10.8 hPa).

4.6.1.7 Special Weather Phenomena

Special weather phenomenon like hail / squall occurs in the region. The annual fog and thunder recorded in the region are 0.2 and 6.0 respectively. These phenomena are not frequent and their intensities are varying from year to year depending on development of special meteorological conditions in the surrounding region.

TABLE 4.14- CLIMATOLOGICAL DATA

Month	Temperature (°C)		Rel. Humidity (%)		Vapour Pressure (hpa)		Mean Wind Speed (kmph)	Rainfall (mm)	Cloud Amount (Oktas)	
	Min	Max.	Mor.	Eve.	Mor.	Eve.			Mor.	Eve.
Jan	8.1	24.3	76	50	10.8	12.2	2.1	27.0	1.2	1.2
Feb	10.8	27.6	68	40	12.1	12.1	2.7	18.4	1.1	0.9
Mar	15.5	33.4	51	29	13.1	12.4	3.3	13.2	0.8	1.0
Apr	21.5	39.1	38	24	15.0	14.1	4.5	3.4	0.5	1.0

Month	Temperature (°C)		Rel. Humidity (%)		Vapour Pressure (hpa)		Mean Wind Speed (kmph)	Rainfall (mm)	Cloud Amount (Oktas)	
	Min	Max.	Mor.	Eve.	Mor.	Eve.			Mor.	Eve.
May	25.8	42.0	35	23	17.5	15.0	5.1	8.8	0.8	1.4
June	27.5	39.2	58	46	26.4	24.0	6.5	133.5	2.7	4.0
July	25.1	32.9	83	74	30.8	30.8	5.3	338.2	5.2	5.5
Aug	24.6	31.7	85	79	30.7	31.0	4.5	325.2	5.3	5.5
Sep	23.8	32.3	82	72	29.1	28.6	3.9	211.8	3.9	4.6
Oct	19.4	32.6	73	53	22.4	20.9	2.4	33.4	1.6	1.9
Nov	13.0	29.5	69	47	14.9	15.0	1.8	12.1	0.8	1.0
Dec	8.3	25.3	74	51	11.5	12.9	1.6	7.7	0.8	0.9

Source: IMD Station at Sidhi (1958 to 1980)

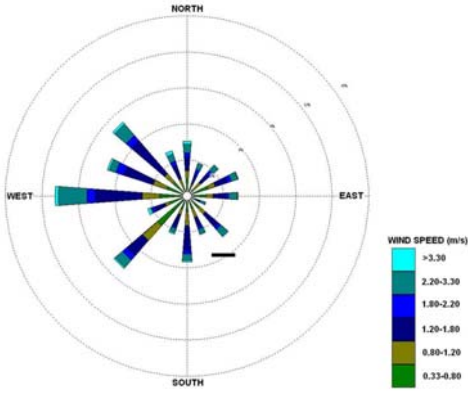
4.6.2 Onsite Micro-meteorology

The on-site meteorological parameters were measured during monsoon, post-monsoon and winter seasons. Measured temperature during monsoon, post-monsoon and winter seasons normally varies from 27.0 to 33.5°C, 19.0 to 31.7 °C and 11.8 to 26.5 °C respectively during monsoon, post-monsoon and winter seasons respectively. The relative humidity of the area remains higher.

Light winds are common during early morning hours, whereas day-time and night hour averages range from 1.9 to 8.7km/hr in summer, 3.1 to 7.3km/hr in monsoon, post-monsoon 1.5 to 5.3 km/hr and 1.6 to 6.1 in winter.

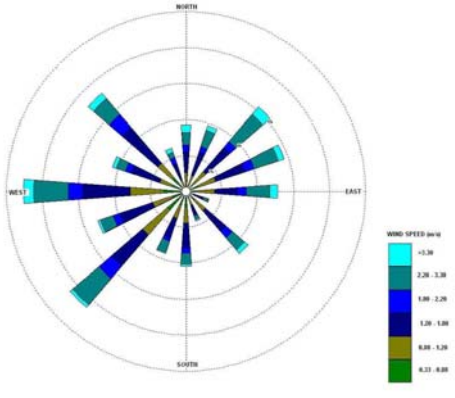
The predominant wind direction in summer and monsoon is west whereas north is predominant wind direction in post-monsoon and winter seasons. Wind-roses for all the seasons are enclosed **Figure 4.11 to 4.14**. Calm condition prevails to the extent of about 21%, 23%, 30% and 34% in summer, monsoon, post-monsoon and winter seasons, respectively. The sky remains clear to lightly cloudy especially during morning hours.

Four (4) rainy days were recorded in March with skies remaining overcast for major part of the days. During monsoon season overcast skies were reported on considerable number of days. The total rainfall recorded during summer, monsoon, post-monsoon and winter seasons are 60.5 mm, 721.0 mm, 18.5 mm and 54.5 mm respectively. Minimum and maximum pressures as recorded at site range from 968 to 981 hpa, 967 to 970 hpa, 978 to 982 hpa and 981 to 984 hpa during summer, monsoon, post-monsoon and winter seasons respectively.



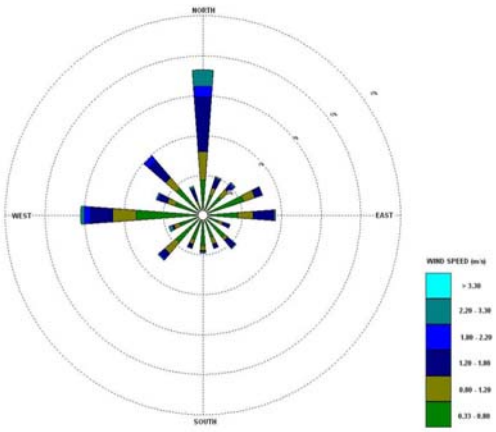
Avg. Wind speed (m/s)- 1.41
Calm (<0.33 m/s)- 20.52%

Fig 4.11: 1st Mar to 31st May, 2006



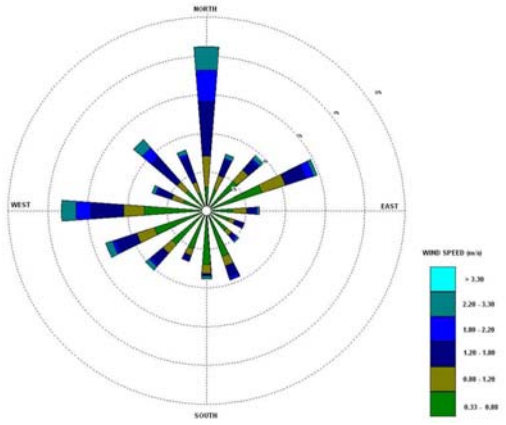
Avg. Wind speed (m/s)- 1.68
Calm (<0.33 m/s)- 22.95%

Fig 4.12: 1st June to 31st Sep, 2006



Avg. Wind speed (m/s)- 1.1
Calm (<0.33 m/s)- 30.12%

Fig 4.13: 1st Oct to 30th Nov, 2006



Avg. Wind speed (m/s)- 1.0
Calm (<0.33 m/s)- 33.89%

Fig 4.14: 1st Dec, 2006 to 28th Feb, 2007

4.7 AMBIENT AIR QUALITY

The air quality measurement shows more or less uniform pattern of ambient concentrations except at Waidhan due to its proximity to industries. The measured concentrations are varying but are within existing air quality standards at all the locations in the area. The sources of particulates are varied, fugitive and not related to any industrial emission, except at Waidhan, which receives pollutants from multiple sources.

However, for the variations in air quality data in each season i.e. summer, monsoon/post-monsoon and winter location wise results are provided with applicable standards in **Table 4.15 to 4.26**. **Table 4.27** provides data on particulate heavy metals specifically Hg and Pb in summer.

Ambient Air Quality Summer (Mar-Apr-May, 2006)

TABLE 4.15- SPM CONCENTRATION IN SUMMER, 2006 (µg/m^3)

Location	Max	Min	Average	P98	NAAQ Standard
Project Site	181.4	92.7	153.5	180.0	200
Sasan	174.5	90.3	152.0	172.5	200
Bhari	167.1	116.3	148.4	165.5	200
Keraha	170.4	112.8	152.5	169.4	200
Tiyara	180.6	135.9	160.6	179.5	200
Waidhan	188.2	92.7	162.1	186.5	200

TABLE 4.16- RPM CONCENTRATION IN SUMMER, 2006 (µg/m^3)

Location	Max	Min	Average	P98	NAAQ Standard
Project Site	76.3	26.4	53.5	74.5	100
Sasan	71.8	28.7	56.8	70.3	100
Bhari	68.5	33.2	51.7	66.2	100
Keraha	73.5	31.7	54.0	72.0	100
Tiyara	89.1	35.7	61.0	86.3	100
Waidhan	82.4	30.5	62.5	81.9	100

TABLE 4.17- SO_2 CONCENTRATION IN SUMMER, 2006 (µg/m^3)

Location	Max	Min	Average	P98	NAAQ Standard
Project Site	13.2	<6.0	10.6	13.0	80
Sasan	18.2	7.1	13.9	18.0	80
Bhari	18.7	8.7	14.3	18.0	80
Keraha	14.6	7.3	10.4	14.4	80
Tiyara	16.8	10.7	13.9	16.5	80
Waidhan	22.3	<6.0	17.1	22.1	80

TABLE 4.18- NO_X CONCENTRATION IN SUMMER, 2006 (µg/m^3)

Location	Max	Min	Average	P98	NAAQ Standard
Project Site	16.8	<6.0	13.3	16.7	80
Sasan	21.2	8.1	17.0	21.0	80
Bhari	21.2	10.8	17.0	21.1	80
Keraha	17.3	9.2	13.1	17.1	80
Tiyara	19.8	13.7	16.8	19.6	80
Waidhan	27.5	<6.0	21.3	27.4	80

Ambient Air Quality Post Monsoon (Sep-Oct-Nov, 2006)

TABLE 4.19- SPM CONCENTRATION IN POST-MONSOON, 2006 (µg/m^3)

Location	Max	Min	Average	P98	NAAQ Standard
Project Site	168.7	90.2	122.2	167.1	200
Sasan	166.1	90.8	139.5	164.1	200
Bhari	154.2	110.0	136.8	153.3	200
Keraha	164.2	121.1	149.0	162.4	200
Tiyara	169.3	131.5	148.8	168.3	200
Waidhan	170.8	96.7	146.1	170.5	200

TABLE 4.20- RPM CONCENTRATION IN POST-MONSOON, 2006 (µg/m^3)

Location	Max	Min	Average	P98	NAAQ Standard
Project Site	52.3	26.2	36.4	51.5	100
Sasan	60.3	25.5	38.2	55.7	100
Bhari	50.3	32.5	43.3	50.3	100
Keraha	59.0	32.5	43.1	57.0	100
Tiyara	69.1	35.1	44.6	68.0	100
Waidhan	72.0	30.1	49.0	71.6	100

TABLE 4.21- SO_2 CONCENTRATION IN POST-MONSOON, 2006 (µg/m^3)

Location	Max	Min	Average	P98	NAAQ Standard
Project Site	12.9	6.2	9.7	12.6	80
Sasan	14.2	6.9	10.3	14.2	80
Bhari	15.4	9.7	11.9	15.0	80
Keraha	13.3	7.2	10.0	13.2	80
Tiyara	15.0	10.2	12.7	15.0	80
Waidhan	19.0	9.6	13.5	19.0	80

TABLE 4.22- NO_X CONCENTRATION IN POST-MONSOON, 2006 (µg/m^3)

Location	Max	Min	Average	P98	NAAQ Standard
Project Site	15.0	7.0	10.5	14.6	80
Sasan	18.7	9.5	14.6	18.4	80
Bhari	19.2	12.3	15.2	19.1	80
Keraha	15.1	9.1	12.2	15.1	80
Tiyara	18.0	10.2	15.2	18.0	80
Waidhan	21.8	7.8	13.9	21.0	80

Ambient Air Quality Winter(Dec-Jan-Feb, 2006-07)

TABLE 4.23- SPM CONCENTRATION IN WINTER, 2006-07 (µg/m^3)

Location	Max	Min	Average	P98	NAAQ Standard
Project Site	175.2	91.7	26.1	172.4	200
Sasan	168.4	92.4	136.9	166.2	200
Bhari	158.6	111.7	138.4	158.2	200
Keraha	166.2	108.3	145.4	165.8	200
Tiyara	174.2	133.7	152.0	172.3	200
Waidhan	177.4	98.5	144.1	175.4	200

TABLE 4.24- RPM CONCENTRATION IN WINTER, 2006-07 (µg/m^3)

Location	Max	Min	Average	P98	NAAQ Standard
Project Site	55.9	24.6	9.6	55.1	100
Sasan	63.1	26.7	42.2	62.8	100
Bhari	58.1	32.9	45.1	57.8	100
Keraha	63.2	29.8	47.2	62.9	100
Tiyara	73.2	34.2	53.9	72.4	100
Waidhan	76.2	28.4	55.4	74.9	100

TABLE 4.25- SO_2 CONCENTRATION IN WINTER, 2006-07 (µg/m^3)

Location	Max	Min	Average	P98	NAAQ Standard
Project Site	13.9	7.2	10.5	13.3	80
Sasan	18.7	7.4	13.4	18.6	80
Bhari	19.1	10.2	14.3	18.8	80
Keraha	15.4	8.3	12.4	14.9	80
Tiyara	17.1	10.5	13.8	16.8	80
Waidhan	23.8	12.3	16.8	23.1	80

TABLE 4.26- NO_X CONCENTRATION IN WINTER, 2006-07 (µg/m^3)

Location	Max	Min	Average	P98	NAAQ Standard
Project Site	17.1	9.4	12.7	16.5	80
Sasan	22.4	9.8	15.9	21.8	80
Bhari	22.8	12.4	17.0	22.7	80
Keraha	17.8	10.6	14.5	17.7	80
Tiyara	20.4	13.1	16.6	20.3	80
Waidhan	28.1	14.7	20.9	27.9	80

Heavy Metals Concentration

TABLE 4.27- AVERAGE HEAVY METALS CONCENTRATION IN WAIDHAN (µg/m^3), Summer Season

	Particulate Mercury	Particulate Lead
Average Value	0.09	0.27

4.8 WATER QUALITY

4.8.1 Water Resources and Use

The general area serves as catchment for watersheds and run-off water resources. The rainfall received in the area is moderate. The existing rivers, reservoir and wells are the main water sources utilized for irrigation and household purpose. The surface water resource within the study area primarily consists of the GBPS or Rihand reservoir and its tributaries mainly Rihand, Mayur and Kanchan. A number of confined water bodies' viz. tanks, ponds etc. also form a part of the surface water resources The principal uses of water are for irrigation, hydel power generation, domestic uses including water supply for drinking purpose and existing thermal power plants.

Rehar River flows through eastern part of the plant and the study area and meets the Sone in Bihar. The River has a dam called GBPS reservoir on the downward side with a large spread area falling in Uttar Pradesh and Madhya Pradesh. Gabaiya River flows from south to north direction between plant and ash pond area. The ground water sources comprise of mainly dug wells and tube wells both in urban and rural front.

Surface Water Use

The majority of water abstraction of surface water is for consumptive use particularly for industrial use and domestic supply. The industrial need and domestic need of the industrial townships, is met primarily by GBPS and its major tributaries through dam and water works after proper treatment. Pond water and tank water are mainly used for bathing, washing and livestock watering by the local people, and rarely lifted for irrigation. No river in the area is navigable, as most of them are hilly streams.

Ground Water Use

Ground water from dug wells and tube wells is abstracted mainly for meeting various domestic needs, and rarely for irrigation needs. Well water is also used for live stock watering and gardening purposes. Domestic water requirement in the rural areas is principally met from these dug wells and tube wells, most of, which are shallow or medium in depth. Sometimes, a single well is shared by few families.

4.8.2 Drainage Pattern

The region falls in the Ganga system. The Son is the major river which flows towards the NE through the northern part of the district and is drained by the rivers Banas, Gopad and Rihand / Rehar.

Rihand / Rehar River flows through eastern part of the study area. Rising from the hills of Surguja, it maintains a general north-easterly course and meets the Son in Bihar. The river has a dam on downstream side creating GBPS reservoir with a large spread area falling in Uttar Pradesh and Madhya Pradesh.

The Kanchan and Mayar are other rivers passing through western side of the study area. Confluence point of these two rivers is located at about 7 km from the site. These rivers also joins GBPS reservoir. The run-off water gets ultimately collected in river basin including the reservoir. The river water is used for drinking, agricultural and industrial purposes.

4.8.3 Groundwater Resource

The groundwater resource is primarily used for drinking and agricultural purposes. Because of the absence of water supply system in rural areas dependence on ground water is high. The groundwater aquifers are smaller in capacity and used extensively in rural areas.

Based on the available information, a water budget has been prepared for the Sarnaiya watershed and Gabaiya watershed. The estimated recharge of this area under the existing conditions is 41.17 ha and the specific yield is 22.5%. There are two watershed of the Gabaiya catchment. The groundwater recharge under the existing conditions for plant area is 55.64 ha. The specific yield of the area is 19.24%.

4.8.4 Water Quality

To understand the existing surface and groundwater quality, tests were performed in a laboratory. For this samples were collected, after reconnaissance, from various locations in the area and tested for water quality parameters.

4.8.4.1 Surface Water

The representative water samples of surface water were collected from three locations; one in the reservoir and the two on the upstream of Rihand / Rehar River. Water characteristics of the collected samples are provided in **Tables 4.28 to 4.30**. The results of heavy metal analysis are provided in **Table 4.31**.

Dissolved solids in the tested samples, are lower in concentration whereas suspended solids are relatively higher in summer season which can be attributed to rainy days during study period.

Mineral contents of the samples are generally influenced by the sampling locations. Nutrient loads in terms of nitrate and phosphate are lower. The COD and BOD values are also lower. Heavy metal concentrations as analyzed are insignificant in all the tested samples.

TABLE 4.28- SURFACE WATER QUALITY NEAR KARKOTA (REHAR RIVER)

S. No	Parameter	Unit	Results				Protocol
			Summer	Monsoon	Post-monsoon	Winter	
1.	pH	--	8.0	7.3	7.5	7.2	IS:3025 (Pt-11)
2.	Conductivity	µmhos/ cm	180	100	152	128	IS:3025(Pt-14)
3.	Total Suspended Solids	mg/l	54.0	281.7	57.3	28.5	IS:3025 (Pt-17)
4.	Turbidity	NTU	7.5	215.7	35.5	16.4	IS:3025 (Pt-10)
5.	T. Hardness as $CaCO_3$	mg/l	75.3	36.7	57.7	54.0	IS:3025 (Pt-21)
6.	Total Alkalinity as $CaCO_3$	mg/l	81	36	60	58	IS:3025 (Pt-23)
7.	Chemical Oxygen Demand	mg/l	9.7	9.3	8.8	10.5	5220B of APHA
8.	Bio-Chemical Oxygen Demand	mg/l	<5.0	<5.0	<5.0	<5.0	IS:3025 (Pt-44)
9.	Oil and Grease	mg/l	<1.0	<1.0	<1.0	<2.0	IS:3025 (Pt-39)
10.	Total Dissolved Solids	mg/l	122	70	86	80	IS:3025 (Pt-16)
11.	Sodium as Na	mg/l	7.7	3.0	7.0	6.3	IS:3025 (Pt-45)
12.	Potassium as K	mg/l	2.7	1.7	2.7	2.3	IS:3025 (Pt-45)
13.	Calcium as Ca	mg/l	18.0	10.7	15.3	14.7	IS:3025 (Pt-40)
14.	Magnesium as Mg	mg/l	7.3	2.3	4.7	4.0	IS:3025 (Pt-46)
15.	Fluoride as F	mg/l	0.5	0.3	0.6	0.1	SM(APHA)4500 FD
16.	Total Phosphorus as PO_4	mg/l	<0.02	0.03	<0.02	<0.02	SM (APHA) 4500 D
17.	Nitrates – Nitrogen	mg/l	0.78	0.87	0.85	0.43	IS:3025 (Pt-34)
18.	Silica as SiO_2	mg/l	13.9	13.5	11.6	7.2	4500 of APHA

S. No	Parameter	Unit	Results				Protocol
			Summer	Monsoon	Post-monsoon	Winter	
19.	Phenols as C_6H_5OH	mg/l	<0.01	<0.001	<0.001	<0.001	IS:3025 (Pt-43)
20.	Dissolved Oxygen	mg/l	6.8	7.2	6.6	6.1	APHA 4500 OC

TABLE 4.29- SURFACE WATER QUALITY NEAR BHARI (REHAR RIVER)

S. No	Parameter	Unit	Results				Protocol
			Summer	Monsoon	Post-monsoon	Winter	
1.	pH	--	8.1	7.3	7.4	7.5	IS:3025 (Pt-11)
2.	Conductivity	µmhos/ cm	128	105	121	125	IS:3025(Pt-14)
3.	Total Suspended Solids	mg/l	34.2	264.0	44.7	30.8	IS:3025 (Pt-17)
4.	Turbidity	NTU	7.5	217.0	42.6	15.7	IS:3025 (Pt-10)
5.	T. Hardness as $CaCO_3$	mg/l	49.3	37.3	46.7	51.7	IS:3025 (Pt-21)
6.	Total Alkalinity as $CaCO_3$	mg/l	48	37	49	56	IS:3025 (Pt-23)
7.	Chemical Oxygen Demand	mg/l	9.3	9.0	10.0	8.2	5220B of APHA
8.	Bio-Chemical Oxygen Demand	mg/l	<5.0	<5.0	<5.0	<5.0	IS:3025 (Pt-44)
9.	Oil and Grease	mg/l	<1.0	<1.0	<1.0	<2.0	IS:3025 (Pt-39)
10.	Total Dissolved Solids	mg/l	89	78	75	78	IS:3025 (Pt-16)
11.	Sodium as Na	mg/l	4.0	3.0	5.7	6.3	IS:3025 (Pt-45)
12.	Potassium as K	mg/l	2.3	1.7	2.0	2.0	IS:3025 (Pt-45)
13.	Calcium as Ca	mg/l	12.3	11.3	12.7	14.3	IS:3025 (Pt-40)
14.	Magnesium as Mg	mg/l	4.7	2.3	3.7	3.7	IS:3025 (Pt-46)
15.	Fluoride as F	mg/l	0.5	0.3	0.2	0.2	SM(APHA)4500FD
16.	Total Phosphorus as PO_4	mg/l	<0.02	0.6	<0.02	0.02	SM(APHA)4500D
17.	Nitrates – Nitrogen	mg/l	0.72	0.88	0.77	0.60	IS:3025 (Pt-34)
18.	Silica as SiO_2	mg/l	13.6	13.0	9.7	7.3	4500 of APHA
19.	Phenols as C_6H_5OH	mg/l	<0.01	<0.001	<0.001	<0.001	IS:3025 (Pt-43)
20.	Dissolved Oxygen	mg/l	6.5	6.4	6.5	6.1	APHA 4500 OC

TABLE 4.30- SURFACE WATER OF GOVIND BALLABH PANT RESERVOIR

S. NO.	PARAMETER	UNIT	RESULTS				PROTOCOL
			Summer	Monsoon	Post-monsoon	Winter	
1.	pH	--	8.0	7.3	7.6	7.4	IS:3025 (Pt-11)
2.	Conductivity	µmhos /cm	123	137	132	126	IS:3025(Pt-14)
3.	Total Suspended Solids	mg/l	41.6	355.0	27.0	22.0	IS:3025 (Pt-17)
4.	Turbidity	NTU	4.3	185.5	18.4	20.3	IS:3025 (Pt-10)
5.	T. Hardness as $CaCO_3$	mg/l	46.7	50.3	55.7	52.3	IS:3025 (Pt-21)
6.	Total Alkalinity as $CaCO_3$	mg/l	48	52	50	57	IS:3025 (Pt-23)
7.	Chemical Oxygen Demand	mg/l	8.0	11.0	12.0	10.5	5220B of APHA
8.	Bio-Chemical Oxygen Demand	mg/l	<5.0	<5.0	<5.0	<5.0	IS:3025 (Pt-44)
9.	Oil and Grease	mg/l	<1.0	<1.0	<1.0	<2.0	IS:3025 (Pt-39)

S. No.	Parameter	Unit	Results				Protocol
			Summer	Monsoon	Post-monsoon	Winter	
10.	Total Dissolved Solids	mg/l	85	100	90	79	IS:3025 (Pt-16)
11.	Sodium as Na	mg/l	4.0	4.7	6.7	6.3	IS:3025 (Pt-45)
12.	Potassium as K	mg/l	2.3	2.0	2.0	2.0	IS:3025 (Pt-45)
13.	Calcium as Ca	mg/l	12.3	13.7	14.0	14.0	IS:3025 (Pt-40)
14.	Magnesium as Mg	mg/l	4.0	4.0	3.3	4.0	IS:3025 (Pt-46)
15.	Fluoride as F	mg/l	0.5	0.5	0.3	0.2	SM(APHA)4500FD
16.	Total Phosphorus as PO_4	mg/l	<0.02	<0.02	<0.02	<0.02	SM(APHA)4500 D
17.	Nitrates – Nitrogen	mg/l	0.73	0.97	0.81	0.60	IS:3025 (Pt-34)
18.	Silica as SiO_2	mg/l	12.5	13.6	9.1	7.8	4500 APHA
19.	Phenols as C_6H_5OH	mg/l	<0.01	<0.001	<0.001	<0.001	IS:3025 (Pt-43)
20.	Dissolved Oxygen	mg/l	6.7	6.9	6.9	6.2	APHA 4500 OC

TABLE 4.31- HEAVY METAL ANALYSIS IN SURFACE WATER

S. No.	Parameters	Units	Sampling Locations		
			1	2	3
1.	Cadmium as Cd	mg/l	<0.01	<0.01	<0.01
2.	Zinc as zn	mg/l	0.03	0.06	0.05
3.	Copper as Cu	mg/l	<0.02	<0.02	<0.02
4.	Lead as Pb	mg/l	<0.1	<0.1	<0.1
5.	T. Chromium	mg/l	<0.01	<0.01	<0.01
6.	H. Chromium	mg/l	<0.01	<0.01	<0.01
7.	Iron as Fe	mg/l	1.66	0.96	1.25

1 = Near Karkota (Rehar River), 2= Near Bhari (Rehar river) , 3= Govind Ballabh Pant Reservoir

4.8.4.2 Ground Water

Groundwater data provided in Tables **4.32 to 4.41** shows significant variation in quality, due mainly to variation in geology. The nutrient load is lesser and heavy metals as analysed are within limits. The water is generally potable and used for domestic purpose in rural areas. The results of metal parameters analysis (summer) are provided in **Table 4.42.**

TABLE 4.32- GROUND WATER QUALITY OF TIARA VILLAGE

S. No.	Parameter	Unit	Results				Protocol
			Summer	Monsoon	Post-monsoon	Winter	
1.	pH	--	6.8	6.9	7.4	7.2	IS:3025 (Pt-11)
2.	Conductivity	µmhos / cm	457	771	880	754	IS:3025(Pt-14)
3.	Total Suspended Solids	mg/l	7.9	6.5	<5.0	<5.0	IS:3025 (Pt-17)
4.	Turbidity	NTU	35.7	10.8	14.5	15.2	IS:3025 (Pt-10)
5..	Total Alkalinity as $CaCO_3$	mg/l	189	355	386	392	IS:3025 (Pt-23)
6.	Temperature	°C	30.9	29.7	29.2	27.8	IS:3025 (Pt-9)

S. No.	Parameter	Unit	Results				Protocol
			Summer	Monsoon	Post-monsoon	Winter	
7.	T. Hardness as $CaCO_3$	mg/l	170	298	286	260	IS:3025 (Pt-21)
8.	Oil and Grease	mg/l	<1.0	<1.0	<1.0	<1.0	IS:3025 (Pt-39)
9.	Total Dissolved Solids	mg/l	296	513	584	562	IS:3025 (Pt-16)
10.	Sodium as Na	mg/l	28	52	84	75	IS:3025 (Pt-45)
11.	Potassium as K	mg/l	1.0	1.0	1.0	1.2	IS:3025 (Pt-45)
12.	Calcium as Ca	mg/l	54	75	74	58	IS:3025 (Pt-40)
13.	Magnesium as Mg	mg/l	8	27	24	28	IS:3025 (Pt-46)
14.	Fluoride as F	mg/l	1.2	2.3	2.5	1.8	SM (APHA) 4500 FD
15.	Total Phosphorus as PO_4	mg/l	<0.02	<0.02	<0.02	<0.02	SM (APHA) 4500 D
16.	Nitrates – Nitrogen	mg/l	1.8	4.0	3.8	3.8	IS:3025 (Pt-34)
17.	Silica as SiO_2	mg/l	34.3	32.7	37.2	31.5	4500SiO2 of APHA
18.	Phenols as C_6H_5OH	mg/l	<0.01	<0.01	<0.01	<0.01	IS:3025 (Pt-43)
19.	Mercury as Hg	mg/l	<0.01	<0.01	<0.01	<0.01	IS:3025 (Pt-48)
20.	Arsenic as As	mg/l	<0.01	<0.01	<0.01	<0.01	IS:3025 (Pt-37)
21.	Chloride as Cl	mg/l	22	28	34	31	IS:3025 (Pt-32)
22.	Sulphate as SO_4	mg/l	13	16	23	24	IS:3025 (Pt-24)
23.	Coliform Organism	MPN / 100ml	<1.1	<1.1	<1.1	<1.1	IS:1622

TABLE 4.33- GROUND WATER QUALITY OF SIDHI KHURD

S. No.	Parameter	Unit	Results				Protocol
			Summer	Monsoon	Post-monsoon	Winter	
1.	pH	--	6.9	6.6	6.8	7.01	IS:3025 (Pt-11)
2.	Conductivity	µmhos / cm	330	325	332.67	452	IS:3025(Pt-14)
3.	Total Suspended Solids	mg/l	6	1	<5.0	<5.0	IS:3025 (Pt-17)
4.	Turbidity	NTU	3	4	2.7	0.5	IS:3025 (Pt-10)
5..	Total Alkalinity as $CaCO_3$	mg/l	140	132	137	194	IS:3025 (Pt-23)
6.	Temperature	°C	32.4	30.7	27.8	27.8	IS:3025 (Pt-9)
7.	T. Hardness as $CaCO_3$	mg/l	110	105	97	140	IS:3025 (Pt-21)

S. No.	Parameter	Unit	Results				Protocol
			Summer	Monsoon	Post-monsoon	Winter	
8.	Oil and Grease	mg/l	<1.0	<1.0	<1.0	<1.0	IS:3025 (Pt-39)
9.	Total Dissolved Solids	mg/l	210	213	219	297	IS:3025 (Pt-16)
10.	Sodium as Na	mg/l	26	22	30	43	IS:3025 (Pt-45)
11.	Potassium as K	mg/l	<1.0	<1.0	<1.0	<1.0	IS:3025 (Pt-45)
12.	Calcium as Ca	mg/l	33	33	35	41	IS:3025 (Pt-40)
13.	Magnesium as Mg	mg/l	6	9	3	9	IS:3025 (Pt-46)
14.	Fluoride as F	mg/l	1.9	2.0	2	1.8	SM (APHA) 4500 FD
15.	Total Phosphorus as PO_4	mg/l	<0.02	<0.02	<0.02	<0.02	SM (APHA) 4500 D
16.	Nitrates – Nitrogen	mg/l	2.5	2.7	3	3.0	IS:3025 (Pt-34)
17.	Silica as SiO_2	mg/l	57.1	41.5	42	40.2	4500SiO2 of APHA
18.	Phenols as C_6H_5OH	mg/l	<0.001	<0.001	<0.001	<0.001	IS:3025 (Pt-43)
19.	Mercury as Hg	mg/l	<0.01	<0.01	<0.01	<0.01	IS:3025 (Pt-48)
20.	Arsenic as As	mg/l	<0.01	<0.01	<0.01	<0.01	IS:3025 (Pt-37)
21.	Chloride as Cl	mg/l	9	11	11	17	IS:3025 (Pt-32)
22.	Sulphate as SO_4	mg/l	5	6	5	10	IS:3025 (Pt-24)
23.	Coliform Organism	MPN / 100ml	<1.1	<1.1	<1.1	<1.1	IS:1622

TABLE 4.34- GROUND WATER QUALITY OF GARHARA

S. No.	Parameter	Unit	Results				Protocol
			Summer	Monsoon	Post-monsoon	Winter	
1.	pH	--	7.8	7.7	7.6	7.5	IS:3025 (Pt-11)
2.	Conductivity	µmhos / cm	797	757	784.00	778.00	IS:3025(Pt-14)
3.	Total Suspended Solids	mg/l	<5.0	<5.0	<5.0	<5.0	IS:3025 (Pt-17)
4.	Turbidity	NTU	2.7	1.4	2.1	2.1	IS:3025 (Pt-10)
5..	Total Alkalinity as $CaCO_3$	mg/l	250	247	248	245.00	IS:3025 (Pt-23)
6.	Temperature	°C	30.7	29.5	29.4	29.2	IS:3025 (Pt-9)
7.	T. Hardness as $CaCO_3$	mg/l	322	303	304	299	IS:3025 (Pt-21)
8.	Oil and Grease	mg/l	<1.0	<1.0	<1.0	<1.0	IS:3025 (Pt-39)

S. No.	Parameter	Unit	Results				Protocol
			Summer	Monsoon	Post-monsoon	Winter	
9.	Total Dissolved Solids	mg/l	449	436	445	434	IS:3025 (Pt-16)
10.	Sodium as Na	mg/l	31	28	29	27	IS:3025 (Pt-45)
11.	Potassium as K	mg/l	1.0	1.4	1.5	1.4	IS:3025 (Pt-45)
12.	Calcium as Ca	mg/l	102	98	97	95	IS:3025 (Pt-40)
13.	Magnesium as Mg	mg/l	16	14	15	15	IS:3025 (Pt-46)
14.	Fluoride as F	mg/l	1.1	1.4	1.2	1.2	SM (APHA) 4500 FD
15.	Total Phosphorus as PO_4	mg/l	<0.02	<0.02	<0.02	<0.02	SM (APHA) 4500 D
16.	Nitrates – Nitrogen	mg/l	6.0	5.7	5.6	5.7	IS:3025 (Pt-34)
17.	Silica as SiO_2	mg/l	27.4	27.2	28	27	4500SiO2 of APHA
18.	Phenols as C_6H_5OH	mg/l	<0.01	<0.01	<0.01	<0.01	IS:3025 (Pt-43)
19.	Mercury as Hg	mg/l	<0.01	<0.01	<0.01	<0.01	IS:3025 (Pt-48)
20.	Arsenic as As	mg/l	<0.01	<0.01	<0.01	<0.01	IS:3025 (Pt-37)
21.	Chloride as Cl	mg/l	79	68	75	74	IS:3025 (Pt-32)
22.	Sulphate as SO_4	mg/l	32	32	31	28	IS:3025 (Pt-24)
23.	Coliform Organism	MPN / 100ml	<1.1	<1.1	<1.1	<1.1	IS:1622

TABLE 4.35- GROUND WATER QUALITY OF PROJECT SITE

S. No.	Parameter	Unit	Results				Protocol
			Summer	Monsoon	Post-monsoon	Winter	
1.	pH	--	7.4	7.3	7.2	7.1	IS:3025 (Pt-11)
2.	Conductivity	µmhos / cm	584	487	535	520	IS:3025(Pt-14)
3.	Total Suspended Solids	mg/l	6	<5.0	<5.0	<5.0	IS:3025 (Pt-17)
4.	Turbidity	NTU	1.4	1.2	1.1	0.8	IS:3025 (Pt-10)
5..	Total Alkalinity as $CaCO_3$	mg/l	293	248	257	269	IS:3025 (Pt-23)
6.	Temperature	°C	32.5	29.8	28.5	28.1	IS:3025 (Pt-9)
7.	T. Hardness as $CaCO_3$	mg/l	229	212	214	242	IS:3025 (Pt-21)
8.	Oil and Grease	mg/l	<1.0	<1.0	<1.0	<1.0	IS:3025 (Pt-39)
9.	Total Dissolved Solids	mg/l	377	324	347	354	IS:3025 (Pt-16)

S. No.	Parameter	Unit	Results				Protocol
			Summer	Monsoon	Post-monsoon	Winter	
10.	Sodium as Na	mg/l	38	28	32	31	IS:3025 (Pt-45)
11.	Potassium as K	mg/l	1.3	1.2	0.9	0.8	IS:3025 (Pt-45)
12.	Calcium as Ca	mg/l	68	57	61	67	IS:3025 (Pt-40)
13.	Magnesium as Mg	mg/l	14	17	15	18	IS:3025 (Pt-46)
14.	Fluoride as F	mg/l	3.10	2.7	2.5	2.8	SM (APHA) 4500 FD
15.	Total Phosphorus as PO_4	mg/l	<0.02	<0.02	<0.02	<0.02	SM (APHA) 4500 D
16.	Nitrates – Nitrogen	mg/l	<0.1	<0.1	<0.1	<0.1	IS:3025 (Pt-34)
17.	Silica as SiO_2	mg/l	44.6	43.2	42.5	41.6	4500SiO2 of APHA
18.	Phenols as C_6H_5OH	mg/l	<0.01	<0.01	<0.01	<0.01	IS:3025 (Pt-43)
19.	Mercury as Hg	mg/l	<0.01	<0.01	<0.01	<0.01	IS:3025 (Pt-48)
20.	Arsenic as As	mg/l	<0.01	<0.01	<0.01	<0.01	IS:3025 (Pt-37)
21.	Chloride as Cl	mg/l	9	8	11	12	IS:3025 (Pt-32)
22.	Sulphate as SO_4	mg/l	10	9	12	11	IS:3025 (Pt-24)
23.	Coliform Organism	MPN / 100ml	<1.1	<1.1	<1.1	<1.1	IS:1622

TABLE 4.36- GROUND WATER QUALITY OF GIDDA KHARI VILLAGE

S. No.	Parameter	Unit	Results				Protocol
			Summer	Monsoon	Post-monsoon	Winter	
1.	pH	--	7.7	7.2	7.1	7.3	IS:3025 (Pt-11)
2.	Conductivity	µmhos / cm	730	640	680	725	IS:3025(Pt-14)
3.	Total Suspended Solids	mg/l	<5.0	<5.0	<5.0	<5.0	IS:3025 (Pt-17)
4.	Turbidity	NTU	1.9	2.0	2.1	1.8	IS:3025 (Pt-10)
5..	Total Alkalinity as $CaCO_3$	mg/l	365	345	347	357.00	IS:3025 (Pt-23)
6.	Temperature	°C	32.4	29.8	28.2	28.5	IS:3025 (Pt-9)
7.	T. Hardness as $CaCO_3$	mg/l	165	145	148	167	IS:3025 (Pt-21)
8.	Oil and Grease	mg/l	<1.0	<1.0	<1.0	<1.0	IS:3025 (Pt-39)
9.	Total Dissolved Solids	mg/l	443	405	422	436	IS:3025 (Pt-16)
10.	Sodium as Na	mg/l	105	89	98	97	IS:3025 (Pt-45)

S. No.	Parameter	Unit	Results				Protocol
			Summer	Monsoon	Post-monsoon	Winter	
11.	Potassium as K	mg/l	1.0	1.2	1.3	1.4	IS:3025 (Pt-45)
12.	Calcium as Ca	mg/l	40	35	38	42	IS:3025 (Pt-40)
13.	Magnesium as Mg	mg/l	16	14	13	15	IS:3025 (Pt-46)
14.	Fluoride as F	mg/l	2.5	1.4	1.5	1.6	SM (APHA) 4500 FD
15.	Total Phosphorus as PO_4	mg/l	<0.02	<0.02	<0.02	<0.02	SM (APHA) 4500 D
16.	Nitrates – Nitrogen	mg/l	1.3	1.4	1.5	1.6	IS:3025 (Pt-34)
17.	Silica as SiO_2	mg/l	25.7	21.4	23	24	4500SiO2 of APHA
18.	Phenols as C_6H_5OH	mg/l	<0.01	<0.01	<0.01	<0.01	IS:3025 (Pt-43)
19.	Mercury as Hg	mg/l	<0.01	<0.01	<0.01	<0.01	IS:3025 (Pt-48)
20.	Arsenic as As	mg/l	<0.01	<0.01	<0.01	<0.01	IS:3025 (Pt-37)
21.	Chloride as Cl	mg/l	16	14	13	15	IS:3025 (Pt-32)
22.	Sulphate as SO_4	mg/l	9	8	10	11	IS:3025 (Pt-24)
23.	Coliform Organism	MPN / 100ml	<1.1	<1.1	<1.1	<1.1	IS:1622

TABLE 4.37- GROUND WATER QUALITY OF HARRAHAWA VILLAGE

S. No.	Parameter	Unit	Results				Protocol
			Summer	Monsoon	Post-monsoon	Winter	
1.	pH	--	7.0	6.8	6.7	7.2	IS:3025 (Pt-11)
2.	Conductivity	µmhos / cm	566	524	535	514	IS:3025(Pt-14)
3.	Total Suspended Solids	mg/l	<5.0	<5.0	<5.0	<5.0	IS:3025 (Pt-17)
4.	Turbidity	NTU	1.1	1.2	0.8	1.2	IS:3025 (Pt-10)
5..	Total Alkalinity as $CaCO_3$	mg/l	197	175	182	192.00	IS:3025 (Pt-23)
6.	Temperature	°C	32.4	31.2	28.9	28.2	IS:3025 (Pt-9)
7.	T. Hardness as $CaCO_3$	mg/l	196	177	173	170	IS:3025 (Pt-21)
8.	Oil and Grease	mg/l	<1.0	<1.0	<1.0	<1.0	IS:3025 (Pt-39)
9.	Total Dissolved Solids	mg/l	339	324	327	335	IS:3025 (Pt-16)
10.	Sodium as Na	mg/l	36	34	32	28	IS:3025 (Pt-45)
11.	Potassium as K	mg/l	4.0	3.0	2.0	2.5	IS:3025 (Pt-45)

S. No.	Parameter	Unit	Results				Protocol
			Summer	Monsoon	Post-monsoon	Winter	
12.	Calcium as Ca	mg/l	44	41	38	35	IS:3025 (Pt-40)
13.	Magnesium as Mg	mg/l	21	18	19	20	IS:3025 (Pt-46)
14.	Fluoride as F	mg/l	3.0	2.5	2.8	2.8	SM (APHA) 4500 FD
15.	Total Phosphorus as PO_4	mg/l	<0.02	<0.02	<0.02	<0.02	SM (APHA) 4500 D
16.	Nitrates – Nitrogen	mg/l	7.5	7.6	7.2	7.0	IS:3025 (Pt-34)
17.	Silica as SiO_2	mg/l	50.6	47.8	49	48	4500SiO2 of APHA
18.	Phenols as C_6H_5OH	mg/l	<0.01	<0.01	<0.01	<0.01	IS:3025 (Pt-43)
19.	Mercury as Hg	mg/l	<0.01	<0.01	<0.01	<0.01	IS:3025 (Pt-48)
20.	Arsenic as As	mg/l	<0.01	<0.01	<0.01	<0.01	IS:3025 (Pt-37)
21.	Chloride as Cl	mg/l	22	21	18	19	IS:3025 (Pt-32)
22.	Sulphate as SO_4	mg/l	25	23	22	20	IS:3025 (Pt-24)
23.	Coliform Organism	MPN / 100ml	<1.1	<1.1	<1.1	<1.1	IS:1622

TABLE 4.38- GROUND WATER QUALITY OF KARKOTA VILLAGE

S. No.	Parameter	Unit	Results				Protocol
			Summer	Monsoon	Post-monsoon	Winter	
1.	pH	--	6.8	7.0	6.9	7.2	IS:3025 (Pt-11)
2.	Conductivity	µmhos / cm	327	328	315	336	IS:3025(Pt-14)
3.	Total Suspended Solids	mg/l	<5.0	<5.0	<5.0	<5.0	IS:3025 (Pt-17)
4.	Turbidity	NTU	156.0	154.1	148.7	157.2	IS:3025 (Pt-10)
5..	Total Alkalinity as $CaCO_3$	mg/l	102	98	94	99	IS:3025 (Pt-23)
6.	Temperature	°C	31.4	29.8	28.7	29.5	IS:3025 (Pt-9)
7.	T. Hardness as $CaCO_3$	mg/l	109	91	96	105	IS:3025 (Pt-21)
8.	Oil and Grease	mg/l	<2.0	<2.0	<2.0	<2.0	IS:3025 (Pt-39)
9.	Total Dissolved Solids	mg/l	218	206	210	208	IS:3025 (Pt-16)
10.	Sodium as Na	mg/l	30	27	25	22	IS:3025 (Pt-45)
11.	Potassium as K	mg/l	<1.0	<1.0	<1.0	<1.0	IS:3025 (Pt-45)
12.	Calcium as Ca	mg/l	34	28	27	32	IS:3025 (Pt-40)

S. No.	Parameter	Unit	Results				Protocol
			Summer	Monsoon	Post-monsoon	Winter	
13.	Magnesium as Mg	mg/l	6	5	7	6	IS:3025 (Pt-46)
14.	Fluoride as F	mg/l	1.3	1.4	1.2	1.3	SM (APHA) 4500 FD
15.	Total Phosphorus as PO_4	mg/l	<0.02	<0.02	<0.02	<0.02	SM (APHA) 4500 D
16.	Nitrates – Nitrogen	mg/l	2.9	3.4	2.8	3.2	IS:3025 (Pt-34)
17.	Silica as SiO_2	mg/l	37	25	31	27	4500SiO2 of APHA
18.	Phenols as C_6H_5OH	mg/l	<0.01	<0.01	<0.01	<0.01	IS:3025 (Pt-43)
19.	Mercury as Hg	mg/l	<0.01	<0.01	<0.01	<0.01	IS:3025 (Pt-48)
20.	Arsenic as As	mg/l	<0.01	<0.01	<0.01	<0.01	IS:3025 (Pt-37)
21.	Chloride as Cl	mg/l	11	10	12	10	IS:3025 (Pt-32)
22.	Sulphate as SO_4	mg/l	6	7	5	5	IS:3025 (Pt-24)
23.	Coliform Organism	MPN / 100ml	<1.1	<1.1	<1.1	<1.1	IS:1622

TABLE 4.39- GROUND WATER QUALITY OF JHANJHI TOLA VILLAGE

S. No.	Parameter	Unit	Results				Protocol
			Summer	Monsoon	Post-monsoon	Winter	
1.	pH	--	7.1	7.0	7.2	7.7	IS:3025 (Pt-11)
2.	Conductivity	µmhos / cm	748	644	698	738	IS:3025(Pt-14)
3.	Total Suspended Solids	mg/l	6	5	<5.0	<5.0	IS:3025 (Pt-17)
4.	Turbidity	NTU	1.2	2.1	1.1	1.2	IS:3025 (Pt-10)
5..	Total Alkalinity as $CaCO_3$	mg/l	397	311	318	374.00	IS:3025 (Pt-23)
6.	Temperature	°C	30.8	29.7	28.5	27.5	IS:3025 (Pt-9)
7.	T. Hardness as $CaCO_3$	mg/l	275	224	254	275	IS:3025 (Pt-21)
8.	Oil and Grease	mg/l	<1.0	<1.0	<1.0	<1.0	IS:3025 (Pt-39)
9.	Total Dissolved Solids	mg/l	489	424	459	470	IS:3025 (Pt-16)
10.	Sodium as Na	mg/l	68	55	59	68	IS:3025 (Pt-45)
11.	Potassium as K	mg/l	1	1	2	2	IS:3025 (Pt-45)
12.	Calcium as Ca	mg/l	64	54	65	70	IS:3025 (Pt-40)
13.	Magnesium as Mg	mg/l	28	21	22	24	IS:3025 (Pt-46)

S. No.	Parameter	Unit	Results				Protocol
			Summer	Monsoon	Post-monsoon	Winter	
14.	Fluoride as F	mg/l	3.3	3.2	2.7	2.2	SM (APHA) 4500 FD
15.	Total Phosphorus as PO_4	mg/l	<0.02	<0.02	<0.02	<0.02	SM (APHA) 4500 D
16.	Nitrates – Nitrogen	mg/l	<0.1	<0.1	2	2	IS:3025 (Pt-34)
17.	Silica as SiO_2	mg/l	48.8	37.1	32	31	4500SiO2 of APHA
18.	Phenols as C_6H_5OH	mg/l	<0.01	<0.01	<0.01	<0.01	IS:3025 (Pt-43)
19.	Mercury as Hg	mg/l	<0.01	<0.01	<0.01	<0.01	IS:3025 (Pt-48)
20.	Arsenic as As	mg/l	<0.01	<0.01	<0.01	<0.01	IS:3025 (Pt-37)
21.	Chloride as Cl	mg/l	9	12	9	11	IS:3025 (Pt-32)
22.	Sulphate as SO_4	mg/l	20	16	20	25	IS:3025 (Pt-24)
23.	Coliform Organism	MPN / 100ml	<1.1	<1.1	<1.1	<1.1	IS:1622

TABLE 4.40- GROUND WATER QUALITY OF NEAR JHANJI VILLAGE

S. No.	Parameter	Unit	Results				Protocol
			Summer	Monsoon	Post-monsoon	Winter	
1.	pH	--	7.9	7.4	7.5	7.1	IS:3025 (Pt-11)
2.	Conductivity	µmhos / cm	431	428	421	438	IS:3025(Pt-14)
3.	Total Suspended Solids	mg/l	33	28	25	27	IS:3025 (Pt-17)
4.	Turbidity	NTU	39.3	34.5	35.7	36.4	IS:3025 (Pt-10)
5..	Total Alkalinity as $CaCO_3$	mg/l	204	198	201	208	IS:3025 (Pt-23)
6.	Temperature	°C	30.7	29.8	29.9	30.1	IS:3025 (Pt-9)
7.	T. Hardness as $CaCO_3$	mg/l	145	137	136	143	IS:3025 (Pt-21)
8.	Oil and Grease	mg/l	<1.0	<1.0	<1.0	<1.0	IS:3025 (Pt-39)
9.	Total Dissolved Solids	mg/l	291	290	278	292	IS:3025 (Pt-16)
10.	Sodium as Na	mg/l	40	35	37	38	IS:3025 (Pt-45)
11.	Potassium as K	mg/l	1.0	1.4	1.2	1.5	IS:3025 (Pt-45)
12.	Calcium as Ca	mg/l	40	35	38	39	IS:3025 (Pt-40)
13.	Magnesium as Mg	mg/l	11	12	10	11	IS:3025 (Pt-46)
14.	Fluoride as F	mg/l	2.4	2.30	2.50	3	SM (APHA) 4500 FD

S. No.	Parameter	Unit	Results				Protocol
			Summer	Monsoon	Post-monsoon	Winter	
15.	Total Phosphorus as PO_4	mg/l	<0.02	<0.02	<0.02	<0.02	SM (APHA) 4500 D
16.	Nitrates – Nitrogen	mg/l	<0.1	<0.1	<0.1	<0.1	IS:3025 (Pt-34)
17.	Silica as SiO_2	mg/l	54.2	52.1	50.7	53.2	4500SiO2 of APHA
18.	Phenols as C_6H_5OH	mg/l	<0.01	<0.01	<0.01	<0.01	IS:3025 (Pt-43)
19.	Mercury as Hg	mg/l	<0.01	<0.01	<0.01	<0.01	IS:3025 (Pt-48)
20.	Arsenic as As	mg/l	<0.01	<0.01	<0.01	<0.01	IS:3025 (Pt-37)
21.	Chloride as Cl	mg/l	11	11	11	11	IS:3025 (Pt-32)
22.	Sulphate as SO_4	mg/l	15	13	14	15	IS:3025 (Pt-24)
23.	Coliform Organism	MPN / 100ml	<1.1	<1.1	<1.1	<1.1	IS:1622

TABLE 4.41- GROUND WATER QUALITY OF NEAR MOHANBAN FOREST

S. No.	Parameter	Unit	Results				Protocol
			Summer	Monsoon	Post-monsoon	Winter	
1.	pH	--	7.5	7.4	7.4	7.6	IS:3025 (Pt-11)
2.	Conductivity	µmhos / cm	712	658	710	724	IS:3025(Pt-14)
3.	Total Suspended Solids	mg/l	<5.0	<5.0	<5.0	<5.0	IS:3025 (Pt-17)
4.	Turbidity	NTU	1.3	0.9	1.1	0.8	IS:3025 (Pt-10)
5..	Total Alkalinity as $CaCO_3$	mg/l	367	345	354	369	IS:3025 (Pt-23)
6.	Temperature	°C	31.0	30.4	29.5	29.7	IS:3025 (Pt-9)
7.	T. Hardness as $CaCO_3$	mg/l	348	327	332	344	IS:3025 (Pt-21)
8.	Oil and Grease	mg/l	<1.0	<1.0	<1.0	<1.0	IS:3025 (Pt-39)
9.	Total Dissolved Solids	mg/l	455	422	421	448	IS:3025 (Pt-16)
10.	Sodium as Na	mg/l	24	25	26	21	IS:3025 (Pt-45)
11.	Potassium as K	mg/l	1	1	0.8	0.9	IS:3025 (Pt-45)
12.	Calcium as Ca	mg/l	73	70	72	75	IS:3025 (Pt-40)
13.	Magnesium as Mg	mg/l	40	37	37	38	IS:3025 (Pt-46)
14.	Fluoride as F	mg/l	1.0	1.2	1.3	0.9	SM (APHA) 4500 FD
15.	Total Phosphorus as	mg/l	<0.02	<0.02	<0.02	<0.02	SM (APHA) 4500 D

S. No.	Parameter	Unit	Results				Protocol
			Summer	Monsoon	Post-monsoon	Winter	
	PO_4						
16.	Nitrates – Nitrogen	mg/l	4.6	4.5	4.6	5.1	IS:3025 (Pt-34)
17.	Silica as SiO_2	mg/l	50.0	54.1	53.2	51.7	4500SiO2 of APHA
18.	Phenols as C_6H_5OH	mg/l	<0.01	<0.01	<0.01	<0.01	IS:3025 (Pt-43)
19.	Mercury as Hg	mg/l	<0.01	<0.01	<0.01	<0.01	IS:3025 (Pt-48)
20.	Arsenic as As	mg/l	<0.01	<0.01	<0.01	<0.01	IS:3025 (Pt-37)
21.	Chloride as Cl	mg/l	15	14.5	15.8	15.2	IS:3025 (Pt-32)
22.	Sulphate as SO_4	mg/l	10.7	11.3	10.8	11.1	IS:3025 (Pt-24)
23.	Coliform Organism	MPN / 100ml	<1.1	<1.1	<1.1	<1.1	IS:1622

TABLE 4.42- HEAVY METALS

S. No	Parameters	Units	Sampling Locations									
			GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8	GW9	GW10
1.	**Cadmium as Cd**	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2.	**Zinc as Zn**	mg/l	0.15	0.08	0.09	0.3	0.11	0.8	0.2	0.09	0	0.02
3.	**Copper as Cu**	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
4.	**Lead as Pb**	mg/l	<0.01	<0.1	<0.01	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
5.	**T. Chromium**	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
6.	**H. Chromium**	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
7.	**Iron as Fe**	mg/l	<0.05	0.37	0.41	<0.05	2.16	<0.05	<0.05	<0.05	<0.05	<0.05

4.9 AMBIENT NOISE QUALITY

4.9.1 Noise Sources

The project site is located primarily in a rural area. However, several sources contributing to noise levels specially the rail/road traffic and commercial activities are available in the area. Movement of heavy vehicles, tankers and trucks in particular contribute to existing background levels.

4.9.2 Noise Levels

The traffic activity is the main source for higher noise in the area. However, the levels drop considerably during night time. The peak and background noise levels at selected locations were monitored within study area at hourly intervals during day and night-time during the period. The results are presented in **Tables 4.43 and 4.44**. The distribution of Leq is similar to the distribution of L10 indicating the effects of correlation between Leq and L10. The noise levels are generally higher at Waidhan which may be due to road traffic and commercial activities. Measured noise levels are observed to be in compliance with prescribed standards for ambient noise for the respective applicable categories.

TABLE 4.43- NOISE LEVELS IN STUDY AREA, SUMMER

Sampling Location	Distance (km)	Direction	Noise Level in dB (A)					
			Day (6am to 10 pm)			Night (10 pm to 6 am)		
			L10	L90	Leq	L10	L90	Leq
Project Site	-	-	52.8	36.4	42.7	37.2	32.6	34.9
Waidhan	9.5	N	60.9	44.7	49.8	41.8	36.4	38.2
Sasan	3.5	N	49.6	40.2	44.2	41.6	33.8	36.3
Tiyara	5.0	NW	51.4	39.8	43.6	39.4	34.6	36.7
Tusa	5.0	NE	54.7	42.3	47.7	40.3	34.9	37.8
Keraha	4.0	SW	48.1	38.5	42.6	38.2	32.1	34.6
Pedarwah	4.5	SW	52.6	41.8	45.6	42.3	31.7	35.6
Harrhawa	2.5	SE	47.2	38.6	41.8	36.4	32.1	34.3
Pipra	3.5	NW	48.1	37.7	40.2	37.3	33.4	35.5
Bhari	2.5	E	46.8	37.5	40.3	36.8	32.7	34.1

TABLE 4.44- NOISE LEVELS IN STUDY AREA, WINTER

Sampling Location	Distance (km)	Direction	Noise Level in dB (A)					
			Day (6am to 10 pm)			Night (10 pm to 6 am)		
			L10	L90	Leq	L10	L90	Leq
Project Site	-	-	54.1	36.9	43.3	36.8	33.6	35.3
Waidhan	9.5	N	58.7	43.1	48.6	40.7	35.8	37.6
Sasan	3.5	N	50.3	39.3	44.7	38.6	32.7	35.4
Tiyara	5	NW	52.6	38.4	42.2	40.8	35.3	37.7
Tusa	5	NE	53.9	40.8	46.4	39.2	33.4	35.9
Keraha	4	SW	49.2	37.3	43.1	37.5	32.8	35.1
Pedarwah	4.5	SW	50.4	39.8	44.6	40.9	32.3	34.8
Harrhawa	2.5	SE	48.7	37.6	40.9	35.8	32.6	33.9
Pipra	3.5	NW	46.4	36.7	40.8	36.3	32.8	34.2
Bhari	2.5	E	45.9	36.3	39.7	35.7	32.1	34

4.10 TRAFFIC ENVIRONMENT

4.10.1 Traffic Survey

Transport sector causes noise generating activities especially in those areas where the highways merge with urban roads. The existing NH-75 passes through the area at peripheral location at about one (1) km from Waidhan. The site is connected to Waidhan by a metalled road. The existing NH-75 connects the area to the district town of Sidhi. The existing road connecting the site to Waidhan does not bring in significant traffic load on the existing highways.

Since road transport constitutes a major source of ambient noise in the area, a survey was conducted to find out possible correlations with existing noise levels.

4.10.2 Traffic Noise

Traffic noise levels depend mainly on the type, number and conditions of vehicles and road conditions. The traffic noise peaks up with heavy vehicles which are noisier than other vehicles. The number of light vehicles is found to be higher than that of medium and heavy vehicles (**Tables 4.45 to 4.47**). Therefore, measured noise levels at Waidhan were found to

be peaking together with traffic flow both during day and night time, though the levels are in general conformity with the prescribed standards for applicable category.

TABLE 4.45- AVERAGE TRAFFIC SURVEY DATA AT WAIDHAN (GANIYARI)

Time (Hours)	Incoming : Waidhan			Outgoing : Sasan Project Site & Bijpur		
	Heavy	Medium	Light	Heavy	Medium	Light
0600-0700	8	11	41	7	8	49
0700-0800	21	14	98	11	8	50
0800-0900	14	17	91	17	14	68
0900-1000	16	14	78	9	17	65
1000-1100	16	13	79	22	19	68
1100-1200	15	11	66	21	14	82
1200-1300	12	23	44	14	10	59
1300-1400	10	10	45	15	8	41
1400-1500	14	14	23	9	12	27
1500-1600	16	10	33	17	12	45
1600-1700	16	15	33	9	22	45
1700-1800	14	22	27	13	12	46
1800-1900	19	25	33	14	18	42
1900-2000	18	18	33	14	17	37
2000-2100	11	14	29	11	24	41
2100-2200	7	10	29	5	11	23
2200-2300	-	5	15	-	-	17
2300-2400	-	-	11	-	-	-
2400-0100	2	-	-	-	-	-
0100-0200	-	-	-	-	-	-
0200-0300	-	-	-	-	-	-
0300-0400	-	-	-	-	7	-
0400-0500	3	-	10	5	6	9
0500-0600	5	12	22	5	7	27

TABLE 4.46- AVERAGE TRAFFIC SURVEY DATA AT WAIDHAN STADIUM

Time (Hours)	Incoming : Waidhan			Outgoing : Sidhi & Varanasi		
	Heavy	Medium	Light	Heavy	Medium	Light
0600-0700	20	38	66	40	55	76
0700-0800	25	43	104	46	58	89
0800-0900	62	76	113	71	88	139
0900-1000	57	69	149	67	84	155
1000-1100	47	68	156	77	100	226
1100-1200	63	144	250	113	145	224
1200-1300	75	112	238	113	161	241
1300-1400	75	91	213	96	113	156
1400-1500	83	105	115	98	105	173
1500-1600	82	90	139	74	86	123
1600-1700	56	76	109	75	108	224
1700-1800	73	181	167	85	165	290
1800-1900	81	168	186	68	109	193
1900-2000	73	103	85	56	62	145
2000-2100	67	84	68	44	50	128

Time (Hours)	Incoming : Waidhan			Outgoing : Sidhi & Varanasi		
	Heavy	Medium	Light	Heavy	Medium	Light
2100-2200	58	60	63	39	48	97
2200-2300	37	31	51	28	33	71
2300-2400	32	15	37	24	23	30
2400-0100	7	9	5	14	11	13
0100-0200	7	7	-	14	13	11
0200-0300	12	12	-	16	17	17
0300-0400	17	23	15	24	26	22
0400-0500	21	35	41	28	28	36
0500-0600	23	37	45	34	38	43

TABLE 4.47- AVERAGE TRAFFIC SURVEY DATA AT NEAR HOTEL RAJKAMAL, SUMMER

Time (Hours)	Incoming : Waidhan			Outgoing : Vindhya Nagar & Shakti Nagar		
	Heavy	Medium	Light	Heavy	Medium	Light
0600-0700	23	50	82	35	48	168
0700-0800	35	79	136	50	64	199
0800-0900	28	77	173	42	60	214
0900-1000	22	69	215	24	57	203
1000-1100	30	86	235	31	77	234
1100-1200	22	66	164	19	61	162
1200-1300	21	67	161	33	79	169
1300-1400	11	84	125	16	77	129
1400-1500	21	95	119	23	93	107
1500-1600	14	43	127	23	62	103
1600-1700	11	50	145	22	44	191
1700-1800	16	114	198	32	106	179
1800-1900	43	132	191	60	111	164
1900-2000	38	89	101	50	83	95
2000-2100	42	64	78	48	57	69
2100-2200	34	43	61	37	43	42
2200-2300	31	37	47	21	25	28
2300-2400	23	25	28	25	17	16
2400-0100	17	16	13	16	11	-
0100-0200	14	12	-	9	10	-
0200-0300	21	13	-	12	10	-
0300-0400	21	19	31	14	18	13
0400-0500	20	27	37	19	25	29
0500-0600	21	45	57	31	38	92

Note: ***Heavy – Bus, Truck, Dumper etc.***
Medium – Car, Jeep, Matador, Mini Bus, etc
Light - Scooter, Motorcycle

4.11 ECOLOGICAL ENVIRONMENT

4.11.1 Terrestrial System

The terrestrial system essentially consists of vegetation and land-based ecological system. The present study of core area involves reconnaissance using satellite data and ground sampling and analysis.

In the study, available published reports and forest records were also used in preparing the status of forest land.

4.11.1.1 Reconnaissance Survey

The biological components of general study area are highly degraded with low to medium biological diversity. The present status of biological components in the study area was examined with respect to existing land-use and other terrestrial attributes of the area.

4.11.1.2 Floristic Composition

The protected forest lands existing in the area are completely degraded as compared to the reserve forest area. Mohanban reserve forest located at about 4 km southwest of the project site is also degraded.

The revenue lands under wasteland or grazing land category are essentially marginal lands without vegetation cover. The forests in general are under biotic stress with natural vegetation giving way to other species.

The investigation of terrestrial ecosystem was carried out at ten (10) locations using 30 x 30 m^2 quadrates for the evaluation of phyto-sociological characteristics of woody species and twenty (20) locations using 50 x 50 cm^2 quadrates for the herbaceous flora.

The terrestrial investigation carried out for woody species shows that on the Site I, i.e. **Scrub Forest**, the number of woody species is quite less (13). *Acacia catechu, Holerrbena antidysentrica* and *Butea monosperma* are the main woody species. Species richness is found to be lower at this site but many species participated in the community formation, hence species equitability was found to be highest among the three selected sites (**Table 4.48**).

On the Site- II, i.e. **Mohanban Reserve Forest** diversity is similar to Site I but species richness was higher and species equitability was lower than Site-I. This implies that only few species were predominant in the area. The species are *Tectona grandis, Butea monosperma* and *Diospyros melanoxylon* (**Table 4.48**).

On the Site- III i.e., **Chargoda Forest** most of the vegetation is artificially planted, and the number of natural flora is less. Mostly *Rauwolfia serpentina, Holerrbena antidysentrica, Butea monosperma* are found at this location (**Table 4.48**).

The terrestrial herbaceous species investigation shows that on the Site –I, i.e. **Scrub Forest**, number of species is 12 and the dominant herbs are *Eragrastis tenella, Hyptis suaveolensis* and *Vernonis cinerea* (**Table 4.49**).

On the Site-II, i.e. **Mohanban Reserve Forest**, the number of species is 20. The predominant herbs are *Eragrastis tenella, Hyptis suaveolensis* and *Vernonia cinera*.

On the Site III i.e. **Chargoda forest**, the number of species is 21 and predominant herbs are *Eragastis tenella, Vernonia cinerea* and *Euphorbia hirta*.

It may be concluded from the above data that species diversity at Site III, i.e. Chargoda Forest, in respect of woody species as well as herbaceous species is the highest among all the other investigated sites.

TABLE 4.48: FREQUENCY, DENSITY AND ABUNDANCE DATA FOR WOODY SPECIES

S. No.	Woody Species	Frequency (%)	Density	Abundance
Site I- Scrub Forest				
1	*Acacia catechu*	20	27.75	138.75
2	*Holerrhena antidysentrica*	60	82.14	136.53

S. No.	Woody Species	Frequency (%)	Density	Abundance
3	*Butea monosperma*	70	53.28	76.03
4	*Cacia fistula*	20	4.44	22.2
5	*Diospyros melanoxylon*	10	2.22	22.2
6	*Zizipus nummularia*	50	12.21	24.42
7	*Cappris sp.a*	10	1.11	11.1
8	*Acacia nilotica*	50	14.43	28.86
9	*Azadirachta indica*	10	2.22	22.2
10	*Shorea robusta*	10	2.22	22.2
11	*Ficus religiosa*	10	1.11	11.1
12	*Mangifera indica*	20	3.33	16.65
13	*Madhoca indica*	20	3.33	16.65
Site II- Mohanban Reserve Forest				
1	*Acacia Catechu*	10	3.33	33.3
2	*Holerrhena antidysentrica*	80	113.22	12.75
3	*Butea monosperma*	80	255.3	141.52
4	*Cacia fistula*	40	7.77	19.42
5	*Diospyros melanoxylon*	40	15.54	38.85
6	*Cardia mixa*	10	1.11	11.1
7	*Ficus rumphii*	10	1.11	11.1
8	*Acacia nilotica*	40	12.21	30.52
9	*Azadirachta indica*	30	8.88	29.52
10	*Shorea robusta*	10	3.33	33.3
11	*Ficus religiosa*	20	2.22	11.1
12	*Mangifera indica*	20	3.33	16.65
13	*Dendrocalamus strictus*	30	13.32	44.4
14	*Adina cardifolia*	40	15.54	38.85
15	*Hardwickia binata*	20	6.66	33.3
16	*Rauwolfia serpentina*	10	5.55	55.5
17	*Tectona grandis*	20	77.7	388.5
Site III- Chargoda Forest				
1	*Acacia Catechu*	40	6.66	16.65
2	*Holerrhena antidysentrica*	100	93.24	93.24
3	*Butea monosperma*	100	96.24	96.57
4	*Cacia fistula*	80	22.2	27.75
5	*Zizipus nummularia*	90	23.31	25.53
6	*Cappris sp.a*	30	4.44	14.43
7	*Ficus rupmhii*	80	14.43	17.76
8	*Acacia nilotica*	40	5.55	13.32
9	*Azadirachta indica*	20	2.22	11.1
10	*Ficus religiosa*	20	2.22	11.1
11	*Madhuca indica*	20	2.22	11.1
12	*Dendrocalamus strictus*	100	43.29	43.29
13	*Adina cardifolia*	40	4.44	11.1
14	*Hardwickia binata*	30	3.33	11.1

S. No.	Woody Species	Frequency (%)	Density	Abundance
15	*Rauwolfia serpentina*	100	209.79	209.7
16	*Tectona grandis*	30	7.77	25.53
17	*Bauhinia racenmosa*	30	4.44	14.43
18	*Ierminalia arjuna*	20	3.33	16.65
19	*Largerstroemia parvifolia*	30	4.44	14.43
20	*Grewie helicterifolia*	10	1.11	11.1

TABLE 4.49: FREQUENCY, DENSITY AND ABUNDANCE DATA FOR HERBACEOUS SPECIES

S. No.	Woody Species	Frequency (%)	Density	Abundance
Site I- Scrub Forest				
1	*Evolvulus alsinoedes*	50	680	1360
2	*Eragrastis tenella*	100	4680	4680
3	*Desmodium microphyllum*	55	980	1800
4	*Hyptis suaveolensis*	100	3040	3040
5	*Tephrosia strigosa*	100	700	700
6	*Vernonia cinerea*	100	3800	3800
7	*Abutelon indicum*	35	320	912
8	*Ecnocarpus frutescens*	35	620	1768
9	*Euphorbia hirta*	25	220	880
10	*Solenum xanthocarpum*	50	500	1000
11	*Xanthium strumarium*	35	480	872
12	*Crotolaria albida*	15	300	1332
Site II- Mohanban Reserve Forest				
1	*Evolvulus alsinoedes*	25	300	1200
2	*Eragrastis tenella*	100	4400	4400
3	*Desmodium microphyllum*	65	840	1292
4	*Hyptis suaveolensis*	100	3460	3460
5	*Tephrosia strigosa*	40	560	1400
6	*Vernonia cinerea*	100	3200	3200
7	*Abutelon indicum*	20	260	864
8	*Ecnocarpus frutescens*	30	300	544
9	*Euphorbia hirta*	30	260	864
10	*Solenum xanthocarpum*	45	620	1376
11	*Xanthium strumarium*	40	240	600
12	*Crotolaria albida*	30	260	864
13	*Parthenium hysterophorus*	60	720	1200
14	*Phyllanthus virgatus*	35	300	856
15	*Crotolaria rumosissima*	65	1320	2028
16	*Heteropogon contortus*	15	100	664
17	*Aristida adscensionis*	20	180	600
18	*Sida acuta*	50	480	960
19	*Lenotis nepatasfolia*	50	400	840
20	*Cassia tora*	85	680	800
Site III- Chargoda Forest				
1	*Evolvulus alsinoedes*	30	260	864

S. No.	Woody Species	Frequency (%)	Density	Abundance
2	*Eragastis tenella*	100	4540	4540
3	*Desmodium microphyllum*	45	480	1064
4	*Hyptis suaveolensis*	100	1240	1240
5	*Tephrosia strigosa*	45	360	800
6	*Vernonia cinerea*	100	3280	3280
7	*Ecnocarpus frutescens*	50	320	640
8	*Euphorbia hirta*	90	1260	1400
9	*Solenum xanthocarpum*	30	280	932
10	*Xanthium strumarium*	35	340	968
11	*Crotolaria albida*	50	400	800
12	*Parthenium hysterophorus*	75	600	800
13	*Phyllanthus virgatus*	40	300	748
14	*Crotolaria rumosissima*	65	520	800
15	*Heteropogon contortus*	45	360	800
16	*Aristida adscensionis*	40	320	800
17	*Sida acuta*	35	280	800
18	*Lenotis nepatasfolia*	60	940	1564
19	*Scoparia dulsi*	85	1060	1244
20	*Cyperus species*	65	620	952
21	*Cassia tora*	100	840	840

4.11.2 Aquatic System

The GBPS reservoir is fed by Rihand / Rehar, Mayar and Kanchan rivers and is the main surface water body in the area. The UP Department of Fisheries and Central Inland Fisheries Research Institute has carried out studies on aquatic system of the reservoir. Detailed investigations were carried out at three (3) identified locations in study area: Kanchan / Mayar river confluence near Railway Bridge (5 km north of Plant Site), Rehar river near Railway Bridge and Rehar river (6km southwest of Plant Site).

4.11.2.1 Phytoplanktons

The planktons have high ecological value as these provide food to animals of higher trophic level and play an important role in fisheries development. Phytoplanktons including *Cyanophyceae, Bacillariophyceae* and *Chlorophyceae* predominate in the aquatic ecosystem. The phytoplankton frequency, density as well as macrophyte frequency is highest at Kanchan / Mayar river confluence as compared to other two locations (**Table 4.50** and **4.51**).

TABLE 4.50- PHYTOPLANKTON DENSITY (NO. OF CELLS/FILAMENTS/COLONY X 10^4 L^{-1})

S. No.	Group/ Name	Kanchan Mayar River	Rehar River near bridge	Rehar river near Karakota
Chlorophyceae				
1	*Chlorella vulgaris*	0.84	0.75	1.01
2	*Microspora*	6.15	11.22	13.21
3	*Pediastrum*	1.05	1.2	1.62
4	*Scenedesmus*	0.12	0.16	0.26
5	*Spirogyra*	3.2	2.8	2.36
6	*Cosmarium*	0.39	0.23	-

S. No.	Group/ Name	Kanchan Mayar River	Rehar River near bridge	Rehar river near Karakota
7	*Zygnea*	4.2	3.8	1.3
8	*Ulothrix*			
Cyanophyceae				
9	*Anabaena*	12.2	6.5	-
10	*Anacystis nidnlans*	0.81	0.82	0.62
11	*Arthrospira*	1.9	1.1	-
12	*Lyngbya*	3.98	2.36	1.3
13	*Spirulina*	2.9	1.14	0.17
14	*Microcystis aeruginosa*	0.94	-	-
15	*Oscillatoria tennis*	5.5	4.8	2.1
16	*Oscillatoria formosa*	14.9	12.3	9.8
17	*Oscillatoria princeps*	4.3	4.2	-
18	*Phormidium*	9.23	8.2	-
19	*Dactylococcopsis*	0.93	-	-
20	*Nostoc*	0.67	0.52	-
Bacillariophyceae				
21	*Navicula sp.*	0.92	1.23	2.8
22	*Cylindrotheca*	0.92	1.42	3.4
23	*Sphaerocystis schroetri*	0.32	0.21	-
24	*Synedra*	2.83	2.62	3.6
25	*Fragilaria*	3.2	4.8	4.3
Euglenophyceae				
26	*Euglena*	2.8	2.83	3.2
27	*Astasia*	0.54	0.45	-

Table 4.51- Phytoplankton Frequency (%)

S. No.	Group / Name	Kanchan Mayar River	Rehar River near bridge	Rehar river near Karakota
Chlorophyceae				
1	*Chlorella vulgaris*	100	100	80
2	*Microspora*	100	100	100
3	*Pediastrum*	100	100	70
4	*Scenedesmus*	100	100	100
5	*Spirogyra*	100	100	60
6	*Cosmarium*	80	70	-
7	*Zygnea*	60	40	-
8	*Ulothrix*	70	80	30
Cyanophyceae				
9	*Anabaena*	100	100	50
10	*Anacystis nidnlans*	90	100	20
11	*Arthrospira*	60	70	-
12	*Lyngbya*	-	-	40
13	*Spirulina*	100	70	40

S. No.	Group / Name	Kanchan Mayar River	Rehar River near bridge	Rehar river near Karakota
14	*Microcystis aeruginosa*	70	-	-
15	*Oscillatoria tennis*	100	100	20
16	*Oscillatoria formosa*	80	70	30
17	*Oscillatoria princeps*	60	40	-
18	*Phormidium*	40	50	-
19	*Dactylococcopsis*	50	-	-
20	*Nostoc*	30	40	-
Bacillariophyceae				
21	*Navicula sp.*	80	70	60
22	*Cylindrotheca*	60	40	30
23	*Sphaerocystis schroetri*	40	30	-
24	*Synedra*	70	60	60
25	*Fragilaria*	60	60	30
Euglenophyceae				
26	*Euglena*	100	90	80
27	*Astasia*	70	60	-

4.11.2.2 Benthic Macro-invertebrates

Benthic macro-invertebrates of the reservoir consist of insect larvae, worms and mollusca. The overall benthic populations are reported to be relatively poor, however higher number of the same was found in the pond water and nala as compared to other locations (**Table 4.52**).

TABLE 4.52- MACROPHYTE FREQUENCY (%)

S. No.	Plant Species	Kanchan Mayar River	Rehar River near bridge	Rehar river near Karakota
Submerged				
1	*Hydrilla verticillata (Dominant)*	100	100	-
2	*Najas graminea (co dominant)*	100	100	-
3	*Ceratophyllum demersum*	100	80	20
4	*Potamogeton crispus*	80	70	-
5	*Potamogeton pectinatus*	60	40	-
Emergent				
6	*Eleocharis palustris (Dominant)*	100	100	-
7	*Polygonum amphibium*	100	100	-

4.11.2.3 Zooplanktons

The zooplankton reported in the study area include *Cyclops, Diaptomus, Daphnia, Ceriodaphnia, Moinodaphania, Chydorus, Keratella, Brachionus, Filinia, Difflugia, Bosmina, Diaphanosoma, Macrothrix and Polyarthra.*

4.11.2.4 Fishes

Surveys in the river / reservoir were periodically carried out in about 100 km stretch of Rihand / Rehar River. A total number of 42 species were recorded in 1949. Subsequently, 44 species of fishes were reported during survey conducted in 1970. The number of fish species recorded during survey conducted between 1971 and 1981 by Central Inland Fisheries Research Institute was reportedly the same. More than 85% of total fishes as recorded include Catla catla. Other species such as *Chanda sp., Esomus sp., Clusisoma garua,*

Cirrhinus mrigala, and *Lobeo rohita* are also present in the river / reservoir water showing varying densities.

4.11.2.5 Primary Productivity

The primary productivity was measured in the collected samples and found to be varying from 41.8 mg cm^{-3} h^{-1}, 41 mg cm^{-3} h^{-1} and 12 mg cm^{-3} h^{-1} at Kanchan /Maya river confluence, Rehar River near bridge and Rehar River near Karkota, respectively.

4.11.3 Sediments

Surface sediment samples were collected from the various identified locations using a grab sampler and analysed for species composition.

- Pond at Karami located at 9 km south of plant site
- Drain at Mohanban Reserve Forest located at 6 km south of plant site
- Kanchan / Mayar river confluence near railway bridge at 5 km north of plant site
- Rehar river at Karkota at 6 km southeast from plant site
- Rehar river near railway bridge at 8 km southeast from plant site
- Govind Sagar near Chargoda at 9 km northeast from plant site

Detailed investigations related to benthos in sediments collected at various sampling sites are given in **Table 4.53**. The Site 1 and Site 2 are rich in benthos and Site 3 is poor in benthos populations. Annelids, mollusca, gastropod, crustaceans and insect larvae of dipetara were present in the collected samples.

No pesticides were found in any of the sediment samples collected from various locations.

TABLE 4.53- BENTHIC MACRO INVERTEBRATES AT VARIOUS LOCATIONS

S. No.	Benthic macro invertebrates	Confluence of Kanchan Mayar	Rehar river near bridge	Rehar River Near Karakota
1	**Isopods**			
	Sow bugs	+	+	-
2	**Molluscs**	**+**	**+**	**-**
	Spchaenius	-	-	-
	Pisidium			
	Anodonta	+	+	-
3	**Mayflies**	**-**	**-**	**+**
	Baetis sp.	+	+	+
	Caenis sp.	+	-	-
	Choroterps sp.			
4	**Caddis flies**	**-**	**-**	**+**
	Hydropsyche	+	+	-
	Leptonema sp.	+	-	+
5	**Damsel flies**			
	Euphaea	+	+	-
6	**Aquatic bugs**	**-**	**-**	**+**
	Micronecta sp.			
	Metrocoris sp.	+	-	-
7	**Snails**	**+**	**+**	**-**
8	**Rotifers**	**+**	**-**	**+**
9	**Beetles**	**+**	**+**	**-**

S. No.	Benthic macro invertebrates	Confluence of Kanchan Mayar	Rehar river near bridge	Rehar River Near Karakota
	Leptelmis	+	+	-
	Eubrianax	-	-	-
	Coleoptera			
10	**Fishes**	**+**	**+**	**-**
	Chanda sp.	-	-	+
	Esomus sp.	+	+	+
	Barilius sp.	+	-	-
	Catla catla			
	Cirrhinus mrigala	-	-	+
	Cypernirinus crrpio	+	+	-
	Lobeo rohita	+	-	+

'+': Presence; '-': Absence

4.11.4 Wildlife

The wild life in the area is not represented by any major species except for common reptilians such as Cobra, Krait, Viper, Rat Snake, etc. The region has Avifauna with common birds including Indian Roller, Peafowl, Spotted Dove, House Sparrow, Little Egret, Grey Heron, Common Myna, Jungle Myna, Pied Myna and Pied King Fisher .As per the report of District Forest Officer the area is devoid of any wild life. Thus "No schedule I species exist in the study area".

B. BASELINE SOCIAL ENVIRONMENT

Data collected on demography, economic status and basic amenities available in the area include secondary information and census data sourced from the various public, semi-public and research organizations. A primary survey was also conducted by the project proponent to know the socio-economic status of the project affected area.

The social aspects include human settlement, demographic status beside infrastructural facilities available in the study area. The economic aspects include occupational pattern and income of people.

4.12 SOCIO-ECONOMIC STATUS AS PER SECONDARY SOURCES

4.12.1 Demographic Characteristics

The proposed power plant will impact land-use categories over about 3341 acres of land. Existing land-use categories are agricultural, semi-agricultural and wastelands. The project area covers Sidhi Kalan, Harrahawa, Jhanjhi Tola, Sidhi khurd and Tiyara villages.

In total 166 villages of Singrauli Tehsil/District fall within ten (10) km of core zone in addition to five (5) villages which will house the main plant area, ash dyke, auxiliaries and other supporting facilities including infrastructure. One urban centre, Waidhan, is the tehsil headquarter under Singrauli District. The study area includes all villages falling under Singrauli tehsil of the district.

The influence area has a population of 2.5 lakhs with 45712 household with annual average growth rate of 3.7%. The existing high growth rate in the area is ascribed to ongoing industrial activities mainly in power and mining sectors. The large scale development has led to mobilization of skilled manpower in the area. **Table 4.54** shows the population distribution in direct impact area and core area of ten (10) km radius. Demographic profile of impact area as well as general area is also presented in **Figures 4.15**.

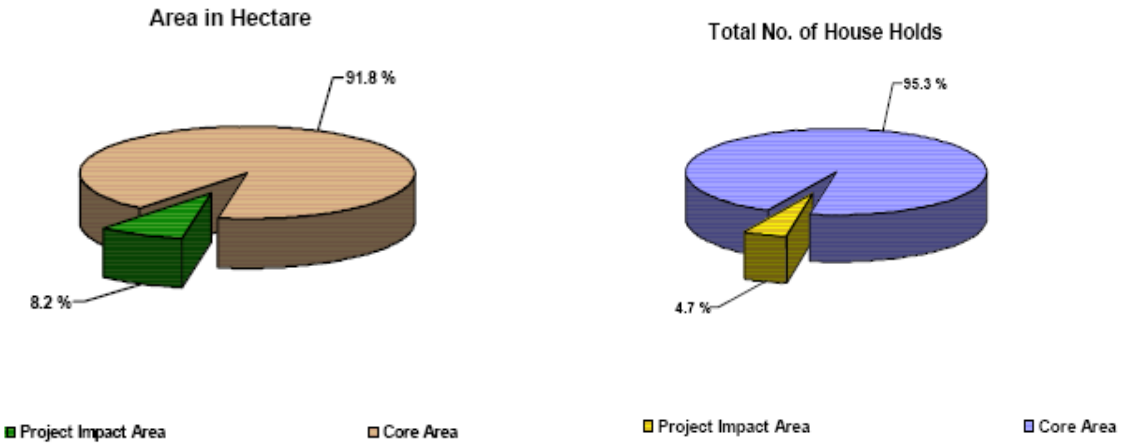


Fig 4.15- Population Distribution in Study Area

4.12.2 Gender

The gender ratio of the project impact area is 960, which is higher than the national average of 933 (**Table 4.55**). Therefore, the female population has more contribution than male population in local employment. However, the core area has a gender ratio of 938 which is close to the national average.

TABLE 4.54- POPULATION DISTRIBUTION IN THE STUDY AREA

S No	Description	Area in Hectare	Total HH	Density (P/km^2)	Population		AAGR
					2001	1981	(81-01)
i	Siddhi Khurd	1013	413	234	2373	978	4.5
ii	Siddhi Kalan	924.8	293	199	1842	894	3.7
iii	Harrahawa	2152.5	579	166	3576	1883	3.3
iv	Jhanjhi Tola	544.2	163	172	940	561	2.6
v	Tiyara	1846.9	692	215	3975	2082	3.3
Project Impact Area		**6481.4**	**2140**	**196**	**12706**	**6398**	**3.5**
Core Area		**72412.6**	**43201**	**344**	**249272**	**124663**	**3.5**

AAGR: Annual Average Growth Rate
Source: Primary Census Abstract, Census of India, Madhya Pradesh, 2001 & 1981

TABLE 4.55- FEMALE POPULATION AND POPULATION BELOW 6 YEARS IN THE STUDY AREA

S. No.	Description	Total Population	Male	Female	Gender Ratio	Population Below 6 Years
i	Siddhi Khurd	2373	1187	1186	999	551
Ii	Siddhi Kalan	1842	924	918	994	422
iii	Harrahawa	3576	1882	1694	900	806
iv	Jhanjhi Tola	940	458	482	1052	241
v	Tiyara	3975	2030	1945	958	920
Project Impact Area		**12706**	**6481**	**6225**	**960**	**2940**
Core Area		**249272**	**128569**	**120703**	**938**	**29442**

Source: Primary Census Abstract, Census of India, Madhya Pradesh, 2001

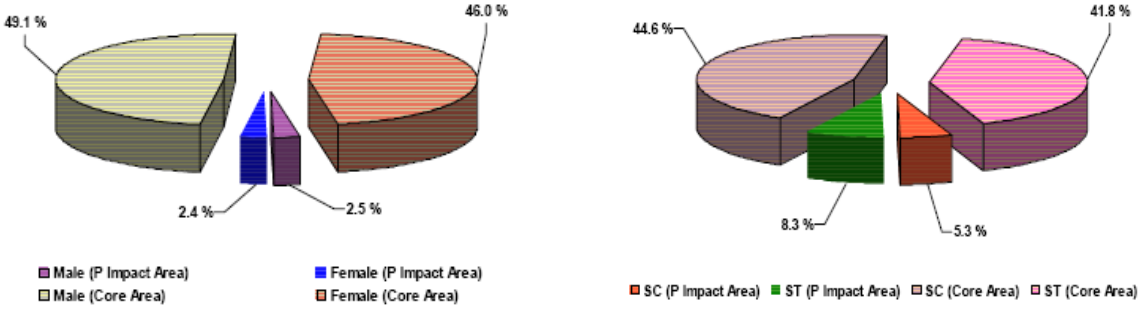


Fig 4.16- Gender Distribution

4.12.3 SC and ST Population

The study area has significant SC and ST population which is higher than the national and state average. The main indigenous groups are Kol, Sahariya and Gond contributing to 19% of the population of the core area. The composition of SC and ST population in the study area is provided in **Table 4.56**.

TABLE 4.56- COMPOSITION OF SC & ST POPULATION IN THE STUDY AREA

S. No.	Description	SC Population			ST Population		
		Total	Male	Female	Total	Male	Female
i.	Siddhi Khurd	467	236	231	324	166	158
ii.	Siddhi Kalan	197	92	105	196	90	106
iii.	Harrahawa	504	266	238	962	513	449
iv.	Jhanjhi Tola	141	71	70	549	255	294
v.	Tiyara	453	222	231	716	364	352
Project Impact Area		**1762**	**887**	**875**	**2747**	**1388**	**1359**
Core Area		**14814**	**7580**	**7234**	**13865**	**7485**	**6378**

Source: Primary Census Abstract, Census of India, Madhya Pradesh, 2001

4.12.4 Economic Characteristics

4.12.4.1 Work Participation Rate

The work participation rate shows the economic potential of the local community. The work participation rate of the study area is presented in **Table 4.57**.

TABLE 4.57- WORK PARTICIPATION IN THE STUDY AREA

S. No.	Description	Marginal	Total Worker	WPR
i	Siddhi Khurd	333	530	22.3
ii	Siddhi Kalan	52	692	37.6
iii	Harrahawa	226	1532	42.8
iv	Jhanjhi Tola	256	240	25.5
v	Tiyara	177	1186	29.8
Project Impact Area		**4533**	**79464**	**32.1**
Core Area		**76789**	**22304**	**30.8**

Source: Primary Census Abstract, Census of India, Madhya Pradesh, 2001

In the project impact area 90% of population are engaged in primary sector followed by 9% engaged in tertiary sector, whereas in the core area primary sector employs about 63% of the workforce.

4.12.4.2 Workers Composition

The study area is characterized by agrarian economy with primary sector being main source of employment, whereas the area falls in the declared drought-prone district and is without developed irrigation facility Agriculture mainly depends on rain. **Table 4.58** provides workers composition in the study area.

TABLE 4.58- OCCUPATIONAL STRUCTURE IN THE STUDY AREA (NOS)

S. No.	Description	Primary	Secondary	Tertiary
i	Siddhi Khurd	416	33	81
ii	Siddhi Kalan	657	10	25
iii	Harrahawa	1504	1	27
iv	Jhanjhi Tola	222	0	18
v	Tiyara	1066	23	97
Project Impact Area		**3865**	**67**	**248**
Core Area		**48378**	**1536**	**26876**

Source: Primary Census Abstract, Census of India, Madhya Pradesh, 2001

4.12.5 Infrastructural Facility

Development depends on accessibility to various amenities and infrastructural facilities available to the people. Availability of infrastructure is an indicator of development in an area. The present study area lacks adequate infrastructural facility as available to the local population. Most of the villages are devoid of power supply and water supply is not available except in Waidhan town. The area falls in water scarcity zone and people generally depend on hand pumps and wells for drinking purpose. The primary schools available in the area are inadequate. The infrastructural facilities available in the study area are given in **Table 4.59.**

TABLE 4.59- INFRASTRUCTURE AVAILABILITY IN THE STUDY AREA

S. No.	Description	Hospital	Primary School	Secondary School	College	Water Supply
i	Siddhi Khurd	0	1	0	0	HP, Well
ii	Siddhi Kalan	0	1	0	0	HP, Well
iii	Harrahawa	0	3	0	0	HP, Well
iv	Jhanjhi Tola	0	1	0	0	HP, Well
v	Tiyara	0	1	1	0	HP, Well
Project Impact Area		**0**	**7**	**1**	**0**	**HP, Well**
Core Area		**1**	**189**	**10**	**1**	**Tap, Tank, HP, Well**

Source: Primary Census Abstract, Census of India, Madhya Pradesh, 2001

4.13 SOCIO-ECONOMIC STATUS AS PER PRIMARY SURVEY

4.13.1 Affected Household

Approximately 820 Project Affected Families (PAF) are expected to lose their homestead due the project. The village wise details of PAFs are given in **Table 4.60**.

TABLE 4.60- VILLAGE-WISE DETAILS OF PAFS

S. No.	Village	No of affected Families
1	Siddhikhurd	448
2	Siddhikalan	23
3	Jhanjitola	8
4	Harrahawa	185
5	Tiyara	154
Total		**820**

4.13.2 Caste Distribution

Multiple caste groups and sub-groups inhabit the project area. The different classes of caste are grouped as Scheduled Castes (SC), Scheduled Tribes (ST), Other Backward Classes (OBC) and other General or Forward Castes. The village wise caste distribution is given **Table 4.61**.

TABLE 4.61- VILLAGE-WISE DISTRIBUTION OF CASTE CATEGORIES OF HOUSEHOLDS

Caste / Village	General	SC	ST	OBC	Total
Siddhi Khurd	54	110	19	646	829
Siddhi Kalan	4	0	0	66	70
Harrahawa	35	0	13	78	126
Tiyara	3	56	15	82	156
Total (%)	96 (8%)	166 (14%)	47 (4%)	872 (74%)	1181

4.13.3 Occupational Status

Majority of the affected families (71%) are engaged in cultivating their own lands. Other than cultivators, 16% are non-agricultural labourers and another 11% work as agricultural labourers in others lands. The non-agricultural labourers usually get jobs as casual workers to contractors in the neighboring power plants and coal mines or work in construction sites in Waidhan. A small fraction (2%) of the families own shops or is engaged in government/private service.

4.13.4 Income Level

The households get their livelihood through various means. They mainly include cultivation and non-agricultural labourers followed by agricultural labourers. Agriculture is the main income generating activity in the project area which generates around 70% of the revenue. Income pattern is depicted in **Table 4.62**.

TABLE 4.62- INCOME LEVEL OF AFFECTED HOUSEHOLDS

Monthly Income / Villages	Below Rs. 2000	Rs. 2000-5000	Above Rs. 5000	Total
Siddhi Khurd	758	48	23	829
Siddhi Kalan	51	13	6	70
Harrahawa	101	16	9	126
Tiyara	139	9	8	156
Total	1049 (89%)	86 (7%)	46 (4%)	1181

As the above table shows, most of the target population is below the poverty line. About 89% of the respondents earn less than Rs 24,000 annually although the people who had BPL Cards were only 50%. This reflects that the scope of employment in this area is extremely low. Although people have landholdings, productivity is low due to bad soil conditions and poor water sources.

Chapter 5

Project Consultation & Information Disclosure

CHAPTER 5. PUBLIC CONSULTATION AND INFORMATION DISCLOSURE

5.1 INTRODUCTION

The need for public consultation and disclosure arises from the universal belief that transparency and accountability are fundamental to fulfilling any development mandate and in strengthening public involvement in the decision making process.

For all 'Category A' projects the project proponent or third party experts must have consulted with project affected communities in a structured and culturally appropriate manner. In projects with significant impacts on affected communities, the process must ensure their free, prior and informed consultation (FPIC) and facilitate their informed participation.

5.2 OBJECTIVES OF COMMUNITY CONSULTATION

Community Consultation was carried out in this project in order to minimize probable adverse impact of the project. The Community Consultation process has been carried out with the following objectives:

- To inform potentially impacted communities / individuals about the
  - Probable time of initiation of project;
  - Time taken for disbursement of compensation; Nature of compensation;
  - Probable compensation amount for various categories of losses;
- To solicit the views of affected communities/ individuals on social, economic and environment components and the significance of impacts;
- To serve as an important tool for collecting information about the natural and the human environments, much of which would never be accessible through more traditional approaches of data collection;
- To ensure enhanced public cooperation by creating awareness about purpose and benefits of the project.

Project Understanding (Jhanji-Tola)

Group Discussion (Jhanji-Tola)

5.3 DISCUSSION WITH THE AFFECTED VILLAGERS

Since 2006, SPL (then a subsidiary of PFC) officials have been periodically meeting the villagers to discuss the land acquisition processes, future development potential of the area and other benefits that the community would accrue. However, these meetings have been more of informal in nature and have not been documented.

Chapter-5: Public Consultation

This chapter is an attempt to understand the opinion of the villagers of the study area regarding the Thermal Power Project and their expectations. It also attempts to describe the process of information disclosure by the project proponents to the villagers.

The baseline household consultation and survey as provided in the R&R Plan, could not be completed in two villages namely Jhanjhitola and Harrahawa due to resistance from the villages during first consultation period i.e. year 2006.

Initially, people of Jhanjitola and Harrahawa villages were not happy or comfortable with the idea of government acquiring land as they thought it will take a lot of time to pay compensation. They were of the opinion that the compensations should be paid well in advance so that they can get settled before the start of the construction work.

The experience of the displaced people of Harrahwa is not good regarding resettlement. Most of the villagers are oustees of Rihand Dam project in the 1960s. They said that the government promises something before the displacement but does not keep the promises afterwards. They made it very clear that they were not in support of the project.

Subsequently, many meetings were held with the villagers of Jhanji Tola and Harrahwa. The concerns of the Jhanjitola and Harrahwa village's community have been addressed suitably by the SPL. The details have been incorporated in the disclosed R&R plan of SPL. Presently, people of these villages are accepting compensation under the R&R. The summary of mitigation measures is given below.

- Public Information Centre (PIC) has been setup in affected villages to resolve their grievances.
- Compensation to displaced families is being paid at current market rate.
- Special attention is being taken to ensure that the affected people are set up in the same social environment as it was earlier
- High priority is being accorded to provision of food grain supplies during resettlement process at both the old and new sites
- Specific quota of shops to be constructed in the project township and the areas allotted to displaced families, especially those families who are defined as agriculture family by census .
- TERI, a reputed NGO in India is assisting Sasan Power Ltd & District Administration in resettlement of affected persons.
- Efforts are being made to give employment to the educated unemployed youth in project area.
- People from affected displaced families are being given priority based on their skills in the jobs available during the implementation of the project as well as other works.
- Additional facility for technical training is being provided to displaced families so as to enable them to benefit from new employment opportunities. Technical training like masonry, welding, carpentry, etc. is being given to affected persons. Also, SPL has started providing employment to trained people.

SPL has initiated stakeholder engagement at the conceptual design stage of the project, throughout the ESIA process, and will continue through the operations phase.

One-to-one meetings or collective meetings with small groups of stakeholders located near the project receive higher priority in SPL rather than large public meetings or workshops. In large group meetings, many individuals cannot express their opinions.

SPL has ensured and will continue to ensure that a broad range of stakeholders, including those with major concerns about SPL projects, are included. Meetings are organized to encourage feedback on SPL activities to date. Response to requests is being provided wherein SPL explains how their views, opinions or needs have been considered and in some cases incorporated into project design.

5.4 INFORMATION DISCLOSURE

5.4.1 ESIA Preparation Phase

In addition to project affected communities, stakeholders such as landowners, NGOs and institutions were engaged and Public Consultation & Information Disclosure activities were conducted. All ESIA documents were designed to ensure that the following objectives were met:

- Identify project stakeholders and ensure they have access to project information.
- Ensure dialogue and participation, which fully informs the stakeholders about the project and its scope.
- Identify the stake-holders interests and perceptions regarding the project implementation.
- Evaluate the stake-holders issues of concern identified in the consultations during the ESIA process and ensure that appropriate mitigations are developed.
- Communicate the results of the evaluation and the actions and mitigation measures developed by the project regarding issues of concern identified during the consultation process.

Based on various studies carried out prior to construction the following documents have been prepared:

- Baseline Social Impact Assessment
- Comprehensive Environmental Impact Assessment which is now being updated vide the ESIA
- R&R Plan

These assessments have been developed according to international best practice standards, including IFC Performance Standards. The EIA were all initiated at different stages during the development of the project and submitted and clearance obtained from the Government of India.

5.4.2 Land Acquisition Phase

The process of Land Acquisition was initiated as per Land Acquisition (LA) Act, 1894 and policies of Government of Madhya Pradesh in 2008. The consultation that took place over the past years since the Project's inception is laid out in **Table 5.1**.

TABLE 5.1: STAGES OF LAND ACQUISITION

Date	Stage of Acquisition
	SPL identified the land for the Project based on the MoEF Site Selection Criteria
	SPL conducted land survey
	Meetings conducted with the Revenue Department
	No Objection Certificates (NOCs) were obtained from the Gram Panchayats of the five villages
18.08.2006	Notification under Section 4.1 of the LA Act, 1894
10.08.2007	Notification under Section 6 of the LA Act, 1894
11.04.2008	Notification under 17.1 of the LA Act, 1894
09.09.2008	Compensation amount was finalized by the Government and released to the revenue office.
28.12.2008	Grievance Redressal Camp
	Substantial part of the land acquisition for the Plant was complete
	Awarding of compensation is in progress

After declaration of the compensation amount, local administration has received complaints in writing from villagers. A Grievance Redressal Camp was organized by SPL on 28th December, 2008 to resolve out the issue of PAPs.

5.4.3 Ongoing Communication

SPL maintains and will continue to maintain permanent contact with stakeholders throughout the life of the project. SPL has continued with numerous consultations which have been conducted through offices in site, Waidhan, Delhi and Mumbai and the field teams.

5.5 PUBLIC CONSULTATIONS

In 2007, SPL established a permanent office in Waidhan. This office set up has a section for queries, complaints, and to provide general information to the community.

Consultations & communication will be a continuous process and will be conducted through individual meetings and workshops around the main areas of concern which could include local employment, compensation, infrastructure development and environmental pollution. Also PIC has been setup in each of the villages to resolve the grievances of affected persons.

5.5.1 Field Consultation

The main issues raised during consultation were mainly related to the impact due to large-scale acquisition of land and built-up properties throughout the project area. However, SPL will provide adequate compensation as per consideration of approved R&R Plan and is also implementing a long term sustainable R&R Package.

5.5.2 Future Stakeholder Engagement Activities

SPL has the ultimate responsibility for community liaison and consultation and will be responsible for all communications with the public, stakeholders and local authorities regarding the Project construction. The Contractors shall not make any commitments or make any direct arrangements with local communities without prior coordination with SPL. SPL Community Relations team is monitoring and shall continue to monitor the Contractors performance and take appropriate corrective action.

5.5.3 Records of Meetings

Records will be maintained of all stakeholder meetings. Information such as date, time, location and names of attendees shall be included in appropriate format. The record will summarize the information provided/ discussed with the attendees. It will also indicate any documents that were left with the participants.

5.5.4 Grievance Redress Framework

The IFC guidelines and Central Government guidelines lay special emphasis on Grievance redressal for addressing concerns/problems of project affected persons who may consider themselves deprived of appropriate compensation, rehabilitation benefits as prescribed under the policy guidelines and or be exposed to other adverse impacts on account of the project.

The company has prepared a framework (refer Grievance Procedures in Section 9.15) for redress of grievances / complaints during all phases of the project. This framework will continuously be reviewed and modified for improvements during the life of the project.

5.6 PUBLIC HEARING MEETING

The Environmental public hearing was conducted in accordance with the norms of Environment (Protection) Act, 1986. The public notice for the Public Hearing of the project was published in local news papers 'Dainik Kranti', 'Samay' & 'Navbharat' and national news' paper 'Dainik Bhaskar' on 6th May, 2006. This was followed by public hearing on 17th June, 2006 at community hall at Waidhan, which was attended by approximately 200 persons. The public hearing was chaired by Assistant District Collector. The official of SPL (then a subsidiary of PFC) provided details of project purpose, design and components of operation and remedial measures proposed for reducing environmental impact on air, water and land due to project operations.

The issue / suggestion made by the villagers along-with their compliance status are given in **Table 5.2**.

TABLE 5.2: OPINIONS & COMPLIANCE

S. No.	Name & address	Queries, Comments, Objection & Suggestion expressed	Replies from the representative of project proponent
1.	Ramadhar Vill. Harrahawa	The region doesn't have the basic facilities like Medicine, road, electricity etc. These should be provided by the project. In addition to this the provision of employment should also be there.	The project is expected to improve the infrastructure facilities of the region. The project will also generate employment facilities in the area.
2.	Vansmani Sharma MLA Singrauli Region	Some the project affected persons are already rehabilitated by the other projects in the region like Rihand and NTPC. Therefore, a permanent accommodation scheme should be placed for those. Project may create a problem in the water availability of the region. How much compensation will be provided by the SPL for the affected population?	A separate R&R colony will be constructed by the SPL for project affected population. SPL will also ensure adequate supply of basic requirements to the local people. The compensation will be provided as per market rate.
3.	Ramllalu Shah Sarpanch Vill.- Sidhi Khurd	Some the project affected persons are already rehabilitated by the other projects in the region. Therefore, a permanent solution of this problem should be made by the SPL.	A separate R&R colony will be constructed by the SPL for project affected population.
4.	Jagwali Singh City- Singrauli	No account information on the pollution being emitted by the already installed plants. How the people will be compensated? Employment & medical treatment facility should be provided to land less people and school should	A baseline study has been conducted by the SPL to find the baseline environment scenario of the region. Impact prediction was also been done to find-out the future impact of the project. It was found that the pollution level in the region will be well within the prescribed

S. No.	Name & address	Queries, Comments, Objection & Suggestion expressed	Replies from the representative of project proponent
		be constructed.	standards. All basic infrastructural facilities e.g. School, panchayat bhawan, hospital, religious place, market, road, water, proper drainage & sanitation will be provided in rehabilitated villages. Compensation & employment opportunities will be as per rehabilitation policy.
5.	Ashok Shah Chairman District Panchayat	A detailed Environment Impact Analysis should be done by the SPL. Employment should be provided for the local people.	A detailed EIA study has been done by the project proponent and same has been submitted to the MoEF for the project clearance. EIA study shows that the pollution level of the area will be well within the prescribed limit during the operation phase of the project. The project will also improve the employment status of the area. Project will provide employment to the local people in both ways primary as well as secondary.
6.	Ramlallu Vaisya Mayer	Provide the details of R&R policy prepared for the project	R&R Policy prepared for the project has been provided in the local administration office for the local people. The R&R policy made for the project include the provision of both National R&R Policy and State R&R Policy.
7.	Chandrashekhar Neelkanth District Collector Sidhi	Proper compensation and employment should be provided.	Compensation will be provided as per market rate. Employment opportunities will be provided as per State Govt. rehabilitation policy.

5.7 MONITORING AND REPORTING

Environmental and social key performance indicators will be developed in accordance to IFC guidelines and will be monitored at regular interval to identify changes in conditions, new issues, mitigation, successes and opportunities for improvement in consultation and disclosure. The monitoring results will be reported as required, and will be available to the public. Stakeholder perceptions will also be monitored by SPL Community Relations Team Representatives.

Chapter 6

Impact Assessment

CHAPTER 6. ANTICIPATED ENVIRONMENT & SOCIAL IMPACT

6.1 BACKGROUND OF THE STUDY

The construction and operational phase of the proposed project comprises various activities each of which may have an impact on environmental parameters. Various impacts during the construction and operation phase on the environment have been studied to estimate the impact on the environmental attributes and are discussed in the subsequent section. The probable impacts of each of these activities on various sectors of environment have been mentioned below in two phases:

- Construction Phase
- Operation Phase

A. ENVIRONMENT IMPACT

6.2 IMPACT DURING CONSTRUCTION PHASE

The environment impact during construction is localized and short term except permanent changes in use of surrounding land and socio-economic condition of the people as compared to the earlier conditions. Impact is primarily related to the civil works and some intensive impact due to erection of the equipment. The details of the activities and probable impact are discussed below.

6.2.1 Impact on Land use

Prior to construction, land is developed through leveling and grading. Past land use of the selected site was mainly single-cropped agriculture land with scrub forests and scattered settlements. Out of the total site area, 793 acres of forest land was diverted for the project purpose. However, to improve the forest cover and animal food value in the surrounding forest area and create water holes, shelter and food for wildlife, compensatory afforestation will be undertaken over 1586 acres at a cost of about Rupees 15 crores. This will fulfill the requirement of forest cover and habitat restoration in the adjoining areas.

SPL is also in the process to improve the infrastructure of the area such as roads, schools, hospitals, railways etc. The project would add to the economic development of the area through allied business, which will be set-up along with the plant.

6.2.2 Impact on Soil Cover

Only cutting and filling is required during construction. Leveling of the site is in the process. The construction activities result in loss of vegetation cover (grass and shrubs) and topsoil to some extent in the plant area. Apart from localized impact inside the plant site, no adverse impact on soil in the surrounding area is anticipated.

6.2.3 Impact of Solid Waste

Solid waste during the construction phase consists primarily of scrapped building materials, excess concrete and cement, rejected components and materials, packing and shipping materials (pallets, crates, Styrofoam, plastics etc.) and human waste.

During the construction there will be generation of garbage, for which suitable disposal methods and designated practices of solid waste disposal are being followed.

6.2.4 Air Impact

The main source of emission during the construction phase is the movement of equipment and vehicles at site. Equipment deployed during the construction phase is also likely to result in marginal increase in the levels of SO_2, NO_X, and particulate matter. The impact is reversible, marginal and temporary in nature. Proper upkeep and maintenance of vehicles, sprinkling of water on roads and construction site, providing sufficient vegetation etc. are helping to reduce the impact during construction.

The impact is confined to the construction area and is almost negligible outside the plant boundaries. The plant site is also being cordoned off by a high boundary wall.

6.2.5 Noise Impact

The study area is likely to experience increase in ambient noise level due to construction traffic for loading and unloading, fabrication and handling of equipments and material. The areas affected are those close to the site.

Construction noise will be created by vehicles, heavy machinery, and equipment, as well as activities such as percussion piling and equipment erection. Typical noise levels from different sources during construction are earthmoving equipment: 72–100 dB(A); material handling: 75–98 dB(A); stationary equipment: 69–95 dB(A); and impact-based equipment: 81–105 dB(A). Noise will be reduced by providing acoustic hoods (covers) on equipment, regularly maintaining machinery, erecting noise enclosures and walls, and imposing vehicle speed restrictions. Construction workers in excessively noisy areas will wear ear protection equipment. Noise reduction and hearing protection measures required during construction will be prescribed in the construction contracts.

To minimize the impact on nearby communities, construction schedules have been optimized. Also the noise level is substantially lower near the plant boundary due to attenuation caused over the distance. The resultant noise will not add to the existing levels in settlement areas.

Overall, the impact **on ambient** noise during construction period is insignificant, reversible and localized in nature.

6.2.6 Impact on Water Environment

The construction personnel, housed in temporary settlements discharge considerable amount of domestic wastewater. The main pollutants are organic components and microorganisms with the potential to cause contamination of water quality. To address potential impacts on water quality, disinfected latrines (e.g., through regular liming) are being used as main component of the sanitation system.

Construction process includes fabrication of concrete and related water usage. The resulting wastewater could potentially carry inorganic solids and result alkalinity above applicable discharge standards. The impact is considered minor as it mostly occurs during construction period and has no long-term impact with view to persistent pollution. Alkaline wash water containing excessive amounts of cement is being collected in a waste water tank where cemented material will be settled and neutralized before discharge.

Surface run-off water is not there in dry months during construction. However, during monsoon, surface run-off including effluents may cause higher loading of suspended solids. But, since the river water will already have higher suspended solids concentration during monsoon period, significant impact due to site discharge is not envisaged on the river water.

No objection Certificate for drawal of 4500m^3/day has been obtained from Central Ground Water Board for drawal of Ground water during construction phase. The project site falls in

the safe category area as per ground water resource consideration. Thus no significant impact will take place due to extraction of ground water during construction. Also, rainwater harvesting structure will be constructed by SPL in consultation with the Central Ground Water Board.

6.2.7 Ecological Impact

Prior to construction activity the land use of the selected site was mainly single-cropped agriculture land with scrub forests and scattered settlements.

As already mentioned earlier 793 acres of degraded forest land is diverted for the proposed project. However, compensatory afforestation is being implemented over 1586 acres at a cost of Rs 15 Crs.

6.2.8 Traffic Congestion

To avoid Traffic congestion on nearby highways / roads and to minimize public inconvenience because of construction activity strengthening & widening of roads will be carried out. As a result, no significant impact is envisaged.

6.3 IMPACT DURING OPERATION PHASE

6.3.1 Impact on Land use

Development activity induces changes in land use pattern of the adjoining areas because of the increased availability of infrastructural facilities, increase in commercial value/ potential of land etc. However, in operation phase it will be insignificant since construction phase would have experienced infrastructural developments during the construction/commissioning. Therefore, such effects, if any, would have stabilized.

6.3.2 Impact on Soil Cover

Most of the impacts of Coal-based power plant project on soil are restricted to the construction phase, which will get stabilized during operational phase

The soil conditions of the project site would be allowed to stabilize during this period after the impacts of the construction phase. The topsoil in non-built up areas would be restored and such portions of the site would be subjected to plantations, which would help in bonding of the soil, thus increasing its strength.

The impact on soil quality due to deposition of air borne pollutants is also expected to be negligible, as the project is envisaged to have high efficient Electro-Static Precipitators (ESPs) to control emission of Suspended Particulate Matter (ash particles). Samples would be periodically collected from close to maximum deposition areas of air pollutants and analyzed for relevant parameters during the post operational monitoring programs.

6.3.3 Impact of Solid Waste

The primary solid waste generated by the thermal power plant is ash. The disposal of ash to the ash dump area is envisaged in wet (slurry) form. Unutilized ash will be disposed in the clay lined ash pond.

6.3.4 Air Impact

Plant operation could affect the air quality in many ways, such as, gaseous emissions from the stacks, fugitive emissions from raw material (coal) handling and transportation activities. The impact of fugitive emissions from all sources is likely to be restricted over a limited area (up to a maximum distance of 500 m from the source), but the gaseous emissions from the stacks will have an impact over a very wide area. Methodology and results for predicting impact due to stack emissions are given below.

6.3.4.1 Air Pollution Modeling

The impact on ambient air quality is assessed hereunder considering the following:

- The air quality impacts have been predicted for the power plant assuming that the pollution due to the existing activities has already been covered under baseline environmental monitoring.
- Site-specific meteorological parameters have been recorded by using continuous recorders. Short term 24 hourly GLC's incremental values were estimated using the site-specific meteorological conditions.

Prediction of impacts on air environment has been carried out employing mathematical model based on a Steady State Gaussian Plume Dispersion Model designed for multiple point sources for short term. In the present case, Industrial Source Complex Short-term [ISC3] 1993 Dispersion Model based on steady state Gaussian Plume Dispersion, designed for multiple point sources for short term and developed by United States Environmental Protection Agency [USEPA] has been used for simulations from point sources.

The various measures proposed to minimize the pollution from the power plant are as follows:

- A Multi-flue chimney of height 275 mts for wider dispersal of pollutants
- Electrostatic Precipitators with 99.97% efficiency will be installed to limit the particulate (SPM) emission within 50 mg/Nm^3.
- The NO_X emissions from the boilers will be controlled by controlling combustion measures, which will be approached by way of low NO_X burners
- Fugitive dust will be controlled by adopting dust extraction and dust suppression measures and development of green belt along the periphery of the power plant.

6.3.4.2 Model and Methodology for Computation

The predictions for air quality during operation phase were carried out for suspended particulate matter (SPM), sulphur dioxide (SO_2) and oxides of Nitrogen (NO_X) concentration using Air Quality model "Industrial Source Complex Version 99155 (ISCST3)" developed by the US Environmental Protection Agency (USEPA) in 1995 for atmospheric dispersion of stack emissions from point source.

For the modeling purpose three pollutants namely, SPM, SO_2 and NO_X are considered.

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 increase in plume dispersion during the ascension phase;
- Calms processing routine is used by default;
- Wind profile exponents is used by default, 'Irwin';
- Flat terrain is used for computations;
- It is assumed that the pollutants do not undergo any physico-chemical transformation and that there is no pollutant removal by dry deposition;
- Cartesian co-ordinate system has been used for computations; and
- The model computations have been done for 10 km with 1 km interval.

6.3.4.3 Model Input Data

The details of stack emissions and coal consumption are given in **6.1.** Emissions were for 6x660MW were arrived based on actual coal characteristics and project details.

TABLE 6.1- STACK EMISSION DATA FOR 6X660 MW CONFIGURATION

Parameter	Unit	Value
		For 6x660MW
No. of Stacks	-	2
Stack Height	m	275
Inter stack distance	m	425
No. of Flues/stack	-	3
Flue Diameter	m	7.1
Flue gas Exit Velocity	m/s	25
Flue gas Exit Temperature	oC	138
Flue gas Quantity	M3/Sec	990.2
Flue gas quantity at 0 deg C#	Nm3/Sec	657.7
Coal Consumption per Unit	TPH	316.8
Sulphur in coal	%wt/wt	0.48
Atmospheric Emissions per Unit		
SO_2 (based on Organic sulphur emissions)	g/s	556.7
NO_X	g/s	329.5
SPM	g/s	32.9
CO_2 Emissions gm CO_2/kWh		829.4

#: Required as per EHS guide lines.

6.3.4.4 Meteorological Data

From the observation of the mixing height of the region it was found that the summer season is the worst season for plume down. Therefore, to show the worst scenario only summer season has been considered for air dispersion modeling.

Data recorded at the continuous weather monitoring station on wind speed, direction, and temperature at one-hour interval for three months [March, 2006 – May 2006] was used as meteorological input.

6.3.4.5 Stability Classification

The percentage occurrence of stability class for the monitoring period and used for the model is given in the **Table 6.2**.

TABLE 6.2-STABILITY CLASSIFICATION

Stability Class	Frequency of Occurrence
A	10.26
B	9.56
C	24.40
D	24.46
E	15.86
F	15.46

6.3.4.6 Mixing Height

As site specific mixing heights were not available, mixing heights based on CPCB publication, "Spatial Distribution of Hourly Mixing Depth over Indian Region", Probes/

88/2002-03 has been considered for Industrial Source Complex model to establish the worst case scenario. Mixing heights considered for modeling are in **Table 6.3**.

TABLE 6.3- MIXING HEIGHT (M)

Day Time	Height (m)
0700	80
0800	200
0900	500
1000	800
1100	1200
1200	1600
1300	2100
1400	2200
1500	2200
1600	2200
1700	2000
1800	1800
1900	1600

6.3.4.7 Presentation of Results

In the present case model simulations have been carried using the hourly Triple Joint Frequency data. Short-term simulations were carried to estimate concentrations at the receptors to obtain an optimum description of variations in concentrations over the site in 10-km radius covering 16 directions. The incremental concentrations are estimated for the monitoring period due to operation of the all the units of the project.

6.3.4.8 Resultant Concentrations after Implementation of the Project

As emissions of particulate matter include particulate of all sizes, for the purpose of Air Quality predictions 40% of SPM was considered as RSPM. Accordingly, the maximum incremental GLCs due to the proposed project for SPM, RSPM, SO_2 and NO_X are superimposed on the maximum baseline SPM, RSPM, SO_2 and NO_X concentrations recorded at the monitoring locations during the monitoring period summer season (March to May, 2006). The cumulative concentrations (baseline + incremental) after implementation of project are given in **Table 6.4**.

TABLE 6.4 CUMULATIVE RESULTANT CONCENTRATIONS AFTER IMPLEMENTATION OF THE SASAN POWER PROJECT ON 24 HOURLY BASIS IN µg/m^3 (6X660 MW CONFIGURATION)

Locations	Baseline Concentrations				Incremental Concentrations				Resultant Concentrations			
	SPM	RPM	SO_2	NO_X	SPM	RPM	SO_2	NO_X	SPM	RPM	SO_2	NO_X
Near Site	181.4	76.3	13.2	16.8	1.3	0.5	21.4	12.6	182.7	76.8	34.6	29.4
Waidhan	188.2	82.4	22.3	27.5	0.7	0.3	12.4	7.3	188.9	82.7	34.7	34.8
Sasan Village	174.5	71.8	18.2	21.2	1.8	0.7	30.5	18.0	176.3	72.5	48.7	39.2
Tiyara Village	180.6	89.1	16.8	19.8	0.9	0.3	14.6	8.6	181.5	89.4	31.4	28.4
Bhari	167.1	68.5	18.7	21.2	3.3	1.3	55.1	32.6	170.4	69.8	73.8	53.8
Keraha	170.4	73.5	14.6	17.3	2.0	0.8	33.6	19.9	172.4	74.3	48.2	37.2
National AAQ Standards									200	100	80	80

All values are found well below within the prescribed standards after implementation of the project. Also the ground level concentration due to the effect of the above projects shall be monitored at regular intervals in the operation phase of all the units. However, if GLCs is

found to be higher than the prescribed norms during operation period adequate mitigation measures will be taken care by the SPL.

6.3.5 Noise Impact

The noise impacts will be mainly from the following machineries

- Steam Turbine Generator
- Rotating equipments
- Combustion induced noises
- Flow induced noises

In order to predict ambient noise levels due to the proposed power plant the propagative modeling has been done.

Noise Modeling: 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 decreased 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:

$$L_{p2} = L_{p1} - 20Log(r_2 / r_1) - A_E - A_M \qquad (1)$$

Where

Sound L_{P2} and L_{P1} are the Sound Pressure Levels (SPLs) at points located at a distances of r_2 and r_1 from the source.
A_E and A_M are attenuations due to Environmental conditions (E) and Machine correction (M).

The cumulative impact of multiple stationary noise sources (through hemispherical wave propagation) at a particular place can be calculated by

$$\mathbf{L_p\ (Total)} = \mathbf{10\ Log\ [\sum_{i=1}^{N} 10^{(Lpi/10)}]}$$

Lp (Total) is the resultant cumulative sound pressure level due to N separate sources. The calculation does not consider additional attenuation due to vegetation, boundary wall and buildings.

Based on the above equations a user-friendly model has been developed. The designed noise levels for the various equipments from the proposed project are given in **Table 6.5**. The values mentioned are at 1 m distance from the source.

The cumulative impact from different stationary noise sources at proposed project site has been predicted using the above model. Since the ambient noise is higher than predicted levels therefore, due to the masking effect, an increase is not expected.

TABLE 6.5- SOURCE STRENGTH OF NOISE

Source Name	Noise Levels L_{eq} in dB(A)- 1 m from Source
ID Fan	85
FD Fan	85
PA Fan	85
Boiler Feed Pump	85
Turbine	90
Unit Control Room	65
Cooling Water Pump	85
Coal Handling Plant	90
Coal Mill	85
Cooling Tower	85
Transformer	75
Air Compressor	90

Work Zone Noise Levels

Protective instruments will be provided to the operators and workers working near the high noise generating machinery. As per Occupational Safety and Health Administration (OSHA) Standards, the maximum allowable noise level for the workers is 90 dB(A) for 8 hours exposure a day. Therefore, adequate protective measures in the form of ear mufflers/ear plugs to the workers working in high noise areas will be provided.

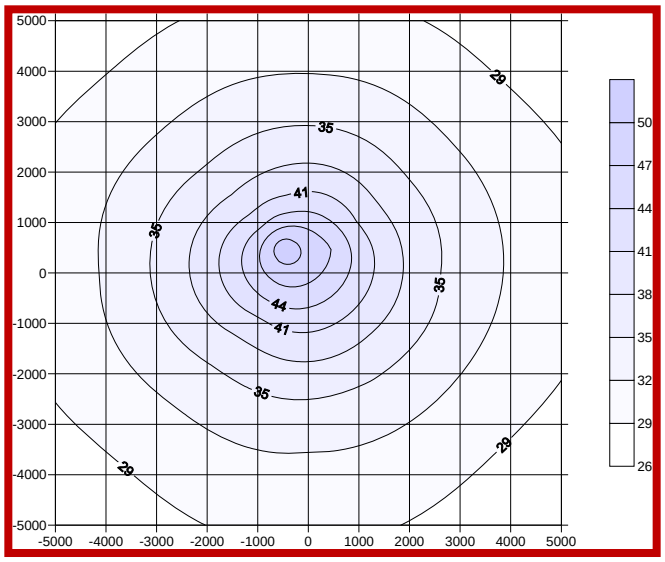


Figure 6.1: Noise Impact Contour

In addition, reduction in noise levels in the high noise machinery areas will be achieved by adoption of suitable preventive measures such as adding sound barriers, use of enclosures with suitable absorption material, etc. Further, all the open areas within the plant premises and all along the plant boundary will be provided with adequate green belt to diffuse the noise.

6.3.6 Impact on Water Environment

6.3.6.1 Impact on Ground Water

Groundwater issues during the operation phase are typically limited to:

- Consumptive use of groundwater, and
- Re-injection or percolation or leaching.

No ground water will be drawn during operation for any purpose. So lowering of groundwater table will not be an issue. In addition, Rainwater Harvesting will be implemented at proposed plant to conserve storm water.

The impact on ground water due to the power plant operations would primarily result due to likely leaching of toxic metals from the ash pond area. However, Clay lining is provided in ash dyke area to prevent groundwater pollution on the long term basis.

6.3.6.2 Impact on Surface Water

The plant will be based on the minimal discharge norms. Effluent discharge quantity Discharge of effluents from power plant will be less than 5% of the total consumption of water except monsoon. Therefore minimal effluent will be discharged outside the plant. The effluents generated from the power plant during operations will be collected stream-wise for various treatments as envisaged in the wastewater treatment scheme. The wastewater recovery, as practiced, will considerably reduce the impact on the surface water quality. The recovered wastewaters collected in a central monitoring basin will be reused for ash handling system, coal dust suppression and greenbelt irrigation. Colony wastewater will be treated in a separate treatment plant. The treated colony wastewater will also be used for irrigating the greenbelt in and around the colony. The effluents will be utilized as per water balance scheme. A state-of-art rain water harvesting system in consultation with CGWB will be provided to harvest the run-off water during heavy rainfall. The effluents would meet the prescribed norms prescribed by regulatory agencies andthus no impact of surface water is envisaged.

6.3.7 Ecological Impact

6.3.7.1 Terrestrial Ecology

The effects of air emissions on nearby vegetation and croplands are not likely to be injurious and noticeable as the pollutants concentrations are expected to be well within the prescribed standards. The effluents generated from the plant will be treated and reused after complying with prescribed standards.

6.3.7.2 Aquatic Ecology

Impact due to Water Withdrawal

As the water for the project will be drawn from Govind Ballabh Pant Sagar, which is one of major water body in Singrauli, small fish may tend to get entrapped and impinged in the intake system. The entrapped organisms will be subjected to a combination of physico-chemical and mechanical stresses, leading to their destruction. Smaller organisms such as phytoplankton, zooplanktons are entrainable and subject to entrainment in the treatment system. Suitable screens will be provided at the intake point to prevent entrapment/ impingement. Water drawl for the project is about 1.5% of the total live storage of GBPL. GBPL allocates about 19% of total live storage for industrial use. Water system of the project has been designated with maximum recycle and reuse of water, there by impact will be minimum.

Impact due to Discharge

For meeting the various plant water requirements viz. coal handling, ash handling and greenbelt development the wastewater will be utilized. Since the plant will be based on the minimal discharge norms therefore no impacts are anticipated on the aquatic ecology due to effluent discharge.

Therefore, overall impacts on the existing ecosystem would be negligible / marginal. However, regular monitoring will be necessary for detecting any undesirable change occurring in the ecological system which need to be appropriately monitored for mitigation requirements, if any.

6.3.8 Traffic Congestion

The fuel oil for the project will be transported in tankers or via Indian railway system. However the quantity of fuel oil required will be very less. Therefore, no overburden on the local transportation system is envisaged due to the proposed Project. SPL would also undertake widening and strengthen of the existing roads wherever required.

B. SOCIAL IMPACT

6.4 LABOUR INFLUENCE

6.4.1 Construction Phase

During construction activities, there will be a sizeable influx of population and Labour colony is being constructed with basic amenities for the labourers working on the project. This will have an effect on social fabrics of the areas surrounding the project. However, this impact is envisaged to be insignificant due to the following reasons:

- Temporary labour colonies shall be situated in the areas already acquired for the project.
- It will be only a temporary change (restricted to construction period). After construction phase, the areas acquired by labor colonies shall be reverted back as per the requirement of the plant / green belt / afforestation.

Human Resources Policy, which specifies the terms of employment and working conditions under SPL. These include procedures for hiring and recruiting, probation, training, performance review, promotion, insurance, salary and compensation, resignation, lay-off and retrenchment, leave and vacation, and superannuation, which follow Indian labour law. All the employees will have access to the human resources policy and procedures. Labour inspections are done annually by the relevant government agency, which reviews wages, working hours, benefits, etc.

Most of the construction labor will be on contractual basis. Separate Labor camps have been made within the plant premises for the construction labors. Therefore, conflict of the migrating labor with locals, will not take place during the construction phase. Regarding monitoring of diseases corresponding to labor influx, regular health status monitoring of labors and its surrounding population need to be carried out with the mobile health care facilities already developed and operated by SPL in this area. The environmental health areas and issues that requires attention by SPL is as follows:

TABLE 6.6- LABOUR HEALTH MANAGEMENT

Environmental Health Areas	**Influx camp** followers, job seekers, family, service workers	**Resettlement;** relocation	**Water management** Including creation of new water bodies; altering existing water bodies and changes in drainage pattern	**Linear features** Roadways; transportation routes;	**Hazardous materials** control and disposal	**Changes in income & expenditure** consumption including food/ housing inflation
Vector Related	Increasing human parasite	Movement to different prevalence area	Creation and movement of breeding grounds	Improper drainage, temporary water pool	Creation of breeding sites with drums at household level	

Environmental Health Areas	**Influx camp** followers, job seekers, family, service workers	**Resettlement;** relocation	**Water management** Including creation of new water bodies; altering existing water bodies and changes in drainage	**Linear features** Roadways; transportation routes;	**Hazardous materials** control and disposal	**Changes in income & expenditure** consumption including food/ housing inflation
Respiratory & Housing	Crowded housing, both work camps and community	Number of occupants per room; mix of occupants children/elderly/ adults (different vulnerability)		Facilitating mixing/interaction of different groups		Housing inflation triggered crowding
Veterinary Medicine	Movement and migration of livestock	Movement and migration of livestock due to influx of new groups	Creation and/or movement of livestock watering locations		Inadvertent water source contamination, of streams/ rivers	
Sexually Transmitted Infections; HIV / AIDS				Facilitating movement of high risk groups into rural settings		Men with money mixing with vulnerable women
Soil, Water & sanitation	Overburdening existing services/systems; explosive food-borne epidemics	Failure to anticipate extended family influx in initial design	Changes in surface water flows/quality, potential groundwater drawdown		Releases into surface water; long-term impacts to ground water	
Food & Nutrition	Influx of extended family more mouths to feed	Shift from subsistence agriculture to peri-urban living/petty trading	Changes in crop/garden selection and planting cycle	Changes in access to gardens or local markets		Food inflation further marginalizing vulnerable groups
Accidents & Injuries	Overcrowding, falls, burns, road traffic		Drowning, boat accidents	Road traffic, increased pedestrian activity	Unplanned releases/emissions	
Hazardous Materials Exposure	Squatter developments adjacent to industrial facilities with unplanned releases			Movement via trucks of hazardous materials across communities to project areas	Use of Project drums and containers for water and food storage; Inadequate incinerators design	
Psychosocial; Gender Issues	Cultural shock due to rapid societal change	Transformation of rural to peri urban/urban lifestyle		Greater ease of mixing social/ ethnic groups		Sudden money influx in a barter economic structure

Environmental Health Areas	Influx camp followers, job seekers, family, service workers	Resettlement; relocation	Water management Including creation of new water bodies; altering existing water bodies and changes in drainage	Linear features Roadways; transportation routes;	Hazardous materials control and disposal	Changes in income & expenditure consumption including food/ housing inflation
Cultural Health Practices	Introduction of new practices and / or elimination of existing practices	Introduction of new practices and/or elimination of existing practices				Shift to western medicine
Health Services Infrastructure & Capacity	Increased visits for out and inpatient services	Increased visits for out and inpatient services if access improves		Changes in access		Attraction of additional private providers/ increase in insurance enrollment
Non-communicable; hypertension, diabetes	Changes in diet	urban living versus high intensity subsistence farming				Shift from physical activity to sedentary lifestyle

6.4.2 Operation Phase

The operation & maintenance staff will be accommodated in the SPL Township. Therefore no impact on the local life pattern is envisaged due to operational worker of the project.

6.5 SOCIO-ECONOMIC IMPACT

6.5.1 R&R Issue

The land requirement for the project would mainly cover five villages of Sidhi Khurd, Sidhi Kalan, Jhanjitola, Harrahawa and Tiyara in Tehsil Waidhan, District Singrauli. The major impacts due to land acquisition for the Project are:

- Loss of private property;
- Loss of asset including plantations;
- Loss of livelihood and income directly linked to the above and
- Other indirect losses.

The estimated Project Affected Families (PAFs) losing home stead is shown in the table below.

TABLE 6.7- NO. OF AFFECTED HOUSEHOLDS

S. No.	Village	No. of Affected Households
1.	Siddhi Khurd	448
2.	Siddhi Kalan	23
3.	Jhanjitola	8
4.	Harrahawa	187
5.	Tiyara	154
Total		**820**

However, Resettlement and Rehabilitation of the affected villages in a satisfactory manner will help mitigate the impact of displacement and loss of livelihood. Care is being taken by Sasan Power Limited to provide a long term sustainable package of compensation (already approved by Govt.) to project affected persons based on the Central & Stage Government guidelines.

Approved SPL R&R Plan will also be adopted for affected households or person being affected due to additional land acquisition for linear components of the project like coal conveyor, ash corridor.

6.5.2 Change in Socio-economic Condition

Employment: The project will generate employment opportunities for the local population. Even indirect job opportunities will be created outside the project boundary. Many people will find employment in service sector and marketing of day-to-day needs viz. poultry and other agricultural products. The project will improve the basic infrastructure and the people of nearby villages can also benefit from these amenities.

SPL is working for towards the employment and skills training for the locals through following steps.

- Provision in project contracts to provide priority in employment
- Training for skills up-gradation
- Encouraging labour co-operative of displaced families & giving priority to labour cooperatives of displaced families for award of miscellaneous contracts
- Reservation of shops for displaced families in employee township
- Efforts to employ educated unemployed youth

SPL is also providing training to women for skill-development & self – employment for e.g. SPL is providing training in tailoring skills to group of women.

Overall there will be marginal impact on the socio-economic condition of the locality and the impact will be mostly positive.

Development of Infrastructure: The job opportunities in non-agricultural sector are likely to increase. The installation of the power plant is expected to further increase the prospects by bringing in direct and indirect employment opportunities.

As the project and consequent activities are expected to generate additional employment and income opportunities for the local population, market expansion supported by infrastructural development will foster economic growth in the area. Flow of reliable and adequate power from the proposed plant will not only enhance growth in the region, but will also bring about a change in energy consumption pattern by switching over from other sources of energy. This will ease off burden on existing biomass resource of the area.

6.6 IMPACT FROM WATER PIPELINE CORRIDOR

Make up water shall be drawn from Rihand reservoir. An intake well will be installed at a suitable location inside the reservoir, so that water is available at all seasons.

Water from intake well will be carried on bridges to the right bank of reservoir and then it will be carried through underground pipes following ground profile. Route of the water corridor is based on the minimum disturbance to the forest, settlement and community. No land acquisition is involved in water pipe line corridor. The land for the pipe corridor shall be taken on ROW basis. The impact on erection of this line is temporary in nature due to digging, back filling and temporary disturbance. There is no permanent or long term impact. Suitable road crossings/culverts shall be provided for movement of people. Therefore,

minimal change on the local environment is expected due to the water corridor. In view of this no separate mitigation measures are considered.

6.7 IMPACT FROM ASH CORRIDOR

The Ash from the Plant will be collected in dry form and will utilized. The unutlised ash has been envisaged to be transported in slurry form, and will be disposed off by means of a set of slurry pumps to ash dump area. In order to reduce the fugitive emission due to ash handling system, the disposal of ash to the ash dump area is envisaged in wet (slurry) form. The land requirement for the ash pipeline corridor is estimated to only 3.42 acres. The ash corridor from plant to ash dyke is shown in **Figure 6.2**.

Two ash slurry pipes will be routed in one direction of ash dyke and two pipelines will be routed in the other direction of the ash dyke. Each length of the pipe will be approximately 6500m. Necessary crossover connections will be provided at the ash dyke area where the four streams of ash slurry pipelines will be converted into 2 x 100 percent garlanding.

All ash disposal pipelines will be routed through pipe rack up to the plant boundary, and beyond this point these pipes will be routed on reinforced concrete sleepers/pedestals. At road crossings, the slurry disposal pipes will be routed on culverts, and at canals these pipes will be routed on pipe bridges. To minimise the impact of ash leaking, 100% redundancy is envisaged to facilitate periodic maintenance. Provision is given in the system for periodic maintenance and rotation/replacement of the disposal pipe line to check for erosion and thinning of pipe lines, so as to avoid bursting of ash lines.

Therefore, negligible impact due to ash transportation system is envisaged. Since all measures are taken at the design stage, no separate additional mitigation measures are considered necessary.

6.8 IMPACT FROM COAL TRANSPORTATION

Coal from mines will be transported to plant through overland conveyor route. Fugitive emission will not take place due to closed conveyor system. Also no congestion on the local transportation is envisaged due to proposed overland conveyor. Approx. 73 acres of land will required additionally for the belt coal conveyor system affect about 280 families. The route of the coal conveyor system has been finalized on the basis of minimum disturbance especially agriculture and habitats.

For transportation of the coal from mines to the power plant, a single flight overland coal conveyor is proposed. Since it is a single flight conveyor from mines to the power plant, there are no transfer points along the route of conveyor.

Because of no transfer point in between the conveyor, there shall not be any dust generation and spillage. All the gantries shall have continuous roof and side sheeting and the floor will be totally covered, preventing possible spillage on to the ground.

The total length of conveyor shall be approx. 20 Km from mines to the power plant passes through Amhlori, Nougarh, Dhatura Barwa, Bilounji Bhatwa, Pachore, Hirwah, Kam, Gadharkhurd and Sidhikurd villages. The alignment of the Overland coal conveyor passes through the submergence land in between Hirwah , Kam and Gadahara Khurd villages for a distance of approx 3.5 kms and crosses Mayar river at Kam village. The project R&R plan will be applicable for these as well.

The impact of the coal corridor is envisaged to be minimal as the preventive measures are inbuilt in the design of conveyor systems and all safety measures are adopted .

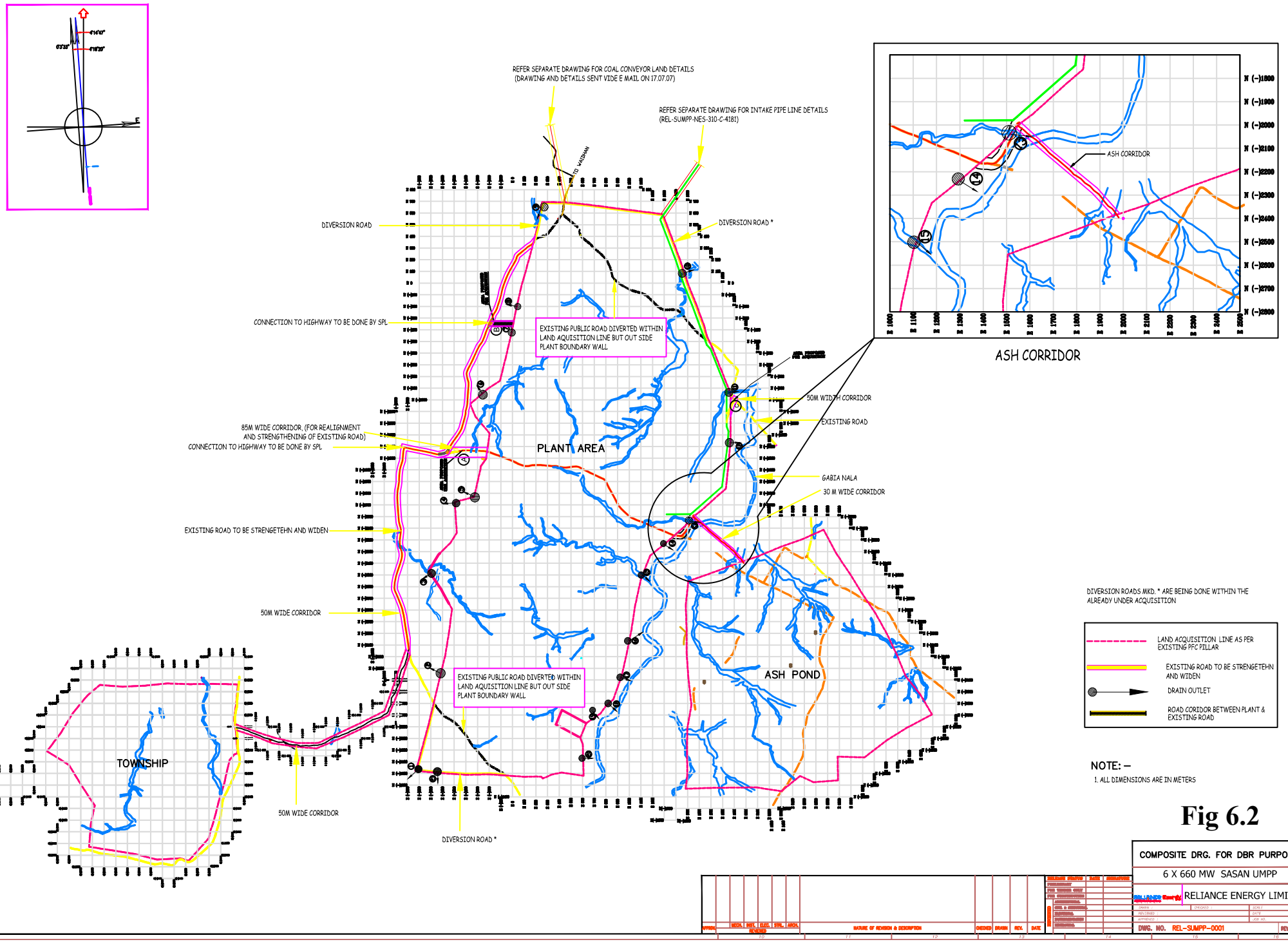

REFER SEPARATE DRAWING FOR COAL CONVEYOR LAND DETAILS
(DRAWING AND DETAILS SENT VIDE E MAIL ON 17.07.07)
REFER SEPARATE DRAWING FOR INTAKE PIPE LINE DETAILS
(REL-SUMPP-NES-310-C-4181)
TO VADINAR
DIVERSION ROAD
DIVERSION ROAD *
CONNECTION TO HIGHWAY TO BE DONE BY SPL
EXISTING PUBLIC ROAD DIVERTED WITHIN LAND AQUISITION LINE BUT OUT SIDE PLANT BOUNDARY WALL
50M WIDTH CORRIDOR
EXISTING ROAD
85M WIDE CORRIDOR, (FOR REALIGNMENT AND STRENGTHENING OF EXISTING ROAD)
CONNECTION TO HIGHWAY TO BE DONE BY SPL
PLANT AREA
GABIA NALA
30 M WIDE CORRIDOR
EXISTING ROAD TO BE STRENGETEHN AND WIDEN
50M WIDE CORRIDOR
EXISTING PUBLIC ROAD DIVERTED WITHIN LAND AQUISITION LINE BUT OUT SIDE PLANT BOUNDARY WALL
ASH POND
TOWNSHIP
50M WIDE CORRIDOR
DIVERSION ROAD *
ASH CORRIDOR
ASH CORRIDOR
DIVERSION ROADS MKD. * ARE BEING DONE WITHIN THE ALREADY UNDER ACQUISITION
LAND ACQUISITION LINE AS PER EXISTING PFC PILLAR
EXISTING ROAD TO BE STRENGETEHN AND WIDEN
DRAIN OUTLET
ROAD CORIDOR BETWEEN PLANT & EXISTING ROAD
NOTE: –
1. ALL DIMENSIONS ARE IN METERS
COMPOSITE DRG. FOR DBR PURPOSE
6 X 660 MW SASAN UMPP
RELIANCE ENERGY LIMITED
DWG. NO. REL-SUMPP-0001
REV.00

Fig 6.2

6.9 IMPACT FROM PROPOSED AND EXISTING INDUSTRIAL ACTIVITY

Presently there are no new industries proposed to be established within 15 kms radius from the project site.

6.10 IMPACT ON CULTURAL RESOURCES

There are no specific cultural heritage sites in and around the project area. Also there are no tangible properties or natural features that would be considered cultural heritage site.

6.11 IMPACT ON CONSTRUCTION LABOUR

Most of the construction labours will be on contractual basis. Separate labour camps have been made within the plant premises for the construction labors. Therefore, conflict of the migrating labour with local, is not likely to take place during the construction phase.

Regular check will be done through supervisors so that construction labour does not interfere with the local inhabitants for their cultural values.

6.12 IMPACT DURING DE-COMMISSIONING OF THE PROJECT

Sasan UMPP is a project of national importance involving huge investment. While in Operation, the plant management will employ the best maintenance techniques and systems. These efforts result in extended life of the plant.

Similarly efforts and investment for renovation and Modernization will result in further life extension of the plant. From the present trends, the life of the plant would not be less than 35 to 40 years. However when the plant becomes unviable due to major technological changes or fuel availability or due to Environmental regulations, decommissioning of the plant will be undertaken. This involves a series of steps to be planned and executed. The total operation can be broadly categorized in to De-operationalisation and Dismantling phases.

De-operationalisation is a technical activity carried out experts. Dismantling operation however will have impact on environment due to noise and dust arising out of it. For an understanding of the activity involved, the approximate quantities that are to be handled are given in **Table 6.8**.

TABLE 6.8- QUANTITIES OF MATERIAL DURING DECOMMISSIONING STAGE

S. No.	Description	Qty	Remarks
1	Boiler	180000 MT	6 units of 30,000 Tons each
2	Other Structural steel	100000MT	Main Power House, Conveyor galleries, Water tanks, Oil tanks, Pipe support racks, reinforcement steels, etc.
3	Piping	5000 MT	High pressure and Low pressure Piping
4	Concrete	400000 m^3	Foundations, Powerhouse building and other buildings
5	Chimney	2 Nos	1 each per block of 3 units consisting of steel and cement concrete
6	Mechanical Equipment	Lot	Turbine components, Pumps, fans, compressors, Valves etc.
7	Electrical equipment	Lot	Switchgears, transformers, Cables, batteries, Trays etc.
8	Electronic equipment	Lot	Control panels, Electronic hardware, PCs, Instruments etc.

In order to handle the de-installation of each type of item a specific strategy will have to be planned to keep the impact during the actual activity low. During this phase of the plant, all structures will be cleared away, all rubbish cleared, excreta or other disposal pits or

trenches filled in and effectively sealed off and the site left clean and tidy, at the contractor's expenses, to the entire satisfaction of the engineer.

The decommissioning will also have social impact. The decommissioning of the power house which was a part of the local social fabric for many years will certainly create vacuum in the lives of the people directly and indirectly connected with it. The impact due to decommissioning on power, social and environmental scenario will be guided by applicable laws and guidelines. These will be addressed appropriately.

E. Impact Summary

6.13 SUMMARY OF THE IMPACTS

The summary of the construction activities and probable impact are discussed below in **Table 6.9**.

TABLE 6.9- IDENTIFICATION OF ACTIVITIES & PROBABLE IMPACTS (CONSTRUCTION)

Construction Activities	Environment Attribute	Probable Impacts
Land Acquisition	Land	• Change in Land Use Pattern • Change in land use pattern in the vicinity
	Socio-economics	• Rehabilitation & Resettlement issues
Site clearing and Leveling (cutting, stripping, excavation, earth movement, compaction)	Air	• Fugitive Dust Emissions • Air Emissions from construction equipment and machinery
	Water	• Run-off from area
	Land	• Loss of top soil • Change in Drainage Pattern
	Ecology	• Loss of vegetation/ habitat
Transportation and Storage of Construction Material/ Equipment	Air	• Noise and Air Emissions from Vehicles • Fugitive Dust Emissions due to Traffic Movement
	Water	• Run-off from Storage Areas of Construction Material
	Public Utilities	• Increased flow of traffic
Civil Construction Activities	Air	• Noise and Air Emissions from Construction Machinery • Fugitive Dust Emissions
	Water	• Run-off from Construction Areas
Mech. and Elec. Erection Activities	Air	• Noise and Air Emissions from Machines / activities
	Water	• Run-off from Erection Areas containing Oils, Paints
Influx of Labour and Constn. of Temp. Houses	Socio-economics	• Stress on infrastructure • Stress on social relations
	Land	• Change in land use pattern of the area
	Water	• Sanitary effluents from labour colonies
Transportation and Disposal of Construction Debris	Air	• Noise and Air Emissions from Transport Vehicles • Fugitive Dust Emissions due to Movement of Traffic • Spillage and fugitive emissions of debris materials
	Water	• Run-off from Disposal Areas
	Soil	• Conversion of land into waste land

Table 6.10 lists various activities of operation and maintenance phase and their probable impacts on various sectors of environment. Most of these impacts are long term impacts.

However, the significance of most of these impacts is envisaged to be low, as discussed in the subsequent sections.

TABLE 6.10- IDENTIFICATION OF ACTIVITIES AND PROBABLE IMPACTS (O&M)

O&M Activities	Sector	Probable Impacts
Transportation of Coal/ Oil	Air	• Noise and Air Emissions from Vehicles • Fugitive Dust Emissions due to Traffic Movement • Spillage and fugitive emissions of coal
	Water	• Spillage of coal and flow into streams
	Public Utilities	• Increased flow of traffic
Unloading, Crushing and Storage of Crushed Coal/ Unloading and Storage of Oil	Air	• Fugitive Dust Emissions from Coal Handling Areas
	Water	• Effluents for CHP/ Oil Storage Areas • Run-off from Coal Stock Yard
Burning of Fuel	Air	• Stack emissions (Particulate Matter, SO_2, NO_X etc.)
Water Treatment for various uses	Water	• Generation of Effluents and sludge from Water Treatment Plant
Power Cycle	Water	• Discharge of Blow-down
Transportation and Disposal of Ash	Water	• Overflow/ Leachate from Ash Disposal Area
	Land	• Land requirement for ash disposal
	Air	• Fugitive Emissions
Domestic Use of Water in Plant and Township	Water	• Generation of sanitary effluents

6.14 SIGNIFICANCE OF THE IMPACTS

The Important Environmental Components (IECs) and their potential interaction with the major project activities are presented in this section. This needs to be summarised in one table for easy comparison and interpretation. The 'Modified Matrix' method has been adopted to identify the potential of Impacts. This method involves the establishment of cause-effect relationship and also **'The Parameter Important Value (PIV)'** against each environmental impact parameter.

The identification of environmental impact is based on the baseline condition as described in chapter 4 and nature of proposed activities as detailed in chapter 3 and other indirect resultant activities.

The PIV values are determined by subjective judgment considering the relative importance and significance of individual parameter. After deciding PIV, these values have to be distributed among all the cause-effect relationship, which are established between those particular affected Environmental and Social parameters and the concerned project activities by means of indices called **"Relative Parameter Importance Indices (RPII)"** such that the sum of all indices is equal to unity. The RPII values are decided based on the relative importance of cause-effect relationship and highest important one is given highest RPII value and the lowest important one is given lowest RPII value.

Another index, which is to be determined for each cause effect relationship is called **"Environmental Impact Index (EII)".** The scale for EII varies from zero to one. The value one is assigned to an impact of highest order and zero to assign to an impact of negligible magnitude. The adverse impacts, EII carries a negative sign and for beneficial impacts, it carries positive sign. **Weighted Environmental Impact Index (WEII)** is arrived by multiplying score of RPII and EII.

For determining the value of EII, the environmental impact parameters are divided into two categories.

6.14.1 Category 'A' Parameter

This category incorporates environmental and social impact parameters, whose quality varies linearly with the magnitude of impact area as related to the proposed project activities and includes:

- Surface and ground water resources
- Socio-economic aspects
- Land-use
- Human Settlement

6.14.2 Category 'B' Parameter

This category incorporates environmental and social impact parameters, whose quality varies logarithmically with the magnitude of impact area as related to the proposed project activities and includes:

- Surface and Ground water quality
- Air quality
- Noise level
- Health
- Flora
- Wildlife
- Aquatic Life
- Thermal

The bases for determination of EII value are given in **Table 6.11** and **6.12** respectively. After determining EII for each cause-effect relationship the same will be multiplied with RPII to get a 'Weighted Environmental Impact Index (WEII)". These values are once again multiplied with PIV and addition of all these values gives the impact score of that particular environmental parameter. The impact score, obtained for all environmental and social impact parameters is added together to get total impact score. This total impact score is used for interpretation and decision-making.

TABLE 6.11: DETERMINATION OF EII FOR CATEGORY 'A' PARAMETERS

S. No.	Impact Magnitude (in %)	EII
1	No Change	0.00
2	0 – 4.9% Change	0.05
3	5 – 14.9% Change	0.10
4	15 – 24.9% Change	0.20
5	25 – 34.9% Change	0.30
6	35 – 44.9% Change	0.40
7	45 – 54.9% Change	0.50
8	55 – 64.9% Change	0.60
9	65 – 74.9% Change	0.70
10	75 – 84.9% Change	0.80
11	85 – 94.9% Change	0.90
12	> 95% Change	1.00

TABLE 6.12: DETERMINATION OF EII FOR CATEGORY 'B' PARAMETERS

S. No.	Impact Magnitude (in %)	EII
1	No Change	0.00
2	0 – 4.9% Change	0.02
3	5 – 14.9% Change	0.05
4	15 – 24.9% Change	0.10
5	25 – 34.9% Change	0.15
6	35 – 44.9% Change	0.25
7	45 – 54.9% Change	0.50
8	55 – 64.9% Change	0.75
9	> 65% Change	1.00

6.14.3 Project activities and environmental parameters

The power generation and allied activities, which are likely to cause potential impacts on environment, are listed below:

- Involuntary Resettlement
- Air emission from fuel combustion
- Water consumption
- Wastewater generation / disposal
- Noise generation
- Provision of civic amenities
- Tree plantation programmes

The likely impacts of these activities and benefits are already discussed under present chapter.

6.14.4 Parameters importance value for environmental components

The environmental components listed in the earlier section are assigned with PIV so as to convert the environmental impacts into commensurate units, which could be aggregated easily to get the total score of environmental impacts. The parameter importance values are assigned by marking and pair-wise comparison procedure. This procedure involves preparation of a table containing number of columns corresponding to the range of value, which can be assigned a 'Score of importance' against each impact area. The score of importance is any integer ranging from one to six. The most affected parameters carries a score of six and the least affected parameters carries a score of one.

6.14.5 Importance Ranking

This score is made considering the intensity and nature of impact over the identified impact area. The impact areas considered along with their ranking are tabulated in **Table 6.13**. The weightage for each impact area is calculated by dividing the ranking integer by sum of rankings as done in this table. The total parameter importance value is assumed to be 1000 as per the standard practice. The value of total PIV is distributed among each impact area according to its weightage. The final values computed by this procedure are also tabulated in **Table 6.14**.

TABLE 6.13: DETERMINATION OF PARAMETERS IMPORTANCE VALUE (PIV)

S. No.	Impact Area	Ranking 1	2	3	4	5	6
1.	Surface Water Resources	Intake and discharge through	Intake and discharge through	Intake through pipeline	Intake through open	Intake through open	Intake and discharge through

Client: Sasan Power Limited,
A wholly owned subsidiary of Reliance Power Limited
Consultant: GIS Enabled Environment & Neo-graphic Centre (GREENC)

S. No.	Impact Area	Ranking 1	2	3	4	5	6
		pipeline through adequate planning with negligible change in quality of the water	pipeline with Minimum change in quality of the water	And change in quality of water	channel and minimum changes in water quality	channel and significant change in water quality	open channel
2.	Ground Water Resources	No intake of ground water during construction & operation and no land discharge	Intake of ground water during construction & but not in operation and no land discharge	Make up water Intake during operation but no land discharge	Make up water Intake during operation but treated waste water discharge for gardening	Seasonal dependence on ground water in case of pre-monsoon shortage	Project located in declared drought prone area and abstraction of surface will also impact ground water table further
3.	Air Quality	Predicted Air Quality is nearly 20% of the stipulated standard from the project and cumulative impact is also same	Predicted Air Quality is nearly 20% from the project and cumulative impact with all future development is 50% of the stipulated standard	Predicted Air Quality is nearly 30% from the project and cumulative impact with all future development is 50% of the stipulated standard	Predicted Air Quality is nearly 50% from the project and cumulative impact with all future development is 80% of the stipulated standard	Predicted Air Quality is nearly 60% from the project and cumulative impact with all future development is 80% of the stipulated standard	Predicted Air Quality will exceed the stipulated standard
4.	Water Quality	No change in surface water quality with negligible change in physic-chemical properties of the receiving water body	Minimum change in physic-chemical properties of the receiving water body	Moderate Change in Surface water quality due to discharge and no change in the Ground Water Table as well as quality	Moderate Change in Surface water quality due to discharge and insignificant change in ground water quality due to leaching	Change in Surface water quality due to discharge and significant change in ground water quality due to leaching	Significant change in Surface water quality due to discharge and significant change in ground water quality due to leaching and deterioration of ground water table due to extraction
5.	Noise levels	No change beyond noise generating equipment	Minimum change beyond noise generating equipment	Moderate change beyond noise main plant	Moderate change in ambient level	Moderately high change in ambient	Significant change in ambient level

S. No.	Impact Area	Ranking 1	2	3	4	5	6
		premises	premises	premises		level	
6.	Health	Minimum Risk due to State of Art Technology with health care facilities for workers and host population	Minimum Risk due to State of Art Technology with first aid facility for workers	Low Risk due to Available Technology with first aid facility for workers	Moderate Risk due to PPE with first aid facility for workers	High Risk working environment with first aid facility for workers	High Risk working environment which requires frequent monitoring of workers health
7.	Public Utilities	No change in utilities due to project activity except for strengthening of utilities for host community	Use of existing roads and acquisition of Govt. owned wasteland and strengthening facilities for host community	Acquisition of agriculture land, diversion of road, etc	Acquisition of agriculture land, community areas, facility places, diversion of road, etc	Acquisition of agriculture land, water body, community areas, facility places, diversion of road, etc	Acquisition of agriculture land, residential areas, water body, community areas, facility places, diversion of road or nala, etc
8.	Economic aspects	Positive impact since project located in backward region required alternate employment generation for host community	Located in agriculturally developed but dense population required more employment opportunity	Located in agriculturally poor but having some traders as host community with tertiary employment and with thin population base	Located in agriculturally developed area with opportunity of primary as well as tertiary sources of income	Located in highly industrialized mining areas with opportunity of secondary sources of income	Located in highly industrialized urban area with opportunity of secondary as well as tertiary sources of income
9.	Land-use & Soil Characteristics	Poor Soil fertility and without any sensitive land use within impact distance	Poor Soil fertility and with only degraded Reserve Forests and Protected Forests within impact distance	Poor Soil Fertility but marshy area within 1 km from site boundary	Moderate Soil Fertility with sensitive zones within impact distance	Fertile Soil with sensitive zones within impact distance	Fertile Soil with sensitive zones adjacent to site
10.	Flora	No change and impact on flora at site or in impact zone	Insignificant change and impact on flora in impact zone	Due to ground clearance shrubs will be removed	Site have flora with economic and medicinal value	Part of degraded forest land been acquired	Project Site fall in protected or reserve forest area
11.	Wildlife	The site and immediate adjacent area is devoid of wild animals	Entire Impact zone does not have any schedule I & II species	Entire Impact zone does not have any endangered fauna and migratory routes	Impact zone have endangered fauna but devoid of migratory routes	Entire Impact zone have endangered fauna and migratory routes	The site fall in the migratory route
12.	Human	Host	Host	Major influx	In-	In-migration	In-migration

S. No.	Impact Area	Ranking 1	2	3	4	5	6
	Settlement	community is capable to provide skilled and unskilled labour, no cultural change and no impact on natural resources	community is capable to provide unskilled labour, insignificant cultural change	of construction labours and chances of conflict of culture & communicable diseases	migration will effect natural resources and amenities already available	of skilled and moderate change in socio-cultural profile of host community	of skilled and unskilled labor and significant change in socio-cultural profile
13.	Culture	No change in culture of host community	Minimum impact in culture due to influx of migrants labor and introduction of their culture within host community	Moderate impact in culture due to change in economic activity and social status	Moderate impact in culture due to change in economic activity and impact on their cultural or religious precincts	Change in culture due to involuntary resettlement and livelihood pattern associated with income generation of host community	Significant impact in culture due to involuntary resettlement of indigenous people
14.	Human Resettlement	No R&R issues with no impact on host community	No R&R issues only minimum immigration of construction labours and minimum chances of conflict with host community	No R&R issues only major influx of construction labours and chances of conflict with host community and communicable diseases	Involve Involuntary resettlement with only land oustees consist	Involve Involuntary resettlement with only land oustees consist of indigenous population	Involve Involuntary resettlement with both land and home oustees consist of indigenous population
15.	Thermal	No thermal imbalance with State of Art Heat Recovery System	Chances of thermal imbalance with Best Available Technology of Heat Recovery System	Chances of moderate thermal imbalance with of Heat Recovery System in stable air shed	Inadequate waste heat recovery may cause thermal imbalance	Moderate thermal imbalance is expected	Significant thermal imbalance is expected due to conventional Technology

TABLE 6.14: PARAMETERS IMPORTANCE VALUE (PIV)

S. No.	Impact Area	Ranking 1	2	3	4	5	6	Total	Weightage	PIV
1.	Surface Water (Seawater) Resources			-				3	3/54	55.6
2.	Ground Water Resources		-					2	2/54	37.0
3.	Air Quality					-		5	5/54	92.6
4.	Water Quality			-				3	3/54	55.6
5.	Noise levels				-			4	4/54	74.1
6.	Health			-				3	3/54	55.6
7.	Public Utilities						-	6	6/54	111.1

S. No.	Impact Area	Ranking						Total	Weightage	PIV
		1	2	3	4	5	6			
8.	Economic aspects			-				3	3/54	55.6
9.	Land-use & Soil Characteristics		-					2	2/54	37.0
10.	Flora						-	6	6/54	111.1
11.	Wildlife				-			4	4/54	74.1
12.	Human Settlement			-				3	3/54	55.6
13.	Culture		-					2	2/54	37.0
14.	Human Resettlement						-	6	6/54	111.1
15.	Thermal		-					2	2/54	37.0
Total								54		1000.1

6.14.6 Weighted Environmental Impact Index (WEII)

It is necessary to establish Relative Parameter Importance Index (RPII) and Environmental Impact Index (EII) in order to arrive at the Weighted Environmental Impact Index (WEII).

Relative Parameter Importance index (RPII)

The RPII indicates the importance of interaction between the action and environmental components. It is assigned any value between 0 and 1 and the sum of all the values of RPII under each environmental component is equal to 1. The importance of an interaction is related to the significance or assessment of the consequences, of the anticipated interaction. Assignment of RPII to an interaction is based on the subjective judgement. While deciding RPII, first the RPII values are distributed among adverse and beneficial impacts depending upon their significance. The RPII values, distributed are once again distributed among the respective interactions depending upon their individual significance. The most important interactions under a particular impact area is given the maximum RPII, whereas the lowest important one is given minimum RPII. As the significance increases the RPII also increases.

The RPII values for all the interactions, along with the criteria for deciding the same is presented in **Table 6.15**.

Environmental Impact Index (EII) Matrix

The index represents the magnitude of an impact due to the interaction established between an environmental component and a project activity. This impact magnitude is represented by a numerical value, which is determined from **Tables 6.11** and **6.12**. The environmental components are grouped into two categories viz. 'A' and 'B' discussed in earlier paragraph. The EII for category 'A ' environmental component is determined from **Table 6.11** and the same for category 'B' is determined from **Table 6.12**. The EII are determined for each impact area project activity interaction and are given in **Table 6.16** along with remarks.

The WEII is determined by multiplying RPII and EII of corresponding interaction. The values are tabulated in **Table 6.15**.

TABLE 6.15: IMPACT MATRIX WITHOUT MITIGATION MEASURES

Impact Area	WEII (RPII X EII)	PIV	Total (WEII X PIV)
Surface Water Resources	-0.650	55.6	-36.14
Ground Water Resources	-0.500	37.0	-18.50
Air Quality	-0.635	92.6	-58.80
Water Quality	-0.900	55.6	-50.04

Noise levels	-0.530	74.1	-39.27
Health	-0.315	55.6	-17.51
Public Utilities	0.380	111.1	42.22
Economic aspects	0.530	55.6	29.47
Land-use & Soil Characteristics	-0.510	37.0	-18.87
Flora	-0.570	111.1	-63.33
Wildlife	-0.413	74.1	-30.57
Human Settlement	-0.300	55.6	-16.68
Culture	0.000	37.0	0.00
Human Resettlement	-1.000	111.1	-111.10
Thermal	-0.250	37.0	-9.25
Total		**1000.1**	**-398.38**

Calculation has been done upto 3rd place of decimals

6.14.7 Potential Impact Identification using Environmental Impact Matrix without Mitigation Measures

The total impact score is assessed by the use of following relative scales.

Upto -200	:	No appreciable impact on environment
-200 to -400	:	Appreciable but reversible impact and appropriate control measure are important
-400 to -600	:	Significant Impact mostly reversible after a short period and mitigation measure are crucial
-600 to -800	:	Major Impact, which is mostly irreversible
-800 to -1000	:	Permanent irreversible impact

After arriving at WEII and PIV values as described above the Environmental Impact Matrix incorporating all the environmental components and project activities (Without control measures for proposed Thermal Power Plant), is presented in **Table 6.16**.

The impact is calculated by multiplying the sum of all WEII's against each environmental component by it's corresponding PIV. Total Impact Score is calculated by adding all individual impact scores.

6.14.8 Summary of Impact

The total score is '–398.38', which indicate "Appreciable but reversible impact and appropriate control measure are important". Hence proper control measure must be incorporated in context of Environmental Management.

TABLE 6.16 – POTENTIAL IMPACT IDENTIFICATION IMPACT MATRIX WITHOUT MITIGATION MEASURES

Sl. No.	Environmental Components	Project Activities	Interaction No.	Impacts	Adverse / Beneficial	RPII values	Remark for RPII	EII Index	EII (%)	Remark for EII
Social and Environmental Assessment and Management System										
1.	Air Quality	Power generation operations	1	Coal Combustion will generate SPM, SO_2 and NO_X etc.	Adverse	0.60	Coal is primary source of fuel	-1.00	70.0	Un-controlled combustion will generate SPM, SO_2 and NO_X etc.
2.	Air Quality	Transportation of coal during operation	2	Causes dust nuisance and gaseous pollution due to transportation	Adverse	0.10	Insignificant increased in traffic density envisaged	-0.15	30.0	Insignificant impact on air quality as road transportation is not envisaged, coal will be transported closed conveyor system
3.	Air Quality	Vegetation Plantation	3	It serves as a natural screen in attenuation of air pollution	Beneficial	0.10	Less significant, as emission are mostly through 275m stack	0.00	0.0	No vegetation proposed in the pre-mitigative stage
4.	Air Quality	Dust emission during Construction Phase	4	During construction phase temporary impact	Adverse	0.20	Insignificant, as emission will take place only on the construction site	-0.10	15.0	Insignificant amount of fugitive dust would be released
5.	Water Quality	Provision of civic amenities	1	Deterioration in water quality due to disposal of domestic waste water	Adverse	0.20	Release of domestic wastewater is relatively low	-0.50	50.0	Un-treated domestic waste water contains high BOD, Coliform and suspended matter
6.	Water Quality	Power generation operation	2	Impact due to wastewater from different industrial operations	Adverse	0.80	Significant quantity of wastewater generated	-1.00	70.0	Un-treated waste water contains high suspended matter, Oil & grease and heat
7.	Noise Levels	Power generation operation	1	Increase in noise level due to operation of various equipment	Adverse	0.70	Significance due to operation of ID fans, compressors, turbines, pumps, cooling towers etc.	-0.75	60.0	High noise generation from the equipment during non-mitigative stage
8.	Noise Levels	Transportation	2	Increase in noise level due to vehicular traffic	Adverse	0.10	Less significant as road transportation of raw/material product not	-0.05	10.0	Insignificant increase in noise level due to movement of few

Sl. No.	Environmental Components	Project Activities	Interaction No.	Impacts	Adverse / Beneficial	RPII values	Remark for RPII	EII Index	EII (%)	Remark for EII
							envisaged			trucks and vehicles used for raw material transportation in emergency
9.	Noise Levels	Vegetative Plantation	3	It serves as barrier for noise propagation, thereby reducing noise levels	Beneficial	0.20	Less significant as compared to the noise sources	0.0	0.00	No plantation is proposed in pre-mitigative stage
10.	Thermal Pollution	Power generation	1	Inadequate waste heat recovery may cause thermal pollution	Adverse	1.00	Significant	-0.25	40.0	Important under pre-mitigative Stage
Labor and Working Condition										
11.	Health	Power generation operation	1	Impact on health due to air & noise pollution, toxic exposure and accidents & injuries	Adverse	0.50	Potential for exposure to noise, air pollution, toxic exposure, accidents and injuries is high	-0.50	50.0	High potential for air pollution and noise level, as well as Toxic and Flammable gas & Chemicals – Chlorine, Hydrogen, LDO / HFO etc., accident in pre-mitigative case
12.	Health	Vegetative Plantation	4	Improves the health of inhabitants by acting as a barrier to air and noise pollution, uptake of liquid waste disposed on land and impacts pleasant atmosphere	Beneficial	0.20	More significant as compared to effects due to transportation and civic amenities	0.00	0.0	No plantation in pre-mitigative stage
Pollution Prevention and Abatement										
13.	Land use and Soil Characteristics	Disposal of solid waste	1	Land degradation due to disposal of solid wastes	Adverse	0.40	A large quantity of ash will generate	-0.70	70.0	Large quantity of ash will be generated
14.	Land use and Soil Characteristics	Civic Structure	2	Landuse degradation due to erection of civil structures	Adverse	0.30	Civil Structure are within plant area	-0.50	50.0	Impact due to civil structures will be nominal
15.	Land use and Soil	Provision of civic	3	Domestic Waste Disposal	Adverse	0.10	Domestic waste will be generated by laborers	-0.80	80.0	Potential for adverse impact under pre-

Sl. No.	Environmental Components	Project Activities	Interaction No.	Impacts	Adverse / Beneficial	RPII values	Remark for RPII	EII Index	EII (%)	Remark for EII
	Characteristics	amenities					engaged during construction.			mitigative stage
16.	Land use and Soil Characteristics	Vegetation Plantation	4	Beneficial effect on land as it improves aesthetics and provides shelter for wildlife	Beneficial	0.20	Moderate importance due to potential for soil erosion prevention	0.00	0.0	No impact in pre-mitigative stage
Community health, safety and security										
17.	Health	Transportation	2	Deteriorates health due to Air & Noise Pollution	Adverse	0.10	Insignificant increase in transportation activities	-0.15	30.0	Lower impact envisaged
18.	Health	Provision of civic amenities	3	Affects health through disposal of sewage on open land causing mosquito breeding & water borne diseases	Adverse	0.10	Less significant in comparison to plant operation	-1.00	70.0	Potential for water borne diseases and mosquito nuisance is high during pre-mitigative stage
19.	Health	Improvement in the medical facility	5	Ambulance and Other facility will improve the regional medical facility	Beneficial	0.10	Less significant as compared to the effects due to vegetative plantation	0.50	50.0	Ambulance and regular health Camp would be provided by SPL
Land Acquisition and Involuntary Resettlement										
20.	Human Resettlement	Power generation operations	1	Five villages will get affected due to the project	Adverse	1.00	Significant impact	-1.00	99.9	Five villages will get affected due to the project
Bio-diversity Conservation and Sustainable Natural Resource Management										
21.	Flora	Power generation operations	1	Impact due to air pollution over larger area	Adverse	0.40	The power plant will release gases	-0.8	80.0	Highly significant during pre-mitigative stage
22.	Flora	Transportation	2	Adverse impact of dust and fumes emission due to vehicular traffic	Adverse	0.10	Dust and fume generation during vehicular movement is low	-0.25	40.0	Low potential for negative impact on flora & yield of crop could be anticipated
23.	Flora	Construction of Plants/Civil Structures	3	Deforestation	Averse	0.30	Proposed site consist approx. 320 ha. of forest area	-0.75	60.0	Impact due to deforestation of the forest area for project purpose

Sl. No.	Environmental Components	Project Activities	Interaction No.	Impacts	Adverse / Beneficial	RPII values	Remark for RPII	EII Index	EII (%)	Remark for EII
24.	Flora	Vegetative Plantation and compensatory afforestation	4	Creation of vegetative habitat	Beneficial	0.20	This interaction has high significance	0.00	0.0	No vegetative plantation in pre-mitigative stage
25.	Wild Life	Power generation operations	1	Adverse through Air & Noise Pollution and habitat destruction	Adverse	0.50	Interaction has high significance	-0.75	60.0	Effect due to noise and emission is high during pre-mitigative stage
26.	Wild Life	Transportation	2	Adverse effect due to air and noise pollution	Adverse	0.15	Not Significant	-0.25	30.0	Not significant
27.	Wild Life	Green belt & Plantation	3	Habitat be created	Beneficial	0.35	Interaction has less significance than Air and Noise Impacts	0.0	0.0	No Plantation in the pre-mitigative stage
28.	Surface Water Resources	Power generation operation	1	GBPS will be the source of raw water for plants	Adverse	0.45	High significance as compared to interaction No. 3	-0.70	70.0	Large amount of water is required for power generation
29.	Surface Water Resources	Disposal of Waste Water	2	Surplus wastewater, after treatment, will be disposed into local drainage	Adverse	0.45	Significant as wastewater will be disposed into the local water body	-0.70	70.0	Wastewater will be disposed of into the local water body
30.	Surface Water Resources	Provision of civic amenities	3	Surface water will also be used for domestic purpose in plants	Adverse	0.10	This interaction is less significance	-0.20	20.0	Lower impact as water consumption is relatively low
31.	Ground Water Resources	Plant operation and civic amenities	1	Ground water will be used for construction purpose	Adverse	1.00	As construction phase requires extraction of ground water	-0.50	50.0	Ground water will meet both potable as well as construction purpose requirement
Indigenous Peoples										
32.	Public Utilities	Power generation operations	1	Improved Public Utility Services and amenities in the area, e.g. Power Supply, Road Network, Water Supply, Sanitation, Medical Facilities & Communication	Beneficial	0.60	Much significant as it covers the surrounding villages	0.50	50.0	SPL will facilitate improvement of amenities
33.	Public Utilities	Transportation	2	Provides better transportation System,	Beneficial	0.20	Less significant than interaction 1	0.30	30.0	Access roads will be made to the project

Sl. No.	Environmental Components	Project Activities	Interaction No.	Impacts	Adverse / Beneficial	RPII values	Remark for RPII	EII Index	EII (%)	Remark for EII
				Road Network and vehicular movement						area, which will also be available to surrounding area
34.	Public Utilities	Provision of civic amenities	3	Provides Water supply, Sanitation, Power Supply, Medical facilities and communication to the employees	Beneficial	0.20	Civic amenities will be provided to employees only	0.10	10.0	Limited to the employees and work force during pre-mitigative stage
35.	Economic Aspects	Power generation operations	1	Increased employment opportunities, both direct and indirect, thereby increasing economic status	Beneficial	0.60	Significant potential of Direct as well as Indirect Employment	0.60	60.0	Indirect and Direct employment, plus availability of power will enhance economic activities
36.	Economic Aspects	Transportation	2	Increased indirect employment opportunities and thereby increase in the economic status	Beneficial	0.30	Comparatively less influential interaction	0.50	50.0	The proposed plant activity will increase a number of Indirect Employment
37.	Economic Aspects	Provision of civic amenities	3	Increased employment both by direct and indirect ways. Employment in commercial services improve economic status of people	Beneficial	0.10	Employment is restricted to limited persons in commercial services	0.20	20.0	Marginal job opportunities are envisaged
38.	Human Settlement	Power generation operations	1	Environmental degradation due to increase in population, impacting natural resources	Adverse	0.50	Significant Importance	-0.30	30.0	Influx of People in the project influence area
39.	Human Settlement	Transportation	2	Influx of construction labor thereby change in culture and stress on available resources	Adverse	0.20	Less significant	-0.30	30.0	The employees will be established in the SPL Colony
40.	Human Settlement	Provision of civic amenities	3	Increased population puts the strain on existing transport facilities	Adverse	0.30	Transportation is moderate	-0.30	25.0	Low significance as marginal increase will take place

Sl. No.	Environmental Components	Project Activities	Interaction No.	Impacts	Adverse / Beneficial	RPII values	Remark for RPII	EII Index	EII (%)	Remark for EII
Cultural Heritage										
41.	Culture	Power generation operations	1	Influx of people of various culture will have substantial effect on local culture	Adverse	0.50	Only two interaction	-0.10	10.0	Low impact due to limited employees from outside the study area
42.	Culture	Provision of civic amenities	2	The project will create a boom in the economic growth of nearby villagers	Beneficial	0.50	Moderate Impact	0.10	10.0	Project will improve the economic status of the area

Chapter 7

Alternative Analysis

CHAPTER 7. THE ALTERNATIVES

7.1 WITHOUT PROJECT SCENARIO

GoI under mega power policy initiatives has envisaged large capacity addition through Ultra mega Power projects (UMPP). Under this policy, nodal agencies of GoI identify the projects and obtain all clearances and transfers the projects through competitive bidding for Private sector on BOO basis. The projects are identified based on regional demand of electricity and also on techno economical site selection criteria. Power position in Western and Northern regions in April 2006 is given in **Table 7.1.**

As per the report the power scenario published by Central Electricity Authority. The power scenario in the western region, Northern region at the end of 9th plan as on 30.04.2006 is as under.

TABLE 7.1- POWER SCENARIO AS ON 30.04.2006

	Unit	Western Region		Northern Region	
		9th Plan end	April, 06	9th Plan end	April, 06
Peak Demand	MW	26510	31049	23200	26926
Peak Availability	MW	22024	24475	21346	23240
Peak surplus / deficit	MW	(-) 4486	(-) 6574	(-) 1854	(-) 3686
Peak surplus / deficit	%	(-) 16.9	(-) 21.2	(-) 8.0	(-) 13.7
Energy Requirement	Mu	175016	20077	150383	15062
Energy Availability	Mu	156793	16243	142410	12895
Energy surplus / deficit	Mu	(-) 18223	(-) 3834	(-) 7973	(-) 2167
Energy surplus / deficit	%	(-) 10.4	(-) 19.1	(-) 5.3	(-) 14.4)

Source- CEA Website

It may be seen that Western region has highest deficit both in terms of peak MW and energy demands compared to National average.

The current peak deficit & energy deficit is 11% & 11% respectively in Northern Region & 19% and 16% in Western Region. At the end of 11th Plan (i.e. 2012) the peak deficit and energy deficit in Northern Region is expected to be 21% and 7% respectively and in Western Region is expected to be 3% and 13% respectively. At the end of 12th Plan (i.e. 2017) peak deficit is expected to be 7%.

The National Electricity Policy has set up the goal of adding new generation capacity to not only eliminate energy and peaking shortages but to have a spinning reserve of 5% in the system. In view of the above, one UMPP is identified at SASAN in Madhya Pradesh state in Western region. Sasan Ultra Mega Power Project (6x660 MW) will not only fill the demand supply gap in energy sector but also help in the industrial growth of the region. The Sasan Ultra Mega Power Project is a project of national importance and would benefit 35 crore people in 7 states of India.

7.2 SITE ALTERNATIVES

Singrauli District has high potential for indigenous coal based thermal generation of electricity. Madhya Pradesh and Chhattisgarh are rich in mineral deposits and water resources, which are required for power generation. The TPP site for Sasan UMPP has

been selected on the basis of guidelines applicable to set up a Thermal Power Plant by Central Electricity Authority and Ministry of Environment & Forest as well.

Site selection study was carried out identifying three (3) possible locations for the proposed power plant. The main consideration of identifying the site(s) was availability of adequate non-arable land / proximity to sources fuel and water as well as infrastructural and power evacuation facilities. Site Prioritization Matrix was prepared as below and Site III was eventually selected on following basis.

TABLE 7.2- SITE ALTERNATIVE ANALYSIS

Parameters	Site I	Site II	Site III
State	Uttar Pradesh	Madhya Pradesh	Madhya Pradesh
District	Sonbhadra	Singrauli	Singrauli
No. of villages affected	6	3	5
Location	About 7.0 km west from Sewakatanr	About 6.0 km West from Waidhan	About 6.0 km South from Waidhan
Distance from coal source	Approx. 70 kms.	Approx. 20 kms	Approx. 20 kms
Distance from water source	50 kms	2 kms	12 kms
Environmental sensitivity as per image	The site consist some portion of dense forest land	The site consist a very little forest land	The site consist some portion of degraded forest land
Drainage Pattern	No prominent drainage at the site	The site is surrounded by Govind Ballabh Pant Sagar and traversed by many small drainage	No prominent drainage at the site
Environmental sensitivity as per ESZIS Map	RF & PF in 10 kms radius	RF & PF in 10 kms radius	RF & PF in 10 kms radius
Land use	Waste upland with scrubs mixed with patches of single crop land	Mainly agriculture land with some patches of waste and marshy area	Waste land with scrub forest and patches of agriculture land and settlement
R&R as per oustees (No. of HHs)	About 2000	About 1100	About 1600
Forest land (%)	Approx. 25%	Approx. 12%	Approx. 20%

- Site I is in UP and since UP has no share of water in Rihand reservoir left with the State it was decided to look for site in MP.
- Site II is traversed by many drainage system and minor stream of Govind Ballabh Pant Sagar and plant can cause harm to the catchment area of GBPS. Hence Site II was also not considered.
- The proposed project at site III will be more effective for socio-economic development because this area can support only single crop agriculture activities and does not ensure full time employment.
- Land elevation difference is not very high. Hence, the site will involve optimum requirement of land grading.
- The plant will be located in such a manner so as to minimize displacement of the villagers.
- No sensitive locations are present within 10 km radius from the site.
- The site is at a distance of 12 km from GBPS from where consumptive water is to be drawn for the power project.

Client: Sasan Power Limited,
A wholly owned subsidiary of Reliance Power Limited
Consultant: GIS Enabled Environment & Neo-graphic Centre (GREENC)

- The selected site is close to the border of northern region & western region both being power deficit regions and hence has proximity to load centres, also requiring shorter transmission network.
- Proximity to coal mines thereby requiring shorter coal transportation and hence less pollution.

7.3 ASH POND ALTERNATIVES

For 6x660 MW plant, about 140 million m^3 of ash is expected to be produced in 25 years. According to ash utilization plan, in the design life period of 25 years, 91 million m^3 of ash has to be utilized. Balance quantity of 28 million m^3 of bottom ash and 21 million m3 of fly ash will have to be disposed off.

As per present design the ash which is not utilized will be conveyed in slurry form through ash pipe line supported on concrete pedestal following contour as far as possible and discharged at various points in the pond and decanted ash water will be recirculated through recirculation pump house.

The dyke will be constructed all around to create the holding capacity of pond for 25 years, however stage raising of the dyke shall be done using pond ash to economise. Dyke shall satisfy all relevant codes and practices.

Ash pond for the project has been planned in South-eastern corner of the main plant site. The site for the ash pond has been selected on the basis of following considerations.

- Less distance for ash transportation i.e. less acquisition of the land. Hence, minimum social impacts due to the land acquisition.
- Proximity of the ash pond to power plant to reduce particulate matter emission

7.4 TECHNOLOGY ALTERNATIVES

The proposed plant will be using super-critical technology for power generation. The thermal efficiency of the power plant can be improved by using the steam at super critical condition. The indirect cost reduction in maintenance cost, auxiliary power consumption, ash dyke land and environmental benefits such as reduction in green house gases; water requirements, etc. are additional to the above increase in efficiency.

Importance of Efficiency: Since the time thermal power stations have been engineered, there is a quest for efficiency improvement. One such effort in that direction is supercritical parameters (i.e.) the pressure above 225kg/cm^2 and temperature above 374.15ºC.

7.4.1 Supercritical Boiler

A Boiler operating at a pressure above critical point is called Supercritical Boiler. Supercritical Boiler has no drum and heat-absorbing surface being, in effect, one continuous tube hence called 'once through Supercritical Pressure Boilers'. Boiler Feed Pump pressurizes the water in boiler, sensible heat is added in feed heaters, economizer and furnace tubes, until water attains saturation temperature and flashes instantaneously to dry saturated steam and super heating commences.

7.4.2 Advantages of Supercritical Thermal Cycle

Super-critical Technology	Sub-critical Technology
High Efficiency	Less efficiency compared to Super-critical
Reduction in Coal consumption	Higher coal consumption due to lower boiler efficiency.
Reduction in Green house gases and SO_2 emission	Higher Pollution in Terms of GHGs emission, SO_2 emission
Low NO_X Emission	High NO_X emission
Reduction in Water Consumption	More Water Consumption

Less start up time of the boiler.	More Start-up Time

7.5 CONFIGURATION ALTERNATIVES

During the project environment clearance process 5x800 MW units has been considered for the project. However, in the later stage, on the basis of techno-financial revision of the configuration, 6x660 MW size of the unit was found more viable. The factors which led to the selection of 6x660MW configuration are as follows:

- Availability of technology for 660MW units both from indigenous and imported sources
- High thermodynamic efficiency attainable
- Favourable experience of similar set size in the country
- Low specific fuel consumption rate
- Load variation capability if required
- Availability of manpower
- Capability of grid to tolerate any outage
- Less time for implementation
- Optimum specific investment requirements (i.e. Rs. Crore / MW)

7.6 ALTERNATIVES OF ASH COLLECTION AND DISPOSAL SYSTEM

As the ash utilization potential in India is increasing, the importance is being attached to such systems in which ash can be extracted and transported in dry form for the users. The systems adopted are keeping in view these requirements.

Further the extracted ash from ESPs has been envisaged to be transported in wet form with water and the resultant slurry will be disposed off by means of a set of slurry pumps to ash dump area. From Environment Point of view and reduce the fugitive emission due to ash handling system, the disposal of ash to the ash dump area is envisaged in wet (slurry) form. Also, Ash Pond will be lined with Clay lining.

Ash is generated in boiler due to combustion of coal. The coarse ash collected in bottom of the furnace is called Bottom Ash and the finer ash carried by flue gases is called fly ash. Bottom ash is mixed with water to form medium concentration slurry in accordance with MoEF stipulation and disposed off in the ash pond.

The fly ash is collected in ESPs working with a dust collection efficiency of 99.97% in dry form and transported to ash silos. From here the ash will be issued to industries mainly by roadways. Provision for bulk loading into rail cars is also being envisaged. As a standby for dry disposal, 100% fly ash disposal in slurry form will also be provided.

The water required for ash disposal is drawn mainly from the blow down generated in the cooling towers and other effluents generated in the process. Ash water is also re-circulated from the ash pond, treated in ash water treatment system and transferred to ash slurry sump. The entire process is designed to maximize the conservation of water.

The market potential for ash utilization in Singrauli area is estimated to be approximately 5 Million tons per annum as per the **Table 7.3**.

TABLE 7.3- MARKET POTENTIAL OF SINGRAULI IN ASH UTILISATION

S. No.	Utilization Areas	Utilization Potential (MTPA)
1.	Manufacture of Portland Pozzolana Cement (PPC)	3.50
2.	Manufacture clay ash and fly ash bricks	0.03
3.	Roads and Embankment Construction	0.26
4.	Low-lying area/ Wasteland development	0.51
5.	Agriculture	0.62
Total		**4.92**

More detailed discussion on ash utilization is presented in Ash management under Environmental management plan in Chapter 9.

7.7 WATER INTAKE SYSTEM

The consumptive water requirement for the project is estimated to be 150 cusecs. The water is tied up from Rihand reservoir for Sasan UMPP from Madhya Pradesh Govt quota. The decision parameters for siting the intake pump house are

a) Availability of water in the location

b) Distance from Sasan UMPP and

c) Availability of land for construction of pump house.

Various alternatives possible for water drawl from Rihand reservoir are under consideration like,

- Pumping of water from NTPC Singrauli Power station discharge canal directly
- Pumping of water from the outfall area of the canal
- Building a pump house at a separate location

The water in take from NTPC discharge canal directly requires permission from NTPC authorities. The location at the outfall area was earmarked by NTPC for construction of mini Hydel power station. In view of the above factors, a new location has been identified.

Chapter 8

Risk Assessment

CHAPTER 8. RISK ASSESSMENT

8.1 INTRODUCTION

Despite all precautions and protective measures, emergencies / accidents like release of chlorine, fire and explosion in oil storage tank may occur. Even though such occurrence may be rare and a remote possibility, such accidents will have an adverse effect on the plant, property and people working inside the plant. To cope with and contain such "Emergency", a Risk Analyses exercise has been conducted, based on which a Disaster Management Plan has been developed. Such assessment includes policy issues, programmes, plans, technology, economics and education.

As per the Environment Protection Act, Section 8 and Rules under Manufacturing and Storage of Hazardous Chemical Rules 1994 4(2), an occupier of an existing industrial plant shall have identified the major accident hazards and taken adequate steps to prevent such major accidents; occupier shall provide to the persons working on the site with the information, training and equipment including antidotes necessary to ensure their safety.

Also Rule 10 (4&6) stipulates that the Occupier shall have to update Safety Audit report once in a year by conducting a fresh Safety Audit. The Factories Act 1948, Rule 7A specifies the general duties of occupier such as to ensure the health, safety and welfare of all workers while they are at work in the factory and to maintain all places of work in the factory in condition that is safe and without risk to health.

In light of above, risk assessment is one such tool to identify hazards at industrial site and take engineering and managerial steps to mitigate the same.

Risk assessment provides information to decision makers about potential risks & mitigation measures to serve as a foundation for decision making.

8.2 APPLICABLE STATUTORY RULES AND REGULATIONS

Power Plant need to comply with following statutory rules and regulations on Safety, Health and Environment are as follows:

- Environment Protection Act 1986 and Rules made there under including the Manufacture, Storage & Import of Hazardous Chemicals Rules, 1989 (MSIHC) amended in 1994 & 2000.
- Chemical Accidents (Emergency Planning, Preparedness & Response) Rules, 1996
- Public Liability Insurance Act 1991, amended 1992 and the Public Liability Insurance Rules 1991, amended 1993.
- Factory Act 1948 & Factory Rules.
- Petroleum Act 1934 and Petroleum Rules 1981 amended 2002.
- Gas Cylinder rules 2004 and Static & Mobile Pressure Vessels (SMPV) (unfired) Rules 1981 amended in 1993.
- Explosives Act 1984 and Explosive Rules 1983.
- The Electricity Act 2003 and India Electricity Rules 1956.

8.3 RISK ASSESSMENT PROCESS

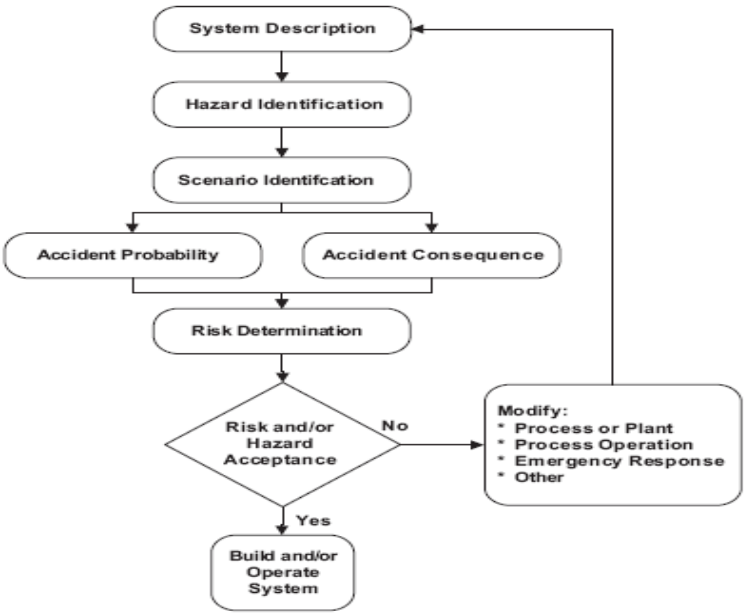


Fig 8.1- The hazard identification and risk assessment procedure (Crowl & Louvar, 2002)

The broad risk assessment methodology for evaluating and assessing risks from handling and storage of above chemicals includes:

- Identification of hazards arising from storage and process
- Establish failure frequencies for selected scenarios
- Perform Consequence Analysis
- Assess the Vulnerability
- Provide Risk Reduction Strategies including emergency plans

8.4 IDENTIFICATION OF HAZARDS

Hazard identification is one tool by which hazards can be properly identified for further assessment and more importantly adequate safety measures can be adopted to screen off personnel from exposure to the same.

Another aim of hazard identification is to keep the plant engineering integrity in accordance with the best design principle for safe and reliable operation.

8.5 IDENTIFICATION OF ALL HAZARDS ASSOCIATED WITH EACH ACTIVITY

The following main hazards may exist in the factory under the situations given in **Table 8.1**.

TABLE 8.1- HAZARD ASSOCIATED WITH PLANT ACTIVITY

Hazard	Potential location
High temperature and pressure	Boiler House, Generator Area
Fire & explosions (due to inflammable/ combustible materials)	Boiler Feed Chamber, Coal Handling Plant, Conveyor galleries,Cable galleries, Hydrogen Generation Plant,Fuel Oil Handling and Oil storage tanks areas, Burners area in Boilers,Turbine Hall, Turbine Oil tanks,Central Stores/Godowns, Boiler

Hazard	Potential location
Toxic and corrosive chemicals	Water treatment Plant, Chlorine dosing
Toxic and poisonous gases and dust	Conveyor system, Coal handling plant,Ash Handling Plant
Electricity (Receiving/Clue ration/ Distribution).	Entire area specifically generator section, distribution, control rooms
Disposal of wastes	Ash dyke, spent oils, electrostatic precipitator
Work at heights	Boiler house, cooling towers, chimney
Work in confined spaces / vessels / tank etc.	Maintenance section, control room
Specific jobs carried under highly hazards atmosphere (CO_2, toxic vapours etc.)	Hydrogen Generation Plant,Fuel Oil storage areas, Chlorine handling areas.
Non-working of safety devices, inter locks, failure of high RPM machineries	Turbo-generator section
Failure of boilers etc.	Boiler area
Any other consequences due to leak of Ammonia, Chlorine gases	Dosing system, testing and quality section
Hazards during heavy equipment handling (Crane, etc.)	Maintenance section
Road accidents	Receipt and dispatch section, loading/ unloading gantry

The hazard identification method for the project was performed by analyzing physico-chemical properties of the substances and evaluating them against the system specific backdrop.

8.6 CHEMICAL HAZARD

Apart from coal, hazardous chemicals handled at the site are Chlorine, LDO and HFO.

8.6.1 Coal

Coal is susceptible to spontaneous combustion, most commonly due to oxidation of pyrite or other sulphuric contaminants in coal. Coal preparation operations also present a fire and explosion hazard due to the generation of coal dust, which may ignite depending on its concentration in air and presence of ignition sources. Coal dust therefore represents explosion hazard in coal storage and handling facilities where coal dust clouds may be generated in enclosed spaces. Dust clouds may also be present wherever loose coal dust accumulates, such as on structural ledges. Defect Associated with Coal Handling Unit are given in **Table 8.2**.

TABLE 8.2- DEFECT ASSOCIATED WITH COAL HANDLING UNIT

Component	Type of defect	Affecting factor	Reasons
Transfer Chute Liners, Grinding jib of crushers.	Reduction in thickness due to wearing of surface	Continuous coal flow	Friction between coal and component
Transfer Chute Liners, Grinding jib of crushers.	Development of cracks, holes	Impact of coal	Crack generated from the holes for fixing of bolts
Transfer Chute Liners, Grinding jib of crushers	Pitting	Corrosive component of coal	The wet coal when flows through then chances are more.
Conveyor structures	Reduction in thickness due to wearing of surface and pitting	Corrosive component of coal	The accumulation of coal on structures

Component	Type of defect	Affecting factor	Reasons
Conveyor structures	Catastrophic structure failure	Cyclic Loading	A result of manufacturing fabrication defects or localized damage in service,
Crusher Rotors, Motor shafts, Suspension Bars, Arms	Development of cracks	Impact of coal	Due to internal flaw
Bearings	Development of cracks	Improper loading,	Due to internal flaw
Conveyor pulleys	Due to End disc failure	Cyclic loading	Failure of the weld between the hub and the end disc in welded-in hub designs.

Coal dust (<5% SiO_2) [TWA 2 mg/m^3 (as the respirable dust fraction)]
Coal dust (≥ 5% SiO_2) [TWA 0.1 mg/m^3 (as the respirable quartz fraction)]

8.6.2 LDO, HFO and Chlorine

The identification of specific scenarios is based on the assessment of likely events and incidence of failures. In most of the cases stored quantities of liquid fuel and chemicals are considered in hazard identification. **Table 8.3** provides the details of storage of fuel and chemicals.

TABLE 8.3- MAXIMUM STORED QUANTITIES OF FUELS AND CHEMICALS

Material Stored	Maximum Storage	Mode of Storage	Storage Conditions	
			Pressure	Temperature
HFO	7500 KL (3x2500 KL)	Four vertical cylindrical storage tanks	Atmospheric	Ambient
LDO	2500 KL (2x1250 KL)	Two vertical cylindrical storage tanks	Atmospheric	Ambient
Chlorine	68 tonners	Cylindrical storage tonners	Atmospheric	Ambient

8.6.2.1 Likely Events Due to Various Hazards

Fire and chemical release may occur due to the storage of fuel and chemicals. In case of failure of the systems, the likely incidents to occur are listed in **Table 8.4**.

TABLE 8.4- LIKELY INCIDENTS IN CASE OF SYSTEMS FAILURE

Fuel / Chemical Stored	Likely Incident			
	Fire ball	Pool fire	Toxic Release	Explosion
HFO	No	Yes	No	No
LDO	No	Yes	No	No
Cl_2	No	No	Yes	No

8.6.2.2 Selected Failure Cases

In view of plant layout developed for the site and hazard identification, failure cases as selected for consequence analysis are provided in **Table 8.5**.

TABLE 8.5- INCIDENT CONSIDERED FOR CONSEQUENCE ANALYSIS

Fuel / Chemical	Incident
HFO	Pool Fire due to shell rupture
LDO	Pool Fire due to Shell rupture
Cl_2	Leakage

8.6.2.3 Models used to Compute zone of Influence

In order to compute the zones of influence, due to various incidents as listed above, standard equations and models were used in the risk analysis. The details of all such equations / models used are referred below.

Chlorine vapour dispersions were evaluated with the help of Aloha Dispersion Model; the equations used are available in "Process Plant Layout", and "Guidelines for Chemical process Quantitative Risk Analysis", by AICHE, Center for Chemical Process Safety, American Institute of Chemical Engineers, New York. These equations have found acceptance during project appraisals.

8.6.2.4 Risk Assessment and Consequence Analysis

Consequence analysis is that part of risk analysis which considers individual failure cases and damages caused by them. To predict the hazardous outcome of accidents and their possible effects, consequence analysis is generally employed. The analysis is carried out on a variety of preconceived scenarios. The purpose and benefits that are likely to be derived by carrying out consequence analysis include:

- Improvement in plant layout
- Meeting statutory requirement
- A part of overall risk analysis
- Protection of public in nearby areas
- A training tool

The results of consequence analysis provide information about the effects from an accident scenario, thus helping in dealing with the situation. The analysis also betters an understanding of the risks involved in the area.

Approach

The present risk analysis as undertaken has two basic considerations:

- The proposed project will use HFO and LDO as secondary fuel and start-up fuel respectively. These fuels are flammable.
- To prevent growth of organic matter and micro organisms, which tend to foul condenser tubes etc, chlorine is the most common biocide use. The system is based on conventional gas chlorination using evaporator – chlorinators proposed to be housed in building close to the cooling tower and CW pumps.
- HFO and LDO storage tanks burst, and leakage of chlorine were subjected to consequence analysis. The outcome of this analysis provides information about possible hazards due to accidents or tank failures.

8.6.2.5 Intrinsic Hazards of HFO, LDO and Chlorine Storage

Hazardous and other toxic properties of these materials, under consideration, are provided in Material Safety Data Sheets (MSDS).

Effects of Release

Pool formation occurs through HFO and LDO storage tank release causing different levels of thermal radiation incident. However, the pool fire will remain confined within dyke provided around storage tanks.

Toxic chlorine gas can spread to long distances forcing exposures to different levels of doses; the highest may prove to be lethal.

Damage Criteria

In order to appreciate the effects produced by various scenarios, including thermal radiation and toxic release, the criteria laid down are based on both physical and physiological effects.

- HFO / LDO released accidentally will normally spread out and form a pool. If its pool finds ignition source, a fire is likely to occur. Any person caught in the fire is likely to suffer severe burn injuries. Therefore, in the consequence analysis, the distance to which Lower Flammable Limit (LFL) value persists is taken to indicate the area which may be affected by fire. Any other combustible materials within fire zone are also likely to catch fire and secondary fire may ensure. It may be mentioned that due to HFO / LDO spillage the evaporation of diesel vapours will be insignificant and, as such, no Lower Flammable Limit (LFL) and Upper Flammable Limit (UFL) values for HFO/LDO are reported in literature. Hence due to HFO, LDO spillages pool fire may result if there is an immediate ignition source.
- Thermal radiation due to fire may cause various degrees of burns on human bodies. Moreover, their effects on inanimate objects like equipment, piping or vegetation also need to be evaluated to assess the impact. **Tables 8.6 and 8.7** provide the effects due to thermal radiation intensity and escape time respectively. **Table 8.8** lists out tolerable intensities of various objects as given in "Guidelines for Chemical Process Quantitative Risk Analysis" and "Process Plant Layout".

TABLE 8.6- DAMAGE DUE TO INCIDENT RADIATION INTENSITY

Incident Radiation Intensity (kW/m^2)	Types of Damages
62.0	Spontaneous ignition of wood
37.5	Sufficient to cause process equipment damage
25	Minimum energy required to ignite wood at infinitely long exposure (non piloted)
12.5	Minimum energy required for piloted ignition of wood, melting plastic tubing etc.
4.5	Sufficient to cause pain to personnel unable to reach over within 20 sec; however blistering of skin (Ist degree burns) is likely
1.6	Will cause no discomfort during long exposure

TABLE 8.7- HEAT RADIATION AND ESCAPE TIME

Radiation Intensity ($BTU/hr/ft^2$)	Time to pain Threshold (Seconds)
440 (1.39 kW/m^2)	60
550 (1.74 kW/m^2)	40
740 (2.33 kW/m^2)	30
920 (2.9 kW/m^2)	16
1500 (4.7 kW/m^2)	9
2200 (6.93 kW/m^2)	6

Radiation Intensity (BTU/hr/ft^2)	Time to pain Threshold (Seconds)
3000 (9.5 kW/m^2)	5
3700 (11.66 kW/m^2)	4
6300 (19.9 kW/m^2)	2

TABLE 8.8- TOLERABLE INTENSITIES FOR VARIOUS OBJECTS

Object	Tolerable Intensity (kW/m^2)
Drenched Tank	38
Special Buildings (No Windows, fire proof doors)	25
Normal Buildings	14
Vegetation	10-12
Escape Route	6 (upto 30 seconds)
Personnel in Emergencies	3 (upto 30 seconds)
Plastic cables	2
Stationary Personnel	1.5

- BLEVE is an acronym of Boiling Liquid Expanding Vapour Explosion. When a diesel oil tank is subjected to external fire, the metal temperature rises to an extent that it may fail at the operating pressure itself. With metal failure, the entire content of the tank is released to atmosphere. The liquid starts boiling and expands violently. Huge vapour cloud is formed almost instantaneously. Because of high degree of turbulence, a lot of air is drawn into it and the vapour cloud that is formed is quickly diluted within flammable range. Immediately following the rupture of tank, the body of this expanding boiling liquid is likely to be ignited by the fire that initiated the failure. Since the core of the body is still too rich, therefore the fire burning is usually controlled by the rate at which the air is drawn.
- The release of chlorine vapours will have damaging effects on human being. The toxic effects of chlorine vapours are provided in **Table 8.9**.

TABLE 8.9- DAMAGE DUE TO CHLORINE VAPOURS

Parts of Chlorine (ppm)	Type of damage
0.2-0.4	Threshold of odor perception with considerable variation among subjects (a decrease in odor perception occurs over time);
1-3	Mild, mucous membrane irritation, tolerated for up to one hour;
5-15	Moderate irritation of the respiratory tract;
30	Immediate chest pain, vomiting, dyspnea, and cough;
40-60	Toxic Pneumonitis and pulmonary edema;
430	Lethal over 30 minutes;
1000	Fatal within a few minutes.

8.6.2.6 Meteorological Conditions

Meteorology plays a vital role in the propagation, dispersion and diffusion of toxic gases and hydrocarbon vapours. The fire also propagates in downwind direction provided wind speeds are appreciably higher. The meteorological condition has another significance that it is required as input data for the computations of zones of influence of various incidents for different fire intensities. The dominant wind directions, average temperature, wind speed range during various months are commonly observed parameters. One source of such long term and reliable data is India Meteorological Department (IMD) which runs an

observatory, at Sidhi. The climatological data of this observatory has been analysed for the predominant wind speed range and temperature and used in computations.

Ambient average temperature	24-35° C
Wind speed	4.5 m/s
Humidity	50%
Stability (Pasquill)	D

One of the most important characteristics of atmosphere is its stability, which is its tendency to resist vertical motion or suppress existing turbulence. This tendency directly influences the ability of atmosphere to disperse the pollutants emitted into it after the release. The atmospheric stability criteria, defined by Pasquill have been used in the study. Based on the above including stability condition, various zones of influence are drawn for selected failure cases.

8.6.2.7 Consequence Analysis

Consequence analysis was carried out for identified selected failure cases. Consequence analysis quantifies vulnerable zones. For the selected accidental scenarios, after vulnerable zone is defined, measures can be proposed to minimise damages caused.

HFO and LDO Tanks on Fire

HFO tank at the plant site is located in the tank farm area. The tanks (3x2500 KL) on fire scenario are presented in **Table 8.10** with distances of various intensities. The distance of occurrence of 4.5 kW/m^2 radiation intensity, sufficient to cause first degree burn, has been calculated at 71.8 m. Plant personnel not involved in fire fighting shall remain beyond this distance.

TABLE 8.10- DISTANCES OF OCCURRENCE OF VARIOUS THERMAL RADIATION INTENSITIES DUE TO RUPTURE OF ALL THREE (3X2500 KL) HEAVY FUEL OIL (HFO) TANKS

Radiation Intensity (kW/m^2)	Distance (m)
62.0	19.3
37.5	24.9
25.0	30.5
12.5	43.1
4.5	71.8
1.6	120.4

LDO tanks on fire scenarios for both (2x1250 KL) tanks are presented in **Table 8.11** with distances of occurrence of various radiation intensities due to LDO fire.

TABLE 8.11- DISTANCES OF OCCURRENCE OF VARIOUS THERMAL RADIATION INTENSITIES DUE TO RUPTURE OF TWO LDO (2X1250 KL) TANKS

Radiation Intensity (kW/m^2)	Distance (m)
62.0	15.1
37.5	19.4
25.0	23.8
12.5	33.7
4.5	56.1
1.6	94.1

8.6.2.8 Chlorine Release

Daily requirement of chlorine has been estimated to be 4320 kg for CW Chlorination and 842 Kg for RW chlorination. It is proposed to house 48 chlorine tonners for CW chlorination and 24 chlorine tonners for RW chlorination (each containing 930 kg chlorine) at the dosing site. 12 Chlorine tonners will be in operation & 36 in standbye for CW Chlorination and 9 in operation and 15 in standbye for RW Chlorination.

In the Chlorination Plant, Two Chlorine tonners will be connected to pipeline out of which one is discharged at a time. Leakage of chlorine may occur due to many reasons, a few situations could be:

- Failure of pipeline and / or equipment (e.g. corrosion, fatigue erosion of pipes etc.) used for transfer of liquid chlorine;
- Accident while handling chlorine tonners by crane; and
- Operator errors

The probable scenario is a one ton tonner leaking as if releasing liquid chlorine at full throw through an open valve. Worst scenario, however, would be two tonners discharging simultaneously, due to operator error and leakage through pipelines, equipment or two tonners involved in an accident while handling. But the spread of cloud of chlorine formed by leakage on ground would be time dependent on the wind direction and its speed.

A computer model ALOHA 5.4.1.2 (Developed by USEPA and NOAA) has been employed to arrive threat zones that is spread of chlorine and its concentrations for different discharge rates of chlorine in kg/min for continuous and instantaneous release.

Input Data Considered for Estimations: The model was run for different scenarios of chlorine storage namely, Continuous gas (1 and 2 Tons of chlorine) and Instantaneous gas (6 tons of chlorine). The meteorological and Source strengths considered are given in **Table 8.12.**

TABLE 8.12- ALOHA MODEL INPUT DATA

Chemical Data	
Chemical Name	CHLORINE
Molecular Weight	70.91 g/mol
Ambient Boiling Point	-34.6° C
Vapor Pressure at Ambient Temperature	greater than 1 atm
Atmospheric Data	
Wind	4.5 meters/second from 270° true at 10 meters
Ground Roughness	Open Country
Cloud Cover	0 tenths
Air Temperature	35° C
Stability Class	D No Inversion Height
Relative Humidity	5%

Source Strength (Direct Source)	1 Ton	2 Ton
Source Height	1 meters	1 meters
Release Duration	30 minutes	10 minutes
Release Rate	31 kilograms/min	62 kilograms/min
Total Amount Released	930 kilograms	1860 kilograms
Note	This chemical may flash boil and / or result in two phase flow.	This chemical may flash boil and / or result in two phase flow.

Selected Concentration Contours: The concentration contours for 140, 60 and 15 ppm were selected based on the effect on the people. The consequences of chlorine for various concentrations are given below:

- Concentrations of 140 ppm of Chlorine or more are Lethal for 50% of active healthy people in case of 30 minute exposures.
- Concentrations of Chlorine more than 60 ppm but less than 140 ppm , Fatal for more vulnerable people and dangerous for all.
- Concentrations of Chlorine between 15 ppm to 60 ppm, Dangerous - immediate irritation of nose, throat and eyes with cough and lachrymation.

Results and Discussions

The predicted hazard distances for 1 ton and 2 tons release of chlorine are given in **Table-8.13** and **Figures 8.2 & 8.3.**

TABLE 8.13- AREA LIKELY TO BE AFFECTED DUE TO THE RELEASE OF CHLORINE (CONTINUOUS SPILL)

Concentration of Chlorine in ppm	Distance in mts / Direction from Source of Release of Chlorine		
	1 Ton	2 Tons	Direction
140	250	369	East
60	399	585	East
15	842	1200	East

It is observed that the chlorine may spread in an area of the plant depending mainly on wind direction. Actual direction and the likely affected area will depend on the prevailing wind direction and speed at the time of the accident.

The nearest settlement is located at distance of 1.0 km from the Chlorine handling place. In the present scenario the dispersion for the threat zone i.e. 140 ppm is likely to extend upto a distance of maximum of 369 m. The leakage scenario has been calculated for 30 min. However, in general there is too much possibility to control the chlorine leakage in less than 30 min of time. The IDLH value is for the worst case scenario, whereas the probability of such meteorological conditions coinciding with the failure of the cylinder is remote. Risk contours for Chlorine shown in **Figures 8.1** & **8.2**.

Figure– 8.1

Toxic Threat Zone ALOHA® 5.4.1.2

Time: June 16, 2010 1531 hours ST (using computer's clock)

Chemical Name: CHLORINE

Wind: 10 miles/hour from 270° true at 10 meters

THREAT ZONE:
Model Run: Heavy Gas
Red : 250 meters --- (140 ppm)
Orange: 399 meters --- (60 ppm)
Yellow: 842 meters --- (15 ppm)

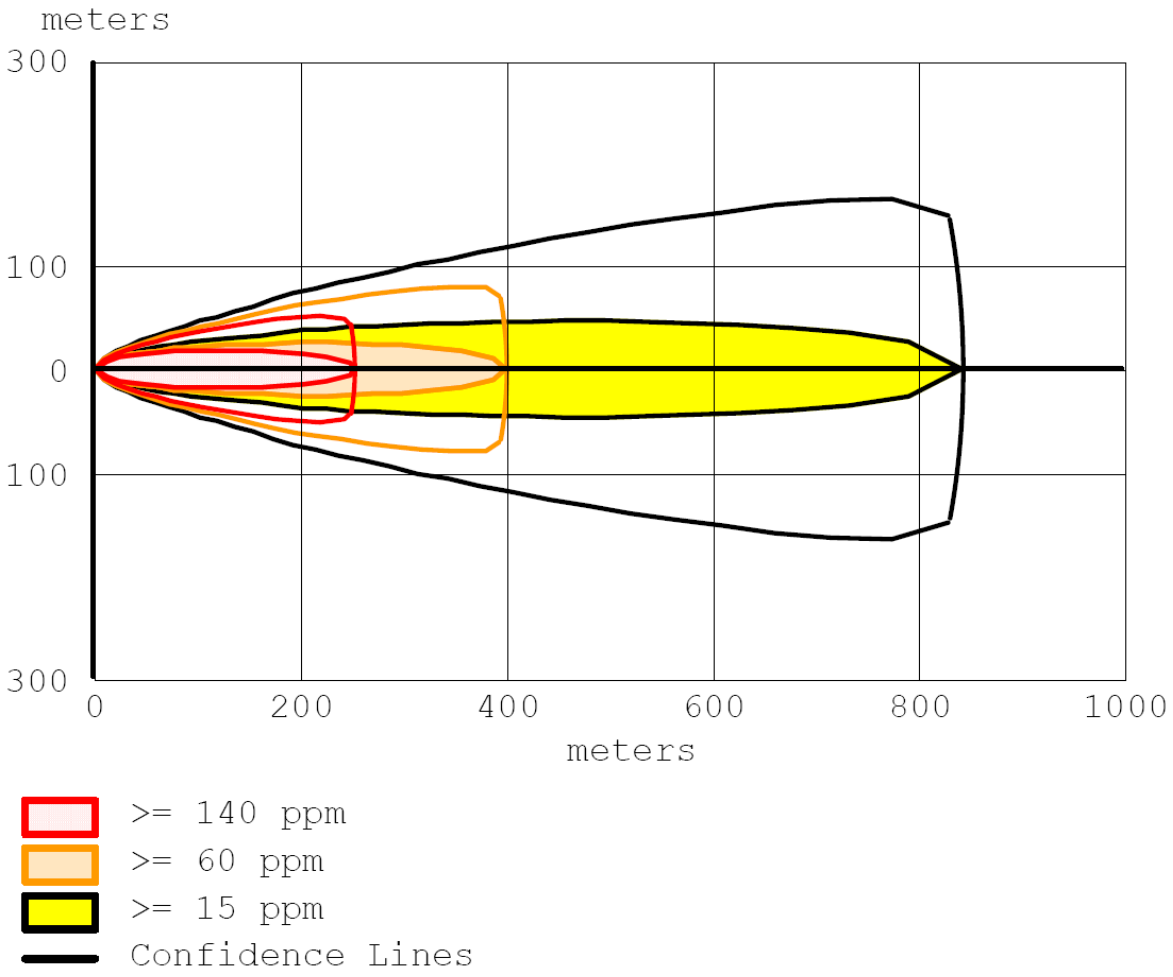


Figure- 8.2

Toxic Threat Zone ALOHA® 5.4.1.2

```
Time: June 16, 2010  1531 hours ST (using computer's clock)

Chemical Name: CHLORINE

Wind: 10 miles/hour from 270° true at 10 meters

THREAT ZONE:
  Model Run: Heavy Gas
  Red    : 369 meters --- (140 ppm)
  Orange: 585 meters --- (60 ppm)
  Yellow: 1.2 kilometers --- (15 ppm)
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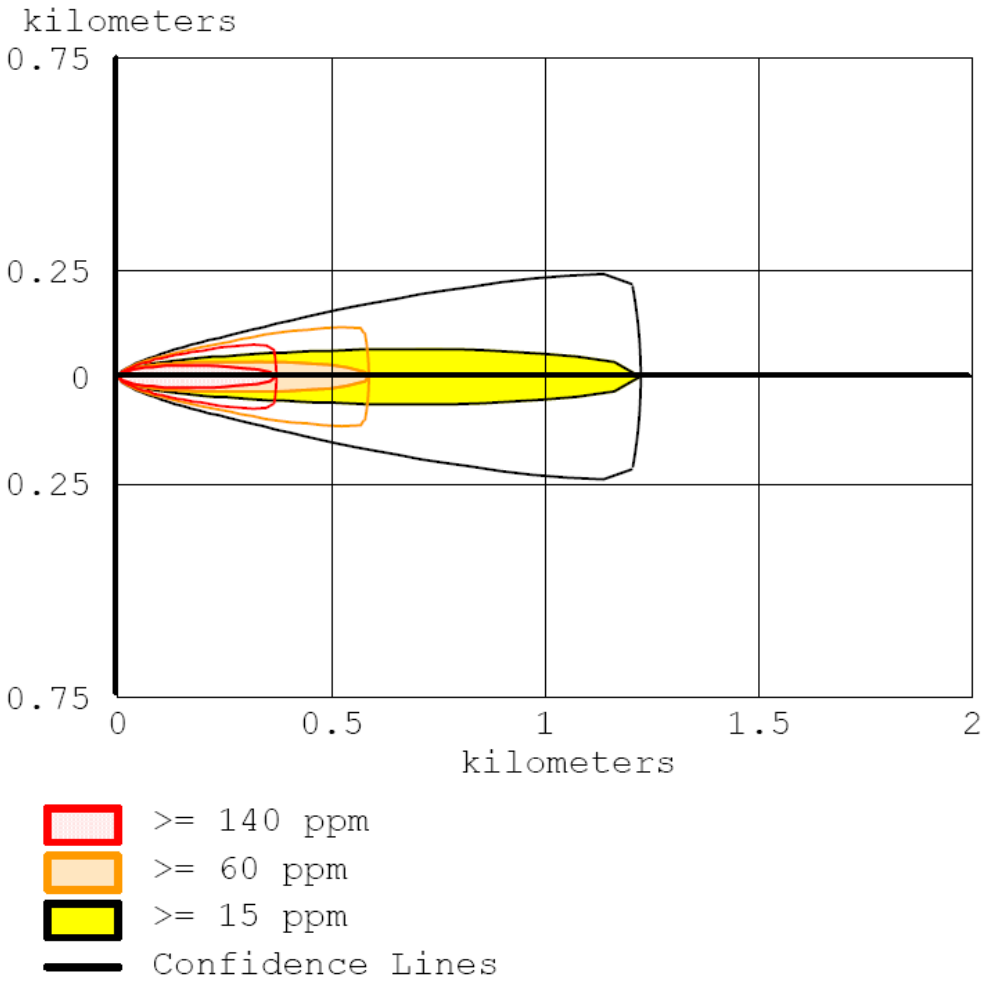


8.7 MITIGATION MEASURES

8.7.1 General Mitigation Measures

- Fire is one of the major hazards, which can result from auxiliary fuel (LDO & HFO) storage tanks. Fire prevention and relevant code enforcement is one of the major responsibilities of project proponent. The fire service facility should be equipped with:
  - Smoke and fire detection alarm system
  - Water supply
  - Fire hydrant and nozzle installation
  - Foam system
  - Water fog and sprinkler system
  - Mobile Firefighting equipment
  - First aid appliances
- Smoke and fire detection, fire hydrant & nozzle installation etc. as indicated above shall be included as part of all major units at the proposed project
- Periodic maintenance of all protective and safety equipment
- Wind socks/wind cock should be installed at suitable height and with proper visibility to check the prevailing wind direction at the time of accident
- Periodical training/awareness should be given to work force at the project as refresher courses to handle any emergency situation
- Periodic mock drills should be conducted so as to check the alertness and efficiency of the Disaster Management Plan (DMP) and corresponding records should be maintained
- Signboards including emergency phone numbers and no smoking signs should be installed at all appropriate locations
- Plant shall have adequate communication system
- All major units/equipment shall be provided with smoke/fire detection and alarm system
- All electrical equipments shall be provided with proper earthing. Earthed electrode shall be periodically tested and maintained
- Emergency lighting shall be available at all critical locations including the operator's room to carry out safe shut down of the plant, ready identification of fire fighting facilities such as fire water pumps, fire alarm stations, etc.
- In addition to normal lighting each installation shall be equipped with emergency (AC) and critical (DC) lighting.
- All electrical equipments shall be free from carbon dust, oil deposits, grease, etc.
- Cable routing shall be planned away from heat sources, gas, water, oil, drain piping, air conditioning ducts, etc.
- Cable route markers shall be provided in the permanent way at the location of changes in the direction of cables and at cable joint locations.
- Chlorine detectors and Chlorine arresting kits should be provided at relevant locations

8.7.2 Project Specific Mitigation Measures

8.7.2.1 Chlorine Tonners

For chlorine tonners following control/containment measures are recommended.

- Auto chorine leak absorption system to be provided to absorb the leaked chorine from the tonners/system.

- To prevent the large release of chlorine to atmosphere, monitoring and feedback facilities for early detection leaks and emergency shutdown shall be provided
- There should be facilities in the form of water curtain for absorption of chlorine released during an emergency as chlorine is highly soluble in water
- Flow control valves at key points should be installed to prevent excess chlorine flow from the tonner with multiple level safety per line
- Provision for immediate evacuation of all personnel in case of accidental release of chlorine
- Eye wash stations and emergency shower stations should be provided at appropriate locations especially in the vicinity of Chlorine storage and dosing facilities
- The stand by chlorine tonners shall be kept / stored at isolated covered warehouse at safe distance. It shall be provided with sufficient high (about 6 m) roof ventilation, chlorine detection and water spray system inside storage facility
- Conduct awareness programmes on regular basis in order to educate villagers around the project about the consequences of possible health hazards and their precautionary measures during accidental conditions

8.7.2.2 Auxiliary Fuel System

- Protective systems with high reliability and availability should be designed to ensure that physical conditions are maintained
- Dyke would be provided for LDO and HFO storage tanks
- Co-ordination with local authorities such as fire, police, ambulance, district administration & nearby industries to manage / control any eventuality
- To prevent the hazard of static electricity, the fill and recirculation lines to the storage tanks shall be discharged below the liquid level.
- The 4.5 kw/m^2 heat intensity radiation will not spread beyond the plant boundary.
- The following arrangements are suggested for LDO/HFO storage tanks:
  - One independent high level alarm and trip off liquid inlet-line.
  - One low level alarm with trip off device.
  - Provision of auto deluge water sprinkler system for each bulk storage tank. The auto deluge water sprinkler would be set to start working at a temperature of 66^0 C.
- The ST turbine building, switchyard, transformer yard, administrative building canteen, first aid center, fire stations etc. should be located safely, if viewed in the light of worst accident scenarios.
- In case of any tank on fire or fire in the vicinity, the cooling of adjoining tank should be resorted promptly in addition to tank on fire so that neighbouring tanks does not give away.
- The night vision wind stocking be mounted on top of administrative building, main plant building and storage tanks so that people can move in upwind directions in the event of massive spillage or tank on fire.
- No machinery of vital importance like fire fighting pump house, Hydrant and Fuel oil pump house should be placed out of radiation contours of 37.5 kW/m^2 heat intensity.
- Maintenance plays a vital role in proper upkeep of plant. One important function is the monitoring of equipment health, pipelines and machines. Adoption of system like thickness survey (including supports) maintenance practices will improve plant performance and safety. Normally, failure rates of equipment and pipes are influenced by maintenance practices especially when plant starts aging.

- The Project site is located under zone-III as per IS:1893. Analysis and design of structures to resist the seismic forces are to be carried out as per the provisions of IS:1892 2002/1985 (latest).

It is recommended that strict adherence to standards and accepted maintenance and operation of the plant plays a vital role in proper up keep of the plant. The monitoring of the health of equipment, pipeline and machines, thickness survey will improve plant performance and safety.

Chapter 9

Environment & Social Management Plan

CHAPTER 9. MANAGEMENT & MONITORING PLAN (ESMMP)

9.1 INTRODUCTION

This section of the report discusses the Environment and Social Management and Monitoring Plan (ESMMP) for mitigation / abatement of identified adverse environmental and social impacts and enhancement of beneficial impacts due to the Project.

The ESMMP has been designed within the framework of requirement under Indian legislation and IFC's Performance Standards on environmental and socio-economic aspects. The mitigation measures to be adopted for the implementation of the proposed project include the following:

- Environmental Management Plan;
- Ash Utilization Plan;
- Green Belt Development Plan;
- Rain Water Harvesting;
- Clean Development Mechanism;
- Occupational Health and Safety;
- Labour Working Conditions;
- Construction Labour Management;
- Labour Demobilization;
- Residual Impact Identification;
- Environmental Action and Monitoring Plan;
- Resettlement Action Plan;
- Community Development Plan;
- Public Consultation and Information Disclosure Plan;
- Grievance Redressal Mechanism;
- Disaster Management Plan

The ESMMP has been prepared considering life cycle approach that SPL will own and operate the Sasan Ultra Mega Power Project. During the construction and operation periods, SPL will have the sole responsibility to meet the identified environmental and social requirements under the ESMMP.

9.2 ENVIRONMENTAL MANAGEMENT PLAN

The Environment Management Plan (EMP) outlines the environmental management system that will be implemented during the detailed design and construction works of the project for minimization of deleterious effects and implementation of enhancement measures. The EMP embraces environmental management issues comprising of beneficial impacts as well as long-term adverse impacts and their remedial measures.

The Management Action Plan aims at controlling pollution and community risk at the source level to the maximum possible extent with the available and affordable technology followed by treatment measures before they are discharged. Specifically, the EMP monitors and manages environmental aspects and issues of the project during operation phase by:

Chapter-9: ESMMP

Process and technology proposed to mitigate the adverse impact on Environment during the Construction and Operation activity are described in this chapter. Chapter also provides the details about emergency response plan including management Social issue.

- Identifying potential environmental impacts;
- Recommending mitigation measures for the negative impacts;
- Identifying opportunities for enhancement measures;
- Providing an organizational framework for operating Environment Management System and other functions of the project by assigning roles and responsibilities for environmental monitoring and management;
- Formulating Environmental Management Plan, which specify mitigation, monitoring activities and indicators to be attached to Annual and periodic activity plans for project implementation

The responsibilities for undertaking specific required activities at design; construction and operation stages are listed in **Table 9.1**.

TABLE 9.1- RESPONSIBILITIES OF DIFFERENT ORGANIZATIONS IN ENVIRONMENT MANAGEMENT

Project Stage	Responsible Organization	Responsibilities
Participatory design	Project Consultants	Minimize non-avoidable losses in consultation with diverse stakeholders and prepare Environment Action Plan by specifying mitigation and enhancement measure for engineering design, bid & contract documents, non-structure program plans & periodic implementation plans
	Sasan Power Ltd. (SPL) Management	Review and approve environmental mitigation measures reflected as EMP and attached to documents mentioned above
Construction Phase	Contractors	Implement required environmental measures as reflected in EMP
	SPL Management	Supervise contractors & service providers for implementation of EMP and enforce contractual and program requirements
	SPL Engineers	Monitor and report environmental indicators
Operation	SPL Management	Provide budget to undertake environmental monitoring
	Environment Consultant	Carry out environmental monitoring and reporting

9.2.1 Management Plan: Construction Phase

Based on the findings of the site visit and consideration of the necessity to limit environmental impact and community risk during construction, the following general guidelines have been devised. **Figure 9.1** outlines the implementation of the EMP during construction ensuring compliance with environmental rules, regulations and standards.

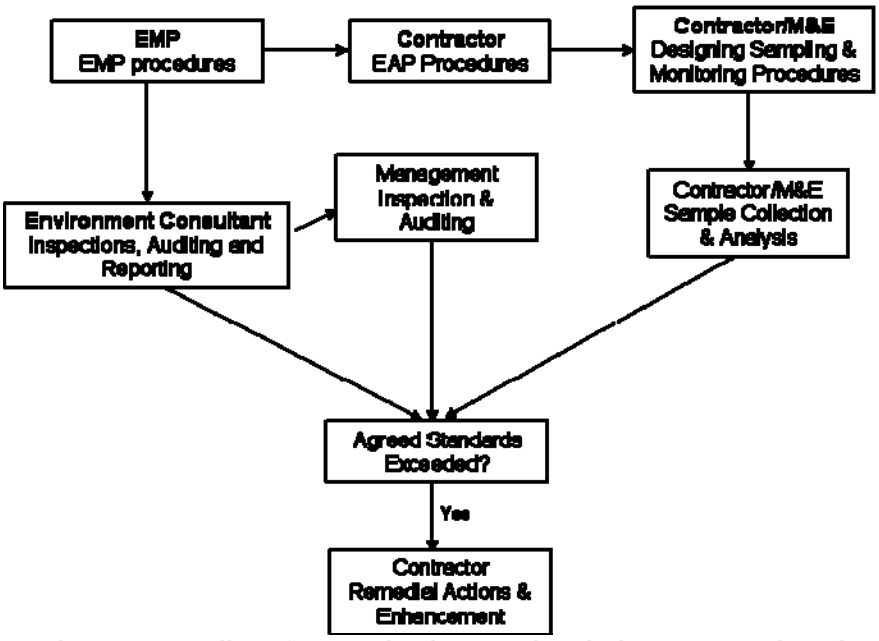


Figure 9.1- Outlines for EMP implementation during construction Phase

9.2.1.1 Contractor's Responsibilities with Respect to Community Health and Safety

General

The contractor's responsibilities has been prescribed in the tender document and subsequently incorporated in contract, which includes the need to adhere to environmental clause in the contract and the guidelines provided. The contractors are also taking all reasonable steps to protect the environment and to prevent environmental damage & public nuisance resulting from construction activities.

Contractors are complying with all statutory requirements, environmental regulations and environmental quality standards as stated in the Pollution Control Law Series PCLS/02/2006, CPCB, Ministry of Environment & Forest (MoEF), Govt. of India guidelines, Indian Labour Law relevant to the proposed project.

Pollution from Wastes

Recycled aggregates are being used/ stored for filler applications and as sub-base for roads. Site grading operations involve stockpiling and for use as backfill materials. Contractors have been asked to store good topsoil properly during construction so that it can be reused later for green-belt development. Recyclable wastes such as plastics, glass fibers and insulations are being stored separately and will be sold to recyclers.

During the construction phase, many toxic substances such as paints, solvents, wood preservatives, and sealants are likely to be used. The wastes generated will be stored in sealed containers, labeled and disposed as required by the Hazardous Waste Storage, Handling and Transportation Rules of Environment Protection Act 1989.

Due care will be taken to avoid water pollution problems during rainy season due to washout of waste material. At construction site, petroleum powered equipments and temporary storage of petroleum products (Highly inflammable) may lead to fire hazard, if safety norms are not strictly followed. Therefore, care would be taken to avoid all sources of ignition at such places.

Protection of Human Health

Adequate sanitation facilities on construction site have been provided. All waste from the sanitary system is being disposed suitably to avoid environmental pollution. Wastewater is being routed through suitable designed septic tank and soak pit, without contaminating either ground or surface water or causing a health risk.

The main mitigation measures for environmental control during construction are summarized in the **Table 9.2**. SPL will monitor the Environmental status and to ensure efficacy of mitigation measures.

TABLE 9.2- MAIN ENVIRONMENTAL MITIGATION MEASURES DURING CONSTRUCTION PHASE

Mitigation Measure	Purpose	Failure consequence	Responsible Organization
Water sprinkling	Control of fugitive dust during construction and transportation activity	Increment in SPM concentration	• Contractor • SPL Management • Environment Consultant
Transportation of construction material in covered trucks	Control of fugitive dust	Increase in dust emission	• SPL Management • Environment Consultant
Regular maintenance of transport vehicle and provision of acoustic cover on construction machinery	Control of Noise	Increase the noise level of surrounding area	• Contractor • SPL Management
Construction of temporary sediments tanks for effluent	Control of suspended solids to prevent the surface water quality	Contamination in surface water	• Contractor • SPL Management • Environment Consultant
Provision of environmentally safe camping area for migrant laborers	To provide a clean and healthy living condition for labours	Unhealthy living condition and spread of disease	• Contractor • SPL Management

9.2.2 Management Plan: Operation Phase

During operation phase of the proposed project pollution impacts are envisaged on Air, Noise and Land/Biological components as per the impact predicted in this study. However, in order to limit within predicted impact levels and to further mitigate the impacts wherever possible on individual environment components, the following mitigation measures are recommended:

9.2.2.1 Air Environment

A permanent weather monitoring station will be installed within the plant premises. The wind speed, wind direction, temperature, cloud cover, rainfall shall be monitored and recorded daily.

Coal based thermal power plants emit fly ash as the major pollutant besides varying degree of other pollutants namely: coal dust, sulphur dioxide and oxides of nitrogen etc. Therefore it is recommended to monitor the concentration of RSPM, SPM, SO_2 and NO_X in the ambient air at regular intervals on predetermined locations.

The control measures to combat air pollution due to proposed power plant are as under.

For the fine dust control due to crushing operation, bag filters have been successfully tried in such operations. Better efficiency dry collection system shall prove to be long term cost effective because of possibility of coal recovery after blending as a domestic fuel.

As far as gaseous pollutants namely: NO_X and SO_2 are concerned provision of tall stack i.e. 275 m height as per regulations in the EPA, 1986 is proposed to mitigate the adverse impact of SO_2 emission. The proposed plant will be utilizing low NO_X coal burners to restrict the NO_X emission within the permissible limit.

Electrostatic precipitator of desired efficiency will be provided to control the particulate levels in the flue-gas at 50 mg/Nm^3. As low sulphur and low volatile matter containing coal will be used, major emissions requiring control are not anticipated.

9.2.2.2 Water Environment

Plant effluents generated during operation will be adequately treated to meet the prescribed standards for effluent. The treated effluents will be collected in a central monitoring basin for observation and use before discharging on land inside the premises. The wastewaters will be used for greenbelt development, ash handling and dust suppression.

The effluent quality will be monitored for all the regulated parameters as per prescribed standards. A state-of-the-art water harvesting system will be provided to capture the run-off water during heavy rainfall. Ash pond will be lined with clay lining. Adequate safety measures will also be implemented to protect the ash bund from getting breached.

Rain water harvesting measures can be applied through direct or indirect methods. The indirect methods may be construction of recharge shafts, pits and trenches in previous areas. The direct methods may be construction of recharge wells in suitable aquifer zones, wherein collected rain water through filters is used to recharge the aquifer.

A separate detailed study, in consultation with Central Ground Water Board (CGWB) / State Ground Water Board, for planning and design of rain water harvesting has been carried out and it has been approved by CGWB.

9.2.2.3 Noise Environment

Noise generating devices/machines like steam turbine generator, compressors and other rotating equipment shall be designed for low noise levels adopting appropriate design & state of art technology for fabricating/assembling machines.

Proper noise barriers/ shields etc shall be provided in the equipment whenever required. Noise from equipment shall be adequately attenuated by providing soundproof enclosure and insulation to minimize the noise level.

Recommendations for noise management

- All opening like covers, partitions may be acoustically sealed
- The operator's cabin (control rooms) would be properly insulated with special doors and observation windows
- The operators working in the high-noise areas would be strictly instructed to use Persnoal protective equipment like ear-muffs/ear plugs
- Noise levels would be reduced by the use of absorbing material on floors, walls and ceilings
- There will be thick vegetation in the plant premises to attenuate continuous noise.

9.2.2.4 Hazardous Solid Waste Management

The Boiler Ash is collected from the boiler's hopper precipitator and fly ash is collected from the electrostatic precipitator hoppers. Clay lining will be provided for the ash pond to contain the possibility of the leaching.

Hazardous solid waste in the form of waste oil, spent ion exchange material and water pre treatment clarifier sludge will be generated from the power plant. The oil will be collected in MS drums and will be sold to the recycler registered with MPPCB / Central Pollution Control Board. Sludge will be dried on solar drying bed, bagged and sent for land filling. Spent Ion exchange material will also be sent for land filling.

9.2.2.5 Ecological Environment Management

The greenery to be developed under green belt development programme will improve the floral environment of the adjoining area and will bring back the animals, birds, insects, reptiles and other small animals, which might have gone away temporarily during construction. The species of trees will be native and will provide habitat for birds. The green belt will also control dust pollution and mitigate noise in addition to increasing vegetative cover. Also the following mitigation measures are proposed to reduce the load of tree felling and also improve the ecology of the region.

- To improve the forest cover and animal food value in the surrounding forest area and create favourable conditions for wildlife, compensatory afforestation will be implemented proposed over an approximate area of 1586 acres at a cost of Rs.15 crores. Compensatory afforestation scheme has been prepared as per guidelines of Madhya Pradesh Forest Department.
- Awareness programmes will be organized to create a sense of belonging and love for nature and wildlife in the adjoining villages.
- To increase the status of wildlife by creating consciousness among the local people and thereby preventing poaching.
- To convince the villagers not to cultivate crops those attract wild animals.
- To improve the socio economic condition of the villagers by providing them with training and finance for dairy, poultry, vegetable cultivation, horticulture, farm forestry, tailoring, small business etc.
- Educating the village youth regarding the need for conservation of wildlife and measures taken for the same through visits to exemplary site like Sanctuaries and National Parks may be within the division or outside.
- Sprinkling of water to reduce dust pollution.

The summary of mitigation measures proposed for the project is given in **Table 9.3.**

TABLE 9.3: ENVIRONMENT IMPACT AND MITIGATION MEASURE

Possible Impact	Mitigation during planning and design	Mitigation during construction	Mitigation during operation
Air Impact	Incorporate consultant and engineers advice	• Spray water on dry surface generating dust particles • Regulate vehicle emission	• Use of high efficiency ESP • Low NO_X burners • Provide proper ash utilization Plan • Green belt development
Soil Quality Degradation	Consider strategies to avoid soil quality degradation	Preserve top soil for construction, turfing and plantation after civil works.	• Continuous monitoring of soil quality. • Green belt development.

Possible Impact	Mitigation during planning and design	Mitigation during construction	Mitigation during operation
			• Proper ash utilization.
Groundwater depletion and quality degradation		• Groundwater will be used only for construction activity • Ground water table will be checked on regular interval	• Govind Ballabh Pant Sagar will be the source of water for the power plant. • Suitable arrangement will be provided to remove the possibility of leaching from ash pond
Surface water pollution	Incorporate the guidelines suggested by consultant	• Proper treatment of sewage generated from the labour camp • Treatment of grey water	• Only treated effluent will be discharged after conforming to discharge standards as prescribed by regulatory authority
Terrestrial ecosystem (disruption to flora and fauna)	Suitable site selection and alignment of roads	• Workers will be provided with adequate fuel oil	• Green belt development to conserve local biota
Disruption of road traffic	Suitable planning for traffic movement as per time schedule	• Practice caution while using vehicles	• Monitoring road trafficking situation
Disturbance to water supply	Minimize impediments to water supply	• Establish adequate alternative water supply • Rain Water Harvesting	• Establish adequate alternative water supply and continuous monitoring • Rain Water Harvesting
Occupational health hazard		• Providing health inspection & vaccination • Organizing proper disposal procedure of waste • Providing adequate sanitary facilities to personnel and workers	• Providing health inspection and vaccination • Periodic health check-up
Safety of workers		• Adopt appropriate safety measures • Provide first aid services • Make workers aware of risks and how to avoid these	• Workers would be provided with hand gloves ear muffs, safety boots, safety goggles, helmets etc. • Workers should be trained to follow safe working practices • Proper hospital facility would be provided

9.3 ASH UTILISATION AND MANAGEMENT PLAN

As per the MoEF notification at the time of Environmental Clearance for the Sasan UMPP, 100 percent Fly Ash utilization is to be achieved progressively within 9 years of plant commissioning. However, as per the latest MoEF notification, the Fly Ash Utilization is to be achieved progressively within 4 years of plant commissioning. Therefore, to meet the

increased Ash Utilization targets as per the MoEF guidelines, a Cement Plant is planned to be set up so that the Ash can be utilized in the manufacture of Portland Pozzolana Cement (PPC).

Ash which is not utilized will be conveyed in slurry form through ash pipe line supported on concrete pedestals following contour as far as possible and discharged at various points in the pond and decanted ash water will be re-circulated through recirculation pump house.

The dyke will be constructed all around to create the holding capacity of pond for 25 years, however stage raising of the dyke shall be done using pond ash to economize. Sufficiently wide top width will be provided for running the ash pond all rounds to allow ash deposits all round and also inspection road for facilitate quick access to all points. Dyke shall satisfy all relevant codes and practices.

The total yearly ash generated based on average coal and PLF of 90% is given below.

Total coal fired	: 14.986 MMT
Ash percentage in coal	: 27.54%
Total ash generated	: 4.127 MMT
Bottom ash @ 20%	: 0.83 MMT
Fly ash @ 80%	: 3.3 MMT

The total ash generated based on design coal and PLF of 90% is 4.127 MMT per annum. Total ash of about 103 MMT is expected to be produced in 25 years.

9.3.1.1 Market potential for ash utilization

TABLE 9.4: MARKET POTENTIAL OF ASH UTILISATION, SINGRAULI

S. No.	Utilization Areas	Utilization Potential (MTPA)
1.	Manufacture of Portland Pozzolana cement (ppc)	3.50
2.	Manufacture clay ash and fly ash bricks	0.03
3.	Roads and embankment construction	0.26
4.	Low-lying area/ wasteland development	0.51
5.	Agriculture	0.62
Total		**4.92**

9.3.2 Ash Utilization Plan

9.3.2.1 Fly Ash

The fly ash is proposed to be collected in silos and most of it would be utilized/ marketed in dry form. Provision is kept for segregation of coarse and fine ash, loading of ash in to closed trucks and also for loading in railway wagons. The fly ash which cannot be utilized / marketed would be disposed off to the ash dump area in slurry form.

The fly ash generated in thermal power stations has commercial value because of its usage in cement and construction industries. Fly ash generated from the power plant would be commercially utilized in one or more of the following industries, to the extent possible.

Cement Industry

Fly ash is used in the production of Pozzolona cement by inter grinding Portland cement clinkers and fly ash or by blending intimately and uniformly Portland cement and fly ash. Indian Standard specifications limit the Pozzolona (fly ash or similar material) component upto 35% by weight whereas in other countries it varies from 15 to 50%.

Fly ash is preferred in the manufacture of Portland Pozzolona Cement (PPC) over other pozzolonic material due to:

- Better hydraulic properties of fly ash
- Cement retains its natural and accepted grey color instead of becoming mud-red in case bricks / tiles are used as Pozzolonic materials.

By the time Sasan UMPP starts generating ash, many cement plants may be installed in the surrounding area. Therefore, there will be lot of demand for fly ash and entire fly ash utilization can be assured.

Brick Industry

Fly ash produced in modern thermal power stations can be used in making bricks. The Cement Association of India has conducted research and experiments for making hollow bricks using fly ash. The Central Building Research Institute (CBRI), Roorkee has also conducted experiments in making bricks by using fly ash as an admixture with black cotton soil. The bricks of minimum 105 kg/sq.cm strength have been produced by CBRI.

Concrete Building Industry

Fly ash is used in the building industry largely as a concrete additive. Laboratory and pilot plant trials carried out at CBRI, Roorkee have established that sintered light weight aggregate can be successfully produced from Indian fly ash and used for producing plain concrete as well as reinforced concrete beams and slabs. Laboratory investigations and factory trials have shown the techno economic feasibility of manufacture of cellular concrete from lime and fly ash. It is cheaper than the cement-sand cellular concrete, which is being produced in the country at present. Fly ash can also be used as masonry mortar. Lime fly ash mortars are cheaper and better in performance and strength than Lime-Sand mortars.

Road Paving

It has been reported from the laboratory tests conducted by the Cement Association of India that fly ash with other ingredients can be used for paving roads and airport runways. Fly ash mixed with sand and hydrated lime is used as a base course of asphalt pavement. The breaking strength of such a pavement is calculated to be as high as 68 kg/sq.cm (1000 psi). As a result of a series of experiments, recommended proportions have been identified for using Ash as a good paving material ingredient.

India as a developing country is concentrating on building infrastructure like Roads etc. There is lot of potential of using Ash in these areas.

Fly Ash Aggregate

The fly ash can be converted to light weight aggregate which can substitute the presently used conventional aggregate, in concrete blocks, flooring and non-load bearing structures such as compound walls, canals, pavements, etc.

It may be noted that proportions of different ingredients to make bricks / cellular concrete / briquettes with fly ash chiefly depends on the constituents of the particular fly ash. Therefore, the particular type of fly ash is to be analyzed for the properties of its constituents and checked for suitability or otherwise and suitable proportions of ingredients are to be determined by laboratory tests / pilot plant tests.

Bottom Ash

Bottom ash generated in the power plant would be only 20% of the total ash generated, which will be disposed off to the ash pond in the form of slurry. After drying up, this ash will be used mainly in following areas.

Raising of ash dyke

There will be huge requirement of ash for the raising of ash dyke walls and there will be continuous scope for it. Traditionally embankments for ash dykes will be constructed only with Earth. Ash will be utilized as a core embankment material for raising of ash dykes at Sasan UMPP. This is likely to result in utilization of several million MT of Pond ash during the life time of the Plant.

Filling of low lying areas

In this area also there is potential of ash utilization. Low lying areas of power plant & surrounding villages can be back filled with ash hence use of "Earth" can be minimized.

Use in Agriculture

Experimental studies have proved that the Fly ash can be used in agriculture also for developing the waste lands. The studies have also indicated that use of ash has increased agriculture production.

Environmental Advantages of Ash Utilization

As a socially conscious utility, Sasan UMPP will take up ash utilization as a thrust area and utilize the ash generated in various areas as explained above thereby contributing positively for Environment Protection measures.

The low lying lands, ditches etc., can't be put into use unless filled. The ash filling in low lying lands will help in reclaiming the land for play grounds, parks etc. Roads and other infrastructure also can be built on reclaimed land. Where ever Ash is filled in low lying areas, the top layer is filled with earth and greenery will be developed. This prevents the fugitive emissions from the ash and also increases the landscape value.

The utilization of Ash in raising of ash dykes has following major advantages.

- Reduces the requirement of extra land for construction of ash dyke thereby conserving the land.
- Increases the capacity of the existing ash dyke to the extent ash taken out for raising the dyke.
- Reduces the requirement of precious top soil from other areas for dyke raising.

Ash utilized for making the ash bricks seeks to replace the natural materials such as Earth / Clay which has formed after millions of years of nature's activity. Similarly the other natural materials conserved are rocks, sand, limestone reserves etc.

9.4 GREEN BELT DEVELOPMENT PLAN

Greenbelts are normally designed as either source or receptor oriented. In the present case there is a co-existence of defined pollution source and receptors. Besides, the

project site is located in a rural area. Therefore, it is imperative that source-oriented approach be considered.

About 474 acres of land will be earmarked as greenbelt area as per land use plan & Environment Clearance obtained from MoEF to be used for plantation

Since vegetation provides enormous surface area for impingement of air pollutants, species selected for plantation will be semi-tolerant, fast growing, wind-firm, deep-rooted and, if possible, evergreen. In view of the local conditions prevailing in the area native species will be preferable over other species for eco-physiological reasons. The criteria selected for greenbelt development will be based on existing guidelines.

9.4.1 Greenbelt Design

The greenbelt will generally be elliptical in shape following the prevailing wind directions, except for a uniform curtain layer provided along the boundary.

Primary Pollutant - Attenuating zone: This zone will be the nearest one to the emission source, where the ambient pollutant concentration usually remains higher than in other directions. The trees planted in this zone will preferably have dense spreading canopy. The width is required to be 20 to 40 m in upwind and downwind directions.

Secondary Pollutant - Attenuating Zone: Outer to the former zone, trees with moderate tolerance to pollutants but endowed with fast growing, dense foliage and globose canopy will be planted. Similar width as provided above will be adequate for this zone.

Mixed Zone: To optimise the attenuation potential of the greenbelt in plant area, mixed zones will be created specially near fugitive sources of emission. The width will vary as per size and strength of the fugitive emission sources.

Curtain Zone: On the peripheral boundary all along the power plant and colony areas, a curtain zone will be provided with trees tall and evergreen in habit. This zone will act as a barrier and as far as possible check the pollutants from going to other areas beyond the power plant premises. The width of this area will be 10-20 m depending on the availability of land all around.

9.4.2 General Guidelines

- Trees growing upto 20 m in height will be planted around the installation.
- Planting of trees will be undertaken in appropriate encircling rows around the installation in alternating rows to prevent horizontal pollution dispersion.
- Trees will be planted along road sides to arrest exhaust and noise pollution in such a way that there is no direct line of sight to the installation when viewed from a point outside the foliage perimeter.
- Since tree trunks are normally devoid of foliage (upto 3 m), it would be appropriate to have shrubby in front of such trees to give coverage to the portion.
- Fast growing trees with thick perennial foliage will be grown as it will take many years for trees to grow to their full height.
- Monoculture will be avoided.
- Bulk organic matter (manures, composts, etc.), which improves the structure, fertility and water-holding capacity of the soil will be applied.
- Use of indigenous knowledge of local people will be part of greenbelt development programme.

9.4.3 Plant Selection

For any specific greenbelt development it is unlikely that a few species alone will fulfill all requirements. Mixtures of species with complementary characteristics will allow vegetation to fulfill the desired functions and, at the same time, will allow adjustment of the species balance in response to changing environmental conditions. Appropriately selected mixtures will also be ecologically more viable. Based on the existing guidelines on species selection, species considered to be suitable in iso-ecological conditions are provided in **Table 9.5**.

TABLE 9.5- SPECIES SELECTED FOR GREENBELT PLANTATION

Species	Regeneration	Height (m)	Crown Shape	Remark
Acacia indica	Seeds	5	Oblong	Tree
A. catechu	Seeds	3	Oblong	Shrub
A. leucophloea	Seeds	3	Oblong	Shrub
A. nilotica	Seeds	8	Spreading	Tree
Abbizia moluccana	Seeds	15	Oblong	Tree
Adenanthera pavonina	Seeds	20	Spreading	Tree
Bauhinia racemosa	Seeds	5	Oblong	Tree
Bauhinia varigata	Seeds	5	Oblong	Tree
Calotropis procera	Seeds, Cutting	5	Oblong / Round	Shrub
Cordia dichotoma	Seeds, Stem	10	Oblong / Round	Tree
Cassia fistula	Seeds, suckers	12	Round	Tree
Clerodendrum infortunatum	Seeds, Cutting	4	Round	Shrub
Ficus benghalensis	Cutting/seeds	20	Spreading	Tree
F. benjamina	Seeds, cutting	12	Spreading	Tree
F. religiosa	Seeds, cutting	20	Round / Oblong	Tree
Grewia subinequalis	Seeds	7	Round	Shrub
Grevillea robusta	Seeds	20	Oblong	Tree
Madhuca longifolia	Seeds	15	Round / Oblong	Tree
Mimusops elengi	Seeds	10	Oblong / Round	Tree
Prosopis cineraria	Seeds, Root suckers	12	Spreading	Tree
Saraca asoka	Seeds	5	Spreading	Tree
Soymida febrifuga	Seeds	15	Round / Oblong	Tree
Syzygium cumini	Seeds, Cuttings, Grafting,	20	Oblong	Tree
Terminalia arjuna	Seeds, Cutting	15	Oblong/Round	Tree

9.4.4 Site Preparation

Careful preparation of the greenbelt site will enhance vegetation growth overcoming the establishment problems which are often encountered on construction sites.

The handling and treatment of soils which are to be used within the potential root zone of the vegetation will take account of the following factors:

- Soil as a medium for plant growth
- Continuity between soil layers
- Proper soil handling avoiding destruction of natural aerobic soil organisms
- Minimum soil compaction without excessive densities

9.4.5 Soil Improvement

Soil used as a growing medium will often benefit from improvement. A mixture of soil will be prepared for filing pits in the following composition:

Agricultural soil from nearby land	1 part
Commercial fertilizer	1 part
Organic manure + potassium nitrate or bone meal	1 part
Commercial cultures of Rhizobium leguminous species) and Azotobacter for Non-leguminous species)	Proportion as (indicated on the packets)

9.4.6 Plant Propagation

Plants reproduce by following mechanisms:

- Seed Production
- Vegetatively (by runners/suckers/buds)

There are three widely used techniques of propagation used appropriately for landscaping:

- Direct sowing
- Planting nursery – raised plants
- Planting cuttings

Planting nursery – raised plants and planting cuttings are normally practiced for trees and shrubs. Direct sowing (seeding) is, however, becoming more widely used for trees and shrubs. Seeds are cheap and very versatile but during the establishment phase they are very vulnerable to desiccation and predation.

In each of above mentioned cases the establishment period is critical because the individual plant is at risk from many sources i.e. drought, predation and damage.

9.4.7 Procurement of Seedlings/Plantation Material

Seeds will be procured from a certified agency. The seedlings of species selected will be obtained from the nursery of Forest Department or from commercial nurseries.

Seeding spots will vary in size from 100 – 150 mm diameter containing a few seeds only, to 1-2 m^2 patches containing many species. Existing groundcover will be removed before seeding, in order to reduce competition for moisture and nutrients.

9.4.8 Plantation

This will include digging pits with proper spacing, filling pits with prepared soil, plantation of seedlings and watering.

The size of the pit will be 1m x 1m x 1 m for big trees and 0.5 m x 0.5 m x 0.5 m for smaller trees and shrubs. The spacing will be,

Plantation on filled land	3 m
Trees along internal wide road	5 m
Trees along internal small roads	3 m
Trees on outer boundary	5 m

The pits will be filled with soil mixture. The soil will be irrigated soaking wet prior to placing of seedling.

In the centre of pits bags containing seedlings along with attached ball of earth will be placed for firm rooting of the seedlings.

The water required for greenbelt development will be met from the treated effluents generated during plant operation. During construction period water supply will be met from available sources.

9.4.9 Time- Frame

A suitable time-frame provides enough space for keeping the construction materials and for the realization of planned development of greenbelt area in and around the power plant premises.

9.4.9.1 First Year

Plantation in the outer zone will be initiated with the commencement of construction work.

9.4.9.2 Second Year

During second year, plantation will be done in the secondary zone and along the road sides.

9.4.9.3 Third Year

Greenbelt will be developed around buildings, openspace and primary zone. Besides, mixed-area plantations will be developed after the finalisation of actual size and strength of equipment or emission sources.

9.4.10 Finance

The cost of greenbelt development will mainly include the soil handling and sapling costs including:

- Use of biocides
- Preparation of agricultural soil and use of fertilizers, and
- Cultures of *Azotobacter* and *Rhizobium*

The costs will depend on local conditions including distance of nearest nursery and sapling survival rates.

9.5 RAINWATER HARVESTING

Rain water harvesting and artificial recharge to ground water are the process of adding water to an aquifer through human effort. It is an indispensable measure by which the groundwater reservoir is augmented at a rate exceeding that under natural condition of replenishment. The planned augmentation of water storage in the ground water reservoirs by suitable recharge techniques is useful for reducing over draft, conserving runoff and increasing available ground water supplies.

On the basis of the analysis of the data, generated from the systematic and comprehensive Hydro geological survey, the Geophysical Resistivity Survey, the lineament fabric studies of the area, thoroughly understanding the aquifer geometry and its disposition at depth, Hydro meteorological studies (Rain fall intensity etc.), the location and types, suitable rainwater harvesting structures are finalized to impound as well as recharge ground water.

9.5.1 Check dams

Check dams are small dam constructed across stream of second order, in areas having gentle slopes. The structures are suitable for areas with annual rainfall of less than 1100

mm. The catchment area of the nala should normally be between 40 to 100 ha. The site selected for check dam should have sufficient thickness of permeable rock or weathered formation in the stream course to facilitate recharge of the impounded surface water to the groundwater storage. The water stored in these structures is mostly confined to stream course with a pounded water column of generally less than 2 meters. Nala bunds are generally of 10 to 25 m length and height of 1 to 2 m with a width of 1 to 3 m constructed in a trapezoidal form.

9.5.2 Gravity head recharge wells

In areas of heavy groundwater exploitation dug wells often gets partially or fully dried up. The rock material exposed in the open well is permeable and the unsaturated horizon of the phreatic aquifer can be a good repository of water if recharged from surface water. The rain water collected from roofs of the buildings, storm drain water, surplus irrigation water collected from trenches along irrigation fields, surplus canal/tank water etc can be diverted into abandoned dug wells to directly recharge the dried aquifer. However, to avoid pollution of groundwater it is necessary to route the source water through a pipe filled with gravel and sand filter. Arrangement for measurement of quantity of water being recharged to the well can also be made before the filtered water is let into the well. Such gravity head recharge can also be made directly in tubewells subject to ensuring of the good quality of source water for recharge In case of Roof Top rainwater harvesting, the service tubewells adjacent to buildings of urban areas can be effectively utilized for recharge. However, in rural area, if source water is surplus surface water, all precautions of providing silt pit and filtration arrangement should be made.

9.6 CLEAN DEVELOPMENT MECHANISM (CDM)

9.6.1 Project

The project activity aims at reducing Green House Gas (GHG) emission by setting up 6 x 660 MW coal based Super-critical Thermal Power Plant at Sasan, District- Singrauli in the state of Madhya Pradesh, India.

9.6.2 Reduction in GHG emissions due to Proposed Project Activity

The Project would employ latest advanced class super-critical technology resulting in a) higher plant efficiency; b) lower Greenhouse Gas (GHG) emissions, so that there is considerably lesser environmental impact. The Project is the greenest coal based power plant in the region. The Project would consume approximately 1.5 million tons of coal less per year compared to the sub-critical plants of comparable size. As a result, net GHG emission is estimated to be lesser by 14% in comparison to the sub-critical technology based generation plant of similar capacity to generate the equivalent electricity.

By deploying the super-critical technology, Sasan Project would abate CO2 emissions by approximately 60 Million Tonnes over the the life of the Project. This would enable the project to earn Certified Emission Reductions (CERs) / Carbon Credits during the initial 10 years life time of the Project. As the project achieves sustainable development goals of GoI, Sasan Power has secured Host country approval from Ministry of Environment & Forests, GoI on February 06, 2009.

9.6.3 Eligibility for CERs under UNFCCC CDM

Clean Development Mechanism - Executive Board's (CDM-EB) Approved Consolidated Methodology - 13 (ACM-0013) allow super-critical technology based generation projects to generate CERs, provided the projects meets the criterion established for baseline identification. Established criterion for the selection of baseline takes into accounts several factors inter-alia include:

- Percentage electricity generation contributed by each of the fossil fuel sources.
- Net efficiency of generation technology in project vis-à-vis baseline scenarios

Electricity generated in India, in-excess of 60% is produced by sub-critical technology using sub-bituminous coal as fuel. Integrated Energy Policy and National Electricity Policy utilization of sub-bituminous coal for electricity generation in India. Under such conditions, sub-bituminous coal will continue to remain as baseline fuel at least till year 2030.

Although India has a coal based generation capacity of 72,807 MW (2008-09), efforts to introduce higher efficiency super-critical technology could not be achieved for reasons associated with inefficient and regulated markets, policy-level impediments, lack of manufacturing capacity amongst others. As a result, no super-critical technology power plant was commissioned in India, although it has reached a level of maturity worldwide. According to Thermal Performance Review – 2007-08, published by CEA, indicates the weighted average net efficiency of sub-critical generation units commissioned in India at 31.8% and the highest net efficiency achived by sub-critical technology as 34.07%.

Considering highest net efficiency achieved by sub-critical technology as baseline efficiency, Implementation of super-critical technology deployed would increase the efficiency of generation by 3.1% to 37.2%.

Such increased efficiency would allow Sasan Power to abate 60 Million Tonnes of CO_2 over the life of the Project.

Clean Development Mechanism (CDM)
As a result of higher efficiency generation, Sasan Power would consume approximately 1.5 million tons per year lesser coal compared to the sub-critical plant of comparable size, which in turn would reduce GHG emissions by 14%.

As per ex-ante estimates, Sasan Power would generate 2.2 CERs per annum during the initial 10 years of registration.

9.7 OCCUPATIONAL HEALTH & SAFETY

SPL will provide necessary infrastructural facilities and install suitably designed equipment, which will meet good industrial practices. The company will construct, design, operate, maintain and monitor all the aspects of the power plant to minimize adverse impact on environment, health, community and safety. SPL will ensure suitable contractual provisions in a manner that adverse impacts on community environment, health and safety are minimized. The company will also enforce Risk assessment, Environment Management and Monitoring, and develop on site and off site Disaster Management Plan to ensure that associated risks are contained within the plant premises and social risk is minimal and could be addressed promptly with the best practices of international norms.

SPL will ensure through their Safety and Environment Engineers that the contractors adopt good practices during construction by arranging safety-training programs for the operators, drivers and labors. Suitable material movement plan will be developed for the vehicles and other earth moving equipments during the construction phase to ensure minimum impact on daily life pattern of nearby communities. Appropriate measures will be taken to reduce fugitive emissions due to excavating, storage and transport of earth and other construction materials. This will be followed by periodic Ambient Air Quality and

Noise level monitoring in potentially affected villages and take suitable mitigation measures as required.

All safety incidents shall be recorded, investigated and corrective actions implemented. Similarly bona-fide complaints against safety violations shall be investigated and disciplinary actions/measures implemented. There shall be a grievance mechanism for aggrieved members of community and employees in the event of violation of the code of conduct of security personnel.

Assigned employees and visitors to workplaces may be exposed to a variety of personal health and safety risks. The type and level of exposure is generally related to factors controlled by the SPL. Such factors include without being limited to workplace design, installations, equipment, tools, work procedures, raw materials, byproducts, and the degree and sophistication of employee training. Administrative and managerial facilities generally involve fewer risks and hazards than industrial settings.

SPL will implement appropriate national and internationally recognized OHS standards, codes and guidelines. Maximum effectiveness of OHS systems requires the inclusion and meaningful participation of employees in implementation and maintenance of procedures and processes. To achieve meaningful and effective participation, SPL will also implement a program to change employee culture and attitudes regarding health and safety. The summary of safety measures adopted by SPL are described below.

9.7.1 Hazard and Mitigation Measures – Construction Phase

9.7.1.1 Welding / Hot Work

Hazards

Welding creates an extremely bright and intense light that may seriously injure a worker's eyesight. In extreme cases, blindness may result. Additionally, welding may produce noxious fumes to which prolonged exposure can cause serious chronic diseases.

Mitigation Measures

Recommended measures shall include:

- SPL shall ensure that proper eye protection gear such as welder goggles and/or a full-face eye shield are provided for all personnel involved in, or assisting, welding operations. Additional methods may include the use of welding barrier screens around the specific work station (a solid piece of light metal, canvas, or plywood designed to block welding light from others). Devices to extract and remove noxious fumes at the source shall be provided.
- Special hot working and fire prevention precautions and Standard Operating Procedures (SOPs) shall be implemented.

9.7.1.2 Rotating and Moving Equipment

Hazards

Injury or death can occur from being trapped, entangled, or struck by machinery parts due to unexpected starting of equipment or unobvious movement during operations and maintenance/breakdown.

Mitigation Measures

Recommended protective measures shall include:

- Where a machine or equipment has an exposed moving part or exposed pinch point that may endanger the safety of any worker, the machine or equipment should be

equipped with, and protected by, a guard or other device that prevents access to the moving part or pinch point. Guards should be designed and installed in conformance with appropriate machine safety standards.

9.7.1.3 Working at Heights

Hazards

Fall prevention and protection measures shall be implemented whenever a worker is likely to be exposed to the hazard of falling more than two meters; onto operating machinery; into water or other liquid; into hazardous substances; or through an opening in a work surface. Fall prevention / protection measures may also be warranted on a case-specific basis when there are risks of falling from lesser heights.

Mitigation Measures

- Proper use of ladders and scaffolds by trained employees
- Use of fall prevention devices, including safety belt and lanyard travel limiting devices to prevent access to fall hazard
- Appropriate training in use, serviceability, and integrity of the necessary PPE
- Inclusion of rescue and/or recovery plans

9.7.2 Building and Structures

Permanent and recurrent places of work shall be designed and equipped with Occupational Health and Safety (OHS). Surfaces, structures and installations shall be easy to clean and maintain, and not allow for accumulation of hazardous compounds. Buildings shall be structurally safe, provide appropriate protection against the climate and have acceptable light and noise conditions. Fire resistant, noise-absorbing materials shall, to the extent feasible, be used for cladding on ceilings and walls. Floors shall be leveled, even, and non-skid. Heavy oscillating, rotating or alternating equipment shall be located in dedicated buildings or structurally isolated sections.

The space provided for each worker and in total shall be adequate for safe execution of all activities including transport and interim storage of materials and products. A sufficient number and capacity of emergency exits shall be provided for safe and orderly evacuation of the greatest number of people present at any time.

9.7.3 Confined Space

Adequate engineering measures should be implemented to eliminate feasible existence and adverse character of confined spaces. Unavoidable confined spaces shall, to the extent possible, be provided with permanent safety measures for venting, monitoring and rescue operations. The area adjoining an access to a confined space shall provide ample room for emergency and rescue operations.

9.7.4 Access

Segregated passageways for pedestrians and vehicles within and outside buildings shall be provided for easy, safe and appropriate access. Hand, knee and foot railings shall be installed on stairs, fixed ladders, platforms, permanent and interim floor openings, loading bays, ramps, etc. Covers shall, if feasible, be installed to protect against falling items. Measures to prevent unauthorized access to dangerous areas shall take place properly.

9.7.5 Installations, Equipment, Tools and Substances

Installations, equipment, tools and substances shall be suitable for their use and selected to minimize dangers to safety or health. Appropriate shields, guards or railings shall be installed and maintained to eliminate human contact with moving parts, or hot and cold

items. Equipment must be provided with adequate noise and vibration enclosures. Electrical installations shall be designed, constructed and maintained to eliminate fire or explosion hazards and risks to employees.

9.7.6 Signage

All the Hazardous and risky areas, installations, materials, safety measures, emergency exits, etc. shall be marked appropriately. Signage shall be in accordance with international standards, be well known to, and easily understood by workers, visitors and the general public as appropriate.

9.7.7 Lighting

Workplaces shall, to the degree feasible, receive natural light and be supplemented with sufficient artificial illumination to promote workers' safety and health. Emergency lighting of adequate intensity shall be installed and automatically activated upon failure of the artificial light source to ensure safe shut down, evacuation, etc.

9.7.8 Ventilation and temperatures

Proper fresh air shall be supplied for indoor and confined workspaces. Factors shall be considered in ventilation design include physical activity, substances in use and process related emissions. Mechanical ventilation systems shall be maintained in good working order. Air inlet filters shall be kept clean and free of dust and microorganisms. Industrial evaporative cooling systems shall be equipped, maintained and operated so as to prevent growth and spreading of disease agents (e.g. *Legionnella pneumophilia*) or breeding of vectors e.g. mosquitoes and flies of public health concern. The temperature in work, rest room and other welfare facilities shall during service hours, be maintained at a level appropriate for the purpose of the facility.

9.7.9 Fire Detection and Fire Fighting

The workplace shall be equipped with fire detectors, alarm systems and fire-fighting equipment. The equipment shall be maintained in good working order. These systems shall be adequate for the dimensions and use of the premises, equipment installed, physical and chemical properties of substances present, and the maximum number of people present. Non-automatic fire fighting equipment shall be made easily accessible and simple to use.

9.7.10 First Aid

SPL shall ensure that qualified first-aid can be provided at all times. Appropriately equipped first-aid stations shall be easily accessible throughout the place of work. Eye-wash stations and/or emergency showers shall be provided close to all workstations, where the recommended first-aid response is immediate flushing with water. Dedicated and appropriately equipped first-aid room(s) shall be provided, where the scale of work or the type of activity so requires. First aid stations and rooms shall be equipped with gloves, gowns and masks for protection against direct contact with blood and other body fluids. Remote sites shall have in place written emergency procedures for dealing with cases of trauma or serious illness up to the point at which care of the patient can be transferred to an appropriate medical facility.

9.7.11 Welfare Facilities

Welfare facilities shall include locker rooms, an adequate number of toilets with washbasins, and a room dedicated for eating. Separate eating facilities shall be provided for employees wearing clean and soiled work clothes respectively. Gender-segregated changing rooms with lockers and benches shall be provided when special work-clothes

are required. Hot and cold water shower facilities and washbasins shall be available in connection with locker rooms. Water supplied to areas with food preparation or for the purpose of personal hygiene (washing or bathing) shall meet drinking water quality standards.

9.7.12 Personal Protective Equipment

SPL will identify and provide appropriate Personal Protective Equipment (PPE) that will offer adequate protection to the worker, co-workers and occasional visitors without incurring unnecessary inconvenience. SPL will actively enforce use of PPE if alternative technologies, work plans or procedures cannot eliminate or sufficiently reduce a hazard or exposure. SPL will ensure that PPE is cleaned when dirty, properly maintained and replaced when damaged or worn out. Proper use of PPE shall be part of the recurrent training programs for employees. Workers without appropriate PPE will be restricted from entering construction premises. **Table 9.6** presents types of PPE for different purposes.

TABLE 9.6– OCCUPATIONAL HAZARDS – EXPOSURE EXAMPLES AND TYPES OF PPE AVAILABLE

Objective	PPE
Eye And Face Protection	Glasses, Shields, Protective shades etc.
Head Protection	Helmets with or without electrical Protection
Hearing Protection	Hearing Protectors
Foot Protection	Safety shoes and boots for protection against liquids and chemicals
Hand Protection	Gloves made of rubber or synthetic materials, leather, steel, insulating materials etc.
Respiratory Protection	Facemasks with appropriate filters for dust removal and air purification (chemical and gases) or air supply
Body/leg Protection	Insulating clothing, body suits, aprons etc. of appropriate materials

9.7.13 Ambient Conditions in the Work Place

9.7.13.1 Drinking Water

SPL shall ensure an ample supply of drinking water at all places of work. Water supplies shall be conveniently located especially for areas of elevated temperatures, high physical activity, and cold or dry environments. Drinking water supplies shall be clearly marked especially where non-drinking water is also available.

9.7.13.2 Noise

No employee shall be exposed to a noise level greater than 85 dB(A) for a duration of more than 8 hours per day.

9.7.13.3 Illumination, Light Radiation and Reflection

Work area light intensity shall be adequate for the general purpose of the location and type of activity and must be supplemented with dedicated workstation illumination as needed. All light sources shall be energy efficient with minimum heat emission. SPL shall take measures to eliminate reflections and flickering of lights. SPL shall take precautions to minimize and control optical radiation including direct sunlight.

9.7.13.4 Temperature

SPL shall maintain indoor temperatures that are reasonable and appropriate for the type of work. Risks of heat or cold related stress shall be adequately addressed and feasible control measures implemented for work in adverse environments. Additional

investigations shall also be undertaken to properly assess the magnitude of the problem and identify feasible heat stress control measures.

9.7.13.5 Hazardous Materials

Organizations that handle, store, transport and dispose of hazardous materials (chemicals, gases, vapors, fumes, dust, fibers, etc.) shall in addition to the present guidelines fulfill the requirements of the IFC Hazardous Materials Management Guidelines. SPL shall avoid the use of any hazardous substance by replacing it with a substance that under its normal conditions of use is not dangerous or less dangerous to the workers, if the nature of the activity so permits. Precautions shall be taken to keep the risk of exposure as low as possible. Work processes, engineering and administrative control measures must be designed, maintained and operated so as to avoid or minimize the release of hazardous substances into the working environment. The number of employees exposed or likely to become exposed shall be kept at a minimum and the level of exposure maintained below recognized exposure limits.

9.7.14 Occupational Health Service (OHS)

SPL will establish Occupational Health Service Centre inside the Plant premises whose basic objective will be to promote and maintain the physical, mental and social well being of all the employees.

- Occupational Health Service at the unit level will function under Medical Department. The unit shall be equipped to detect and prevent occupational/work related diseases and will offer effective emergency and injury care at work.
- The Occupational Health Service centre will be headed by a physician who will be totally responsible for organizing various functions and comprehensive occupational health programmes as decided from time to time.
- Occupational Health Service (OHS) shall arrange to provide adequate number of First Aid Boxes with approved contents on the shop floor. These boxes shall be maintained and kept under the charge of Shift-in-charges and will be handled by trained competent first- aiders in each shift. Periodic inspection of these boxes shall be carried out by OHS staff to ensure availability of all the contents in the first aid boxes.
- OHS shall develop health education training packages including use of personal protective equipment for all employees and impart training accordingly.
- OHS centre will play a vital role in suitably redeploying or rehabilitating an employee, if it is found he/she is incapacitated due to an accidental injury, occupational disease or otherwise.
- The occupational physician will advice on suitability of the various personal protective equipment. While recommending, he/she will consider all factors relating to health, comfort and other ergonomic aspects of relevance.
- OHS centre will take special care of women employees working in hazardous areas or handling toxic substances, which may cause danger or interfere with her physical well being in any manner.

9.7.15 Monitoring and Reporting Guidelines

Safety features, ambient working environments and OHS-indicators are subject to regular monitoring and review. The collected information shall be processed and findings reported to authorities as required. The compiled information and any corrective measures taken shall be applied in a continuous process to improve the OHS management system. The report shall also outline and justify changes made to the OHSMS. Employee monitoring data (originals) must be saved for a period of 5 years or longer as required by national

regulations. The OHSMS shall include specifications for performance monitoring, evaluation, and improvement of the system as well as for recording and reporting occupational diseases and accidents.

9.7.16 Performance Monitoring

9.7.16.1 OHSMS organization

The performance and achievements of the OHSMS organization shall be re-assessed annually.

9.7.16.2 Safety inspection, testing and calibration

SPL will arrange regular inspection and testing of all safety features and hazard control measures at the premises. The inspection shall focus on engineering and personal protective features, work procedures, places of work, installations, equipment, and tools used. The inspection must ensure that issued personal protective equipment continues to provide adequate protection and is being worn as required. All instruments installed or used for monitoring and recording of working environment parameters shall be regularly tested and calibrated. Records shall be kept of all inspections, tests, and calibrations.

9.7.16.3 Surveillance of the working environment

SPL shall document compliance using an appropriate combination of portable and stationary sampling and monitoring instruments. Monitoring and analyses shall be conducted according to internationally recognized methods and standards. Monitoring methodology, locations, frequencies, and parameters shall be established individually for each facility following a review of the seriousness of the inherent hazards.

Generally, monitoring should be performed during commissioning of facilities or equipment and at the end of the defect and liability period, and otherwise repeated according to the monitoring plan established as part of the OHSMS.

9.7.16.4 Surveillance of Workers Health

SPL shall provide appropriate and relevant health surveillance to workers prior to first exposure and at regular intervals thereafter. The surveillance shall, if deemed necessary be continued after termination of the employment.

9.7.16.5 Training

Training activities for employees and visitors shall be adequately monitored and documented (curriculum, duration, and participants). Emergency exercises including fire drills shall be adequately documented. Service providers and contractors must be contractually required to submit to SPL adequate training documentation before start of their assignment.

9.7.17 Accidents and Diseases Monitoring

SPL shall establish procedures and systems for reporting and recording:

- Occupational accidents and diseases; and
- Dangerous occurrences and incidents.

The systems shall ensure and enable workers to report to their immediate supervisor immediately any situation they believe presents a serious danger to life or health. The systems and the employer shall further enable and encourage workers to report all:

- Occupational injuries and near misses;
- Suspected cases of occupational disease; and

- Dangerous occurrences and incidents.

9.7.17.1 Occupational accidents and diseases

SPL shall with the assistance of a competent person shall investigate all reported occupational accidents, occupational diseases, dangerous occurrences, and incidents together with near misses. The investigation shall as far as possible:

- Find out the actual incidents/accidents
- Determine the cause of such incidents; and
- Identify measures necessary to prevent recurrence

9.7.18 Reporting Guidelines

The annual report on OHS shall include a comprehensive summary of the following.

9.7.18.1 Host Country Regulatory Compliance

Reports submitted to host country authorities, e.g. on OHS, fire and safety inspections, compliance monitoring, emergency exercises, etc., as well as comments received and actions taken shall be recorded, listed & preserved. Host country authority monitoring and inspections with subsequent actions taken shall also be summarized and reported.

9.7.18.2 OHSMS Reporting

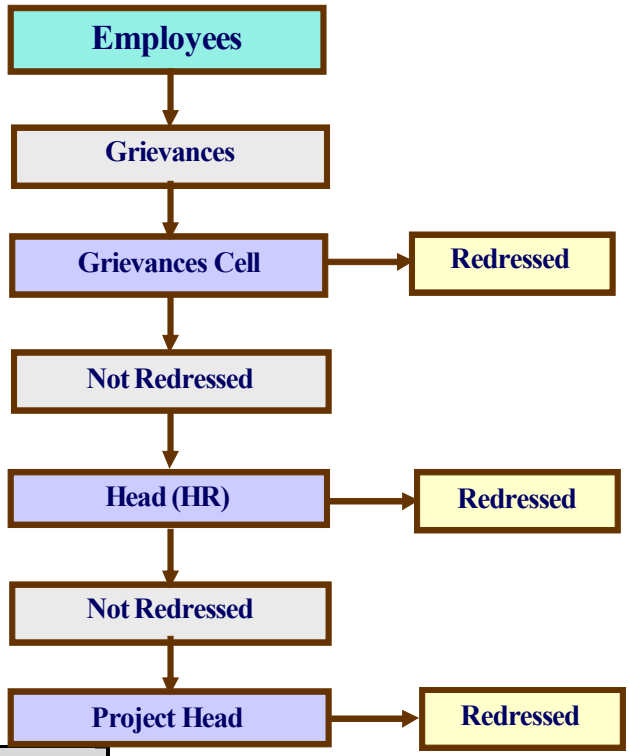
The annual report shall include summary of OHS performance monitoring, and records of occurred occupational accidents, incidents and diseases. Special emphasis shall be placed on evaluation of findings and actions taken or planned due to the number and type of accidents observed. The report shall also include an assessment of the degree of fulfillment of the previous year's OHS objectives and action plans for improvement.

The report shall include proposed revisions to the OHS Management System; revised quantitative objectives; action plans for technical improvements; and planned training activities.

9.8 LABOUR AND WORKING CONDITIONS

Through a constructive employee-management relationship, and by treating the employees fairly and providing them with safe and healthy conditions, tangible benefits may be created, such as enhancement of the efficiency and productivity of their operations. The basic objectives is to ensure following.

- To establish, maintain and improve the employee-management relationship
- To promote fair treatment, non-discrimination and equal opportunity of employee, and compliance with national labor and employment laws



- To protect the employee by addressing child labor and forced labor
- To promote safe and healthy working conditions, and to protect and promote the health of workers by evolving safe working practices.

In order to achieve these objectives, relevant provisions of employee laws will be complied.

9.8.1 Working Relationship

All employees of SPL and workers directly engaged by the contracting agencies will be communicated their working conditions and terms of employment, including their entitlement to wages and any other benefits.

9.8.2 Workers Organizations

The company will not discourage workers from collective bargaining in a positive manner for mutual benefit.

9.8.3 Equal Opportunities

The company will base the employment relationship on the principle of equal opportunities and fair treatment and will not discriminate with respect to aspects of the employment relationship including recruitments and hiring, compensation, working conditions and terms of employment, access to training, promotion, termination of employment or retirement and discipline except on the basis of merit.

9.8.4 Grievance Mechanism

SPL will provide a grievance mechanism where employees may raise reasonable work place concerns. The mechanism shall involve appropriate level of management involvement and address concerns promptly, using a transparent process that provides feedback to those concerns without any retribution.

9.8.5 Child Labour

SPL will not employ children in any manner i.e. economically exploitative or is likely to be hazardous or to interfere with the child education or to be harmful to the child's health or physical, mental, spiritual, moral or social development. Children below the age of 18 years will not be employed in dangerous work. SPL's R&R Compensation package in fact discourages child labour & encourages them to go to School by providing free education facilities & also providing education stipend for attending school.

9.8.6 Occupational Health and Safety

SPL will provide the employees with a safe and healthy work environment taking into account inherent risks in its particular sector and specific classes of hazards in the works premises, including physical, chemical and biological hazards. SPL will take steps to prevent accidents, injuries and disease arising from, associated with or occurring in the course of work by minimizing as far as reasonably practicable the causes of hazards.

9.9 CONSTRUCTION LABOUR MANAGEMENT

For completion of the project, there may be engagement of contracting agencies which may engage labour. It will be ensured that relevant provision of labour laws as provided in chapter 2 are complied with.

The detailed EHS plan proposed for the construction labour is given in **Section 6.4 of Chapter 6**.

9.9.1 Labour Colony

Following facilities are recommended for the labour camps:

- Labour camp site is provided with electricity and ventilation system, water supply and community latrines with semi-permanent structures for the workers
- Water is disinfected before consumption.
- Community latrines and septic tanks are constructed.
- Adequate facilities for collection, conveyance and disposal of solid waste are developed for solid waste collection conveyance and disposal.

9.9.2 Fuel Arrangement for Construction Labour

During construction of the project, a large number of people are working in the project area. The necessary fuel wood requirement shall be met though supply of fossil fuel to avoid encroachment on forest area during construction phase. In order that influx of labourers in the project area does not lead to deforestation, necessary arrangements for supply of coal/fuel wood and kerosene to the labourers on an individual basis shall be arranged

9.10 LABOUR CAMP DEMOBILISATION

On completion of the works, all temporary structures will be cleared away, all rubbish cleared, excreta or other disposal pits or trenches filled in and effectively sealed off and the site left clean and tidy.

9.11 RESIDUAL IMPACT IDENTIFICATION

9.11.1 Basis

As discussed earlier the anticipated impact assessment was made using 'Modified Leopold Matrix Method'. The negative score of '-398.38' at premitigative stage indicated that the adverse impact is within "Appreciable but reversible impact and appropriate control measure are important " limit. This is mainly because care has been taken at the planning and engineering stage to incorporate environmental protection measures in the process involved. Control measures have been proposed for mitigating the degradation effects and improvement schemes such as afforestation programme and annual environmental management scheme. To predict the resultant effect at post-mitigation stage, same Matrix method is used details whereof are given in the following paragraphs.

9.11.2 Environmental Impact Matrix with Protection Measures

Components such as PIV, RPII, EII, WEII and sum of the above are arrived at and same are shown in **Tables 9.7 and 9.8**. It is seen that the total score which was originally '-398.38' without mitigation has improved to '-161.47', as shown in **Table 9.8.** This indicates that the overall impact from the project would be under the category 'No appreciable impact on Environment'. Rehabilitation and Resettlement of the peoples contributed the major adverse impact. Reduction in total score is mainly on account of Water quality, Air quality, Noise Levels & Human Resettlement, etc. Measures undertaken for the same are summarized in **Table 9.7**.

TABLE 9.7 – POTENTIAL IMPACT IDENTIFICATION IMPACT MATRIX WITH MITIGATION MEASURES

Sl. No.	Environmental Components	Project Activities	Interaction No.	Impacts	Adverse / Beneficial	RPII values	Remark for RPII	EII Index	EII (%)	Remark for EII
Social and Environmental Assessment and Management System										
1.	Air Quality	Power generation operations	1	Coal Combustion will generate SPM, SO_2 and NO_X etc.	Adverse	0.60	Coal is primary source of fuel	-0.50	50.0	Following control measures shall be adopted during Operation Phase: • ESP to control SPM emission upto 50 mg/Nm^3 • Low NO_X burner to control the NO_X emission
2.	Air Quality	Transportation of coal material during operation	2	Causes dust nuisance and gaseous pollution due to transportation	Adverse	0.10	Insignificant increased in traffic density envisaged	-0.10	20.0	• Proper Management Plan will be made to manage the transportation • Transport of construction materials and machinery shall be carried out during lean traffic period of the day or during night
3.	Air Quality	Vegetation Plantation	3	It serves as a natural screen in attenuation of air pollution	Beneficial	0.10	Less significant, as emission are mostly through 275m stack	0.10	20.0	Proposed vegetation and greenbelt will mitigate fugitive emission
4.	Air Quality	Dust emission during Construction Phase	4	During construction phase temporary impact due to construction activity	Adverse	0.20	Insignificant, as emission will take place only on the construction site	-0.10	15.0	Insignificant amount of dust would be released and can be controlled by regular water sprinkling and planned metalled road inside the site boundary for

Sl. No.	Environmental Components	Project Activities	Interaction No.	Impacts	Adverse / Beneficial	RPII values	Remark for RPII	EII Index	EII (%)	Remark for EII
										transportation of materials
5.	Water Quality	Provision of civic amenities	1	Deterioration in water quality due to disposal of domestic waste water	Adverse	0.20	Release of domestic wastewater is relatively low	-0.25	35.0	• Treated domestic waste water will be utilized quantitatively for greenbelt & horticulture • Sewage treated in sewage treatment plant and suitable utilization will be done
6.	Water Quality	Power generation operation	2	Impact due to wastewater from different industrial operations	Adverse	0.80	Significant quantity of wastewater generated	-0.25	40.0	• Effluent treatment plant will established to meet the waste water standard • Water will be recycled as far as possible • Treated waste water will be used for green belt and dust suppression
7.	Noise Levels	Power generation operation	1	Increase in noise level due to operation of various equipment	Adverse	0.70	Significance due to operation of ID fans, compressors, turbines, pumps, cooling towers etc.	-0.25	40.0	All the operational equipment will be provided with proper acoustic enclosure
8.	Noise Levels	Transportation	2	Increase in noise level due to vehicular traffic	Adverse	0.10	Less significant as road transportation of raw/material product not envisaged	-0.05	10.0	Insignificant increase in noise level due to movement of few trucks and vehicles used for raw material transportation
9.	Noise Levels	Vegetative Plantation	3	It serves as barrier for noise propagation, thereby reducing noise	Beneficial	0.20	Less significant as compared to the noise sources	0.10	00.0	Proposed greenbelt will attenuate Noise.

Sl. No.	Environmental Components	Project Activities	Interaction No.	Impacts	Adverse / Beneficial	RPII values	Remark for RPII	EII Index	EII (%)	Remark for EII
				levels						
10.	Thermal Pollution	Power generation	1	Inadequate waste heat recovery may cause thermal pollution	Adverse	1.00	Significant	-0.15	25.0	Proper mitigation measure shall be undertaken to minimize the thermal pollution
Labor and Working Condition										
11.	Health	Power generation operation	1	Impact on health due to air & noise pollution, toxic exposure and accidents & injuries	Adverse	0.50	Potential for exposure to noise, air pollution, toxic exposure, accidents and injuries is high	-0.15	30.0	Mitigation measure shall be undertaken to reduce the potential of Air Pollution, Noise Pollution. EHS guidelines and use of PPE and training will be implemented by EMP Cell. Proper Handling and Storage Facility shall be provided for LDO/HFO to ensure no spillage will be there All the chemicals storage in proposed TPP will be well within the threshold limit
12.	Health	Vegetative Plantation	4	Improves the health of inhabitants by acting as a barrier to air and noise pollution, uptake of liquid waste disposed on land and impacts pleasant atmosphere	Beneficial	0.20	More significant as compared to effects due to transportation and civic amenities	0.10	20.0	Proposed green belt plantation will help to improve the environment condition. It will also improve the health status
Pollution Prevention and Abatement										
13.	Land use and	Disposal of	1	Land degradation due	Adverse	0.40	A large quantity of ash	-0.30	30.0	100% Fly Ash

Sl. No.	Environmental Components	Project Activities	Interaction No.	Impacts	Adverse / Beneficial	RPII values	Remark for RPII	EII Index	EII (%)	Remark for EII
	Soil Characteristics	solid waste		to disposal of solid wastes			will generate			utilization is proposed as per the guidelines of MoEF and Bottom ash is planned to be disposed in the lined ash pond
14.	Land use and Soil Characteristics	Civic Structure	2	Landuse degradation due to erection of civil structures	Adverse	0.30	Civil Structure are within plant area	-0.50	50.0	Impact due to civil structures will be nominal
15.	Land use and Soil Characteristics	Provision of civic amenities	3	Domestic Waste Disposal	Adverse	0.10	Domestic waste will be generated by labour engaged during construction phase	-0.50	50.0	Mitigation measure such as toilet facility with septic tank shall be provided to minimize the impact
16.	Land use and Soil Characteristics	Vegetation Plantation	4	Beneficial effect on land as it improves aesthetics and provides shelter for wildlife	Beneficial	0.20	Moderate impact due to potential for soil erosion prevention	0.20	15.0	The proposed greenbelt will help to restrict the soil erosion
Community health, safety and security										
17.	Health	Transportation	2	Deteriorates health due to Air & Noise Pollution	Adverse	0.10	Insignificant increase in transportation activities	-0.15	30.0	Lower impact envisaged
18.	Health	Provision of civic amenities	3	Affects health through disposal of sewage on open land causing mosquito breeding & water borne diseases	Adverse	0.10	Less significant in comparison to plant operation	-0.15	30.0	Spray in Water Reservoir Area and STP will reduce the potential for water borne diseases and mosquito nuisance is high during pre-mitigative stage
19.	Health	Improvement in the medical facility	5	Ambulance and Other facility will improve the regional medical facility	Beneficial	0.10	Less significant as compared to the effects due to vegetative plantation	0.50	50.0	Ambulance and regular health Camp would be provided by SPL

Sl. No.	Environmental Components	Project Activities	Interaction No.	Impacts	Adverse / Beneficial	RPII values	Remark for RPII	EII Index	EII (%)	Remark for EII
Land Acquisition and Involuntary Resettlement										
20.	Human Resettlement	Power generation operations	1	Five villages will get affected due to the project	Adverse	1.00	Significant as Five villages will get affected due to the project	-0.70	65.0	Compensation will be provided as per approved R&R Policy R&R will be done to regain the original social conditions
Bio-diversity Conservation and Sustainable Natural Resource Management										
21.	Flora	Power generation operations	1	Impact due to air pollution over larger area	Adverse	0.40	The power plant will release gases	-0.25	40.0	Following control measures shall be adopted during Operation Phase: • ESP to control SPM emission upto 50 mg/Nm^3 • Low NOx burner to control the NOx emission
22.	Flora	Transportation	2	Adverse impact of dust and fumes emission due to vehicular traffic	Adverse	0.10	Dust and fume generation during vehicular movement is low	-0.25	40.0	Low potential for negative impact on flora & yield of crop could be anticipated
23.	Flora	Construction of Plants/Civil Structures	3	Deforestation	Averse	0.30	Proposed site consist approx. 793 acres of forest area	-0.15	25.0	Compensatory Afforestation in 1586 acres. of land
24.	Flora	Vegetative Plantation	4	Creation of vegetative habitat	Beneficial	0.20	This interaction has high significance	0.10	20.0	Significant Plantation is proposed
25.	Wild Life	Power generation operations	1	Adverse through Air & Noise Pollution and habitat destruction	Adverse	0.50	Interaction has high significance	-0.25	40.0	Attempts shall be made to keep the noise and other pollutants within the prescribed standards
26.	Wild Life	Transportation	2	Adverse effect due to air and noise pollution	Adverse	0.15	Not Significant	-0.10	20.0	Less significant as proper transportation

Sl. No.	Environmental Components	Project Activities	Interaction No.	Impacts	Adverse / Beneficial	RPII values	Remark for RPII	EII Index	EII (%)	Remark for EII
										system shall be developed
27.	Wild Life	Green belt & Plantation	3	Habitat be created	Beneficial	0.35	Interaction has less significance than Air and Noise Impacts	0.10	20.0	Proposed plantation and compensatory afforestation will provide food and habitats
28.	Surface Water Resources	Power generation operation	1	GBPS will be the source of raw water for plants	Adverse	0.45	High significance as compared to interaction No. 3	-0.70	70.0	Large amount of water is required for power generation
29.	Surface Water Resources	Disposal of Waste Water	2	Surplus wastewater, after treatment, will be disposed	Adverse	0.45	Significant as wastewater will be disposed into the water body	-0.30	30.0	• Effluent treatment plant will established to meet the waste water standard • Water will be recycled as far as possible • Treated waste water will be used for green belt and dust suppression
30.	Surface Water Resources	Provision of civic amenities	3	GBPS water will also be used for domestic purpose in plants	Adverse	0.10	This interaction is less significance	-0.20	20.0	Lower impact as water consumption is relatively low
31.	Ground Water Resources	Plant operation and civic amenities	1	Ground water will be used for the construction phase	Adverse	1.00	As construction phase requires extraction of ground water	0.50	50.0	Use of groundwater will be limited during construction phase only.
Indigenous Peoples										
32.	Public Utilities	Power generation operations	1	Improved Public Utility Services and amenities in the area, e.g. Power Supply, Road Network, Water Supply, Sanitation,	Beneficial	0.60	Much significant as it covers the surrounding villages	0.50	50.0	SPL will facilitate improvement of amenities

Sl. No.	Environmental Components	Project Activities	Interaction No.	Impacts	Adverse / Beneficial	RPII values	Remark for RPII	EII Index	EII (%)	Remark for EII
				Medical Facilities & Communication						
33.	Public Utilities	Transportation	2	Provides better transportation System, Road Network and vehicular movement	Beneficial	0.20	Less significant than interaction 1	0.30	30.0	Access roads will be made to the project area, which will also be available to surrounding habitants
34.	Public Utilities	Provision of civic amenities	3	Provides Water supply, Sanitation, Power Supply, Medical facilities and communication to the employees	Beneficial	0.20	Civic amenities will be provided to employees only	0.10	10.0	Limited to the employees and work force during premitigative stage
35.	Economic Aspects	Power generation operations	1	Increased employment opportunities, both direct and indirect, thereby increasing economic status	Beneficial	0.60	Significant potential of Direct as well as Indirect Employment	0.60	60.0	Indirect and Direct employment, plus availability of power will enhance economic activities
36.	Economic Aspects	Transportation	2	Increased indirect employment opportunities and thereby increase in the economic status	Beneficial	0.30	Comparatively less influential interaction	0.50	50.0	The proposed plant activity will increase a number of Indirect Employment
37.	Economic Aspects	Provision of civic amenities	3	Increased employment both by direct and indirect ways. Employment in commercial services improve economic status of people	Beneficial	0.10	Employment is restricted to limited persons in commercial services	0.20	20.0	Marginal job opportunities are envisaged
38.	Human Settlement	Power generation operations	1	Environmental degradation due to increase in population, impacting natural resources	Adverse	0.50	Significant Importance	-0.20	15.0	Influx of People in the project influence area
39.	Human Settlement	Provision of civic	2	Increased employment opportunities in	Adverse	0.20	Less significant	-0.20	15.0	The employees will be settled in the SPL Staff

Sl. No.	Environmental Components	Project Activities	Interaction No.	Impacts	Adverse / Beneficial	RPII values	Remark for RPII	EII Index	EII (%)	Remark for EII
		amenities		service sector, increase in population density in and around plant						Colony
40.	Human Settlement	Transportation	3	Increased population puts the strain on existing transport facilities	Adverse	0.30	Transportation is moderate	-0.20	15.0	Low significance as marginal increase will take place
Cultural Heritage										
41.	Culture	Power generation operations	1	Influx of people of various culture will have substantial effect on local culture	Adverse	0.50	Moderate Impact due to Influx of people	-0.10	10.0	Low impact due to chances of employees conflict with host community as labor colony has been proposed separately
42.	Culture	Provision of civic amenities	2	The project will create a boom in the economic growth of nearby villagers	Beneficial	0.50	Moderate Impact	0.10	10.0	Project will improve the economic status of the area

TABLE 9.8 - IMPACT MATRIX WITH MITIGATION MEASURES

Impact Area	WEII (RPII X EII)	PIV	Total (WEII X PIV)
Surface Water Resources	-0.470	55.6	-26.13
Ground Water Resources	-0.500	37.0	-18.50
Air Quality	-0.320	92.6	-29.63
Water Quality	-0.250	55.6	-13.90
Noise levels	-0.160	74.1	-11.86
Health	-0.070	55.6	-3.89
Public Utilities	0.380	111.1	42.22
Economic aspects	0.530	55.6	29.47
Land-use & Soil Characteristics	-0.280	37.0	-10.36
Flora	-0.150	111.1	-16.67
Human Settlement	-0.200	55.6	-11.12
Culture	0.000	37.0	0.00
Human Resettlement	-0.700	111.1	-77.77
Thermal	-0.150	37.0	-5.55
Total		**1000.1**	**-161.47**

9.12 ENVIRONMENT ACTION AND MONITORING PLAN

9.12.1 Environment Management Cell: Structure and Responsibilities

A separate environment management cell comprising of a team of experienced and qualified personnel reporting to a very senior level executive preferably an environmental engineer is proposed. He/She will be assisted by well trained staffs comprising of environmental and safety specialists.

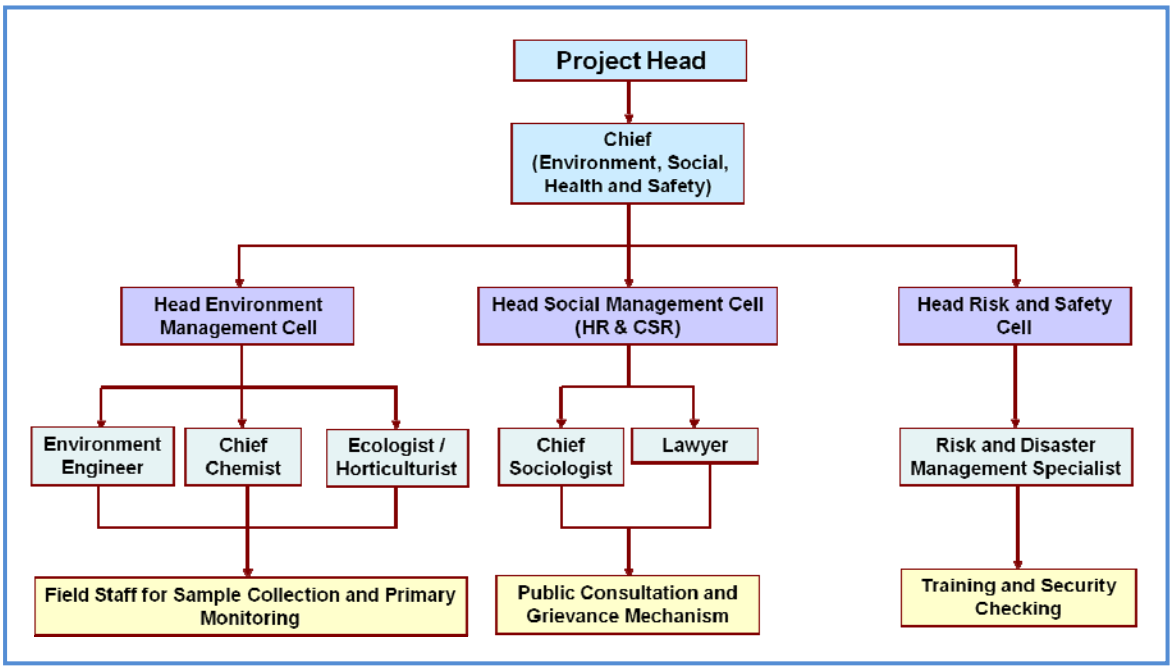


Fig 9.3- Environment Management Cell

Staff will be trained for environment control measures like air, water quality monitoring, solid waste management, noise abatement etc. Staff would also be trained to operate ESP and other pollution control equipment at optimum efficiency.

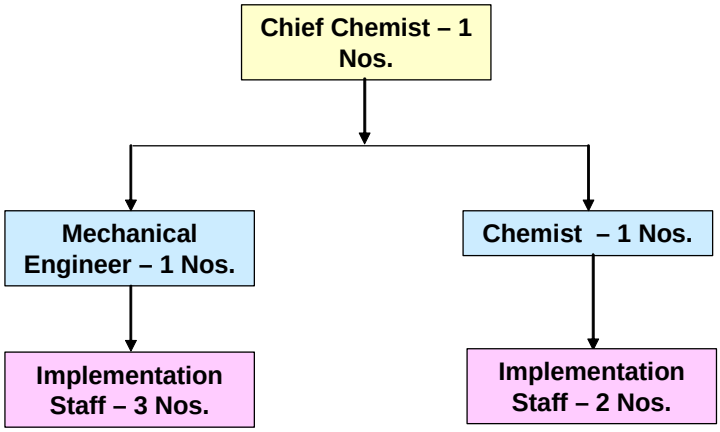
The Environment Management Cell will be responsible for following activities related to environment function of proposed Power Plant:

- Coordinate and manage the EMP implementation during pre-construction, construction and operation phase
- Appoint dedicated environment staff to manage environmental monitoring responsibilities
- Manage and coordinate environmental monitoring and control
- Coordination with other sections of the plant and government agencies in relation to environmental management activities
- Implement and monitor ecology protection and plantation activities
- Safety specialist will ensure safe working practices in all the sections of the plant

9.12.2 Implementation of Environment & Social Management System (ISO 14000)

A structured and certified environment management system is suggested at the industry level for ensuring that all the activities, products and services conform to the environmental and social requirement. Environmental and Social Management System and its set up, role and responsibilities will be based on the requirement as per ISO 14000 certification. The company is also committed to pursue Occupational Health and Safety Assessment System OHSAS 18001 to be certified by national and international certifying agencies. These shall include latest international technologies and practices.

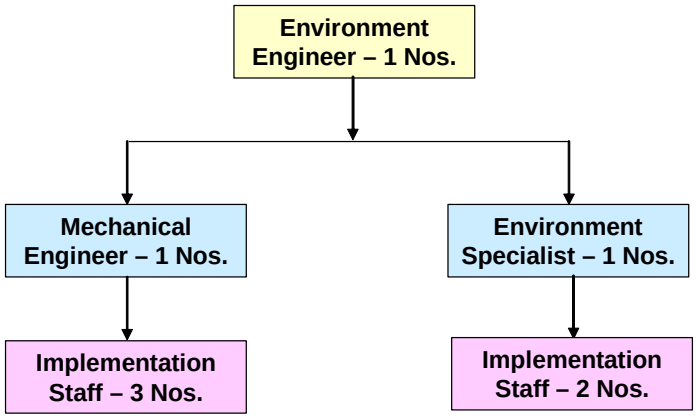
Implementation Team for SOIL and WATER Mitigation Measures & Monitoring



Responsibilities

Chemist	• Will have post-graduate degree in Industrial Chemistry • Will responsible for Co-ordination and Implementation of Monitoring Plan • Will ensure effluent disposed is as per specified Norms
Mechanical Engineer	• Will ensured the implementation of mitigation measures • Will responsible to proper working of diffuser system, ETP and other mitigative instruments used for water Pollution Mitigation

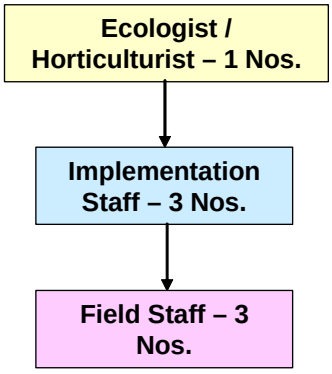
Implementation Team for AIR and NOISE Mitigation Measures & Monitoring



Responsibilities

Environment Specialist	• Will have post-graduate degree in Environment Science • Will responsible for Co-ordination and Implementation of Monitoring Plan • Sample collected by field staff will be analyzed by his.
Mechanical Engineer	• Will ensured the implementation of mitigation measures • Will responsible to proper working of ESP, Low NOX burners and other mitigative instruments used for Air Pollution Mitigation

Implementation Team for Ecology Mitigation & Monitoring



Responsibilities

Ecologist / Horticulturist	• Will have post-graduate degree in Forestry / Agriculture Science • Will responsible for Co-ordination and Implementation of Green Belt
Implementation Staff	• Responsible for implementation of Green Belt • Seeding and Plantation

9.12.3 Environment Monitoring Plan

TABLE 9.9: ENVIRONMENT MONITORING PROGRAM

Aspect	Parameters	Frequency	Location	Equipment used
Ambient Air Quality	RPM, SO_2, NO_X, PM 2.5	Twice in a week and 24 hour at each station	Five sites within the Impact area, including plant site	Respirable dust Sampler
Stack Emission	SPM, SO_2, NO_X	Continuous	Each Stack	In-situ continous monitors
Meteorology	Temperature, wind speed and direction, Relative humidity, Rainfall, atmospheric temperature	Continuous on hourly basis	One site inside the plant	Anemometer with data logger and printer facility, thermo hygrograph, Rain gauge
Surface water quality	Physical, chemical and biological parameters including heavy metals	Quarterly	4 locations within the impact zone including GBPS	Standard laboratory Equipment
Ground water quality	Physical, chemical and biological parameters including heavy metals	Quarterly	4 stations with ash disposal area	Standard laboratory Equipment
Plant effluents	Physical and chemical properties including heavy metals	Monthly		Standard laboratory Equipment
Soils	Physical and chemical parameters with organic content and heavy metals	Once in a years	Around ash disposal site	Standard laboratory Equipment
Noise level	Noise	Once in a week	Five station close to air quality monitoring stations	Noise level meter
Ecology	Visible damage to crops, forest density	Yearly	2	Team of Ecologist

SPL will ensure independent monitoring and reporting requirements under the Equator Principles, Performance Standards on environment and social requirements and other Project covenants.

9.12.4 Environment Action Plan

TABLE 9.10: ROLES AND RESPONSIBILITIES WITH MONITORING PLAN

Project Activities / Aspects	Associated Impacts	Mitigation – Action Plans	Audit / Monitoring Frequency	Responsibility
Pre-Construction and Construction Phase				
Land Acquisition	Loss of land, livelihood, assets etc. broader socio-economic impacts	• Compensation for Land is being provided as per approved R&R Policy	• Regular Grievance Mechanism	Grievance Redressal Committee
		• Community Development Programme for the project	• Grievance Redressal system is set-up • SPL is already working in the field for community development	SPL
Influx of Labour Force	Potential disturbance to the social and cultural fabric of the affected nearby villages due to migratory labour	• Labour camps will be set-up within the plant site	• Regular check-up of daily needs	Contractors
		• SPL stipulates in its labour contracts that preference will be given to hiring local labourers first and then to outside labourers	• As far as possible Local labour will be contracted	Contractors and SPL Management
		• Regular check to control interference of labour force with local people	• Proper HR policy for construction labour.	Social Management Cell of SPL
	Potential Adverse sanitation conditions due to influx of migratory labour	• Proper sanitation facilities will be provided	• Sewage Treatment Plant will be set-up during construction phase • Awareness programmes on various communicable disease, hygiene etc.	Contractors & SPL
Water Supply	Water Quality Degradation and water borne disease	• Ground water will be used for construction purpose	• RO system will be established for potable water purpose	SPL
Establishment of building, Storage	Soil Quality degradation	• The topsoil removed for the purpose of construction will be stored properly	• Stored Top Soil will be reused later for green-belt development.	Contractors & SPL

Project Activities / Aspects	Associated Impacts	Mitigation – Action Plans	Audit / Monitoring Frequency	Responsibility
facilities, workshop for maintenance of vehicles and Machinery / Equipment	Use of toxic substances such as paints, solvents, wood preservatives, and sealants will be used	• The wastes generated will be stored in sealed containers, labeled. • Efforts will be made to use less of hazardous chemicals during rainy seasons and special care taken to store these materials.	• Appropriate disposal plan will be established as required by the Hazardous Waste Storage, Handling and Transportation Rules of Environment Protection Act 1989. • Employees and contractors will be educated to handle hazardous wastes and materials.	Contractors and SPL
	Effluent discharge	• Waste water through fabrication of concrete and related water usage	• Care will be taken to avoid water pollution problems during rainy season due to washout of waste material	Contractors and SPL
	Fugitive dust emission	• Regular water sprinkling	• Care will be taken	Contractors and SPL
Vegetation Clearance	Soil erosion	• Green belt will be developed	• Native species will be introduced	SPL
Transportation / Vehicular Movement	Congestion on road may cause public inconvenience	• Subsidiary roads shall be constructed as appropriate, • Instruct drivers of trucks/ dumpers to give way to buses, cars etc. • Transport of construction materials and machinery shall be carried out during lean traffic period of the day or during night	• Proper Traffic Management Plan will be introduced	SPL
Construction Equipment Operation	Noise generation	• Provision of acoustic cover on construction machinery	• Regular Maintenance Check-up	Contractors and SPL
Operation Phase				

Project Activities / Aspects	Associated Impacts	Mitigation – Action Plans	Audit / Monitoring Frequency	Responsibility
Project Process	Air Pollution	• Electrostatic Precipitators • Low NO_X burners • 200 m Green belt is in the western corner of the project site • 50 m wide greenbelt all around the ash pond area	• Five site within the Impact area, including power plant site will be monitored on regular bases • Stack emission will be monitored on regular species	Environment Cell and appointed agency for monitoring
	Water Pollution	• Effluent will be disposed after treatment	• 4 Surface and 5 ground water (including ash pond area) will be checked on regular basis • On-line monitoring of effluents	Environment Cell and appointed agency for monitoring
	Solid Waste	• Fly ash will be utilized for cement manufacturing • Bottom ash will be used as a filler material for low lying area.	- Periodically	Environment Cell
	Noise	• Acoustic enclosure will be provided • 50 m wide green belt to attenuate the noise	• Proper Maintenance of equipment	SPL Administration and EMC
	Social - Issue	• Public consultation • Medical Facility • Education Facility • Community Development	• Grievance Redressal system • Community Development Cell	HR Department and appointed agency for monitoring
Use of Hazardous Materials	Safety and Security Issue	• Workers shall be provided with proper PPE • Accidents and Diseases monitoring • Monitoring Ambient Conditions in Work Place • First Aid Facilities • Training Programmme	• Grievance Redressal Cell • Training Cell	EHS Deptt

Proper mechanism for independent review will be put in place to evaluate the functioning of the Grievance Redressal cell & Implementation of Regulatory Norms specified by CPCB / MoEF and International Banks/ Financial Institution on an annual basis.

9.13 RESETTLEMENT ACTION PLAN

9.13.1 Resettlement and Rehabilitation

Resettlement and Rehabilitation of the affected villages in a satisfactory manner is necessary for smooth project operation. Sasan Power Limited on its part has taken special care to provide a special package of compensation (already approved by Govt.) to project affected persons based on the central and state government guidelines. (**Refer R&R Document**).

The resettlement and rehabilitation plan incorporates provision made for the Tribal peoples residing in the plant area.

9.13.2 Compensation / Benefits to Displaced Families

As per approved SPL R&R Policy, displaced families will be provided the following compensation (apart from compensation legally due under Land Acquisition Act depending on category of the family/ person).

TABLE 9.11- REHABILITATION ENTITLEMENTS – ONE TIME PAYMENT

Category of Displaced Family	Rehabilitation Entitlements
Families whose land is acquired	• Families of small & marginal farmers to get Rs 15,000 for 1 year as rehabilitation allowance • Other land owner families to get Rs 7,500 for 1 year as rehabilitation allowance
Landless families, who do not own any farm land	• Rs 15,000 for 1 year as rehabilitation allowance to agricultural labour families. • Rs 7,500 to other landless families.
SC/ST displaced families	• Rs 15,000 for 1 year as rehabilitation allowance
Families whose house is being acquired	• Families have the options to take plot and/or house and/or cash compensation in lieu thereof • Free transportation facility for each displaced family within 25 km., Shifting Charges Rs. 1000 for each eligible displaced family. Dismantling Charge as applicable. • Residential plot of 60' x 90' is being provided together with a ready to use house.

9.13.3 Replacement Value Compensation

Compensation is being provided on the basis of present market value as defined by Land Acquisition Act, 1894. In addition to this as per approved R&R policy, displaced families are being provided the compensation on replacement value (apart from the compensation legally due under LA Act) depending on category of the family / person.

SPL is also providing the following long term benefits to affected persons

9.13.4 Old age Pension

Every displaced person, who has the age equivalent or more than 60 years is being provided with old age pension of Rs. 1000/month. This pension will be separate from the govt. pension.

9.13.5 Employment & Training

Priority is being given to affected persons and local population and endeavours are being made to provide

Chapter-9: ESMMP
Process and technology proposed to mitigate the adverse impact on Environment during the Construction and Operation activity are described in this chapter. Chapter also provides the details about emergency response plan including management Social issue.

employment opportunity for at least one person from the displaced families. Adequate provisions have been included in project tenders for contractors / sub-contractors to give priority to employ affected persons in construction and other works. Labor co-operatives of affected persons are encouraged. Shops in the employee township have been reserved for affected vulnerable persons

Displaced persons, especially educated unemployed youth, are being provided industrial training free of cost in various skills such as masonry, carpentry, welding, etc. Vocational training is being provided to affected persons for self-employment opportunities. Training is provided to women to encourage self employment.

9.13.6 Education Stipend

SPL is providing free education for children of affected families. For this purpose a school run by a professional organization "DAV" has been established. Presently about 600 students are attending this school.

To encourage families to send their children to schools, education stipend to school going children is being provided by SPL. The details of the same are given in **Table 9.12**. To encourage girl child education, SPL is providing higher education stipend to girl students.

TABLE 9.12- EDUCATION STIPEND PER MONTH

Class	Boys	Girls
1-5	150	200
6-8	200	250
9-10	250	300

Scholarships will also be provided to meritorious students for higher education

9.13.7 R & R Colony Facilities Provided to Affected People

To minimize inconvenience to affected families, SPL has constructed a R&R colony with all basic amenities to resettle the affected families. SPL is providing ready to move-in houses on 5400 sq ft residential plot. The house has been constructed with all basic amenities such as sanitary toilet, kitchen, smokeless chulha, electrical fitting, etc.

A health centre has also been setup in the colony. Free medical treatment and medicines is provided at the health centre.

The amenities in R&R colony include:

- Residential Plot
- Houses
- Health Centre
- School & Playgrounds
- Marketplace
- Panchayat Bhawan
- Herd Land
- Religious place
- Library
- Roads,
- Drinking water

- Sanitation facilities
- Electrification – internal & external

The Energy & Resources Institute (TERI), a reputed not-for-profit NGO in India, is assisting SPL and district administration in resettlement of affected persons. TERI personnel have assisted SPL in identifying key stakeholders at both individual and community level in the affected areas and establishing an information dissemination and consultation process with the local population. TERI is also assisting with development of long term sustainable income generation opportunities for the affected people and dovetailing various social programs of the state and central government.

9.13.8 Development of Infrastructure

The project is providing employment to the local population. Even indirect job opportunities will be created outside the project boundary. Many people will find employment in service sector and marketing of day-to-day needs viz. poultry and other agricultural products. The project will improve the basic infrastructure and the people of nearby villages can also use these amenities.

As the project and consequent activities are expected to generate additional employment and income opportunities for the local population, market expansion supported by infrastructural development will spur economic growth in the area. Flow of reliable and adequate power from the project will not only enhance growth in the region, but will also bring about a change in consumption pattern by switching over to other sources of energy. This will ease off burden on existing biomass resource of the area. Consequently, current practice of illegal tree felling in reserve forest areas will be reduced.

9.14 COMMUNITY DEVELOPMENT PLAN

Any industry has a role to play in development of an area in which it works. In most cases, it is difficult to operate and do business without the co-operation of the local communities and other stakeholders. To build a good rapport with the local communities, it is essential to engage the local community along with village level institutions in an ongoing process of consultations and discussions involving the kind of joint initiatives the project can initiate for the sustainable development in the village.

While the entitlement framework and rehabilitation action plan specifically focus on the project affected families, the project proponents see this project as an opportunity to initiate a broader community development programmes in the area. The community development plan is based on the following principles

- Consultations with community members and key stakeholders through all the phases of the project
- Building trust among the company, community members and other stakeholders for successful implementation of the project as well as community development plan
- The project staff will have to develop adequate skills in implementation of the community development plan if it plans to implement the programme.
- The community will demonstrate its involvement in the programme through labour contributions & other means.

9.14.1 Community Development

The project activities would be spread over five villages namely Sidhi Khurd, Sidhi Kalan, Harrahawa, Jhanji Tola and Tiyara. Focus group discussions were held with the

community members-separate discussions with women, Gram Panchayats, men, elderly people- to understand their apprehensions and expectations from the project.

This section presents an outline of the processes that would be adopted for planning and implementation of Community Development Plan (CDP), which would ensure that the apprehensions of the local communities, especially those not directly affected by the project are dealt with. Some major concerns expressed by the larger community included:

- Additional pressure on local resources like water, fuel wood, fresh vegetables, milk etc
- Loss of forests surrounding the villages

9.14.1.1 Stakeholder Consultations

The project proponents would need to initiate an on-going process to engage stakeholders in meaningful consultations. The main stakeholders for the project include;

- Local communities, both directly and indirectly affected by the project:
- The Gram Panchayats
- Local political groups
- The Land Revenue Department

9.14.1.2 Initiate a dialogue with the Gram Panchayat(GP)

Initiating the dialogue with the GP would ensure local support and would also earn the trust of local communities. While initially the meetings would involve only GP members to understand their concerns, gradually the larger community would also be involved in these consultations to gain their support.

9.14.1.3 Trust building measures

While consultations with the community are being held, the project proponents can initiate small confidence building measures to prove their commitment to the community. These measures will also help to mitigate negative vibes, if any towards the project.

9.14.1.4 Developing village specific micro plans for the CDP

The stakeholder consultations will help the project proponent identify the development needs and prioritise them. The project proponents can decide to focus on few of those needs that can be managed at the community and the project. The micro plans would have the following details:

- The issues and problems identified by the community
- Process of selecting the issues that would be addressed by the CDP
- Role and responsibilities of the project proponents, community and the GP.
- Details of the intended beneficiaries

9.14.2 Monitoring & Evaluation of the CDP implementation

To assess the impacts of CDP implementation and to ensure that it is moving in the right direction, it is important that an effective monitoring and evaluation mechanism is put in place. As the onus of CDP implementation would largely be on the GP / community, internal monitoring is essential to monitor that the activities are being implemented within the prescribed time frame and are likely to produce desirable results. An internal monthly monitoring by the community is recommended so that they are able to identify the gaps and make an effort to bring it back on the right track.

9.15 GRIEVANCE REDRESSAL MECHANISM

Central & State guidelines for R&R lay special emphasis on Grievance redressal for addressing concerns/problems of project affected persons who may consider themselves deprived of appropriate compensation, rehabilitation benefits as prescribed under the policy guidelines and or be exposed to other adverse impacts on account of the project.

The company has prepared a framework for redressal of grievances/complaints during all phases of the project. This framework will be continuously monitored & improved as the project moves from one stage to other.

9.15.1 Grievance Redressal Mechanism

Following its policy of building and maintaining strong community relationships, SPL has formulated a Grievance Procedure, in order to proactively manage and appropriately address complaints/ concerns/ grievances of the community during its different phases (i.e., planning, construction and operation).

As a part of the grievance redressal, SPL will perform the following actions.

- Continuously collect and analyze complaint/grievance related data and
- Disseminate this information into its organizational set up
- Review and upgrade exiting impact mitigation plans; and
- Develop new mitigation plans as required

In addition, this procedure will help to improve the project social performance. This is because the number and nature of received complaints including punctuality, nature and effectiveness of grievance redressal are indicators of the manner in which the Project is implemented and the behavior of employees and contractors.

SPL's senior management team is also meeting project affected persons on a regular basis to address their grievances.

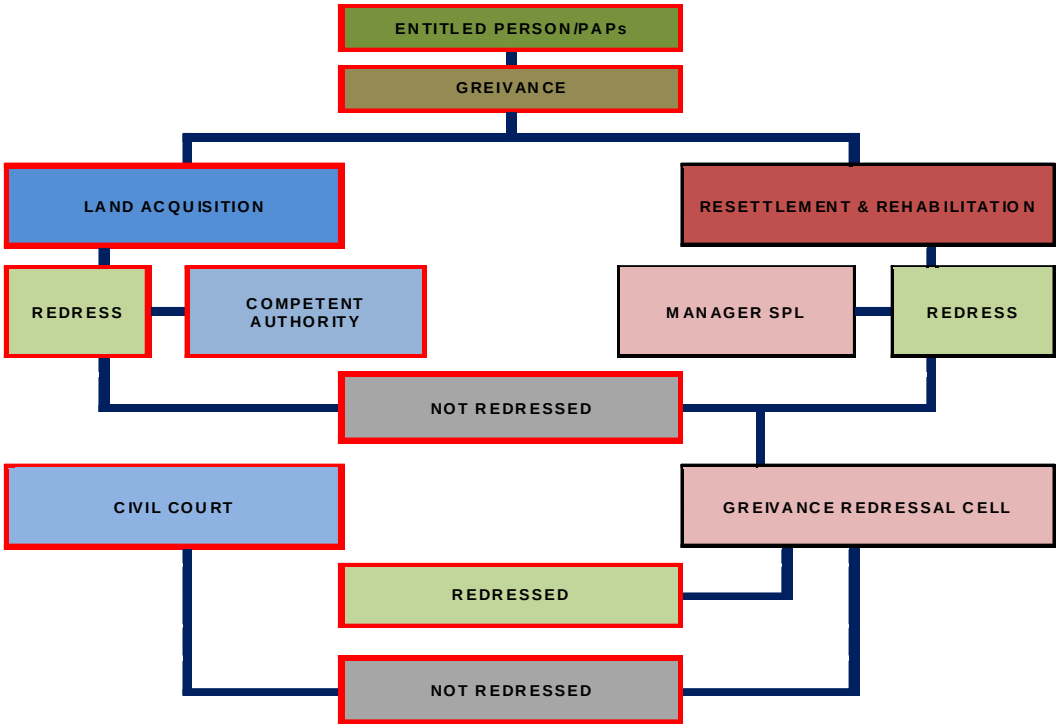


Fig 9.4: Grievance Redressal Cell

Client: Sasan Power Limited,
A wholly owned subsidiary of Reliance Power Limited
Consultant: GIS Enabled Environment & Neo-graphic Centre (GREENC)

9.16 DISASTER MANAGEMENT PLAN

Disaster management planning includes identification of possible scenarios such as fire and explosion and ensuring preparedness.

A plan will be prepared to minimise the damages caused to plant property, vegetation and human beings. The main objectives of the plan include :

- Identification of the locations (sources of hazards) determining the likely effects from the sources.
- Mitigation of the degree of damages caused to property in and outside the plant area.
- Evacuation of the workers/staff from affected areas to appropriate assembly points.
- Providing medical treatment
- Ensuring timely rehabilitation of affected areas

9.16.1 Onsite Disaster Management Plan

9.16.1.1 Emergency Arrangements

The on-site emergency plan is in line with the requirements of the Directorate, Industrial Health and Safety, Government of Madhya Pradesh and IFC. The plan also meets the requirement of other concerned agencies.

9.16.1.2 Emergency Equipment

Alarm

Sirens are being provided at various locations fairly distributed in and around the plant and residential areas.

Emergency light

These lights are provided at different plant locations.

First Aid Box

First aid boxes are provided to fire office and other departments.

Loud-speaker and Telephone

Loudophone systems are provided in the plant and internal telephone system will also be available in different departments.

Information and Warning

Relevant information related to hazard and safety precautions are conveyed through notice board, stickers, circular, literature / booklet. In case of an imminent hazard, announcement will be made on cable TV.

Emergency Vehicles

Ambulances will be provided which includes one (1) shift vehicle available at short notice.

Chlorine Detection System

Chlorine gas detection system will be provided to detect the leakages in water treatment plant. Chloralarm consist of a control unit and a sensor. On the face of the control unit, luminous diodes, indicator, reset, failure and test buttons are mounted. The cell consists of two platinum electrodes encircled by a wick. The cell is connected to control unit through a coaxial cable.

In the event of chlorine leak, an electrochemical reaction is triggered on. The electric current generated by such an electrochemical reaction is proportional to the chlorine gas concentration in the air. The concentration of chlorine gas present at any time in the room, is visually indicated on a 0-5 ppm scale.

Adequate number of fire extinguishers and water hydrants are provided at different locations of plant to meet the need during emergency.

Safety Appliances

Adequate number of safety appliances i.e. hand gloves (leather), asbestos, electricals, canvas and acid/alkali proof), apron (leather, rubber, canvas, chemical, asbestos with face shield), asbestos suit, welders hand screen, welders face shield, safety shoes, face masks, ear muffs, ear plugs, safety belt, helmets, safety goggles (welders, dust and chemicals), self containing breathing apparatus (oxygen cylinders), air line respirator, canstor gas masks, respirator air purifying (chemical castridge), gum boots and rain coats will be provided to the workers.

9.16.1.3 Organization

Safety

As per requirements of Factories Act, Chief Safety Officer and two safety officers will be posted. Chief Engineer will constitute the safety committee for the plant complex.

The committee will comprise Safety Officer, Fire Officer, Security Officer, Site Engineer, Medical Officer and other members. The Chief Safety officer will be the secretary of the committee.

Fire Fighting

A full fledged fire fighting department headed by a qualified fire officer and sub-fire officer alongwith trained staff in the fire fighting department is in place.

Fire Protection System

For providing protection against fire, all yard equipment and plant equipment will be protected by a combination of hydrant system; automatic sprinkler spray system (emulsifier system); fixed foam system for oil handling areas; automatic high velocity and medium velocity sprinkler spray system; auto-modular inert gas based system for control rooms apart from portable and mobile fire extinguishers located at strategic areas of plant buildings and adequate Passive Fire Protection measures. The systems will be designed as per the recommendations of NFPA or approved equals in accordance with the Tariff Advisory Committee of the Insurance Association of India stipulations.

In view of vulnerability to fire and its importance in the running of the power station, effective measures will be taken to tackle fire in the susceptible areas such as cable galleries; fuel oil handling areas; coal handling plant areas including transfer points, crusher houses and tunnels, etc. For containment of fire and preventing it from spreading in cable galleries, unit wise fire barriers with self-closing fire doors will be provided. In addition, all cable entries / openings in the cable galleries, tunnels, floors will be sealed with non-inflammable/fire resistant sealing materials.

Adequate separating distances will be maintained between different process blocks and hazardous equipment. To prevent fire from spreading through ventilation and air conditioning ducts damper a appropriate location with auto closing arrangements will be provided. Fire water pumps will be installed in the filtered water pump house. In the filtered water storage tank, water will be stored as dedicated dead storage for meeting fire water requirement in exigencies. The details of system are provided as follows:-

- Electric motor driven fire water pumpsets of adequate capacity along with identical capacity and head diesel engine driven backup fire water pumps of identical capacity will be provided for hydrant and sprinkler system in addition to Jockey pumpsets having adequate capacity which would be brought to operation automatically when hydrant pressure drops. In addition to these pumpsets, other auxiliaries for the fire protection system such as hydro-pneumatic tanks, compressors, pipe work, valves etc will be provided as required.

  The hydrant system will feed pressurized water to hydrant valves located throughout the plant and also at strategic locations within the power house.

- Automatic high velocity sprinkler spray protection system will be provided for generator transformers, unit auxiliary transformers, station service transformers, and turbine oil storage tanks.

- Automatic medium velocity sprinkler protection system actuated by heat detectors, strategically located, will be provided for cable galleries and coal handling areas such as coal conveyors, transfer points, crusher houses etc. The ventilation system provided in cable galleries will be so interlocked with the fire alarm system that in the event of a fire, the ventilation system would be automatically switched-off.

  Automatic medium velocity sprinklers will be used for protection of burner zone of each of the boilers.

- Fuel oil tanks in the fuel oil farm area will be provided with spray water system as well as fixed foam mechanical system to extinguish accidental fires in tanks as well as outside in the dyke.

  Water for foam system will be drawn from the plant hydrant system. Adequate numbers of hydrant points will be distributed near the oil tank farm area. Fire hoses fitted with couplings and nozzles will be located suitably at the oil station and kept in hose boxes.

- Automatic inert gas based flooding type extinguishing system will be provided for unit control room areas independently, apart from the provision of detection and fire alarm system in that area.

  Suitable fire detection system will also be provided at cable vault rooms, unit control rooms and other MCC rooms etc to detect outbreak of fire at an early stage.

- Adequate number of fire hydrant points will be distributed through out the plant building, service building, coal handling plant, ash handling plant and other areas along with fire hoses fitted with couplings and nozzles and kept in the hose boxes.

In addition to the above facilities, adequate number of manual call points; as well as portable and mobile (wheel mounted) fire extinguishers of soda acid type; foam type; chemical type; and carbon-dioxide type will be provided at suitable locations throughout the plant area to meet NFPA code as well as Tariff Advisory Committee stipulations. These extinguishers may be used during the early stages of fire to prevent from spreading.

Fire tenders will be located and kept in readiness complete with all accessories at fire station located close to fire control room.

Emergency Control Centre

There will a Fire-Safety Department in the plant premises with fire fighter and other appliances.

Security and Traffic Control

The plant will have a separate security department headed by a security officer. This department will be responsible for traffic control and in case of emergency it will also take control at the emergency site. Trained security staff stationed at main gate will come to site of assistance.

Medical Facilities

Medical facilities will be made available in the campus which will consist of medical officers including one lady medical officer. In addition, trained nurses and compounders will also be attached to the hospital.

9.16.1.4 Communication

Emergency planning and information to the employees / public are the measures primarily designed to mitigate the consequences of any major incident, though the probability of a major accident will be remote. However, an emergency planning for intervention during escalation will be necessary.

9.16.1.5 Disaster Preventive Measures

The disaster preventive measures include all those tasks that can be undertaken to prevent minor accidents from turning into a major disaster.

Following preventive measures are envisaged during expansion phase.

- Design, manufacture, and construction of all plant machineries and buildings will be as per national (IS, TAC) and international (NFPA) codes as applicable in specific cases and laid down by statutory authorities.
- Provision of adequate access for movement of equipment and personnel will be made.
- A minimum of two numbers of gates for escape during disaster will be provided.
- An emergency assembly point in the vicinity of main plant entrance.
- Water spraying arrangements in fire sensitive areas

The proposed plant will be designed with adequate inbuilt measures / precautions to prevent the occurrence of disaster and its further propagation.

The main power house building will be a steel framed structure with brick walls, RCC floors and RCC slab roof and provided with suitable water proofing arrangement.

The doors and windows will be metallic with glazing to avail of natural light. The auxiliary and ancillary buildings will be RCC framed structure, RCC roof slabs and brick walls.

Safety Department

The department will conduct regular safety awareness courses by organising seminars and training of plant personnel.

9.16.2 Offsite Emergency

Following condition can ordinarily constitute an off-site emergency:

- Heavy release of chlorine, due to rupture of the shell, explosion in chlorine cylinder due to fire, or otherwise; resulting in it spread to neighboring areas.
- Major fire involving combustible materials like oil, and other facilities.

Under the Environmental Protection Act, the responsibility of preparation of Off-Site Emergency plan lies with the state government. The Collector/ Deputy Collector are ordinary nominated by State Government to plan Off-Site Emergency Plan.

The District Collector or his nominated representative would be the team leader of planning team, who shall conduct the planning task in a systematic manner. The members of planning team for off-site emergencies are Collector / Deputy Collector, District Authorities in charge of Fire Services and police and members drawn from Medical Services, Factory Inspectorate, Pollution Control Board, Industries and Transport. In addition to these members, there are Co-opted Members also from district authorities concerned, civil defense, publicity department, Municipal Corporation, and non-official such as elected representative (MPs, MLAs, voluntary organization, non- governmental organizations etc).

In an extremely rare event of massive disaster which will have potential to affect areas outside the plant premises it needs to be informed to the district authorities responsible for the preparation and implementation of offsite disaster plan.

The measures will include:

- Allocation of duties among power plant fire brigade, city fire brigade, police, auxiliary forces.
- Co-operation between plant and city fire brigade.
- Setting up of control stations.
- Warning of population with sirens, by radio, television or loudspeaker.
- Evacuation (if required)
- Setting up of road-blocks, diversion and direction of traffic.
- Keeping roads clear for operational and rescue vehicles.
- Arrangement of medical treatment facilities and transport.

The proposed plant will be designed with adequate inbuilt measures / precautions to prevent occurrence of a disaster and its further propagation.

The plant will be provided with adequate and modern communication facilities which will be of paramount importance for immediate exchange of information within the plant and outside. In a situation well beyond the control of plant administration, like air raids / earthquake, severe flood etc., the plant authorities will have to work in close association with district administration.

9.16.2.1 Post Emergency Relief to the Victims

The Public Liability Insurance Act, 1991 provides for the owner who has control over handling hazardous substances to pay specified amount of money to the victims as interim relief by taking insurance policy for this purpose. The District Collector has definite role in implementation of this act. After proper assessment of the incident, he shall invite applications for relief, conduct an enquiry into the claims and arrange payment of the relief amount to the victims.