# FINAL COMPREHENSIVE ENVIRONMENTAL IMPACT ASSESSMENT REPORT

## FOR

## SIPAT SUPER THERMAL POWER PROJECT, STAGE-III (1 X 800 MW)

## AT

## SIPAT VILLAGE, SIPAT TEHSIL, BILASPUR DISTRICT, CHHATTISGARH

| | | |
|---|---|---|
| **ToR** | **:** | **J-13012/02/2019.IA.I(T) dated: 03.05.2019 & 08.08.2022** |
| **Public Hearing** | **:** | **11.12.2023 at Sipat village, Bilaspur, Chhattisgarh** |
| **Baseline Monitoring Period** | **:** | **March 2019 to March 2020 & March 2023 to May 2023** |

## VOLUME-I
## MAIN REPORT

**Project Proponent :**

**M/s. NTPC Limited, New Delhi**
**(A Government of India Enterprise)**

**Prepared by :**


**MANTEC CONSULTANTS PVT LTD**
*(QCI Accredited EIA Consultant at S.No.162 as per list of Accredited Consultant Organizations/Rev.24/July 05,2022)*
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**January, 2024**

एनटीपीसी NTPC
A Maharatna Company

एन टी पी सी लिमिटेड
(भारत सरकार का उद्यम)
NTPC Limited
(A Govt. of India Enterprise)

केन्द्रीय कार्यालय / Corporate Centre

**Ref.No.: CC: ESE: 9518:2024: EC** **Date: 27.01.2024**

## UNDERTAKING BY PROJECT PROPONENT

M/s. NTPC Limited has complied with all the prescribed Terms of Reference (ToR) issued by Ministry of Environment, Forest & Climate Change (MoEF&CC) vide letter no. J-13012/02/2019-IA.I(T) dated 03.05.2019 and amendment dated 08.08.2022 for Sipat Super Thermal Power Project Stage-III (1x800 MW) at Village Sipat, District Bilaspur (Chhattisgarh).

We undertake that the information and data provided in the EIA report and submitted to the Ministry are factually correct and project proponent is fully accountable for the same.

For NTPC Limited.

Vijay Prakash
27/01/2024

**(Dr. Vijay Prakash)**
**ED (EMG, Envt. Engg. & Ash Utilization)**

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# Undertaking by Head of the ACO/ Authorized Person

I, A. S. Brara, hereby, confirm that the EIA report of "**Sipat Super Thermal Power Project, Stage-III (1 x 800 MW) by NTPC** has been checked and finalized by Mantec Consultants Pvt. Ltd., Noida.

**Head of ACO / Authorised Person:**

**Name** : Mr. A.S. Brara (CMD)

**Signature**



**Name of the EIA Consultant Organization:** M/s Mantec Consultants Pvt. Ltd., Noida

**NABET Certificate no:** NABET/EIA/2023/RA 0205

**Issue date:** 07th May, 2021

*(QCI Accredited EIA Consultant at S.No.167 as per List of Accredited consultant Organizations/Rev.25/Sept 05, 2022)*

# ANNEXURE-VII (As per NABET format)

## DECLARATION BY CONSULTANTS

**Declaration by Experts contributing to the preparation of EIA –**

I, hereby, certify that I was a part of the EIA team in the following capacity for the EIA report of "**SIPAT SUPER THERMAL POWER PROJECT, STAGE-III(1 X 800 MW), NTPC :**

**EIA Coordinator**

| | |
|---|---|
| **Name** | Mr. A.S. Brara |
| **Signature & Date** |  |

**Functional Area Experts**

| S.No. | Functional Areas | Name of the Experts | Involvement (task & period) | Signature & Date |
|---|---|---|---|---|
| 1 | AP* | Mr. A.S. Brara(FAE) | Checked and Finalized the Air Quality Section |  |
| 2 | WP* | Mr. A.S. Brara(FAE) | Checked and Finalized the Water Quality Section |  |
| | | Mr. Gajanand Mallick(TM) | Checked and Finalized the Air Quality Section |  |

| | | | | |
|---|---|---|---|---|
| 3 | SHW* | Mrs. Rekha Singh(FAE) | Checked and Finalized the Solid & Hazardous Waste Section |  |
| 4 | SE | Mr. Braj Vallabh Pandey(FAE) | Checked and Finalized the Socio-Economic Section |  |
| | EB | Mr. Kamal Kumar Saxena (FAE) | Checked and Finalized the Ecology & Biodiversity Section |  |
| | | Mr. Gajanand Mallick(FAE) | Checked and Finalized the Ecology & Biodiversity Section |  |
| 6 | HG* | Mr. R. K. Khanna (FAE) | Checked and Finalized the Hydrogeology Section |  |
| | | Mr. S.I. Tanveer (FAE) | Checked and Finalized the Hydrogeology Section |  |

| | | | | |
|---|---|---|---|---|
| 7 | GEO* | Mr. S.I. Tanveer (FAE) | Checked and Finalized the Geology Section |  |
| | | Ms. Richa Gupta (TM) | Checked and Finalized the Geology Section |  |
| | | Mr. Kamal Kumar Saxena (TM) | Checked and Finalized the SC Section |  |
| | | Mr. Ajay Negi (TM) | Checked and Finalized the SC Section |  |
| 9 | AQ* | Mr. A.S. Brara(FAE) | Checked and Finalized the Air Quality Section |  |
| | | | | |
| 10 | NV* | Mr. A.S. Brara(FAE) | Checked and Finalized the Noise Quality Section |  |
| 11 | LU* | Mr. Jai Deep Singh (FAE) | Checked and Finalized the Land Use Section |  |

| | | | | |
|---|---|---|---|---|
| | | Mr. Braj Vallabh Pandey (TM) | Checked and Finalized the Land Use Section |  |
| 12 | RH* | Mr. P.K. Srivastava(FAE) | Checked and Finalized the Risk and Health Section |  |
| | | Mr. Shrinath Kumar (TM) | Checked and Finalized the Risk and Health Section |  |

भारतीय गुणवत्ता परिषद्
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NABET

# National Accreditation Board for Education and Training

# Certificate of Accreditation

## Mantec Consultants Pvt. Ltd., Noida

D-36, Sector-6, Noida, Uttar Pradesh-110019

*The organization is accredited as **Category-A** under the QCI-NABET **Scheme for Accreditation of EIA Consultant Organization, Version 3**: for preparing EIA/EMP reports in the following Sectors.*

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|---|---|---|---|---|
| | | NABET | MoEFCC | |
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| 2. | Offshore and onshore oil and gas exploration, development & production | 2 | 1 (b) | A |
| 3. | River Valley projects | 3 | 1 (c) | A |
| 4. | Thermal power plants | 4 | 1 (d) | A |
| 5. | Petroleum refining industry | 10 | 4 (a) | A |
| 6. | Chemical fertilizers | 16 | 5 (a) | A |
| 7. | Pesticides industry and pesticide specific intermediates (excluding formulations) | 17 | 5 (b) | A |
| 8. | Synthetic organic chemicals industry | 21 | 5 (f) | A |
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| 10. | Isolated storage & handling of Hazardous chemicals | 28 | - | B |
| 11. | Air ports | 29 | 7 (a) | A |
| 12. | Ports, harbours, break waters and dredging | 33 | 7 (e) | A |
| 13. | Highways | 34 | 7 (f) | A |
| 14. | Common Municipal Solid Waste Management Facility (CMSWMF) | 37 | 7 (i) | B |
| 15. | Building and construction projects | 38 | 8 (a) | B |
| 16. | Townships and Area development projects | 39 | 8 (b) | B |

***Note: Names of approved EIA Coordinators and Functional Area Experts are mentioned in RAAC minutes dated September 15, 2023, and Supplementary Assessment minutes dated December 22, 2023 posted on QCI-NABET website.***

*The Accreditation shall remain in force subject to continued compliance to the terms and conditions mentioned in QCI-NABET's letter of accreditation bearing no QCI/NABET/ENV/ACO/23/2942 dated October 11, 2023. The accreditation needs to be renewed before the expiry date by Mantec Consultants Pvt. Ltd., Noida following due process of assessment.*

**Issue Date**
**January 31, 2024**

**Valid up to**
**April 20, 2026**

**Mr. Ajay Kumar Jha**
**Sr. Director, NABET**

**Certificate No.**
**NABET/EIA/23-26/RA 0305_Rev.01**

**Prof (Dr) Varinder S Kanwar**
**CEO-NABET**

*For the updated List of Accredited EIA Consultant Organizations with approved Sectors please refer to QCI-NABET website.*

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# Chapter-1
# Introduction

# 1.0 INTRODUCTION

Power development is a key infrastructural element in the development of the economy. The development of the power sector in the country, since independence of India has been predominantly through the State Electricity Boards formed in each state under the Electricity (Supply) Act 1948, with the responsibility for generation, transmission and distribution of electric power.

NTPC Limited (A Govt. of India Enterprise), is the largest power generating company in India. Government of India (GoI) set it up in November, 1975 with the objective of planning, promoting and organizing integrated development of thermal power in the country. NTPC was the first public sector company to be granted "Maharatna" status. NTPC is now emerging as a well-diversified company on its way of becoming an Integrated Power Major, having entered into hydro power, coal mining, power trading, equipment manufacturing, power distribution business and renewable energy generation.

Present installed capacity of NTPC Group is 73,874 MW (including 15,986 MW through JVs/Subsidiaries) comprising of 51 NTPC stations (27 coal based, 7 gas based, 1 hydro, 1 small hydro, and 15 solar PV) and 39 Joint Venture/Subsidiary stations (9 coal based, 4 gas based, 8 hydro, 1 small hydro, 14 solar PV and 4 wind).

Apart from integrated power development in the country, NTPC always focuses on adoption of efficient and clean technologies for power generation. Starting from sub-critical 200 MW/500 MW units, NTPC has adopted super-critical & ultra-super critical units of 660/800 MW capacity.

Initially, NTPC intended to develop Advance Ultra Super Critical (AUSC) technology under AUSC mission of Govt of India. The Advanced Ultra Super Critical (AUSC) mission of GOI envisages development of indigenous technology for steam parameters of 310 kg/cm$^2$ and 710°C / 720°C temperature under the mission of development of clean coal (carbon) technologies. The proposed unit under Sipat AUSC Stage-III was a Technology Demonstration Plant (TDP), to be developed for the first time in the world and it is not available commercially.

However, in view of the delay in AUSC Project and the delay in decision regarding grant for the AUSC project, NTPC now intends to establish 1x800 MW unit based on ultra super critical technology at Sipat STPP, Stage-III.

## 1.1 Purpose of the Report

As per Environmental Impact Assessment (EIA) Notification dated 14$^{th}$ September, 2006, commissioning or operation of thermal power plants (≥500 MW) falls under category 'A' under project (Type-1(D)) and requires prior Environmental Clearance (EC) to be obtained from MOEF&CC before the commencement of ground activity.

In line with the said notification, online application for TOR (Form-1 & Pre-feasibility report) for EIA study was submitted to MoEF&CC on 29.01.2019 vide

online proposal no. IA/CG/THE/89473/2018. The Terms of Reference (TOR) for AUSC Technology Demonstration Project was accorded by MOEF&CC vide letter J-13012/02/2019-IA.I (T) dated 03.05.2019. An Amendment in TOR was accorded by MOEF&CC vide letter J-13012/02/2019-IA.I(T) dated 08.08.2022 for setup 1x800 MW with Ultra Super Critical Technology Power Plant instead of earlier proposed AUSCTDP of 1X800 MW.

Comprehensive Environmental Impact Assessment (CEIA) report addresses the environmental impacts of the proposed expansion project and the mitigation measures. This report is prepared, based on the TOR conditions received from MoEF&CC. The Comprehensive Environmental Impact Assessment report (CEIA) has been prepared based on the TOR accorded by MOEF&CC. The Copies of TOR, Amendment in TOR & compliance status of TOR are enclosed as **Annexure-I(A) Annexure-I(B)** & **Annexure-I(C)** respectively.

Vimta Labs Limited, Hyderabad, an accredited agency with Quality Council of India (QCI) / National Accreditation Board of Education and Training (NABET) vide registration no. NABET/EIA/2326/RA0301 with validity up to 26.05.2026 is assigned by NTPC to undertake an Comprehensive Environmental Impact Assessment (CEIA) study and prepare Environment Management Plan (EMP).

Further, as M/s Vimta Labs Ltd, has been debarred by Ministry from appearing before EAC vide letter dated 12.12.2022, the final EIA is prepared and submitted by M/s Mantec Consultants (Pvt) Ltd, who is duly accredited by QCI/NABET NABET Certificate Number: NABET/EIA/23-26/RA 0305-Rev01 valid upto 26$^{th}$ April 2026. M/s Mantec Consultants (Pvt) Ltd, have gone through the contents of the EIA report and have agreed to submit the EIA, make presentation before EAC (Thermal) and process the application for accord of EAC further.

The public hearing scheduled on 27.09.2023, got postponed due to unavoidable reasons and Public Hearing was held on 11.12.2023. The advertisement for initial public hearing for Sipat Stage-III (1x800 MW) was published in the local newspaper Haribhoomi, Bilaspur & in the main edition of the national newspaper Hindustan Times, New Delhi on 25.08.2023 & second advertisement published on 25.11.2023. Accordingly, public hearing was held on 11.12.2023 at 12:00 noon at the sports ground of Mandanlal Shukla Government college, Sipat village & Tehsil, Bilaspur District, Chhattisgarh. The proceeding of public hearing and other documents were forwarded by Member Secretary, CECB vide letter no: 8409/TS/CECB/2024, dated 19.01.2024 to MoEF&CC, New Delhi.

The main objective of conducting Comprehensive Environmental Impact Assessment (CEIA) study is to prevent or at least to considerable reduce activities that may have important harmful effects or consequences on the environment and protected areas, thus realising the principles of sustainable development, integrity and prevention.

Comprehensive environmental impact assessment scope covers the following concerns:

- Define or envisages an activity affecting the environment for which an environmental impact assessment needs to be carried out;
- Assessment of the acceptability of impacts on the protected areas according to the regulations governing conservation is required;
- The responsible estimates that their implementation could have an important effect on the environment.

The objective of comprehensive environmental impact assessment is "to provide a high level of protection of the environment and to include environmental aspects in preparation and adoption of management plan in order to promote sustainable development".

## 1.2 Identification of the Project and Project Proponent

### 1.2.1 Project Proponent

NTPC Limited (A Govt. of India Enterprise), is the largest power generating company in India. Government of India (GoI) set it up in November, 1975 with the objective of planning, promoting and organizing integrated development of thermal power in the country. NTPC was the first public sector company to be granted "Maharatna" status. NTPC is now emerging as a well-diversified company on its way of becoming an Integrated Power Major, having entered into hydro power, coal mining, power trading, equipment manufacturing, power distribution business and renewable energy generation.

### 1.2.2 Identification of the Project

#### *1.2.2.1 Project Background*

Environmental Clearance (EC) for Sipat STPP Stage-I was accorded by MOEF vide letter no. J-13011/10/96/IA.II (T) dated 22.02.1999 for capacity of 2000 MW (4x500 MW) and its amendment dated 30.04.2002 due to change in configuration from 4x500 MW to 3x660 MW.

Environmental Clerance (EC) for Sipat STPP Stage-II accorded by MOEF vide letter no. J.13011/5/2002.IA-II(T) dated 08.06.2004 for capacity of 1000 MW (2x500 MW).

Details of EC granted and subsequent amendments, Forest Clearance, Consent to Establish, Consent to Operate are given at **Table-1.2**.

*1.2.2.2 Present Proposal*

The present proposal is for installation of one unit of 800 MW as Ultra Super Critical Technology based Project under Stage-III at Sipat STPP.

## 1.3 Brief Description of Project

### 1.3.1 Nature of the Project

Sipat STPP, Stage-III will be a pulverised coal fired thermal power project based on ultra-super critical boiler parameters. The proposal involves construction and operation of one unit of 800 MW. The main components of the project include:

- Steam generator, turbine generator and auxiliary units;
- Coal handling system including dust extraction and suppression system;
- Closed cycle cooling system with cooling towers;
- Water & effluent treatment system;
- Fire protection system;
- Air conditioning & ventilation system;
- Electrostatic precipitators, NOx control and Flue Gas Desulphurisation (FGD) system;
- Chimney;
- Limestone and gypsum storage and disposal facilities;
- Ash handling system with dry ash extraction and wet mix system, storage and disposal facilities; and
- Electrical Systems: Generator bus duct, transformers, switchgears, switch yard etc.

### 1.3.2 Size of the Project

The capacity of the proposed expansion would be 1x800 MW. Existing Sipat STPP has already established a dedicated township. Additional quarters/facilities shall be constructed to accommodate staff of Stage-III. The project will operate round the clock in three shifts of operation. No additional land is proposed to be acquired for the expansion project.

About 160 acres of industrial land is available for locating the unit within the vacant space in the MGR bulb. The land in existing ash dyke is sufficient to accommodate the ash for additional 800 MW unit. The water requirement for Sipat STPP Stage-III (1x800 MW) will be about 2340 $m^3$/hr of water. The coal requirement for proposed Sipat Stage-III (1 x 800) MW is estimated at 3.25 MTPA corresponding to 85% PLF considering GCV of 4000 Kcal/kg.

One double lane road under bridge (RUB) and four-lane road with a level crossing are available for access to this area. This space is adequate for locating the main plant facilities of 800 MW unit. Unit can be easily connected to the existing 765 kV switchyard for power evacuation. The project cost is about Rs. 7,360.11 crores.

1.3.3 Location of the Project

The project is located in Bilaspur district of Chhattisgarh State situated near village Sipat. The Main plant and township are bounded by latitude and longitude of $22^0$07'00" N to $22^0$08"53" N and $82^0$16'43" E to $82^0$18'49" E respectively. Proposed Unit under Stage-III is located between 22°07'37" N to 22°07'06" N and 82° 17' 14'' to 82° 16' 47'' E.

1.3.4 Description of the Project Site

This site is located in Bilaspur district, Chhattisgarh. The topography of the project site is flat with slight undulation. Existing ground level elevation of the proposed thermal power plant ranges from 280 m to 287 m above mean sea level and the general slope is towards north to south.

The site is approximately 20.0 km from Bilaspur city and is approachable via Bilaspur-Baloda state highway, which passes through Sipat. The nearest railway station is Jairamnagar, which is about 3 km from the project site. The nearest commercial airport, Raipur is about 150 km from the project site. The detailed environmental setting of project is discussed in **Table-1.1.**

1.3.5 Justification of the Project

Power is one of the key infrastructural elements for the economic growth of a country. Proposed project is envisaged as a base load station to meet the power demand of Chhattisgarh and other states in Western Region (WR).

1.3.6 Environmental Setting

The environmental setting of the project is given in **Table-1.1**. Index map, study area and google imagery showing 10 km radius are shown in **Figure-1.1**, **Figure-1.2** and **Figure-1.3** respectively.

**TABLE-1.1**
**ENVIRONMENTAL SETTING – 10 KM RADIUS**

| Sr. No. | Particulars | Details | |
|---|---|---|---|
| 1 | Coordinates | Main plant and township | 22° 07' 00'' N to 22° 08' 53'' N<br>82° 16' 43'' E to 82° 18' 49'' E |
| | | Proposed plant (1 x 800 MW) | 22° 07' 37'' to 22° 07' 06'' N<br>82° 17' 14'' to 82° 16' 47'' E |
| | | Existing ash dykes | 22° 03' 39'' N to 22°06'34'' N<br>82° 16' 27'' E to 82° 17' 40'' E |
| 2 | Location | Sipat village, Bilaspur district, Chhattisgarh | |
| 3 | Elevation above MSL | 280-287 m | |
| 4 | Topography | Flat with slight undulation | |

| Sr. No. | Particulars | Details |
|---|---|---|
| 5 | Present land use | Industrial |
| 6 | Nearest village | Janj village (0.7 km, W)<br>Sipat (1.3 km, NNW) |
| 7 | Nearest town | Bilaspur city (20 km, SW) |
| 8 | Nearest highway | State highway (1 km, NW)<br>NH-130 (14.0 km, N)<br>NH-200 (11.2 km, SW) |
| 9 | Nearest railway station | Jairamnagar (3 km, S) |
| 10 | Nearest airport | Raipur (150 km, SSW) |
| 11 | Water bodies | Kurung left canal (Adjacent west side)<br>Lilagarh nadi (3.0 km, E)<br>Kurung nadi (3.5 km, W)<br>Arpa nadi (8.8 km, SW) |
| 12 | Reserved / Protected forests | Bitkuli (Sonathi Pahar) Reserved Forest (3.7 km, NE)<br>Dalha Protected Forest (7.0 km, ESE) |
| 13 | Archeological monument of national importance and defence installation | Nil |
| 14 | National parks/wildlife sanctuaries etc | None within 10 km radius (as per SOI toposheet and satellite imagery) |
| 15 | Interstate boundary | Nil |
| 16 | Nearest industries | Hind Energy (3.3 km, NE) |
| 17 | Seismicity | Zone-II as per IS-1893 (Part-I),2002 |

**Note: All distances mentioned above are aerial distances from the proposed expansion of thermal power plant boundary*

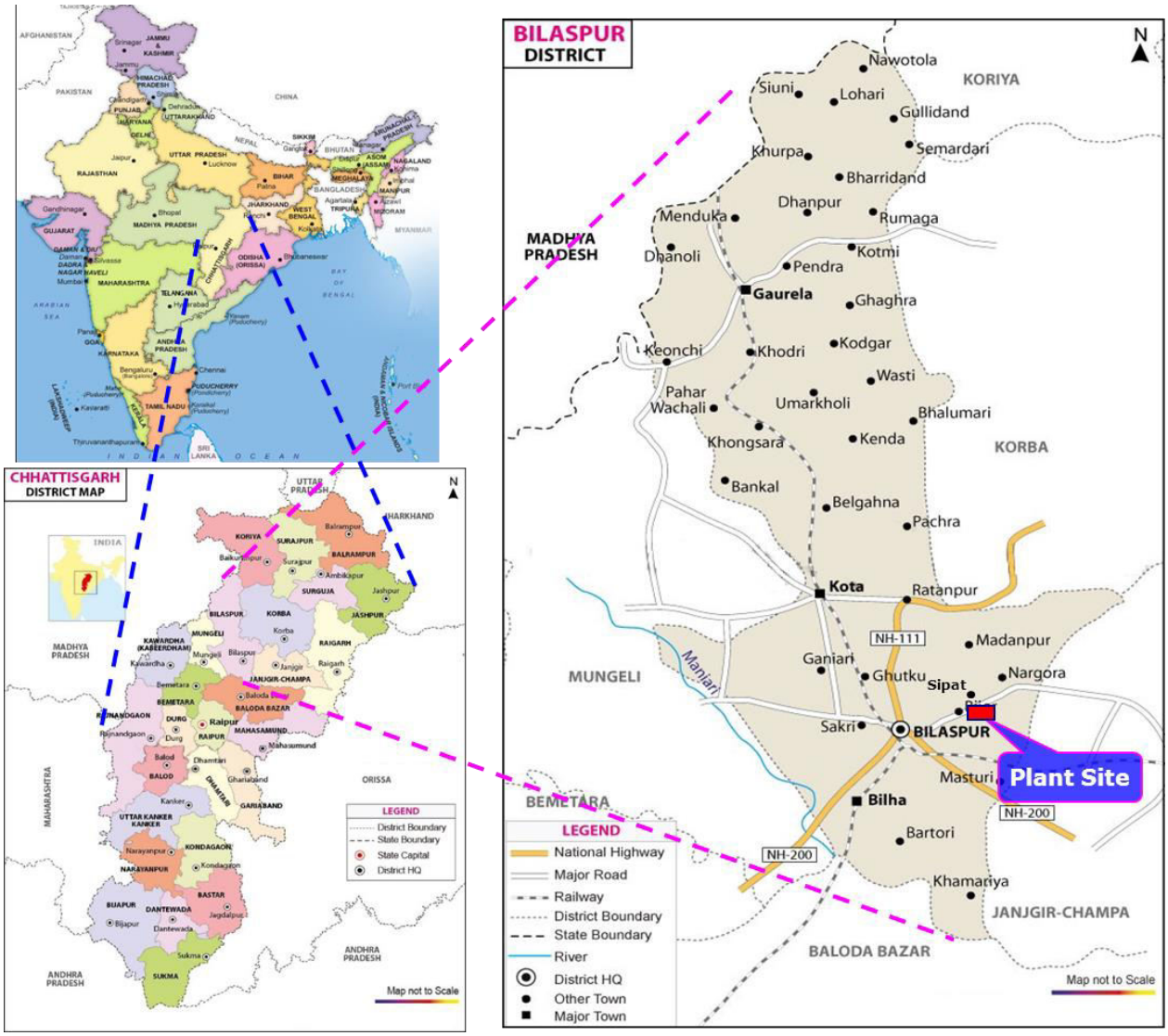



**FIGURE-1.1**
**INDEX MAP**

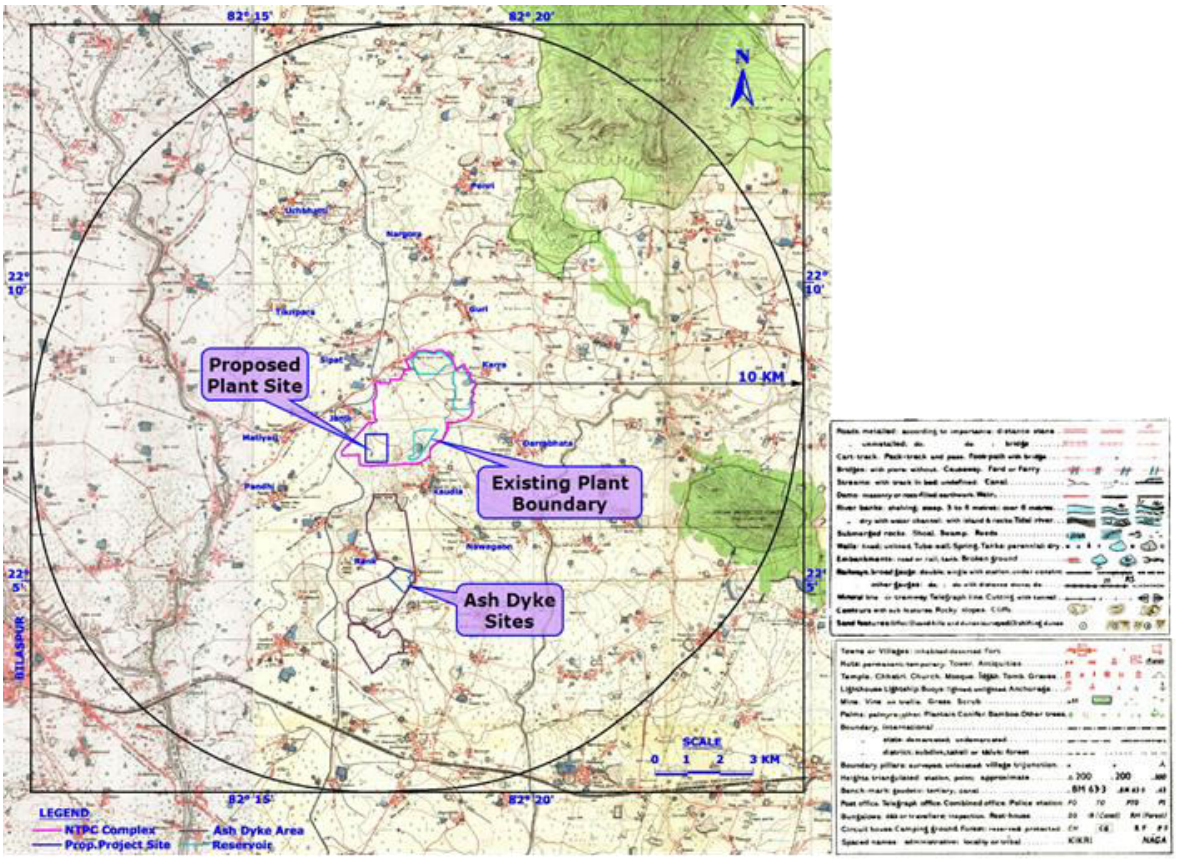



**FIGURE-1.2**
**STUDY AREA MAP (10 KM RADIUS)**

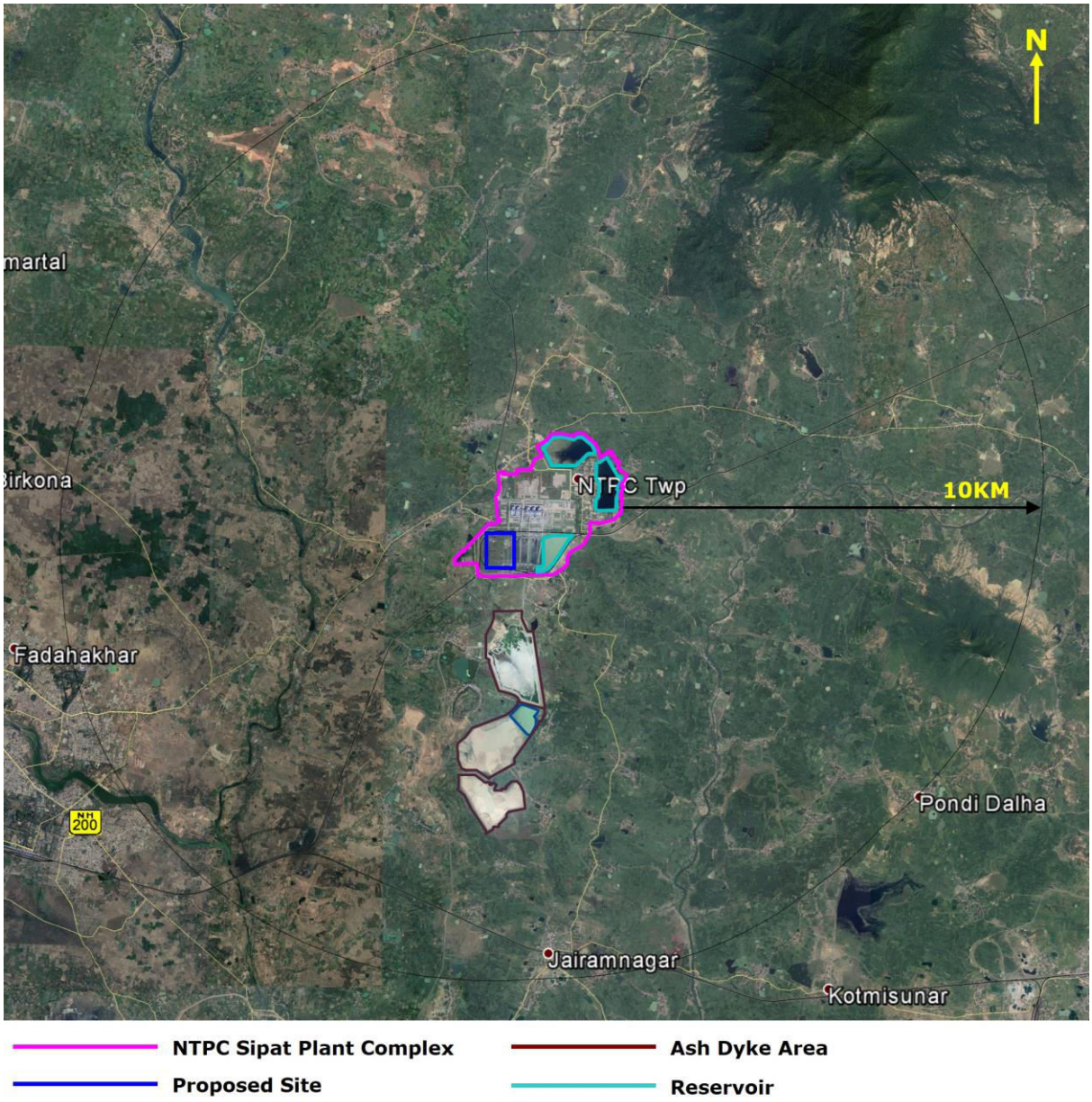



**FIGURE-1.3**
**STUDY AREA MAP ON GOOGLE IMAGERY-10 KM RADIUS**

## 1.4 Statutory Clearances

The list of environmental clearances of existing thermal power plant is given in **Table-1.2.**

**TABLE-1.2**
**LIST OF ENVIRONMENTAL CLEARANCES**

| Sr. No. | Statutory Clearances | Issuing Authority | Letter No | Date of Issue | Remarks |
|---|---|---|---|---|---|
| 1 | 2000 MW Sipat Super Thermal Power Project Stage-I, **Environmental clearance** | MOEF | J.13011/10/96-IA.II (T) | 22.02.1999 | **Annexure-II(A)** |
| 2 | 3 x 660 MW Sipat (Stage-I) Thermal Power project. **Change of fuel composition and unit size** | MOEF | No.13011/10/96-IA.II (T) | 30.04.2002 | **Annexure-II(B)** |
| 3 | 2 x 500 MW Sipat Thermal Power Plant (STPP) Stage-II, expansion **Stage–II Expansion of project** | MOEF | J.13011/5/2002.IA-II(T) | 08.06.2004 | **Annexure-II(C)** |
| 4 | 3 x 660 MW (Stage-I) Sipat Super Thermal Power Project. **Amendment in EC-Change of coal source.** | MOEF&CC | J-13011/10/1996-IA.II (T) | 08.09.2014 | **Annexure-II(D)** |
| 5 | 3 x 660 MW (Stage-I) Sipat Super Thermal Power Project. **Amendment in EC-transportation of coal with tarpaulin covered wagons** | MOEF&CC | J.13011/10/96-IA.II (T) | 08.02.2017 | **Annexure-II(E)** |
| 6 | 3 x 660 MW (Stage-I) Sipat Super Thermal Power Project. **Amendment in EC-transportation of coal with tarpaulin covered wagons** | MOEF&CC | J.13011/10/96-IA.II (T) | 17.05.2018 | **Annexure-II(F)** |
| 7 | 3 x 660 MW (Stage-I) Sipat Super Thermal Power Project. **Amendment in EC- waiving the condition of transportation of coal with tarpaulin covered wagons** | MOEF&CC | J.13011/10/96-IA.II (T) | 09.10.2019 | **Annexure-II(G)** |
| 8 | 3 x 660 MW (Stage-I) Sipat Super Thermal Power Project. **Amendment in EC-reduce the land for brick manufacturing infrastructure from 50 acres to 10 acres and monitoring of radio activity and heavy metals in coal and fly ash from in-built continuous monitoring to regular/ periodic** | MOEF&CC | J.13011/10/96-IA.II (T) | 24.12.2021 | **Annexure-II(H)** |
| 9 | 1 x 800 MW Sipat Advance Ultra Super Critical Technology Demonstration Project, Stage-III**. TOR for Stage-III** | MOEF&CC | J.13012/02/2019.IA-I(T) | 03.05.2019 | **Annexure-II(I)** |
| 10 | 1 x 800 MW Sipat Advance Ultra Super Critical Technology Demonstration Project, Stage-III**. Amendment in TOR for setting up 1X800 MW with Ultra Super Critical Technology** | MOEF&CC | J.13012/02/2019.IA-I(T) | 08.08.2022 | **Annexure-II(J)** |

| Sr. No. | Statutory Clearances | Issuing Authority | Letter No | Date of Issue | Remarks |
|---|---|---|---|---|---|
| | **Power Plant instead of Advance Ultra Super Critical, Technology Demonstration Project** | | | | |
| 11 | Forest Clearance for construction of Railway line from Sipat to Gatora Railway Station and MGR system | MoEF&CC | F.No.8-115.20.03-FC | 30.06.2004 | **Annexure-II(K)** |
| 12 | Consent to Establish for Stage-I | CECB | 410/TS/CECB/2002 | 11.02.2002 | **Annexure-II(L)** |
| 13 | Consent to Establish for Stage-II | CECB | 5299/TS/CESB/2004 | 31.12.2004 | **Annexure-II(M)** |
| 14 | Consent to Operate for Stage-I | CECB | 6025/TS/CECB/2023 | 26.10.2023 | **Annexure-II(N)** |
| 15 | Consent to Operate for Stage-II | CECB | 8783/TS/CECB/2022 | 03.03.2022 | **Annexure-II(O)** |
| 16 | Hazardous Waste Authorization | CECB | 7367/HSMD/HO/CECB/2022 | 18.01.2022 | **Annexure-II(P)** |

## 1.5 Demand Supply Gap

The anticipated power demand supply position of all India, Western Region and Chhattisgarh with and without the benefits of subject project has been worked out considering the following:

- The demand as per 19th EPS;
- The benefit of power from private sector projects is considered only to the state in which the project is located; and
- The commercial production is likely to commence in 2027 as the program envisages a 3 year demonstration period for proving the equipment designs in order to establish the technology.

The anticipated power supply position of the country excluding Sipat Plant (1 x 800 MW) is summarized below in **Table-1.3** & **Table-1.4**.

**TABLE-1.3**
**ALL INDIA DEMAND-SUPPLY SCENARIOS BY 2026-27**

| Description | Units | 2022-23 | 2023-24 | 2024-25 | 2025-26 | 2026-27 |
|---|---|---|---|---|---|---|
| Peak load | MW | 238899 | 252288 | 266844 | 282418 | 298774 |
| Energy requirement | MKWH | 1650594 | 1739618 | 1836001 | 1939111 | 2047434 |

**TABLE-1.4**
**WESTERN REGION DEMAND-SUPPLY SCENARIO BY 2026-27**

| Description | Units | 2022-23 | 2023-24 | 2024-25 | 2025-26 | 2026-27 |
|---|---|---|---|---|---|---|
| Peak load | MW | 75275 | 79748 | 84502 | 89528 | 94825 |
| Energy requirement | MKWH | 508032 | 535810 | 564915 | 595591 | 627624 |

The beneficiaries of western region/ other region(s) will be approached seeking their consent for allocation of power from this project. The power allocation by MoP, GOI will further be subject to the beneficiary states/distribution utilities concluding the Power Purchase Agreement (PPA) with NTPC emergencies and deficits of beneficiary states.

## 1.6 Scope of the Study

The CEIA report has been prepared based on the TOR accorded by MOEF&CC vide letter dated 03.05.2019 and its amendment dated 08.08.2022. The scope of this study broadly includes:

- Conducting literature review and to collect data relevant to the study area;
- Field sampling of environmental attributes at various representative locations in the study area to establish the baseline environmental status;
- Collate and compile secondary data including socio-economic data from published literature/government publications;
- Identifying various existing pollution loads due to various activities;
- Predicting incremental levels of pollutants in the study area due to the proposed expansion of power plant;
- Evaluating the predicted impacts on various environmental attributes in the study area by using scientifically developed and widely accepted Environmental Impact Assessment (EIA) methodologies;
- To prepare an Environment Management Plan (EMP), outlining the measures for improving the environmental quality in view of future project for environmentally sustainable development; and
- Identifying critical environmental attributes that are required to be monitored in the post-project scenario.

## 1.7 Methodology of the Study

Detailed baseline studies have been conducted from 20$^{th}$ March 2019 to 19$^{th}$ March 2020 for one year covering all four seasons pre-monsoon, monsoon season, post-monsoon season and winter season to determine existing conditions of various environmental attributes as outlined in **Table-1.5.**

Additional baseline monitoring was undertaken by NTPC through Mantec Consultants Pvt. Ltd., during summer 2023.

The applicable environmental standards for the project are given in **Annexure-III** and the methodology of monitoring and analysis is given in **Annexure-IV**.

**TABLE-1.5**
**ENVIRONMENTAL ATTRIBUTES AND FREQUENCY OF MONITORING**

| Sr. No. | Attributes | Parameters | Frequency | No of Sampling Locations in the Study Area |
|---|---|---|---|---|
| 1 | Meteorology | Wind speed, wind direction, temperature, relative humidity, rainfall, and other non-instrumental observations | Continuous for one year with hourly recording at one central location and secondary data collected from nearest IMD at Raipur | 1 location |
| 2 | Ambient air quality | As per NAAQ's 2009. | 24 hourly samples twice a week for 52 weeks. CO is monitored for three 8 hourly samples in 24 hours for twice a week for fifty two weeks. | 10 locations |
| 3 | Water quality | Physical, chemical and bacteriological parameters | Grab samples were collected from surface water (SW) and ground water (GW) sources. Sampling and analysis is carried out for monthly once during study period | 6 locations (GW) + 6 locations (SW) |
| 4 | Soil quality | Soil profile with chemical constituents | Once in season | 15 locations |
| 5 | Land use | Trend of land use change for different categories | Based on secondary data and satellite imagery | Study area |
| 6 | Ecology | Terrestrial and aquatic flora and fauna in the study area | Primary survey through field studies during study period and supplemented with published data | 6 terrestrial locations & 4 aquatic locations |
| 7 | Noise levels | $L_{day}$, $L_{night}$, $L_{eq}$ | Hourly readings for 24 hours (day & night) at ten locations, once during study period | 15 locations |
| 8 | Socio-economic aspects | Socio-economic characteristics | Based on data published in district census handbooks and field study and social survey | Once during study period |

## 1.8 Contents of the Report

The report has been divided into twelve chapters and presented as follows:

***Chapter-1: Introduction***

This chapter provides the purpose of the report, background information of the proposed expansion of thermal power plant, brief description of nature, size and location of project, environmental settings of project, scope of the study and methodology of the study.

***Chapter-2: Project Description***

This chapter highlights the features of the technical details of the proposed expansion of thermal power plant, its layout and design, project cost, implementation schedule, project raw material requirement, process description,

resource requirement, utilities and services, infrastructural facilities, sources of pollution and its mitigation measures.

***Chapter-3: Description of the Environment***

This chapter presents the methodology and findings of field studies undertaken to establish the environmental baseline conditions, which is also supplemented by secondary published literature.

***Chapter-4: Anticipated Environmental Impacts & Mitigation Measures***

This chapter details the inferences drawn from the environmental impact assessment of the proposed thermal power plant during construction & operation phase of project advancement, such as design, location of project, regular operations. It also describes the overall impacts of the project activities and underscores the areas of concern, which need mitigation measures.

***Chapter-5: Analysis of Alternatives (Technology & Site)***

This chapter presents the analysis of alternative sites and technologies considered for the proposed expansion of thermal power plant.

***Chapter-6: Environmental Monitoring Program***

This chapter presents the environmental monitoring requirements for effective implementation of mitigation measures during construction and operational phase have been delineated in this chapter.

***Chapter-7: Additional Studies***

This chapter describes various risks associated during operational stage of the project of proposed thermal power plant. A disaster management plan for proposed thermal power plant to minimise the risks or to combat the associated risks is also discussed. Occupational health and safety measures have also provided. Brief information about hydrogeology of study area has given. Out of social survey/need based assessment survey has been discussed.

***Chapter-8: Project Benefits***

This chapter describes various benefits of the project to the community in the vicinity and as well as to the region on the whole.

***Chapter-9: Environmental Cost Benefit Analysis***

This chapter has to be carried out if specifically required as per scoping. As this is not specifically mentioned in scoping, further detailed study is not carried out.

***Chapter-10: Environment Management Plan (EMP)***

This chapter presents the details of institutional arrangements for environment protection and conservation. Organization structure for environment management is also brought out.

***Chapter-11: Summary & Conclusions***

This chapter contains the summary and conclusion of the overall CEIA report.

***Chapter-12: Disclosure of Consultants Engaged***

This chapter contains the list of various experts engaged in preparing the CEIA report along with a brief description of the consultancy services.

# Chapter-2
# Project Description

# 2.0 PROJECT DESCRIPTION

This chapter highlights the features of the proposed expansion of Sipat thermal power plant, fuel/raw material requirement, details of the process, resource requirement, infrastructural facilities and sources of pollution and pollution control measures.

## 2.1 Type of Project

Sipat, Stage-III (1x800 MW), shall be ultra-supercritical once through type, water tube, direct pulverised coal fired, top supported balanced draft furnace, single reheat, radiant, dry bottom type, suitable for outdoor installation.

The gas path arrangement shall be single pass (tower type) or two pass type having 281 kg/cm2 (abs) pressure at super heater outlet and SH/RH outlet temperature of 603°C/603-613°C.

The existing project under Stage-I (3 x 660 MW) and Stage-II (2 x 500 MW) are under operation.

## 2.2 Need for the Project

Sipat STPP Stage-III, is envisaged as a base load station to meet the power demand of Chhattisgarh and other states in western region.

## 2.3 Location of the Project

The proposed Sipat STPP, Stage-III (1x800 MW), project is located at Sipat village, Sipat tehsil, Bilaspur district of Chhattisgarh state. The site is approximately 12.0 km from Bilaspur city and is approachable via Bilaspur-Baloda state highway which passes through Sipat.

The project is approachable from an approach road already constructed during Stage-I. The photographs of proposed site are given in **Figure-2.1.**

### 2.3.1 Layout of the Proposed Project

Layout for the project is developed considering the various existing facilities of the old station. New facilities are proposed to be located such that there is a minimum interference with major existing facilities. Following the layout concept adopted for the old station, the switchyard, main plant and coal handling facilities are located as done for the old station. However, proposed plant of 1 x 800 MW units are proposed to be located on the west of Stage-I.

The main power house is expanding from south to west. The ash slurry ash water pump house is kept towards south-west of main plant. The road over bridge shall be constructed over existing MGR. Railway siding for new project shall be laid nearby existing railway siding. The general layout plan of the power plant is shown in **Figure-2.2**.

➢ **Main Plant Layout**

The main plant of Stage-III (1 x 800 MW) shall be accommodated within existing main plant area. The main power house will be 127.5 long and 42 m wide consisting of TG bay, heater/deaerator bay and HP turbine area.

The salient features of the proposed expansion of Sipat STPP-III are given in **Table-2.1**

## 2.4 Salient Features

**TABLE-2.1**
**SALIENT FEATURES OF PROPOSED EXPANSION OF STPP**

| Sr. No. | Particulars | Details |
|---|---|---|
| 1 | Stage- I<br>Stage- II<br><br><br>Stage-III | **Under Operation**<br>Stage-I: 1980 MW (3 x 660 MW) (Super Critical)<br>Stage-II: 1000 MW (2 x 500 MW) (Sub Critical)<br>**Proposed Expansion**<br>Stage-III: 800 MW (1x800 MW) (Ultra Super Critical) |
| 2 | Technology | Ultra Super Critical (USC) |
| 3 | Total land of the plant | 160 acres of land within the vacant space in MGR bulb.<br><br>No additional land is proposed to be acquired. |
| 4 | Fuel | Coal |
| A | Source of fuel | SLC (LT) in its meeting held on 21.02.2023 has recommended grant of coal linkage to Sipat-III (1x800 MW). |
| B | Fuel transportation | MGR/IR |
| C | Average fuel requirement (Coal) | 3.25 MTPA with 85 % PLF |
| D | Gross calorific value | 4000 Kcal/kg |
| E | Ash content | 39 % (Max) |
| F | Sulphur content | 0.36 % (Max) |
| 5 | Ash generation<br>Fly ash<br>Bottom ash<br>Total ash | <br>1.04 MTPA<br>0.26 MTPA<br>1.30 MTPA |
| 6 | Water requirement and its source | The water requirement will be about 2340 $m^3$/hr with ash water recirculation, which is proposed to be drawn from the Right Bank Canal (RBC) originating from Hasdeo barrage pondage.<br><br>No additional water commitment is required for the expansion project. The water requirement for Stage-III unit will be met from the available committed quantity of 120 MCM from WRD, Govt. of Chhattisgarh accorded vide letter dated 26.11.2001 for Sipat STPS. Water Allocation reduced to 93 MCM from 120 MCM vide letter dated 31.03.2018. Surplus water available is 23 Cusec. |

| Sr. No. | Particulars | Details |
|---|---|---|
| 7 | Cooling system | Closed cycle cooling system with cooling towers |
| 8 | Power requirement and its source | Two number of 11 KV feeder shall be provided from existing 11 KV switchgear of Sipat STPP to meet the construction power requirement. |
| 9 | Power evacuation | 765 KV with appropriate transmission utility |
| 10 | Discharge | Zero Liquid Discharge (ZLD) System |
| 11 | Wastewater treatment | Existing ETP & STP |
| 12 | Fire fighting system | Adequate firefighting systems as per Tariff Advisory Committee (TAC) and OISD guidelines will be provided |
| 13 | Project cost | Rs. 7,360.11 crores |
| 14 | Emission Norms to be followed | Proposed unit shall comply with the latest emission norms notified vide MoEF&CC Notification dated 07.12.2015 and its amendments. |

*Source: NTPC*







**FIGURE-2.1**
**SITE PHOTOGRAPHS**

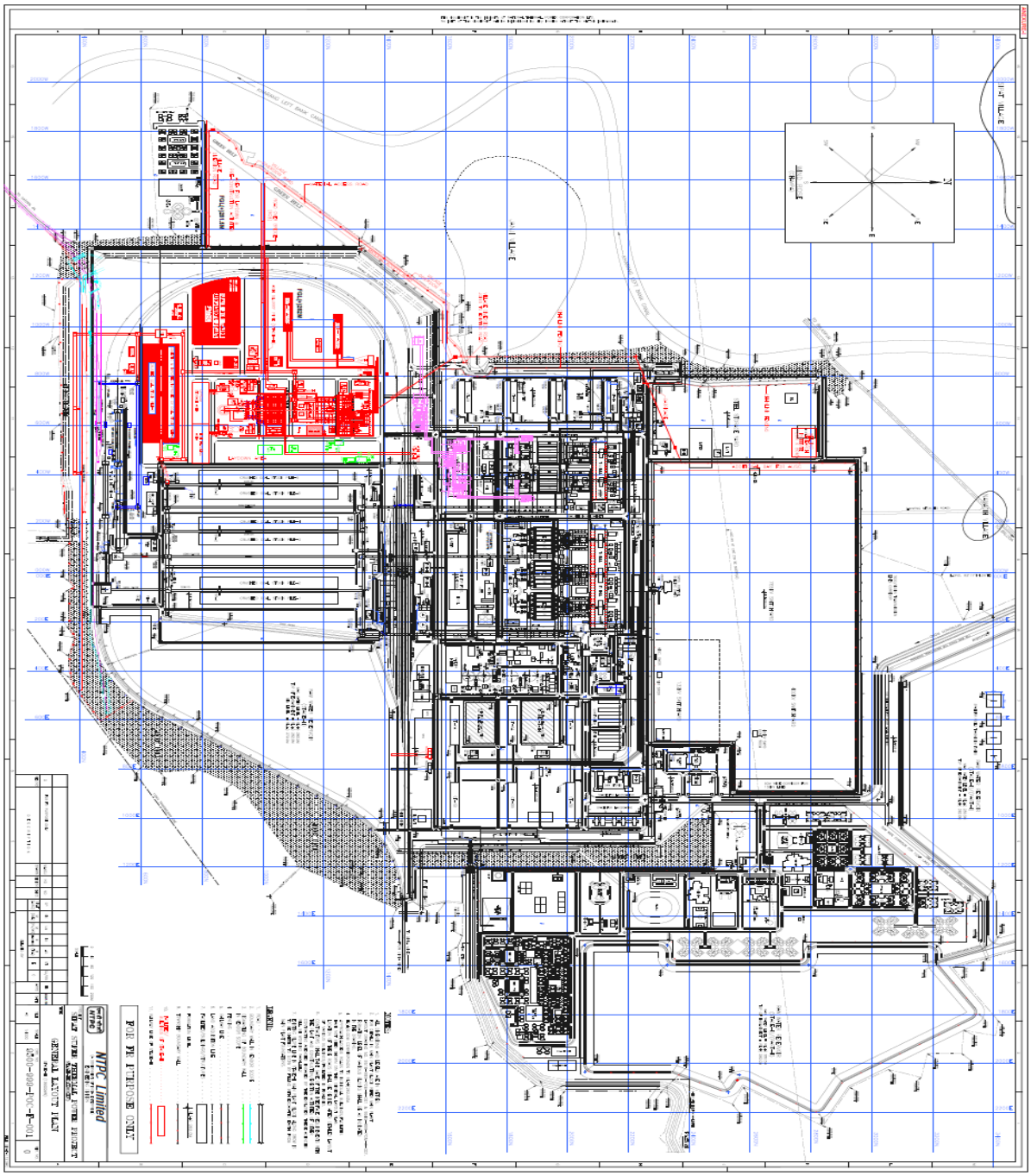


**FIGURE-2.2**
**PLANT LAYOUT**

## 2.5 Project Schedule and Approval for Implementation

### 2.5.1 Proposed Schedule for Implementation

The Commercial Operation Date (COD) of the unit of the project is envisaged in 52 months from the date of investment approval.

### 2.5.2 Approval for Implementation

The establishment of proposed expansion activities will be commenced after obtaining Environmental Clearance from MOEF&CC, New Delhi and Consent to Establish (CTE) from Chhattisgarh Environment Conservation Board (CECB).

## 2.6 Resource Requirement

### 2.6.1 Land Requirement

No additional land is proposed to be acquired for the project. The total land available (acquired under Stage-I & II) is 4369.34 acres. Out of this, about 160 acres of land is available for locating the unit within the vacant space in the MGR bulb. One double lane Road Under Bridge (RUB) and four-lane road with a level crossing are available for access to this area. To transport the machinery and material up to proposed site a Road Over bridge (ROB) is proposed.

This space is adequate for locating the BTG & BOP facilities of 800 MW Sipat STPP Stage-III unit. Unit can be easily connected to the existing 765 kV switchyard for power evacuation. The land in existing ash dyke is sufficient to accommodate the ash for additional 800 MW unit.

Ash dykes for Sipat STPP (2980 MW) shall be used for Stage-III also and no additional land is envisaged for the same. The break-up of land requirement for the main plant is given in **Table-2.2.**

**TABLE-2.2**
**BREAK-UP OF LAND REQUIREMENT**

| Sr. No. | Description | Land Requirement (in Acres)- Stage-III |
|---|---|---|
| 1 | Main plant including cooling towers area | 55 |
| 2 | WTP, fuel oil handling area and other facilities | 35 |
| 3 | CHP and railway siding | 30 |
| 4 | Laydown & miscellaneous area (after construction shall be converted to greenbelt /plantation area) | 40 |
| | Total | **160** |

*Source: NTPC*

### 2.6.2 Manpower Requirement

The proposed expansion power plant will require skilled, semi-skilled and unskilled personal during construction and operational phase. Many of the people from neighboring villages, as found suitable will get opportunity for indirect employment during construction and operational phase. The total manpower from various agencies during construction of Stage-III would be about 2000 (during

peak deployment) and during operation period is estimated to be about 150. The approximate no. of NTPC employees during construction and operation phases are 56 and 203 respectively. However, the exact numbers may vary during construction and operation phases.

2.6.3 Construction Power Requirement & Source

The requirements of the construction power supply for the project would be met from the Stage-II, 11 kV Miscellaneous Switchgear. Necessary 11 kV ring main/LT sub-stations shall be provided for the required power plant area.

*Power Evacuation System*

Step up/power evacuation voltage of the project is 765 kV in line with all other units of exiting Sipat STPP. The issue of power evacuation of the proposed project shall be taken up with appropriate Transmission Utility (STU or CTU) as per regulatory provision. The above scheme considered presently shall be reviewed based on the finalized ATS of the project.

2.6.4 Water Requirement & its Source

The water requirement is estimated to be about 23 cusecs which is proposed to be drawn from the Right Bank Canal (RBC) originating from Hasdeo Barrage pondage. No additional water commitment is required for the expansion project.

The water requirement for Sipat STPP Stage-III unit will be met from the available committed quantity of 120 MCM (134 Cusecs) from WRD, Govt. of Chhattisgarh accorded vide letter dated 26.11.2001 for Sipat STPS. Central Water Commission (CWC) vide letter dated 02.01.2002 had given its concurrence for 120 MCM water for Sipat STPP. The water commitment was later modified to 93 MCM (104 Cusecs).

However, water system of stage I & II will be optimized and saving in water will be sufficient to meet the water requirement for stage-III. The break-up of water requirement is given in **Table-2.3**. The water allocation letter from WRD concurrence letter is attached as **Annexure-V.**

**TABLE-2.3**
**WATER REQUIREMENT FOR EXPANSION PROJECT**

| Sr. No. | Description | Water Requirement ($m^3$/hr) | Source of Water |
|---|---|---|---|
| 1 | DM plant | 60 | Raw water after clarifier |
| 2 | Potable Water | 35 | Raw Water after clarifier |
| 3 | HVAC Makeup | 40 | Raw Water after clarifier |
| 4 | FGD | 20 | Raw Water after clarifier |
| 5 | Service Water | 150 | Raw Water after clarifier |
| 6 | Makeup for CW | 1785 | Raw Water after clarifier |
| 7 | Ash Water tank | 185 | Raw Water |
| 7 | CHP & dust suppression | 35 | Cooling water blow down |
| 8 | Evaporation losses | 360 | Cooling water blow down and effluents & sludge |

## 2.7 Raw Material Requirement, Source & Mode of Transportation

### 2.7.1 Coal

Coal requirement for 800 MW Sipat STPP Stage-III unit will be about 3.25 MTPA at 85% PLF. Coal from coal blocks with GCV of 4000 Kcal/Kg has been considered for FR purpose. SLC (LT) in its meeting held on 21.02.2023 has recommended grant of coal linkage to Sipat-III (1x800 MW). The coal quality parameters having proximate analysis are given below in **Table-2.4.**

**TABLE-2.4**
**COAL CHARACTERISTICS**

| Parameters | Design Coal Characteristics |
|---|---|
| Total moisture (%) | 15 % |
| Ash (%) | 39 % |
| GCV (kcal/kg) | 4000 Kcal/kg |
| Sulphur (%) | 0.36 % (Max) |

*Source: Feasibility Report*

**TABLE-2.4 (A)**
**HEAVY METAL CONCENTRATION IN COAL**

| Sr.No | Parameter | CHP Stage-I | CHP Stage-II | Fidder Coal Unit-I | Fidder Coal Unit-II | Fidder Coal Unit-IV | Protocol |
|---|---|---|---|---|---|---|---|
| 1 | Arsenic as As | 0.18 | 0.20 | 0.10 | 0.02 | 1.28 | EPA 3050 B |
| 2 | Mercury as Hg | 0.37 | 0.25 | 0.24 | 0.19 | 0.21 | EPA 3050 B |
| 3 | Lead as Pb | 0.44 | 0.40 | 0.40 | 0.43 | 2.88 | EPA 3050 B |
| 4 | Cadmium as Cd | 0.01 | 0.15 | 0.02 | 0.01 | 0.04 | EPA 3050 B |
| 5 | Total Chromium as Cr | 2.00 | 2.01 | 1.30 | 0.77 | 1.82 | EPA 3050 B |
| 6 | Hexavalent Chromium as $Cr^{+6}$ | 1.26 | 1.06 | 0.865 | 0.26 | 0.48 | EPA 3050 B |
| 7 | Copper as Cu | 3.10 | 3.11 | 5.28 | 3.27 | 3.44 | EPA 3050 B |
| 8 | Zinc as Zn | 3.48 | 3.46 | 3.73 | 2.36 | 9.23 | EPA 3050 B |
| 9 | Selenium as Se | $BDL^{\#}$ | $BDL^{\#}$ | $BDL^{\#}$ | $BDL^{\#}$ | $BDL^{\#}$ | EPA 3050 B |
| 10 | Iron as Fe | 739.64 | 740.76 | 1073.98 | 655.92 | 991.50 | EPA 3050 B |

#Below Detection Limit

**TABLE-2.4 (B)**
**RADIO ACTIVITY ANALYSIS OF COAL**

| Sr.No | Name of the Product | U-238 (Bq/Kg) | Ra-226 (Bq/Kg) | Th-232 (Bq/Kg) | K-40 (Bq/Kg) |
|---|---|---|---|---|---|
| 1 | Coal-Sample 1 | 62.9 ± 2.7 | 59 ± 7.3 | 67.7 ± 7.6 | 178 ± 15.1 |
| 2 | Coal-Sample 2 | 44.7 ± 2.2 | 51.2 ± 6.6 | 60.4 ± 9.0 | 116 ± 11.0 |
| 3 | Coal-Sample 3 | 40.6 ± 2.2 | 38 ± 5.9 | 52.7 ± 6.2 | 124 ± 11.8 |
| 4 | Coal-Sample 4 | 48.3 ± 2.2 | 39.8 ± 5.6 | 62.1 ± 3.0 | 136 ± 12.1 |
| 5 | Coal-Sample 5 | 42 ± 2.3 | 43.2 ± 6.0 | 56.2 ± 6.4 | 155 ± 13.4 |

The Radioactivity test certificate serial No. CSN: ULR-TC1170324000001426F, dated:11.01.2024 and heavy metal analysis of coal source (SECL mines) of existing Sipat STPP is enclosed as **Annexure-VI**.

*Coal Transportation*

Coal will be transported through existing/augmentation of MGR system of Sipat STPS or Indian Railways.

2.7.2 Fuel Oil

Light Diesel Oil (LDO) will be used for initial start-up, low load operation and as secondary fuel for pulverized coal flame stabilization at the start-ups/low load operations. Light oil (LDO) shall be used for cold startup and low part load (up to 7.5%) operation of the steam generator while firing coal. Since light oil only is to be used for start-up, warm up and low load operation, the specific oil consumption is assumed to be 2.0 ml/kw-hr. Existing LDO unloading and storage facilities shall be used for new stage.

Steam generator will be so designed that oil firing for flame stabilization will not be required beyond 40% Boiler Maximum Continuous Rate (BMCR). Necessary oil supply scheme with pumps filters and valves will be provided. The burners, air registers etc. will have independent pneumatic drives and the entire operation of purging, insertion, air and fuel sequencing/removal and blow off shall be automatic. Ignition of oil shall be directly by igniters. LDO system shall be sized for 30% BMCR capacity of one steam generators. Estimated auxiliary fuel requirement after COD @ 85% PLF for one unit of 800 MW is given in **Table-2.5.**

**TABLE-2.5**
**ESTIMATED AUXILIARY FUEL REQUIREMENT**
**AFTER COD @ 85% PLF FOR ONE UNIT OF 800 MW**

| | |
|---|---|
| Name of auxiliary fuel | LDO (AS PER IS 15770-2008) |
| Estimated annual quantity required | 10000 KL @ 2 ml/KWH |
| Estimated quantity used in one time firing / lightening in boiler | 120 KL for one cold / warm start-up<br>40 KL for one hot start-up |

Existing LDO unloading and storage facilities shall be used for new stage. Fuel oil unloading and storage system shall be designed to handle light oil (LDO). It is proposed to transport light oil (LDO) to the power plant by road tankers. The oil will be unloaded from road tankers by gravity into the unloading header. From there it will be transferred to oil storage tanks through a set of positive displacement pumps. Provision shall be kept to unload ten (6) nos. road tankers at a time for light oil (LDO). The tentative LDO characteristics are given in **Table-2.6.**

**TABLE-2.6**
**LDO CHARACTERISTICS**

| Sr. No. | Particulars Characteristics | LDO - Value |
|---|---|---|
| 1 | Pour point (max) | $21^0$C & $12^0$C<br>for summer & winter |
| 2 | Kinematic viscosity in centistokes at 40 $^0$C | 2.5 to 15.0 |

| Sr. No. | Particulars Characteristics | LDO - Value |
|---|---|---|
| 3 | Sediment percent by mass (max) | 0.10 |
| 4 | Total sulphur percent by mass | 1.5 |
| 5 | Ash percentage by mass | 0.02 |
| 6 | Carbon residue (Rams bottom) percent by pass | 1.5 |
| 7 | Acidity inorganic | Nil |
| 8 | Flash point (Min.)-Pensky Martens | 66 $^0$C |
| 9 | Copper strip corrosion for 3 hours at 100$^0$C | Not worse than No.2 |
| 10 | Water content, % by volume (max) | 0.25 |
| 11 | GCV (kcal/kg) | 10,000 |

### 2.7.3 Limestone

The hourly limestone requirement for 1x 800 MW unit shall be about 8 TPH based on design coal conditions (Gross calorific value of 4000 Kcal/ kg, Sulphur content of 0.36 %). The envisaged mode of limestone transportation to the power plant is by trucks. The trucks shall be unloaded in underground hoppers.

## 2.8 Process Description

In a thermal power plant, the chemical energy of the fuel (coal) is first converted into thermal energy (during combustion), which is then converted into mechanical energy (through a turbine) and finally into electrical energy (through a generator). The schematic diagram of the process of power generation a coal based thermal power plant is shown in **Figure-2.3**. It has the following steps:

- The coal is transferred from the coal handling plant by conveyor belt to the coal bunkers, from where it is fed to the pulverizing mills, which grind it to fine powder. The finely powdered coal mixed with air is then blown into the boiler by a fan where it burns like a gas.
- The process of combustion releases thermal energy from coal. The boiler walls are lined with boiler tubes containing high quality de-mineralized water (known as boiler feed water). The combustion heat is absorbed by the boiler tubes and the heat converts the boiler feed water into steam at high pressure and temperature. The steam, discharged through nozzles on the turbine blades, makes the turbine to rotate, which in turn rotates the generator coupled to the end of the turbine. Rotation of generator produces electricity, which is passed to the step-up transformer to increase its voltage so that it can be transmitted efficiently. The power is evacuated via switchyard through a transmission system.
- During combustion, the non-combustible part of coal is converted into ash. A small part of ash (about 20%) binds together to form lumps, which fall into the ash pits at the bottom of the furnace. This part of ash, known as bottom ash is water quenched, ground and then conveyed to pits for subsequent disposal to ash disposal area or sale.
- Major part of the ash (about 80%) is in fine powder form, known as fly ash, and is carried out of the boiler along with the flue gas. The flue gas, after heat recovery, is passed through the electrostatic precipitators, where the ash is trapped by electrodes charged with high voltage electricity.

- The flue gases exiting from the Electrostatic Precipitators (ESPs) shall be treated in Flue Gas Desulphurisation (FGD) system and discharged through a tall chimney for wider dispersal of remaining ash particles and gases. A suitable system for control of NOx shall also be established. The ash collected in the ESP hoppers is extracted in dry form and conveyed to dry ash storage silos from where it is supplied to user industries.

- Any unused part of fly ash is mixed with water and conveyed to ash disposal area in a slurry form.

  The steam, after passing through the turbines, is condensed back into water in condensers and the same is re-used as a boiler feed water for making steam. The reasons for condensing and reusing the steam are following:

- The cost of boiler feed water is very high as it is very pure demineralised water hence reuse is economical.
- The use of condenser lowers the temperature at the exit end and hence increases the efficiency of the turbine.
- The condenser contains tubes through which cold water is constantly pumped. The steam passing around the tubes of condenser loses heat and condenses as water. During this process, the steam gets cooled while cooling water gets heated up (by about 10°C). This hot water is cooled in a cooling tower and recycled for cooling.

  However, in order to control dissolved solids, a certain amount of blow down is required from the cooling towers, which is used in the plant for other usages such as service water, coal dust suppression etc.

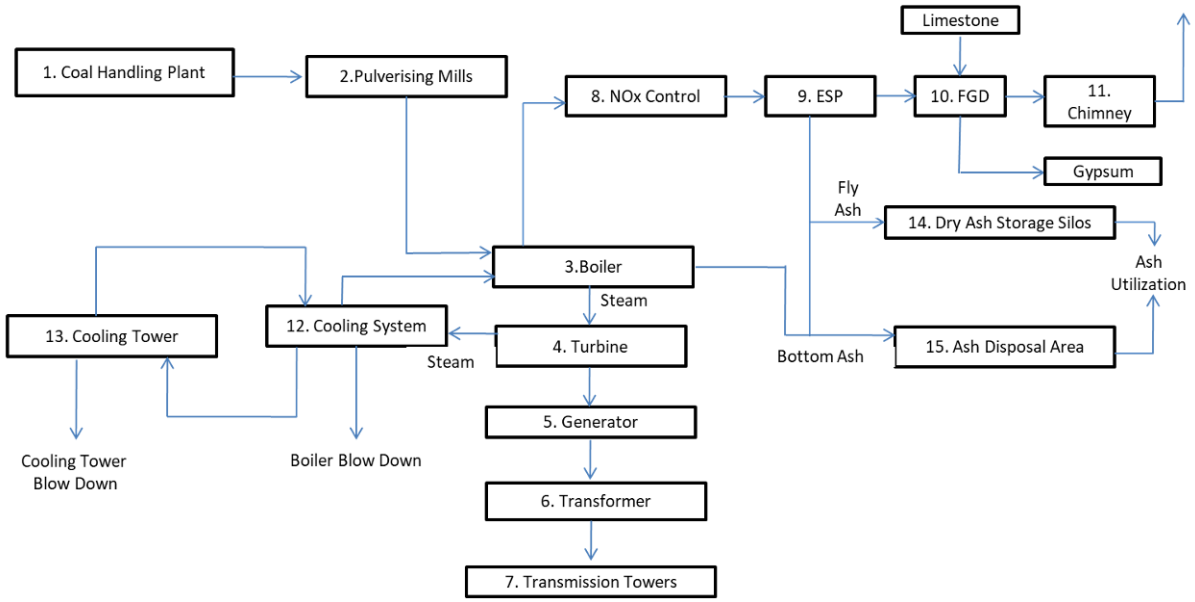



**FIGURE-2.3**

**SCHEMATIC REPRESENTATION OF THERMAL POWER GENERATION IN TYPICAL COAL BASED THERMAL POWER PLANT**

## 2.9 Proposed Infrastructure and Plant Systems

### 2.9.1 Water System and Plant Utilities

*Type of Circulating Water System*

Environmental regulations stipulate that the power project shall install cooling tower. Therefore, re-circulating type CW system with cooling towers has been envisaged for the project.

*Makeup Water System*

A separate make-up water system to pump water from Hasdeo right bank canal to plant reservoir is not envisaged for Sipat Stage-III. As the existing make-up water system at Sipat STPP is sufficient to meet the requirement of proposed stage-III. The make up water requirement for this project would be about 2340 $m^3/h$.

The water balance diagram is given in **Figure-2.4.**

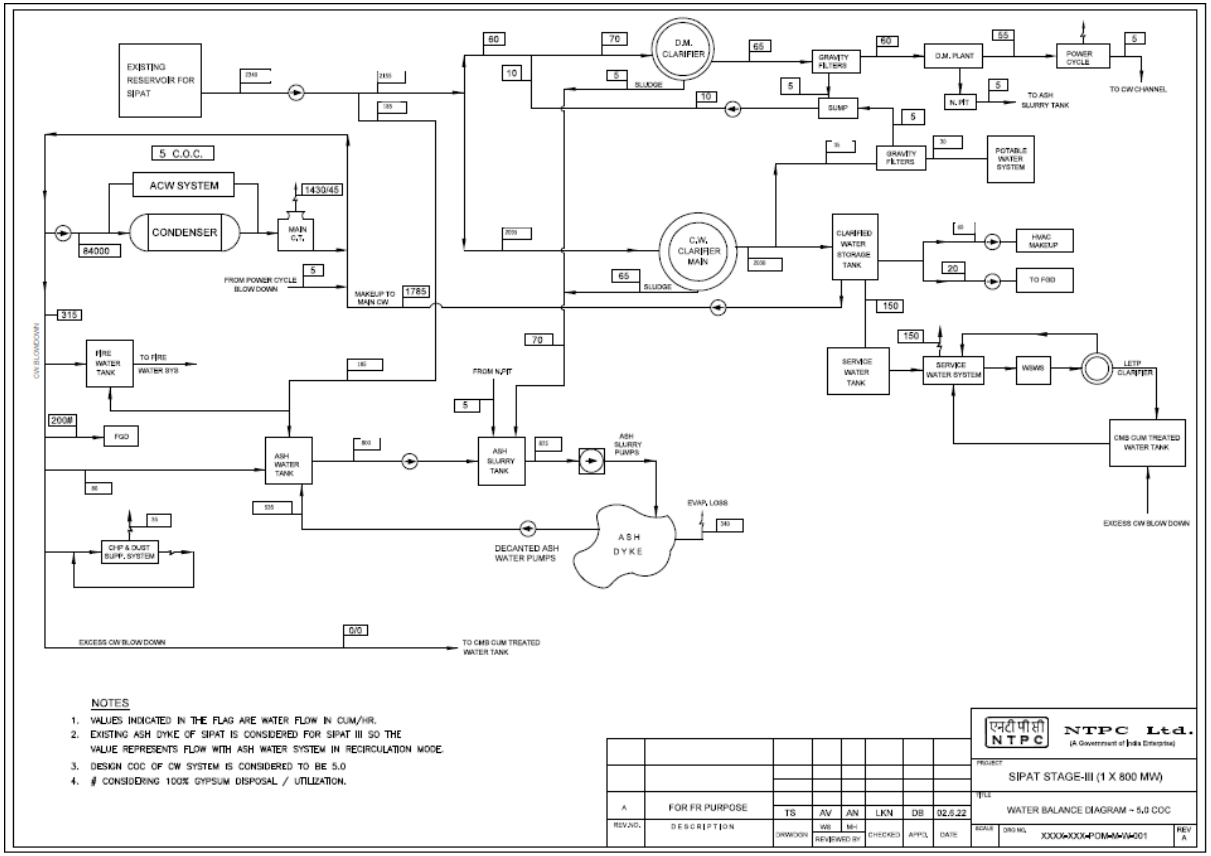



**FIGURE-2.4**
**WATER BALANCE DIAGRAM**

*Circulating Water System*

For the re-circulating type CW system, it is proposed to supply clarified water as makeup. Clarified water shall be fed from the water pre-treatment plant to the cold water channel. Water from cold water channel will enter the CW pump house through trash racks at low velocity to filter out debris. Stop log gates shall be provided after the trash racks to facilitate maintenance.

The total water requirement for the condenser and auxiliary cooling is estimated to be about 84,000 Cu.m/hr. The temperature rise of re-circulating water in the condenser shall be about 10-11$^0$C. A suitable CW chemical treatment programme shall be adopted for CW system. The CW system shall be designed considering a design COC of about 5 (Optimum). The CW chemical treatment programme will include acid & scale and /or corrosion inhibitors apart from chlorination. Hence, required tanks and dosing equipment shall be provided near CW pump house.

The CW system shall be provided with required instrumentation, interlocks, controls, control panels to facilitate safe & reliable operation. One induced draft cooling tower with Splash/Modular/Trickle type fill would be provided.

*Equipment Cooling Water (ECW) System*

Closed circuit type ECW system shall be provided with DM water in the primary circuit and water tapped off from CW system upstream of condenser in the secondary circuit. ECW system shall cater to cooling water requirements of TG, SG & its auxiliaries including station auxiliaries. Primary cooling circuits for auxiliaries of TG and SG shall be independent. However, the secondary cooling water circuit shall be common for both the primary cooling systems.

Normal Make up to the closed loop primary circuit from the discharge of DM water transfer pumps located in DM plant and emergency make up from the discharge of condensate transfer pumps shall be given to overhead storage tank. The secondary cooling water system shall operate in parallel to the condenser and shall receive water through a tapping on the CW inlet line to the main condenser. This water will be further pressurized by auxiliary cooling water pumps and fed through the plate type heat exchangers back to the CW discharge line of the main condenser.

**Auxiliary Water Systems**

a) A pipe network for distribution of potable water for plant shall be provided from the overhead storage tanks. Required number of potable water pumps for plant area shall be provided.

b) A pipe network spread over the entire plant area would be provided for cleaning of main plant area and other buildings. Required number of service water pumps shall be provided which shall draw water from the service water tank which shall be supplied from LETP/Clarified Water Storage Tank.

c) In addition to the above, DM water make up system, boiler fill pumping system, Air Pre-heater wash water system, HVAC make up system and FGD Gypsum wash system shall also be provided as per requirement.

**Water Treatment Systems**

The water treatment system of the project comprises of water pre-treatment plant, water demineralization plant producing ultrapure water, chlorine di-oxide plant, condensate polishing plant, CW chemical treatment plant & liquid effluent treatment plant as described below:

**Water Pre-Treatment Plant**

- The pretreatment plant would be designed to remove suspended/colloidal matter in the raw water. Pre-treatment plant shall be provided for meeting the requirements of CW system and Demineralization (DM) Plant. A common chemical house shall be provided to store chemicals such as lime, alum & coagulant aid and respective lime, alum and coagulant dosing equipment such as tanks, pumps etc. for all the PT systems. Independent chemical preparation tanks and chemical dosing pumps shall be provided for each PT system.

- The Water PT plant for CW system shall consist of two (2) clarifiers of reactor type of 1800 $m^3$/hr capacity and two (2 x 100%) gravity filters of 100 $m^3$/hr for potable water purpose. The water PT plant for DM Plant shall consist of One (1) clarifier of reactor type of 200 $m^3$/hr capacity and two (2 X 100%) numbers of gravity filters of 100 $m^3$/hr.

- Each of the clarifier system (PT-CW & PT-DM) shall be provided with a stilling chamber cum aerator and provision for dosing of alum, lime, coagulant aid and chlorine. There shall be one standby filter for each water PT system. Water from the clarifiers shall be led to clarified water storage tank or to the filters as the case may be. Water from the clarified water storage tank shall be pumped to various systems like HVAC make up, FGD Gypsum wash, Service water, etc. For CW system, make up water shall be supplied through pumps or by gravity as the case may be.

- From the gravity filters, filtered water would flow by gravity to respective filtered water reservoirs and filtered water would be pumped to DM plant.

- Required hoists and weighing scales shall be provided for handling pumps, chemicals etc.

- The water pre-treatment plant shall be provided with required instrumentation, interlocks, controls, control panels to facilitate safe & reliable operation.

The actual capacity of the water treatment plant shall be decided during finalization of specification depending on the available capacity in the WTP plants in existing stages in Sipat.

**Water Demineralization Plant**

The DM plant shall be designed to produce ultra-pure DM water and shall be sized to meet the make-up water requirement of the steam cycle, make-up to closed circuit auxiliary system, hydrogen generation plant (if applicable) and stator water cooling system. The DM plant shall consist of either two (1W + 1S) streams of 75 $m^3$/hr., capacity ion exchange-based streams or two (1W + 1S) RO based streams of 75 $m^3$/hr., (min) capacity. Ion Exchange based stream shall comprise of activated carbon filter, cation exchangers, degasser system (comprising of degasser tower, degassed water tank, degassed water pumps and degasser blowers etc.), anion exchangers and mixed bed exchangers. RO based DM streams shall comprise of UF system, micron cartridge filters, RO system, degasser system and MB. The cation resins shall be regenerated with hydrochloric acid and the anion resins with sodium hydroxide. The regeneration facilities shall consist of the bulk acid & alkali storage tanks, alkali solution preparation system, acid & alkali measuring tanks and dosing ejectors etc. The plant shall be designed for semi-automatic operation with PLC based control. Two (2) D.M. water storage tanks of 2000 $m^3$ capacity will be provided to store DM water. One neutralization pit shall be provided for neutralizing the pH and discharging the effluent water from the DM plant. Suitable interconnection including pumping, piping, valves etc. shall be provided for transferring DM water to either stage from any DM streams/tanks.

An option for polishing UF for conventional DM shall also be kept which shall be decided during finalization of specification depending on the presence of colloidal silica in raw water.

EDI/MB or ultra-pure facility considering existing spare DM water quantity of stage 1 & 2 as input water, will be further explored instead of the proposed conventional DM plant, during finalization of specification, after thorough inspection of site and other facilities.

**Chlorine Di-oxide Plant**

Chlorine dioxide plants for circulating water system (CW-$ClO_2$) and pretreatment plant (PT-$ClO_2$) shall be provided separately. CW-$ClO_2$ shall comprise of one (W) $ClO_2$ generator and PT-$ClO_2$ shall comprise of two (1W + 1S) $ClO_2$ generators with associated pumping, acid, alkali storage and tank etc. system.

**Condensate Polishing Plant**

For maintaining the feed water purity, condensate polishing plant shall be provided in the feed water cycle at the downstream of condensate extraction pumps as per the existing practice. The condensate polishing plant shall consist of 4 x 33% capacity service vessels for the unit. The resins to be used would be strongly acidic cation and strongly basic anion type, appropriate for condensate

polishing system. An external regeneration facility shall be provided. The exhausted charge of resins from the service vessel shall be hydraulically transferred to the resin separation/cation regeneration vessel for regeneration and reuse. One additional charge of resin shall be procured for use during start-up of the unit. Acid, Alkali & DM Water Storage for regeneration, and Wastewater Neutralization facilities shall be provided separately for the external regeneration facility.

**CW Treatment System**

It is proposed to provide suitable Chemical treatment program of acid dosing and scale cum corrosion inhibitor for the CW system for control of CW System water chemistry. It is proposed to provide acid & chemical storage tanks and respective dosing pumps as a part of CW treatment system. The plant shall be provided with neutralization pits, disposal pumps with required corrosion measurement rack, instrumentation for interlocks and controls, control panels etc. to facilitate safe & reliable operation.

### 2.9.2 Liquid Effluent Treatment Plant

The liquid effluents shall be collected and treated / recycled generally as per the following design philosophy.

**Liquid Effluent Treatment Plant**

The liquid effluents shall be collected and treated / recycled generally as per the following design philosophy.

i) The filter backwash water of PT Plant shall be collected and recycled back to the respective system clarifier.

ii) The sludge from clarifiers of Water PT plants shall be collected in a sump/pit and shall be pumped to bottom ash slurry tank for disposal to existing ash dyke.

iii) The waste effluents from neutralization pits of DM plant and Condensate Polishing Plant shall be collected in the respective neutralization pits and neutralized before pumping to bottom ash slurry tank before final disposal.

iv) CW system blowdown would be used for FGD process water system, Ash handling Plant, $ClO_2$ plant and CW treatment system. Excess CW blow down, if any shall bleed to Central Monitoring Basin (cum treated water tank) for further reuse in service water system.

v) Service water effluent drains from various areas shall be separately routed to a sump. From the sump the service water shall be pumped up to lamella clarifier / tube settler for treatment of suspended solids. Treated service water shall be sent back to service water tank for re-use through CMB cum treated water tank.

### 2.9.3 Coal Handling System

Existing Coal handling plant shall be used for new stage. Existing Track Hoppers, WT, Crusher House and Coal Stackyard shall be used for new unit.

Interconnection from existing Transfer point to be done to feed Coal for new unit. Existing Coal Conveying rate (2600 TPH) shall meet the Coal requirement of the proposed unit.

Interconnection of proposed Coal Conveying system shall be from downstream Conveyors of existing conveyor. Proposed new Belt Conveyors-32, 33, 34A/B, 35A/B, 36A/B, 37A/B, 38, 39 shall be provided.

Proposed new Transfer points (TP-26,27,28,29,30,31) shall be required for Coal Conveying upto Coal Bunkers of new unit. Mobile Trippers (2 Nos. complete) shall be used to feed Coal into Coal Bunkers.

Associated system like Dust Suppression, PW, SW, CW etc., shall be provided.

Existing Transfer Points TP-17, TP-24 and TP-25 are required to be modified for additional chute work & Flap Gate arrangements for proposed conveying stream.

2.9.4 Limestone and Gypsum Handling System

Limestone received by trucks shall be unloaded in the underground hoppers. Provision shall be kept for unloading of 2 trucks continuously.

Limestone received at power plant shall be conveyed to the crusher house for sizing of limestone to (-) 20 mm using belt feeders and bucket elevators. A limestone sampler shall be provided in the limestone crusher house.

From the crusher house the crushed limestone shall be stored, using belt feeders and bucket elevators in storage silos. Two (2) numbers of silos are proposed for limestone storage. From the storage belt feeders and bucket elevators will feed limestone to a transfer point from where the same shall be conveyed by conventional conveyors to transfer house near the FGD area. From the transfer house the limestone shall be fed to the silos in FGD area using belt feeders and bucket elevators. Dust extraction and service water system shall be provided throughout the limestone handling plant.

2.9.6 Steam Generator and Auxiliaries

The Steam generators (SG) shall be Ultra-Supercritical, Once through, Water tube, Direct pulverized coal fired, Top supported, Balanced draft furnace, Single reheat, Radiant furnace, Dry bottom type, suitable for outdoor installation. The gas path configuration shall be single pass (tower type) or two pass type. Higher steam parameters with supercritical technology is proposed for the project to have the advantage of higher efficiency / reduced heat rate and reduced environmental emissions. Supercritical units are more efficient than the conventional sub-critical units as these operate on higher steam parameters. This results in lowering of coal consumption and corresponding reduction in emissions. The plant efficiency is expected to be around 41.5- 42% as compared to Subcritical which has efficiency of around 37%. Supercritical units shall bring down the CO2 emissions by 12-13% as compared to conventional sub-critical power plants. The steam Generator and its auxiliaries shall be designed for firing

Indian coal identified for this project. Steam Generator design shall be suitable for variable pressure operation from 30% to 100% BMCR.

The main parameters at 100% BMCR will be as follows:

**TABLE-2.7**
**DETAILS OF THE STEAM GENERATOR**

| Sr. No. | Particulars | Value |
|---|---|---|
| 1 | Main steam flow at superheater outlet | 2580 TPH |
| 2 | Main steam pressure at superheater outlet | 281 kg/cm$^2$ (abs) |
| 3 | Main steam temperature at superheater outlet | 603 $^oC$ |
| 4 | Steam flow to reheater (CRH) | 1995 TPH |
| 5 | Steam temperature at reheater outlet | 603-613 $^oC$ |
| 6 | Feed water temperature at economizer inlet | 307 $^oC$ |

It is envisaged to co-fire 20% biomass (with respect to heat input of the total BMCR capacity) along with coal in the steam generator. The same is to be achieved by way of mixing the prepared biomass as a co-firing fuel in the pulverisers through coal feed bunkers. Suitable space for $CO_2$ Capture, $H_2$ Production and Methanol Production shall be kept.

*Furnace and Convection Zone*

The furnace will be radiant, dry bottom type with tangential wall firing and enclosed by water cooled and all welded membrane walls. The furnace bottom shall be suitable for installation of water impounded bottom ash system, submerged scrapper chain conveying system and also for dry type of bottom ash handling system. Spray type attemperators are envisaged to control the super heater and reheater outlet temperature for varying loads. The superheater and reheater tubes will be a combination of radiation and convection type. Economizer will be non-steaming type and shall be of modular construction.

*Steam Generator Circulation System*

The furnace containment will be formed by membrane walls and will consist of vertical plain in the upper part and wrap around helical tubes in the lower part. The steam generator start up system envisages SG start up drain system with SG start up drain circulation pump. Separator(s) will be used during start up for separating the steam water mixture upto the minimum once through load, above which it will be running dry.

*Air and Flue Gas System*

A balanced draft system will be provided. There will be two axial type Forced Draft (FD) fans and two axial type Induced Draft (ID) fans. Regenerative rotary type Air Pre-Heaters (APH) will be used to heat primary and secondary air. The configuration of air heaters can either be two tri-sector air heaters or four bisector air heaters (two bisector air heaters for secondary air system and two bisector air heaters for primary air system). Two steam coil air pre-heaters (in case of tri-sector APH) or four steam coil air pre-heaters - two on primary and two on secondary air system (in case of bisector APH), will be provided for start-

up, low load operation or abnormal conditions when an increased air inlet temperature is considered desirable to minimize the cold end corrosion of regenerative air pre-heaters.

*Fuel Oil System*

Light Diesel Oil (LDO) shall be used for initial start-up, low load operation and as secondary fuel for pulverized coal flame stabilization at the start ups/low load operations. Necessary oil supply scheme with pumps, filters and valves will be provided. The burners, air registers etc. will have independent pneumatic drives and the entire operation of purging, insertion, air and fuel sequencing shall be automatic. Ignition of oil shall be directly by igniters. LDO system shall be sized for 30% BMCR capacity of the Steam Generators. Steam Generator will be so designed that oil firing for flame stabilization will not be required beyond 40% BMCR.

*Coal Preparation & Firing System*

The coal burning system will comprise of coal mills of vertical spindle type bowl mills. The number and capacities of the mills shall be so selected that while firing the worst and design coals at BMCR/ TMCR, the following spare capacities are ensured.

- With 90% mill loading of the working mills, no spare at 100% BMCR while firing the worst coal;
- With 90% mill loading of the working mills, at least one mill will be spare while firing the design coal at 100% BMCR;
- With 90% loading of the working mills at least one mill will be spare at 100% TMCR load with worst coal firing; and

Coal from raw coal bunkers will be fed into the mills by belt driven gravimetric coal feeders.

There will be two axial type Primary Air (PA) fans for transporting the pulverized coal from mills to the coal burners through pulverized fuel pipes. Two seal air fans will be used for fulfilling the sealing air requirement of all the mills.

*Auxiliary Steam System*

The unit will be provided with two Auxiliary Pressure Reducing & De-superheating Stations (PRDS) i.e. high capacity and low capacity PRDS taking their steam tap-offs from MS line and CRH line respectively. The high capacity auxiliary PRDS will be designed for a minimum capacity of 190 T/hr. Low capacity auxiliary PRDS will be sized for a minimum capacity of 35 T/hr. and will be operated during the normal operation of the unit. Auto-change over between the low and high capacity aux. PRD stations depending on the station auxiliary steam requirement is also envisaged. For station services, common station auxiliary steam headers taking its tap off from the unit auxiliary PRD stations will also be provided. An interconnection shall be provided at station header with auxiliary steam header of existing Stage. Auxiliary steam when sourced through this interconnection shall

be available at a maximum rate of 60 T/hr. with parameters 16 ata / 310 °C, at Stage-II. The provision will also be made for interconnection with future units.

2.9.7 Environment Control

The steam generator shall be designed to comply with the notification dated 7th December 2015 of Ministry of Environment, Forest and Climate Change, which limits the emission of particulate matter to 30 mg/Nm$^3$, $SO_2$ emission to 100 mg/Nm$^3$ and NOx emission to 100 mg/Nm$^3$ for thermal power plant units to be installed after 1st January 2017. The emission control shall be achieved through steam generator design features and through external control equipment.

*Electrostatic Precipitator*

It is proposed to install adequately sized electrostatic precipitator having an efficiency that limits the outlet emission to the applicable value of 30 mg/Nm$^3$. The electrostatic precipitators will have adequate numbers of parallel gas streams, isolated from each other on the electrical as well as gas side and will be provided with gas tight dampers at inlets and outlets of each stream, so as to allow maintenance to be carried out safely on the faulty stream, while the unit is working. Electrostatic precipitator will be provided with transformer rectifier sets, microprocessor based programmable type rapper control system and ESP management system to ensure safe and optimum operation of ESP.

The dust collection hoppers at all strategic locations will have a minimum storage capacity of eight hours. The hoppers will have heating arrangements to prevent ash sticking to the sloping sides and down pipes. Level indicators to indicate ash levels in the hoppers and trip the ESP in case of high ash levels in the ash hoppers are also envisaged to ensure safety of ESP.

In order to meet the environment norms and maintain the sustained efficiency of ESP, it shall be adequately designed with sufficient margins for all operating conditions. The Electrostatic Precipitator Management System (EPMS) in conjunction with opacity monitor shall continuously monitor and maintain the optimum energy level to achieve higher efficiency of ESP.

*NOx Control System*

NOx emission from the steam generator shall be reduced to the applicable standard by employing:

- Low NOx Burners (LNB) which reduces the air available to the fuel stream during the devolatilization process and thus reduces NOx production;
- Combustion staging which is based on creation of fuel rich combustion zone through separation of part of secondary air which is added downstream of main combustion zone as Over Fire Air (OFA); and

*Flue Gas Desulphurization System*

Wet limestone based Flue Gas Desulphurization (FGD) system shall be installed at the tail end of the steam generator downstream of the ESP to reduce $SO_2$ emission to the applicable value of 100 mg/Nm$^3$. The FGD shall be provided with

limestone slurry preparation system which shall grind limestone to desired fineness. The FGD shall have a scrubber as the main reaction vessel in which $SO_2$ gas shall be captured in limestone slurry to produce gypsum byproduct. The scrubber shall be provided with bypass system. Necessary auxiliary equipment and systems like mills, cyclones, vacuum filters, belt conveyors, pumps, storage vessels, piping and fittings etc. shall complete the FGD plant. Following elevators shall be provided for easy access & movement of man/materials in FGD plant.

- One (1) number passenger cum goods elevator of minimum capacity of 1000 kgs for each absorber and
- One (1) number passenger cum goods elevator of minimum capacity of 1000 Kg in Gypsum System Building.
- One (1) number passenger cum goods elevator of minimum capacity of 1000 Kg in Gypsum Dewatering Building.
- One (1) number passenger elevator of minimum capacity of 680 Kg in MCC cum control room building of FGD plant.

*Auxiliary Boiler*

To meet the auxiliary steam requirement for cold start of the unit, a start-up auxiliary boiler of suitable steam parameter with LDO shall be installed to meet the requirement of the unit during black start-up. Auxiliary boiler shall be connected to auxiliary PRDS system suitably.

### 2.9.8 Turbine and its Auxiliaries

The scope of TG unit of 800 MW shall broadly cover the Steam Turbine along with its integral systems and auxiliaries like lube oil system, control fluid system, condensers, condenser air evacuation system, COLTCS, HP & LP Bypass system, complete regenerative feed heating system, condensate pumps along with their drives, boiler feed water pumps along with their drives, automatic turbine run-up system, instrumentation and control devices, turbine supervisory instruments, turbine protection and interlock system, automatic turbine testing system and turbine hall EOT cranes.

*Steam Turbine*

The steam turbine shall be tandem compound, single reheat, regenerative, condensing, multi cylinder design with separate HP, separate IP and two separate LP cylinders, OR combined HP-IP and two separate LP cylinders, directly coupled with the generator suitable for indoor installation. The plant would be designed to operate as a base load station. However, continuous operation under two-shifts and cyclic modes during certain periods of the year is also envisaged. The turbine design shall cover adequate provision for quick start-up and loading of the unit to full load at a fast rate. The turbine shall be capable of operating on variable pressure mode as well as modified sliding pressure mode. The turbine shall be provided with suitable margins for VWO flow.

*Condenser*

Single pass or double pass condensers with stainless steel tubes of welded type as per ASTM-A-249-TP316L shall be adopted. The condenser shall be with divided water box construction. It shall be horizontal, surface type with integral air-cooling section. Condenser hot-well shall be sized for three (3) minutes storage capacity (between normal and low-low level) of total design flow with the turbine operating at VWO condition, 3% make up, and 77 mm Hg (abs) condenser pressure. The condenser shall be adequately sized to cater to all the conditions of turbine operation including the abnormal operating conditions such that condenser would not be a bottle neck at any stage of operation. The exact condenser parameters shall be optimized on the basis of site data and most economical combination of cooling surface and circulating water quantity. The condenser shall be designed, manufactured and tested in accordance with the latest applicable requirements of the Heat Exchange Institute (HEI), USA. Provision of separate sponge rubber ball type condenser onload tube cleaning system for each half of the condenser including ball circulation pumps, strainer, ball monitoring system etc. shall be made.

*Air Extraction System*

The unit shall comprise of 2x100% vacuum pumps for each condenser shell along with all accessories and instrumentation for condenser air evacuation. The vacuum pumps and accessories shall be used to create vacuum by removing air and non-condensable gases from steam condenser during plant operation. Vacuum pumps shall be of single/two stage liquid ring type with both stages (if two-stage pump is selected) mounted on a common shaft. Vacuum pumps shall be sized as per latest HEI requirements.

*Gland Steam Sealing System*

A fully automatic gland sealing steam supply system shall be provided for TG set & the turbine drives for BFPs. HP and IP turbine shaft glands will be sealed to prevent escape of steam into the atmosphere and the LP turbine glands will be sealed for preventing leakage of atmospheric air into the turbine. Steam will be used for sealing these springs backed labyrinth glands. During start-up and low loads (say upto 40% load), seal steam will be supplied to the turbine glands from the auxiliary steam header through a seal steam regulating valve. During normal operation (say above 40% load), the HP and IP turbines will be of self-sealing type and under that condition, the auxiliary steam source will be cut off and the leak-off steam from HP and IP glands will be used for sealing the LP glands. The excess leak-off steam will go to the condenser. A gland steam condenser will be provided to condense and return to the cycle, all gland leak off steam including that from BFP turbines. 2x100% capacity vapour exhausters shall be provided to remove non-condensable gases from the gland steam condenser. The exhaust gases shall be left above the TG Hall roof level.

*Governing / Regulation System*

The turbine will have throttle or nozzle controlled type governing. Steam turbine governing and protection system shall be complete with electro hydraulic governor with suitable back-up as per standard practice of the manufacturer. The governing system shall be highly reliable and operationally safe and it shall be capable of controlling with stability the speed of the turbine at all power outputs between zero and the specified maximum power output when the unit is operating isolated or when the unit is operating in parallel with the other units. The turbine governing system shall be designed for high accuracy, speed and sensitivity of response. The governing system shall limit the over speed of the turbine on loss of full load to value less than over speed trip set point. The steady state regulation shall be adjustable within +3% to +8% of the rated speed. The dead band at rated speed and at any power output within the rated output shall not exceed 0.06 % of the rated speed.

*HP/LP Bypass*

The HP and LP bypass stations shall be capable of meeting the following requirements:

- Quick start-up of the steam generator from cold, warm & hot conditions;
- Parallel operation of the bypass with turbine in the event of large load throw off;
- House load operation followed by complete external load throw-off;
- To keep the steam generator in operation so as to avoid a fire out in the steam generator following full load rejection; and
- The HP/LP Bypass system shall be sized for about 65 % of BMCR steam flow (exact capacity shall be decided later) with rated main steam parameters at upstream of valves. The LP bypass will be sized for steam inlet conditions (pressure and temperature) of HRH line corresponding to about 60 % TMCR.

**Power Cycle Piping**

- Power cycle piping shall cover piping systems for main steam, hot reheat, cold reheat, HP & LP bypass, aux. steam, feed water, condensate, various extractions to heaters, deaerator & BFPT, heater drains & vents, spray to re-heater attemperation/ Aux. PRDS / HP bypass valves, etc.

  For the design, engineering, fabrication, erection, testing and commissioning of aforesaid power cycle piping systems mentioned at point no.1 above, ASME 31.1 (latest edition) shall be considered, as being followed in SC /USC power projects. However, for piping systems coming under the purview of IBR, requirements as laid down in Indian Boiler Regulations (latest edition) are to be met additionally.

The materials envisaged for power cycle piping systems are generally carbon steel for design temperature up to & including 400 deg C and alloy steel for design temperature 400 to $610^0$ C. However, for design temperatures above $610^0$C, Inconel/ nickel-based alloy steels are envisaged.

All piping sub-assemblies /components /fittings (like valves, reducers, tees, elbows, bends, etc.), pipe attachments etc. are to be of the same material as that of pipe.

2.9.9 Ash Handling System

The principal features of this system shall be:

(a.) A wet ash conveying system for ash collected in the boiler furnaces and economizer hoppers, Eco outlet Duct Hoppers and SCR hoppers (Design only), including treatment system of Bottom ash hopper overflow water.

(b.) A dry fly ash conveying system for the ash collected in electrostatic precipitator's collection.

(c.) A pressurized dry fly ash transportation and storage system including dry fly ash storage silos for Road/Rail loading.

(d.) Bottom ash and Economizer ash slurry handling system from respective hoppers to Combined Ash Slurry Pump House.

(e.) Dewatering Bin system for Bottom ash slurry

(f.) Ash water supply system.

(g.) Combined (Bottom+ Fly) ash slurry disposal pumping system taking suction from the combined ash slurry sump delivering ash slurry in Ash Dyke.

(h.) Ash Water recirculation system shall not be required, existing AWRS shall be sufficient for new stage.

**Fugitive Dust Suppression System**

Fugitive dust suppression system for existing combined ash slurry dyke disposal area shall be provided.

2.9.10 Fire Protection System

A comprehensive fire detection and protection system is envisaged for the complete power station. This system shall generally be as per the recommendations of TAC (India)/ IS: 3034 & NFPA- 850/equivalent standard.

i.) The existing Fire Water Pumping & Pressurizing System shall be used to cater requirements of Stage-III. No Fire Water Pump House & Fire Water Tanks have been envisaged in Stage-III.
ii.) Tap off at suitable locations shall be taken from existing fire water mains/header (for both hydrant & spray system).
iii.) In addition to above, hydrant & spray booster pumps shall be located in the fire water booster pump house (in Boiler area of Stage-III) for hydrant

and spray system and the same shall be driven by electric motors and diesel engines as per the regulations of TAC.

iv.) 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.

v.) Automatic high velocity water spray system for all transformers located in transformer yard and transformers having oil capacity of 2000 liters and above located within the boundary limits of plant, Main and unit turbine oil tanks and purifier, oil canal, generator seal oil system, lube oil system for turbine driven boiler feed pumps/lube oil console, boiler burner fronts, fuel oil station rack in boiler, etc. This system shall consist of QB detectors, deluge valves, projectors, valves, piping & instrumentation. Automatic Nitrogen injection system for all transformers located outside plant boundary where water-based fire protection system not envisaged (of rating 10 MVA and above or in case of oil filled transformers with oil capacity of more than 2000 liters).

vi.) Automatic medium velocity water spray system for cable vaults and cable galleries of main plant, switchyard control room and ESP control room, FGD building consisting of smoke detectors, linear heat sensing cable detectors, deluge valves, spray nozzles/projectors, isolation valves, piping, instrumentation, etc.

vii.) Automatic medium velocity water spray system for coal conveyors, & TPs (as applicable), biomass conveyors & TPs consisting of QB detectors, linear heat sensing cables, deluge valves, nozzles, piping, instrumentation, etc.,

viii.) Automatic medium velocity water spray system for fuel oil pressurizing pump house consisting of QB detectors, deluge valves, nozzles, piping, instrumentation, etc.

ix.) For protection of Central control room, Control equipment room, Programmer room, UPS room, etc. Inert Gas extinguishing system as per NFPA-2001 would be opted.

x.) Fire detection and alarm system-microprocessor based 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. 1. Multisensor type smoke detection system 2. Linear heat sensing cable detector. 3. Quartzoid bulb heat detection system. 4. Infra-red type heat detectors (for all coal & biomass conveyors)

xi.) Portable and mobile extinguishers, such as pressurized water type, carbon-dioxide type, foam type, dry chemical powder type, shall be provided at strategic locations throughout the plant.

xii.) Complete instrumentation and control system for the entire fire detection and protection system shall be provided for safe operation of the complete system.

## 2.10 Sources of Pollution

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

- Air pollution;
- Water pollution;
- Solid waste; and
- Noise pollution.

The major type of pollution from the power plant is gaseous emissions. In addition, wastewater and solid waste will also be generated. The quantities and the composition of the gaseous, liquid and solid waste that are likely to be generated in the plant will be managed and treated such that their final disposal into the environment meets all the statutory requirements and thus the environmental impacts are minimized.

### 2.10.1 Air Emissions

The major pollutants emitted from the power plant stack will be $SO_2$, NOx and particulate matter. Proper control measures as described below will be installed to minimize the stack emissions within the stipulated/permissible limits prescribed by MOEF&CC vide notification dated 07.12.2015 and 28.06.2018.

- ***Particulate Matter***

Particulate Matter (PM) is one of the important pollutants from the proposed power plant. High efficiency (>99.98%) electrostatic precipitators are proposed to be installed to limit the particulate matter emissions to below 30 mg/$Nm^3$. One chimney of 150 m height with single flue is envisaged for better dispersion of the gaseous emissions.

- ***Sulphur dioxide***

The sulphur content in coal is about 0.36%. Wet limestone-based flue gas desulphurization (FGD) system shall be installed at the tail end of the steam generator downstream of the ESP to capture $SO_2$. The $SO_2$ emissions from the stack will be limited to below 100 mg/$Nm^3$.

- ***Oxides of Nitrogen***

NOx emission values from the steam generator shall be limited to the applicable values by employing Low NOx Burners (LNB) and combustion staging.

### 2.10.2 Liquid Waste Generation

Zero Liquid Discharge (ZLD) system will be adopted and no effluent will be discharged from proposed project. Blow down from cooling towers will be the main sources of the wastewater that will be reused in FGD, service water system, CHP etc. Besides this, DM plant waste, domestic waste from canteen and toilets

will be the other wastes generated. The treated wastewater from sewage & effluent treatment plant will be used in greenbelt development. The complete power plant shall be designed as a Zero Liquid Discharge (ZLD) Plant. The wastewater likely to be generated from proposed project is given in **Table-2.8**.

**TABLE-2.8**
**WASTEWATER GENERATION FROM THE PROPOSED POWER PLANT**

***All Values are given in $m^3/hr$***

| Wastewater Stream | Effluent Generation ($m^3/hr$) | Effluent Discharged from Plant ($m^3/hr$) | Treatment/Recycle/ Reuse envisaged |
|---|---|---|---|
| Clarifier sludge | 70 | Nil | Reuse into ash slurry sump |
| Tube settler sludge | 9 | Nil | Disposal to ash water tank |
| Filter backwash | 10 | Nil | Recycle to DM clarifier inlet |
| DM neutralization pit regeneration waste | 5 | Nil | Recycled to ash slurry sump |
| Domestic sewage | 24 | Nil | Treatment in existing sewage treatment plant & reuse in plantation & horticulture |

*Source: NTPC*

Adequate storm water drains will be constructed along the boundary of the plant area and within the plant area to drain off the storm water during monsoon period.

### 2.10.3 Solid Waste Generation

Solid waste generated during construction and demolition will be managed as per Construction and Demolition Waste Management Rules, 2016. Ash and Gypsum shall be the major solid waste likely to be generated from Stage-III. The ash management scheme involves dry collection of bottom ash and fly ash, supply of ash to entrepreneurs for utilization, promoting ash utilization and safe disposal of unused ash (if any). NTPC shall make maximum efforts to utilize the ash for various purposes. During emergency, unused fly ash and bottom ash shall be disposed-off through combined High Concentration Slurry Disposal System (HCSD) in the existing ash pond. A blanket of water shall be maintained over the entire bottom ash pond to control fugitive dust emission. Gypsum generated from FGD system shall also be utilized/ disposed of in an environmentally suitable manner. The domestic solid waste generated from plant and township will be disposed as per statutory rules and regulations.

### 2.10.4 Noise Pollution

The major noise generating sources are turbines, generators, compressors, pumps, fans, coal handling plant etc. Acoustic enclosures shall be provided to control the noise level below 90 dB(A). Personal protective equipment's shall be provided to the persons working in high noise area.

The noise levels expected from various noise generating sources in the proposed expansion of power plant are given in **Table-2.9**.

**TABLE-2.9**
**SOURCE NOISE LEVELS IN THE PROPOSED PLANT**

| Sr. No. | Unit | Expected Noise Level dB(A) [1m away] |
|---|---|---|
| 1 | Turbine unit | 80-85 |
| 2 | Boilers | 80-85 |
| 3 | Air compressors | 80-85 |
| 4 | Transformer | 70-75 |

- *Noise Control*

Acoustic enclosures will be provided wherever required to control the noise level below 90 dB(A). Anywhere not possible technically to meet the required noise levels, personal protection equipment will be provided to the workers. The wide greenbelt around the plant will work as green mufflers to attenuate the noise level dissemination outside the plant boundary.

## 2.11 Infrastructure for Labours/Drivers

The basic amenities for the labour force during construction and operation phase are proposed. The facilities comprise the following:

- Separate shelters will be provided for male and female labours/drivers for resting;
- Separate washrooms (sanitary facilities) will be provided for male and female labours;
- The contractors will be directed to provide fuel to labours for cooking;
- The first aid facilities will be made available; and
- Safe drinking water will be provided.

Beside above provisions, measures and facilities will be provided for labour force as per Factory Act.

➢ Residential Area

Township at Sipat is already established and functional. Existing dwelling units are sufficient for the purpose of residential requirements of the expansion project. However, following are required as extension of existing facilities in township area/ new facilities in CISF colony:

- Guesthouse - Additional guest rooms and waiting area for drivers;
- Executive Club - Sports complex building, swimming pool and gym extension;
- Welfare Club - Dining hall complex and sports complex; and
- CISF Colony - Sub officer hostel and community center.

## 2.12 Sustainable Development Mechanism (SDM)

Kyoto Protocol of United Nations Framework Convention on Climate Change (UNFCCC) has come into force from February 2005. Clean Development Mechanism (CDM) contained in Article 12 of the protocol allows governments or private entities in the industrialized countries to implement and / or purchase emission reduction from projects in developing countries and receive credit in the form of "Certified Emission Reductions" (CERs). With the completion of tenure for second commitment period on 31 December 2020, Kyoto Protocol/CDM is no more valid at present. In the meanwhile, The Paris Agreement, second legally binding international treaty on climate change was adopted at COP 21 in Paris on 12 December 2015 and entered into force on 4 November 2016. The agreement brings all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects by reaching global peaking of greenhouse gas emissions as soon as possible to achieve a climate neutral world by mid-century. The Paris Agreement works on a 5- year cycle of increasingly ambitious climate action carried out by countries. Countries submit their plans for climate action known as nationally determined contributions (NDCs), in which they communicate actions they will take to reduce their Greenhouse Gas emissions in order to reach the goals of the Paris Agreement. Article 6 of Paris Agreement provides following mechanisms to all countries to achieve efficiency gains by taking advantage of their differing marginal costs of abatement and thereby potentially facilitate enhanced ambition. Article 6.4: A new international carbon mechanism is envisaged functioning under the authority and guidance of an international body, such as the UNFCCC, for the trading of emissions reductions created anywhere in the world by the public or private sector. This new market is sometimes referred to as the "Sustainable Development Mechanism" (SDM). It would replace the Clean Development Mechanism (CDM). Article 6.2: A basis for countries to engage in various modes of joint market cooperation, including mechanisms such as bilateral/ multilateral crediting mechanisms (at project, program, or policy levels) or linking of existing domestic climate policy instruments under bilateral or multilateral agreements. It will allow a country that has beaten its Paris climate pledge to sell any overachievement to a nation that has fallen short against its own goals. It could be in terms of emissions as well as other types of targets, such as renewable energy capacity or forest expansion. In this regard, it is to be mentioned that at present article 6.0 of Paris agreement is being finalized /negotiated & is likely to be operational by 2023. Sustainable Development Mechanism (SDM) under article 6.4 or Bilateral/ Multilateral crediting mechanisms under article 6.2 provides an opportunity to earn revenue through the reduction of greenhouse gas emissions (GHG). The revenue will play an important role as it will further ameliorate the project IRR. Accordingly, SDM benefits under article 6.4 or Bilateral/ Multilateral crediting mechanisms under article 6.2 are proposed to be availed in this project to improve the Project IRR, whenever these will be operationalized.

# Chapter-3
# Description of the Environment

# 3.0 DESCRIPTION OF THE ENVIRONMENT

## 3.1 Introduction

This chapter illustrates the description of the existing environmental status of the study area with reference to the prominent environmental attributes. The study area covers 10 km radius around the project boundary. The existing environmental setting is considered to adjudge the baseline environmental conditions, which are described with respect to climate, hydrogeological aspects, atmospheric conditions, water quality, soil quality, vegetation pattern, ecology, land use and socio-economic profiles of people.

This report incorporates the baseline data monitored for one year i.e from 20th March 2019 to 19th March 2020 for one year covering all four seasons pre-monsoon, monsoon season, post-monsoon season and winter season. Secondary data has been collected from various Government and Semi-Government organizations.

As the baseline data generation has become more than three years old, a fresh baseline monitoring was undertaken by NTPC through M/s. Mantec Consultants Pvt. Ltd. during Pre-monsoon season (March to May 2023).

## 3.2 Geology and Hydrogeology

### 3.2.1 Geomorphology

The southern part of the district is plain land with gentle slopes. It is also called the Chhattisgarh plains. The land is very fertile and is mostly used for the agriculture purposes. The northern part of the district is mostly hilly with highly undulating topography where the agriculture is restricted to few patches only.

Physiographically the Bilaspur district can be divided into two parts. The first part consists high plateau area covering north and central part of the district (covering Kota, Gaurela, Pendra and Marwahi blocks) separated by the intermittent narrow valleys and steeply slopping plains. The second part is the gently slopping plain land covering southern parts of the district (Takhatpur, Belha and Sipat blocks). The high topographic area on the northern part of the district forms water divide between the rivers Ganges and Mahanadi. The hill ranges on the northwestern part is the water divide between Mahanadi and Narmada Rivers. Major part of the Chhattisgarh basin is drained by Mahanadi River. The topography varies between 250 m amsl in the southern plains and 1120 m amsl in the northern hills. Basically the hill ranges on northern part are due to structural activities and the area on southern part (Chhattisgarh plain) can be categorized as pediplain.

### 3.2.2 Drainage

The Mahanadi River drains about 90% of the area in the district. The Major tributaries of Mahanadi are Seonath, Maghdhara, Sukhad, Jaswa, Sagar, Teswa, Agar, Maniari, Chhotinarmada, Gongha, Arpa, Khurung and Lilagar. Son is the major tributary to the Ganges. The Tipan and Alan nalas are the tributaries to the Son River.

The northern part of the district is characterised by dendritic pattern and the southern part by trellis (sub-parallel drainage pattern). The drainage density

drastically reduces in the plains suggesting the pervious nature of the underlying formations (shale, limestone and dolomite) than the formations on the northern part of the district (granites, gneisses, schists and quartzites). The drainage map of the study area is given in **Figure-3.2.1.**

3.2.3 Geology

Geologically the district can be categorised into three groups.

**i. The Archaean Crystallines:** It consists of granites, gneisses, schists, phyllites and quartzites. Generally occurs in Pendra, Gourela and Kota block of Bilaspur district.

**ii. Precambrian Sedimentaries:** It belongs to Chhattisgarh Supergroup mainly consisting of limestone, shales and dolomites. Generally occurs in Takhatpur, Bilha and Sipat block of Bilaspur district.

**iii. Gondwana Supergroup:** It consists Barakar sandstones and Talchir shales. Generally occurs in Marwahi block of Bilaspur district.

A geological map of Bilaspur showing the location of proposed expansion project site is provided in **Figure 3.2.2**. The mineralogical map of the project site is given in **Figure-3.2.3.**

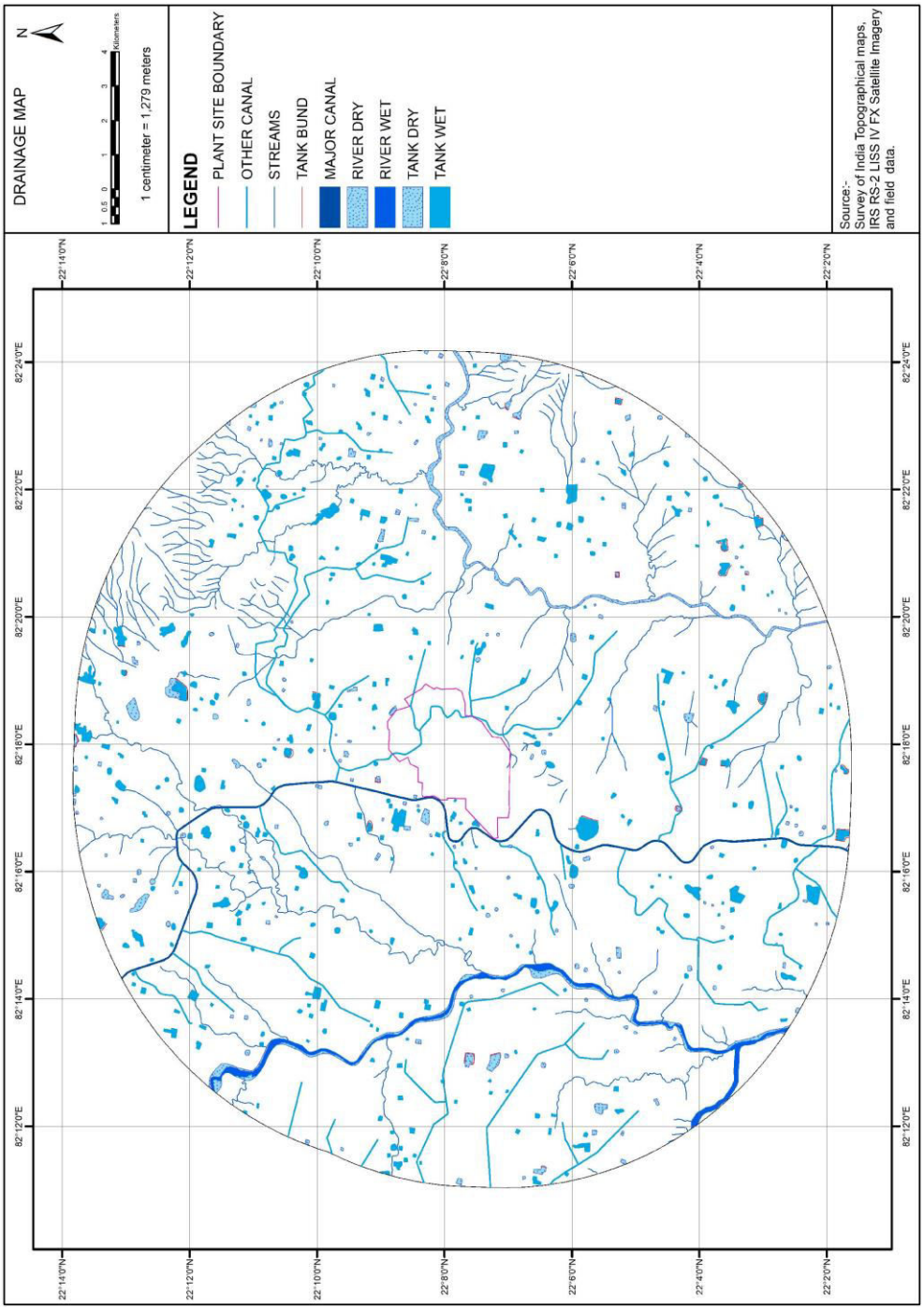



**FIGURE-3.2.1**
**DRAINAGE MAP OF THE STUDY AREA**

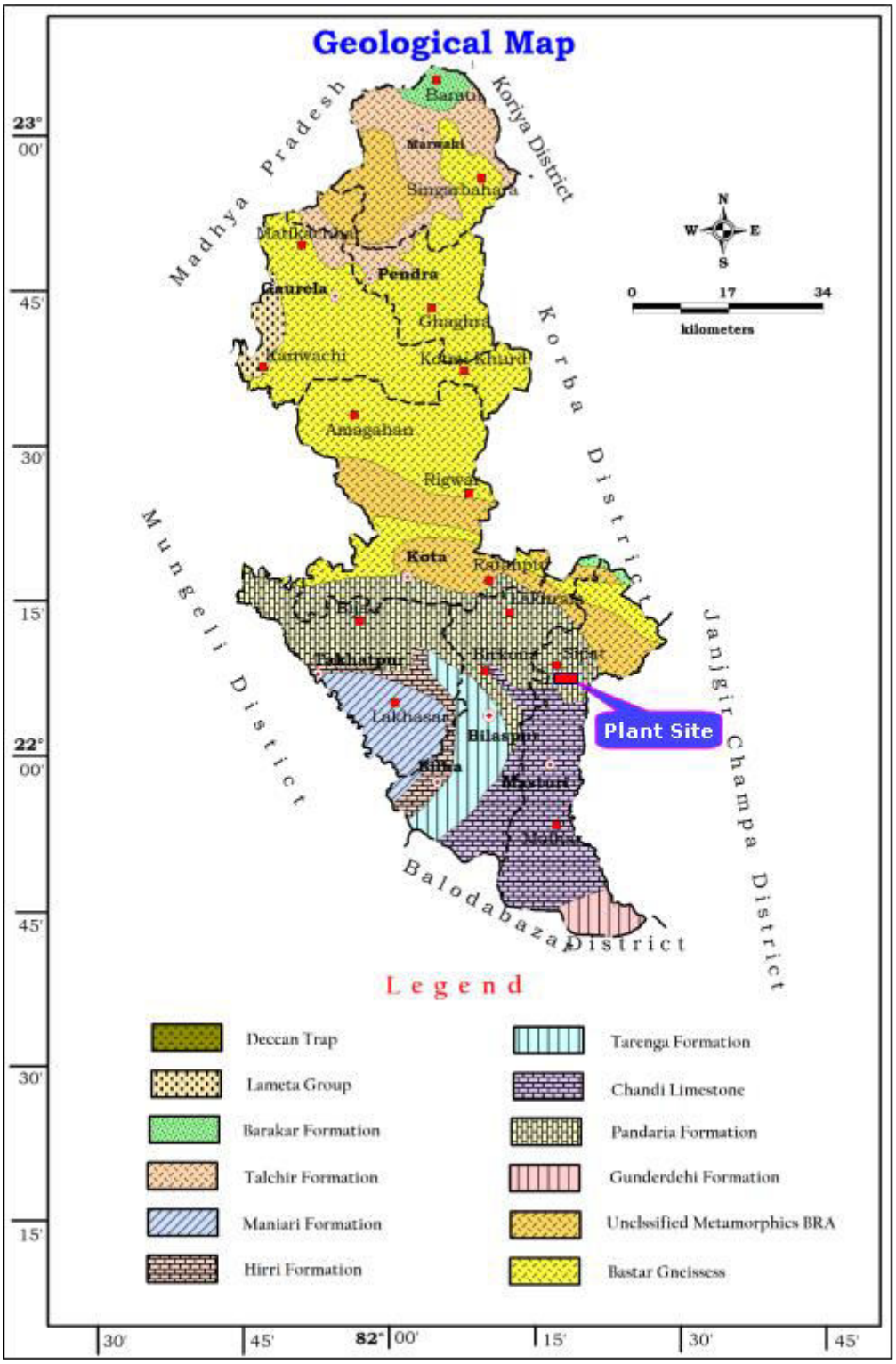



**FIGURE-3.2.2**
**GEOLOGICAL & MINERAL MAP OF BILASPUR DISTRICT**

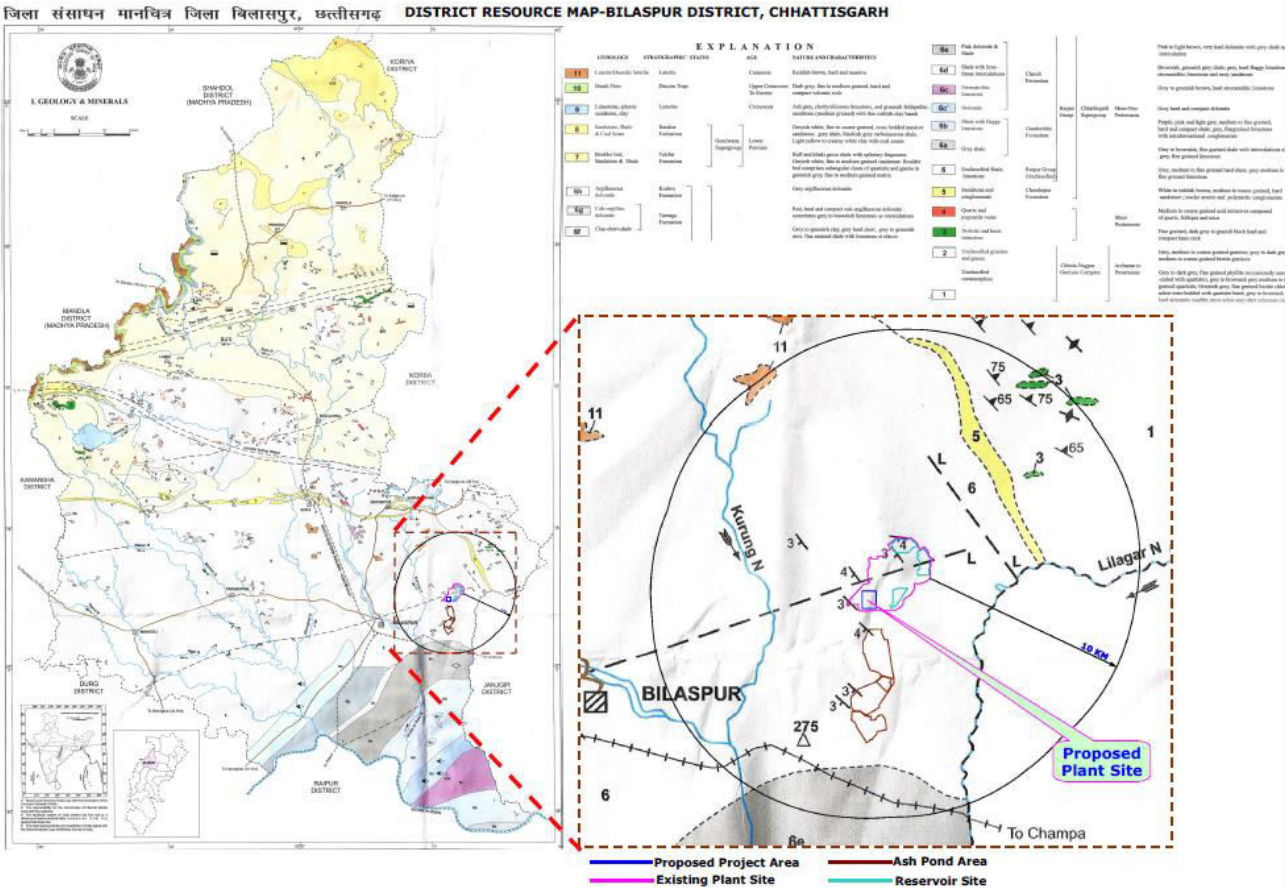



**FIGURE-3.2.3**
**MINERALOGICAL MAP OF THE STUDY AREA**

### 3.2.4 Hydrogeology

The semi-consolidated rocks of study area mainly represented by Kanker granite and Chhattisgarh Super Group of rocks (Predominantly by Maniyari Formation followed by Hirri, Tarenga and Chandi formations), which consists mainly of shale and limestone. In general two aquifers exist in the area. The depth range of the first shallow unconfined/ phreatic aquifer between 4.5 to 37 m bgl and the second fractured aquifer below 15 m bgl. It has been found that within the fractured aquifer, there are 1-6 nos. of water bearing zones are found with different thickness as well as of varying horizontal extent. In the district, key wells were established during the pre-monsoon period and have been subsequently monitored in the post-monsoon period.

- *Water Level Behavior*

As per aquifer mapping and management of ground water resources Bilaspur district, Chhattisgarh – 2020-2021 report the pre-monsoon and post-monsoon depth to water level maps as well as seasonal fluctuation maps have been prepared by CGWB on the basis of the depth to water level periodically monitored data of the key wells established in the district. In the pre-monsoon period, it has been observed that in the district water level in phreatic aquifer vary between 3.37 to 15.10 m bgl with average water level of 7.87 m bgl. In deeper fractured aquifer, water level varies between 4.05 to 45.4 m bgl with average water level of 18.52 m bgl. Pre-monsoon water level map of phreatic aquifer and fractured aquifer of the district is given in **Figure-3.2.4** and **Figure-3.2.5.**

In the post-monsoon period, it has been observed that in the district water level in phreatic aquifer varies between 0.61 to 9.33 m bgl with average water level of 3.68 m. In deeper fractured aquifer, water level varies between 2.1 to 29.57 m bgl with average water level of 9.98 m bgl. Post-monsoon water level map of phreatic aquifer and fractured aquifer of the district is given in **Figure-3.2.6** and **Figure-3.2.7.** The water level fluctuation data indicates that in the district, water level fluctuation in phreatic aquifer varies from 0.15 m to 9 m with an average fluctuation of 4.51 m.

Depth to water level based on ***"Groundwater yearbook of Chhattisgarh, 2021-2022 and National Hydrograph stations of Sipat (pg. 104)",*** the ground water level varies from 9.4 m bgl in pre-monsoon to 9.80-10.10 m bgl during post-monsoon.

- *Aquifer Geometry and Characterization*

Based on the exploratory drilling data generated by CGWB for the blocks of the Bilaspur district, the existing aquifer systems in the area may be divided into two namely phreatic and deeper fractured aquifer.

The major aquifers present in the district is 1. Shale (Maniari and Terenga), 2. Limestone (Pandaria and Chandi) and Granite (Kanker granite). The aquifer map of district is given in **Figure- 3.2.8.**

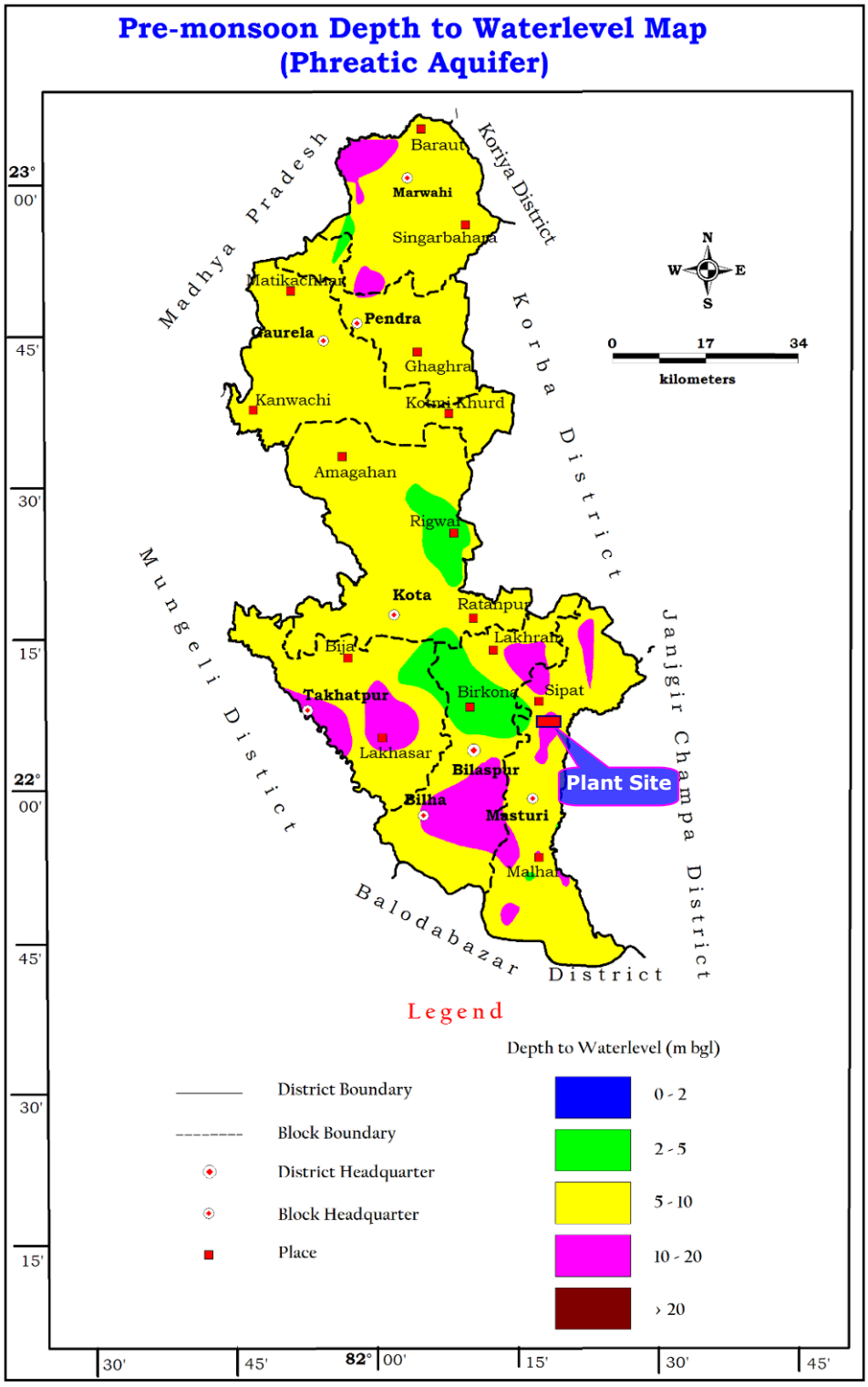



**FIGURE-3.2.4**
**PRE-MONSOON WATERLEVEL MAP OF PHREATIC AQUIFER OF THE DISTRICT**

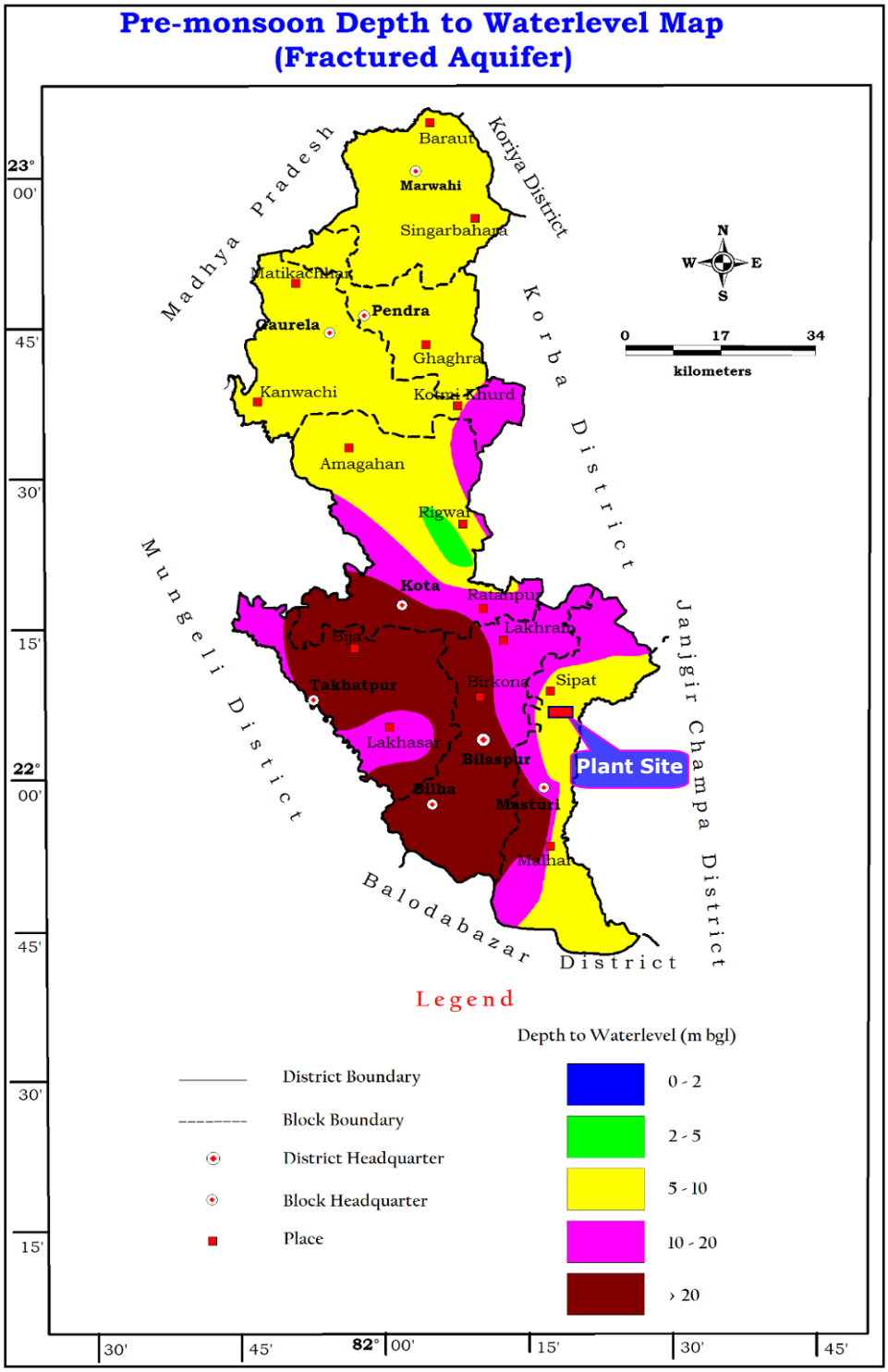



**FIGURE-3.2.5**
**PRE-MONSOON WATER LEVEL MAPS OF FRACTURED AQUIFER OF THE DISTRICT**

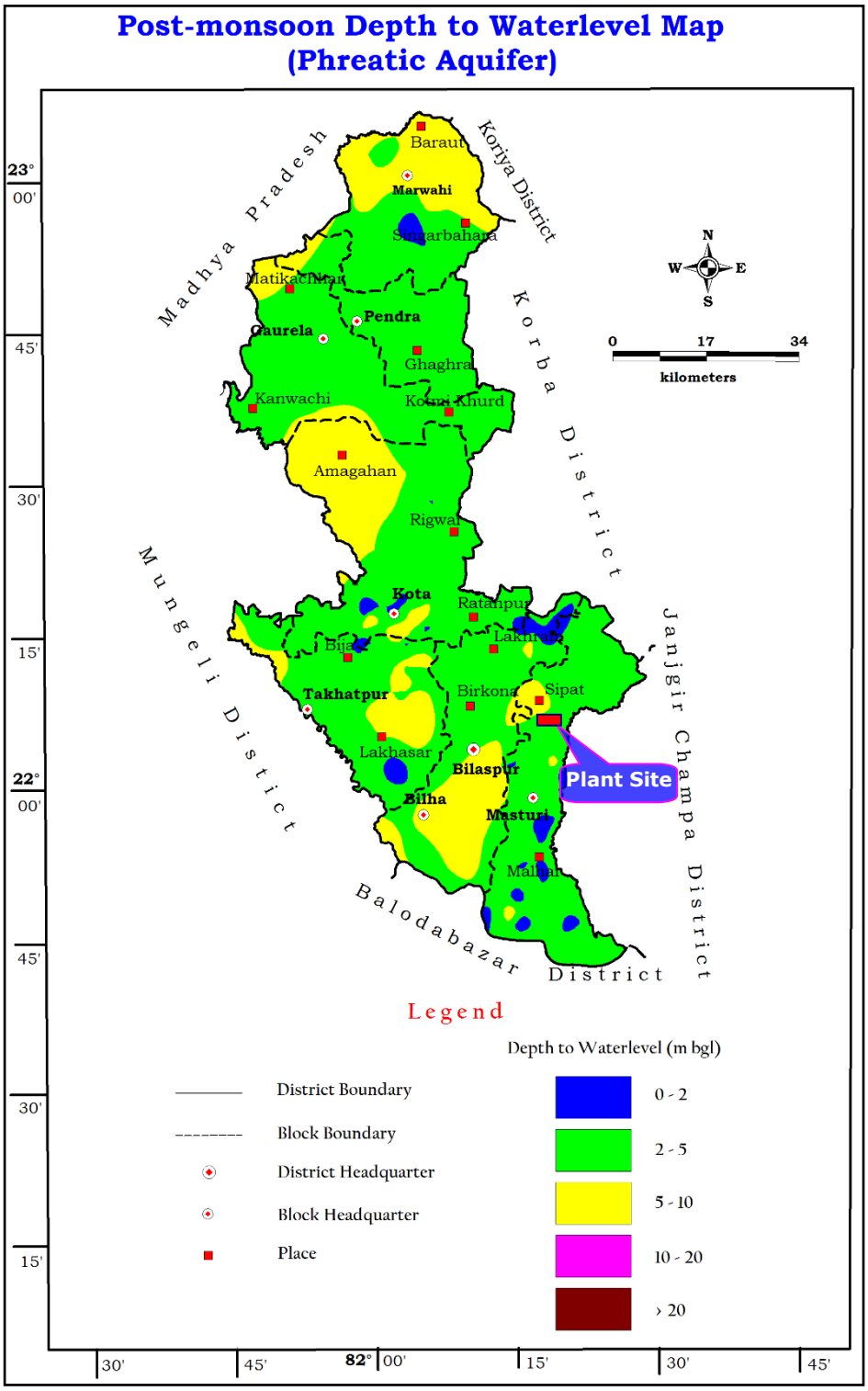



**FIGURE-3.2.6**
**POST-MONSOON WATERLEVEL MAP OF PHREATIC AQUIFER OF THE DISTRICT**

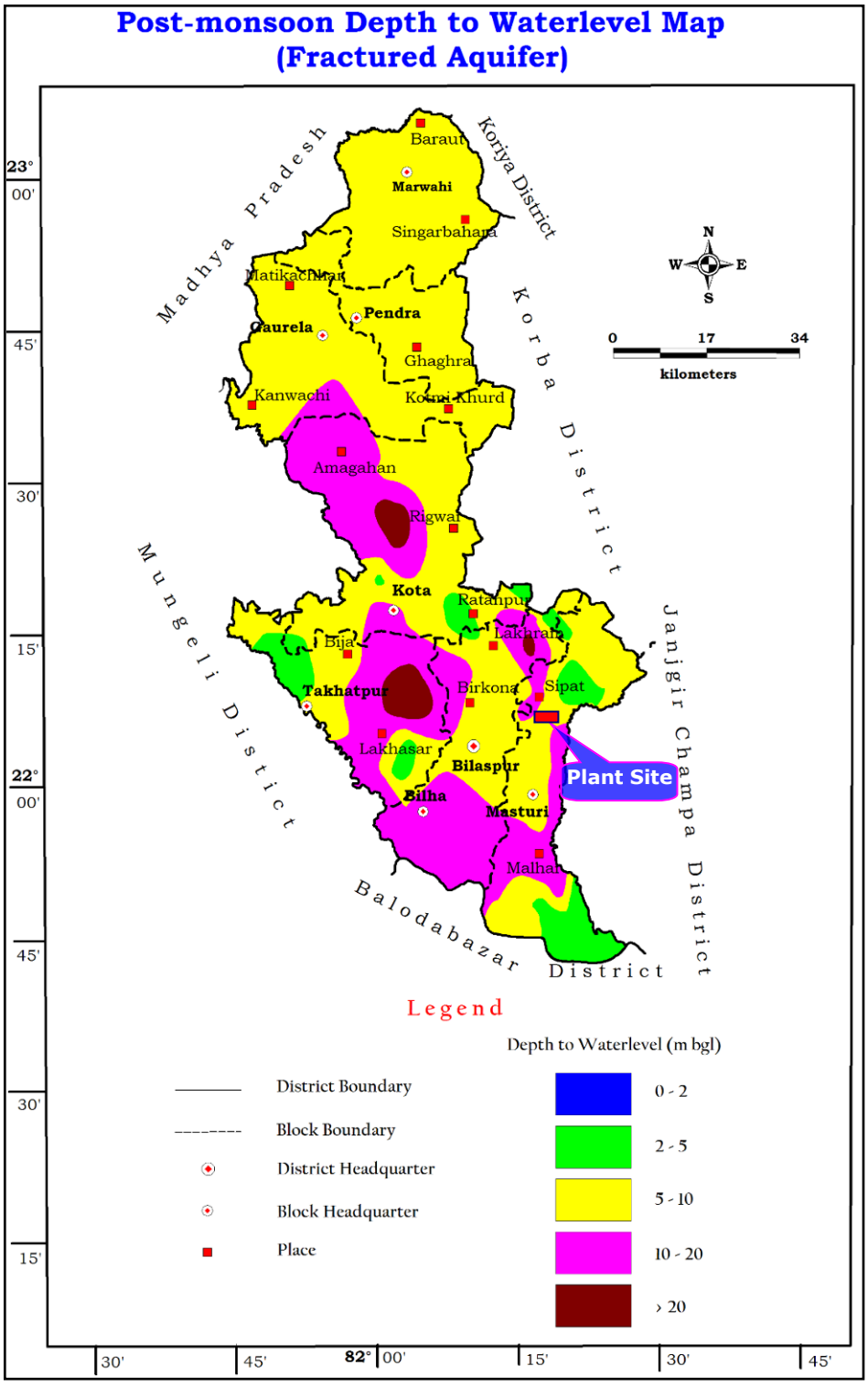



**FIGURE-3.2.7**

**POST-MONSOON WATER LEVEL MAPS OF FRACTURED AQUIFER OF THE DISTRICT**

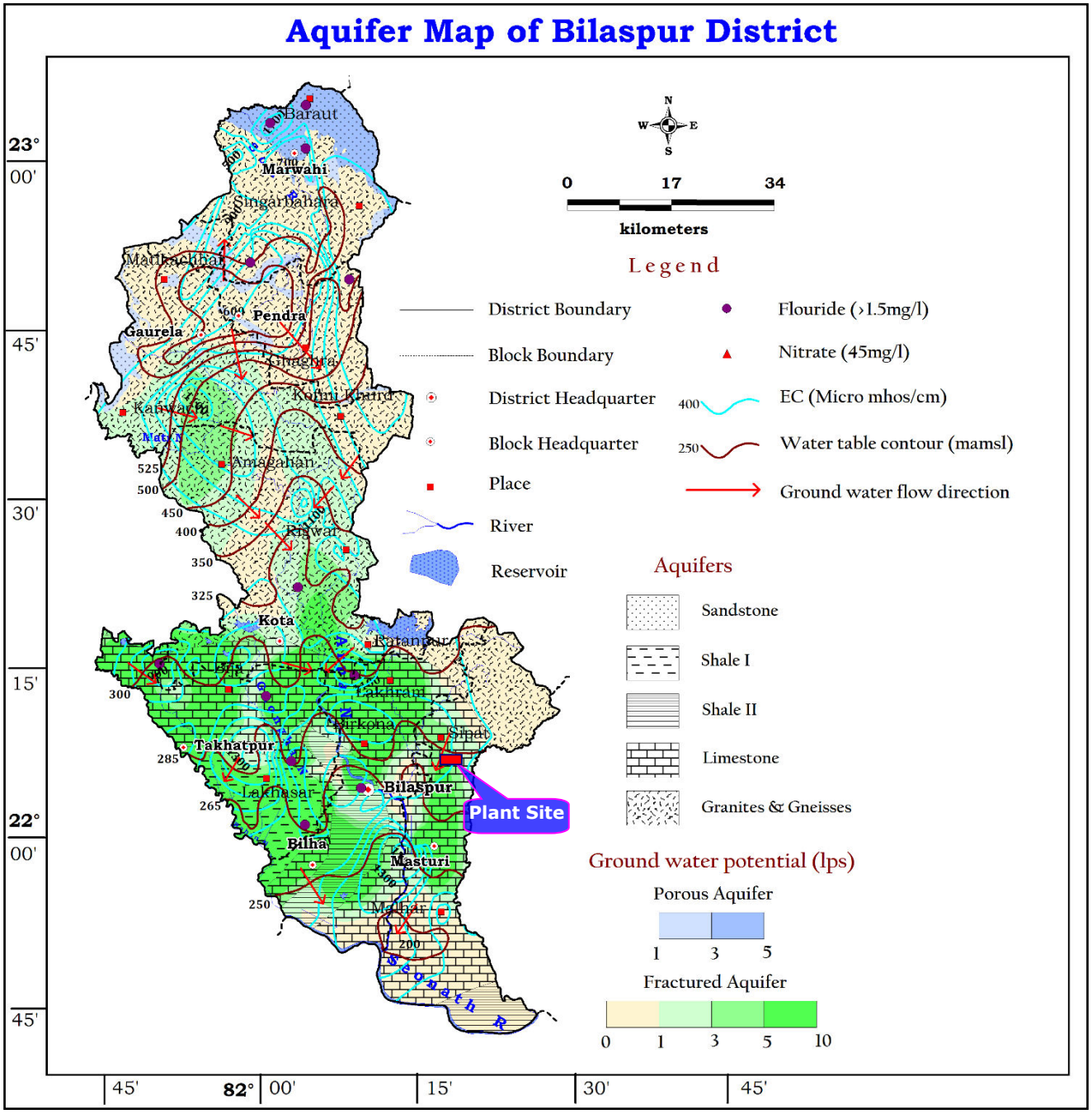



**FIGURE-3.2.8**
**AQUIFER MAP OF THE DISTRICT**

### 3.2.5 Ground Water Resources

- *Ground Water Recharge*

The main source of ground water recharge is by rainfall by direct percolation to the zone of saturation. A significant part of the rainfall is lost as run-off from area while a limited percentage of rainfall therefore reaches zone of saturation and becomes the part of ground water storage after meeting the evaporation and evapo-transpiration losses. There is also ground water recharge from the return flow of irrigation water from dug wells and tube wells operated by the cultivators and from canals.

The dynamic groundwater resources of Bilaspur district have been estimated jointly by Central Ground Water Board and State Water Investigation Directorate. Government of Chhattisgarh, following the norms laid down by Ground Water Estimation Committee-2015 methodology is given in **Table-3.2.1** and the dynamic ground resource of Sipat block is given in **Table-3.2.2.**

**TABLE-3.2.1**
**THE DYNAMIC GROUNDWATER RESOURCES OF BILASPUR DISTRICT**

| S.No | Particulars | Quantity (HAM) |
|---|---|---|
| 1 | Total Annual Ground Water Recharge | 36411.40 |
| 2 | Total Natural Discharges | 3494.22 |
| 3 | Annual Extractable Ground Water Resource | 32917.18 |
| 4 | Total Current Annual Ground Water Extraction | 22739.91 |
| 5 | Annual GW Allocation for Domestic Use as on 2025 | 6529.12 |
| 6 | Net Ground Water Availability for future use | 9767.00 |
| 7 | Stage of Ground Water Extraction (%) | **69.08 % ("Safe")** |

*Source: Dynamic Ground Water Resources of India October-2022*

**TABLE-3.2.2**
**THE DYNAMIC GROUNDWATER RESOURCES OF SIPAT BLOCK**

| Sr. No | Particulars | Quantity (HAM) |
|---|---|---|
| 1 | Total Annual Ground Water Recharge | 8752.33 |
| 2 | Total Natural Discharge | 703.72 |
| 3 | Annual Extractable Ground Water Resourse | 8048.61 |
| 4 | Current Annual Ground Water Extraction | 3149.49 |
| 5 | Annual GW Allocation for Domestic Use as on 2025 | 1291.43 |
| 6 | Net Ground Water Availability for future use | 4553.67 |
| 7 | Stage of ground water Extraction in % | **39.13 % ("Safe")** |

*Source: Aquifer Mapping and Management of Ground Water Resources Bilaspur district, Chhattisgarh – 2020-2021*

## 3.3 Land Use Studies

Studies on land use aspects of eco-system play important roles for identifying sensitive issues, if any, and taking appropriate actions for maintaining the ecological balance in the development of the region.

### 3.3.1 Objectives

The objectives of land use studies are:

- To determine the present land use pattern;
- To analyze the impacts on land use due to 1 x 800 MW Sipat Super Thermal Power Project, (Stage-III) project at Sipat in the study area; and
- To give recommendations for optimizing the future land use pattern due to growth of proposed expansion of 1 x 800 MW Sipat STPP, (Stage-III) project at Sipat in the study area and its associated impacts.

### 3.3.2 Methodology

For the study of land use, literature review of various secondary sources such as District Census Handbooks, regional maps regarding topography, zoning settlement, industry, forest etc., were taken. The data was collected from various sources like District Census Handbook, Revenue records, state and central government offices and Survey of India (SoI) topo-sheets and also through primary field surveys.

### 3.3.3 Land use Based on Secondary Data

Based on the census report, 10 km radial distance around this proposed expansion of 1 x 800 MW Sipat Super Thermal Power Project, (Stage-III) boundary has been considered in the study. These areas were studied in detail to get the idea of land use pattern in the study area. The land use census data 2011 is presented in **Table-3.3.1**. The village wise land use data is presented in **Annexure-VII**.

**TABLE-3.3.1**
**LAND USE PATTERN IN THE STUDY AREA**

*Area in ha*

| Sr. No | Particulars of Land use | 0-3 km | 3-7 km | 7-10 km | 0-10 km | (%) |
|---|---|---|---|---|---|---|
| 1 | Forest area | 176.75 | 491.68 | 1656.53 | 2324.97 | 4.66 |
| 2 | Land under cultivation | | | | | |
| | a) Irrigation land | 4479.79 | 9261.80 | 8778.272 | 22519.86 | 45.16 |
| | b) Un-irrigated land | 1178.95 | 3377.44 | 5672.15 | 10228.54 | 20.51 |
| | c) Land under miscellaneous tree crops etc. area | 43.03 | 53.30 | 9.982 | 106.31 | 0.21 |
| 3 | Area not available for cultivation | | | | | |
| | a) Area under non-agricultural uses | 834.36 | 1125.06 | 1471.087 | 3430.51 | 6.88 |
| | b) Barren & un-cultivable land area | 118.63 | 208.88 | 708.21 | 1035.72 | 2.08 |
| | c) Permanent pastures and other grazing land area | 916.07 | 2311.49 | 2618.088 | 5845.60 | 11.72 |
| 4 | Fallows land other than current fallows area | 696.49 | 455.52 | 736.316 | 1888.32 | 3.79 |
| 5 | Current fallows area | 75.92 | 242.64 | 373.518 | 692.07 | 1.39 |
| 6 | Cultivable waste land area | 619.44 | 549.73 | 274.775 | 1443.94 | 2.90 |
| 7 | Urban area | 0.00 | 0.00 | 346.39 | 346.39 | 0.69 |
| 8 | Total geographical area | 9139.42 | 18077.54 | 22645.32 | 49862.27 | 100.00 |

*Source: Census of India –2011* (It may be noted the census 2021 as been delayed due to Covid-19 pandemic and hence it is the latest available data.)

- **Forest**

  The revenue forest land under the study area consists of 2324.97 ha (4.66%) of the total geographic area.

- **Land under Cultivation**

  Altogether 32,854.71 ha cultivable land (irrigated, un-irrigated and land under miscellaneous tree crops etc.) was observed in the study area. The irrigated land admeasures to about 22,519.86 ha in the study area, which works out to be 45.16 % of total study area. The un-irrigated land admeasures about 10,228.54 ha and works out to about 20.51 % of the total study area. Land under miscellaneous tree crops area admeasures to about 106.31 ha and works out 0.21% of the total study area.

- **Land not available for Cultivation**

  The land not available for cultivation is (10311.83 ha) 20.68% of the total study area, which includes area of land with scrub, land without scrub, permanent pastures, quarry, mining area, rocky/ stony and barren area.

- **Fallow Land other than Current Fallows Land**

  This includes all land which was taken up for cultivation but is temporarily out of cultivation for a period of not less than one year and not more than five years. The fallows land is (1888.32 ha) 3.79 % in the study area.

- **Current Fallow Land**

  This represents cropped area which is kept fallow during the current year. The current fallows land is (692.07 ha) 1.39 % in the total study area.

- **Cultivable Waste**

  This land includes that land, which was cultivated sometime back and left vacant during the past 5 years in succession. Such lands may either be fallows or covered with shrubs, which are not put to any use. Lands under thatching grass, bamboo bushes, other grooves useful for fuel etc., and all grazing lands and village common lands are also included in this category. The study area comprises about (1443.94 ha) 2.90% cultivable wastelands.

- **Urban Area**

  An urban area is a location characterized by high human population density and vast human-built features in comparison to the areas surrounding it. Urban areas may be cities, towns and towns or conurbations, but the term is not commonly extended to rural settlements such as villages and hamlets. The urban area under the study area consists 346.39 ha (0.69 %) of the total geographic area.

### 3.3.4 Land Use Pattern based on Remote Sensing Data

Remote sensing satellite imageries were collected and interpreted for the 10 km radius study area for analyzing the land use pattern of the study area. Based on the satellite data land use/land cover maps have been prepared.

#### *3.3.4.1Land Use/Land Cover Classification System*

The present land use/land cover maps were prepared based on the classification system of national standards. For explanation for each of the land use category the details as given in **Table-3.3.2** were considered.

**TABLE-3.3.2**
**LAND USE/LAND COVER CLASSIFICATION SYSTEM**

| Sr. No. | Level-1 | Level-2 |
|---|---|---|
| 1 | Built-up land | Town/cities |
| | | Villages |
| | | Institution/industry/godown etc |
| | | Plotted area/layout |
| 2 | Agriculture land | Crop land |
| | | Plantations |
| | | Fallow |
| 3 | Forest | Evergreen/Semi evergreen |
| | | Deciduous |
| | | Forest plantation |
| 4 | Wastelands | Rocky/stony waste |
| | | Land with /without scrubs |
| | | Saline/sandy & marshy/swampy |
| 5 | Water bodies | River/stream |
| | | Lake/reservoir/tanks |
| 6 | Others | Orchard/Other plantation |
| | | Shifting cultivation |
| | | Salt pans, snow covered/glacial |
| | | Barren/vacant land |

#### *3.3.4.2 Data Requirement*

IRS RS-2 LISS IV FX data acquired for 19$^{th}$ January 2019 and was used for the mapping and interpretation. Besides, other collateral data as available in the form of maps, charts, census records, other reports and especially topographical survey of India maps are used. In addition to this, ground truth survey was also conducted to verify and confirm the ground features.

#### *3.3.4.3 Methodology*

The methodology adopted for preparation of land use/land cover thematic map is monoscopic visual interpretation of geocoded scenes of IRS RS-2 LISS IV FX data and field observations are taken. The various steps involved in the study are preparatory field work, field survey and post field work.

#### *3.3.4.4 Pre-field Interpretation of Satellite Data*

The False Colour Composite (FCC) of IRS Resources -2 LISS IV FX satellite data used for pre-field interpretation work. Taking the help of topo-sheets, geology and geomorphology and by using the image elements the features are identified

and delineated the boundaries roughly. Each feature is identified on image by their image elements like tone, texture, colour, shape, size, pattern and association. A tentative legend in terms of land cover and land use, physiography and erosion were formulated. The sample areas for field check are selected covering all the physiographic, land use/land cover feature cum image characteristics.

- ***Ground Truth Collection***

Both topo-sheets and imagery were taken for field verification and a transverse plan using existing road network was made to cover as many representative sample areas as possible to observe the broad land use features and to adjust the sample areas according to field conditions. Detailed field observations and investigations were carried out and noted the land use features on the imagery.

- ***Post Field Work***

The base maps of the study area were prepared, with the help of Survey of India (SOI) topo-sheets. Preliminary interpreted land use and the land cover features boundaries from IRS RS-2 LISS IV FX. False colour composite was modified in light of field information and the final thematic details were transferred onto the base maps. The final interpreted and classified thematic map was catrographed. The cartographic map was coloured with standard colour coding and detailed description of feature with standard symbols. All the classes noted and marked by the standard legend on the map.

*3.3.4.5 Final Output*

The final output would be the land use/land cover map numerals were given different colour code for each category as shown in map. Area estimation of all features of land use/land cover categories was noted.

*3.3.4.6 Observations*

The following are the main interpreted land use/land cover classes of the study area and their respective areas are given in Sq. Km in **Table-3.3.3** for the year 2019. The thematic map and land use pattern of 10 km radius based on IRS RS-2 LISS IV FX for 19th January 2019 are shown in **Figure-3.3.1** and **Figure-3.3.2**.

**TABLE-3.3.3**
**LANDUSE BREAK-UP BASED ON IRS RS-2 LISS IV FX DATA (19th JANUARY 2019)**

| Sr.No. | Land Use | Area (Sq. Km) | Percentage (%) |
|---|---|---|---|
| **Built-up Land/Other Development** | | | |
| A | Settlement | 14.948 | 3.7 |
| B | Industrial area | 10.1 | 2.5 |
| | **Sub-total** | **25.048** | **6.2** |
| **Water Bodies** | | | |
| C | Tank/river/reservoir etc | **29.896** | **7.4** |
| **Forest** | | | |
| D | Scrub forest | **31.108** | **7.7** |
| **Crop Land** | | | |
| E | Single crop | 246.036 | 60.9 |

| Sr.No. | Land Use | Area (Sq. Km) | Percentage (%) |
|---|---|---|---|
| F | Double crop | 16.968 | 4.2 |
| G | Plantation | 12.524 | 3.1 |
| | **Sub-total** | **275.528** | **68.2** |
| **Wastelands** | | | |
| H | Land with scrub | 20.604 | 5.1 |
| I | Land without scrub | 12.524 | 3.1 |
| J | Stony waste area | 8.888 | 2.2 |
| K | Sheet rock area | 0.404 | 0.1 |
| | **Sub-total** | **42.42** | **10.5** |
| **Total** | | **404** | **100** |

*Source: IRS RS-2 LISS IV FX Data 19th January, 2019*

As per satellite imagery, the built-up land is 6.2 %, forest land occupies 7.7 %, agricultural land is about 68.2 %, water body is 7.4 % and remaining land is either area available for cultivation or cultivable waste land.

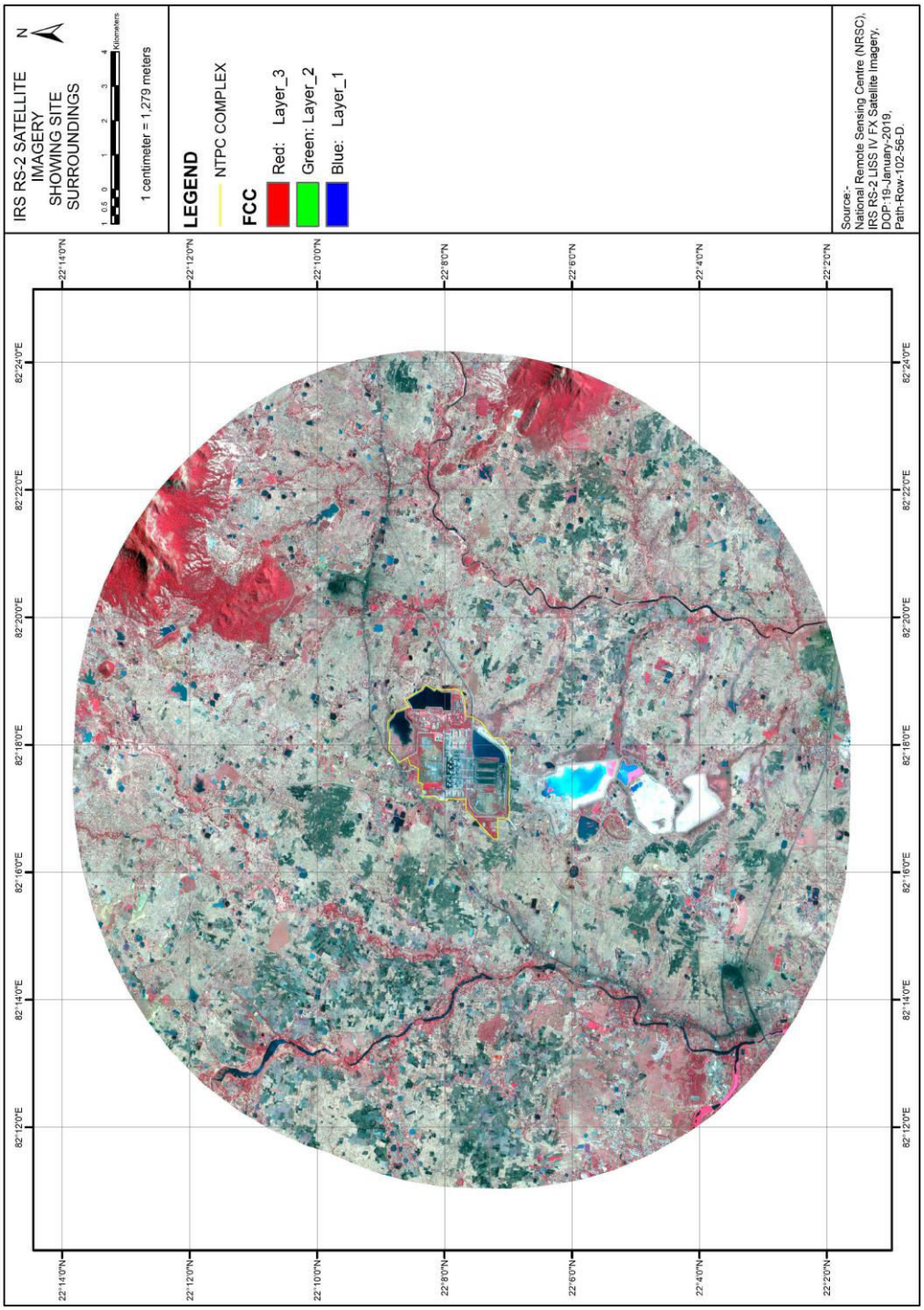



**FIGURE-3.3.1**
**THEMATIC MAP OF STUDY AREA IRS RS- 2 LISS IV FX SATELLITE IMAGERY**

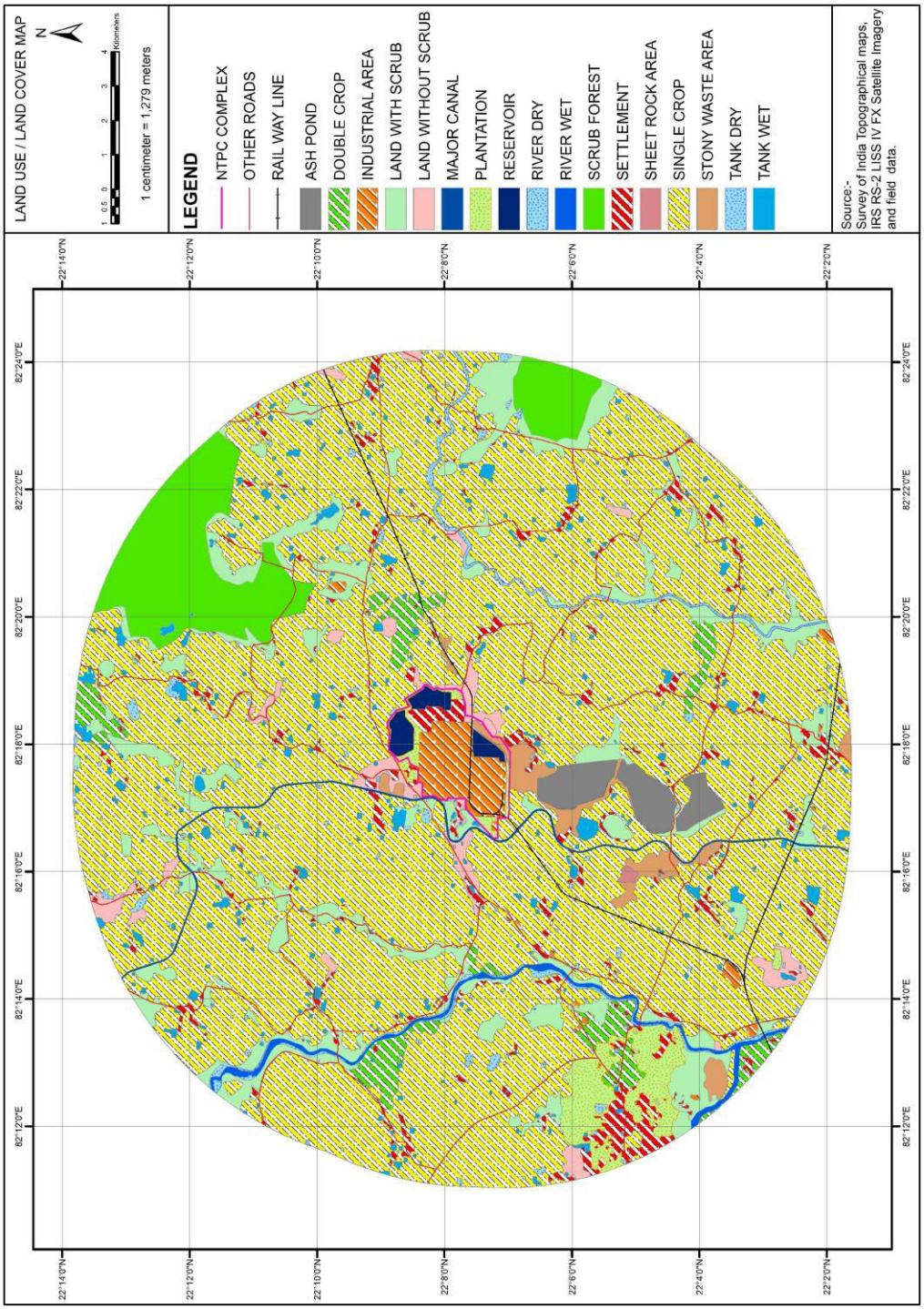



**FIGURE-3.3.2**
**LAND USE PATTERN BASED ON SATELLITE DATA**

## 3.4 Meteorology

The meteorological data recorded during the study period is very useful for proper interpretation of the baseline information regarding proposed capacity expansion of thermal power plant and surrounding area for air quality dispersion. Historical data on meteorological parameters will also play an important role in identifying the general meteorological regime of the region.

The year may broadly be divided into four seasons:

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

### 3.4.1 Methodology

The methodology adopted for monitoring surface observations is as per the standard norms laid down by Bureau of Indian Standards (IS:8829) and India Meteorological Department (IMD). On-site monitoring was undertaken for various meteorological variables in order to generate the site-specific data. Data was collected every hour continuously from one year i.e 20$^{th}$ March 2019 - 19$^{th}$ March 2020 covering four seasons pre monsoon season, monsoon season, post-monsoon season and winter season. The meterological station is placed on a building at Nawadih. The photograph of meterological station is shown in **Figure-3.4.1.** The baseline monitoring photographs are attached as **Annexure-VIII.**



**FIGURE-3.4.1**
**METEOROLOGICAL STATION**

*3.4.1.1* Methodology of Data Generation

The Central Monitoring Station (CMS) equipped with continuous monitoring equipment was installed on top of a residential building at a height of about 10 m above ground level to record wind speed, direction, relative humidity and temperature. The meteorological monitoring station was located in such a way that it is free from any obstructions and as per the guidelines specified under IS: 8829. Cloud cover was recorded by visual observation. Rainfall was monitored by rain gauge.

The continuous recording meteorological instrument of Yash Engineering (Vadodara) has been used for recording the met data. The sensitivity of the equipment is given in **Table-3.4.1**.

**TABLE-3.4.1**
**SENSITIVITY OF METEOROLOGY MONITORING EQUIPMENT**

| Sr. No. | Sensor | Range |
|---|---|---|
| 1 | Wind speed sensor | 0-50 m/s |
| 2 | Wind direction sensor | 0-359 degrees |
| 3 | Temperature sensor | -30$^{o}$C to 65 $^{O}$C |

3.4.2 Meteorological Data Generated at Site

The meteorological parameters were recorded on hourly basis during the study period and comprises of wind speed, wind direction (from 0 to 360 degrees), temperature, relative humidity and rainfall. The meteorological parameters have been recorded and are presented in **Table-3.4.2**.

**TABLE-3.4.2**
**SUMMARY OF THE METEOROLOGICAL DATA GENERATED AT SITE**

| Month | Temperature ($^{o}$C) | | Relative Humidity (%) | | Rainfall (mm) |
|---|---|---|---|---|---|
| | Max | Min | Max | Min | |
| **Pre-Monsoon Season** | | | | | |
| March, 2019 | 43.1 | 16.5 | 52 | 37 | 0 |
| April, 2019 | 45.2 | 22.0 | 49 | 33 | 0 |
| May, 2019 | 46.2 | 24.9 | 54 | 38 | 0 |
| **Range** | **16.5-46.2** | | **33.0-54.0** | | **0** |
| **Monsoon Season** | | | | | |
| June, 2019 | 43.2 | 20.8 | 55 | 43 | 0 |
| July, 2019 | 38.6 | 19.4 | 88 | 73 | 30.6 |
| August, 2019 | 35.8 | 24.7 | 80 | 74 | 35.4 |
| September, 2019 | 35.9 | 24.5 | 82 | 75 | 98.0 |
| **Range** | **19.4-43.2** | | **43.0-88.0** | | **164.0** |
| **Post-Monsoon Season** | | | | | |
| October, 2019 | 36.9 | 19.2 | 73 | 62 | 40.2 |
| November 2019 | 30.1 | 14.5 | 65 | 56 | 6.5 |
| **Range** | **14.5-36.9** | | **56.0-73.0** | | **46.7** |
| **Winter Season** | | | | | |
| December 2019 | 30.9 | 23.5 | 80 | 73 | 28.0 |
| January 2020 | 28.9 | 18.2 | 75 | 61 | 20.2 |
| February 2020 | 35.1 | 13.5 | 66 | 55 | 5.5 |
| **Range** | **13.5-35.1** | | **55.0-80.0** | | **53.7** |

| Month | Temperature ($^0$C) | | Relative Humidity (%) | | Rainfall (mm) |
|---|---|---|---|---|---|
| | Max | Min | Max | Min | |
| **Pre-Monsoon Season carried out by MANTEC Consultants Pvt. Ltd., Noida** | | | | | |
| March, 2023 | 39.2 | 17.4 | 85 | 39 | 22.2 |
| April, 2023 | 43.6 | 18.8 | 84 | 42 | 41 |
| May, 2023 | 44.6 | 18.9 | 86 | 37 | 0 |
| **Range** | **17.4-44.6** | | **37.0-86.0** | | **63.2** |

*3.4.2.1 Site Specific Wind Rose*

The wind rose for the study period representing pre- monsoon, monsoon season, post monsoon season and winter season is shown in **Figure-3.4.2**.

**TABLE-3.4.3**
**SUMMARY OF SITE-SPECIFIC WIND PATTERN**

| Period | First Predominant Wind | Second Predominant Wind | % Calm Condition | Predominant Wind Speed (m/s) |
|---|---|---|---|---|
| Pre- monsoon season | W (17.8 %) | WSW (13.4 %) | 9.6 % | 4.1 |
| Monsoon season | W (21.0 %) | SW (16.0 %) | 12.0 % | 2 -3 |
| Post-monsoon season | SW (12.0 %) | NE (8.1 %) | 31.3 % | 2 |
| Winter season | N (15.0 %) | NNE (13.0 %) | 56.4 % | 3.4 |

*Note: Figures in parenthesis indicates % of time wind blows*

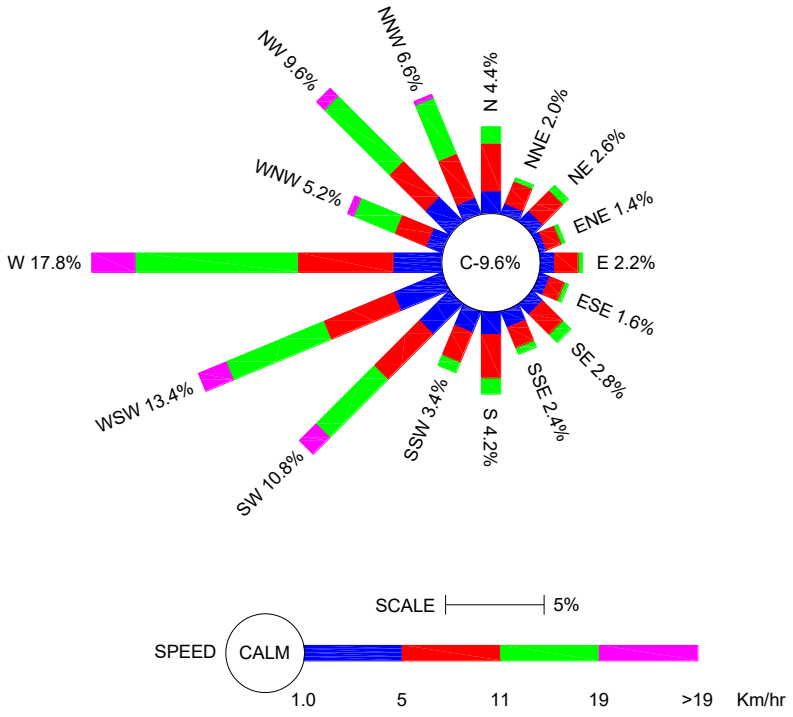



**FIGURE-3.4.2 (A)**
**SITE-SPECIFIC WIND ROSE-PRE-MONSOON SEASON**

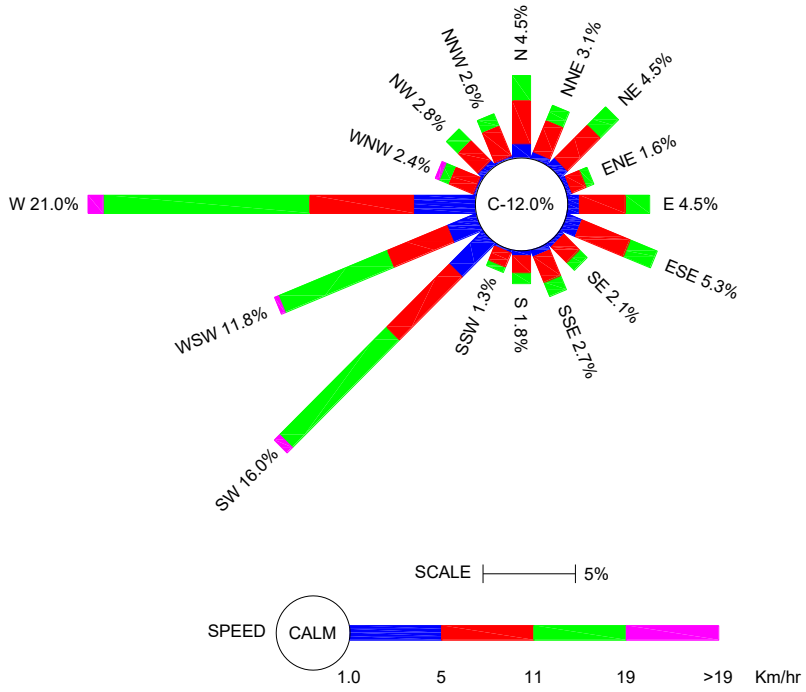



**FIGURE-3.4.2 (B)**
**SITE-SPECIFIC WIND ROSE- MONSOON SEASON**

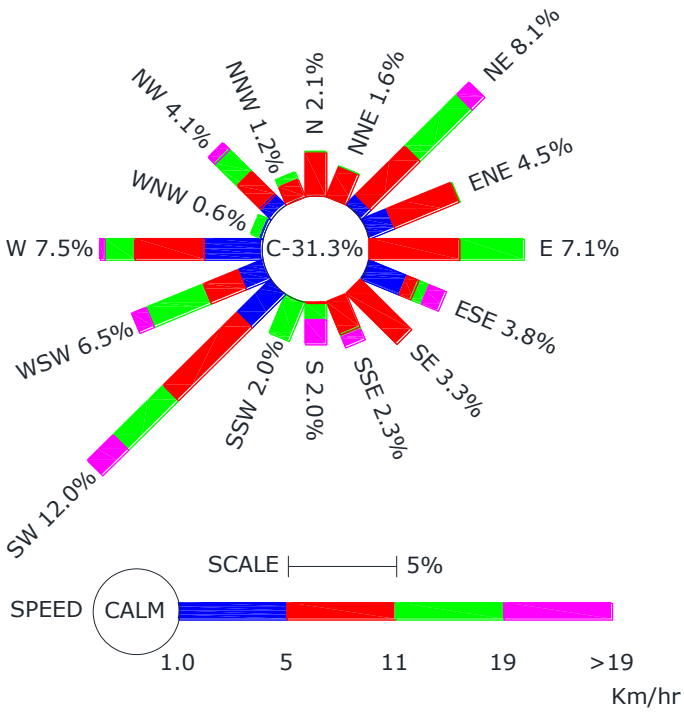



**FIGURE-3.4.2 (C)**
**SITE-SPECIFIC WIND ROSE-POST-MONSOON SEASON**

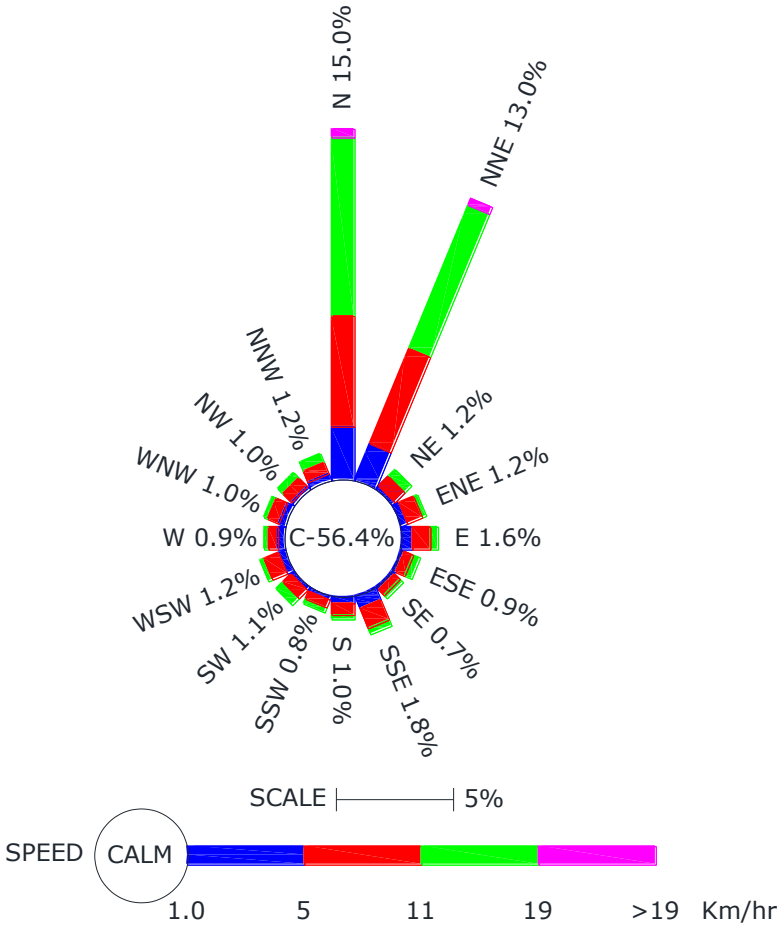



**FIGURE-3.4.2 (D)**
**SITE-SPECIFIC WIND ROSE- WINTER SEASON**

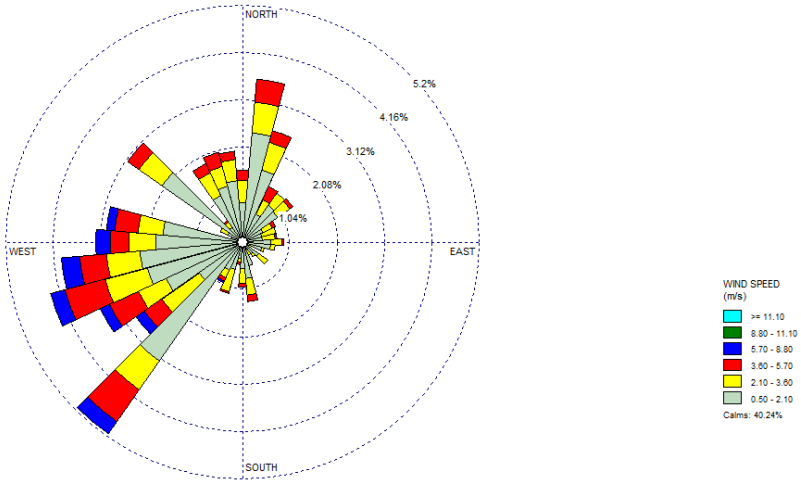



**FIGURE-3.4.2 (E)**
**SITE-SPECIFIC WIND ROSE- ANNUAL**

3.4.3 Secondary Data Collected from IMD- Raipur

Secondary data from IMD-Raipur has been collected for atmospheric pressure, temperature, relative humidity, rainfall, wind speed and direction. The data at IMD is usually measured twice a day viz., at 0830 and 1730 hr. The nearest IMD station at Raipur is about 110.0 km from the project site in the SSW direction.

The monthly maximum, minimum and average values are collected for all the parameters except wind speed and direction. The collected data is tabulated in **Table-3.4.4**.

**TABLE-3.4.4**
**CLIMATOLOGICAL DATA, STATION: IMD - RAIPUR (1991-2020)**

| Month | Atmospheric Pressure (hPa) | | Temperature ($^{o}$C) | | Relative Humidity (%) | | Rainfall (mm) |
|---|---|---|---|---|---|---|---|
| | 08:30 Hrs | 17:30 Hrs | Max | Min | 08:30 Hrs | 17:30 Hrs | Monthly Total |
| January | 982.6 | 978.8 | 31.7 | 9.4 | 67 | 43 | 14.4 |
| February | 980.6 | 976.8 | 35.2 | 12.4 | 61 | 35 | 16.3 |
| March | 978.4 | 974.1 | 39.5 | 16.1 | 50 | 29 | 13.2 |
| April | 975.3 | 970.5 | 43.0 | 19.9 | 43 | 24 | 15.7 |
| May | 971.1 | 966.5 | 45.3 | 22.9 | 43 | 26 | 23.8 |
| June | 968.1 | 964.6 | 44.1 | 22.6 | 66 | 52 | 197.8 |
| July | 968.0 | 965.4 | 36.0 | 22.1 | 85 | 76 | 377.4 |
| August | 969.6 | 966.9 | 33.7 | 22.3 | 87 | 79 | 334.2 |
| September | 972.6 | 969.5 | 34.1 | 22.4 | 83 | 74 | 235.5 |
| October | 977.8 | 974.5 | 34.1 | 18.2 | 77 | 62 | 46.9 |
| November | 981.0 | 977.6 | 32.8 | 13.3 | 72 | 53 | 8.2 |
| December | 982.7 | 979.0 | 31.2 | 10.4 | 68 | 47 | 6.9 |
| **Range** | **964.6-982.7** | | **9.4-45.3** | | **24-87** | | **Total :1290.3** |

*Source: IMD Climatological Tables (1991-2020)*

## 1] Temperature

The winter season starts from December and continues till the end of February. December is the coolest month with the maximum temperature at 35.2$^0$C and the minimum temperature (January) at 9.4 $^0$C. Both the night and day temperatures increase rapidly during the onset of the pre-monsoon from March to May. During pre-monsoon season, the maximum temperature (May) was observed to be 45.3$^0$C with the minimum temperature (March) at 16.1$^0$C. The maximum temperature in the monsoon season (June) observed to be 44.1 $^0$C whereas the minimum temperature was observed to be 22.1 $^0$C. By the end of September with the onset of post-monsoon, the day temperatures increase slightly, with the maximum temperature at 34.1$^0$C and the minimum temperature at 22.4 $^0$C.

## 2] Relative Humidity

The air is generally humid in this region during the monsoon when the relative humidity at 0830 hr. was observed to be with a maximum of 87 % and a minimum of 43 %. Similarly, at 1730 hr., the value was observed to be with a maximum of 79 % and a minimum of 24 %. The relative humidity during pre-monsoon season at 0830 hr was observed to be with a maximum of 50 % and a minimum of 43 %. Similarly, at 1730 hr., the value was observed to be with a maximum of 29 % and minimum of 24 %. Generally, the weather during other seasons was observed to be dry.

## 3] Atmospheric Pressure

The station level atmospheric pressure was recorded throughout the year. The maximum pressure observed was 982.7 hPa at 0830 hr and of 979.0 hPa at 1730 hr, with the maximum pressure occurring during the winter season, in the month of December. The minimum pressure observed was 968.0 hPa at 0830 and of 964.6 hPa at 1730, with the minimum pressure occurring during the month of June in the monsoon season. The average pressure level in all other months was found to be in the range of 972.0 to 975.6. It can be seen from the data that not much variations are observed in the average atmospheric pressure levels. The pressure levels are found to be fairly consistent over the region.

## 4] Rainfall

The average annual rainfall based on the past 30 years data for a period of 1991-2020, was observed to be 1290.3 mm. The monsoon sets in the month of June and continues till mid-September. The maximum amount of rainfall (377.4 mm) was observed in the month of August.

## 5] Cloud Cover

During the winter and the post-monsoon seasons, it was observed that the skies are generally very clear. In the pre-monsoon season, generally light clouds were observed in the evenings, with clear mornings. During the monsoon season, both in the mornings and evenings, the skies were found to be clouded.

## 6] Wind Speed/Direction

Generally, light to moderate winds prevail throughout the year. The seasonal and annual wind roses are presented in **Figure-3.4.3 (A)** to **Figure-3.4.3 (E)**. The summary of wind pattern at IMD, Raipur is given in **Table-3.4.5.**

**TABLE-3.4.5**
**SUMMARY OF WIND PATTERN – IMD RAIPUR (1971-2000)**

| Season | First Predominant Winds | Second Predominant Winds | Wind Speed (m/s) | Calm Conditions |
|---|---|---|---|---|
| **Pre-Monsoon Season** | | | | |
| March | W (14.5) | N (9.5) | 4.5-7 | 21 |
| April | W (19.5) | WSW (13.0) | 4.5-7 | 11 |
| May | W (17.5) | NW (14.8) | 4.5-7 | 10 |
| **Monsoon Season** | | | | |
| June | W (18.0) | WSW (16.5) | 4.5-7 | 6 |
| July | SW (21.5) | W (19.8) | 4.5-7 | 8 |
| August | W (21.0) | SW (20.0) | 4.5-7 | 10 |
| September | W (13.5) | SW (12.0) | 1.5-4.5 | 22 |
| **Post-Monsoon Season** | | | | |
| October | NE (16.8) | NNE (8.5) | 1.5-4.5 | 36 |
| November | NNE (12.5) | NE (12.0) | 1.5-4.5 | 54 |
| **Winter Season** | | | | |
| December | N (10.0) | NE (17.0) | 1.5-4.5 | 68 |
| January | N (11.5) | NNE (7.8) | 1.5-4.5 | 53 |
| February | N (14.5) | W (19.0) | 1.5-4.5 | 27 |
| **Annual** | W (12.0) | WSW (7.5) | 4.5-7 | 27 |

*Note: Figures in parenthesis indicate % time of wind blows*

### *3.4.3.1 Comments*

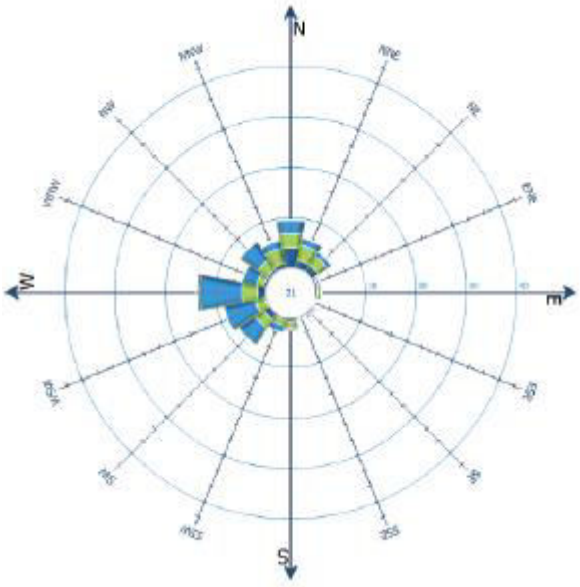
The India Meteorological Department (IMD) records the data two times a day viz. 0830 hr and 1730 hr, while the site-specific data has been recorded at an hourly interval. On comparison of site-specific data generated for study period vis-à-vis the IMD data, slight variations were found. The following observations are brought out:

- The temperature recorded on site when compared with the IMD, slight variations were found. The maximum and minimum temperatures recorded at site during study period were 46.2 $^0$C and 13.5 $^o$C, whereas the maximum and minimum values recorded at IMD, Raipur are 9.4 $^o$C and 45.3 $^o$C respectively during the same period;

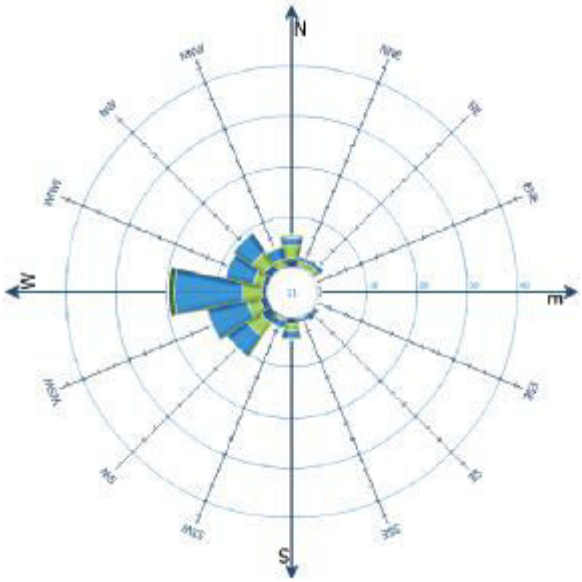
- The relative humidity was observed to range from 33 % –88 % during the study period whereas according to IMD, Raipur the relative humidity was observed to be range from 24 % to 87 %; and

- The data generated at continuous monitoring station at project site when compared with the data recorded at IMD, it can be observed that the data

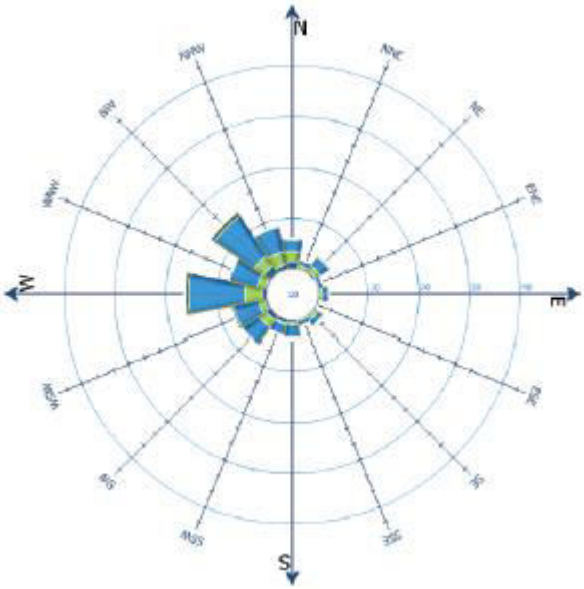
generated at the site is broadly compatible with regional meteorology, except minor variations as described above. However, the data cannot be compared on one to one basis as the two stations (IMD and site) are away and there is elevation difference also.



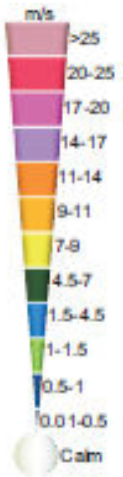

MARCH




APRIL




MAY




WIND SPEED

**FIGURE-3.4.3 (A)**
**SEASONAL WINDROSES - IMD RAIPUR –PRE-MONSOON SEASON**

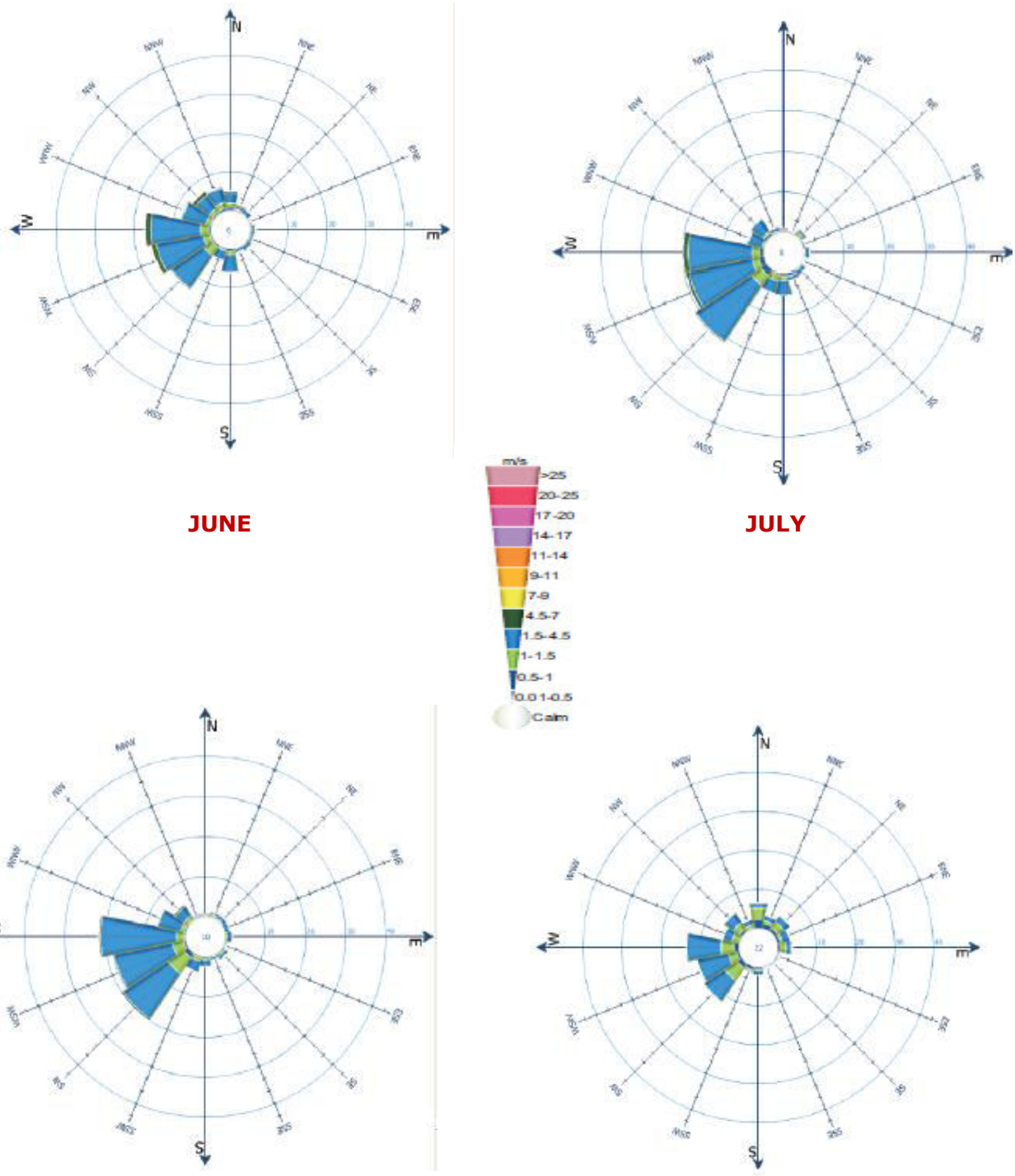
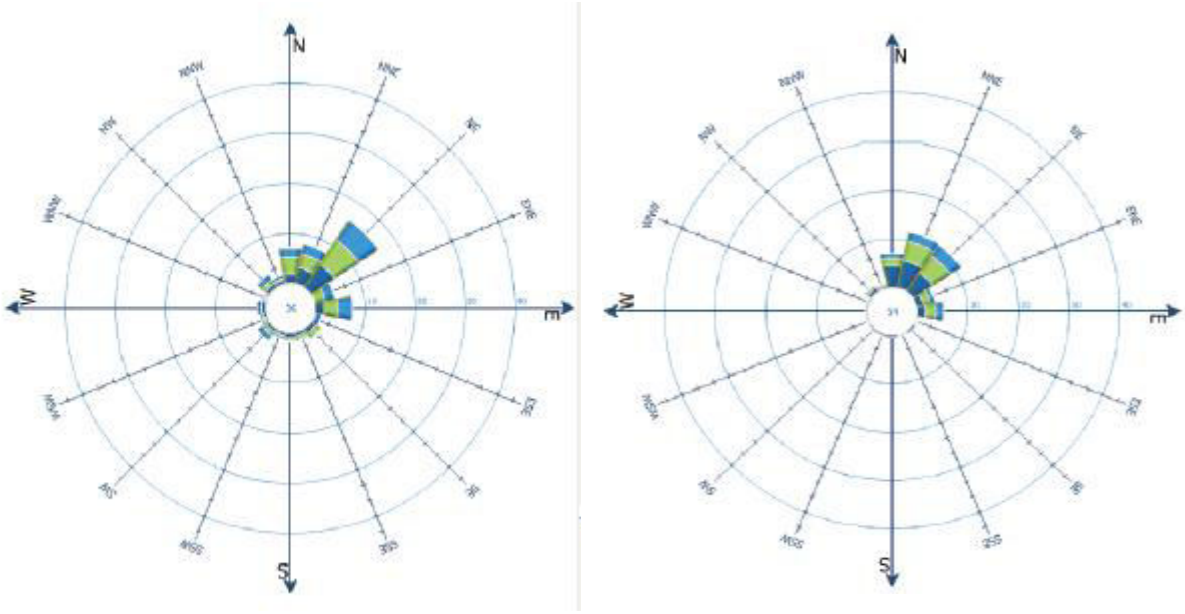


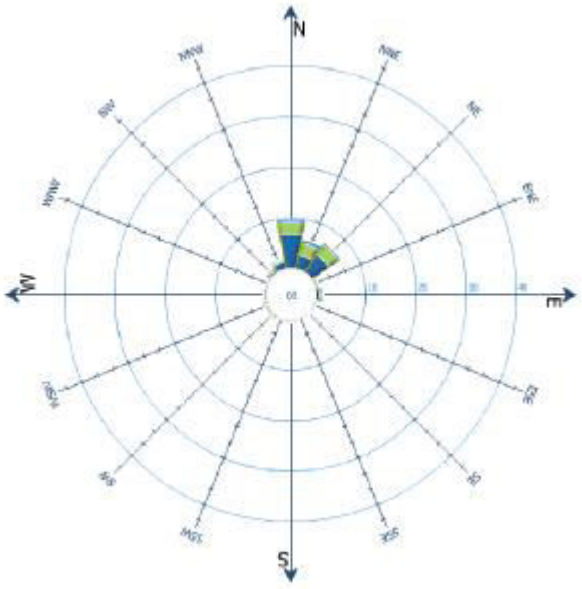

**FIGURE-3.4.3 (B)**
**SEASONAL WINDROSES - IMD RAIPUR - MONSOON SEASON**



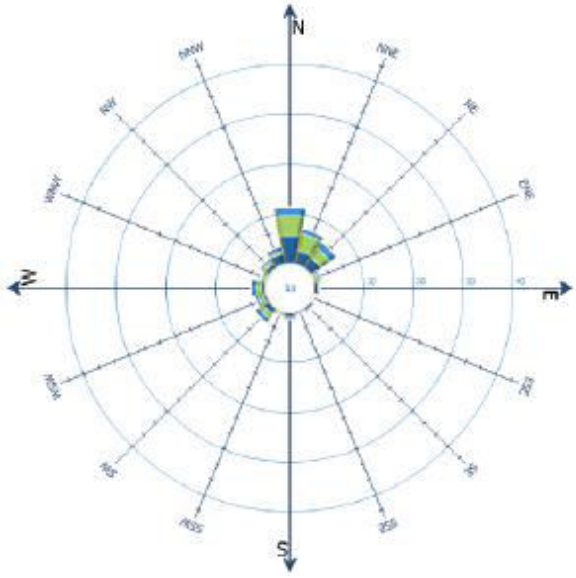

**OCTOBER** **NOVEMBER**

**WIND SPEED**

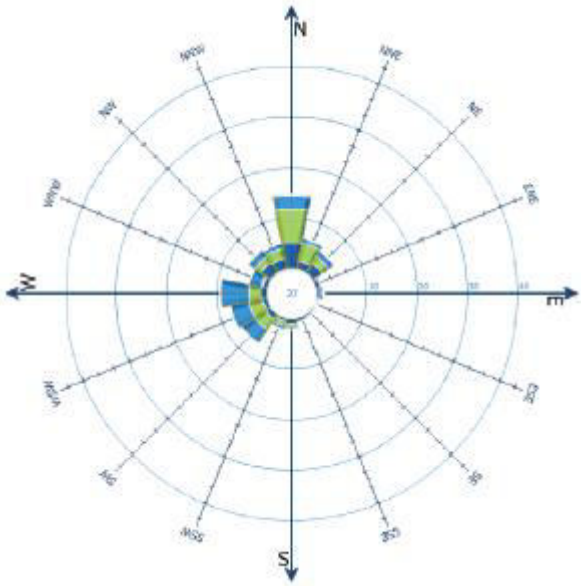
**FIGURE-3.4.3 (C)**
**SEASONAL WINDROSES - IMD RAIPUR – POST-MONSOON SEASON**



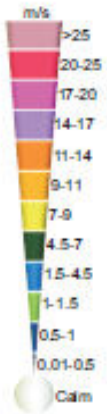

DECEMBER




JANUARY

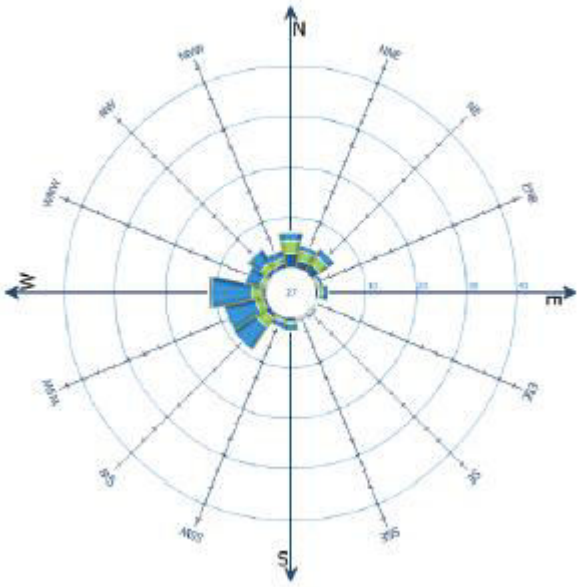



FEBRUARY

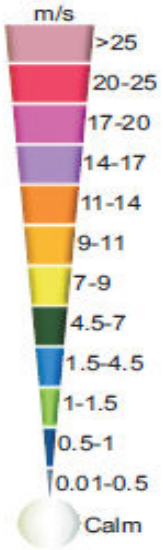



WIND SPEED

**FIGURE-3.4.3 (D)**
**SEASONAL WINDROSES - IMD RAIPUR - WINTER SEASON**




ANNUAL




WIND SPEED

**FIGURE-3.4.3 (E)**
**ANNUAL WINDROSE - IMD RAIPUR**

## 3.5 Ambient Air Quality

The ambient air quality with respect to the study zone of 10 km radius around the proposed expansion of thermal power plant forms the baseline information. The various sources of air pollution in the region are industrial, traffic, urban and rural activities.

This section describes the selection of sampling locations, methodology adopted for sampling, analytical techniques and frequency of sampling. The results of monitoring carried out for one year i.e. from 20th March 2019 - 19th March 2020 covering all four seasons pre-monsoon season, monsoon season, post-monsoon season and winter season are presented in **Annexure-IX.**

### 3.5.1 Methodology Adopted for Air Quality Survey

#### *3.5.1.1 Selection of Sampling Locations*

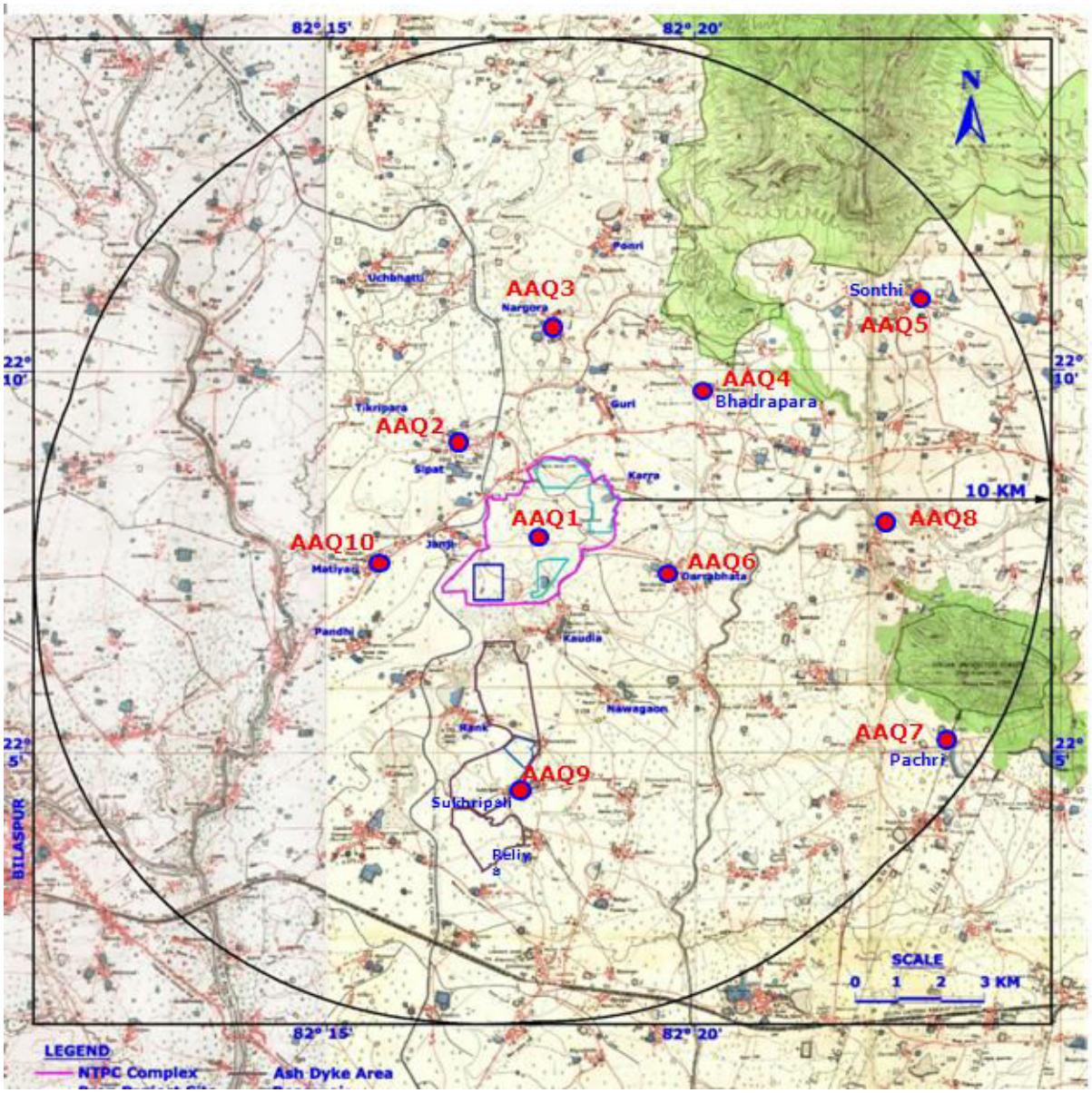
The baseline status of ambient air quality has been assessed through a scientifically designed ambient air quality-monitoring network. The design of monitoring network in the air quality surveillance programme has been based on the following considerations:

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

Ambient air quality monitoring (AAQM) stations were set up at **ten** locations. **Table-3.5.1** gives the details of environmental setting around each monitoring station. The location of the selected stations with reference to the plant area boundary is given in the below table and shown in **Figure-3.5.1**.

**TABLE-3.5.1**
**DETAILS OF AMBIENT AIR QUALITY MONITORING LOCATIONS**

| Station Code | Name of the Station (AAQ) | Distance from the Plant Boundary (km) | Direction w.r.t Boundary | Zone | Remarks |
|---|---|---|---|---|---|
| AAQ1 | Plant site | - | - | Industrial | - |
| AAQ2 | Sipat | 1.3 | NW | Residential/Rural | Cross wind |
| AAQ3 | Nargara | 3.2 | N | Residential/Rural | Cross wind |
| AAQ4 | Bhadrapara | 3.3 | NE | Residential/Rural | Cross wind |
| AAQ5 | Sonthi | 8.6 | NE | Residential/Rural | Cross wind |
| AAQ6 | Darrabhata | 1.7 | E | Residential/Rural | Down wind |
| AAQ7 | Pachri | 9.2 | SE | Forest area | Cross wind |
| AAQ8 | Changaripara | 6.0 | E | Residential/Rural | Down wind |
| AAQ9 | Sukhripali | 4.5 | S | Residential/Rural | Cross wind |
| AAQ10 | Matiyari | 1.8 | W | Residential/Rural | Up wind |



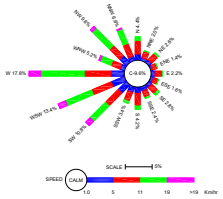



**FIGURE-3.5.1**
**AMBIENT AIR QUALITY MONITORING LOCATIONS**

*3.5.1.2 Justification for Selection of Sampling Locations*

A brief description of the sampling locations is presented hereunder:

Plant Site (AAQ1): This sampling station is located in the proposed expansion plant area. The main objective to select this location is to assess the concentration of pollutants within plant premises. This will also be useful for assessing the conformity to standards of the ambient air quality after expansion of the plant.

Sipat (AAQ2): This sampling station is located at a distance of about 1.3 km in northwest direction of the project site. The objective for selection of this location is to assess the concentration of pollutants in the nearest village. This location represents cross wind direction.

Nargara (AAQ3): This sampling station is located at a distance of about 3.2 km in north direction of the proposed expansion of thermal power plant. The objective for selection of this location is to assess the concentration of pollutants in the crosswind direction.

Bhadrapara (AAQ4): This sampling station is located at a distance of about 3.3 km in NE direction of the proposed expansion of thermal power plant. This location represents cross wind direction. It represents rural and residential condition.

Sonthi (AAQ5): This sampling station is located at a distance of about 8.6 km in north east direction from the project site. The objective for selection of this location is to assess the concentration of pollutants in crosswind direction and also in nearby forest area.

Darrabhata (AAQ6): This sampling station is located at a distance of about 1.7 km in east direction of the project site. The objective for selection of this location is to assess the concentration of pollutants in the downwind direction. The location represents rular and residential conditions.

Pachri (AAQ7): This sampling station is located at a distance of about 9.2 km in SE direction from the project site. The objective for selection of this location is to assess the concentration of pollutants nearby forest area.

Changaripara (AAQ8): This sampling station is located at a distance of about 6.0 km in east direction from the project site. The objective for selection of this location is to assess the concentration of pollutants in downwind direction.

Sukhripali (AAQ9): This sampling station is located in south direction at a distance of about 4.5 km from the project site. The main objective of selecting this location is to assess the concentration of pollutants in crosswind conditions nearby ash pond area.

Matiyari (AAQ10): This sampling station is located in west direction at a distance of about 1.8 km. The main objective of selecting of this location is to assess the concentration of pollutants in the upwind direction.

*3.5.1.3 Frequency and Parameters for Sampling*

Ambient air quality monitoring has been carried out with a frequency of two days per week during study period. The baseline data of air environment was monitored for parameters mentioned below as per MoEF&CC notification dated 16th November 2009:

- Particulate matter ($PM_{10}$);
- Particulate matter ($PM_{2.5}$)
- Sulphur dioxide ($SO_2$);
- Nitrogen dioxide ($NO_2$);
- Carbon monoxide (CO);
- Ozone ($O_3$)
- Ammonia ($NH_3$);
- Lead (Pb);
- Benzo(a) pyrene (BaP) in particulate phase;
- Arsenic (As);
- Mercury (Hg);
- Nickel (Ni); and
- Benzene ($C_6H_6$).

*3.5.1.4 Sampling and Analytical Techniques*

*Particulate Matter ($PM_{10}$)*

Respirable dust samplers APM-460 BL attached with APM-151 instruments have been used for sampling of respirable dust (<10 microns) and gaseous pollutants like $SO_2$ and $NO_2$.

$PM_{10}$ (<10μ) present in ambient air is drawn through the cyclone. Coarse and non-respirable dust (>10μ) is separated from the air stream by centrifugal forces acting on the solid particles. These separated particulates fall through the cyclone's conical hopper and collect in the sampling cup placed at the bottom of the cyclone. The fine dust (<10 microns) forming the respirable fraction passes through the cyclone and is retained by the filter paper.

A tapping is provided on the suction side of the blower to provide suction for sampling air through a set of impingers. Samples of gases are drawn at a flow rate of 0.2 litres per minute (lpm). The air samples were analyzed as per standard methods specified in IS: 5182.

*Particulate Matter ($PM_{2.5}$)*

APM 550 Fine Particulate Sampler ($PM_{2.5}$) attached with impactor have been used for sampling of fine particulate (<2.5 microns).

An electrically powered air sampler draws ambient air at a constant volumetric flow rate (16.7 lpm) maintained by a mass flow / volumetric flow controller coupled to a microprocessor into specially designed inertial particle-size separator (i.e. cyclones or impactors) where the suspended particulate matter in the $PM_{2.5}$ size ranges is separated for collection on a 47 mm polytetrafluoroethylene (PTFE)

filter over a specified sampling period. Each filter is weighed before and after sample collection to determine the net gain due to the particulate matter.

- ***Duration of Sampling***

The sampling duration for $PM_{10}$, $PM_{2.5}$, $SO_2$ and $NO_2$ is twenty-four hourly continuous samples per day and CO and $O_3$ are sampled for 8 hours continuously thrice a day. This is to allow a comparison with the present revised standards mentioned in the latest Gazette Notification of the Central Pollution Control Board (CPCB) (18th November 2009).

*3.5.1.5 Method of Analysis*

The air samples were analyzed as per standard methods specified by Central Pollution Control Board (CPCB), IS: 5182 and American Public Health Association (APHA).

*3.5.1.6 Instruments used for Sampling*

Dust samplers of Envirotech instruments were used for monitoring $PM_{10}$ (<10 microns), $PM_{2.5}$ and gaseous pollutants like $SO_2$, $NO_2$, NH3 & $O_3$ were collected through wet chemical absorbing reagents in gaseous attachment. NDIR spectroscopy has been used for the estimation of CO.

*3.5.1.7 Sampling and Analytical Techniques*

The techniques used for ambient air quality monitoring and minimum detectable levels are given in **Table-3.5.2.**

*3.5.1.8 Duration of Sampling*

$PM_{2.5}$ and $PM_{10}$ have been estimated by gravimetric method. Modified West and Gaeke method (IS-5182 Part-II, 1969) has been adopted for estimation of $SO_2$. Jacobs-Hochheiser method (IS-5182 Part-IV, 1975) has been adopted for the estimation of $NO_2$. The ambient air quality parameters along with their frequency of sampling are given in **Table-3.5.3**.

**TABLE-3.5.2**
**TECHNIQUES USED FOR AMBIENT AIR QUALITY MONITORING**

| Sr. No. | Parameter | Techniques | Technical Protocol | Minimum Detectable Limit (μg/m³) |
|---|---|---|---|---|
| 1 | PM 2.5 | Fine dust sampler (Gravimetric method) | IS-5182 (Part-IV) | 10.0 |
| 2 | PM 10 | Fine dust sampler (Gravimetric method) | IS-5182 (Part-IV) | 5.0 |
| 3 | Sulphur dioxide | Improved West and Gaeke method | IS-5182 (Part-II) | 4.0 |
| 4 | Nitrogen dioxide | Jacob & Hochheiser | IS-5182 (Part-VI) | 10.0 |
| 5 | Carbon monoxide | FID technique (Gas chromatography) | IS-5182(Part-X) | 50 |
| 6 | Ozone | UV-Vis Spectroscopic | ASTM-D | 2.0 |

| Sr. No. | Parameter | Techniques | Technical Protocol | Minimum Detectable Limit (µg/m³) |
|---|---|---|---|---|
| | | Analysis | | |
| 7 | Ammonia | UV-Vis Spectrophotometry | ASTM-D | 20.0 |
| 8 | Benzene | GC-MS/GC | IS-5182 | 1.0 |
| 9 | Benzo (O) Pyrene | GC-MS/GC | IS-5182 | 0.1 ng/m³ |
| 10 | Arsenic | ICP-MS | IS-5182 | 0.001 |
| 11 | Nickel | ICP-MS | IS-5182 | 0.001 |
| 12 | Lead | ICP-MS | IS-5182 | 0.1 |
| 13 | Mercury | ICP-MS | IS-5182 | 0.001 |

**TABLE-3.5.3**
**MONITORED PARAMETERS AND FREQUENCY OF SAMPLING**

| Parameters | Sampling Frequency |
|---|---|
| Particulate matter($PM_{10}$) | 24 hourly sample twice a week for three months |
| Particulate matter ($PM_{2.5}$) | 24 hourly sample twice a week for three months |
| Sulphur dioxide ($SO_2$) | 24 hourly samples twice a week for three months |
| Nitrogen dioxide ($NO_2$) | 24 hourly samples twice a week for three months |
| Carbon monoxide (CO) | 8 hourly samples for 24 hour twice a week for three months |
| Ozone ($O_3$) | 8 hourly samples for 24 hour twice a week for three months |
| Ammonia, $NH_3$ | 24 hourly sample twice a week for three months |
| Benzene, $C_6H_6$ | 24 hourly sample twice a week for three months |
| Benzo(a)pyrene (BaP) | 24 hourly samples twice a week for three months |
| Arsenic (As) | 24 hourly sample twice a week for three months |
| Nickel (Ni) | 24 hourly sample twice a week for three months |
| Lead (Pb) | 24 hourly sample twice a week for three months |
| Mercury (Hg) | 24 hourly sample twice a week for three months |

### 3.5.2 Presentation of AAQ Data

Various statistical parameters like 98$^{th}$ percentile, average, maximum and minimum values have been computed from the observed raw data for all the AAQ monitoring stations. The summary of these results for each location monitored during 20$^{th}$ March, 2019 to 19$^{th}$ March 2020 are presented in **Table-3.5.4** & **Table-3.5.5.** These values are compared with the standards prescribed by Central Pollution Control Board (CPCB) for industrial and rural /residential zone.

## TABLE-3.5.4 (A)-PRE-MONSOON SEASON
## SUMMARY OF AMBIENT AIR QUALITY RESULTS

| Sr No. | Location | $PM_{10}$ (µg/m³) | | | | $PM_{2.5}$ (µg/m³) | | | | $SO_2$ (µg/m³) | | | | $NO_2$ (µg/m³) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Min | Max | Avg | 98% | Min | Max | Avg | 98% | Min | Max | Avg | 98% | Min | Max | Avg | 98% |
| 1 | Plant site | 37.5 | 66.9 | 57.6 | 66.3 | 23.3 | 39.0 | 31.3 | 38.6 | 12.5 | 19.0 | 13.7 | 17.3 | 14.1 | 19.4 | 15.4 | 18.6 |
| 2 | Sipat | 36.0 | 59.8 | 56.7 | 59.7 | 22.3 | 38.4 | 33.7 | 38.4 | 17.0 | 18.8 | 17.5 | 18.4 | 16.8 | 21.2 | 17.9 | 20.6 |
| 3 | Nargara | 38.3 | 49.8 | 42.8 | 48.4 | 25.5 | 30.1 | 27.2 | 30.1 | 10.0 | 12.2 | 10.9 | 12.1 | 17.7 | 20.9 | 19.6 | 20.8 |
| 4 | Bhadrapara | 34.6 | 43.0 | 37.6 | 42.1 | 17.6 | 22.5 | 19.1 | 22.5 | 9.5 | 12.2 | 10.6 | 12.1 | 10.9 | 14.0 | 12.3 | 13.9 |
| 5 | Sonthi | 34.8 | 48.9 | 44.2 | 48.6 | 20.1 | 24.8 | 22.9 | 24.8 | 11.2 | 14.7 | 12.4 | 14.4 | 12.8 | 16.3 | 14.5 | 16.0 |
| 6 | Darrabhata | 36.8 | 59.0 | 54.9 | 58.6 | 21.3 | 35.8 | 24.2 | 33.0 | 13.5 | 16.7 | 15.0 | 16.6 | 14.4 | 19.0 | 16.3 | 18.9 |
| 7 | Pachri | 33.2 | 41.3 | 36.3 | 41.2 | 17.5 | 21.1 | 18.5 | 20.7 | 8.1 | 10.0 | 8.7 | 9.9 | 11.6 | 14.7 | 12.7 | 14.5 |
| 8 | Changaripara | 42.6 | 53.0 | 49.2 | 52.7 | 17.4 | 22.3 | 18.3 | 21.4 | 10.8 | 13.5 | 12.4 | 13.5 | 15.0 | 18.1 | 16.2 | 17.9 |
| 9 | Sukhripali | 43.1 | 55.3 | 47.2 | 53.6 | 21.7 | 33.4 | 25.8 | 31.9 | 11.3 | 14.8 | 12.6 | 14.6 | 13.8 | 18.7 | 16.2 | 18.5 |
| 10 | Matiyari | 35.6 | 50.1 | 38.8 | 48.3 | 23.8 | 25.1 | 27.2 | 27.3 | 11.5 | 13.5 | 12.3 | 13.5 | 12.4 | 14.6 | 13.6 | 14.5 |
| **Range** | | **33.2-66.9** | | | | **17.4-39.0** | | | | **8.1-19.0** | | | | **10.9-21.2** | | | |
| **NAAQ Standards** | | **100** | | | | **60** | | | | **80** | | | | **80** | | | |

| Sr No. | Location | CO (µg/m³) | | | | $O_3$ (µg/m³) | | | | Ammonia (µg/m³) | Benzene (µg/m³) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Min | Max | Avg | 98% | Min | Max | Avg | 98% | | |
| 1 | Plant site | 192 | 299 | 252 | 298 | 5.9 | 7.6 | 6.6 | 7.4 | <20.0 | <1 |
| 2 | Sipat | 220 | 261 | 237 | 259 | 6.2 | 9.2 | 7.3 | 8.8 | <20.0 | <1 |
| 3 | Nargara | 151 | 212 | 175 | 206 | 3.5 | 7.7 | 5.7 | 7.6 | <20.0 | <1 |
| 4 | Bhadrapara | 233 | 284 | 260 | 283 | 4.6 | 7.5 | 6.0 | 7.4 | <20.0 | <1 |
| 5 | Sonthi | 205 | 266 | 233 | 262 | 4.6 | 7.8 | 5.4 | 6.5 | <20.0 | <1 |
| 6 | Darrabhata | 192 | 289 | 256 | 287 | 6.5 | 10.9 | 8.3 | 10.7 | <20.0 | <1 |
| 7 | Pachri | 151 | 204 | 170 | 199 | 4.0 | 7.3 | 5.6 | 7.0 | <20.0 | <1 |
| 8 | Changaripara | 205 | 237 | 216 | 234 | 4.7 | 8.1 | 6.5 | 8.0 | <20.0 | <1 |
| 9 | Sukhripali | 212 | 258 | 237 | 256 | 9.8 | 11.4 | 10.4 | 11.4 | <20.0 | <1 |
| 10 | Matiyari | 200 | 238 | 217 | 236 | 5.4 | 8.5 | 6.7 | 8.3 | <20.0 | <1 |
| **Range** | | **151-299** | | | | **3.5-11.4** | | | | **<20.0** | <1 |
| **NAAQ Standards** | | **2000** | | | | **100** | | | | **400** | **5** |

## TABLE-3.5.4 (A) (Contd...)
## SUMMARY OF AMBIENT AIR QUALITY RESULTS

| Sr No. | Location | B(a)P (ng/m³) | As (µg/m³) | Pb (µg/m³) | Ni (µg/m³) | Hg (µg/m³) |
|---|---|---|---|---|---|---|
| 1 | Plant site | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 2 | Sipat | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 3 | Nargara | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 4 | Bhadrapara | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 5 | Sonthi | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 6 | Darrabhata | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 7 | Pachri | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 8 | Changaripara | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 9 | Sukhripali | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 10 | Matiyari | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| **Range** | | **<0.1** | **<0.001** | **<0.1** | **<0.001** | **<0.001** |
| **NAAQ Standards** | | **1.0** | **0.006** | **1.0** | **0.02** | **-** |

## TABLE-3.5.4 (A)-MONSOON SEASON
## SUMMARY OF AMBIENT AIR QUALITY RESULTS

| Sr No. | Location | $PM_{10}$ (µg/m³) | | | | $PM_{2.5}$ (µg/m³) | | | | $SO_2$ (µg/m³) | | | | $NO_2$ (µg/m³) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Min | Max | Avg | 98% | Min | Max | Avg | 98% | Min | Max | Avg | 98% | Min | Max | Avg | 98% |
| 1 | Plant site | 41.4 | 54.5 | 49.3 | 54.3 | 20.9 | 29.9 | 25.1 | 29.8 | 13.4 | 16.9 | 15.1 | 16.8 | 12.4 | 17.5 | 15.2 | 17.4 |
| 2 | Sipat | 38.7 | 52.9 | 44.2 | 52.1 | 16.3 | 27.8 | 19.4 | 27.6 | 13.4 | 15.9 | 15.0 | 15.9 | 13.9 | 17.3 | 15.5 | 17.0 |
| 3 | Nargara | 28.7 | 47.0 | 38.2 | 46.3 | 18.8 | 27.3 | 22.3 | 27.2 | 10.4 | 13.8 | 12.1 | 13.7 | 10.8 | 16.4 | 13.8 | 16.1 |
| 4 | Bhadrapara | 24.2 | 49.7 | 44.1 | 49.6 | 18.4 | 26.3 | 22.9 | 25.8 | 9.4 | 12.3 | 10.6 | 12.2 | 12.1 | 15.8 | 13.3 | 15.4 |
| 5 | Sonthi | 34.3 | 48.7 | 42.2 | 47.9 | 20.0 | 25.3 | 22.9 | 25.2 | 9.1 | 15.1 | 10.2 | 14.3 | 11.2 | 15.5 | 12.7 | 15.4 |
| 6 | Darrabhata | 20.0 | 43.3 | 36.4 | 42.9 | 20.6 | 28.0 | 23.2 | 26.9 | 13.4 | 15.5 | 14.7 | 15.5 | 11.9 | 17.0 | 14.4 | 16.8 |
| 7 | Pachri | 28.9 | 40.6 | 35.9 | 39.8 | 17.2 | 23.8 | 20.0 | 23.7 | 8.8 | 13.4 | 11.1 | 13.3 | 12.7 | 16.1 | 14.7 | 15.9 |
| 8 | Changaripara | 32.8 | 50.9 | 48.0 | 50.8 | 17.4 | 25.3 | 20.8 | 25.2 | 11.2 | 16.4 | 14.0 | 16.1 | 12.9 | 16.9 | 15.2 | 16.9 |
| 9 | Sukhripali | 36.4 | 49.4 | 44.4 | 49.3 | 16.0 | 25.5 | 20.5 | 25.2 | 10.7 | 15.8 | 13.9 | 15.7 | 12.6 | 17.1 | 15.4 | 17.1 |
| 10 | Matiyari | 36.3 | 47.3 | 42.7 | 47.2 | 18.9 | 24.9 | 22.2 | 24.8 | 11.0 | 15.1 | 12.5 | 14.9 | 13.2 | 16.6 | 14.5 | 16.6 |
| | | **20.0-54.5** | | | | **16.0-29.9** | | | | **8.8-16.9** | | | | **10.8-17.5** | | | |
| **NAAQ Standards** | | **100** | | | | **60** | | | | **80** | | | | **80** | | | |

| Sr No. | Location | CO (µg/m³) | | | | $O_3$ (µg/m³) | | | | Ammonia (µg/m³) | Benzene (µg/m³) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Min | Max | Avg | 98% | Min | Max | Avg | 98% | | |
| 1 | Plant site | 170 | 269 | 225 | 266 | 6.1 | 10.8 | 7.2 | 10.1 | <20.0 | <1 |
| 2 | Sipat | 142 | 250 | 208 | 249 | 6.4 | 9.9 | 8.3 | 9.9 | <20.0 | <1 |
| 3 | Nargara | 126 | 211 | 183 | 210 | 3.3 | 10.7 | 5.9 | 7.8 | <20.0 | <1 |
| 4 | Bhadrapara | 183 | 244 | 213 | 240 | 3.5 | 9.8 | 6.9 | 9.1 | <20.0 | <1 |
| 5 | Sonthi | 165 | 248 | 201 | 240 | 3.7 | 7.0 | 4.8 | 6.6 | <20.0 | <1 |
| 6 | Darrabhata | 123 | 266 | 206 | 265 | 6.2 | 9.7 | 7.7 | 9.6 | <20.0 | <1 |
| 7 | Pachri | 122 | 247 | 178 | 236 | 3.1 | 10.7 | 5.5 | 7.9 | <20.0 | <1 |
| 8 | Changaripara | 137 | 266 | 194 | 265 | 3.7 | 9.1 | 5.7 | 9.0 | <20.0 | <1 |
| 9 | Sukhripali | 111 | 238 | 166 | 224 | 6.3 | 9.8 | 7.6 | 9.5 | <20.0 | <1 |
| 10 | Matiyari | 151 | 266 | 205 | 261 | 4.0 | 9.3 | 6.1 | 8.9 | <20.0 | <1 |
| **Range** | | **111-269** | | | | **3.1-10.8** | | | | <20.0 | <1 |
| **NAAQ Standards** | | **2000** | | | | **100** | | | | **400** | **5** |

## TABLE-3.5.4 (B) -MONSOON SEASON
## SUMMARY OF AMBIENT AIR QUALITY RESULTS

| Sr No. | Location | B(a)P (ng/m³) | As (µg/m³) | Pb (µg/m³) | Ni (µg/m³) | Hg (µg/m³) |
|---|---|---|---|---|---|---|
| 1 | Plant site | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 2 | Sipat | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 3 | Nargara | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 4 | Bhadrapara | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 5 | Sonthi | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 6 | Darrabhata | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 7 | Pachri | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 8 | Changaripara | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 9 | Sukhripali | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 10 | Matiyari | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| **Range** | | **<0.1** | **<0.001** | **<0.1** | **<0.001** | **<0.001** |
| **NAAQ Standards** | | **1.0** | **0.006** | **1.0** | **0.02** | **-** |

## TABLE-3.5.4 (C) – POST MONSOON SEASON
## SUMMARY OF AMBIENT AIR QUALITY RESULTS

| Sr No. | Location | $PM_{10}$ (µg/m³) | | | | $PM_{2.5}$ (µg/m³) | | | | $SO_2$ (µg/m³) | | | | $NO_2$ (µg/m³) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Min | Max | Avg | 98% | Min | Max | Avg | 98% | Min | Max | Avg | 98% | Min | Max | Avg | 98% |
| 1 | Plant site | 40.4 | 63.7 | 52.9 | 62.0 | 22.1 | 27.6 | 25.3 | 27.5 | 14.6 | 19.3 | 16.6 | 19.1 | 15.7 | 20.6 | 18.3 | 20.6 |
| 2 | Sipat | 51.9 | 58.7 | 55.9 | 58.3 | 22.5 | 29.6 | 24.9 | 29.2 | 14.6 | 18.5 | 16.4 | 18.4 | 15.7 | 20.5 | 18.1 | 20.5 |
| 3 | Nargara | 32.3 | 44.3 | 39.2 | 44.3 | 20.0 | 24.8 | 22.5 | 24.7 | 12.0 | 15.0 | 13.2 | 14.7 | 12.8 | 17.0 | 15.1 | 16.9 |
| 4 | Bhadrapara | 40.4 | 61.0 | 58.0 | 61.0 | 22.3 | 27.5 | 24.5 | 27.2 | 11.0 | 12.9 | 11.6 | 12.6 | 13.6 | 14.7 | 14.1 | 14.7 |
| 5 | Sonthi | 41.9 | 56.9 | 50.5 | 56.9 | 21.2 | 26.5 | 24.0 | 26.5 | 10.3 | 11.0 | 10.6 | 11.0 | 12.4 | 14.6 | 13.3 | 14.5 |
| 6 | Darrabhata | 44.4 | 56.8 | 49.3 | 55.4 | 21.8 | 29.2 | 24.8 | 28.7 | 14.6 | 19.1 | 16.4 | 18.9 | 19.5 | 24.7 | 21.9 | 24.6 |
| 7 | Pachri | 34.8 | 41.8 | 38.3 | 41.4 | 19.3 | 25.0 | 22.5 | 24.9 | 11.9 | 14.6 | 13.3 | 14.5 | 14.5 | 17.0 | 15.9 | 16.9 |
| 8 | Changaripara | 44.7 | 56.9 | 51.3 | 56.8 | 21.2 | 26.5 | 24.0 | 26.5 | 14.6 | 17.9 | 16.4 | 17.8 | 14.7 | 19.4 | 16.6 | 19.3 |
| 9 | Sukhripali | 44.7 | 60.1 | 48.9 | 59.2 | 22.2 | 24.8 | 23.6 | 24.7 | 12.4 | 17.6 | 14.1 | 17.4 | 14.1 | 18.9 | 16.7 | 18.8 |
| 10 | Matiyari | 38.2 | 48.5 | 46.2 | 48.5 | 26.9 | 31.1 | 29.2 | 31.0 | 12.2 | 15.9 | 13.0 | 15.1 | 14.4 | 17.8 | 15.2 | 17.2 |
| **Range** | | **32.3-63.7** | | | | **19.3-31.1** | | | | **10.3-19.3** | | | | **12.4-24.7** | | | |
| **NAAQ Standards** | | **100** | | | | **60** | | | | **80** | | | | **80** | | | |

| Sr No. | Location | CO (µg/m³) | | | | $O_3$ (µg/m³) | | | | Ammonia (µg/m³) | Benzene (µg/m³) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Min | Max | Avg | 98% | Min | Max | Avg | 98% | | |
| 1 | Plant site | 167 | 259 | 216 | 255 | 7.3 | 11.3 | 8.2 | 11.2 | <20.0 | <1 |
| 2 | Sipat | 193 | 297 | 242 | 289 | 7.6 | 11.0 | 9.2 | 11.0 | <20.0 | <1 |
| 3 | Nargara | 221 | 262 | 239 | 261 | 4.5 | 8.1 | 6.7 | 8.1 | <20.0 | <1 |
| 4 | Bhadrapara | 234 | 295 | 267 | 290 | 7.3 | 12.3 | 8.2 | 11.4 | <20.0 | <1 |
| 5 | Sonthi | 218 | 291 | 252 | 290 | 4.9 | 6.6 | 5.7 | 6.5 | <20.0 | <1 |
| 6 | Darrabhata | 180 | 293 | 249 | 288 | 7.4 | 13.1 | 8.4 | 10.2 | <20.0 | <1 |
| 7 | Pachri | 179 | 267 | 216 | 258 | 4.3 | 7.9 | 5.7 | 7.6 | <20.0 | <1 |
| 8 | Changaripara | 200 | 287 | 250 | 286 | 4.9 | 6.6 | 5.7 | 6.5 | <20.0 | <1 |
| 9 | Sukhripali | 190 | 287 | 251 | 285 | 7.5 | 12.4 | 8.6 | 9.8 | <20.0 | <1 |
| 10 | Matiyari | 147 | 243 | 195 | 240 | 5.2 | 8.5 | 6.4 | 8.4 | <20.0 | <1 |
| **Range** | | **147-297** | | | | **4.3-13.1** | | | | <20.0 | <1 |
| **NAAQ Standards** | | **2000** | | | | **100** | | | | **400** | **5** |

## TABLE-3.5.4 (C) – POST MONSOON SEASON
## SUMMARY OF AMBIENT AIR QUALITY RESULTS

| Sr No. | Location | B(a)P (ng/m³) | As (µg/m³) | Pb (µg/m³) | Ni (µg/m³) | Hg (µg/m³) |
|---|---|---|---|---|---|---|
| 1 | Plant site | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 2 | Sipat | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 3 | Nargara | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 4 | Bhadrapara | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 5 | Sonthi | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 6 | Darrabhata | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 7 | Pachri | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 8 | Changaripara | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 9 | Sukhripali | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 10 | Matiyari | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| **Range** | | **<0.1** | **<0.001** | **<0.1** | **<0.001** | **<0.001** |
| **NAAQ Standards** | | **1.0** | **0.006** | **1.0** | **0.02** | **-** |

## TABLE-3.5.4 (D) –WINTER SEASON
## SUMMARY OF AMBIENT AIR QUALITY RESULTS

| Sr No. | Location | $PM_{10}$ (µg/m³) | | | | $PM_{2.5}$ (µg/m³) | | | | $SO_2$ (µg/m³) | | | | $NO_2$ (µg/m³) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Min | Max | Avg | 98% | Min | Max | Avg | 98% | Min | Max | Avg | 98% | Min | Max | Avg | 98% |
| 1 | Plant site | 41.7 | 65.3 | 56.0 | 65.3 | 23.4 | 36.2 | 27.5 | 34.4 | 15.9 | 20.6 | 17.6 | 20.2 | 16.9 | 24.9 | 19.5 | 23.4 |
| 2 | Sipat | 53.6 | 66.6 | 58.4 | 64.1 | 24.2 | 34.5 | 26.9 | 34.4 | 16.3 | 20.2 | 18.2 | 20.2 | 17.3 | 22.2 | 19.7 | 22.2 |
| 3 | Nargara | 31.9 | 49.0 | 41.1 | 48.5 | 22.0 | 29.3 | 24.9 | 29.2 | 13.6 | 17.0 | 15.0 | 16.5 | 14.8 | 23.3 | 17.6 | 23.0 |
| 4 | Bhadrapara | 37.5 | 63.1 | 58.2 | 63.1 | 21.7 | 29.6 | 26.1 | 29.1 | 12.7 | 15.0 | 13.6 | 14.7 | 15.4 | 17.9 | 16.3 | 17.6 |
| 5 | Sonthi | 42.6 | 58.0 | 50.8 | 58.0 | 22.3 | 27.6 | 25.0 | 27.6 | 11.4 | 16.2 | 12.0 | 15.6 | 13.5 | 16.6 | 14.6 | 16.5 |
| 6 | Darrabhata | 37.1 | 59.2 | 52.6 | 59.0 | 23.7 | 31.1 | 26.2 | 30.3 | 16.5 | 21.1 | 18.3 | 21.1 | 17.8 | 26.6 | 22.5 | 26.5 |
| 7 | Pachri | 32.3 | 44.0 | 39.5 | 43.4 | 20.6 | 27.2 | 23.7 | 27.1 | 12.2 | 16.8 | 14.7 | 16.7 | 16.1 | 19.2 | 17.9 | 19.1 |
| 8 | Changaripara | 36.4 | 59.3 | 52.7 | 59.2 | 21.0 | 28.9 | 24.9 | 28.9 | 14.8 | 20.3 | 17.9 | 20.2 | 17.1 | 21.8 | 19.1 | 21.6 |
| 9 | Sukhripali | 39.6 | 62.1 | 49.3 | 60.8 | 24.2 | 32.5 | 27.5 | 32.3 | 14.4 | 19.6 | 16.7 | 19.4 | 16.1 | 21.5 | 19.2 | 21.5 |
| 10 | Matiyari | 40.1 | 51.1 | 47.1 | 51.1 | 27.7 | 33.7 | 31.1 | 33.6 | 14.8 | 18.5 | 15.8 | 18.1 | 17.0 | 20.4 | 18.0 | 20.0 |
| **Range** | | **31.9-66.6** | | | | **20.6-36.2** | | | | **11.4-21.1** | | | | **13.5-26.6** | | | |
| **NAAQ Standards** | | **100** | | | | **60** | | | | **80** | | | | **80** | | | |

| Sr No. | Location | CO (µg/m³) | | | | $O_3$ (µg/m³) | | | | Ammonia (µg/m³) | Benzene (µg/m³) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Min | Max | Avg | 98% | Min | Max | Avg | 98% | | |
| 1 | Plant site | 243 | 341 | 295 | 337 | 8.6 | 12.6 | 9.4 | 12.4 | <20.0 | <1 |
| 2 | Sipat | 195 | 302 | 256 | 301 | 9.3 | 13.8 | 11.0 | 12.8 | <20.0 | <1 |
| 3 | Nargara | 179 | 264 | 237 | 263 | 6.5 | 12.7 | 8.8 | 10.1 | <20.0 | <1 |
| 4 | Bhadrapara | 236 | 297 | 267 | 292 | 8.1 | 14.4 | 10.1 | 13.2 | <20.0 | <1 |
| 5 | Sonthi | 217 | 300 | 254 | 295 | 6.0 | 8.1 | 6.8 | 7.9 | <20.0 | <1 |
| 6 | Darrabhata | 195 | 345 | 284 | 339 | 9.3 | 15.0 | 10.6 | 12.6 | <20.0 | <1 |
| 7 | Pachri | 175 | 300 | 242 | 291 | 6.5 | 12.9 | 8.4 | 10.1 | <20.0 | <1 |
| 8 | Changaripara | 210 | 340 | 277 | 339 | 7.3 | 11.5 | 8.7 | 11.4 | <20.0 | <1 |
| 9 | Sukhripali | 223 | 339 | 284 | 335 | 9.5 | 14.7 | 11.6 | 14.6 | <20.0 | <1 |
| 10 | Matiyari | 200 | 359 | 243 | 294 | 7.8 | 11.9 | 9.4 | 11.5 | <20.0 | <1 |
| **Range** | | **175-359** | | | | **6.0-15.0** | | | | <20.0 | <1 |
| **NAAQ Standards** | | **2000** | | | | **100** | | | | **400** | **5** |

## TABLE--3.5.4 (D) -WINTER SEASON
## SUMMARY OF AMBIENT AIR QUALITY RESULTS

| Sr No. | Location | B(a)P (ng/m³) | As (µg/m³) | Pb (µg/m³) | Ni (µg/m³) | Hg (µg/m³) |
|---|---|---|---|---|---|---|
| 1 | Plant site | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 2 | Sipat | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 3 | Nargara | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 4 | Bhadrapara | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 5 | Sonthi | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 6 | Darrabhata | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 7 | Pachri | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 8 | Changaripara | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 9 | Sukhripali | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 10 | Matiyari | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| **Range** | | **<0.1** | **<0.001** | **<0.1** | **<0.001** | **<0.001** |
| **NAAQ Standards** | | **1.0** | **0.006** | **1.0** | **0.02** | **-** |

## TABLE-3.5.5 (A) SEASONAL VARIATION
## (SUMMARY OF AMBIENT AIR QUALITY RESULTS)

| Sr No. | Parameters | Pre-Monsoon | Monsoon | Post-Monsoon | Winter | Range |
|---|---|---|---|---|---|---|
| 1 | $PM_{10}$ (µg/m³) | 33.2-66.9 | 20.0-54.5 | 32.3-63.7 | 31.9-66.6 | 20.0-66.9 |
| 2 | $PM_{2.5}$ (µg/m³) | 17.4-39.0 | 16.0-29.9 | 19.3-31.1 | 20.6-36.2 | 16.0-39.0 |
| 3 | $SO_2$ (µg/m³) | 8.1-19.0 | 8.8-16.9 | 10.3-19.3 | 11.4-21.1 | 8.1-21.1 |
| 4 | $NO_2$ (µg/m³) | 10.9-21.2 | 10.8-17.5 | 12.4-24.7 | 13.5-26.6 | 10.8-26.6 |
| 5 | CO (µg/m³) | 151-299 | 111-269 | 147-297 | 175-359 | 111-359 |
| 6 | $O_3$ (µg/m³) | 3.5-11.4 | 3.1-10.8 | 4.3-13.1 | 6.0-15.0 | 3.1-15.0 |
| 7 | Ammonia (µg/m³) | <20.0 | <20.0 | <20.0 | <20.0 | <20.0 |
| 8 | Benzene (µg/m³) | <1 | <1 | <1 | <1 | <1 |
| 9 | B(a)P (ng/m³) | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| 10 | As (µg/m³) | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 11 | Pb (µg/m³) | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| 12 | Ni (µg/m³) | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 13 | Hg(µg/m³) | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |

## TABLE-3.5.5 (B) ANNUAL AVERAGE (SUMMARY OF AMBIENT AIR QUALITY RESULTS)

| S.No | Location | PM10 (µg/m3) | PM2.5 (µg/m3) | SO2 (µg/m3) | NO2 (µg/m3) | CO (µg/m3) | O3 (µg/m3) | Ammonia (µg/m3) |
|---|---|---|---|---|---|---|---|---|
| 1 | Plant site | 53.6 | 27.5 | 17.6 | 19.5 | 167.2 | 9.4 | <20.0 |
| 2 | Sipat | 52.7 | 25.7 | 16.6 | 17.5 | 233 | 8.8 | <20.0 |
| 3 | Nargara | 40.2 | 24.2 | 12.7 | 16.4 | 203 | 6.7 | <20.0 |
| 4 | Bhadrapara | 48.1 | 23.0 | 11.5 | 13.9 | 247 | 7.7 | <20.0 |
| 5 | Sonthi | 46.1 | 23.6 | 11.3 | 13.7 | 230 | 5.6 | <20.0 |
| 6 | Darrabhata | 46.8 | 24.5 | 16.0 | 18.2 | 245 | 8.7 | <20.0 |
| 7 | Pachri | 37.4 | 21.1 | 12.0 | 15.3 | 200 | 6.3 | <20.0 |
| 8 | Changaripara | 50.1 | 22.0 | 15.1 | 16.7 | 231 | 6.7 | <20.0 |
| 9 | Sukhripali | 47.1 | 24.0 | 14.4 | 16.8 | 227 | 9.4 | <20.0 |
| 10 | Matiyari | 43.7 | 26.3 | 13.4 | 15.4 | 216 | 7.2 | <20.0 |
| **NAAQ STANDARDS** | | **60** | **40** | **50** | **40** | **2000** | **100** | **100** |

## TABLE-3.5.5 (C) ANNUAL AVERAGE (SUMMARY OF AMBIENT AIR QUALITY RESULTS)

| S.No | Location | Benzene (µg/m³) | B(a)P (ng/m³) | As (µg/m³) | Pb (µg/m³) | Ni (µg/m³) | Hg(µg/m³) |
|---|---|---|---|---|---|---|---|
| 1 | Plant site | <1 | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 2 | Sipat | <1 | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 3 | Nargara | <1 | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 4 | Bhadrapara | <1 | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 5 | Sonthi | <1 | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 6 | Darrabhata | <1 | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 7 | Pachri | <1 | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 8 | Changaripara | <1 | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 9 | Sukhripali | <1 | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| 10 | Matiyari | <1 | <0.1 | <0.001 | <0.1 | <0.001 | <0.001 |
| **NAAQ STANDARDS** | | **05** | **01** | **06** | **0.50** | **20** | **-** |

***Observations of AAQ Data-Pre-Monsoon Season***

The minimum and maximum concentrations for $PM_{10}$ were recorded as 33.2 µg/m³ and 66.9 µg/m³ respectively. The minimum and maximum concentration was recorded at Pachri (AAQ7) and plant site (AAQ1) respectively.

The minimum and maximum concentrations for $PM_{2.5}$ were recorded as 17.4 µg/m³ and 39.0 µg/m³ respectively. The minimum and maximum concentration was recorded at Changaripara (AAQ8) and plant site (AAQ1) respectively.
The minimum and maximum concentrations for $SO_2$ were recorded as 8.1 µg/m³ and 19.0 µg/m³ respectively. The minimum and maximum concentration was recorded at Pachri (AAQ7) and plant site (AAQ1) respectively.

The minimum and maximum concentrations for $NO_2$ were recorded as 10.9 µg/m³ and 21.2 µg/m³ respectively. The minimum and maximum concentration was recorded at Bhadrapara (AAQ4) and Sipat (AAQ2) respectively.

The minimum and maximum CO concentrations were recorded as 151 µg/m³ and 299 µg/m³. The minimum and maximum concentration was recorded at Nargara

(AAQ3) & Pachri (AAQ7) and plant site (AAQ1) respectively. The maximum CO concentration might be due to vehicular transportation.

The minimum and maximum $O_3$ concentrations were recorded as 3.5 $\mu g/m^3$ and 11.4 $\mu g/m^3$. The minimum and maximum concentration was recorded at Nargara (AAQ3) and Sukhripali (AAQ9) respectively.

The concentrations of $PM_{2.5}$, $PM_{10}$, $SO_2$, $NO_2$, $O_3$, CO, $NH_3$, Pb, BaP, Hg, As, Ni and $C_6H_6$ are observed to be well within the NAAQ standards prescribed by Central Pollution Control Board (CPCB) for industrial and rural /residential zone.

There are no other major industries in the study area other than the NTPC Sipat power plant.

***Observations of AAQ Data-Monsoon Season***

The minimum and maximum concentrations for $PM_{10}$ were recorded as 20.0 $\mu g/m^3$ and 54.5 $\mu g/m^3$ respectively. The minimum and maximum concentration was recorded at Darrabhatta (AAQ6) and plant site (AAQ1) respectively.

The minimum and maximum concentrations for $PM_{2.5}$ were recorded as 16.0 $\mu g/m^3$ and 29.9 $\mu g/m^3$ respectively. The minimum and maximum concentration was recorded at Sukhripalli (AAQ9) & plant site (AAQ1) respectively.

The minimum and maximum $SO_2$ concentrations were recorded as 8.8 $\mu g/m^3$ and 16.9 $\mu g/m^3$. The minimum and maximum concentration was recorded at Pachri (AAQ7) and Sipat (AAQ1).

The minimum and maximum $NO_2$ concentrations were recorded as 10.8 $\mu g/m^3$ and 17.5 $\mu g/m^3$. The minimum and maximum concentration was recorded at Nargara (AAQ3) and plant site (AAQ1) respectively.

The minimum and maximum CO concentrations were recorded as 111 $\mu g/m^3$ and 269 $\mu g/m^3$. The minimum and maximum concentration was recorded at Sukhripalli (AAQ9) and plant site (AAQ1) respectively. The maximum CO concentration might be due to vehicular transportation.

The minimum and maximum $O_3$ concentrations were recorded as 3.1 $\mu g/m^3$ and 10.8 $\mu g/m^3$. The minimum and maximum concentration was recorded at Pachri (AAQ7) and plant site (AAQ1) respectively.
The concentrations of $PM_{2.5}$, $PM_{10}$, $SO_2$, $NO_2$, $O_3$, CO, $NH_3$, Pb, BaP, Hg, As, Ni and $C_6H_6$ are observed to be well within the NAAQ standards prescribed by Central Pollution Control Board (CPCB) for industrial and rural /residential zone

***Observations of AAQ Data-Post Monsoon Season***

The minimum and maximum concentrations for $PM_{10}$ were recorded as 32.3 $\mu g/m^3$ and 63.7 $\mu g/m^3$ respectively. The minimum and maximum concentration was recorded at Nargara (AAQ3) and plant site (AAQ1) respectively.

The minimum and maximum concentrations for $PM_{2.5}$ were recorded as 19.3 μg/m$^3$ and 31.1 μg/m$^3$ respectively. The minimum and maximum concentration was recorded at Pachri (AAQ7) & Matiyari (AAQ1) respectively.

The minimum and maximum $SO_2$ concentrations were recorded as 10.3 μg/m$^3$ and 19.3 μg/m$^3$. The minimum and maximum concentration was recorded at Sonthi (AAQ5) and plant site (AAQ1).

The minimum and maximum $NO_2$ concentrations were recorded as 12.4 μg/m$^3$ and 24.7 μg/m$^3$. The minimum and maximum concentration was recorded at Matiyari (AAQ5) and Darabhatta (AAQ6) respectively.

The minimum and maximum CO concentrations were recorded as 147 μg/m$^3$ and 297 μg/m$^3$. The minimum and maximum concentration was recorded at Matiyari (AAQ10) and Sipat (AAQ2) respectively. The maximum CO concentration might be due to vehicular transportation.

The minimum and maximum $O_3$ concentrations were recorded as 4.3 μg/m$^3$ and 13.1 μg/m$^3$. The minimum and maximum concentration was recorded at Pachri (AAQ7) and Darabhatta (AAQ6) respectively.

The concentrations of $PM_{2.5}$, $PM_{10}$, $SO_2$, $NO_2$, $O_3$, CO, $NH_3$, Pb, BaP, Hg, As, Ni and $C_6H_6$ are observed to be well within the NAAQ standards prescribed by Central Pollution Control Board (CPCB) for industrial and rural /residential zone.

***Observations of AAQ Data-Winter Season***

The minimum and maximum concentrations for $PM_{10}$ were recorded as 31.9 μg/m$^3$ and 66.6 μg/m$^3$ respectively. The minimum and maximum concentration was recorded at Nargara (AAQ3) and Sipat (AAQ2) respectively.

The minimum and maximum concentrations for $PM_{2.5}$ were recorded as 20.6 μg/m$^3$ and 36.2 μg/m$^3$ respectively. The minimum and maximum concentration was recorded at Pachri (AAQ7) & plant site (AAQ1) respectively.

The minimum and maximum $SO_2$ concentrations were recorded as 11.4 μg/m$^3$ and 21.1 μg/m$^3$. The minimum and maximum concentration was recorded at Sonthi (AAQ5) and plant site (AAQ1).

The minimum and maximum $NO_2$ concentrations were recorded as 13.5 μg/m$^3$ and 26.6 μg/m$^3$. The minimum and maximum concentration was recorded at Sonthi (AAQ5) and Darabhatta (AAQ6) respectively.

The minimum and maximum CO concentrations were recorded as 175 μg/m$^3$ and 359 μg/m$^3$. The minimum and maximum concentration was recorded at Pachri (AAQ6) and Matiyari (AAQ10) respectively. The maximum CO concentration might be due to vehicular transportation.

The minimum and maximum $O_3$ concentrations were recorded as 6.0 $\mu g/m^3$ and 15.0 $\mu g/m^3$. The minimum and maximum concentration was recorded at Pachri (AAQ7) and Darabhatta (AAQ6) respectively.

The concentrations of $PM_{2.5}$, $PM_{10}$, $SO_2$, $NO_2$, $O_3$, CO, $NH_3$, Pb, BaP, Hg, As, Ni and $C_6H_6$ are observed to be well within the NAAQ standards prescribed by Central Pollution Control Board (CPCB) for industrial and rural /residential zone.

## 3.6 Water Quality

Selected water quality parameters of surface and ground water resources in the study area have been studied for assessing the water environment and evaluate anticipated impact of the plant. Understanding the water quality is essential in preparation of environmental impact assessment and to identify critical issues with a view to suggest appropriate mitigation measures for implementation.

The purpose of this study is to:

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

The information required has been collected through primary surveys and secondary sources.

### 3.6.1 Methodology

Reconnaissance survey was undertaken and monitoring locations were finalized based on:

- Drainage pattern;
- Location of residential areas representing different activities/likely impact areas; and
- Likely areas, which can represent baseline conditions.

Six surface water and six ground water sources in the monthly once during study period were examined for physico-chemical, heavy metals and bacteriological parameters in order to assess the effect of industrial activities and other activities on surface and ground water. The samples were analyzed as per the procedures specified in 'Standard Methods for the Examination of Water and Wastewater' published by American Public Health Association (APHA).

Samples for chemical analysis were collected in polyethylene carboys. Samples collected for metal content were acidified with 1 ml $HNO_3$. Samples for bacteriological analysis were collected in sterilized glass bottles. Selected physico-chemical and bacteriological parameters have been analyzed for projecting the existing water quality status in the study area. Parameters like temperature, dissolved oxygen (DO) and pH were analyzed at the time of sample collection.The methodology for sample collection and preservation techniques was followed as per the Standard Operating Procedures (SOP) mentioned in **Table-3.6.1**.

## TABLE-3.6.1
## STANDARD OPERATING PROCEDURES (SOP) FOR WATER AND WASTEWATER SAMPLING AND ANALYSIS

| Parameter | Sample Collection | Sample Size | Storage/ Preservation |
|---|---|---|---|
| pH | Grab sampling - Plastic /glass container | 50 ml | On site analysis |
| Electrical conductivity | Grab sampling - Plastic /glass container | 50 ml | On site parameter |
| Total suspended solids | Grab sampling - Plastic /glass container | 100 ml | Refrigeration, can be stored for 7 days |
| Total dissolved solids | Grab sampling - Plastic /glass container | 100 ml | Refrigeration, can be stored for 7 days |
| BOD | Grab sampling - Plastic /glass container | 500 ml | Refrigeration, 48 hrs |
| Hardness | Grab sampling - Plastic /glass container | 100 ml | Add $HNO_3$ to pH<2, refrigeration; 6 months |
| Chlorides | Grab sampling - Plastic /glass container | 50 ml | Not required; 28 days |
| Sulphates | Grab sampling - Plastic /glass container | 100 ml | Refrigeration; 28 days |
| Sodium, Potassium | Plastic container | 100 ml | Not required; 6 months |
| Nitrates | Plastic containers | 100 ml | Refrigeration; 48 hrs |
| Fluorides | Plastic containers only | 100 ml | Not required; 28 days |
| Alkalinity | Plastic/ glass containers | 100 ml | Refrigeration; 14 days |
| Ammonia | Plastic/ glass containers | 100 ml | Add $H_2SO_4$ to pH>2, refrigeration, 28 days |
| Hexavalent Chromium, $Cr^{+6}$ | Plastic/ glass rinse with 1+1 $HNO_3$ | 100 ml | Grab sample; refrigeration; 24 hrs |
| Heavy metals (Hg, Cd, Cr, Cu, Fe, Zn, Pb etc.) | Plastic/ glass rinse with 1+1 $HNO_3$ | 500 ml | Filter, add $HNO_3$ to pH>2; grab sample; 6 months |

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

## Analytical Techniques

The sampling and analytical techniques are given in **Table–3.6.2.**

## TABLE-3.6.2
## ANALYTICAL TECHNIQUES FOR WATER AND WASTEWATER SAMPLING AND ANALYSIS

| Parameter | Method |
|---|---|
| pH | APHA-4500-$H^+$ |
| Colour | APHA-2120 C |
| Odour | IS: 3025, Part-4 |
| Temperature | APHA-2550 B |
| Dissolved oxygen | APHA-4500 O |
| BOD | APHA-5210 B |
| Electrical conductivity | APHA-2510 B |
| Turbidity | APHA-2130 B |
| Chlorides | APHA-4500 $Cl^-$ |
| Fluorides | APHA-4500 $F^-$ |
| Total dissolved solids | APHA-2540 C |
| Total suspended solids | APHA-2540 D |

| Parameter | Method |
|---|---|
| Total hardness | APHA-2340 C |
| Sulphates | APHA-4500 $SO_4^{-2}$ |
| Arsenic | APHA-3120 B/ APHA-3114 B/ APHA-3500 As |
| Calcium | APHA-3120 B/ APHA-3500 Ca |
| Magnesium | APHA-3120 B/ APHA-3500 Mg |
| Sodium | APHA-3120 B/ APHA-3500 Na |
| Potassium | APHA-3120 B/ APHA-3500 K |
| Manganese | APHA-3120 B/ APHA-3500 Mn |
| Mercury | APHA-3112 B/ APHA-3500 Hg |
| Selenium | APHA-3120 B/ APHA-3114 B/ APHA-3500 Se |
| Lead | APHA-3120 B/ APHA-3500 Pb |
| Copper | APHA-3120 B/ APHA-3500 Cu |
| Cadmium | APHA-3120 B/ APHA-3500 Cd |
| Iron | APHA-3120 B/ APHA-3500 Fe |
| Zinc | APHA-3120 B/ APHA-3500 Zn |
| Boron | APHA-4500 B |
| Coliform organisms | APHA-9215 D |
| Alkalinity | APHA-2320 B |

### 3.6.2 Water Sampling Locations

In the study area, six surface and six ground water samples were collected monthly once during the study period. These samples were taken as grab samples and were analyzed for various parameters to compare with the standards. The water sampling locations are listed below in **Table-3.6.3** and are shown in **Figure-3.6.1**.

**TABLE-3.6.3**
**WATER SAMPLING LOCATIONS**

| Station Code | Location | Distance (km) | Direction |
|---|---|---|---|
| **Surface Water Locations** | | | |
| SW1 | At raw water reservoir at plant | - | - |
| SW2 | Kurung left bank canal | 0.5 | S |
| SW3 | Kurung river near Hardih village | 5.5 | WNW |
| SW4 | Kurung river near Khaira village | 5.6 | SW |
| SW5 | Lilagarh river near Darrabhata village | 3.8 | E |
| SW6 | Lilagarh river near Murpar village | 5.0 | SE |
| **Ground Water Locations** | | | |
| GW1 | Kaudia village | 0.5 | S |
| GW2 | Sipat village | 1.3 | NW |
| GW3 | Rank village near ash pond | 2.7 | S |
| GW4 | Sonthi village | 8.6 | NE |
| GW5 | Darrabhata village | 1.7 | E |
| GW6 | Reliya village near ash pond | 5.7 | S |

### 3.6.3 Description of Sampling Locations

**Ground Water**

The ground water samples were collected from the village hand pumps surrounded by the habitation. The major usages of the ground water are for drinking and domestic activities.

**Surface Water**

The sampling sites are selected for upstream, downstream streams of Lilagarh river and Kurung river.

- **At raw water reservoir at plant (SW1)**

The sample is collected from raw water reservoir near the plant. The water is used for domestic purposes by NTPC Sipat.

- **Kurung left bank canal (SW2)**

The sample is collected from Kurung canal. The water is used for agriculture and domestic purpose. The water is observed to be clear.

- **Kurung River near Hardih village (SW3) & Kurung river near Khaira village (SW4)**

The sample is collected from Kurung river in upstream & downstream locations w.r.t. NTPC Sipat. Bathing and washing activities are observed. The water is observed to be clear.

- **Lilagarh River near Darrabhata village (SW5) & Lilagarh river near Murpar village (SW6)**

The sample is collected from Lilagarh river in upstream & downstream locations w.r.t. Sipat STPP. The water is used for agriculture and domestic purpose. The water is observed to be clear.

3.6.4 Presentation of Results

The analytical monthly results of surface water and ground water samples are given in **Table-3.6.4** & **Table-3.6.5**.

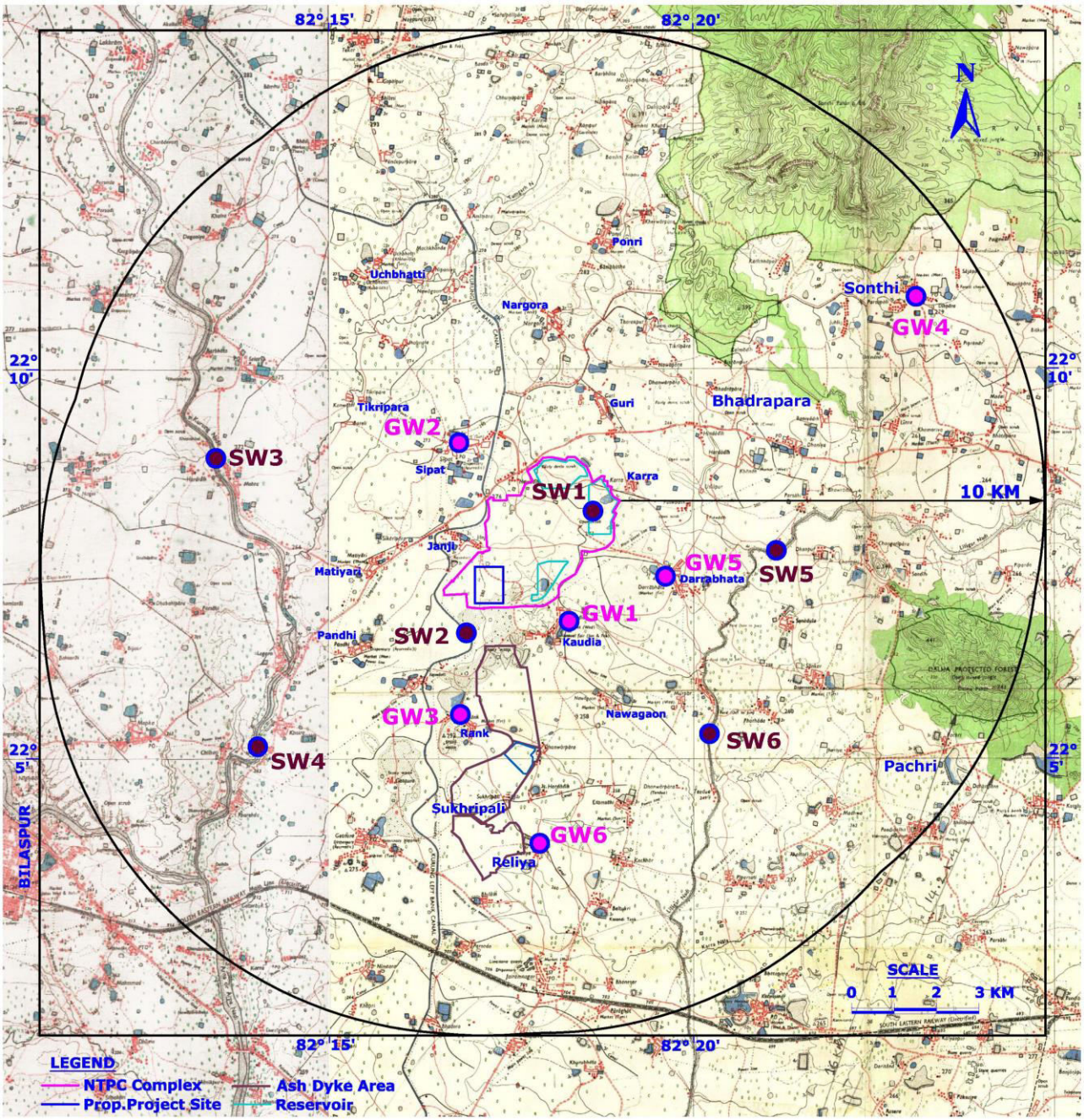



**FIGURE-3.6.1**
**WATER SAMPLING LOCATIONS**

## TABLE-3.6.4 (A)
## SURFACE WATER QUALITY –MARCH 2019

| Sr. No. | Parameters | Unit | SW1 | SW2 | SW3 | SW4 | SW5 | SW6 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | pH | - | 6.9 | 6.7 | 7.3 | 7.1 | 7.0 | 6.7 | 6.7 | 7.3 |
| 2 | Colour | Hazen | 8 | 7 | 9 | 10 | 11 | 8 | 7 | 11 |
| 3 | Conductivity | µS/cm | 473 | 827 | 441 | 473 | 470 | 503 | 441 | 827 |
| 4 | TDS | mg/l | 260.5 | 453.5 | 249.9 | 265.6 | 265.6 | 283.3 | 249.9 | 453.5 |
| 5 | DO | mg/l | 5.6 | 5.8 | 5.4 | 5.8 | 5.5 | 5.3 | 5.3 | 5.8 |
| 6 | BOD | mg/l | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 |
| 7 | COD | mg/l | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 |
| 8 | Turbidity | NTU | 3 | 2 | 2 | 3 | 4 | 2 | 2 | 4 |
| 9 | Total Hardness as CaCO3 | mg/l | 151.9 | 221.1 | 147.3 | 145.7 | 141.9 | 146.6 | 141.9 | 221.1 |
| 10 | Total Alkalinity as CaCO3 | mg/l | 79.6 | 122.6 | 72.4 | 61.5 | 59.5 | 65.5 | 59.5 | 122.6 |
| 11 | Calcium as Ca | mg/l | 37.4 | 44.8 | 36.2 | 32.1 | 31.4 | 34.6 | 31.4 | 44.8 |
| 12 | Magnesium as Mg | mg/l | 14.2 | 26.5 | 13.8 | 15.9 | 15.4 | 14.6 | 13.8 | 26.5 |
| 13 | Chlorides as Cl | mg/l | 90.2 | 172.8 | 86.2 | 99.5 | 101.5 | 108.2 | 86.2 | 172.8 |
| 14 | Residual free chlorine | mg/l | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| 15 | Phosphates as PO4 | mg/l | 0.04 | 0.01 | 0.08 | 0.07 | 0.06 | 0.08 | 0.01 | 0.08 |
| 16 | Sulphates as SO4 | mg/l | 21.2 | 32.8 | 24.6 | 28.8 | 27.7 | 26.4 | 21.2 | 32.8 |
| 17 | Fluorides as F | mg/l | 0.4 | 0.3 | 0.4 | 0.5 | 0.5 | 0.6 | 0.3 | 0.6 |
| 18 | Nitrates as NO3 | mg/l | 6.60 | 10.40 | 8.20 | 6.80 | 6.20 | 7.80 | 6.2 | 10.4 |
| 19 | Sodium as Na | mg/l | 36.5 | 84.2 | 32.5 | 39.8 | 40.8 | 44.6 | 32.5 | 84.2 |
| 20 | Potassium as K | mg/l | 6.2 | 8.1 | 4.6 | 5.3 | 6.4 | 7.2 | 4.6 | 8.1 |
| 21 | Total Boron as B | mg/l | 0.28 | 0.11 | 0.32 | 0.42 | 0.26 | 0.44 | 0.11 | 0.44 |
| 22 | Phenolic Compounds | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 23 | Cyanides | mg/l | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| 24 | Oil & grease | mg/l | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| 25 | Cadmium as Cd | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 26 | Arsenic as As | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 27 | Copper as Cu | mg/l | 0.03 | <0.01 | 0.04 | 0.02 | 0.02 | 0.04 | <0.01 | 0.04 |
| 28 | Lead as Pb | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 29 | Iron as Fe | mg/l | 0.11 | 0.02 | 0.04 | 0.07 | 0.09 | 0.11 | 0.02 | 0.11 |
| 30 | Chromium as Cr+6 | mg/l | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| 31 | Selenium as Se | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 32 | Zinc as Zn | mg/l | 0.06 | 0.04 | 0.07 | 0.06 | 0.09 | 0.07 | 0.04 | 0.09 |
| 33 | Aluminum as Al | mg/l | 0.06 | <0.01 | 0.02 | 0.04 | 0.11 | 0.06 | <0.01 | 0.11 |
| 34 | Mercury as Hg | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 35 | SAR | - | 1.3 | 2.5 | 1.2 | 1.4 | 1.5 | 1.6 | 1.2 | 2.5 |
| 36 | Insecticides | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 37 | Anionic detergents as MBAS | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 38 | Total Coliforms | MPN/100 | 1180 | 2560 | 2280 | 2800 | 2460 | 3240 | 1180 | 3240 |

## TABLE-3.6.4 (B)
## SURFACE WATER QUALITY –APRIL 2019

| Sr. No | Parameters | Unit | SW1 | SW2 | SW3 | SW4 | SW5 | SW6 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | pH | - | 6.7 | 7.1 | 6.9 | 7.2 | 7.3 | 6.9 | 6.7 | 7.3 |
| 2 | Colour | Hazen | 4 | 2 | 3 | 4 | 3 | 6 | 2 | 6 |
| 3 | Conductivity | µS/cm | 516 | 892 | 524 | 492 | 456 | 522.4 | 456 | 892 |
| 4 | TDS | mg/l | 289.3 | 498.2 | 295.7 | 275.5 | 255.7 | 291.2 | 255.7 | 498.2 |
| 5 | DO | mg/l | 5.2 | 5.6 | 5.3 | 5.4 | 5.6 | 5.5 | 5.2 | 5.6 |
| 6 | BOD | mg/l | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 |
| 7 | COD | mg/l | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 |
| 8 | Turbidity | NTU | 5 | 4 | 3 | 2 | 5 | 5 | 2 | 5 |
| 9 | Total Hardness as CaCO3 | mg/l | 157.64 | 225.18 | 150.44 | 148.92 | 135.35 | 150.55 | 135.35 | 225.18 |
| 10 | Total Alkalinity as CaCO3 | mg/l | 72.4 | 116.5 | 68.2 | 54.6 | 62.8 | 61.4 | 54.6 | 116.5 |
| 11 | Calcium as Ca | mg/l | 38.2 | 45.3 | 36.8 | 32.9 | 30.6 | 35.2 | 30.6 | 45.3 |
| 12 | Magnesium as Mg | mg/l | 15.1 | 27.2 | 14.2 | 16.2 | 14.3 | 15.2 | 14.2 | 27.2 |
| 13 | Chlorides as Cl | mg/l | 112.5 | 205.2 | 116.2 | 108.6 | 92.6 | 116.5 | 92.6 | 205.2 |
| 14 | Residual free chlorine | mg/l | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| 15 | Phosphates as PO4 | mg/l | 0.02 | 0.02 | 0.03 | 0.04 | 0.06 | 0.04 | 0.02 | 0.06 |
| 16 | Sulphates as SO4 | mg/l | 22.6 | 33.4 | 26.8 | 31.6 | 29.4 | 24.6 | 22.6 | 33.4 |
| 17 | Fluorides as F | mg/l | 0.5 | 0.4 | 0.3 | 0.6 | 0.7 | 0.5 | 0.3 | 0.7 |
| 18 | Nitrates as NO3 | mg/l | 8.1 | 11.6 | 7.1 | 5.9 | 5.2 | 8.4 | 5.2 | 11.6 |
| 19 | Sodium as Na | mg/l | 42.5 | 96.8 | 48.6 | 41.8 | 39.6 | 47.2 | 39.6 | 96.8 |
| 20 | Potassium as K | mg/l | 6.4 | 8.4 | 4.8 | 5.1 | 5.6 | 6.8 | 4.8 | 8.4 |
| 21 | Total Boron as B | mg/l | 0.46 | 0.61 | 0.68 | 0.51 | 0.42 | 0.56 | 0.42 | 0.68 |
| 22 | Phenolic Compounds | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 23 | Cyanides | mg/l | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| 24 | Oil & grease | mg/l | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| 25 | Cadmium as Cd | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 26 | Arsenic as As | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 27 | Copper as Cu | mg/l | 0.02 | <0.01 | <0.01 | 0.01 | <0.01 | <0.01 | <0.01 | 0.02 |
| 28 | Lead as Pb | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 29 | Iron as Fe | mg/l | 0.08 | 0.04 | 0.03 | 0.03 | 0.11 | 0.09 | 0.03 | 0.11 |
| 30 | Chromium as Cr+6 | mg/l | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| 31 | Selenium as Se | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 32 | Zinc as Zn | mg/l | 0.02 | 0.05 | 0.04 | 0.06 | 0.13 | 0.05 | 0.02 | 0.13 |
| 33 | Aluminum as Al | mg/l | 0.03 | 0.06 | 0.09 | 0.04 | 0.06 | 0.06 | 0.03 | 0.09 |
| 34 | Mercury as Hg | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 35 | SAR | - | 1.5 | 2.8 | 1.7 | 1.5 | 1.5 | 1.7 | 1.5 | 2.8 |
| 36 | Insecticides | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 37 | Anionic detergents as MBAS | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 38 | Total Coliforms | MPN/100 | 2160 | 2850 | 3240 | 3640 | 2080 | 2650 | 2080 | 3640 |

## TABLE-3.6.4 (C)
## SURFACE WATER QUALITY –MAY 2019

| Sr. No | Parameters | Unit | SW1 | SW2 | SW3 | SW4 | SW5 | SW6 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | pH | - | 6.8 | 7.3 | 7.2 | 7.0 | 7.4 | 6.7 | 6.7 | 7.4 |
| 2 | Colour | Hazen | 5 | 3 | 4 | 6 | 4 | 6 | 3 | 6 |
| 3 | Conductivity | µS/cm | 524 | 842 | 542 | 516 | 502 | 534 | 502 | 842 |
| 4 | TDS | mg/l | 271.6 | 450.1 | 272.1 | 278.9 | 274.7 | 287.0 | 271.6 | 450.1 |
| 5 | DO | mg/l | 5.7 | 5.6 | 5.4 | 5.3 | 5.2 | 5.4 | 5.2 | 5.7 |
| 6 | BOD | mg/l | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 |
| 7 | COD | mg/l | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 |
| 8 | Turbidity | NTU | 2 | 6 | 5 | 4 | 6 | 5 | 2 | 6 |
| 9 | Total Hardness as CaCO3 | mg/l | 159.87 | 214.17 | 149.76 | 153.14 | 146.17 | 152.02 | 146.17 | 214.17 |
| 10 | Total Alkalinity as CaCO3 | mg/l | 78.6 | 108.8 | 71.4 | 60.2 | 61.2 | 63.5 | 60.2 | 108.8 |
| 11 | Calcium as Ca | mg/l | 38.6 | 43.2 | 36.2 | 33.6 | 31.8 | 34.8 | 31.8 | 43.2 |
| 12 | Magnesium as Mg | mg/l | 15.4 | 25.8 | 14.4 | 16.8 | 16.2 | 15.8 | 14.4 | 25.8 |
| 13 | Chlorides as Cl | mg/l | 90.2 | 172.8 | 86.2 | 99.5 | 101.5 | 108.2 | 86.2 | 172.8 |
| 14 | Residual free chlorine | mg/l | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| 15 | Phosphates as PO4 | mg/l | 0.06 | 0.03 | 0.05 | 0.07 | 0.06 | 0.04 | 0.03 | 0.07 |
| 16 | Sulphates as SO4 | mg/l | 23.1 | 34.2 | 27.8 | 32.6 | 30.6 | 25.4 | 23.1 | 34.2 |
| 17 | Fluorides as F | mg/l | 0.6 | 0.5 | 0.5 | 0.6 | 0.4 | 0.5 | 0.4 | 0.6 |
| 18 | Nitrates as $NO_3$ | mg/l | 7.1 | 9.8 | 6.6 | 9.2 | 7.1 | 8.2 | 6.6 | 9.8 |
| 19 | Sodium as Na | mg/l | 43.5 | 90.6 | 53.4 | 45.6 | 45 | 48.6 | 43.5 | 90.6 |
| 20 | Potassium as K | mg/l | 5.9 | 7.9 | 4.2 | 4.9 | 5.4 | 7.4 | 4.2 | 7.9 |
| 21 | Total Boron as B | mg/l | 0.31 | 0.64 | 0.41 | 0.31 | 0.39 | 0.66 | 0.31 | 0.66 |
| 22 | Phenolic Compounds | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 23 | Cyanides | mg/l | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| 24 | Oil & grease | mg/l | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| 25 | Cadmium as Cd | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 26 | Arsenic as As | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 27 | Copper as Cu | mg/l | <0.01 | <0.01 | 0.01 | <0.01 | <0.01 | 0.02 | <0.01 | 0.02 |
| 28 | Lead as Pb | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 29 | Iron as Fe | mg/l | <0.01 | 0.03 | 0.03 | 0.06 | 0.02 | 0.06 | <0.01 | 0.06 |
| 30 | Chromium as Cr+6 | mg/l | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| 31 | Selenium as Se | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 32 | Zinc as Zn | mg/l | 0.08 | 0.02 | 0.04 | 0.06 | 0.02 | 0.01 | 0.01 | 0.08 |
| 33 | Aluminum as Al | mg/l | 0.02 | 0.06 | 0.02 | 0.06 | 0.04 | 0.05 | 0.02 | 0.06 |
| 34 | Mercury as Hg | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 35 | SAR | - | 1.50 | 2.69 | 1.90 | 1.60 | 1.62 | 1.72 | 1.5 | 2.69 |
| 36 | Insecticides | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 37 | Anionic detergents as MBAS | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 38 | Total Coliforms | MPN/100 | 2460 | 3260 | 3560 | 3480 | 3260 | 3360 | 2460 | 3560 |

## TABLE-3.6.4 (D)
## SURFACE WATER QUALITY –JUNE 2019

| Sr. No | Parameters | Unit | SW1 | SW2 | SW3 | SW4 | SW5 | SW6 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | pH | - | 6.8 | 7.4 | 7.6 | 7.1 | 7.1 | 6.9 | 6.8 | 7.6 |
| 2 | Colour | Hazen | 6 | 5 | 6 | 6 | 4 | 6 | 4 | 6 |
| 3 | Conductivity | µS/cm | 502 | 824 | 536 | 518 | 526 | 562 | 502 | 824 |
| 4 | TDS | mg/l | 258.9 | 454.7 | 269.6 | 275.3 | 281.5 | 292.9 | 258.9 | 454.7 |
| 5 | DO | mg/l | 5.3 | 5.6 | 5.8 | 5.6 | 5.4 | 5.6 | 5.3 | 5.8 |
| 6 | BOD | mg/l | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 |
| 7 | COD | mg/l | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 |
| 8 | Turbidity | NTU | 4 | 6 | 3 | 5 | 8 | 6 | 3 | 8 |
| 9 | Total Hardness as CaCO3 | mg/l | 151.58 | 215.44 | 150.79 | 155.35 | 141.27 | 151.42 | 141.27 | 215.44 |
| 10 | Total Alkalinity as CaCO3 | mg/l | 70.6 | 118.5 | 69.8 | 63.4 | 66.8 | 58.6 | 58.6 | 118.5 |
| 11 | Calcium as Ca | mg/l | 36.6 | 44.2 | 37.6 | 33.5 | 30.5 | 33.9 | 30.5 | 44.2 |
| 12 | Magnesium as Mg | mg/l | 14.6 | 25.5 | 13.8 | 17.4 | 15.8 | 16.2 | 13.8 | 25.5 |
| 13 | Chlorides as Cl | mg/l | 90.2 | 172.8 | 86.2 | 99.5 | 101.5 | 108.2 | 86.2 | 172.8 |
| 14 | Residual free chlorine | mg/l | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| 15 | Phosphates as PO4 | mg/l | 0.02 | 0.04 | 0.03 | 0.06 | 0.07 | 0.04 | 0.02 | 0.07 |
| 16 | Sulphates as SO4 | mg/l | 20.8 | 34.2 | 25.1 | 27.6 | 28.2 | 27.4 | 20.8 | 34.2 |
| 17 | Fluorides as F | mg/l | 0.4 | 0.6 | 0.5 | 0.6 | 0.7 | 0.5 | 0.4 | 0.7 |
| 18 | Nitrates as NO3 | mg/l | 5.9 | 10.6 | 8.6 | 8.8 | 6.5 | 8.6 | 5.9 | 10.6 |
| 19 | Sodium as Na | mg/l | 42.4 | 88.5 | 51.2 | 44.8 | 52.8 | 55.8 | 42.4 | 88.5 |
| 20 | Potassium as K | mg/l | 5.6 | 7.2 | 4.7 | 5.1 | 5.4 | 7.1 | 4.7 | 7.2 |
| 21 | Total Boron as B | mg/l | 0.56 | 0.49 | 0.37 | 0.67 | 0.52 | 0.41 | 0.37 | 0.67 |
| 22 | Phenolic Compounds | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 23 | Cyanides | mg/l | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| 24 | Oil & grease | mg/l | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| 25 | Cadmium as Cd | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 26 | Arsenic as As | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 27 | Copper as Cu | mg/l | 0.02 | <0.01 | 0.02 | <0.01 | 0.01 | 0.02 | <0.01 | 0.02 |
| 28 | Lead as Pb | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 29 | Iron as Fe | mg/l | 0.03 | 0.05 | 0.07 | 0.05 | 0.09 | 0.05 | 0.03 | 0.09 |
| 30 | Chromium as Cr+6 | mg/l | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| 31 | Selenium as Se | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 32 | Zinc as Zn | mg/l | 0.03 | 0.08 | 0.09 | 0.02 | 0.04 | 0.06 | 0.02 | 0.09 |
| 33 | Aluminum as Al | mg/l | 0.05 | 0.06 | <0.01 | 0.02 | 0.01 | 0.05 | <0.01 | 0.06 |
| 34 | Mercury as Hg | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 35 | SAR | - | 1.50 | 2.62 | 1.81 | 1.56 | 1.93 | 1.97 | 1.5 | 2.62 |
| 36 | Insecticides | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 37 | Anionic detergents as MBAS | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 38 | Total coliforms | MPN/100 | 3200 | 3160 | 2950 | 3650 | 3840 | 3710 | 2950 | 3840 |

## TABLE-3.6.4 (E)
## SURFACE WATER QUALITY –JULY 2019

| Sr.No | Parameters | Unit | SW1 | SW2 | SW3 | SW4 | SW5 | SW6 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | pH | - | 6.8 | 7.3 | 6.8 | 6.9 | 7.5 | 6.8 | 6.8 | 7.5 |
| 2 | Colour | Hazen | 2 | 3 | 3 | 2 | 4 | 4 | 2 | 4 |
| 3 | Conductivity | µS/cm | 498.3 | 764.1 | 562.3 | 511.2 | 495.6 | 475.6 | 475.6 | 764.1 |
| 4 | TDS | mg/l | 313.0 | 481.0 | 354.0 | 321.9 | 312.2 | 299.5 | 299.5 | 481 |
| 5 | DO | mg/l | 5.0 | 5.2 | 5.3 | 5.2 | 5.4 | 5.6 | 5 | 5.6 |
| 6 | BOD | mg/l | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 |
| 7 | COD | mg/l | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 |
| 8 | Turbidity | NTU | 4 | 5 | 3 | 4 | 5 | 3 | 3 | 5 |
| 9 | Total Hardness as CaCO3 | mg/l | 151.00 | 186.00 | 166.00 | 154.00 | 167.00 | 130.00 | 130 | 186 |
| 10 | Total Alkalinity as CaCO3 | mg/l | 62.3 | 95.6 | 70.3 | 57.2 | 58.4 | 56.4 | 56.4 | 95.6 |
| 11 | Calcium as Ca | mg/l | 36.4 | 40.8 | 40.9 | 38.4 | 40.1 | 31.4 | 31.4 | 40.9 |
| 12 | Magnesium as Mg | mg/l | 14.6 | 20.4 | 15.4 | 14.0 | 16.2 | 12.4 | 12.4 | 20.4 |
| 13 | Chlorides as Cl | mg/l | 110.2 | 173.2 | 118.4 | 108.6 | 112.4 | 101.6 | 101.6 | 173.2 |
| 14 | Residual free chlorine | mg/l | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| 15 | Phosphates as PO4 | mg/l | 0.03 | 0.02 | 0.04 | 0.03 | 0.05 | 0.02 | 0.02 | 0.05 |
| 16 | Sulphates as SO4 | mg/l | 20.3 | 26.5 | 32.4 | 36.4 | 22.4 | 26.4 | 20.3 | 36.4 |
| 17 | Fluorides as F | mg/l | 0.4 | 0.4 | 0.3 | 0.5 | 0.4 | 0.5 | 0.3 | 0.5 |
| 18 | Nitrates as NO3 | mg/l | 7.6 | 11.1 | 7.6 | 5.1 | 4.9 | 8.6 | 4.9 | 11.1 |
| 19 | Sodium as Na | mg/l | 41.2 | 85.4 | 50.1 | 43.7 | 34.1 | 46.1 | 34.1 | 85.4 |
| 20 | Potassium as K | mg/l | 5.9 | 8.1 | 5.2 | 5.6 | 5.1 | 6.1 | 5.1 | 8.1 |
| 21 | Total Boron as B | mg/l | 0.32 | 0.46 | 0.52 | 0.42 | 0.36 | 0.58 | 0.32 | 0.58 |
| 22 | Phenolic Compounds | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 23 | Cyanides | mg/l | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| 24 | Oil & grease | mg/l | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| 25 | Cadmium as Cd | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 26 | Arsenic as As | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 27 | Copper as Cu | mg/l | 0.03 | <0.01 | <0.01 | 0.01 | <0.01 | <0.01 | <0.01 | 0.03 |
| 28 | Lead as Pb | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 29 | Iron as Fe | mg/l | 0.06 | 0.08 | 0.04 | 0.02 | 0.12 | 0.11 | 0.02 | 0.12 |
| 30 | Chromium as Cr+6 | mg/l | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| 31 | Selenium as Se | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 32 | Zinc as Zn | mg/l | 0.12 | 0.05 | 0.11 | 0.08 | 0.12 | 0.08 | 0.05 | 0.12 |
| 33 | Aluminum as Al | mg/l | 0.04 | 0.08 | 0.1 | 0.05 | 0.08 | 0.02 | 0.02 | 0.1 |
| 34 | Mercury as Hg | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 35 | SAR | - | 1.5 | 2.7 | 1.7 | 1.5 | 1.2 | 1.6 | 1.2 | 2.7 |
| 36 | Insecticides | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 37 | Anionic detergents as MBAS | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 38 | Total Coliforms | MPN/100 | 1968 | 2127 | 2974 | 3217 | 2387 | 2963 | 1968 | 3217 |

## TABLE-3.6.4 (F)
## SURFACE WATER QUALITY –AUGUST 2019

| Sr.No | Parameters | Unit | SW1 | SW2 | SW3 | SW4 | SW5 | SW6 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | pH | - | 7.1 | 7.6 | 7.4 | 6.9 | 6.8 | 6.7 | 6.7 | 7.6 |
| 2 | Colour | Hazen | 2 | 4 | 4 | 3 | 2 | 5 | 2 | 5 |
| 3 | Conductivity | µS/cm | 564.3 | 812.4 | 578.4 | 586.3 | 496.3 | 578.1 | 496.3 | 812.4 |
| 4 | TDS | mg/l | 355.3 | 511.5 | 364.1 | 369.1 | 312.4 | 364.1 | 312.4 | 511.5 |
| 5 | DO | mg/l | 5 | 5.4 | 5.1 | 5.6 | 5.4 | 5.3 | 5 | 5.6 |
| 6 | BOD | mg/l | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 |
| 7 | COD | mg/l | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 |
| 8 | Turbidity | NTU | 4 | 3 | 5 | 2 | 4 | 5 | 2 | 5 |
| 9 | Total Hardness as CaCO3 | mg/l | 155.00 | 196.00 | 164.00 | 173.00 | 142.00 | 161.00 | 142 | 196 |
| 10 | Total Alkalinity as CaCO3 | mg/l | 82.1 | 126.4 | 92.4 | 73.2 | 72.6 | 76.8 | 72.6 | 126.4 |
| 11 | Calcium as Ca | mg/l | 38.6 | 41.8 | 38.6 | 39.6 | 36.4 | 36.8 | 36.4 | 41.8 |
| 12 | Magnesium as Mg | mg/l | 14.1 | 22.3 | 16.4 | 18.1 | 12.4 | 16.8 | 12.4 | 22.3 |
| 13 | Chlorides as Cl | mg/l | 114.8 | 164.5 | 115.4 | 127.6 | 96.8 | 118.4 | 96.8 | 164.5 |
| 14 | Residual free chlorine | mg/l | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| 15 | Phosphates as PO4 | mg/l | 0.02 | 0.02 | 0.03 | 0.04 | 0.06 | 0.04 | 0.02 | 0.06 |
| 16 | Sulphates as SO4 | mg/l | 26.7 | 32.1 | 21.6 | 29.4 | 26.7 | 31.1 | 21.6 | 32.1 |
| 17 | Fluorides as F | mg/l | 0.4 | 0.5 | 0.6 | 0.4 | 0.6 | 0.4 | 0.4 | 0.6 |
| 18 | Nitrates as NO3 | mg/l | 7.1 | 8.1 | 7.2 | 8.1 | 6.2 | 12.1 | 6.2 | 12.1 |
| 19 | Sodium as Na | mg/l | 53.8 | 92.4 | 54.6 | 52.1 | 43.1 | 54.1 | 43.1 | 92.4 |
| 20 | Potassium as K | mg/l | 8.1 | 7.6 | 4.2 | 5.2 | 9.8 | 8.2 | 4.2 | 9.8 |
| 21 | Total Boron as B | mg/l | 0.32 | 0.56 | 0.51 | 0.29 | 0.32 | 0.45 | 0.29 | 0.56 |
| 22 | Phenolic Compounds | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 23 | Cyanides | mg/l | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| 24 | Oil & grease | mg/l | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| 25 | Cadmium as Cd | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 26 | Arsenic as As | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 27 | Copper as Cu | mg/l | 0.03 | <0.01 | <0.01 | 0.01 | <0.01 | <0.01 | <0.01 | 0.03 |
| 28 | Lead as Pb | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 29 | Iron as Fe | mg/l | 0.06 | 0.03 | 0.02 | 0.04 | 0.23 | 0.11 | 0.02 | 0.23 |
| 30 | Chromium as Cr+6 | mg/l | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| 31 | Selenium as Se | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 32 | Zinc as Zn | mg/l | 0.03 | 0.04 | 0.05 | 0.06 | 0.12 | 0.08 | 0.03 | 0.12 |
| 33 | Aluminum as Al | mg/l | 0.05 | 0.08 | 0.1 | 0.02 | 0.08 | 0.04 | 0.02 | 0.1 |
| 34 | Mercury as Hg | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 35 | SAR | - | 1.8 | 2.7 | 1.8 | 1.7 | 1.5 | 1.8 | 1.5 | 2.7 |
| 36 | Insecticides | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 37 | Anionic detergents as MBAS | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 38 | Total Coliforms | MPN/100 | 2384 | 2596 | 3452 | 3512 | 3214 | 2174 | 2174 | 3512 |

## TABLE-3.6.4 (G)
## SURFACE WATER QUALITY-SEPTEMBER 2019

| Sr.No | Parameters | Unit | SW1 | SW2 | SW3 | SW4 | SW5 | SW6 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | pH | - | 7.1 | 6.9 | 7.2 | 6.8 | 7.6 | 6.8 | 6.8 | 7.6 |
| 2 | Colour | Hazen | 3 | 4 | 4 | 3 | 3 | 4 | 3 | 4 |
| 3 | Conductivity | µS/cm | 538.2 | 828.4 | 546.5 | 528.6 | 508.4 | 514.8 | 508.4 | 828.4 |
| 4 | TDS | mg/l | 298.4 | 462.8 | 306.8 | 297.3 | 277.8 | 291.5 | 277.8 | 462.8 |
| 5 | DO | mg/l | 5.2 | 5.1 | 5.4 | 5.3 | 5.5 | 5.4 | 5.1 | 5.5 |
| 6 | BOD | mg/l | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 |
| 7 | COD | mg/l | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 |
| 8 | Turbidity | NTU | 5 | 2 | 4 | 5 | 3 | 6 | 2 | 6 |
| 9 | Total Hardness as CaCO3 | mg/l | 159.0 | 195.1 | 154.0 | 162.3 | 174.9 | 138.0 | 138 | 195.1 |
| 10 | Total Alkalinity as CaCO3 | mg/l | 61.4 | 96.4 | 72.4 | 59.6 | 56.8 | 52.9 | 52.9 | 96.4 |
| 11 | Calcium as Ca | mg/l | 37.6 | 42.8 | 38.9 | 38.9 | 42.3 | 32.8 | 32.8 | 42.8 |
| 12 | Magnesium as Mg | mg/l | 15.8 | 21.4 | 13.8 | 15.8 | 16.8 | 13.6 | 13.6 | 21.4 |
| 13 | Chlorides as Cl | mg/l | 125.6 | 198.6 | 112.5 | 116.4 | 118.6 | 118.6 | 112.5 | 198.6 |
| 14 | Residual free chlorine | mg/l | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| 15 | Phosphates as PO4 | mg/l | 0.01 | 0.02 | 0.02 | 0.04 | 0.03 | 0.03 | 0.01 | 0.04 |
| 16 | Sulphates as SO4 | mg/l | 21.6 | 27.4 | 33.8 | 35.8 | 21.9 | 27.8 | 21.6 | 35.8 |
| 17 | Fluorides as F | mg/l | 0.5 | 0.4 | 0.4 | 0.3 | 0.5 | 0.6 | 0.3 | 0.6 |
| 18 | Nitrates as NO3 | mg/l | 7.2 | 10.4 | 7.3 | 5.3 | 5.1 | 9.2 | 5.1 | 10.4 |
| 19 | Sodium as Na | mg/l | 47.2 | 96.2 | 51.8 | 43.7 | 33.6 | 51.4 | 33.6 | 96.2 |
| 20 | Potassium as K | mg/l | 6.1 | 7.8 | 4.9 | 5.3 | 4.9 | 5.8 | 4.9 | 7.8 |
| 21 | Total Boron as B | mg/l | 0.16 | 0.22 | 0.32 | 0.42 | 0.39 | 0.62 | 0.16 | 0.62 |
| 22 | Phenolic Compounds | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 23 | Cyanides | mg/l | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| 24 | Oil & grease | mg/l | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| 25 | Cadmium as Cd | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 26 | Arsenic as As | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 27 | Copper as Cu | mg/l | 0.01 | <0.01 | <0.01 | 0.02 | 0.01 | <0.01 | <0.01 | 0.02 |
| 28 | Lead as Pb | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 29 | Iron as Fe | mg/l | 0.05 | 0.06 | 0.05 | 0.03 | 0.1 | 0.09 | 0.03 | 0.1 |
| 30 | Chromium as Cr+6 | mg/l | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| 31 | Selenium as Se | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 32 | Zinc as Zn | mg/l | 0.08 | 0.06 | 0.14 | 0.06 | 0.14 | 0.06 | 0.06 | 0.14 |
| 33 | Aluminum as Al | mg/l | 0.02 | 0.04 | 0.08 | 0.06 | 0.12 | 0.04 | 0.02 | 0.12 |
| 34 | Mercury as Hg | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 35 | SAR | - | 1.6 | 3.0 | 1.8 | 1.5 | 1.1 | 1.9 | 1.1 | 3 |
| 36 | Insecticides | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 37 | Anionic detergents as MBAS | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 38 | Total Coliforms | MPN/100 | 2060 | 1820 | 2650 | 2860 | 2240 | 2690 | 1820 | 2860 |

## TABLE-3.6.4 (H)
## SURFACE WATER QUALITY –OCTOBER 2019

| Sr.No | Parameters | Unit | SW1 | SW2 | SW3 | SW4 | SW5 | SW6 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | pH | - | 7.4 | 7.3 | 7.6 | 6.7 | 7.2 | 6.8 | 6.7 | 7.6 |
| 2 | Colour | Hazen | 5 | 3 | 4 | 4 | 3 | 4 | 3 | 5 |
| 3 | Conductivity | µS/cm | 552.8 | 855.7 | 562.4 | 536.1 | 521.4 | 546.0 | 521.4 | 855.7 |
| 4 | TDS | mg/l | 307.2 | 477.5 | 312.8 | 298.3 | 286.6 | 303.3 | 286.6 | 477.5 |
| 5 | DO | mg/l | 5.6 | 5.2 | 5.3 | 5.2 | 5.3 | 5.4 | 5.2 | 5.6 |
| 6 | BOD | mg/l | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 |
| 7 | COD | mg/l | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 |
| 8 | Turbidity | NTU | 4 | 5 | 6 | 3 | 5 | 6 | 3 | 6 |
| 9 | Total Hardness as CaCO3 | mg/l | 162.2 | 198.7 | 163.4 | 169.3 | 180.2 | 155.9 | 155.9 | 198.7 |
| 10 | Total Alkalinity as CaCO3 | mg/l | 69.8 | 102.5 | 77.9 | 62.4 | 61.8 | 76.8 | 61.8 | 102.5 |
| 11 | Calcium as Ca | mg/l | 38.2 | 43.6 | 39.2 | 38.4 | 41.8 | 36.2 | 36.2 | 43.6 |
| 12 | Magnesium as Mg | mg/l | 16.2 | 21.8 | 15.9 | 17.8 | 18.4 | 15.9 | 15.9 | 21.8 |
| 13 | Chlorides as Cl | mg/l | 125.8 | 202.6 | 111.8 | 114.2 | 118.6 | 108.4 | 108.4 | 202.6 |
| 14 | Residual free chlorine | mg/l | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| 15 | Phosphates as PO4 | mg/l | 0.01 | 0.03 | 0.03 | 0.02 | 0.04 | 0.05 | 0.01 | 0.05 |
| 16 | Sulphates as SO4 | mg/l | 22.8 | 28.9 | 34.6 | 36.5 | 24.8 | 29.4 | 22.8 | 36.5 |
| 17 | Fluorides as F | mg/l | 0.5 | 0.5 | 0.5 | 0.6 | 0.7 | 0.5 | 0.5 | 0.7 |
| 18 | Nitrates as NO3 | mg/l | 6.8 | 9.5 | 7.8 | 5.9 | 6.2 | 10.2 | 5.9 | 10.2 |
| 19 | Sodium as Na | mg/l | 48.7 | 101.2 | 51.2 | 42.4 | 34.2 | 50.4 | 34.2 | 101.2 |
| 20 | Potassium as K | mg/l | 6.3 | 7.9 | 5.1 | 5.1 | 4.8 | 6.2 | 4.8 | 7.9 |
| 21 | Total Boron as B | mg/l | 0.38 | 0.52 | 0.46 | 0.32 | 0.26 | 0.41 | 0.26 | 0.52 |
| 22 | Phenolic Compounds | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 23 | Cyanides | mg/l | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| 24 | Oil & grease | mg/l | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| 25 | Cadmium as Cd | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 26 | Arsenic as As | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 27 | Copper as Cu | mg/l | 0.02 | <0.01 | 0.02 | 0.02 | <0.01 | 0.01 | <0.01 | 0.02 |
| 28 | Lead as Pb | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 29 | Iron as Fe | mg/l | 0.07 | 0.04 | 0.03 | 0.02 | 0.18 | 0.14 | 0.02 | 0.18 |
| 30 | Chromium as Cr+6 | mg/l | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| 31 | Selenium as Se | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 32 | Zinc as Zn | mg/l | 0.04 | 0.08 | 0.07 | 0.09 | 0.14 | 0.11 | 0.04 | 0.14 |
| 33 | Aluminum as Al | mg/l | 0.07 | 0.06 | 0.04 | 0.03 | 0.09 | 0.06 | 0.03 | 0.09 |
| 34 | Mercury as Hg | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 35 | SAR | - | 1.7 | 3.1 | 1.7 | 1.4 | 1.1 | 1.8 | 1.1 | 3.1 |
| 36 | Insecticides | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 37 | Anionic detergents as MBAS | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 38 | Total Coliforms | MPN/100 | 2340 | 2280 | 2140 | 2680 | 2260 | 2890 | 2140 | 2890 |

## TABLE-3.6.4 (I)
## SURFACE WATER QUALITY –NOVEMBER 2019

| Sr.No | Parameters | Unit | SW1 | SW2 | SW3 | SW4 | SW5 | SW6 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | pH | - | 7.2 | 7.6 | 7.2 | 7.4 | 7.4 | 7.8 | 7.2 | 7.8 |
| 2 | Colour | Hazen | 3 | 5 | 4 | 4 | 3 | 5 | 3 | 5 |
| 3 | Conductivity | µS/cm | 548.6 | 846.9 | 574.8 | 522.8 | 536.9 | 524.8 | 522.8 | 846.9 |
| 4 | TDS | mg/l | 306.6 | 471.7 | 319.1 | 295.4 | 296.1 | 292.1 | 292.1 | 471.7 |
| 5 | DO | mg/l | 5.3 | 5.2 | 5.1 | 5.3 | 5.4 | 5.5 | 5.1 | 5.5 |
| 6 | BOD | mg/l | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 |
| 7 | COD | mg/l | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 |
| 8 | Turbidity | NTU | 5 | 4 | 3 | 6 | 4 | 4 | 3 | 6 |
| 9 | Total Hardness as CaCO3 | mg/l | 149.6 | 190.1 | 184.9 | 160.3 | 181.7 | 155.2 | 149.6 | 190.1 |
| 10 | Total Alkalinity as CaCO3 | mg/l | 67.4 | 98.6 | 74.6 | 63.3 | 64.8 | 71.6 | 63.3 | 98.6 |
| 11 | Calcium as Ca | mg/l | 39.1 | 41.8 | 49.6 | 36.8 | 43.2 | 35.9 | 35.9 | 49.6 |
| 12 | Magnesium as Mg | mg/l | 12.6 | 20.8 | 14.8 | 16.6 | 17.9 | 15.9 | 12.6 | 20.8 |
| 13 | Chlorides as Cl | mg/l | 124.6 | 201.3 | 121.5 | 108.4 | 119.6 | 105.2 | 105.2 | 201.3 |
| 14 | Residual free chlorine | mg/l | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| 15 | Phosphates as PO4 | mg/l | 0.03 | 0.05 | 0.02 | 0.04 | 0.03 | 0.05 | 0.02 | 0.05 |
| 16 | Sulphates as SO4 | mg/l | 23.4 | 27.6 | 31.9 | 37.4 | 26.8 | 30.4 | 23.4 | 37.4 |
| 17 | Fluorides as F | mg/l | 0.6 | 0.5 | 0.5 | 0.6 | 0.7 | 0.6 | 0.5 | 0.7 |
| 18 | Nitrates as NO3 | mg/l | 6.2 | 10.1 | 6.9 | 8.6 | 7.2 | 9.4 | 6.2 | 10.1 |
| 19 | Sodium as Na | mg/l | 54.1 | 103.2 | 44.5 | 43.4 | 37.6 | 46.2 | 37.6 | 103.2 |
| 20 | Potassium as K | mg/l | 5.6 | 7.2 | 4.6 | 5.6 | 4.2 | 5.5 | 4.2 | 7.2 |
| 21 | Total Boron as B | mg/l | 0.28 | 0.44 | 0.31 | 0.46 | 0.52 | 0.49 | 0.28 | 0.52 |
| 22 | Phenolic Compounds | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 23 | Cyanides | mg/l | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| 24 | Oil & grease | mg/l | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| 25 | Cadmium as Cd | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 26 | Arsenic as As | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 27 | Copper as Cu | mg/l | 0.01 | <0.01 | <0.01 | 0.02 | <0.01 | 0.01 | <0.01 | 0.02 |
| 28 | Lead as Pb | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 29 | Iron as Fe | mg/l | 0.08 | 0.09 | 0.02 | 0.04 | 0.19 | 0.14 | 0.02 | 0.19 |
| 30 | Chromium as Cr+6 | mg/l | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| 31 | Selenium as Se | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 32 | Zinc as Zn | mg/l | 0.03 | 0.08 | 0.11 | 0.06 | 0.14 | 0.08 | 0.03 | 0.14 |
| 33 | Aluminum as Al | mg/l | 0.04 | 0.11 | 0.07 | 0.08 | 0.12 | 0.06 | 0.04 | 0.12 |
| 34 | Mercury as Hg | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 35 | SAR | - | 1.9 | 3.3 | 1.4 | 1.5 | 1.2 | 1.6 | 1.2 | 3.3 |
| 36 | Insecticides | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 37 | Anionic detergents as MBAS | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 38 | Total Coliforms | MPN/100 | 2850 | 2360 | 2246 | 3000 | 2150 | 2060 | 2060 | 3000 |

## TABLE-3.6.4 (J)
## SURFACE WATER QUALITY-DECEMBER 2019

| Sr.No | Parameters | Unit | SW1 | SW2 | SW3 | SW4 | SW5 | SW6 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | pH | - | 7.4 | 7.2 | 7.1 | 7.1 | 7.3 | 7.1 | 7.1 | 7.4 |
| 2 | Colour | Hazen | 2 | 3 | 4 | 4 | 2 | 3 | 2 | 4 |
| 3 | Conductivity | µS/cm | 542.6 | 846.5 | 592.6 | 538.4 | 516.2 | 538.6 | 516.2 | 846.5 |
| 4 | TDS | mg/l | 299.0 | 469.9 | 332.3 | 302.1 | 282.8 | 304.1 | 282.8 | 469.9 |
| 5 | DO | mg/l | 5.4 | 5.3 | 5.5 | 5.2 | 5.6 | 5.5 | 5.2 | 5.6 |
| 6 | BOD | mg/l | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 |
| 7 | COD | mg/l | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 |
| 8 | Turbidity | NTU | 4 | 3 | 6 | 4 | 4 | 7 | 3 | 7 |
| 9 | Total Hardness as CaCO3 | mg/l | 161.5 | 197.9 | 157.4 | 164.3 | 174.5 | 149.5 | 149.5 | 197.9 |
| 10 | Total Alkalinity as CaCO3 | mg/l | 59.6 | 94.6 | 70.8 | 60.4 | 57.6 | 53.8 | 53.8 | 94.6 |
| 11 | Calcium as Ca | mg/l | 38.1 | 43.6 | 39.6 | 39.2 | 42.8 | 36.9 | 36.9 | 43.6 |
| 12 | Magnesium as Mg | mg/l | 16.1 | 21.6 | 14.2 | 16.1 | 16.4 | 13.9 | 13.9 | 21.6 |
| 13 | Chlorides as Cl | mg/l | 126.8 | 202.6 | 128.6 | 118.8 | 120.5 | 126.5 | 118.8 | 202.6 |
| 14 | Residual free chlorine | mg/l | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| 15 | Phosphates as PO4 | mg/l | 0.02 | 0.01 | 0.03 | 0.02 | 0.02 | 0.04 | 0.01 | 0.04 |
| 16 | Sulphates as SO4 | mg/l | 22.2 | 28.6 | 34.2 | 36.2 | 22.4 | 26.9 | 22.2 | 36.2 |
| 17 | Fluorides as F | mg/l | 0.6 | 0.5 | 0.5 | 0.4 | 0.4 | 0.5 | 0.4 | 0.6 |
| 18 | Nitrates as NO3 | mg/l | 6.4 | 9.6 | 6.8 | 4.9 | 5.3 | 9.6 | 4.9 | 9.6 |
| 19 | Sodium as Na | mg/l | 47.2 | 99.2 | 60.8 | 45.5 | 35.8 | 52.1 | 35.8 | 99.2 |
| 20 | Potassium as K | mg/l | 5.8 | 7.4 | 5.1 | 4.8 | 4.6 | 5.4 | 4.6 | 7.4 |
| 21 | Total Boron as B | mg/l | 0.26 | 0.46 | 0.33 | 0.38 | 0.42 | 0.56 | 0.26 | 0.56 |
| 22 | Phenolic Compounds | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 23 | Cyanides | mg/l | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| 24 | Oil & grease | mg/l | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| 25 | Cadmium as Cd | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 26 | Arsenic as As | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 27 | Copper as Cu | mg/l | 0.02 | 0.01 | <0.01 | 0.03 | <0.01 | <0.01 | <0.01 | 0.03 |
| 28 | Lead as Pb | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 29 | Iron as Fe | mg/l | 0.06 | 0.04 | 0.03 | 0.06 | 0.11 | 0.08 | 0.03 | 0.11 |
| 30 | Chromium as Cr+6 | mg/l | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| 31 | Selenium as Se | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 32 | Zinc as Zn | mg/l | 0.11 | 0.08 | 0.12 | 0.11 | 0.08 | 0.11 | 0.08 | 0.12 |
| 33 | Aluminum as Al | mg/l | 0.03 | 0.05 | 0.06 | 0.04 | 0.09 | 0.06 | 0.03 | 0.09 |
| 34 | Mercury as Hg | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 35 | SAR | - | 1.6 | 3.1 | 2.1 | 1.5 | 1.2 | 1.9 | 1.2 | 3.1 |
| 36 | Insecticides | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 37 | Anionic detergents as MBAS | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 38 | Total Coliforms | MPN/100 | 2120 | 2080 | 2340 | 2690 | 2350 | 2580 | 2080 | 2690 |

## TABLE-3.6.4 (K)
## SURFACE WATER QUALITY –JANUARY 2020

| Sr.No | Parameters | Unit | SW1 | SW2 | SW3 | SW4 | SW5 | SW6 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | pH | - | 7.2 | 7.4 | 7.3 | 7.6 | 7.5 | 7.1 | 7.1 | 7.6 |
| 2 | Colour | Hazen | 3 | 2 | 5 | 2 | 4 | 3 | 2 | 5 |
| 3 | Conductivity | µS/cm | 536.8 | 842.6 | 587.6 | 543.8 | 528.4 | 548.2 | 528.4 | 842.6 |
| 4 | TDS | mg/l | 296.3 | 469.4 | 329.3 | 303.0 | 290.9 | 305.1 | 290.9 | 469.4 |
| 5 | DO | mg/l | 5.7 | 5.4 | 5.6 | 5.3 | 5.7 | 5.5 | 5.3 | 5.7 |
| 6 | BOD | mg/l | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 |
| 7 | COD | mg/l | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 |
| 8 | Turbidity | NTU | 3 | 6 | 7 | 5 | 6 | 7 | 3 | 7 |
| 9 | Total Hardness as CaCO3 | mg/l | 157.3 | 192.7 | 164.9 | 165.5 | 174.9 | 152.4 | 152.4 | 192.7 |
| 10 | Total Alkalinity as CaCO3 | mg/l | 62.4 | 99.8 | 78.3 | 64.5 | 66.8 | 74.3 | 62.4 | 99.8 |
| 11 | Calcium as Ca | mg/l | 36.9 | 42.2 | 41.6 | 39.2 | 42.3 | 37.6 | 36.9 | 42.3 |
| 12 | Magnesium as Mg | mg/l | 15.8 | 21.2 | 14.8 | 16.4 | 16.8 | 14.2 | 14.2 | 21.2 |
| 13 | Chlorides as Cl | mg/l | 121.8 | 198.6 | 121.4 | 115.2 | 119.2 | 112.6 | 112.6 | 198.6 |
| 14 | Residual free chlorine | mg/l | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| 15 | Phosphates as PO4 | mg/l | 0.02 | 0.04 | 0.02 | 0.03 | 0.02 | 0.04 | 0.02 | 0.04 |
| 16 | Sulphates as SO4 | mg/l | 23.4 | 29.6 | 35.6 | 36.6 | 22.8 | 27.6 | 22.8 | 36.6 |
| 17 | Fluorides as F | mg/l | 0.6 | 0.4 | 0.4 | 0.7 | 0.6 | 0.5 | 0.4 | 0.7 |
| 18 | Nitrates as NO3 | mg/l | 6.7 | 9.3 | 7.2 | 5.2 | 5.8 | 9.8 | 5.2 | 9.8 |
| 19 | Sodium as Na | mg/l | 47.6 | 100.6 | 56.4 | 46.4 | 38.1 | 52.6 | 38.1 | 100.6 |
| 20 | Potassium as K | mg/l | 6.1 | 7.6 | 4.9 | 4.6 | 5.2 | 5.6 | 4.6 | 7.6 |
| 21 | Total Boron as B | mg/l | 0.29 | 0.42 | 0.36 | 0.41 | 0.44 | 0.51 | 0.29 | 0.51 |
| 22 | Phenolic Compounds | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 23 | Cyanides | mg/l | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| 24 | Oil & grease | mg/l | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| 25 | Cadmium as Cd | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 26 | Arsenic as As | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 27 | Copper as Cu | mg/l | 0.01 | 0.02 | <0.01 | 0.03 | <0.01 | 0.02 | <0.01 | 0.03 |
| 28 | Lead as Pb | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 29 | Iron as Fe | mg/l | 0.08 | 0.05 | 0.04 | 0.08 | 0.06 | 0.12 | 0.04 | 0.12 |
| 30 | Chromium as Cr+6 | mg/l | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| 31 | Selenium as Se | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 32 | Zinc as Zn | mg/l | 0.06 | 0.09 | 0.11 | 0.11 | 0.08 | 0.09 | 0.06 | 0.11 |
| 33 | Aluminum as Al | mg/l | 0.08 | 0.09 | 0.05 | 0.06 | 0.11 | 0.09 | 0.05 | 0.11 |
| 34 | Mercury as Hg | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 35 | SAR | - | 1.7 | 3.2 | 1.9 | 1.6 | 1.3 | 1.9 | 1.3 | 3.2 |
| 36 | Insecticides | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 37 | Anionic detergents as MBAS | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 38 | Total Coliforms | MPN/100 | 2290 | 2360 | 2250 | 2780 | 2340 | 2760 | 2250 | 2780 |

## TABLE--3.6.4 (L)
## SURFACE WATER QUALITY –FEBRUARY 2020

| Sr.No | Parameters | Unit | SW1 | SW2 | SW3 | SW4 | SW5 | SW6 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | pH | - | 6.8 | 7.3 | 7.6 | 7.4 | 7.1 | 7.4 | 6.8 | 7.6 |
| 2 | Colour | Hazen | 5 | 4 | 2 | 3 | 4 | 3 | 2 | 5 |
| 3 | Conductivity | µS/cm | 556.4 | 832.9 | 564.8 | 536.4 | 546.5 | 556.4 | 536.4 | 832.9 |
| 4 | TDS | mg/l | 306.0 | 461.1 | 315.8 | 303.4 | 300.8 | 310.6 | 300.8 | 461.1 |
| 5 | DO | mg/l | 5.5 | 5.1 | 5.6 | 5.7 | 5.3 | 5.6 | 5.1 | 5.7 |
| 6 | BOD | mg/l | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 |
| 7 | COD | mg/l | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 |
| 8 | Turbidity | NTU | 4 | 3 | 5 | 4 | 5 | 4 | 3 | 5 |
| 9 | Total Hardness as CaCO3 | mg/l | 160.7 | 193.0 | 184.1 | 156.3 | 174.8 | 146.6 | 146.6 | 193 |
| 10 | Total Alkalinity as CaCO3 | mg/l | 63.8 | 97.8 | 77.6 | 65.3 | 67.2 | 73.6 | 63.8 | 97.8 |
| 11 | Calcium as Ca | mg/l | 37.6 | 41.3 | 48.6 | 35.2 | 41.6 | 33.8 | 33.8 | 48.6 |
| 12 | Magnesium as Mg | mg/l | 16.2 | 21.8 | 15.2 | 16.6 | 17.2 | 15.1 | 15.1 | 21.8 |
| 13 | Chlorides as Cl | mg/l | 128.6 | 194.6 | 116.4 | 113.6 | 122.4 | 115.6 | 113.6 | 194.6 |
| 14 | Residual free chlorine | mg/l | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| 15 | Phosphates as PO4 | mg/l | 0.03 | 0.04 | 0.03 | 0.06 | 0.04 | 0.06 | 0.03 | 0.06 |
| 16 | Sulphates as SO4 | mg/l | 21.6 | 28.4 | 34.2 | 37.9 | 24.8 | 29.8 | 21.6 | 37.9 |
| 17 | Fluorides as F | mg/l | 0.7 | 0.6 | 0.5 | 0.7 | 0.6 | 0.5 | 0.5 | 0.7 |
| 18 | Nitrates as NO3 | mg/l | 6.5 | 9.8 | 6.9 | 6.4 | 6.6 | 8.9 | 6.4 | 9.8 |
| 19 | Sodium as Na | mg/l | 51.1 | 98.6 | 42.3 | 48.6 | 42.5 | 57.1 | 42.3 | 98.6 |
| 20 | Potassium as K | mg/l | 5.4 | 7.3 | 5.1 | 5.2 | 4.8 | 5.6 | 4.8 | 7.3 |
| 21 | Total Boron as B | mg/l | 0.31 | 0.41 | 0.36 | 0.41 | 0.29 | 0.52 | 0.29 | 0.52 |
| 22 | Phenolic Compounds | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 23 | Cyanides | mg/l | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| 24 | Oil & grease | mg/l | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| 25 | Cadmium as Cd | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 26 | Arsenic as As | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 27 | Copper as Cu | mg/l | 0.02 | 0.02 | 0.01 | <0.01 | <0.01 | 0.01 | <0.01 | 0.02 |
| 28 | Lead as Pb | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 29 | Iron as Fe | mg/l | 0.07 | 0.05 | 0.04 | 0.07 | 0.14 | 0.09 | 0.04 | 0.14 |
| 30 | Chromium as Cr+6 | mg/l | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| 31 | Selenium as Se | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 32 | Zinc as Zn | mg/l | 0.04 | 0.11 | 0.09 | 0.07 | 0.09 | 0.1 | 0.04 | 0.11 |
| 33 | Aluminum as Al | mg/l | 0.08 | 0.14 | 0.06 | 0.09 | 0.09 | 0.09 | 0.06 | 0.14 |
| 34 | Mercury as Hg | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 35 | SAR | - | 1.8 | 3.1 | 1.4 | 1.7 | 1.4 | 2.1 | 1.4 | 3.1 |
| 36 | Insecticides | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 37 | Anionic detergents as MBAS | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 38 | Total Coliforms | MPN/100 | 2920 | 2410 | 2360 | 2860 | 2260 | 2220 | 2220 | 2920 |

## TABLE-3.6.5 (A)
## GROUNDWATER QUALITY-MARCH 2019

| Sr.No | Parameters | Unit | IS: 10500 Limits | GW1 | GW2 | GW3 | GW4 | GW5 | GW6 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | pH | - | 6.5 – 8.5(NR) | 7.1 | 6.9 | 7.2 | 6.9 | 7.0 | 6.8 | 6.8 | 7.2 |
| 2 | Colour | Hazen | 5(15) | 6 | 4 | 5 | 6 | 7 | 7 | 4 | 7 |
| 3 | Taste | - | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable |
| 4 | Odour | - | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable |
| 5 | Conductivity | µS/cm | $ | 1108 | 1337 | 1107 | 964 | 515 | 713 | 515 | 1337 |
| 6 | Turbidity | NTU | 1(5) | 4 | 2 | 3 | 5 | 2 | 4 | 2 | 5 |
| 7 | TDS | mg/l | 500(2000) | 604.0 | 736.1 | 607.96 | 532.34 | 293.7 | 402.9 | 293.7 | 736.1 |
| 8 | Total Hardness as CaCO3 | mg/l | 200(600) | 356.2 | 379.3 | 346.32 | 320.4 | 160.5 | 205.3 | 160.5 | 379.3 |
| 9 | Total Alkalinity | mg/l | 200(600) | 152.6 | 212.5 | 142.6 | 126.4 | 68.5 | 78.5 | 68.5 | 212.5 |
| 10 | Calcium as Ca | mg/l | 75(200) | 79.6 | 86.2 | 76.8 | 74.2 | 32.6 | 42.3 | 32.6 | 86.2 |
| 11 | Magnesium as Mg | mg/l | 30(100) | 38.2 | 39.8 | 37.5 | 32.8 | 19.2 | 24.2 | 19.2 | 39.8 |
| 12 | Residual Chlorine | mg/l | 0.2(1.0) | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| 13 | Boron as B | mg/l | 0.5(1.0) | 0.52 | 0.48 | 0.38 | 0.24 | 0.44 | 0.56 | 0.24 | 0.56 |
| 14 | Chlorides as Cl | mg/l | 250(1000) | 252.8 | 278.5 | 258.6 | 220.4 | 105.4 | 169.5 | 105.4 | 278.5 |
| 15 | Sulphates as SO4 | mg/l | 200(400) | 28.8 | 34.2 | 30.5 | 24.5 | 21.2 | 14.8 | 14.8 | 34.2 |
| 16 | Fluorides as F | mg/l | 1.0(1.5) | 0.6 | 0.7 | 0.6 | 0.7 | 0.5 | 0.5 | 0.5 | 0.7 |
| 17 | Nitrates as NO3 | mg/l | 45(NR) | 12.60 | 22.30 | 14.8 | 18.9 | 21.9 | 24.8 | 12.6 | 24.8 |
| 18 | Sodium as Na | mg/l | $ | 78.6 | 114.5 | 84.2 | 60.2 | 35 | 55.2 | 35 | 114.5 |
| 19 | Potassium as K | mg/l | $ | 21.2 | 32.4 | 19.4 | 24.8 | 16.8 | 24.5 | 16.8 | 32.4 |
| 20 | Phenolic Compounds | mg/l | 0.001(0.002) | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 21 | Cyanides as CN | mg/l | 0.05 (NR) | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| 22 | Anionic Detergents | mg/l | 0.2 (1.0) | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 |
| 23 | Mineral Oil | mg/l | 0.5(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 24 | Cadmium as Cd | mg/l | 0.003 (NR) | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| 25 | Arsenic as As | mg/l | 0.01(0.05) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 26 | Copper as Cu | mg/l | 0.05 (1.5) | 0.02 | 0.04 | 0.02 | 0.03 | 0.04 | 0.04 | 0.02 | 0.04 |
| 27 | Lead as Pb | mg/l | 0.01 (NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 28 | Manganese as Mn | mg/l | 0.1 (0.3) | 0.04 | 0.07 | 0.06 | 0.05 | 0.04 | 0.08 | 0.04 | 0.08 |

| Sr.No | Parameters | Unit | IS: 10500 Limits | GW1 | GW2 | GW3 | GW4 | GW5 | GW6 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 29 | Iron as Fe | mg/l | 0.3(NR) | 0.09 | 0.08 | 0.06 | 0.07 | 0.06 | 0.08 | 0.06 | 0.09 |
| 30 | Total Chromium as Cr | mg/l | 0.05(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 31 | Selenium as Se | mg/l | 0.01(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 32 | Zinc as Zn | mg/l | 5(15) | 0.11 | 0.09 | 0.08 | 0.06 | 0.09 | 0.08 | 0.06 | 0.11 |
| 33 | Aluminum as Al | mg/l | 0.03(0.2) | 0.07 | 0.09 | 0.04 | 0.06 | 0.03 | 0.05 | 0.03 | 0.09 |
| 34 | Mercury as Hg | mg/l | 0.001(NR) | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 35 | Pesticides | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 36 | E.Coli | - | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 37 | Total Coliforms | MPN/100 | 10 | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |

## TABLE-3.6.5 (B)
## GROUNDWATER QUALITY-APRIL 2019

| Sr. No | Parameters | Unit | IS: 10500 Limits | GW1 | GW2 | GW3 | GW4 | GW5 | GW6 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | pH | - | 6.5 – 8.5(NR) | 6.8 | 7.2 | 7.3 | 7.0 | 6.9 | 6.9 | 6.8 | 7.3 |
| 2 | Colour | Hazen | 5(15) | 3 | 4 | 5 | 3 | 4 | 2 | 2 | 5 |
| 3 | Taste | - | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable |
| 4 | Odour | - | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable |
| 5 | Conductivity | µS/cm | $ | 1186 | 1408 | 1216 | 1040 | 558 | 743.5 | 558 | 1408 |
| 6 | Turbidity | NTU | 1(5) | 1 | 2 | 2 | 2 | 2 | <1.0 | <1.0 | 2 |
| 7 | TDS | mg/l | 500(2000) | 650.2 | 788.8 | 672.7 | 582.4 | 314.0 | 431.0 | 314 | 788.8 |
| 8 | Total Hardness as CaCO3 | mg/l | 200(600) | 375.81 | 386.96 | 356.96 | 335.94 | 163.45 | 197.71 | 163.45 | 386.96 |
| 9 | Total Alkalinity | mg/l | 200(600) | 184.5 | 201.4 | 156.8 | 162.4 | 71.6 | 74.5 | 71.6 | 201.4 |
| 10 | Calcium as Ca | mg/l | 75(200) | 80.2 | 86.8 | 77.6 | 73.8 | 31.8 | 43.2 | 31.8 | 86.8 |
| 11 | Magnesium as Mg | mg/l | 30(100) | 42.6 | 41.3 | 39.6 | 36.8 | 20.4 | 21.8 | 20.4 | 42.6 |
| 12 | Residual Chlorine | mg/l | 0.2(1.0) | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| 13 | Boron as B | mg/l | 0.5(1.0) | 0.45 | 0.68 | 0.49 | 0.58 | 0.67 | 0.48 | 0.45 | 0.68 |
| 14 | Chlorides as Cl | mg/l | 250(1000) | 248.6 | 278.5 | 252.8 | 206.8 | 108.2 | 152.4 | 108.2 | 278.5 |
| 15 | Sulphates as SO4 | mg/l | 200(400) | 46.6 | 78.4 | 66.8 | 52.6 | 32.6 | 56.8 | 32.6 | 78.4 |
| 16 | Fluorides as F | mg/l | 1.0(1.5) | 0.7 | 0.6 | 0.5 | 0.4 | 0.6 | 0.5 | 0.4 | 0.7 |
| 17 | Nitrates as NO3 | mg/l | 45(NR) | 13.2 | 24.2 | 16.8 | 19.4 | 18.4 | 22.7 | 13.2 | 24.2 |
| 18 | Sodium as Na | mg/l | $ | 89.2 | 128.6 | 103.2 | 72.3 | 44.8 | 67.4 | 44.8 | 128.6 |
| 19 | Potassium as K | mg/l | $ | 18.4 | 29.6 | 21.3 | 22.9 | 14.2 | 21.5 | 14.2 | 29.6 |
| 20 | Phenolic Compounds | mg/l | 0.001(0.002) | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 21 | Cyanides as CN | mg/l | 0.05 (NR) | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| 22 | Anionic Detergents | mg/l | 0.2 (1.0) | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 |
| 23 | Mineral Oil | mg/l | 0.5(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 24 | Cadmium as Cd | mg/l | 0.003 (NR) | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| 25 | Arsenic as As | mg/l | 0.01(0.05) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 26 | Copper as Cu | mg/l | 0.05 (1.5) | 0.02 | <0.01 | <0.01 | 0.01 | <0.01 | 0.02 | <0.01 | 0.02 |
| 27 | Lead as Pb | mg/l | 0.01 (NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 28 | Manganese as Mn | mg/l | 0.1 (0.3) | 0.04 | <0.01 | <0.01 | 0.05 | 0.02 | 0.01 | <0.01 | 0.05 |

| Sr. No | Parameters | Unit | IS: 10500 Limits | GW1 | GW2 | GW3 | GW4 | GW5 | GW6 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 29 | Iron as Fe | mg/l | 0.3(NR) | 0.04 | 0.03 | 0.05 | 0.06 | 0.07 | 0.07 | 0.03 | 0.07 |
| 30 | Total Chromium as Cr | mg/l | 0.05(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 31 | Selenium as Se | mg/l | 0.01(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 32 | Zinc as Zn | mg/l | 5(15) | 0.04 | 0.03 | 0.05 | 0.06 | 0.02 | 0.06 | 0.02 | 0.06 |
| 33 | Aluminum as Al | mg/l | 0.03(0.2) | 0.03 | 0.08 | 0.04 | 0.03 | <0.01 | <0.01 | <0.01 | 0.08 |
| 34 | Mercury as Hg | mg/l | 0.001(NR) | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 35 | Pesticides | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 36 | E.Coli | - | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 37 | Total Coliforms | MPN/100 | 10 | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |

## TABLE-3.6.5 (C)
## GROUNDWATER QUALITY-MAY 2019

| Sr. No | Parameters | Unit | IS: 10500 Limits | GW1 | GW2 | GW3 | GW4 | GW5 | GW6 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | pH | - | 6.5 – 8.5(NR) | 6.9 | 6.7 | 6.9 | 7.2 | 7.4 | 7.1 | 6.7 | 7.4 |
| 2 | Colour | Hazen | 5(15) | 4 | 3 | 3 | 2 | 3 | 3 | 2 | 4 |
| 3 | Taste | - | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable |
| 4 | Odour | - | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable |
| 5 | Conductivity | µS/cm | $ | 1234 | 1432 | 1186 | 1090 | 582 | 762 | 582 | 1432 |
| 6 | Turbidity | NTU | 1(5) | <1.0 | <1.0 | 2 | 1 | 2 | <1.0 | <1 | 2 |
| 7 | TDS | mg/l | 500(2000) | 676.8 | 803.5 | 657.5 | 602.3 | 335.3 | 445.6 | 335.3 | 803.5 |
| 8 | Total Hardness as CaCO3 | mg/l | 200(600) | 375.93 | 384.30 | 362.17 | 324.39 | 163.73 | 203.50 | 163.73 | 384.3 |
| 9 | Total Alkalinity | mg/l | 200(600) | 191.6 | 198.6 | 154.2 | 172.6 | 72.6 | 81.6 | 72.6 | 198.6 |
| 10 | Calcium as Ca | mg/l | 75(200) | 81.4 | 85.9 | 78.2 | 72.8 | 32.9 | 44.2 | 32.9 | 85.9 |
| 11 | Magnesium as Mg | mg/l | 30(100) | 41.9 | 41.2 | 40.5 | 34.6 | 19.8 | 22.6 | 19.8 | 41.9 |
| 12 | Residual Chlorine | mg/l | 0.2(1.0) | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| 13 | Boron as B | mg/l | 0.5(1.0) | 0.61 | 0.25 | 0.51 | 0.24 | 0.24 | 0.35 | 0.24 | 0.61 |
| 14 | Chlorides as Cl | mg/l | 250(1000) | 253.5 | 284.6 | 242.6 | 204.6 | 110.2 | 152.4 | 110.2 | 284.6 |
| 15 | Sulphates as SO4 | mg/l | 200(400) | 52.4 | 82.6 | 71.6 | 54.5 | 38.8 | 61.2 | 38.8 | 82.6 |
| 16 | Fluorides as F | mg/l | 1.0(1.5) | 0.6 | 0.5 | 0.7 | 0.6 | 0.4 | 0.4 | 0.4 | 0.7 |
| 17 | Nitrates as NO3 | mg/l | 45(NR) | 13.2 | 23.5 | 16.4 | 21.2 | 24.6 | 25.6 | 13.2 | 25.6 |
| 18 | Sodium as Na | mg/l | $ | 99.6 | 135.2 | 94.2 | 89.2 | 49.6 | 70.4 | 49.6 | 135.2 |
| 19 | Potassium as K | mg/l | $ | 19.2 | 30.8 | 20.8 | 21.2 | 15.4 | 19.8 | 15.4 | 30.8 |
| 20 | Phenolic Compounds | mg/l | 0.001(0.002) | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 21 | Cyanides as CN | mg/l | 0.05 (NR) | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| 22 | Anionic Detergents | mg/l | 0.2 (1.0) | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 |
| 23 | Mineral Oil | mg/l | 0.5(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 24 | Cadmium as Cd | mg/l | 0.003 (NR) | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| 25 | Arsenic as As | mg/l | 0.01(0.05) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 26 | Copper as Cu | mg/l | 0.05 (1.5) | <0.01 | 0.03 | <0.01 | 0.02 | <0.01 | 0.04 | <0.01 | 0.04 |
| 27 | Lead as Pb | mg/l | 0.01 (NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 28 | Manganese as Mn | mg/l | 0.1 (0.3) | 0.03 | <0.01 | 0.04 | 0.02 | 0.04 | 0.06 | <0.01 | 0.06 |
| 29 | Iron as Fe | mg/l | 0.3(NR) | 0.04 | 0.03 | 0.04 | 0.08 | 0.11 | 0.06 | 0.03 | 0.11 |

| Sr. No | Parameters | Unit | IS: 10500 Limits | GW1 | GW2 | GW3 | GW4 | GW5 | GW6 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | Total Chromium as Cr | mg/l | 0.05(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 31 | Selenium as Se | mg/l | 0.01(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 32 | Zinc as Zn | mg/l | 5(15) | 0.05 | 0.04 | 0.06 | 0.03 | 0.04 | 0.06 | 0.03 | 0.06 |
| 33 | Aluminum as Al | mg/l | 0.03(0.2) | 0.08 | 0.09 | 0.04 | <0.01 | 0.01 | 0.02 | <0.01 | 0.09 |
| 34 | Mercury as Hg | mg/l | 0.001(NR) | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 35 | Pesticides | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 36 | E.Coli | - | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 37 | Total Coliforms | MPN/100 | 10 | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |

## TABLE-3.6.5 (D)
## GROUNDWATER QUALITY-JUNE 2019

| Sr. No | Parameters | Unit | IS: 10500 Limits | GW1 | GW2 | GW3 | GW4 | GW5 | GW6 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | pH | - | 6.5–8.5(NR) | 6.8 | 7.3 | 6.9 | 6.9 | 7.2 | 7.1 | 6.8 | 7.2 |
| 2 | Colour | Hazen | 5(15) | 4 | 3 | 3 | 3 | 4 | 4 | 3 | 4 |
| 3 | Taste | - | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable |
| 4 | Odour | - | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable |
| 5 | Conductivity | µS/cm | $ | 1259 | 1462 | 1224 | 1120 | 642 | 801 | 642 | 1462 |
| 6 | Turbidity | NTU | 1(5) | <1.0 | 1 | 1 | 2 | 1 | <1.0 | <1.0 | 2 |
| 7 | TDS | mg/l | 500(2000) | 695.1 | 820.9 | 684.6 | 621.5 | 372.2 | 463.8 | 372.2 | 820.9 |
| 8 | Total Hardness as CaCO3 | mg/l | 200(600) | 374.56 | 384.08 | 356.96 | 333.74 | 169.02 | 204.30 | 169.02 | 384.08 |
| 9 | Total Alkalinity | mg/l | 200(600) | 202.8 | 210.6 | 146.8 | 184.6 | 74.3 | 76.8 | 74.3 | 210.6 |
| 10 | Calcium as Ca | mg/l | 75(200) | 82.4 | 86.8 | 77.6 | 74.4 | 33.7 | 43.2 | 33.7 | 86.8 |
| 11 | Magnesium as Mg | mg/l | 30(100) | 40.96 | 40.6 | 39.6 | 35.9 | 20.6 | 23.4 | 20.6 | 40.96 |
| 12 | Residual Chlorine | mg/l | 0.2(1.0) | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| 13 | Boron as B | mg/l | 0.5(1.0) | 0.62 | 0.52 | 0.26 | 0.47 | 0.48 | 0.52 | 0.26 | 0.62 |
| 14 | Chlorides as Cl | mg/l | 250(1000) | 254.6 | 294.5 | 261.4 | 212.5 | 135.2 | 172.6 | 135.2 | 294.5 |
| 15 | Sulphates as SO4 | mg/l | 200(400) | 58.4 | 80.4 | 76.8 | 56.8 | 42.6 | 59.9 | 42.6 | 80.4 |
| 16 | Fluorides as F | mg/l | 1.0(1.5) | 0.7 | 0.5 | 0.4 | 0.6 | 0.4 | 0.7 | 0.4 | 0.7 |
| 17 | Nitrates as NO3 | mg/l | 45(NR) | 10.4 | 19.6 | 11.4 | 16.5 | 18.4 | 19.8 | 10.4 | 19.8 |
| 18 | Sodium as Na | mg/l | $ | 106.2 | 142.5 | 100.7 | 90.2 | 60.8 | 79.6 | 60.8 | 142.5 |
| 19 | Potassium as K | mg/l | $ | 19.8 | 29.6 | 28.6 | 23.8 | 15.9 | 18.5 | 15.9 | 29.6 |
| 20 | Phenolic Compounds | mg/l | 0.001(0.002) | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 21 | Cyanides as CN | mg/l | 0.05 (NR) | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| 22 | Anionic Detergents | mg/l | 0.2 (1.0) | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 |
| 23 | Mineral Oil | mg/l | 0.5(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 24 | Cadmium as Cd | mg/l | 0.003 (NR) | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| 25 | Arsenic as As | mg/l | 0.01(0.05) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 26 | Copper as Cu | mg/l | 0.05 (1.5) | <0.01 | 0.03 | <0.01 | 0.02 | <0.01 | 0.01 | <0.01 | 0.03 |
| 27 | Lead as Pb | mg/l | 0.01 (NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 28 | Manganese as Mn | mg/l | 0.1 (0.3) | 0.07 | 0.06 | 0.07 | 0.06 | 0.04 | 0.06 | 0.04 | 0.07 |
| 29 | Iron as Fe | mg/l | 0.3(NR) | 0.05 | 0.06 | 0.02 | 0.02 | 0.08 | 0.06 | 0.02 | 0.08 |

| Sr. No | Parameters | Unit | IS: 10500 Limits | GW1 | GW2 | GW3 | GW4 | GW5 | GW6 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | Total Chromium as Cr | mg/l | 0.05(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 31 | Selenium as Se | mg/l | 0.01(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 32 | Zinc as Zn | mg/l | 5(15) | 0.04 | 0.08 | 0.07 | 0.06 | 0.09 | 0.11 | 0.04 | 0.11 |
| 33 | Aluminum as Al | mg/l | 0.03(0.2) | 0.06 | 0.04 | 0.03 | 0.08 | 0.09 | 0.02 | 0.02 | 0.09 |
| 34 | Mercury as Hg | mg/l | 0.001(NR) | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 35 | Pesticides | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 36 | E.Coli | - | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 37 | Total Coliforms | MPN/100 | 10 | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |

## TABLE-3.6.5 (E)
## GROUNDWATER QUALITY- JULY 2019

| Sr. No. | Parameters | Unit | IS: 10500 Limits | GW1 | GW2 | GW3 | GW4 | GW5 | GW6 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | pH | - | 6.5 – 8.5(NR) | 6.8 | 7.4 | 7.2 | 7.1 | 6.9 | 6.8 | 6.8 | 7.4 |
| 2 | Colour | Hazen | 5(15) | 3 | 4 | 4 | 3 | 3 | 4 | 3 | 4 |
| 3 | Taste | - | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable |
| 4 | Odour | - | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable |
| 5 | Conductivity | µS/cm | $ | 1074.5 | 1326.7 | 1102.3 | 923.6 | 596.7 | 802.3 | 596.7 | 1326.7 |
| 6 | Turbidity | NTU | 1(5) | <1.0 | 2 | 1 | 1 | 2 | <1.0 | <1 | 2 |
| 7 | TDS | mg/l | 500(2000) | 676.6 | 835.4 | 694.3 | 581.5 | 375.5 | 505.3 | 375.5 | 835.4 |
| 8 | Total Hardness as CaCO3 | mg/l | 200(600) | 335 | 837 | 695 | 582 | 377 | 215 | 215 | 837 |
| 9 | Total Alkalinity | mg/l | 200(600) | 168.4 | 194.3 | 145.3 | 147.6 | 73.1 | 89.6 | 73.1 | 194.3 |
| 10 | Calcium as Ca | mg/l | 75(200) | 74.1 | 82.6 | 72.3 | 62.8 | 38.1 | 46.8 | 38.1 | 82.6 |
| 11 | Magnesium as Mg | mg/l | 30(100) | 36.4 | 40.1 | 33.0 | 30.7 | 18.4 | 23.7 | 18.4 | 40.1 |
| 12 | Residual Chlorine | mg/l | 0.2(1.0) | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| 13 | Boron as B | mg/l | 0.5(1.0) | 0.52 | 0.61 | 0.32 | 0.41 | 0.46 | 0.38 | 0.32 | 0.61 |
| 14 | Chlorides as Cl | mg/l | 250(1000) | 218.4 | 256.3 | 232.1 | 174.6 | 121.7 | 164.8 | 121.7 | 256.3 |
| 15 | Sulphates as SO4 | mg/l | 200(400) | 42.1 | 74.6 | 58.4 | 46.7 | 35.4 | 52.1 | 35.4 | 74.6 |
| 16 | Fluorides as F | mg/l | 1.0(1.5) | 0.6 | 0.7 | 0.6 | 0.5 | 0.6 | 0.6 | 0.5 | 0.7 |
| 17 | Nitrates as NO3 | mg/l | 45(NR) | 11.8 | 20.4 | 14.2 | 18.2 | 15.4 | 22.7 | 11.8 | 22.7 |
| 18 | Sodium as Na | mg/l | $ | 83.4 | 118.6 | 96.7 | 72.1 | 48.7 | 72.6 | 48.7 | 118.6 |
| 19 | Potassium as K | mg/l | $ | 16.4 | 26.4 | 18.8 | 17.6 | 16.2 | 22.7 | 16.2 | 26.4 |
| 20 | Phenolic Compounds | mg/l | 0.001(0.002) | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 21 | Cyanides as CN | mg/l | 0.05 (NR) | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| 22 | Anionic Detergents | mg/l | 0.2 (1.0) | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 |
| 23 | Mineral Oil | mg/l | 0.5(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 24 | Cadmium as Cd | mg/l | 0.003 (NR) | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| 25 | Arsenic as As | mg/l | 0.01(0.05) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 26 | Copper as Cu | mg/l | 0.05 (1.5) | <0.01 | 0.03 | <0.01 | 0.02 | <0.01 | 0.01 | <0.01 | 0.03 |
| 27 | Lead as Pb | mg/l | 0.01 (NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 28 | Manganese as Mn | mg/l | 0.1 (0.3) | 0.04 | 0.05 | 0.06 | 0.04 | 0.05 | 0.06 | 0.04 | 0.06 |
| 29 | Iron as Fe | mg/l | 0.3(NR) | 0.05 | 0.02 | 0.03 | 0.02 | 0.06 | 0.08 | 0.02 | 0.08 |

| Sr. No. | Parameters | Unit | IS: 10500 Limits | GW1 | GW2 | GW3 | GW4 | GW5 | GW6 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | Total Chromium as Cr | mg/l | 0.05(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 31 | Selenium as Se | mg/l | 0.01(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 32 | Zinc as Zn | mg/l | 5(15) | 0.03 | 0.09 | 0.07 | 0.08 | 0.12 | 0.09 | 0.03 | 0.12 |
| 33 | Aluminum as Al | mg/l | 0.03(0.2) | 0.08 | 0.06 | 0.04 | 0.09 | 0.06 | 0.02 | 0.02 | 0.09 |
| 34 | Mercury as Hg | mg/l | 0.001(NR) | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 35 | Pesticides | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 36 | E.Coli | - | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 37 | Total Coliforms | MPN/100 | 10 | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |

## TABLE-3.6.5 (F)
## GROUNDWATER QUALITY-AUGUST 2019

| Sr. No. | Parameters | Unit | IS: 10500 Limits | GW1 | GW2 | GW3 | GW4 | GW5 | GW6 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | pH | - | 6.5 – 8.5(NR) | 7.1 | 6.8 | 6.9 | 7.4 | 7.6 | 7.2 | 6.8 | 7.6 |
| 2 | Colour | Hazen | 5(15) | 4 | 4 | 3 | 5 | 4 | 3 | 3 | 5 |
| 3 | Taste | - | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable |
| 4 | Odour | - | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable |
| 5 | Conductivity | µS/cm | $ | 1185.6 | 1352.4 | 1265.3 | 1145.2 | 623.4 | 798.4 | 623.4 | 1352.4 |
| 6 | Turbidity | NTU | 1(5) | <1.0 | 1 | 2 | 3 | 2 | <1.0 | <1 | 3 |
| 7 | TDS | mg/l | 500(2000) | 746.6 | 851.7 | 796.9 | 721.4 | 392.5 | 502.7 | 392.5 | 851.7 |
| 8 | Total Hardness as CaCO3 | mg/l | 200(600) | 314 | 338 | 390 | 360 | 188 | 216 | 188 | 390 |
| 9 | Total Alkalinity | mg/l | 200(600) | 181.6 | 169.4 | 159.6 | 186.9 | 79.4 | 83.4 | 79.4 | 186.9 |
| 10 | Calcium as Ca | mg/l | 75(200) | 71.6 | 72.6 | 85.7 | 91.3 | 41.6 | 46.7 | 41.6 | 91.3 |
| 11 | Magnesium as Mg | mg/l | 30(100) | 32.8 | 38.0 | 42.6 | 32.1 | 20.4 | 24.1 | 20.4 | 42.6 |
| 12 | Residual Chlorine | mg/l | 0.2(1.0) | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| 13 | Boron as B | mg/l | 0.5(1.0) | 0.48 | 0.58 | 0.51 | 0.48 | 0.38 | 0.32 | 0.32 | 0.58 |
| 14 | Chlorides as Cl | mg/l | 250(1000) | 239.6 | 271.6 | 261.9 | 212.6 | 113.6 | 159.6 | 113.6 | 271.6 |
| 15 | Sulphates as SO4 | mg/l | 200(400) | 50.9 | 86.4 | 82.7 | 62.8 | 43.8 | 64.8 | 43.8 | 86.4 |
| 16 | Fluorides as F | mg/l | 1.0(1.5) | 0.7 | 0.5 | 0.7 | 0.6 | 0.5 | 0.6 | 0.5 | 0.7 |
| 17 | Nitrates as NO3 | mg/l | 45(NR) | 11.9 | 26.9 | 12.9 | 17.6 | 26.4 | 22.4 | 11.9 | 26.9 |
| 18 | Sodium as Na | mg/l | $ | 118.6 | 136.7 | 98.7 | 82.6 | 45.6 | 72.9 | 45.6 | 136.7 |
| 19 | Potassium as K | mg/l | $ | 14.6 | 32.4 | 22.4 | 26.3 | 19.1 | 19.1 | 14.6 | 32.4 |
| 20 | Phenolic Compounds | mg/l | 0.001(0.002) | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 21 | Cyanides as CN | mg/l | 0.05 (NR) | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| 22 | Anionic Detergents | mg/l | 0.2 (1.0) | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 |
| 23 | Mineral Oil | mg/l | 0.5(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 24 | Cadmium as Cd | mg/l | 0.003 (NR) | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| 25 | Arsenic as As | mg/l | 0.01(0.05) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 26 | Copper as Cu | mg/l | 0.05 (1.5) | <0.01 | 0.02 | <0.01 | 0.03 | <0.01 | 0.03 | <0.01 | 0.03 |
| 27 | Lead as Pb | mg/l | 0.01 (NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 28 | Manganese as Mn | mg/l | 0.1 (0.3) | 0.02 | 0.06 | 0.04 | 0.02 | 0.04 | 0.06 | 0.02 | 0.06 |
| 29 | Iron as Fe | mg/l | 0.3(NR) | 0.02 | 0.04 | 0.04 | 0.01 | 0.04 | 0.07 | 0.01 | 0.07 |

| Sr. No. | Parameters | Unit | IS: 10500 Limits | GW1 | GW2 | GW3 | GW4 | GW5 | GW6 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | Total Chromium as Cr | mg/l | 0.05(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 31 | Selenium as Se | mg/l | 0.01(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 32 | Zinc as Zn | mg/l | 5(15) | 0.04 | 0.08 | 0.02 | 0.05 | 0.12 | 0.11 | 0.02 | 0.12 |
| 33 | Aluminum as Al | mg/l | 0.03(0.2) | 0.07 | 0.08 | 0.04 | 0.02 | 0.06 | 0.04 | 0.02 | 0.08 |
| 34 | Mercury as Hg | mg/l | 0.001(NR) | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 35 | Pesticides | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 36 | E.Coli | - | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 37 | Total Coliforms | MPN/100 | 10 | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |

## TABLE-3.6.5 (G)
## GROUNDWATER QUALITY-SEPTEMBER 2019

| Sr. No. | Parameters | Unit | IS: 10500 Limits | GW1 | GW2 | GW3 | GW4 | GW5 | GW6 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | pH | - | 6.5 – 8.5(NR) | 6.7 | 7.2 | 7.3 | 7.4 | 6.9 | 7.1 | 6.7 | 7.4 |
| 2 | Colour | Hazen | 5(15) | 4 | 6 | 3 | 2 | 6 | 3 | 2 | 6 |
| 3 | Taste | - | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable |
| 4 | Odour | - | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable |
| 5 | Conductivity | µS/cm | $ | 1134.6 | 1382.4 | 1158.9 | 962.4 | 612.8 | 827.6 | 612.8 | 1382.4 |
| 6 | Turbidity | NTU | 1(5) | 1 | 2 | <1.0 | 2 | 1 | 1 | 1 | 2 |
| 7 | TDS | mg/l | 500(2000) | 624.6 | 772.3 | 643.44 | 530.78 | 350.01 | 475.12 | 350.01 | 772.3 |
| 8 | Total Hardness as CaCO3 | mg/l | 200(600) | 336.7 | 366.0 | 326.9 | 289.4 | 180.5 | 220.7 | 180.5 | 366 |
| 9 | Total Alkalinity | mg/l | 200(600) | 171.5 | 204.5 | 156.4 | 151.8 | 78.6 | 91.2 | 78.6 | 204.5 |
| 10 | Calcium as Ca | mg/l | 75(200) | 75.6 | 80.9 | 73.8 | 63.4 | 39.6 | 47.8 | 39.6 | 80.9 |
| 11 | Magnesium as Mg | mg/l | 30(100) | 35.9 | 39.8 | 34.6 | 31.8 | 19.8 | 24.6 | 19.8 | 39.8 |
| 12 | Residual Chlorine | mg/l | 0.2(1.0) | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| 13 | Boron as B | mg/l | 0.5(1.0) | 0.44 | 0.56 | 0.34 | 0.44 | 0.38 | 0.42 | 0.34 | 0.56 |
| 14 | Chlorides as Cl | mg/l | 250(1000) | 241.5 | 272.6 | 241.5 | 182.6 | 124.6 | 174.8 | 124.6 | 272.6 |
| 15 | Sulphates as SO4 | mg/l | 200(400) | 43.2 | 75.6 | 59.8 | 48.2 | 36.85 | 53.2 | 36.85 | 75.6 |
| 16 | Fluorides as F | mg/l | 1.0(1.5) | 0.5 | 0.6 | 0.7 | 0.6 | 0.5 | 0.7 | 0.5 | 0.7 |
| 17 | Nitrates as NO3 | mg/l | 45(NR) | 13.2 | 18.6 | 16.4 | 17.8 | 16.9 | 21.6 | 13.2 | 21.6 |
| 18 | Sodium as Na | mg/l | $ | 97.6 | 132.9 | 106.4 | 78.4 | 48.8 | 76.1 | 48.8 | 132.9 |
| 19 | Potassium as K | mg/l | $ | 14.2 | 28.6 | 16.4 | 16.9 | 15.8 | 21.6 | 14.2 | 28.6 |
| 20 | Phenolic Compounds | mg/l | 0.001(0.002) | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 21 | Cyanides as CN | mg/l | 0.05 (NR) | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| 22 | Anionic Detergents | mg/l | 0.2 (1.0) | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 |
| 23 | Mineral Oil | mg/l | 0.5(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 24 | Cadmium as Cd | mg/l | 0.003 (NR) | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| 25 | Arsenic as As | mg/l | 0.01(0.05) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 26 | Copper as Cu | mg/l | 0.05 (1.5) | <0.01 | 0.02 | <0.01 | 0.01 | 0.02 | <0.01 | 0.01 | 0.02 |
| 27 | Lead as Pb | mg/l | 0.01 (NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |

| Sr. No. | Parameters | Unit | IS: 10500 Limits | GW1 | GW2 | GW3 | GW4 | GW5 | GW6 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 28 | Manganese as Mn | mg/l | 0.1 (0.3) | 0.03 | 0.02 | 0.04 | 0.03 | 0.06 | 0.05 | 0.02 | 0.06 |
| 29 | Iron as Fe | mg/l | 0.3(NR) | 0.03 | 0.03 | 0.02 | 0.04 | 0.07 | 0.11 | 0.02 | 0.11 |
| 30 | Total Chromium as Cr | mg/l | 0.05(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 31 | Selenium as Se | mg/l | 0.01(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 32 | Zinc as Zn | mg/l | 5(15) | 0.02 | 0.06 | 0.09 | 0.04 | 0.06 | 0.07 | 0.02 | 0.09 |
| 33 | Aluminum as Al | mg/l | 0.03(0.2) | 0.03 | 0.08 | 0.06 | 0.11 | 0.04 | 0.05 | 0.03 | 0.11 |
| 34 | Mercury as Hg | mg/l | 0.001(NR) | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 35 | Pesticides | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 36 | E.Coli | - | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 37 | Total Coliforms | MPN/100 | 10 | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |

## TABLE-3.6.5 (H)
## GROUNDWATER QUALITY- OCTOBER 2019

| Sr. No. | Parameters | Unit | IS: 10500 Limits | GW1 | GW2 | GW3 | GW4 | GW5 | GW6 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | pH | - | 6.5 – 8.5(NR) | 7.4 | 6.9 | 7.2 | 7.1 | 7.7 | 6.9 | 6.9 | 7.7 |
| 2 | Colour | Hazen | 5(15) | 5 | 4 | 3 | 4 | 7 | 4 | 3 | 7 |
| 3 | Taste | - | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable |
| 4 | Odour | - | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable |
| 5 | Conductivity | µS/cm | $ | 1204 | 1411.7 | 1239.6 | 1042.5 | 634.5 | 812.5 | 634.5 | 1411.7 |
| 6 | Turbidity | NTU | 1(5) | <1.0 | <1.0 | 2 | 1 | 2 | <1.0 | <1 | 2 |
| 7 | TDS | mg/l | 500(2000) | 669.86 | 797.22 | 684.14 | 581.88 | 362.66 | 467.644 | 362.66 | 797.22 |
| 8 | Total Hardness as CaCO3 | mg/l | 200(600) | 314.6 | 360.2 | 364.3 | 301.9 | 189.7 | 210.6 | 189.7 | 364.3 |
| 9 | Total Alkalinity | mg/l | 200(600) | 182.6 | 182.4 | 162.9 | 164.8 | 82.6 | 99.74 | 82.6 | 182.6 |
| 10 | Calcium as Ca | mg/l | 75(200) | 76.8 | 78.9 | 74.6 | 65.8 | 40.8 | 45.9 | 40.8 | 78.9 |
| 11 | Magnesium as Mg | mg/l | 30(100) | 29.8 | 39.6 | 43.2 | 33.4 | 21.3 | 23.3 | 21.3 | 43.2 |
| 12 | Residual Chlorine | mg/l | 0.2(1.0) | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| 13 | Boron as B | mg/l | 0.5(1.0) | 0.52 | 0.54 | 0.62 | 0.46 | 0.44 | 0.28 | 0.28 | 0.62 |
| 14 | Chlorides as Cl | mg/l | 250(1000) | 252.6 | 302.6 | 256.8 | 198.4 | 121.4 | 163.8 | 121.4 | 302.6 |
| 15 | Sulphates as SO4 | mg/l | 200(400) | 49.8 | 77.6 | 68.5 | 58.6 | 41.8 | 54.6 | 41.8 | 77.6 |
| 16 | Fluorides as F | mg/l | 1.0(1.5) | 0.6 | 0.6 | 0.8 | 0.7 | 0.6 | 0.5 | 0.5 | 0.8 |
| 17 | Nitrates as NO3 | mg/l | 45(NR) | 12.6 | 17.4 | 18.6 | 18.1 | 21.6 | 20.4 | 12.6 | 21.6 |
| 18 | Sodium as Na | mg/l | $ | 124.2 | 141.7 | 108.2 | 90.8 | 49.2 | 77.4 | 49.2 | 141.7 |
| 19 | Potassium as K | mg/l | $ | 13.9 | 29.38 | 15.7 | 17.2 | 16.4 | 21.9 | 13.9 | 29.38 |
| 20 | Phenolic Compounds | mg/l | 0.001(0.002) | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 21 | Cyanides as CN | mg/l | 0.05 (NR) | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| 22 | Anionic Detergents | mg/l | 0.2 (1.0) | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 |
| 23 | Mineral Oil | mg/l | 0.5(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 24 | Cadmium as Cd | mg/l | 0.003 (NR) | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| 25 | Arsenic as As | mg/l | 0.01(0.05) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 26 | Copper as Cu | mg/l | 0.05 (1.5) | <0.01 | 0.01 | <0.01 | 0.02 | 0.01 | <0.01 | <0.01 | 0.02 |

| Sr. No. | Parameters | Unit | IS: 10500 Limits | GW1 | GW2 | GW3 | GW4 | GW5 | GW6 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 27 | Lead as Pb | mg/l | 0.01 (NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 28 | Manganese as Mn | mg/l | 0.1 (0.3) | 0.03 | 0.04 | 0.02 | 0.01 | 0.06 | 0.04 | 0.01 | 0.06 |
| 29 | Iron as Fe | mg/l | 0.3(NR) | 0.03 | 0.05 | 0.03 | 0.02 | 0.06 | 0.04 | 0.02 | 0.06 |
| 30 | Total Chromium as Cr | mg/l | 0.05(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 31 | Selenium as Se | mg/l | 0.01(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 32 | Zinc as Zn | mg/l | 5(15) | 0.11 | 0.09 | 0.04 | 0.06 | 0.14 | 0.08 | 0.04 | 0.14 |
| 33 | Aluminum as Al | mg/l | 0.03(0.2) | 0.09 | 0.11 | 0.06 | 0.04 | 0.12 | 0.06 | 0.04 | 0.12 |
| 34 | Mercury as Hg | mg/l | 0.001(NR) | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 35 | Pesticides | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 36 | E.Coli | - | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 37 | Total Coliforms | MPN/100 | 10 | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |

## TABLE-3.6.5 (I)
## GROUNDWATER QUALITY-NOVEMBER 2019

| Sr. No. | Parameters | Unit | IS: 10500 Limits | GW1 | GW2 | GW3 | GW4 | GW5 | GW6 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | pH | - | 6.5 – 8.5(NR) | 6.8 | 7.1 | 7.6 | 7.4 | 7.1 | 6.9 | 6.8 | 7.6 |
| 2 | Colour | Hazen | 5(15) | 3 | 2 | 4 | 5 | 3 | 2 | 2 | 5 |
| 3 | Taste | - | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable |
| 4 | Odour | - | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable |
| 5 | Conductivity | µS/cm | $ | 1186.4 | 1388.9 | 1287.2 | 1094.6 | 649.8 | 789.6 | 649.8 | 1388.9 |
| 6 | Turbidity | NTU | 1(5) | <1.0 | 2 | <1.0 | 2 | <1.0 | 3 | 2 | 3 |
| 7 | TDS | mg/l | 500(2000) | 655.44 | 774.74 | 808.16 | 606.32 | 371.98 | 459.21 | 371.98 | 808.16 |
| 8 | Total Hardness as CaCO3 | mg/l | 200(600) | 324.9 | 357.0 | 358.4 | 300.6 | 188.6 | 205.9 | 188.6 | 358.4 |
| 9 | Total Alkalinity | mg/l | 200(600) | 176.4 | 186.9 | 158.6 | 171.2 | 72.8 | 94.6 | 72.8 | 186.9 |
| 10 | Calcium as Ca | mg/l | 75(200) | 76.3 | 79.6 | 74.9 | 66.9 | 41.2 | 46.8 | 41.2 | 79.6 |
| 11 | Magnesium as Mg | mg/l | 30(100) | 32.6 | 38.4 | 41.6 | 32.4 | 20.8 | 21.6 | 20.8 | 41.6 |
| 12 | Residual Chlorine | mg/l | 0.2(1.0) | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| 13 | Boron as B | mg/l | 0.5(1.0) | 0.36 | 0.51 | 0.34 | 0.44 | 0.32 | 0.51 | 0.32 | 0.51 |
| 14 | Chlorides as Cl | mg/l | 250(1000) | 252.6 | 291.5 | 384.5 | 218.5 | 138.6 | 161.2 | 138.6 | 384.5 |
| 15 | Sulphates as SO4 | mg/l | 200(400) | 47.4 | 76.2 | 61.4 | 55.6 | 38.6 | 56.8 | 38.6 | 76.2 |
| 16 | Fluorides as F | mg/l | 1.0(1.5) | 0.7 | 0.7 | 0.6 | 0.5 | 0.4 | 0.8 | 0.4 | 0.8 |
| 17 | Nitrates as NO3 | mg/l | 45(NR) | 10.2 | 11.4 | 12.6 | 9.4 | 19.6 | 19.8 | 9.4 | 19.8 |
| 18 | Sodium as Na | mg/l | $ | 114.2 | 139.9 | 122.5 | 103.5 | 53.2 | 74.6 | 53.2 | 139.9 |
| 19 | Potassium as K | mg/l | $ | 15.6 | 24.9 | 14.9 | 16.8 | 15.9 | 20.85 | 14.9 | 24.9 |
| 20 | Phenolic Compounds | mg/l | 0.001(0.002) | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 21 | Cyanides as CN | mg/l | 0.05 (NR) | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| 22 | Anionic Detergents | mg/l | 0.2 (1.0) | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 |
| 23 | Mineral Oil | mg/l | 0.5(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 24 | Cadmium as Cd | mg/l | 0.003 (NR) | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| 25 | Arsenic as As | mg/l | 0.01(0.05) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 26 | Copper as Cu | mg/l | 0.05 (1.5) | <0.01 | 0.01 | 0.02 | <0.01 | 0.02 | 0.01 | <0.01 | 0.02 |
| 27 | Lead as Pb | mg/l | 0.01 (NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 28 | Manganese as Mn | mg/l | 0.1 (0.3) | 0.05 | 0.03 | 0.04 | 0.02 | 0.03 | 0.03 | 0.02 | 0.05 |

| Sr. No. | Parameters | Unit | IS: 10500 Limits | GW1 | GW2 | GW3 | GW4 | GW5 | GW6 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 29 | Iron as Fe | mg/l | 0.3(NR) | 0.08 | 0.06 | 0.05 | 0.06 | 0.05 | 0.06 | 0.05 | 0.08 |
| 30 | Total Chromium as Cr | mg/l | 0.05(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 31 | Selenium as Se | mg/l | 0.01(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 32 | Zinc as Zn | mg/l | 5(15) | 0.09 | 0.11 | 0.05 | 0.06 | 0.11 | 0.08 | 0.05 | 0.11 |
| 33 | Aluminum as Al | mg/l | 0.03(0.2) | 0.09 | 0.04 | 0.03 | 0.03 | 0.04 | 0.08 | 0.03 | 0.09 |
| 34 | Mercury as Hg | mg/l | 0.001(NR) | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 35 | Pesticides | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 36 | E.Coli | - | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 37 | Total Coliforms | MPN/100 | 10 | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |

## TABLE-3.6.5 (J)
## GROUNDWATER QUALITY-DECEMBER 2019

| Sr. No. | Parameters | Unit | IS: 10500 Limits | GW1 | GW2 | GW3 | GW4 | GW5 | GW6 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | pH | - | 6.5 – 8.5(NR) | 7.2 | 6.9 | 7.6 | 7.3 | 7.1 | 7.4 | 6.9 | 7.6 |
| 2 | Colour | Hazen | 5(15) | 2 | 2 | 3 | 2 | 3 | 3 | 2 | 3 |
| 3 | Taste | - | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable |
| 4 | Odour | - | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable |
| 5 | Conductivity | µS/cm | $ | 1182.5 | 1346.8 | 1432.5 | 926.8 | 652.8 | 834.6 | 652.8 | 1432.5 |
| 6 | Turbidity | NTU | 1(5) | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| 7 | TDS | mg/l | 500(2000) | 646.84 | 756.34 | 803.94 | 513.9 | 368.56 | 483.56 | 368.56 | 803.94 |
| 8 | Total Hardness as CaCO3 | mg/l | 200(600) | 333.7 | 353.7 | 351.9 | 287.7 | 189.2 | 226.8 | 189.2 | 353.7 |
| 9 | Total Alkalinity | mg/l | 200(600) | 168.4 | 196.4 | 162.4 | 154.6 | 74.6 | 89.6 | 74.6 | 196.4 |
| 10 | Calcium as Ca | mg/l | 75(200) | 76.2 | 78.6 | 82.8 | 61.4 | 42.1 | 48.6 | 42.1 | 82.8 |
| 11 | Magnesium as Mg | mg/l | 30(100) | 34.8 | 38.2 | 35.2 | 32.6 | 20.4 | 25.6 | 20.4 | 38.2 |
| 12 | Residual Chlorine | mg/l | 0.2(1.0) | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| 13 | Boron as B | mg/l | 0.5(1.0) | 0.38 | 0.42 | 0.44 | 0.39 | 0.41 | 0.38 | 0.38 | 0.44 |
| 14 | Chlorides as Cl | mg/l | 250(1000) | 252.6 | 268.5 | 334.2 | 171.34 | 136.4 | 181.4 | 136.4 | 334.2 |
| 15 | Sulphates as SO4 | mg/l | 200(400) | 44.1 | 76.8 | 62.4 | 49.6 | 37.4 | 54.4 | 37.4 | 76.8 |
| 16 | Fluorides as F | mg/l | 1.0(1.5) | 0.6 | 0.5 | 0.6 | 0.7 | 0.6 | 0.6 | 0.5 | 0.7 |
| 17 | Nitrates as NO3 | mg/l | 45(NR) | 13.5 | 18.1 | 16.7 | 18.2 | 17.1 | 22.2 | 13.5 | 22.2 |
| 18 | Sodium as Na | mg/l | $ | 111.2 | 131.4 | 157.8 | 72.1 | 53.4 | 74.6 | 53.4 | 157.8 |
| 19 | Potassium as K | mg/l | $ | 12.8 | 26.4 | 16.8 | 15.2 | 16.4 | 22.4 | 12.8 | 26.4 |
| 20 | Phenolic Compounds | mg/l | 0.001(0.002) | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 21 | Cyanides as CN | mg/l | 0.05 (NR) | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| 22 | Anionic Detergents | mg/l | 0.2 (1.0) | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 |
| 23 | Mineral Oil | mg/l | 0.5(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 24 | Cadmium as Cd | mg/l | 0.003 (NR) | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| 25 | Arsenic as As | mg/l | 0.01(0.05) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 26 | Copper as Cu | mg/l | 0.05 (1.5) | 0.01 | <0.01 | 0.02 | <0.01 | 0.02 | 0.01 | <0.01 | 0.02 |
| 27 | Lead as Pb | mg/l | 0.01 (NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 28 | Manganese as Mn | mg/l | 0.1 (0.3) | 0.01 | 0.03 | 0.03 | 0.04 | 0.03 | 0.04 | 0.01 | 0.04 |

| Sr. No. | Parameters | Unit | IS: 10500 Limits | GW1 | GW2 | GW3 | GW4 | GW5 | GW6 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 29 | Iron as Fe | mg/l | 0.3(NR) | 0.04 | 0.05 | 0.03 | 0.02 | 0.06 | 0.09 | 0.02 | 0.09 |
| 30 | Total Chromium as Cr | mg/l | 0.05(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 31 | Selenium as Se | mg/l | 0.01(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 32 | Zinc as Zn | mg/l | 5(15) | 0.03 | 0.04 | 0.08 | 0.11 | 0.08 | 0.06 | 0.03 | 0.11 |
| 33 | Aluminum as Al | mg/l | 0.03(0.2) | 0.05 | 0.06 | 0.02 | 0.09 | 0.03 | 0.08 | 0.02 | 0.09 |
| 34 | Mercury as Hg | mg/l | 0.001(NR) | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 35 | Pesticides | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 36 | E.Coli | - | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 37 | Total Coliforms | MPN/100 | 10 | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |

## TABLE-3.6.5 (K)
## GROUNDWATER QUALITY –JANUARY 2020

| Sr. No. | Parameters | Unit | IS: 10500 Limits | GW1 | GW2 | GW3 | GW4 | GW5 | GW6 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | pH | - | 6.5 – 8.5(NR) | 7 | 7.2 | 7.4 | 6.9 | 7.8 | 7.3 | 6.9 | 7.8 |
| 2 | Colour | Hazen | 5(15) | 3 | 3 | 2 | 2 | 3 | 3 | 2 | 3 |
| 3 | Taste | - | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable |
| 4 | Odour | - | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable |
| 5 | Conductivity | µS/cm | $ | 1142.8 | 1352.9 | 1346.4 | 942.8 | 664.9 | 842.6 | 664.9 | 1352.9 |
| 6 | Turbidity | NTU | 1(5) | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| 7 | TDS | mg/l | 500(2000) | 634.77 | 766.44 | 754.58 | 519.2 | 378.76 | 487.08 | 378.76 | 766.44 |
| 8 | Total Hardness as CaCO3 | mg/l | 200(600) | 326.5 | 359.3 | 353.8 | 295.3 | 194.6 | 224.2 | 194.6 | 359.3 |
| 9 | Total Alkalinity | mg/l | 200(600) | 172.8 | 188.4 | 164.8 | 174.5 | 88.6 | 92.3 | 88.6 | 188.4 |
| 10 | Calcium as Ca | mg/l | 75(200) | 74.8 | 79.2 | 81.6 | 62.5 | 43.6 | 49.2 | 43.6 | 81.6 |
| 11 | Magnesium as Mg | mg/l | 30(100) | 33.89 | 39.2 | 36.4 | 33.8 | 20.8 | 24.6 | 20.8 | 39.2 |
| 12 | Residual Chlorine | mg/l | 0.2(1.0) | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| 13 | Boron as B | mg/l | 0.5(1.0) | 0.43 | 0.52 | 0.49 | 0.47 | 0.41 | 0.32 | 0.32 | 0.52 |
| 14 | Chlorides as Cl | mg/l | 250(1000) | 246.5 | 281.6 | 302.6 | 162.5 | 132.5 | 179.6 | 132.5 | 302.6 |
| 15 | Sulphates as SO4 | mg/l | 200(400) | 44.2 | 77.2 | 63.8 | 50.4 | 38.5 | 56.5 | 38.5 | 77.2 |
| 16 | Fluorides as F | mg/l | 1.0(1.5) | 0.5 | 0.6 | 0.7 | 0.6 | 0.7 | 0.6 | 0.5 | 0.7 |
| 17 | Nitrates as NO3 | mg/l | 45(NR) | 13.2 | 17.6 | 17.4 | 17.2 | 19.4 | 21.8 | 13.2 | 21.8 |
| 18 | Sodium as Na | mg/l | $ | 104.8 | 129.1 | 137.8 | 71.4 | 54.2 | 77.8 | 54.2 | 137.8 |
| 19 | Potassium as K | mg/l | $ | 13.2 | 28.9 | 15.4 | 16.1 | 15.9 | 21.6 | 13.2 | 28.9 |
| 20 | Phenolic Compounds | mg/l | 0.001(0.002) | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 21 | Cyanides as CN | mg/l | 0.05 (NR) | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| 22 | Anionic Detergents | mg/l | 0.2 (1.0) | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 |
| 23 | Mineral Oil | mg/l | 0.5(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 24 | Cadmium as Cd | mg/l | 0.003 (NR) | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| 25 | Arsenic as As | mg/l | 0.01(0.05) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 26 | Copper as Cu | mg/l | 0.05 (1.5) | <0.01 | 0.02 | <0.01 | <0.01 | 0.02 | 0.01 | <0.01 | 0.02 |
| 27 | Lead as Pb | mg/l | 0.01 (NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 28 | Manganese as Mn | mg/l | 0.1 (0.3) | 0.05 | 0.03 | 0.02 | 0.02 | 0.05 | 0.06 | 0.02 | 0.06 |
| 29 | Iron as Fe | mg/l | 0.3(NR) | 0.04 | 0.06 | 0.02 | 0.03 | 0.08 | 0.06 | 0.02 | 0.08 |

| Sr. No. | Parameters | Unit | IS: 10500 Limits | GW1 | GW2 | GW3 | GW4 | GW5 | GW6 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | Total Chromium as Cr | mg/l | 0.05(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 31 | Selenium as Se | mg/l | 0.01(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 32 | Zinc as Zn | mg/l | 5(15) | 0.13 | 0.08 | 0.06 | 0.08 | 0.11 | 0.09 | 0.06 | 0.13 |
| 33 | Aluminum as Al | mg/l | 0.03(0.2) | 0.08 | 0.09 | 0.03 | 0.05 | 0.08 | 0.09 | 0.03 | 0.09 |
| 34 | Mercury as Hg | mg/l | 0.001(NR) | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 35 | Pesticides | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 36 | E.Coli | - | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 37 | Total Coliforms | MPN/100 | 10 | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |

## TABLE-3.6.5 (L)
## GROUNDWATER QUALITY-FEBRUARY 2020

| Sr. No. | Parameters | Unit | IS: 10500 Limits | GW1 | GW2 | GW3 | GW4 | GW5 | GW6 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | pH | - | 6.5 – 8.5(NR) | 7.2 | 6.9 | 7.2 | 6.8 | 7.6 | 7.1 | 6.8 | 7.6 |
| 2 | Colour | Hazen | 5(15) | 2 | 3 | 3 | 4 | 2 | 4 | 2 | 4 |
| 3 | Taste | - | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable |
| 4 | Odour | - | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable |
| 5 | Conductivity | µS/cm | $ | 1163.4 | 1296.5 | 1366.4 | 986.4 | 634.5 | 812.4 | 634.5 | 1366.4 |
| 6 | Turbidity | NTU | 1(5) | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| 7 | TDS | mg/l | 500(2000) | 639.34 | 726.04 | 763.68 | 540.68 | 359.88 | 466.88 | 359.88 | 763.68 |
| 8 | Total Hardness as CaCO3 | mg/l | 200(600) | 327.2 | 348.7 | 360.7 | 294.2 | 190.9 | 216.9 | 190.9 | 360.7 |
| 9 | Total Alkalinity | mg/l | 200(600) | 172.4 | 187.9 | 162.8 | 173.8 | 79.8 | 96.8 | 79.8 | 187.9 |
| 10 | Calcium as Ca | mg/l | 75(200) | 74.6 | 72.8 | 82.4 | 61.4 | 40.8 | 47.6 | 40.8 | 82.4 |
| 11 | Magnesium as Mg | mg/l | 30(100) | 34.2 | 40.5 | 37.6 | 34.2 | 21.6 | 23.8 | 21.6 | 40.5 |
| 12 | Residual Chlorine | mg/l | 0.2(1.0) | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| 13 | Boron as B | mg/l | 0.5(1.0) | 0.39 | 0.53 | 0.44 | 0.38 | 0.36 | 0.48 | 0.36 | 0.53 |
| 14 | Chlorides as Cl | mg/l | 250(1000) | 244.6 | 255.6 | 308.9 | 176.8 | 123.6 | 164.2 | 123.6 | 308.9 |
| 15 | Sulphates as SO4 | mg/l | 200(400) | 46.4 | 78.4 | 64.5 | 51.4 | 39.2 | 57.4 | 39.2 | 78.4 |
| 16 | Fluorides as F | mg/l | 1.0(1.5) | 0.5 | 0.6 | 0.7 | 0.5 | 0.4 | 0.7 | 0.4 | 0.7 |
| 17 | Nitrates as NO3 | mg/l | 45(NR) | 12.6 | 16.4 | 17.1 | 13.8 | 21.6 | 18.6 | 12.6 | 21.6 |
| 18 | Sodium as Na | mg/l | $ | 108.8 | 122.2 | 139.2 | 81.9 | 49.2 | 73.7 | 49.2 | 139.2 |
| 19 | Potassium as K | mg/l | $ | 14.2 | 26.8 | 15.6 | 16.4 | 15.6 | 22.8 | 14.2 | 26.8 |
| 20 | Phenolic Compounds | mg/l | 0.001(0.002) | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 21 | Cyanides as CN | mg/l | 0.05 (NR) | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| 22 | Anionic Detergents | mg/l | 0.2 (1.0) | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 |
| 23 | Mineral Oil | mg/l | 0.5(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 24 | Cadmium as Cd | mg/l | 0.003 (NR) | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| 25 | Arsenic as As | mg/l | 0.01(0.05) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 26 | Copper as Cu | mg/l | 0.05 (1.5) | 0.02 | <0.01 | 0.01 | 0.02 | <0.01 | <0.01 | <0.01 | 0.02 |
| 27 | Lead as Pb | mg/l | 0.01 (NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 28 | Manganese as Mn | mg/l | 0.1 (0.3) | 0.03 | 0.04 | 0.02 | 0.03 | 0.02 | 0.04 | 0.02 | 0.04 |
| 29 | Iron as Fe | mg/l | 0.3(NR) | 0.11 | 0.04 | 0.06 | 0.05 | 0.06 | 0.08 | 0.04 | 0.11 |

| Sr. No. | Parameters | Unit | IS: 10500 Limits | GW1 | GW2 | GW3 | GW4 | GW5 | GW6 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | Total Chromium as Cr | mg/l | 0.05(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 31 | Selenium as Se | mg/l | 0.01(NR) | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 32 | Zinc as Zn | mg/l | 5(15) | 0.11 | 0.06 | 0.08 | 0.07 | 0.13 | 0.09 | 0.06 | 0.13 |
| 33 | Aluminum as Al | mg/l | 0.03(0.2) | 0.11 | 0.05 | 0.06 | 0.04 | 0.07 | 0.07 | 0.04 | 0.11 |
| 34 | Mercury as Hg | mg/l | 0.001(NR) | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 35 | Pesticides | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 36 | E.Coli | - | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 37 | Total Coliforms | MPN/100 | 10 | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |

The discussion on the analytical results of water samples is presented in the following sections:

***Pre-Monsoon Season***

*Surface Water Quality*

- The results of surface water sample analysis indicate that the pH value was observed to be in the range of 6.7 to 7.4, which are well within the specified standards of 6.5 to 8.5.
- Electrical conductivity of surface water samples was observed to be in the range of 441 µS/cm to 892 µS/cm.
- The dissolved oxygen was observed in the range of 5.2 mg/l to 5.8 mg/l.
- The total hardness was found to be in the range of 135.35 mg/l to 225.18 mg/l.
- The chloride concentration was observed in the range of 86.2 mg/l to 205.2 mg/l and the sulphates were found to be in the range of 21.2 mg/l to 34.2 mg/l.
- Fluoride content was found to be in the range of 0.3 mg/l to 0.7 mg/l.
- Cyanides and phenolic compounds found to be below detection limits.
- Bacteriological studies revealed that the total coliform count is measured 1180-3640 MPN/100ml.

The surface water quality in the study area does not indicate any industrial contamination.

*Ground Water Quality*

- The analysis results of ground water samples showed the pH in range of 6.7 - 7.4 which are with the specified standard limits of 6.5 to 8.5.
- Color and turbidity of the samples ranged from 2-7 Hazens and <1-5 NTU respectively.
- Electrical conductivity of the samples ranged from 515-1432 µS/cm.
- The total hardness of the samples ranged from 160.5-386.9 mg/l.
- Calcium and magnesium concentrations ranged from 31.8-86.8 mg/l and 19.2 - 42.6 mg/l respectively.
- The total dissolved solids of the samples ranged from 293.7 -803.5 mg/l.
- Range of chlorides and sulphates concentrations at all the locations 105.4-284.6 mg/l and 14.8-82.6 mg/l respectively.
- Fluoride concentration ranged from 0.4-0.7 mg/l and is found to be within the permissible limits.
- Similarly, nitrates are also found to be ranging in between 12.6–25.6 mg/l.
- Iron concentrations in ground water varied from 0.03-0.11 mg/l. Zinc levels varied from 0.02 mg/l to 0.11 mg/l respectively.
- Aluminium concentration in ground water is <0.01-0.09 mg/l which are within the limits stipulated.
- All other metal concentrations are observed to be below detectable limits.
- The total coliform counts is absent in all the samples against the standard limit of 10 MPN/100 ml.

Based on the above results, it is evident that all of the parameters in ground water fairly meet the desirable standard limits of IS: 10500. The ground water quality in the study area does not indicate any industrial contamination.

***Monsoon Season***

*Surface Water Quality*

- The results of surface water sample analysis indicate that the pH value was observed to be in the range of 6.7 to 7.6, which are well within the specified standards of 6.5 to 8.5.
- Electrical conductivity of surface water samples was observed to be in the range of 475.6 µS/cm to 828.4 µS/cm.
- The dissolved oxygen was observed in the range of 5.0 mg/l to 5.8 mg/l.
- The total hardness was found to be in the range of 130 mg/l to 215.44 mg/l.
- The chloride concentration was observed in the range of 86.2 mg/l to 198.6 mg/l and the sulphates were found to be in the range of 20.3 mg/l to 36.4 mg/l.
- Fluoride content was found to be in the range of 0.3 mg/l to 0.7 mg/l.
- Cyanides and phenolic compounds found to be below detection limits.
- Bacteriological studies revealed that the total coliform count is measured 1820-3840 MPN/100ml.

The surface water quality in the study area does not indicate any industrial contamination.

*Ground Water Quality*

- The analysis results of ground water samples showed the pH in range of 6.7 - 7.6 which are with the specified standard limits of 6.5 to 8.5.
- Color and turbidity of the samples ranged from 2-6 Hazens and <1-3 NTU respectively.
- Electrical conductivity of the samples ranged from 596.7-1462 µS/cm.
- The total hardness of the samples ranged from 169.02-837 mg/l.
- Calcium and magnesium concentrations ranged from 33.7-91.3 mg/l and 18.4-42.6 mg/l respectively.
- The total dissolved solids of the samples ranged from 350.1 -851.7 mg/l.
- Range of chlorides and sulphates concentrations at all the locations 113.6-294.5 mg/l and 35.4-86.4 mg/l respectively.
- Fluoride concentration ranged from 0.4-0.7 mg/l and is found to be within the permissible limits.
- Similarly, nitrates are also found to be ranging in between 10.4 – 26.9 mg/l.
- Iron concentrations in ground water varied from 0.01-0.11 mg/l. Zinc levels varied from 0.02 mg/l to 0.12 mg/l respectively.
- Aluminium concentration in ground water is 0.02-0.11 mg/l which are within the limits stipulated.
- All other metal concentrations are observed to be below detectable limits.
- The total coliform counts are absent in all the samples against the standard limit of 10 MPN/100 ml.

Based on the above results, it is evident that all of the parameters in ground water fairly meet the desirable standard limits of IS: 10500. The ground water quality in the study area does not indicate any industrial contamination.

***Post Monsoon Season***

*Surface Water Quality*

- The results of surface water sample analysis indicate that the pH value was observed to be in the range of 6.7 to 7.8, which are well within the specified standards of 6.5 to 8.5.
- Electrical conductivity of surface water samples was observed to be in the range of 521.4 µS/cm to 855.7 µS/cm.
- The dissolved oxygen was observed in the range of 5.1 mg/l to 5.6 mg/l.
- The total hardness was found to be in the range of 149.6 mg/l to 198.7 mg/l.
- The chloride concentration was observed in the range of 105.2-202.6 mg/l and the sulphates were found to be in the range of 22.8 mg/l to 37.4 mg/l.
- Fluoride content was found to be in the range of 0.5 mg/l to 0.7 mg/l.
- Cyanides and phenolic compounds found to be below detection limits.
- Bacteriological studies revealed that the total coliform count is measured 2060-3000 MPN/100ml.

  The surface water quality in the study area does not indicate any industrial contamination.

*Ground Water Quality*

- The analysis results of ground water samples showed the pH in range of 6.8 - 7.7 which are with the specified standard limits of 6.5 to 8.5.
- Color and turbidity of the samples ranged from 2-7 Hazens and <1-3 NTU respectively.
- Electrical conductivity of the samples ranged from 634.5-1411.7 µS/cm.
- The total hardness of the samples ranged from 188.6-364.3 mg/l.
- Calcium and magnesium concentrations ranged from 40.8-79.6 mg/l and 20.8-43.2 mg/l respectively.
- The total dissolved solids of the samples ranged from 362.66 -808.16 mg/l.
- Range of chlorides and sulphates concentrations at all the locations 121.4-384.5 mg/l and 38.6-77.6 mg/l respectively.
- Fluoride concentration ranged from 0.4-0.8 mg/l and is found to be within the permissible limits.
- Similarly, nitrates are also found to be ranging in between 9.4– 21.6 mg/l.
- Iron concentrations in ground water varied from 0.02-0.08 mg/l. Zinc levels varied from 0.02 mg/l to 0.14 mg/l respectively.
- Aluminium concentration in ground water is 0.03-0.12 mg/l which are within the limits stipulated.
- All other metal concentrations are observed to be below detectable limits.
- The total coliform counts are absent in all the samples against the standard limit of 10 MPN/100 ml.

Based on the above results, it is evident that all of the parameters in ground water fairly meet the desirable standard limits of IS: 10500. The ground water quality in the study area does not indicate any industrial contamination.

***Winter Season***

*Surface Water Quality*

The discussion on the analytical results of water samples is presented in the following sections:

- The results of surface water sample analysis indicate that the pH value was observed to be in the range of 6.8 to 7.6, which are well within the specified standards of 6.5 to 8.5.
- Electrical conductivity of surface water samples was observed to be in the range of 516.2 µS/cm to 846.5 µS/cm.
- The dissolved oxygen was observed in the range of 5.1 mg/l to 5.7 mg/l.
- The total hardness was found to be in the range of 146.6 mg/l to 197.9 mg/l.
- The chloride concentration was observed in the range of 112.6-202.6 mg/l and the sulphates were found to be in the range of 21.6 mg/l to 37.9 mg/l.
- Fluoride content was found to be in the range of 0.4 mg/l to 0.7 mg/l.
- Cyanides and phenolic compounds found to be below detection limits.
- Bacteriological studies revealed that the total coliform count is measured 2080-2920 MPN/100ml.

The surface water quality in the study area does not indicate any industrial contamination.

*Ground Water Quality*

- The analysis results of ground water samples showed the pH in range of 6.8 - 7.8 which are with the specified standard limits of 6.5 to 8.5.
- Color and turbidity of the samples ranged from 2-7 Hazens and <1 NTU respectively.
- Electrical conductivity of the samples ranged from 634.5-1432.5 µS/cm.
- The total hardness of the samples ranged from 189.2-360.7 mg/l.
- Calcium and magnesium concentrations ranged from 40.8-82.8 mg/l and 20.4-40.5 mg/l respectively.
- The total dissolved solids of the samples ranged from 359.8 -803.9 mg/l.
- Range of chlorides and sulphates concentrations at all the locations 123.6-334.2 mg/l and 37.4-78.4 mg/l respectively.
- Fluoride concentration ranged from 0.4-0.7 mg/l and is found to be within the permissible limits.
- Similarly, nitrates are also found to be ranging in between 12.6– 22.2 mg/l.
- Iron concentrations in ground water varied from 0.02-0.11 mg/l. Zinc levels varied from 0.03 mg/l to 0.13 mg/l respectively.
- Aluminium concentration in ground water is 0.02-0.11 mg/l which are within the limits stipulated.
- All other metal concentrations are observed to be below detectable limits.
- The total coliform counts are absent in all the samples against the standard limit of 10 MPN/100 ml.

Based on the above results, it is evident that all of the parameters in ground water fairly meet the desirable standard limits of IS: 10500. The ground water quality in the study area does not indicate any industrial contamination.

## TABLE-3.6.5 (M)
## SEASONAL VARIATION- (SURFACE WATER QUALITY)

| Sr. No | Parameters | Unit | Pre-Monsoon | | Monsoon | | Post-Monsoon | | Winter | | Range | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max |
| 1 | pH | - | 6.7 | 7.4 | 6.7 | 7.6 | 6.7 | 7.8 | 6.8 | 7.6 | 6.7 | 7.8 |
| 2 | Colour | Hazen | 2 | 11 | 2 | 6 | 3 | 5 | 2 | 5 | 2 | 5 |
| 3 | Conductivity | µS/cm | 441 | 892 | 475.6 | 828.4 | 521.4 | 855.7 | 516.2 | 846.5 | 516.2 | 846.5 |
| 4 | TDS | mg/l | 249.9 | 498.2 | 258.9 | 511.5 | 286.6 | 477.5 | 282.8 | 469.9 | 282.8 | 469.9 |
| 5 | DO | mg/l | 5.2 | 5.8 | 5 | 5.8 | 5.1 | 5.6 | 5.1 | 5.7 | 5.1 | 5.7 |
| 6 | BOD | mg/l | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 | <3.0 |
| 7 | COD | mg/l | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 |
| 8 | Turbidity | NTU | 2 | 6 | 2 | 8 | 3 | 6 | 3 | 7 | 3 | 7 |
| 9 | Total Hardness as CaCO3 | mg/l | 135.35 | 225.18 | 130 | 215.44 | 149.6 | 198.7 | 146.6 | 197.9 | 146.6 | 197.9 |
| 10 | Total Alkalinity as CaCO3 | mg/l | 54.6 | 122.6 | 52.9 | 126.4 | 61.8 | 102.5 | 53.8 | 99.8 | 53.8 | 99.8 |
| 11 | Calcium as Ca | mg/l | 30.6 | 45.3 | 30.5 | 44.2 | 35.9 | 49.6 | 33.8 | 48.6 | 33.8 | 48.6 |
| 12 | Magnesium as Mg | mg/l | 13.8 | 27.2 | 12.4 | 25.5 | 12.6 | 21.8 | 13.9 | 21.8 | 13.9 | 21.8 |
| 13 | Chlorides as Cl | mg/l | 86.2 | 205.2 | 86.2 | 198.6 | 105.2 | 202.6 | 112.6 | 202.6 | 112.6 | 202.6 |
| 14 | Residual free chlorine | mg/l | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| 15 | Phosphates as PO4 | mg/l | 0.01 | 0.08 | 0.01 | 0.07 | 0.01 | 0.05 | 0.01 | 0.06 | 0.01 | 0.06 |
| 16 | Sulphates as SO4 | mg/l | 21.2 | 34.2 | 20.3 | 36.4 | 22.8 | 37.4 | 21.6 | 37.9 | 21.6 | 37.9 |
| 17 | Fluorides as F | mg/l | 0.3 | 0.7 | 0.3 | 0.7 | 0.5 | 0.7 | 0.4 | 0.7 | 0.4 | 0.7 |
| 18 | Nitrates as NO3 | mg/l | 5.2 | 11.6 | 4.9 | 12.1 | 5.9 | 10.2 | 4.9 | 9.8 | 4.9 | 9.8 |
| 19 | Sodium as Na | mg/l | 32.5 | 96.8 | 33.6 | 96.2 | 34.2 | 103.2 | 35.8 | 100.6 | 35.8 | 100.6 |
| 20 | Potassium as K | mg/l | 4.2 | 8.4 | 4.2 | 9.8 | 4.2 | 7.9 | 4.6 | 7.6 | 4.6 | 7.6 |
| 21 | Total Boron as B | mg/l | 0.11 | 0.68 | 0.16 | 0.67 | 0.26 | 0.52 | 0.26 | 0.56 | 0.26 | 0.56 |
| 22 | Phenolic Compounds | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 23 | Cyanides | mg/l | <0.001 | <0.001 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| 24 | Oil & grease | mg/l | <0.001 | <0.001 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 | <1.0 |
| 25 | 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 |
| 26 | Arsenic as As | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |

| Sr. No | Parameters | Unit | Pre-Monsoon | | Monsoon | | Post-Monsoon | | Winter | | Range | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 27 | Copper as Cu | mg/l | <0.01 | 0.04 | <0.01 | 0.03 | 0.02 | 0.02 | <0.01 | 0.03 | <0.01 | 0.03 |
| 28 | Lead as Pb | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 29 | Iron as Fe | mg/l | <0.01 | 0.11 | 0.02 | 0.23 | 0.02 | 0.19 | 0.03 | 0.14 | 0.03 | 0.14 |
| 30 | Chromium as Cr+6 | mg/l | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 | <0.05 |
| 31 | Selenium as Se | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 32 | Zinc as Zn | mg/l | 0.01 | 0.13 | 0.02 | 0.14 | 0.03 | 0.14 | 0.04 | 0.12 | 0.04 | 0.12 |
| 33 | Aluminum as Al | mg/l | <0.01 | 0.11 | 0.02 | 0.12 | 0.03 | 0.12 | 0.03 | 0.14 | 0.03 | 0.14 |
| 34 | Mercury as Hg | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 35 | SAR | - | 1.2 | 2.8 | 1.1 | 3 | 1.1 | 3.3 | 1.2 | 3.2 | 1.2 | 3.2 |
| 36 | Insecticides | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 37 | Anionic detergents as MBAS | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 38 | Total coliforms | MPN/100 | 1180 | 3640 | 1820 | 3840 | 2060 | 3000 | 2080 | 2920 | 2080 | 2920 |

## TABLE-3.6.6 (N)
## SEASONAL VARIATION-(GROUND WATER QUALITY)

| Sr.No | Parameters | Unit | Pre-Monsoon | | Monsoon | | Post-Monsoon | | Winter | | Range | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max |
| 1 | pH | - | 6.7 | 7.4 | 6.7 | 7.6 | 6.8 | 7.7 | 6.8 | 7.8 | 6.7 | 7.8 |
| 2 | Colour | Hazen | 2 | 7 | 2 | 6 | 2 | 7 | 2 | 4 | 2 | 7 |
| 3 | Taste | - | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable |
| 4 | Odour | - | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable |
| 5 | Conductivity | µS/cm | 515 | 1432 | 596.7 | 1462 | 634.5 | 1411.7 | 634.5 | 1432.5 | 515 | 1462 |
| 6 | Turbidity | NTU | 2 | 5 | 1 | 3 | 2 | 3 | <1.0 | <1.0 | <1.0 | 5 |
| 7 | TDS | mg/l | 293.7 | 803.5 | 350.01 | 851.7 | 362.66 | 808.16 | 359.88 | 803.94 | 293.7 | 851.7 |
| 8 | Total Hardness as CaCO3 | mg/l | 160.5 | 386.96 | 169.02 | 837 | 188.6 | 364.3 | 189.2 | 360.7 | 160.5 | 837 |
| 9 | Total Alkalinity | mg/l | 68.5 | 212.5 | 73.1 | 210.6 | 72.8 | 186.9 | 74.6 | 196.4 | 68.5 | 212.5 |
| 10 | Calcium as Ca | mg/l | 31.8 | 86.8 | 33.7 | 91.3 | 40.8 | 79.6 | 40.8 | 82.8 | 31.8 | 91.3 |
| 11 | Magnesium as Mg | mg/l | 19.2 | 42.6 | 18.4 | 42.6 | 20.8 | 43.2 | 20.4 | 40.5 | 18.4 | 43.2 |
| 12 | Residual Chlorine | mg/l | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| 13 | Boron as B | mg/l | 0.24 | 0.68 | 0.26 | 0.62 | 0.28 | 0.62 | 0.32 | 0.53 | 0.24 | 0.68 |
| 14 | Chlorides as Cl | mg/l | 105.4 | 284.6 | 113.6 | 294.5 | 121.4 | 384.5 | 123.6 | 334.2 | 105.4 | 384.5 |
| 15 | Sulphates as SO4 | mg/l | 14.8 | 82.6 | 35.4 | 86.4 | 38.6 | 77.6 | 37.4 | 78.4 | 14.8 | 86.4 |
| 16 | Fluorides as F | mg/l | 0.4 | 0.7 | 0.4 | 0.7 | 0.4 | 0.8 | 0.4 | 0.7 | 0.4 | 0.8 |
| 17 | Nitrates as NO3 | mg/l | 12.6 | 25.6 | 10.4 | 26.9 | 9.4 | 21.6 | 12.6 | 22.2 | 9.4 | 26.9 |
| 18 | Sodium as Na | mg/l | 35 | 135.2 | 45.6 | 142.5 | 49.2 | 141.7 | 49.2 | 157.8 | 35 | 157.8 |
| 19 | Potassium as K | mg/l | 14.2 | 32.4 | 14.2 | 32.4 | 13.9 | 29.38 | 12.8 | 28.9 | 12.8 | 32.4 |
| 20 | Phenolic Compounds | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 21 | Cyanides as CN | mg/l | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| 22 | Anionic Detergents | mg/l | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 | <0.20 |
| 23 | Mineral Oil | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 24 | Cadmium as Cd | mg/l | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| 25 | Arsenic as As | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 26 | Copper as Cu | mg/l | <0.01 | 0.04 | <0.01 | 0.03 | <0.01 | 0.02 | <0.01 | 0.02 | <0.01 | 0.04 |
| 27 | Lead as Pb | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 28 | Manganese as Mn | mg/l | <0.01 | 0.08 | 0.02 | 0.07 | 0.01 | 0.06 | 0.01 | 0.06 | 0.01 | 0.08 |
| 29 | Iron as Fe | mg/l | 0.03 | 0.11 | 0.01 | 0.11 | 0.02 | 0.08 | 0.02 | 0.11 | 0.01 | 0.11 |

| Sr.No | Parameters | Unit | Pre-Monsoon | | Monsoon | | Post-Monsoon | | Winter | | Range | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | Total Chromium as Cr | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 31 | Selenium as Se | mg/l | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| 32 | Zinc as Zn | mg/l | 0.02 | 0.11 | 0.02 | 0.12 | 0.04 | 0.14 | 0.03 | 0.13 | 0.02 | 0.14 |
| 33 | Aluminum as Al | mg/l | <0.01 | 0.09 | 0.02 | 0.11 | 0.03 | 0.12 | 0.02 | 0.11 | 0.02 | 0.12 |
| 34 | Mercury as Hg | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 35 | Pesticides | mg/l | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 36 | E.Coli | - | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |
| 37 | Total Coliforms | MPN/100 | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent | Absent |

## 3.7 Soil Characteristics

It is essential to determine the potential of soil in the area and identify the current impacts of urbanization and industrialization on soil quality and also predict impacts, which may arise due to the proposed capacity expansion of thermal power plant. Accordingly, a study of assessment of the baseline soil quality has been carried out.

### 3.7.1 Data Generation

For studying soil profile of the region, sampling locations were selected to assess the existing soil conditions in and around the plant area representing various land use conditions. The physical, chemical and heavy metal concentrations were determined. The samples were collected by ramming a core-cutter into the soil up to a depth of 90 cm.

The present study of the soil profile establishes the baseline characteristics and this will help in future identification of the incremental concentrations if any, due to the operation of the plant. The sampling locations have been identified with the following objectives:

- To determine the baseline soil characteristics of the study area;
- To determine the impact of industrialization on soil characteristics; and
- To determine the impact on soil more importantly from agricultural productivity point of view.

Fifiteen locations in and around the proposed expansion of power plant area were selected for soil sampling. At each location, soil samples were collected from three different depths viz. 30 cm, 60 cm and 90 cm below the surface and are homogenized. This is in line with IS: 2720 and Methods of Soil Analysis, Part-1, 2nd edition, 1986 of (American Society for Agronomy and Soil Science Society of America). The homogenized samples were analyzed for physical and chemical characteristics. The samples have been analyzed as per the established scientific methods for physico-chemical parameters. The heavy metals have been analyzed by using Atomic Absorption Spectrophotometer (AAS) and Inductive Coupled Plasma Analyzer (ICP). The methodology adopted for each parameter is described in **Table-3.7.1**.

**TABLE-3.7.1**
**ANALYTICAL TECHNIQUES FOR SOIL ANALYSIS**

| Parameter | Method (ASTM Number) |
|---|---|
| Grain size distribution | Sieve analysis (D 422 – 63) |
| Textural classification | Chart developed by Public Roads Administration |
| Bulk density | Sand replacement, core cutter |
| Sodium absorption ratio | Flame photometric (D 1428-82) |
| pH | pH meter (D 1293-84) |
| Electrical conductivity | Conductivity meter (D 1125-82) |
| Nitrogen | Kjeldahl distillation (D 3590-84) |
| Phosphorus | Molybdenum blue, colourimetric (D 515-82) |
| Potassium | Flame photometric (D 1428-82) |
| Iron | AAS (D 1068-84) |
| Zinc | AAS (D 1691-84) |
| Boron | Surcumin, colourimetric (D 3082-79) |
| Chlorides | Argentometric (D 512-81 Rev 85) |

*Selection of Site*

- A visual survey of the field is made for slope, texture and cropping pattern;
- The collection site is demarcated into uniform portions, each of which sampled separately; and
- Sampling is made during normal environmental conditions.

The details of the sampling locations are given in **Table-3.7.2** and are shown in **Figure-3.7.1**. The standard classification and results are given in **Table-3.7.3** and **Table-3.7.4.** The soil infiltration report is attached as **Annexure-X.**

**TABLE-3.7.2**
**DETAILS OF SOIL SAMPLING LOCATIONS**

| Station Code | Name of the Station | Distance (km) | Direction | Zone |
|---|---|---|---|---|
| S1 | Project Site | - | - | Industrial |
| S2 | Sipat | 1.3 | NW | Agricultural |
| S3 | Nargora | 3.2 | N | Agricultural |
| S4 | Bhadrapara | 3.3 | NE | Agricultural |
| S5 | Near Sonthi at Bitkuli Reserve Forest | 8.6 | NE | Forest |
| S6 | Darrabhata | 1.7 | E | Agricultural |
| S7 | Near Pachri at Dalha Protected Forest | 9.2 | SE | Forest |
| S8 | Raliya | 5.7 | S | Agricultural |
| S9 | Sukhiripali | 4.5 | S | Agricultural |
| S10 | Matiyari | 1.8 | W | Agricultural |
| S11 | Selar | 6.4 | NW | Agricultural |
| S12 | Pandi | 2.3 | SW | Agricultural |
| S13 | Kaudia | 0.5 | S | Agricultural |
| S14 | Changaripara | 6.0 | E | Agricultural |
| S15 | Uchbhatti | 6.0 | NNW | Agricultural |

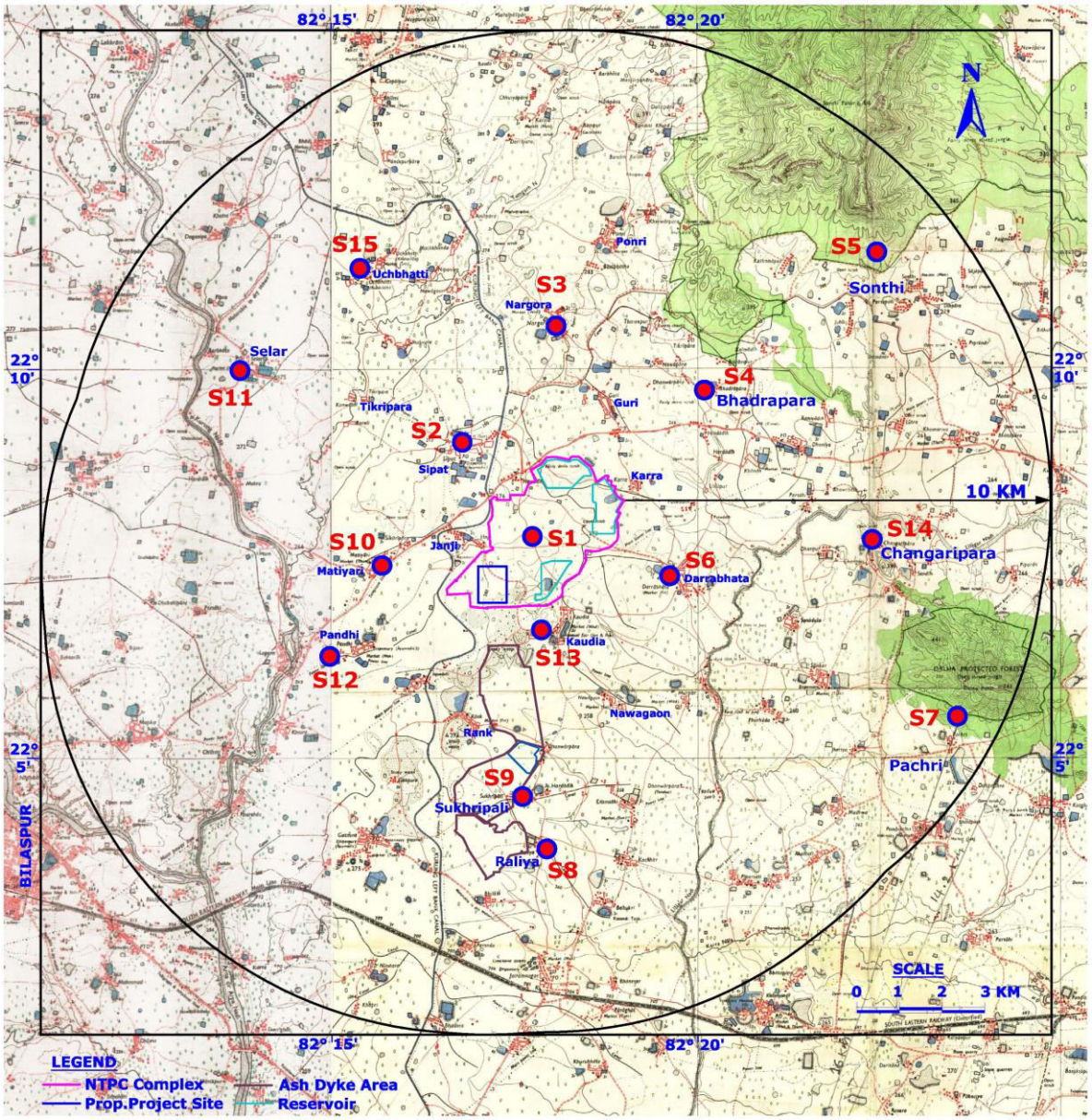



**FIGURE-3.7.1**
**SOIL SAMPLING LOCATIONS**

3.7.2 Site Description

*Plant Site (S1):* The sample is collected from the plant boundary.

Other remaining samples S2, S3, S4, S5, S6, S8, S9, S10, S11, S12, S13, S14 & S15 are collected from the agricultural fields of respective villages.

Sample (S5) is collected from Bitkuli Reserved Forest near village Sonthi and Sample (S7) is collected from Dalha Protected Forest near village Pachri.

3.7.3 Baseline Soil Status

**Pre-Monsoon Season**

- It has been observed that the pH of the soil in the study area ranged from 7.16 to 8.23. The maximum pH value of 8.23 was observed at Bhadpara (S4) and whereas the minimum value of 7.16 was observed at Kaudia (S13).
- The electrical conductivity was observed to be in the range of 59.6 µmhos/cm to 196.2 µmhos/cm with the maximum observed at Matiyari (S10) and the minimum observed in Bhadpara (S4).
- The nitrogen values range between 38.6 to 83.4 kg/ha. The nitrogen content in the study area is very less to less category.
- The phosphorus values range between 78.6 to 195.6 kg/ha, indicating that the phosphorus content in the study area falls in sufficient to more than sufficient category.
- The potassium values range between 152.8 to 346.5 kg/ha. The potassium content in the study area falls in less to better category.
- The chlorides were found to be in the range of 71.0 to 296 mg/kg of soil.

The analysis of soil samples does not indicate any external industrial contamination.

**Monsoon Season**

- It has been observed that the pH of the soil in the study area ranged from 7.24 to 8.27. The maximum pH value of 8.27 was observed at Pandi (S12) and whereas the minimum value of 7.24 was observed at Sipat (S2).
- The electrical conductivity was observed to be in the range of 99.8 µs/cm to 205.6 µs/cm with the maximum observed at Matiyari (S10) and the minimum observed in Sipat (S2).
- The nitrogen values range between 48.6 to 83.6 kg/ha. The nitrogen content in the study area is very less to less category.
- The phosphorus values range between 92.6 to 196.2 kg/ha, indicating that the phosphorus content in the study area falls in more than sufficient category.
- The potassium values range between 186.5 to 302.4 kg/ha. The potassium content in the study area falls in medium to better category.
- The chlorides were found to be in the range of 108.0 to 268.0 mg/kg of soil.

The analysis of soil samples does not indicate any external industrial contamination.

**Post-Monsoon Season**

- It has been observed that the pH of the soil in the study area ranged from 7.52 to 8.19.
- The electrical conductivity was observed to be in the range of 104.8 µs/cm to 208.6 µs/cm with the maximum observed at Selar (S11) and the minimum observed in Pandi (S12).
- The nitrogen values range between 41.6 to 81.6 kg/ha. The nitrogen content in the study area is very less to less category.
- The phosphorus values range between 82.4 to 205.5 kg/ha, indicating that the phosphorus content in the study area falls in more than sufficient category.
- The potassium values range between 186.4 to 384.6 kg/ha. The potassium content in the study area falls in medium to more than sufficient category.
- The chlorides were found to be in the range of 112 to 286.0 mg/kg of soil.

The analysis of soil samples does not indicate any external industrial contamination.

**Winter Season**

- It has been observed that the pH of the soil in the study area ranged from 7.13 to 7.86

- The electrical conductivity was observed to be in the range of 112.8 µs/cm to 212.6 µs/cm.

- The nitrogen values range between 41.6 to 86.4 kg/ha. The nitrogen content in the study area is very less to less category.
- The phosphorus values range between 94.6 to 216.5 kg/ha, indicating that the phosphorus content in the study area falls in more than sufficient category.
- The potassium values range between 208.6 to 376.8 kg/ha. The potassium content in the study area falls in medium to more than sufficient category.
- The chlorides were found to be in the range of 102 to 294 mg/kg of soil.

The analysis of soil samples does not indicate any external industrial contamination.

## TABLE-3.7.3
## STANDARD SOIL CLASSIFICATION

| Sr. No | Soil Test | Classification |
|---|---|---|
| 1 | pH | <4.5 Extremely acidic<br>4.51- 5.50 Very strongly acidic<br>5.51-6.0 moderately acidic<br>6.01-6.50 slightly acidic<br>6.51-7.30 Neutral<br>7.31-7.80 slightly alkaline<br>7.81-8.50 moderately alkaline<br>8.51-9.0 strongly alkaline<br>>9.01 very strongly alkaline |
| 2 | Salinity Electrical Conductivity (ppm)<br>(1 ppm =640 µmho/cm) | Upto 1.00 Average<br>1.01-2.00 harmful to germination<br>2.01-3.00 harmful to crops (sensitive to salts) |
| 3 | Organic Carbon (%) | Upto 0.2: very less<br>0.21-0.4: less<br>0.41-0.5 medium,<br>0.51-0.8: on an average sufficient<br>0.81-1.00: sufficient<br>>1.0 more than sufficient |
| 4 | Nitrogen (kg/ha) | Upto 50 very less<br>51-100 less<br>101-150 good<br>151-300 Better<br>>300 sufficient |
| 5 | Phosphorus (kg/ha) | Upto 15 very less<br>16-30 less<br>31-50 medium,<br>51-65 on an average sufficient<br>66-80 sufficient<br>>80 more than sufficient |
| 6 | Potash (kg/ha) | 0 -120 very less<br>120-180 less<br>181-240 medium<br>241-300 average<br>301-360 better<br>>360 more than sufficient |

***Source: Handbook of Agriculture, Indian Council of Agricultural Research, New Delhi***

## TABLE-3.7.4 (A)
## SOIL ANALYSIS RESULTS-PRE-MONSOON SEASON

| Sr. No. | Parameters | Unit | S1 | S2 | S3 | S4 | S5 | S6 | S7 | S8 | S9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Texture | | | | | | | | | | |
| a | Sand | % | 28 | 33 | 19 | 46 | 32 | 31 | 23 | 36 | 24 |
| b | Silt | % | 21 | 23 | 23 | 16 | 25 | 25 | 19 | 15 | 34 |
| c | Clay | % | 51 | 44 | 58 | 38 | 43 | 44 | 58 | 49 | 42 |
| 2 | Textural Class | - | Sandy Clay | Sandy Clay | Clay | Sandy Clay | Sandy Clay | Sandy Clay | Clay | Sandy Clay | Sandy Clay |
| 3 | Bulk Density | g/cc | 1.21 | 1.25 | 1.18 | 1.27 | 1.22 | 1.2 | 1.12 | 1.21 | 1.16 |
| 4 | pH (1:5 Aq. Extraction) | - | 7.82 | 7.64 | 7.93 | 8.23 | 7.51 | 7.64 | 7.55 | 7.86 | 7.46 |
| 5 | Conductivity (1:5 Aq. Extraction) | µS/cm | 76.8 | 85.4 | 123.5 | 59.6 | 94.8 | 114.6 | 108.6 | 86.4 | 88.4 |
| 6 | Exchangeable Calcium as Ca | mg/kg | 4174.0 | 2825.0 | 5864.0 | 2436.0 | 4108.0 | 3625.0 | 6152.0 | 3846.0 | 5846.0 |
| 7 | Exchangeable Magnesium as Mg | mg/kg | 968.6 | 628.5 | 824.6 | 842.6 | 575.6 | 358.6 | 864.2 | 162.8 | 672.4 |
| 8 | Exchangeable Sodium as Na | mg/kg | 175.2 | 233.8 | 152.6 | 108.4 | 152.6 | 173.2 | 212.6 | 165.2 | 375.6 |
| 9 | Sodium Absorption Ratio (SAR) | - | 0.43 | 0.31 | 0.39 | 0.39 | 0.29 | 0.30 | 0.63 | 0.53 | 0.68 |
| 10 | Available Nitrogen as N | Kg/hac | 56.8 | 83.4 | 38.6 | 58.4 | 48.7 | 59.4 | 72.4 | 66.8 | 39.8 |
| 11 | Available Phosphorous as P | Kg/hac | 125.6 | 168.5 | 78.6 | 132.6 | 112.8 | 138.6 | 182.6 | 172.4 | 108.6 |
| 12 | Available Potassium as K | Kg/hac | 286.5 | 312.6 | 212.3 | 179.7 | 246.5 | 228.6 | 346.5 | 248.6 | 255.6 |
| 13 | Organic Carbon | % | 0.32 | 0.41 | 0.46 | 0.42 | 0.29 | 0.52 | 0.55 | 0.43 | 0.59 |
| 14 | Organic Matter | % | 0.55 | 0.71 | 0.79 | 0.72 | 0.50 | 0.90 | 0.95 | 0.74 | 1.02 |
| 15 | Water Soluble Chlorides as Cl | mg/kg | 90 | 163 | 152 | 71 | 82 | 296 | 234 | 183 | 190 |
| 16 | Water Soluble Sulphates as SO4 | mg/kg | 107.9 | 150.2 | 136.5 | 129.8 | 152.8 | 182.5 | 124.6 | 106.4 | 107.9 |
| 17 | Aluminum | % | 2.14 | 2.36 | 2.89 | 1.76 | 2.07 | 2.21 | 3.82 | 2.86 | 1.87 |
| 18 | Total Iron | % | 2.46 | 1.82 | 3.06 | 3.22 | 1.86 | 3.46 | 2.86 | 1.82 | 3.12 |
| 19 | Manganese | mg/kg | 412 | 354 | 287 | 316 | 258 | 346 | 425 | 326 | 458 |
| 20 | Boron | mg/kg | 24.5 | 32.6 | 22.4 | 19.6 | 24.5 | 28.4 | 34.6 | 24.5 | 31.5 |
| 21 | Zinc | mg/kg | 42.6 | 37.5 | 45.5 | 31.4 | 49.6 | 41.6 | 34.2 | 32.5 | 28.6 |
| 22 | Total Chromium as Cr | mg/kg | 5.6 | 6.6 | 4.2 | 3.5 | 4.2 | 5.1 | 6.2 | 3.5 | 4.2 |
| 23 | Lead as Pb | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| 24 | Nickel as Ni | mg/kg | 18.2 | 16.8 | 15.2 | 11.2 | 16.7 | 22.6 | 16.8 | 21.6 | 18.4 |
| 25 | Arsenic as As | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |

| Sr. No. | Parameters | Unit | S1 | S2 | S3 | S4 | S5 | S6 | S7 | S8 | S9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 26 | Mercury as Hg | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| 27 | Cadmium as Cd | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| 28 | Exchangeable Sodium | meq/100g | 0.98 | 1.26 | 0.87 | 0.58 | 0.84 | 0.97 | 1.28 | 0.92 | 2.18 |
| 29 | Exchangeable Potassium | meq/100g | 1.14 | 1.24 | 0.84 | 0.71 | 0.98 | 0.91 | 1.38 | 0.99 | 1.02 |
| 30 | Exchangeable Calcium | meq/100g | 26.73 | 17.52 | 38.51 | 14.87 | 26.10 | 23.41 | 42.57 | 24.63 | 39.06 |
| 31 | Exchangeable Magnesium | meq/100g | 10.34 | 6.49 | 9.03 | 8.57 | 6.09 | 3.86 | 9.97 | 1.74 | 7.49 |
| 32 | Cation Exchange Capacity | meq/100g | 39.19 | 26.51 | 49.26 | 24.72 | 34.01 | 29.15 | 55.19 | 28.28 | 49.74 |

## TABLE-3.7.4 (A)
## SOIL ANALYSIS RESULTS- PRE-MONSOON SEASON

| Sr. No. | Parameters | Unit | S10 | S11 | S12 | S13 | S14 | S15 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Texture | | | | | | | | | |
| a | Sand | % | 28 | 34 | 24 | 28 | 34 | 32 | 19 | 46 |
| b | Silt | % | 21 | 12 | 14 | 30 | 28 | 22 | 12 | 34 |
| c | Clay | % | 51 | 54 | 62 | 42 | 38 | 46 | 38 | 62 |
| 2 | Textural Class | - | Sandy Clay | Sandy Clay | Clay | Sandy Clay | Sandy Clay | Clay | - | - |
| 3 | Bulk Density | g/cc | 1.18 | 1.28 | 1.04 | 1.16 | 1.19 | 1.08 | 1.04 | 1.28 |
| 4 | pH (1:5 Aq. Extraction) | - | 7.62 | 7.93 | 8.06 | 7.16 | 7.32 | 7.46 | 7.16 | 8.23 |
| 5 | Conductivity (1:5 Aq. Extraction) | µS/cm | 196.2 | 124.7 | 85.4 | 158.6 | 132.4 | 102.6 | 59.6 | 196.2 |
| 6 | Exchangeable Calcium as Ca | mg/kg | 4028.0 | 4128.0 | 3260.0 | 3752.0 | 4520.0 | 5960.0 | 2436 | 6152 |
| 7 | Exchangeable Magnesium as Mg | mg/kg | 362.5 | 1042.0 | 642.5 | 956.8 | 486.5 | 846.5 | 162.8 | 1042 |
| 8 | Exchangeable Sodium as Na | mg/kg | 93.8 | 148.2 | 68.9 | 118.6 | 142.7 | 88.7 | 68.9 | 375.6 |
| 9 | Sodium Absorption Ratio (SAR) | - | 0.43 | 0.31 | 0.39 | 0.39 | 0.29 | 0.30 | 0.29 | 0.68 |
| 10 | Available Nitrogen as N | Kg/hac | 61.4 | 42.8 | 52.4 | 42.8 | 51.4 | 79.5 | 38.6 | 83.4 |
| 11 | Available Phosphorous as P | Kg/hac | 175.6 | 156.2 | 143.2 | 165.8 | 168.2 | 195.6 | 78.6 | 195.6 |
| 12 | Available Potassium as K | Kg/hac | 192.4 | 218.6 | 152.8 | 194.6 | 215.6 | 218.6 | 152.8 | 346.5 |
| 13 | Organic Carbon | % | 0.27 | 0.44 | 0.82 | 0.34 | 0.49 | 0.39 | 0.27 | 0.82 |
| 14 | Organic Matter | % | 0.47 | 0.76 | 1.41 | 0.59 | 0.84 | 0.67 | 0.47 | 1.41 |
| 15 | Water Soluble Chlorides as Cl | mg/kg | 166 | 151 | 171 | 213 | 143 | 234 | 71 | 296 |
| 16 | Water Soluble Sulphates as SO4 | mg/kg | 124.6 | 136.5 | 82.6 | 144.6 | 216.5 | 124.6 | 82.6 | 216.5 |
| 17 | Aluminum | % | 1.46 | 1.72 | 2.06 | 2.14 | 1.06 | 2.95 | 1.06 | 3.82 |
| 18 | Total Iron | % | 2.28 | 2.81 | 3.64 | 3.26 | 2.98 | 1.54 | 1.54 | 3.64 |
| 19 | Manganese | mg/kg | 326 | 406 | 326 | 256 | 346 | 401 | 256 | 458 |
| 20 | Boron | mg/kg | 40.4 | 24.5 | 16.8 | 24.6 | 29.5 | 34.7 | 16.8 | 40.4 |
| 21 | Zinc | mg/kg | 37.8 | 42.8 | 52.8 | 51.2 | 41.8 | 55.4 | 28.6 | 55.4 |
| 22 | Total Chromium as Cr | mg/kg | 6.4 | 4.4 | 5.2 | 6.4 | 5.2 | 4.6 | 3.5 | 6.6 |
| 23 | Lead as Pb | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| 24 | Nickel as Ni | mg/kg | 21.6 | 25.6 | 21.4 | 16.7 | 18.6 | 21.4 | 11.2 | 25.6 |
| 25 | Arsenic as As | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| 26 | Mercury as Hg | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |

| Sr. No. | Parameters | Unit | S10 | S11 | S12 | S13 | S14 | S15 | Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|
| 27 | Cadmium as Cd | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| 28 | Exchangeable Sodium | meq/100g | 0.54 | 0.78 | 0.45 | 0.69 | 0.81 | 0.55 | 0.45 | 2.18 |
| 29 | Exchangeable Potassium | meq/100g | 0.76 | 0.87 | 0.61 | 0.77 | 0.86 | 0.87 | 0.61 | 1.38 |
| 30 | Exchangeable Calcium | meq/100g | 26.46 | 24.99 | 24.29 | 25.07 | 29.44 | 42.77 | 14.87 | 42.77 |
| 31 | Exchangeable Magnesium | meq/100g | 3.97 | 10.51 | 7.98 | 10.65 | 5.28 | 10.12 | 1.74 | 10.65 |
| 32 | Cation Exchange Capacity | meq/100g | 31.72 | 37.16 | 33.33 | 37.18 | 36.38 | 54.31 | 24.72 | 55.19 |

## TABLE-3.7.4 (B)
## SOIL ANALYSIS RESULTS-MONSOON SEASON

| Sr. No. | Parameters | Unit | S1 | S2 | S3 | S4 | S5 | S6 | S7 | S8 | S9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **Texture** | | | | | | | | | | |
| a | Sand | % | 24 | 28 | 24 | 42 | 26 | 32 | 24 | 34 | 31 |
| b | Silt | % | 25 | 26 | 22 | 17 | 56 | 22 | 20 | 18 | 26 |
| c | Clay | % | 51 | 46 | 54 | 41 | 44 | 46 | 56 | 48 | 43 |
| 2 | Textural Class | - | Sandy Clay | Sandy Clay | Clay | Sandy Clay | Sandy Clay | Sandy Clay | Clay | Sandy Clay | Sandy Clay |
| 3 | Bulk Density | g/cc | 1.21 | 1.08 | 1.16 | 1.21 | 1.32 | 1.26 | 1.24 | 1.16 | 1.34 |
| 4 | pH (1:5 Aq. Extraction) | - | 7.86 | 7.24 | 7.93 | 7.98 | 8.16 | 8.09 | 8.06 | 7.84 | 7.69 |
| 5 | Conductivity (1:5 Aq. Extraction) | µS/cm | 104.6 | 99.8 | 142.8 | 132.6 | 124.8 | 135.6 | 146.9 | 127.5 | 116.8 |
| 6 | Exchangeable Calcium as Ca | mg/kg | 4215.8 | 2759.8 | 6345.8 | 2457.6 | 4105.2 | 3659.8 | 5786.8 | 4215.6 | 5342.5 |
| 7 | Exchangeable Magnesium as Mg | mg/kg | 856.9 | 736.5 | 812.4 | 924.6 | 708.6 | 522.4 | 908.6 | 246.8 | 634.5 |
| 8 | Exchangeable Sodium as Na | mg/kg | 216.8 | 236.5 | 194.2 | 116.2 | 207.6 | 236.5 | 208.5 | 168.5 | 305.6 |
| 9 | Sodium Absorption Ratio (SAR) | - | 0.80 | 1.03 | 0.61 | 0.51 | 0.79 | 0.97 | 0.67 | 0.68 | 1.05 |
| 10 | Available Nitrogen as N | Kg/hac | 74.6 | 82.4 | 48.6 | 68.8 | 54.5 | 62.4 | 83.6 | 72.4 | 54.6 |
| 11 | Available Phosphorous as P | Kg/hac | 124.3 | 135.6 | 92.6 | 112.4 | 126.5 | 134.2 | 186.5 | 192.4 | 124.8 |
| 12 | Available Potassium as K | Kg/hac | 272.4 | 288.6 | 264.5 | 207.8 | 256.8 | 261.2 | 302.4 | 252.8 | 276.5 |
| 13 | Organic Carbon | % | 0.46 | 0.41 | 0.53 | 0.38 | 0.61 | 0.56 | 0.44 | 0.59 | 0.54 |
| 14 | Organic Matter | % | 0.79 | 0.71 | 0.91 | 0.66 | 1.05 | 0.97 | 0.76 | 1.02 | 0.93 |
| 15 | Water Soluble Chlorides as Cl | mg/kg | 121 | 134 | 182 | 108 | 124 | 234 | 258 | 216 | 192 |
| 16 | Water Soluble Sulphates as SO4 | mg/kg | 126.5 | 172.4 | 152.4 | 146.7 | 174.6 | 156.8 | 146.9 | 132.4 | 144.6 |
| 17 | Aluminum | % | 2.09 | 2.71 | 2.36 | 2.14 | 2.86 | 2.74 | 3.26 | 2.16 | 2.28 |
| 18 | Total Iron | % | 3.16 | 2.19 | 3.08 | 2.79 | 3.26 | 3.98 | 2.67 | 1.88 | 3.48 |
| 19 | Manganese | mg/kg | 396 | 358 | 346 | 352 | 316 | 342 | 516 | 394 | 432 |
| 20 | Boron | mg/kg | 21.2 | 26.4 | 29.8 | 23.8 | 29.6 | 32.4 | 34.8 | 28.4 | 31.2 |
| 21 | Zinc | mg/kg | 42.5 | 43.8 | 39.7 | 32.5 | 46.7 | 41.7 | 44.8 | 52.4 | 38.8 |
| 22 | Total Chromium as Cr | mg/kg | 5.2 | 4.6 | 4.4 | 4.3 | 3.9 | 4.6 | 5.6 | 5.2 | 4.8 |
| 23 | Lead as Pb | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| 24 | Nickel as Ni | mg/kg | 21.2 | 16.8 | 24.6 | 16.4 | 20.8 | 16.9 | 15.8 | 21.2 | 24.8 |
| 25 | Arsenic as As | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |

| Sr. No. | Parameters | Unit | S1 | S2 | S3 | S4 | S5 | S6 | S7 | S8 | S9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 26 | Mercury as Hg | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| 27 | Cadmium as Cd | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| 28 | Exchangeable Sodium | meq/100g | 1.42 | 1.36 | 1.12 | 1.09 | 0.95 | 1.36 | 0.68 | 0.91 | 1.69 |
| 29 | Exchangeable Potassium | meq/100g | 1.03 | 1.36 | 1.09 | 0.66 | 1.39 | 1.47 | 1.02 | 1.33 | 1.26 |
| 30 | Exchangeable Calcium | meq/100g | 27.00 | 19.80 | 42.40 | 15.74 | 24.10 | 22.51 | 36.17 | 28.16 | 30.90 |
| 31 | Exchangeable Magnesium | meq/100g | 9.15 | 8.81 | 9.05 | 9.87 | 6.93 | 5.36 | 9.46 | 2.75 | 6.12 |
| 32 | Cation Exchange Capacity | meq/100g | 38.60 | 31.33 | 53.65 | 27.36 | 33.38 | 30.70 | 47.33 | 33.15 | 39.96 |

## TABLE-3.7.4 (B)
## SOIL ANALYSIS RESULTS-MONSOON SEASON

| Sr No. | Parameters | Unit | S10 | S11 | S12 | S13 | S14 | S15 | Range |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Texture | | | | | | | | |
| a | Sand | % | 29 | 31 | 28 | 26 | 31 | 32 | 24-42 |
| b | Silt | % | 18 | 13 | 14 | 18 | 26 | 20 | 13-56 |
| c | Clay | % | 53 | 56 | 58 | 56 | 43 | 48 | 41-58 |
| 2 | Textural Class | - | Sandy Clay | Sandy Clay | Clay | Sandy Clay | Sandy Clay | Clay | - |
| 3 | Bulk Density | g/cc | 1.31 | 1.27 | 1.34 | 1.34 | 1.26 | 1.18 | 1.08-1.34 |
| 4 | pH (1:5 Aq. Extraction) | - | 8.11 | 7.86 | 8.27 | 7.69 | 7.58 | 7.48 | 7.24-8.27 |
| 5 | Conductivity (1:5 Aq. Extraction) | µS/cm | 205.6 | 164.5 | 121.6 | 142.9 | 132.8 | 126.9 | 99.8-205.6 |
| 6 | Exchangeable calcium as Ca | mg/kg | 4475.9 | 4652.6 | 3542.6 | 3962.5 | 4568.5 | 5748.9 | 2457.6-6345.8 |
| 7 | Exchangeable magnesium as Mg | mg/kg | 412.8 | 1146.8 | 625.6 | 986.5 | 625.3 | 856.9 | 246.8-1146.8 |
| 8 | Exchangeable sodium as Na | mg/kg | 326.5 | 248.6 | 122.4 | 152.6 | 142.6 | 86.6 | 86.6-326.5 |
| 9 | Sodium Absorption Ratio (SAR) | ---- | 1.25 | 0.85 | 0.50 | 0.56 | 0.52 | 0.28 | 0.28-1.25 |
| 10 | Available nitrogen as N | Kg/hac | 72.4 | 52.8 | 62.3 | 64.5 | 58.6 | 72.8 | 48.6-83.6 |
| 11 | Available phosphorous as P | Kg/hac | 182.6 | 132.5 | 124.6 | 152.8 | 164.2 | 196.2 | 92.6-196.2 |
| 12 | Available potassium as K | Kg/hac | 235.6 | 267.8 | 186.5 | 204.8 | 232.6 | 252.8 | 186.5-302.4 |
| 13 | Organic carbon | % | 0.41 | 0.56 | 0.68 | 0.74 | 0.46 | 0.52 | 0.38-0.74 |
| 14 | Organic matter | % | 0.71 | 0.97 | 1.17 | 1.28 | 0.79 | 0.90 | 0.66-1.28 |
| 15 | Water soluble chlorides as Cl | mg/kg | 164 | 156 | 212 | 243 | 182 | 268 | 108-268 |
| 16 | Water soluble sulphates as SO4 | mg/kg | 116.4 | 135.4 | 126.5 | 173.4 | 216.5 | 168.5 | 116.4-216.5 |
| 17 | Aluminum | % | 1.92 | 1.62 | 2.34 | 3.01 | 1.82 | 2.41 | 1.62-3.26 |
| 18 | Total iron | % | 2.89 | 3.18 | 3.56 | 3.81 | 2.69 | 2.48 | 1.88-3.98 |
| 19 | Manganese | mg/kg | 386 | 398 | 346 | 289 | 374 | 391 | 289-516 |
| 20 | Boron | mg/kg | 36.5 | 31.2 | 26.4 | 27.8 | 34.6 | 36.5 | 21.2-36.5 |
| 21 | Zinc | mg/kg | 49.5 | 51.2 | 53.4 | 50.8 | 56.9 | 51.8 | 32.5-56.9 |
| 22 | Total chromium as Cr | mg/kg | 5.2 | 4.8 | 5.2 | 5.8 | 5.9 | 4.6 | 3.9-5.9 |

| Sr No. | Parameters | Unit | S10 | S11 | S12 | S13 | S14 | S15 | Range |
|---|---|---|---|---|---|---|---|---|---|
| 23 | Lead as Pb | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| 24 | Nickel as Ni | mg/kg | 23.2 | 19.4 | 21.4 | 19.7 | 21.8 | 20.8 | 15.8-24.8 |
| 25 | Arsenic as As | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| 26 | Mercury as Hg | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| 27 | Cadmium as Cd | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| 28 | Exchangeable sodium | meq/100g | 0.51 | 0.76 | 0.66 | 0.96 | 0.61 | 0.49 | 0.49-1.69 |
| 29 | Exchangeable potassium | meq/100g | 0.72 | 0.94 | 0.78 | 0.81 | 1.10 | 0.83 | 0.66-1.47 |
| 30 | Exchangeable calcium | meq/100g | 26.48 | 28.39 | 20.49 | 22.92 | 28.10 | 37.76 | 15.74-42.4 |
| 31 | Exchangeable magnesium | meq/100g | 4.07 | 11.66 | 6.03 | 9.51 | 6.41 | 9.38 | 2.75-11.66 |
| 32 | Cation Exchange Capacity | meq/100g | 31.78 | 41.76 | 27.96 | 34.20 | 36.22 | 48.46 | 27.36-53.65 |

## TABLE-3.7.4 (C)
## SOIL ANALYSIS RESULTS-POST MONSOON SEASON

| Sr. No. | Parameters | Unit | S1 | S2 | S3 | S4 | S5 | S6 | S7 | S8 | S9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **Texture** | | | | | | | | | | |
| a | Sand | % | 27 | 31 | 21 | 42 | 34 | 32 | 21 | 28 | 26 |
| b | Silt | % | 25 | 23 | 19 | 22 | 20 | 22 | 20 | 25 | 28 |
| c | Clay | % | 48 | 46 | 60 | 36 | 46 | 46 | 59 | 47 | 46 |
| 2 | Textural Class | - | Sandy Clay | Sandy Clay | Clay | Sandy Clay | Sandy Clay | Sandy Clay | Clay | Sandy Clay | Sandy Clay |
| 3 | Bulk Density | g/cc | 1.18 | 1.22 | 1.21 | 1.24 | 1.24 | 1.24 | 1.16 | 1.24 | 1.19 |
| 4 | pH (1:5 Aq. Extraction) | - | 7.94 | 7.76 | 8.04 | 8.19 | 7.94 | 7.72 | 7.64 | 7.91 | 7.84 |
| 5 | Conductivity (1:5 Aq. Extraction) | µS/cm | 125.6 | 108.9 | 142.7 | 152.4 | 108.9 | 132.6 | 161.8 | 146.8 | 118.4 |
| 6 | Exchangeable Calcium as Ca | mg/kg | 3956.8 | 3086.4 | 5572.8 | 2864.9 | 4326.5 | 3856.9 | 6645.8 | 4156.2 | 6122.4 |
| 7 | Exchangeable Magnesium as Mg | mg/kg | 1020.5 | 762.4 | 1124.8 | 758.6 | 865.9 | 475.6 | 1124.8 | 452.6 | 846.5 |
| 8 | Exchangeable Sodium as Na | mg/kg | 216.5 | 248.5 | 132.5 | 159.8 | 164.5 | 182.6 | 238.5 | 182.6 | 412.6 |
| 9 | Sodium Absorption Ratio (SAR) | - | 0.43 | 0.31 | 0.39 | 0.39 | 0.29 | 0.30 | 0.63 | 0.53 | 0.68 |
| 10 | Available Nitrogen as N | Kg/hac | 54.4 | 81.6 | 41.6 | 61.4 | 52.8 | 61.3 | 73.4 | 65.4 | 43.8 |
| 11 | Available Phosphorous as P | Kg/hac | 121.8 | 172.4 | 82.4 | 139.5 | 122.4 | 146.9 | 194.2 | 188.4 | 116.4 |
| 12 | Available Potassium as K | Kg/hac | 291.6 | 326.5 | 234.5 | 186.4 | 266.9 | 237.8 | 384.6 | 296.5 | 264.5 |
| 13 | Organic Carbon | % | 0.38 | 0.42 | 0.51 | 0.46 | 0.34 | 0.56 | 0.58 | 0.49 | 0.62 |
| 14 | Organic Matter | % | 0.66 | 0.72 | 0.88 | 0.79 | 0.59 | 0.97 | 1.00 | 0.84 | 1.07 |
| 15 | Water Soluble Chlorides as Cl | mg/kg | 113 | 143 | 169 | 151 | 112 | 265 | 245 | 192 | 212 |
| 16 | Water Soluble Sulphates as SO4 | mg/kg | 132.6 | 146.5 | 152.8 | 115.6 | 138.6 | 174.6 | 138.5 | 124.5 | 128.9 |
| 17 | Aluminum | % | 2.84 | 2.54 | 2.56 | 2.04 | 1.86 | 2.34 | 3.64 | 2.92 | 1.67 |
| 18 | Total Iron | % | 2.34 | 1.61 | 2.84 | 3.16 | 2.08 | 3.28 | 2.92 | 2.08 | 2.96 |
| 19 | Manganese | mg/kg | 386 | 364 | 296 | 302 | 265 | 324 | 396 | 306 | 426 |

| Sr. No. | Parameters | Unit | S1 | S2 | S3 | S4 | S5 | S6 | S7 | S8 | S9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 20 | Boron | mg/kg | 21.6 | 33.4 | 28.6 | 21.8 | 26.4 | 27.8 | 31.4 | 26.8 | 29.6 |
| 21 | Zinc | mg/kg | 39.8 | 36.4 | 43.8 | 33.5 | 46.7 | 38.6 | 36.9 | 28.4 | 29.8 |
| 22 | Total Chromium as Cr | mg/kg | 6.1 | 6.4 | 5.6 | 4.2 | 3.8 | 5.2 | 5.90 | 4.6 | 4.4 |
| 23 | Lead as Pb | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| 24 | Nickel as Ni | mg/kg | 21.2 | 18.5 | 16.4 | 13.4 | 17.4 | 21.5 | 18.2 | 19.8 | 22.8 |
| 25 | Arsenic as As | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| 26 | Mercury as Hg | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| 27 | Cadmium as Cd | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| 28 | Exchangeable Sodium | meq/100g | 1.24 | 1.37 | 0.74 | 0.87 | 0.89 | 0.99 | 1.39 | 0.99 | 2.34 |
| 29 | Exchangeable Potassium | meq/100g | 1.16 | 1.30 | 0.93 | 0.74 | 1.06 | 0.95 | 1.53 | 1.18 | 1.05 |
| 30 | Exchangeable Calcium | meq/100g | 25.99 | 19.61 | 35.69 | 17.91 | 27.04 | 24.11 | 44.40 | 25.98 | 39.87 |
| 31 | Exchangeable Magnesium | meq/100g | 11.17 | 8.07 | 12.01 | 7.90 | 9.02 | 4.95 | 12.52 | 4.71 | 9.19 |
| 32 | Cation Exchange Capacity | meq/100g | 39.55 | 30.35 | 49.37 | 27.42 | 38.02 | 31.00 | 59.84 | 32.86 | 52.45 |

## TABLE-3.7.4 (C)
## SOIL ANALYSIS RESULTS-POST MONSOON SEASON

| Sr No. | Parameters | Unit | S10 | S11 | S12 | S13 | S14 | S15 | Range |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Texture | | | | | | | | |
| A | Sand | % | 32 | 30 | 23 | 26 | 31 | 29 | 21-42 |
| B | Silt | % | 15 | 19 | 21 | 28 | 23 | 23 | 15-28 |
| C | Clay | % | 53 | 51 | 56 | 46 | 46 | 48 | 36-60 |
| 2 | Textural Class | - | Sandy Clay | Sandy Clay | Clay | Sandy Clay | Sandy Clay | Clay | - |
| 3 | Bulk Density | g/cc | 1.22 | 1.26 | 1.11 | 1.09 | 1.25 | 1.11 | 1.09-1.26 |
| 4 | pH (1:5 Aq. Extraction) | - | 7.77 | 7.86 | 7.94 | 8.04 | 7.63 | 7.52 | 7.52-8.19 |
| 5 | Conductivity (1:5 Aq. Extraction) | µS/cm | 208.6 | 142.8 | 104.8 | 164.8 | 132.4 | 121.5 | 104.8-208.6 |
| 6 | Exchangeable calcium as Ca | mg/kg | 4325.6 | 4462.5 | 3486.9 | 3826.5 | 4211.5 | 5681.5 | 2864.9-6645.8 |
| 7 | Exchangeable magnesium as Mg | mg/kg | 642.8 | 1148.9 | 756.6 | 1042.8 | 674.8 | 1124.6 | 452.6-1148.9 |
| 8 | Exchangeable sodium as Na | mg/kg | 156.2 | 86.5 | 172.4 | 124.4 | 186.9 | 172.4 | 86.5-412.6 |
| 9 | Sodium Absorption Ratio (SAR) | ---- | 0.43 | 0.31 | 0.39 | 0.39 | 0.29 | 0.30 | 0.29-0.68 |
| 10 | Available nitrogen as N | Kg/hac | 59.6 | 44.5 | 53.8 | 46.8 | 53.7 | 81.4 | 41.6-81.6 |
| 11 | Available phosphorous as P | Kg/hac | 186.2 | 142.8 | 164.8 | 182.9 | 176.4 | 205.5 | 82.4-205.5 |
| 12 | Available potassium as K | Kg/hac | 198.6 | 226.8 | 217.4 | 204.8 | 216.8 | 304.5 | 186.4-384.6 |
| 13 | Organic carbon | % | 0.34 | 0.49 | 0.76 | 0.44 | 0.52 | 0.44 | 0.34-0.76 |
| 14 | Organic matter | % | 0.59 | 0.84 | 1.31 | 0.76 | 0.90 | 0.76 | 0.59-1.31 |
| 15 | Water soluble chlorides as Cl | mg/kg | 178 | 169 | 186 | 228 | 152 | 286 | 112-286 |
| 16 | Water soluble sulphates as SO4 | mg/kg | 108.9 | 124.6 | 92.6 | 152.4 | 186.9 | 152.6 | 92.6-186.9 |
| 17 | Aluminum | % | 1.88 | 1.94 | 2.11 | 2.32 | 1.15 | 2.85 | 1.15-3.64 |
| 18 | Total iron | % | 2.34 | 2.77 | 3.46 | 3.02 | 2.86 | 1.65 | 1.61-3.36 |
| 19 | Manganese | mg/kg | 342 | 422 | 335 | 296 | 324 | 386 | 265-426 |
| 20 | Boron | mg/kg | 38.9 | 26.8 | 17.9 | 25.9 | 30.8 | 35.6 | 17.9-38.9 |
| 21 | Zinc | mg/kg | 34.9 | 39.6 | 48.9 | 52.4 | 39.8 | 50.9 | 28.4-52.4 |
| 22 | Total chromium as Cr | mg/kg | 5.9 | 4.8 | 5.6 | 6.8 | 5.5 | 4.2 | 3.8-6.8 |
| 23 | Lead as Pb | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| 24 | Nickel as Ni | mg/kg | 19.4 | 28.6 | 22.8 | 17.8 | 21.2 | 22.8 | 13.4-28.6 |
| 25 | Arsenic as As | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |

| Sr No. | Parameters | Unit | S10 | S11 | S12 | S13 | S14 | S15 | Range |
|---|---|---|---|---|---|---|---|---|---|
| 26 | Mercury as Hg | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| 27 | Cadmium as Cd | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| 28 | Exchangeable sodium | meq/100g | 0.86 | 0.46 | 1.05 | 0.77 | 1.01 | 1.05 | 0.46-2.34 |
| 29 | Exchangeable potassium | meq/100g | 0.79 | 0.90 | 0.86 | 0.81 | 0.86 | 1.21 | 0.74-1.53 |
| 30 | Exchangeable calcium | meq/100g | 27.48 | 27.45 | 24.35 | 27.21 | 26.11 | 39.67 | 17.91-44.4 |
| 31 | Exchangeable magnesium | meq/100g | 6.81 | 11.78 | 8.80 | 12.36 | 6.97 | 13.09 | 4.71-13.09 |
| 32 | Cation Exchange Capacity | meq/100g | 35.94 | 40.59 | 35.06 | 41.15 | 34.95 | 55.01 | 27.42-59.84 |

## TABLE-3.7.4 (D)
## SOIL ANALYSIS RESULTS-WINTER SEASON

| Sr. No. | Parameters | Unit | S1 | S2 | S3 | S4 | S5 | S6 | S7 | S8 | S9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **Texture** | | | | | | | | | | |
| a | Sand | % | 29 | 30 | 24 | 36 | 32 | 30 | 24 | 26 | 24 |
| b | Silt | % | 24 | 22 | 14 | 26 | 24 | 22 | 14 | 23 | 28 |
| c | Clay | % | 47 | 48 | 62 | 38 | 44 | 48 | 62 | 51 | 48 |
| 2 | Textural Class | - | Sandy Clay | Sandy Clay | Clay | Sandy Clay | Sandy Clay | Sandy Clay | Clay | Sandy Clay | Sandy Clay |
| 3 | Bulk Density | g/cc | 1.21 | 1.19 | 1.24 | 1.22 | 1.21 | 1.23 | 1.18 | 1.19 | 1.21 |
| 4 | pH (1:5 Aq. Extraction) | - | 7.13 | 7.24 | 7.82 | 7.22 | 7.36 | 7.42 | 7.48 | 7.72 | 7.64 |
| 5 | Conductivity (1:5 Aq. Extraction) | µS/cm | 132.6 | 112.8 | 162.5 | 155.8 | 132.4 | 152.8 | 132.4 | 154.8 | 128.4 |
| 6 | Exchangeable Calcium as Ca | mg/kg | 3652.8 | 3254.9 | 5344.8 | 2956.5 | 4432.5 | 3946.8 | 6485.8 | 4258.7 | 6342.8 |
| 7 | Exchangeable Magnesium as Mg | mg/kg | 1124.5 | 826.4 | 1245.8 | 768.4 | 835.6 | 524.6 | 1285.6 | 526.5 | 786.5 |
| 8 | Exchangeable Sodium as Na | mg/kg | 232.8 | 256.8 | 142.6 | 164.8 | 152.9 | 194.7 | 242.8 | 194.6 | 428.6 |
| 9 | Sodium Absorption Ratio (SAR) | - | 0.86 | 1.04 | 0.46 | 0.70 | 0.55 | 0.77 | 0.72 | 0.75 | 1.35 |
| 10 | Available Nitrogen as N | Kg/hac | 61.2 | 86.4 | 44.9 | 58.4 | 53.8 | 59.6 | 71.2 | 64.2 | 41.6 |
| 11 | Available Phosphorous as P | Kg/hac | 128.6 | 143.8 | 94.6 | 144.6 | 132.4 | 154.6 | 201.5 | 192.4 | 124.6 |
| 12 | Available Potassium as K | Kg/hac | 268.5 | 312.8 | 246.5 | 208.6 | 274.8 | 246.8 | 376.8 | 302.6 | 261.8 |
| 13 | Organic Carbon | % | 0.42 | 0.46 | 0.52 | 0.48 | 0.43 | 0.55 | 0.62 | 0.53 | 0.56 |
| 14 | Organic Matter | % | 0.72 | 0.79 | 0.90 | 0.83 | 0.74 | 0.95 | 1.07 | 0.91 | 0.97 |
| 15 | Water Soluble Chlorides as Cl | mg/kg | 102 | 152 | 148 | 156 | 124 | 236 | 252 | 208 | 242 |
| 16 | Water Soluble Sulphates as SO4 | mg/kg | 141.8 | 152.8 | 136.8 | 124.8 | 152.6 | 128.6 | 142.9 | 132.6 | 152.6 |
| 17 | Aluminum | % | 3.02 | 2.86 | 2.48 | 2.11 | 2.06 | 2.46 | 3.38 | 3.04 | 1.82 |
| 18 | Total Iron | % | 2.33 | 1.82 | 2.64 | 3.08 | 2.24 | 2.82 | 3.02 | 2.36 | 3.02 |
| 19 | Manganese | mg/kg | 352 | 372 | 312 | 286 | 284 | 252 | 342 | 315 | 432 |
| 20 | Boron | mg/kg | 23.5 | 29.5 | 31.2 | 22.6 | 27.8 | 26.4 | 34.6 | 28.9 | 31.2 |
| 21 | Zinc | mg/kg | 40.2 | 38.5 | 41.2 | 38.6 | 43.5 | 34.8 | 32.6 | 31.2 | 32.4 |
| 22 | Total Chromium as Cr | mg/kg | 5.8 | 6.1 | 5.9 | 5.3 | 4.2 | 4.6 | 4.9 | 4.3 | 4.1 |
| 23 | Lead as Pb | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |

| Sr. No. | Parameters | Unit | S1 | S2 | S3 | S4 | S5 | S6 | S7 | S8 | S9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 24 | Nickel as Ni | mg/kg | 19.4 | 22.6 | 19.8 | 16.8 | 21.2 | 23.8 | 19.8 | 16.4 | 26.8 |
| 25 | Arsenic as As | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| 26 | Mercury as Hg | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| 27 | Cadmium as Cd | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| 28 | Exchangeable Sodium | meq/100g | 1.30 | 1.45 | 0.78 | 0.91 | 0.85 | 1.07 | 1.39 | 1.10 | 2.39 |
| 29 | Exchangeable Potassium | meq/100g | 1.07 | 1.24 | 0.98 | 0.83 | 1.09 | 0.98 | 1.50 | 1.20 | 1.04 |
| 30 | Exchangeable Calcium | meq/100g | 23.40 | 21.20 | 33.41 | 18.78 | 28.39 | 24.87 | 42.60 | 27.74 | 40.63 |
| 31 | Exchangeable Magnesium | meq/100g | 12.00 | 8.97 | 12.98 | 8.14 | 8.92 | 5.51 | 14.07 | 5.71 | 8.40 |
| 32 | Cation Exchange Capacity | meq/100g | 37.76 | 32.87 | 48.14 | 28.66 | 39.25 | 32.42 | 59.55 | 35.75 | 52.45 |

## TABLE--3.7.4 (D)
## SOIL ANALYSIS RESULTS- WINTER SEASON

| Sr No. | Parameters | Unit | S10 | S11 | S12 | S13 | S14 | S15 | Range |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Texture | | | | | | | | |
| a | Sand | % | 33 | 28 | 27 | 25 | 28 | 31 | 24-36 |
| b | Silt | % | 11 | 17 | 16 | 27 | 24 | 18 | 11-28 |
| c | Clay | % | 56 | 55 | 57 | 48 | 48 | 51 | 38-62 |
| 2 | Textural Class | - | Sandy Clay | Sandy Clay | Clay | Sandy Clay | Sandy Clay | Clay | - |
| 3 | Bulk Density | g/cc | 1.23 | 1.24 | 1.16 | 1.11 | 1.21 | 1.13 | 1.11-1.24 |
| 4 | pH (1:5 Aq. Extraction) | - | 7.52 | 7.38 | 7.62 | 7.86 | 7.46 | 7.36 | 7.13-7.86 |
| 5 | Conductivity (1:5 Aq. Extraction) | µS/cm | 212.6 | 152.6 | 132.8 | 128.6 | 152.6 | 134.8 | 112.8-212.6 |
| 6 | Exchangeable calcium as Ca | mg/kg | 4862.5 | 4682.5 | 3846.9 | 3947.8 | 4326.5 | 5476.8 | 2956.5-6485.8 |
| 7 | Exchangeable magnesium as Mg | mg/kg | 624.8 | 1248.6 | 726.8 | 1128.6 | 638.5 | 1028.6 | 524.6-1285.6 |
| 8 | Exchangeable sodium as Na | mg/kg | 164.2 | 102.5 | 164.2 | 144.8 | 192.6 | 164.8 | 102.5-428.6 |
| 9 | Sodium Absorption Ratio (SAR) | ---- | 0.59 | 0.34 | 0.64 | 0.52 | 0.72 | 0.54 | 0.34-1.34 |
| 10 | Available nitrogen as N | Kg/hac | 62.8 | 48.6 | 51.6 | 47.9 | 54.9 | 76.8 | 41.6-86.4 |
| 11 | Available phosphorous as P | Kg/hac | 194.6 | 161.4 | 152.8 | 199.4 | 164.2 | 216.5 | 94.6-216.5 |
| 12 | Available potassium as K | Kg/hac | 211.2 | 231.8 | 241.6 | 228.6 | 235.6 | 296.5 | 208.6-376.8 |
| 13 | Organic carbon | % | 0.38 | 0.52 | 0.72 | 0.48 | 0.54 | 0.46 | 0.38-0.72 |
| 14 | Organic matter | % | 0.66 | 0.90 | 1.24 | 0.83 | 0.93 | 0.79 | 0.66-12.4 |
| 15 | Water soluble chlorides as Cl | mg/kg | 186 | 174 | 194 | 238 | 164 | 294 | 102-294 |
| 16 | Water soluble sulphates as SO4 | mg/kg | 112.5 | 142.6 | 124.6 | 164.2 | 192.6 | 146.8 | 112.5-192.6 |
| 17 | Aluminum | % | 1.76 | 1.82 | 2.34 | 2.46 | 1.34 | 2.69 | 1.34-3.38 |
| 18 | Total iron | % | 2.62 | 2.84 | 3.64 | 3.07 | 2.94 | 1.82 | 1.82-3.64 |
| 19 | Manganese | mg/kg | 354 | 408 | 342 | 285 | 316 | 374 | 252-432 |
| 20 | Boron | mg/kg | 36.2 | 27.8 | 19.2 | 26.8 | 27.8 | 36.8 | 19.2-36.8 |
| 21 | Zinc | mg/kg | 33.4 | 41.2 | 52.5 | 46.8 | 38.6 | 52.4 | 31.2-52.5 |
| 22 | Total chromium as Cr | mg/kg | 6.1 | 5.2 | 5.1 | 4.9 | 5.8 | 4.3 | 4.1-6.1 |
| 23 | Lead as Pb | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| 24 | Nickel as Ni | mg/kg | 22.8 | 26.4 | 28.6 | 19.6 | 22.8 | 25.6 | 16.4-28.6 |
| 25 | Arsenic as As | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| 26 | Mercury as Hg | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| 27 | Cadmium as Cd | mg/kg | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |

| Sr No. | Parameters | Unit | S10 | S11 | S12 | S13 | S14 | S15 | Range |
|---|---|---|---|---|---|---|---|---|---|
| 28 | Exchangeable sodium | meq/100g | 0.90 | 0.56 | 0.95 | 0.88 | 1.07 | 0.98 | 0.56-2.39 |
| 29 | Exchangeable potassium | meq/100g | 0.84 | 0.92 | 0.96 | 0.91 | 0.94 | 1.18 | 0.83-1.5 |
| 30 | Exchangeable calcium | meq/100g | 30.64 | 29.27 | 25.70 | 27.56 | 27.71 | 37.56 | 18.78-42.6 |
| 31 | Exchangeable magnesium | meq/100g | 6.56 | 13.01 | 8.09 | 13.13 | 6.82 | 11.76 | 5.51-14.07 |
| 32 | Cation Exchange Capacity | meq/100g | 38.94 | 43.75 | 35.71 | 42.48 | 36.54 | 51.48 | 28.66-59.55 |

## 3.8 Noise Level Survey

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

The impact of noise sources on surrounding community depends on:

- Characteristics of noise sources (instantaneous, intermittent or continuous in nature). It can be observed that steady noise is not as annoying as one which is continuously varying in loudness;
- The time of day at which noise occurs, for example high noise levels at night in residential areas are not acceptable because of sleep disturbance; and
- The location of the noise source, with respect to noise sensitive land use, which determines the loudness and period of exposure.

The environmental impact of noise can have several effects varying from Noise Induced Hearing Loss (NIHL) to annoyance depending on loudness of noise. The environmental impact assessment of noise from the existing plant operations and vehicular traffic can be undertaken by taking into consideration various factors like potential damage to hearing, physiological responses, and annoyance and general community responses.

The main objective of noise monitoring in the study area is to establish the baseline noise levels, and assess the impact of the total noise expected to be generated by the operation of the plant facilities around it.

### 3.8.1 Identification of Sampling Locations

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

The noise monitoring survey was conducted for determination of ambient noise levels at fifteen locations in the study area during pre-monsoon season, monsoon season, post-monsoon season and winter season (20$^{th}$ March, 2019 to 19$^{th}$ March 2020). The noise levels at each location were recorded for 24 hours. The details of noise monitoring locations is given in **Table-3.8.1** and shown in **Figure-3.8.1**.

### 3.8.2 Method of Monitoring

Sound Pressure Level (SPL) measurements were measured at all locations. The readings were taken for every hour for 24 hours. The day noise levels have been monitored during 6 am to 10 pm and night levels during 10 pm to 6 am at all the locations covered in 10 km radius of the study area.

**TABLE-3.8.1**
**DETAILS OF NOISE MONITORING LOCATIONS**

| Location Code | Noise Sampling Location | Distance (km) | Direction | Zone |
|---|---|---|---|---|
| N1 | Existing plant site | - | - | Industrial |
| N2 | Project site | - | - | Industrial |
| N3 | Guri | 1.4 | NNE | Residential |
| N4 | Karra | 0.5 | E | Sensitive |
| N5 | Janji | 0.7 | W | Sensitive |
| N6 | Sipat | 1.3 | NW | Residential |
| N7 | Nargara | 3.2 | N | Residential |
| N8 | Bhadrapara | 3.3 | NE | Residential |
| N9 | Sonthi | 8.6 | NE | Residential |
| N10 | Darrabhata | 1.7 | E | Residential |
| N11 | Pachri | 9.2 | SE | Residential |
| N12 | Raliya | 5.7 | S | Residential |
| N13 | Sukhripali | 4.5 | S | Residential |
| N14 | Matiyari | 1.8 | W | Residential |
| N15 | Kaudia | 0.5 | S | Residential |

## 3.8.3 Methodology of Data Generation

### *3.8.3.1 Instrument Used for Monitoring*

Noise levels were measured using integrated sound level meter manufactured by Quest Technologies, USA (Model No.2900). The integrating sound level meter is an integrating/logging type with Octave filter attachment (model OB-100) with frequency range of 31.5 to 16000 Hz. This instrument is capable of measuring the Sound Pressure Level (SPL), $L_{eq}$ and octave band frequency analysis.

### *3.8.3.2 Method of Monitoring*

Noise level monitoring was carried out continuously for 24 hours with one hour interval starting at 06:00 hrs to 06:00 hrs next day. During each hour, $L_{eq}$ were directly computed by the instrument based on the sound pressure levels. Lday ($L_d$), Lnight ($L_n$) and Ldn values were computed using corresponding hourly $L_{eq}$ of day and night respectively. Monitoring was carried out at 'A' response and fast mode.

### *3.8.3.3 Parameters Measured During Monitoring*

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

- $L_{10}$ is the noise level exceeded 10 percent of the time;
- $L_{50}$ is the noise level exceeded 50 percent of the time; and
- $L_{90}$ is the noise level exceeded 90 percent of the time.

**Equivalent Sound Pressure Level ($L_{eq}$):**

The Leq is the equivalent continuous sound level, which is equivalent to the same sound energy as the actual fluctuating sound measured in the same period. This is necessary because sound from noise source often fluctuates widely during a given period of time. This is calculated from the following equation:

$$L_{eq} = L_{50} + \frac{(L_{10} - L_{90})^2}{60}$$

$L_{day}$ is defined as the equivalent noise level measured over a period of time during day (6 am to 10 pm).

$L_{night}$ is defined as the equivalent noise level measured over a period of time during night (10 pm to 6 am).

**Day-Night Sound Level ($L_{dn}$):**

The noise rating developed for community noise from all sources is the Day-Night Sound Level ($L_{dn}$). It is similar to a 24 hr equivalent sound level except that during night time period (10 pm to 6 am) a 10 dB (A) weighting penalty is added to the instantaneous sound level before computing the 24 hr average.

This night time penalty is added to account for the fact that the noise during night, when people are usually in sleep, is judged as more annoying than the same noise during the day time.

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

$$L_{dn} = 10\log\{1/24[16(10^{L_d/10}) + 8(10^{(L_n+10)/10})]\}$$

Where $L_d$ is the equivalent sound level during the day time (6 am to 10 pm) and $L_n$ is the equivalent sound level during the night time (10 pm to 6 am).

3.8.4 Presentation of Results

The statistical analysis is done for measured noise levels at fifteen locations. The parameters are analyzed for $L_{10}$, $L_{50}$, $L_{90}$, $L_{eq}$, $L_{day}$, $L_{night}$, and $L_{dn}$. The statistical analysis results are given in **Table-3.8.2.**

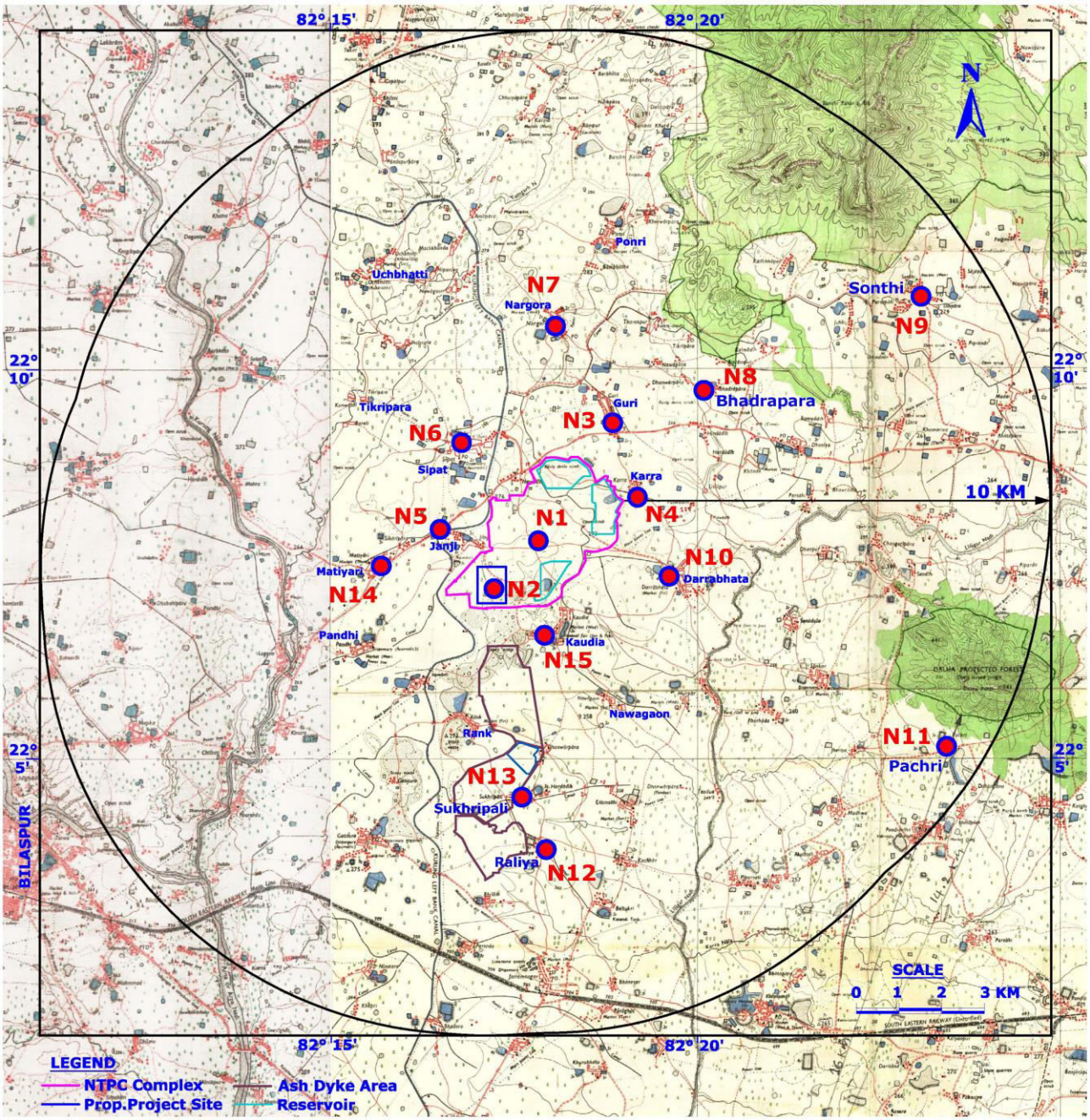



**FIGURE-3.8.1**
**NOISE MONITORING LOCATIONS**

## TABLE-3.8.2 (A)
## NOISE LEVELS [dB (A)] IN THE STUDY AREA –PRE-MONSOON SEASON

| Station Code | Location | Zone | Limit in dB(A) Leq | | L10 | L50 | L90 | Leq | Lday | Lnight | Ldn |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Day | Night | | | | | | | |
| N1 | Existing plant site | Industrial | 75 | 70 | 54.0 | 50.3 | 46.7 | 51.2 | 51.8 | 48.6 | 55.6 |
| N2 | Proposed project site | Industrial | 75 | 70 | 52.2 | 48.3 | 44.5 | 49.3 | 50.2 | 46.6 | 53.7 |
| N3 | Guri | Residential | 55 | 45 | 44.2 | 40.4 | 36.9 | 41.3 | 41.9 | 38.9 | 45.9 |
| N4 | Karra | Sensitive | 50 | 40 | 44.2 | 40.6 | 36.9 | 41.5 | 42.0 | 39.0 | 46.0 |
| N5 | Janji | Sensitive | 50 | 40 | 46.2 | 42.3 | 38.5 | 43.3 | 44.3 | 40.4 | 47.6 |
| N6 | Sipat | Residential | 55 | 45 | 52.2 | 48.5 | 44.9 | 49.4 | 49.9 | 47.0 | 54.0 |
| N7 | Nargara | Residential | 55 | 45 | 46.8 | 43.2 | 39.5 | 44.1 | 44.6 | 41.5 | 48.5 |
| N8 | Bhadrapara | Residential | 55 | 45 | 45.2 | 41.4 | 37.9 | 42.3 | 43.2 | 40.0 | 47.0 |
| N9 | Sonthi | Residential | 55 | 45 | 46.2 | 42.5 | 38.9 | 43.4 | 44.0 | 40.8 | 47.8 |
| N10 | Darrabhata | Residential | 55 | 45 | 48.2 | 44.3 | 40.5 | 45.3 | 46.2 | 42.6 | 49.7 |
| N11 | Pachri | Residential | 55 | 45 | 40.2 | 36.4 | 32.9 | 37.3 | 37.9 | 34.9 | 41.9 |
| N12 | Raliya | Residential | 55 | 45 | 50.2 | 46.6 | 42.9 | 47.5 | 48.0 | 45.0 | 52.0 |
| N13 | Sukhripali | Residential | 55 | 45 | 51.2 | 47.5 | 43.9 | 48.4 | 49.0 | 45.8 | 52.8 |
| N14 | Matiyari | Residential | 55 | 45 | 45.2 | 41.3 | 37.5 | 42.3 | 43.2 | 39.6 | 46.7 |
| N15 | Kaudia | Residential | 55 | 45 | 53.2 | 49.4 | 45.9 | 50.3 | 50.9 | 47.9 | 54.9 |

## TABLE-3.8.2 (B)
## NOISE LEVELS [dB (A)] IN THE STUDY AREA-MONSOON SEASON

| Station Code | Location | Zone | Limit in dB(A) Leq | | L10 | L50 | L90 | Leq | Lday | Lnight | Ldn |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Day | Night | | | | | | | |
| N1 | Existing plant site | Industrial | 75 | 70 | 52.0 | 48.3 | 44.7 | 49.2 | 49.8 | 46.6 | 53.6 |
| N2 | Proposed project site | Industrial | 75 | 70 | 50.2 | 46.3 | 42.5 | 47.3 | 48.2 | 44.6 | 51.7 |
| N3 | Guri | Residential | 55 | 45 | 43.2 | 39.4 | 35.9 | 40.3 | 40.9 | 37.9 | 44.9 |
| N4 | Karra | Sensitive | 50 | 40 | 45.2 | 41.6 | 37.9 | 42.5 | 43.0 | 40.0 | 47.0 |
| N5 | Janji | Sensitive | 50 | 40 | 42.2 | 38.3 | 34.5 | 39.3 | 40.3 | 36.4 | 43.6 |
| N6 | Sipat | Residential | 55 | 45 | 50.2 | 46.5 | 42.9 | 47.4 | 47.9 | 45.0 | 52.0 |
| N7 | Nargara | Residential | 55 | 45 | 44.8 | 41.2 | 37.5 | 42.1 | 42.6 | 39.5 | 46.5 |
| N8 | Bhadrapara | Residential | 55 | 45 | 44.2 | 40.4 | 36.9 | 41.3 | 42.2 | 39.0 | 46.0 |
| N9 | Sonthi | Residential | 55 | 45 | 45.2 | 41.5 | 37.9 | 42.4 | 43.0 | 39.8 | 46.8 |
| N10 | Darrabhata | Residential | 55 | 45 | 47.2 | 43.3 | 39.5 | 44.3 | 45.2 | 41.6 | 48.7 |
| N11 | Pachri | Residential | 55 | 45 | 43.2 | 39.4 | 35.9 | 40.3 | 40.9 | 37.9 | 44.9 |
| N12 | Raliya | Residential | 55 | 45 | 51.2 | 47.6 | 43.9 | 48.5 | 49.0 | 46.0 | 53.0 |
| N13 | Sukhripali | Residential | 55 | 45 | 52.2 | 48.5 | 44.9 | 49.4 | 50.0 | 46.8 | 53.8 |
| N14 | Matiyari | Residential | 55 | 45 | 46.2 | 42.3 | 38.5 | 43.3 | 44.2 | 40.6 | 47.7 |
| N15 | Kaudia | Residential | 55 | 45 | 52.2 | 48.4 | 44.9 | 49.3 | 49.9 | 46.9 | 53.9 |

## TABLE-3.8.2 (C)
## NOISE LEVELS [dB (A)] IN THE STUDY AREA-POST-MONSOON SEASON

| Station Code | Location | Zone | Limit in dB(A) Leq | | L10 | L50 | L90 | Leq | Lday | Lnight | Ldn |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Day | Night | | | | | | | |
| N1 | Existing plant site | Industrial | 75 | 70 | 51.0 | 47.3 | 43.7 | 48.2 | 48.8 | 45.6 | 52.6 |
| N2 | Proposed project site | Industrial | 75 | 70 | 49.2 | 45.3 | 41.5 | 46.3 | 47.2 | 43.6 | 50.7 |
| N3 | Guri | Residential | 55 | 45 | 44.2 | 40.4 | 36.9 | 41.3 | 41.9 | 38.9 | 45.9 |
| N4 | Karra | Sensitive | 50 | 40 | 46.2 | 42.6 | 38.9 | 43.5 | 44.0 | 41.0 | 48.0 |
| N5 | Janji | Sensitive | 50 | 40 | 44.2 | 40.3 | 36.5 | 41.3 | 42.3 | 38.4 | 45.6 |
| N6 | Sipat | Residential | 55 | 45 | 51.2 | 47.5 | 43.9 | 48.4 | 48.9 | 46.0 | 53.0 |
| N7 | Nargara | Residential | 55 | 45 | 42.8 | 39.2 | 35.5 | 40.1 | 40.6 | 37.5 | 44.5 |
| N8 | Bhadrapara | Residential | 55 | 45 | 44.2 | 40.4 | 36.9 | 41.3 | 42.2 | 39.0 | 46.0 |
| N9 | Sonthi | Residential | 55 | 45 | 44.2 | 40.5 | 36.9 | 41.4 | 42.0 | 38.8 | 45.8 |
| N10 | Darrabhata | Residential | 55 | 45 | 46.2 | 42.3 | 38.5 | 43.3 | 44.2 | 40.6 | 47.7 |
| N11 | Pachri | Residential | 55 | 45 | 42.2 | 38.4 | 34.9 | 39.3 | 39.9 | 36.9 | 43.9 |
| N12 | Raliya | Residential | 55 | 45 | 50.2 | 46.6 | 42.9 | 47.5 | 48.0 | 45.0 | 52.0 |
| N13 | Sukhripali | Residential | 55 | 45 | 51.2 | 47.5 | 43.9 | 48.4 | 49.0 | 45.8 | 52.8 |
| N14 | Matiyari | Residential | 55 | 45 | 43.2 | 39.3 | 35.5 | 40.3 | 41.2 | 37.6 | 44.7 |
| N15 | Kaudia | Residential | 55 | 45 | 51.2 | 47.4 | 43.9 | 48.3 | 48.9 | 45.9 | 52.9 |

## TABLE-3.8.2 (D)
## NOISE LEVELS [dB (A)] IN THE STUDY AREA-WINTER SEASON

| Station Code | Location | Zone | Limit in dB(A) Leq | | L10 | L50 | L90 | Leq | Lday | Lnight | Ldn |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Day | Night | | | | | | | |
| N1 | Existing plant site | Industrial | 75 | 70 | 52.0 | 48.3 | 44.7 | 49.2 | 49.8 | 46.6 | 53.6 |
| N2 | Proposed project site | Industrial | 75 | 70 | 48.2 | 44.3 | 40.5 | 45.3 | 46.2 | 42.6 | 49.7 |
| N3 | Guri | Residential | 55 | 45 | 45.2 | 41.4 | 37.9 | 42.3 | 42.9 | 39.9 | 46.9 |
| N4 | Karra | Sensitive | 50 | 40 | 47.2 | 43.6 | 39.9 | 44.5 | 45.0 | 42.0 | 49.0 |
| N5 | Janji | Sensitive | 50 | 40 | 44.2 | 40.3 | 36.5 | 41.3 | 42.3 | 38.4 | 45.6 |
| N6 | Sipat | Residential | 55 | 45 | 50.2 | 46.5 | 42.9 | 47.4 | 47.9 | 45.0 | 52.0 |
| N7 | Nargara | Residential | 55 | 45 | 43.8 | 40.2 | 36.5 | 41.1 | 41.6 | 38.5 | 45.5 |
| N8 | Bhadrapara | Residential | 55 | 45 | 45.2 | 41.4 | 37.9 | 42.3 | 43.2 | 40.0 | 47.0 |
| N9 | Sonthi | Residential | 55 | 45 | 45.2 | 41.5 | 37.9 | 42.4 | 43.0 | 39.8 | 46.8 |
| N10 | Darrabhata | Residential | 55 | 45 | 47.2 | 43.3 | 39.5 | 44.3 | 45.2 | 41.6 | 48.7 |
| N11 | Pachri | Residential | 55 | 45 | 43.2 | 39.4 | 35.9 | 40.3 | 40.9 | 37.9 | 44.9 |
| N12 | Raliya | Residential | 55 | 45 | 51.2 | 47.6 | 43.9 | 48.5 | 49.0 | 46.0 | 53.0 |
| N13 | Sukhripali | Residential | 55 | 45 | 51.2 | 47.5 | 43.9 | 48.4 | 49.0 | 45.8 | 52.8 |
| N14 | Matiyari | Residential | 55 | 45 | 41.2 | 37.3 | 33.5 | 38.3 | 39.2 | 35.6 | 42.7 |
| N15 | Kaudia | Residential | 55 | 45 | 52.2 | 48.4 | 44.9 | 49.3 | 49.9 | 46.9 | 53.9 |

3.8.5 Observations

**Pre-Monsoon Season**

*Daytime Noise Levels ($L_{day}$)*

The day time noise levels at all the locations were ranged in between 37.9 dB(A) 51.8 dB(A). The minimum value (37.9 dB (A)) was recorded near Pachri (N11) and the maximum value (51.8 dB (A)) was recorded at existing plant site (N1).

*Night time Noise Levels ($L_{night}$)*

The nighttime noise levels were ranged in between 34.9 to 48.6 dB (A). The minimum value (34.9 dB (A)) was recorded near Pachri (N11) and the maximum value (48.6 dB (A)) was recorded at existing plant site (N1).
The higher noise levels are observed mainly due to due to vehicular movement in the study area.

**Monsoon Season**

*Day time Noise Levels ($L_{day}$)*

The day time noise levels at all the locations were ranged in between 40.3 dB(A) 50.0 dB(A). The minimum value (40.3 dB (A)) was recorded near Janji (N5) and the maximum value (50.0 dB (A)) was recorded at Sukhripali (N13).

*Night time Noise Levels ($L_{night}$)*

The night time noise levels were ranged in between 36.4 to 46.9 dB (A). The minimum value (36.4 dB (A)) was recorded near Janji (N5) and the maximum value (47.6 dB (A)) was recorded at Sukhripali (N13).

**Post-Monsoon Season**

*Day time Noise Levels ($L_{day}$)*

The day time noise levels at all the locations were ranged in between 39.9 dB(A) 49.0 dB(A). The minimum value (49.0 dB (A)) was recorded near Pachri (N11) and the maximum value (49.0 dB (A)) was recorded at Sukhripali (N13).

*Night time Noise Levels ($L_{night}$)*

The night time noise levels were ranged in between 36.9 to 45.8 dB (A). The minimum value (36.9 dB (A)) was recorded near Pachri (N11) and the maximum value (45.8 dB (A)) was recorded at Sukhripali (N13).

**Winter Season**

*Day time Noise Levels ($L_{day}$)*

The day time noise levels at all the locations were ranged in between 39.2 dB(A) 49.9 dB(A). The minimum value (39.2 dB (A)) was recorded near Matiyari (N14) and the maximum value (49.9 dB (A)) was recorded at Kaudia (N15).

*Night time Noise Levels ($L_{night}$)*

The night time noise levels were ranged in between 35.6 to 46.9 dB (A). The minimum value (36.9 dB (A)) was recorded near Matiyari (N14) and the maximum value (45.8 dB (A)) was recorded at Kaudia (N15).

## 3.9 Ecology and Biodiversity

The present proposal is for installation of one unit of 800 MW as Sipat Super Thermal Power Project under Stage-III at Sipat STPS. The project aims to develop a Super Critical Unit with higher steam parameters and higher efficiency. This would result in reduction in coal consumption per unit of electricity generation and consequent reduction in Greenhouse Gase (GHG) emissions.

The proposed expansion unit doesnot involve any acquisition of land and unit will be established within the existing premises of Sipat STPP. About 160 acres of land within vacant space in MGR bulb is going to be utilized. No additional land is proposed to be acquired. No forest land is involved in the project proposal.

There are no National Parks or Wildlife Sanctuaries or Elephant, corridor/Tiger Reserves (existing as well as proposed) or migratory routes / wildlife corridor or Wetlands of National or International Importance or Important Bird Areas (IBAs) or other protected areas. The following forest blocks are present in the buffer zone of project as given in **Table-3.9.1.**

**TABLE-3.9.1**
**FOREST BLOCKS IN BUFFER ZONE**

| Sr. No | Forest Block | Distance (km) | Direction |
|---|---|---|---|
| 1 | Bitkuli RF | 3.7 | NE |
| 2 | Dalha PF | 7.0 | ESE |

Both the forest blocks present in the buffer zone belong to tropical dry deciduous forests. The forest area is a hilly terrain with tall rocky hills. There are dense patches of shrubs mixed occasionally with some tall trees. There are also steep rocky slopes without any vegetation. There are no reports or records of occurrence of any rare or endangered or threatened (RET) species in the study area. The list of terrestrial and aquatic sampling locations in the study area is presented in **Table-3.9.2** and shown in **Figure-3.9.1.**

## TABLE-3.9.2
## DETAILS OF ECOLOGICAL SAMPLING LOCATIONS

| Code | Name of the Locations | Distance from Plant Site (km) | Direction w.r.t. Plant Site |
|---|---|---|---|
| **Terrestrial Location** | | | |
| TE-1 | Near Sonthi village at Bitkuli Reserve forest | 8.5 | NE |
| TE-2 | Near Bamhni Khurd village at Bitkuli Reserve forest | 7.7 | NNE |
| TE-3 | Near Pachri village at Dalha Protected forest | 8.0 | ESE |
| TE-4 | Near Amripali village at Dalha Protected forest | 7.5 | E |
| TE-5 | Near Rank village and ash ponds | 2.9 | SSW |
| TE-6 | Near Tikripara village | 3.7 | NW |
| **Aquatic Locations** | | | |
| AE-1 | Lilagarh river near Darabhata village | 3.5 | E |
| AE-2 | Lilagarh river near Murpar village | 4.2 | SE |
| AE-3 | Kurung river near Pandhi village | 4.1 | WSW |
| AE-4 | Kurung river near Mohra village | 6.3 | W |

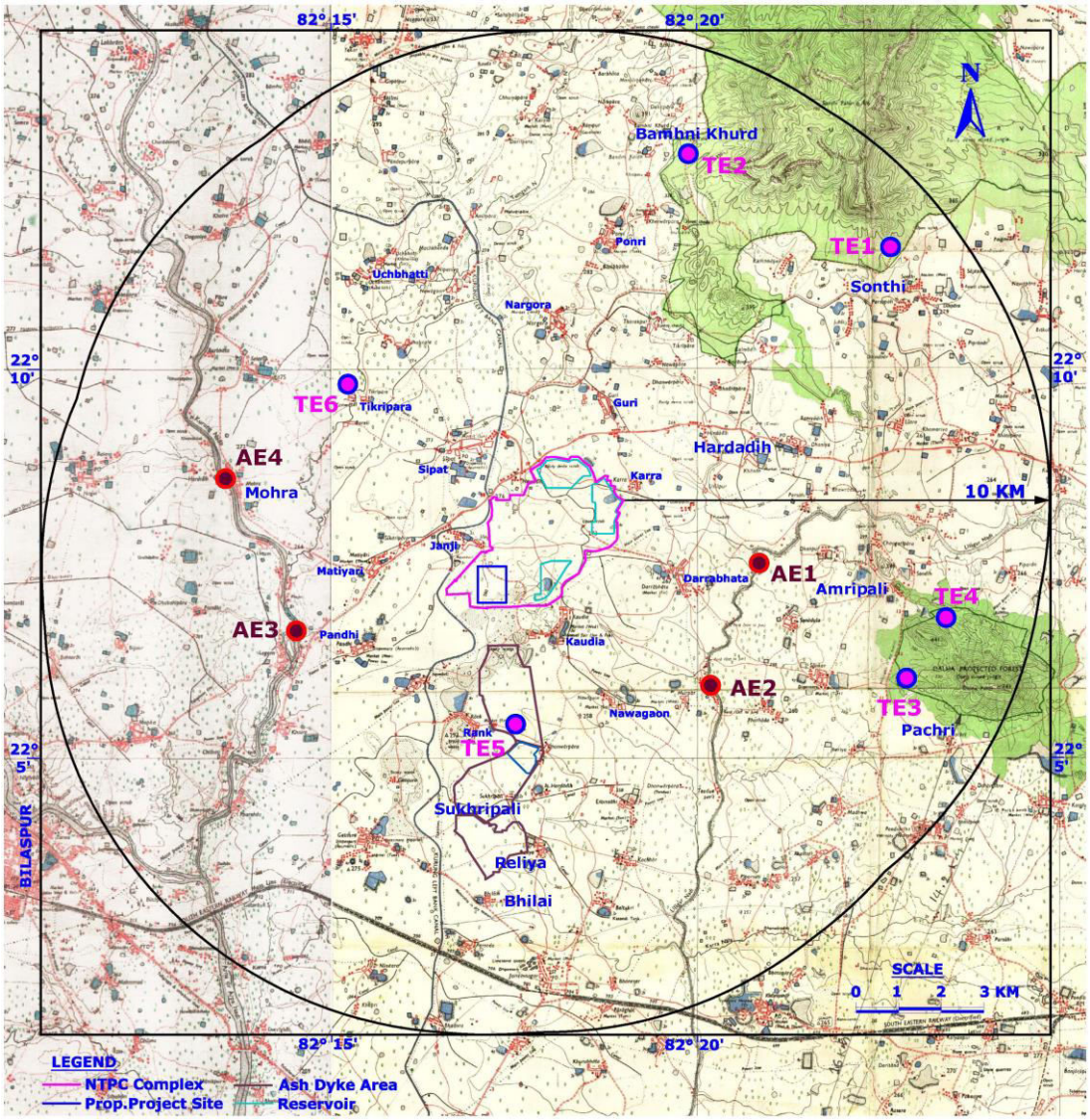



**FIGURE-3.9.1**
**ECOLOGICAL SAMPLING LOCATIONS**

A detailed primary survey of the project site and its buffer zone was carried out during the study period. The vegetation of the area mainly comprises of croplands, built-up areas, industries and two hill forests. The core area includes the following plantations and greenbelt. About 3,27,400 trees and shrubs are grown under the greenbelt, avenue plantations and block plantation. The average density is about 1004 per acres. The list of plant grown in existing greenbelt, avenue and block plantation in the core area is shown in **Table-3.9.3.**

**TABLE-3.9.3**
**LIST OF PLANTS GROWN IN THE EXISTING GREENBELT, AVENUE AND BLOCK PLANTATIONS IN THE CORE AREA**

| Sr.No | Scientific Name | Common Name | Family |
|---|---|---|---|
| 1 | *Acaia auriculiformis* | Australian wattle | Mimosaceae |
| 2 | *Acalypha wilkesiana* | Garden Acalypha | Euphorbaceae |
| 3 | *Achras sapota* | Sapodilla | Sapotaceae |
| 4 | *Albizia lebbeck* | Siris | Mimosaceae |
| 5 | *Allamanda cathartica* | Golden Trumpet Wine | Apocynaceae |
| 6 | *Ailanthus excelsa* | Maha neem | Simaroubaceae |
| 7 | *Alstonia scholaris* | Indian Tree of Heaven | Apocynaceae |
| 8 | *Araucaria columnaris* | Christmas tree | Araucariaceae |
| 9 | *Artocarpus heterophyllus* | Jackfruit | Moraceae |
| 10 | *Azadirachta indica* | Neem | Meliaceae |
| 11 | *Bambusa vulgaris* | Yellow Bamboo | Poaceae |
| 12 | *Bauhinia racemosa* | Katmauli | Caesalpiniaceae |
| 13 | *Bauhinia variegata* | Kachnar | Caesalpiniaceae |
| 14 | *Bombax malabaricum* | Silk cotton tree | Bombacaceae |
| 15 | *Borassus flabellifer* | Palmyra palm | Arecaeae |
| 16 | *Bougainvillea spectabilis* | Bougainvillea | Nyctaginaceae |
| 17 | *Caesalpinia pulcherrima* | Peacock Flower | Caesalpiniaceae |
| 18 | *Callistemon lanceolatus* | Bottle brush tree | Myrtaceae |
| 19 | *Calotropis gigantea* | Aak | Asclepiadaceae |
| 20 | *Calotropis procera* | Sodom Apple | Asclepiadaceae |
| 21 | *Carica papaya* | Papaya | Caricaceae |
| 22 | *Caryota urens* | Fishtail Palm | Arecaceae |
| 23 | *Cascabela thevetia* | Yellow Oleander | Apocynaceae |
| 24 | *Cassia fistula* | Golden Shower Cassia | Caesalpiniaceae |
| 25 | *Cassia siamea* | Siamese Cassia | Caesalpiniaceae |
| 26 | *Chamaedorea sefritzii* | Bamboo palm | Arecaceae |
| 27 | *Chromolaena odorata* | Siam weed | Asteraceae |
| 28 | *Clerodendrum inerme* | Glory tree | Verbenaceae |
| 29 | *Cocos nucifera* | Coconut | Arecaceae |
| 30 | *Codiaeum variegatum* | Croton | Euphorbiaceae |
| 31 | *Cordia sebestena* | Scarlet Cassia | Boraginaceae |
| 32 | *Cycas revoluta* | Sago palm | Cycadaceae |
| 33 | *Daemia extensa* | Utaran | Asclepiadaceae |
| 34 | *Delonix elata* | Gulmohar | Caesalpiniaceae |
| 35 | *Dendrocalamus strictus* | Bamboo | Poaceae |
| 36 | *Duranta repens* | Golden Duranta | Verbenaceae |
| 37 | *Dypsis lutescens* | Areca palm | Arecaceae |
| 38 | *Erythrina suberosa* | Corky coral tree | Fabaceae |
| 39 | *Eucalyptus tereticornis* | Red Gum | Myrtaceae |
| 40 | *Ficus benghalensis* | Banyan tree | Moraceae |
| 41 | *Ficus benjamina* | Weeping fig | Moraceae |
| 42 | *Ficus elastica* | Rubber plant | Moraceae |
| 43 | *Ficus religiosa* | Peepal | Moraceae |
| 44 | *Hibiscus rosasinenis* | China Rose | Malvaceae |

| Sr.No | Scientific Name | Common Name | Family |
|---|---|---|---|
| 45 | *Holoptelea integrifolia* | Chilbil | Ulmaceae |
| 46 | *Hyophorbe lagenicaulis* | Bottle palm | Arecaceae |
| 47 | *Ipomoea carnea* | Pink Morning glory | Convolvulaceae |
| 48 | *Jacaranda mimosaefolia* | Jacaranda | Mimosaceae |
| 49 | *Lagerstroemia parviflora* | *Pride of India* | Lythraceae |
| 50 | *Lantana camara* | Lantana | Verbenaceae |
| 51 | *Leucaena leucocephala* | Subabul | Mimosaceae |
| 52 | *Mangifera indica* | Mango | Anacardiaceae |
| 53 | *Mimusops elengi* | Spanish Cherry | Sapotaceae |
| 54 | *Muntingia calabura* | Singapore cherry | Muntingiaceae |
| 55 | *Musa paradisiaca* | Banana | Musaceae |
| 56 | *Nerium odorum* | Nerium | Apocynaceae |
| 57 | *Pedilanthus tithymaloides* | Slipper surge | Euphorbiaceae |
| 58 | *Peltophorum pterocarpum* | Copper pod | Caesalpiniaceae |
| 59 | *Phoenix sylvestris* | Wild date | Aesthetic |
| 60 | *Phyllanthus acidus* | Star Gooseberry | Phyllanthaceae |
| 61 | *Phyllanthus emblica* | Indian Gooseberry | Phyllanthaceae |
| 62 | *Pithecellobium dulce* | Jungle jalebi | Mimosaceae |
| 63 | *Plumeria alba* | Temple tree | Apocynacae |
| 64 | *Plumeria rubra* | Temple tree | Apocynacae |
| 65 | *Polyalthia longifolia* | Ashok | Annonaceae |
| 66 | *Polyalthia pendula* | Ashok | Annonaceae |
| 67 | *Pongamia pinnata* | Karanj | Fabaceae |
| 68 | *Prosopis juliflora* | Mesquite | Mimosaceae |
| 69 | *Psidium guajava* | Guava | Myrtaceace |
| 70 | *Quisqualis indica* | Rangoon Creeper | Combretaceae |
| 71 | *Roystonea regia* | Royal palm | Arecaceae |
| 72 | *Samanea saman* | Rain Tree | Mimosaceae |
| 73 | *Spathodea companulata* | African tulip tree | Bignoniaceae |
| 74 | *Sterculia foetida* | Wild almond | Sterculiaceae |
| 75 | *Syzygium cumini* | Jamun | Myrtaceae |
| 76 | *Tamarindus indica* | Tamarind | Caesalpiniaceae |
| 77 | *Tectona grandis* | Teak | Verbenaceae |
| 78 | *Terminalia arjuna* | Arjun | Combretaceae |
| 79 | *Terminalia catappa* | Almond | Combretaceae |
| 80 | *Thespesia populnea* | Portia tree | Malvaceae |
| 81 | *Vitex negundo* | Nirgundi | Verbenaceae |
| 82 | *Wattakaka volubilis* | Sneeze Wort | Asclepiadaceae |
| 83 | *Wodyetia bifurcata* | Fox tail palm | Arecaceae |

*Vegetation and Flora of the Buffer Zone*

Detailed primary survey of the flora of the buffer zone was carried out. A total of 30 nested quarts of 5 x 20 m, 2 x 5 m and 1 x 1 m were taken at random covering the entire buffer zone. Out of the 30, 5 each were from the two forest blocks. The list of trees found in the study area is given in **Table-3.9.4.** A check list of herbs, shrubs and climbers including cultivated plants grown in the buffer zone is given in **Table-3.9.5**. Grasses and sedges (graminoids) are listed in **Table-3.9.6.**

## TABLE-3.9.4
## LIST OF TREES FOUND IN THE STUDY AREA

| Sr.No | Botanical Name | Local Name | Family |
|---|---|---|---|
| 1 | *Acacia auriculiformis* | Sickle leaf Acacia | Mimosaceae |
| 2 | *Acacia catechu* | Khair | Mimosaceae |
| 3 | *Acacia leucophloea* | Rinjha | Mimosaceae |
| 4 | *Acacia nilotica* | Babul / Babool | Mimosaceae |
| 5 | *Aegle marmelos* | Bel | Rutaceae |
| 6 | *Ailanthus excelsa* | Mahaneem | Simaroubaceae |
| 7 | *Alangium salviifolium* | Akol | Cornaceae |
| 8 | *Albizia procera* | Safed Siris | Mimosaceae |
| 9 | *Alstonia scholaris* | Saptaparni | Apocynaceae |
| 10 | *Annona reticulata* | Ramphal | Annonaceae |
| 11 | *Annona squamosa* | Sheetaphal | Annonaceae |
| 12 | *Anogeissus latifolia* | Dhaura | Combretaceae |
| 13 | *Anogeissus latifolia* | Dhawada | Combrataceae |
| 14 | *Anthocephalus indica* | Cadamb | Rubiaceae |
| 15 | *Azadirachta indica* | Neem | Meliacceae |
| 16 | *Bauhinia racemosa* | Astra, Asta ,Bosa | Caesalpinaceae |
| 17 | *Boswellia serrata* | Salai | Burseraceae |
| 18 | *Breynia vitis-ideae* | Breynia | Euphorbiaceae |
| 19 | *Buchanania lanzan* | Chironjee | Anacardiaceae |
| 20 | *Butea monosperma* | Palash | Fabaceae |
| 21 | *Calliandra haematocephala* | Powder puff | Mimosaceae |
| 22 | *Cassia siamea* | Seemia or Kassod | Caesalpiniaceae |
| 23 | *Celastrus paniculatus* | Unjain | Celastraceae |
| 24 | *Delonix regia* | Gulmohar | Caesalpiniaceae |
| 25 | *Dendrocalamus strictus* | Bamboo | Poaceae |
| 26 | *Diospyros ebenum* | Makar tendu | Ebenaceae |
| 27 | *Diospyros melanoxylon* | Tendu | Ebenaceae |
| 28 | *Diospyros montana* | Bistendu | Ebenaceae |
| 29 | *Eucalyptus tereticornis* | Eucalypts | Myrtaceae |
| 30 | *Euphorbia neriifolia* | Indian spurge | Euphorbiaceae |
| 31 | *Ficus hispida* | Hairy Fig | Moraceae |
| 32 | *Ficus racemosa* | Cluster Fig | Moraceae |
| 33 | *Ficus religiosa* | Peepal | Moraceae |
| 34 | *Filicium decipiens* | Fern leaf tree | Sapindaceae |
| 35 | *Flacourtia indica* | Kakai | Salicaceae |
| 36 | *Gardenia latifolia* | Papada, Papara | Rubiaceae |
| 37 | *Garuga pinnata* | Khenkara | Burseraceae |
| 38 | *Helicteris isora* | Maror Phali | Sterculiaceae |
| 39 | *Holarrhena pubescens* | Koriya | Annonaceae |
| 40 | *Leucaena leucocephala* | Subabul | Mimosaceae |
| 41 | *Madhuca longifolia* | Mahua | Sapotaceae |
| 42 | *Mangifera indica* | Aam / Mango | Anacardiaceae |
| 43 | *Peltophorum pterocarpum* | Copper Pod | Caesalpiniaceae |
| 44 | *Phoenix sylvestris* | Bankhajuri | Arecaceae |
| 45 | *Plumeria alba* | Gulchin or Champa | Apocynaceae |
| 46 | *Polyalthia longifolia* | Ashok | Annonaceae |
| 47 | *Polyalthia pendula* | Ashok | Annonaceae |
| 48 | *Prosopis spicigera* | Kejdi | Mimosaceae |
| 49 | *Prosopis juliflora* | Mesquite | Mimosaceae |
| 50 | *Semecarpus anacardium* | Bhelwa | Anacardiaceae |
| 51 | *Shorea robusta* | Sal | Dipterocarpaceae |
| 52 | *Spathodea companulata* | Rugtoora | Bignoniaceae |
| 53 | *Sterculia urens* | Gum karaya | Sterculiaceae |
| 54 | *Strebulus asper* | Toothbrush tree | Moraceae |
| 55 | *Syzygium cumini* | Jamun | Myrtaceae |

| Sr.No | Botanical Name | Local Name | Family |
|---|---|---|---|
| 56 | *Terminalia alata* | Saj | Combrataceae |
| 57 | *Terminalia arjuna* | Kahua | Combrataceae |
| 58 | *Terminalia bellirica* | Baheda | Combrataceae |
| 59 | *Terminalia catappa* | Almond | Combretaceae |
| 60 | *Terminalia chebula* | Harra | Combrataceae |
| 61 | *Terminalia elliptica* | Asan | Combrataceae |
| 62 | *Terminalia tomentosa* | Saja | Combrataceae |
| 63 | *Wodyetia bifurcata* | Foxtail Palm | Arecaeace |
| 64 | *Wrightia tinctoria* | Dudhi | Apocynaceae |
| 65 | *Ziziphus mauritiana* | Ber | Rhamnaceae |

## TABLE-3.9.5
## LIST OF HERBS, SHRUBS AND CLIMBERS INCLUDING CULTIVATED PLANTS GROWN IN THE BUFFER ZONE

| Sr.No | Botanical Name | Local Name | Family |
|---|---|---|---|
| 1 | *Abelmoschus ficulneus* | Jangli bhindi | Malvaceae |
| 2 | *Abelmoschus moschatus* | Jangali bhindi | Malvaceae |
| 3 | *Abrus precatorius* | Crabs eye | Fabaceae |
| 4 | *Abutilon hirtum* | Bankanghi | Malvaceae |
| 5 | *Abutilon indicum* | Kanghi | Malvaceae |
| 6 | *Acalypha indica* | Indian copperleaf | Euphorbiaceae |
| 7 | *Achyranthes* aspera | Chirchira/latjira | Amaranthaceae |
| 8 | *Acorus calamus* | Bacha | Araceae |
| 9 | *Adhatoda vasica* | Adusa | Acanthaceae |
| 10 | *Aerva lanata* | Gorakhbuti | Amaranthaceae |
| 11 | *Aeschynomene indica* | Indian jointvetch | Fabaceae |
| 12 | *Ageratum conyzoides* | Goat weed | Asteraceae |
| 13 | *Ageratum houstonianum* | Floss flower | Asteraceae |
| 14 | *Alangium salvifolium* | Thelkajani | Alangiaceae |
| 15 | *Allium cepa* | Pyaj | Liliaceae |
| 16 | *Allium sativum* | Lahsun | Liliaceae |
| 17 | *Aloe vera* | Ghritkumari | Liliaceae |
| 18 | *Alternanthera paronychioides* | Smooth joyweed | Amaranthaceae |
| 19 | *Alternanthera philoxeroides* | Alligator weed | Amaranthaceae |
| 20 | *Alternanthera pungens* | Khaki weed | Amaranthaceae |
| 21 | *Alternanthera sesslis* | Sessile joy weed | Amaranthaceae |
| 22 | *Alysicarpus longifolius* | Long leaved alyce clover | Fabaceae |
| 23 | *Alysicarpus monilifer* | Alyce clover | Fabaceae |
| 24 | *Amaranthus spinosus* | Chaulai | Amaranthaceae |
| 25 | *Amaranthus viridis* | Slender amaranth | Amaranthaceae |
| 26 | *Ammannia baccifera* | Blistering ammannia | Lythraceae |
| 27 | *Ammannia octandra* | | Lythraceae |
| 28 | *Amorpbophyllus paeonifolius* | Kand | Araceae |
| 29 | *Anacyclus pyrethrum* | Akarkara | Asteraceae |
| 30 | *Anagallis arvensis* | Scarlet pimpernel | Primulaceae |
| 31 | *Andrographis paniculata* | Bhuileem | Acanthaceae |
| 32 | *Anisomeles indica* | | Lamiaceae |
| 33 | *Anisomeles malabarica* | | Lamiaceae |
| 34 | *Antigonon leptopus* | | Polygonaceae Pontederiaceae |
| 35 | *Argemone maxicana* | Pilikateri | Papavaraceae |
| 36 | *Aerva javanica* | | Amaranthaceae |
| 37 | *Asparagus racemosus* | Satawar | Asteraceae |
| 38 | *Asteracantha longifolia* | Talmakhana | Acanthaceae |
| 39 | *Asystasia gangetica* | Chinese viole | Acanthaceae |

| Sr.No | Botanical Name | Local Name | Family |
|---|---|---|---|
| 40 | *Aternanthera bettzickiana* | | Amaranthaceae |
| 41 | *Atylosia sacarabaeoides* | Showy pigeonpea | Fabaceae |
| 42 | *Bacopa monnieri* | Brahmi | Scrophulariaceae |
| 43 | *Barleria cristata* | | Acanthaceae |
| 44 | *Barleria prionitis* | | Acanthaceae |
| 45 | *Basella alba* | Poi | Basellaceae |
| 46 | *Bauhinia retusa* | Gobi | Caesalpiniaceae |
| 47 | *Bergia ammannoides* | Jerry water-fire | Euphorbiaceae |
| 48 | *Bergia capensis* | Cape ash | Euphorbiaceae |
| 49 | Bidens pilosa | Spanish needles | Asteraceae |
| 50 | *Biophytum sensitivum* | | Onagraceae |
| 51 | *Blepharis maderaspatensis* | Creeping blepharis | Acanthaceae |
| 52 | *Blepharispermum subsessile* | Rasna jadi | Asteraceae |
| 53 | *Blumea lacera* | Malay blumea | Asteraceae |
| 54 | *Blumea oxyodonta* | Spiny leaved blumea | Asteraceae |
| 55 | *Blumea wightriana* | Soft blumea | Asteraceae |
| 56 | *Boerhaavia diffusa* | Red spiderling | Nictaginaceae |
| 57 | *Boerhaavia erecta* | Erect spiderling | Nictaginaceae |
| 58 | *Borreria hispida* | Shaggy buttonweed | Rubiaceae |
| 59 | *Borreria pusilla* | Tiny false buttonweed | Rubiaceae |
| 60 | *Cabomba aquatica* | Yellow cabomba | Cabombaceae |
| 61 | *Caesulia axillaries* | Pink node flower | Asteraceae |
| 62 | *Cajanus cajan* | Gunga pea | Fabaceae |
| 63 | *Calotropis gigantea* | Crown flower | Asparagaceae |
| 64 | *Calotropis procera* | Aank | Asparagaceae |
| 65 | *Cannabis sativa* | Hemp | Cannabaceae |
| 66 | *Cardamine hirsuta* | Hairy bittercress | Brassicaceae |
| 67 | *Cardiospermum halicacabum* | Balloonvine | Sapindaceae |
| 68 | *Cassia absus* | Pig's senna | Fabaceae |
| 69 | *Cassia mimooides* | Feather-leaved cassia | Fabaceae |
| 70 | *Cassia occidentalis* | Coffee senna | Fabaceae |
| 71 | *Cassia occidentalis* | Kasmard | Caesalpiniaceae |
| 72 | *Cassia pumila* | Dwarf cassia | Fabaceae |
| 73 | *Cassia tora* | Sicklepod | Fabaceae |
| 74 | *Cassia trifolia* | | Fabaceae |
| 75 | *Catharanthus pusillus* | Tiny periwinkle | Apocynaceae |
| 76 | *Catharanthus roseus* | Sadabahar | Apocynaceae |
| 77 | *Cayratia trifolia* | Bush grape | Vitaceae |
| 78 | *Celastrus paniculatus* | Kujureed | Celastraceae |
| 79 | *Celosia argentea* | Cock's comb | Amaranthaceae |
| 80 | *Centella asiatica* | Indian pennywort | Apiaceae |
| 81 | *Centratherum punctatum* | Lark daisy | Asteraceae |
| 82 | *Centrosema pubescens* | Butterfly pea | Fabaceae |
| 83 | *Chenopodium album* | Common lambsquarter | Chenopodiaceae |
| 84 | *Chenopodium murale* | Nettle-leaved goosefoot | Chenopodiaceae |
| 85 | *Chlorophytum tuberosum* | Safed musli | Asteraceae |
| 86 | *Chromolaena odorata* | Siam weed | Asteraceae |
| 87 | *Chrozophora plicata* | Giradol | Euphorbiaceae |
| 88 | *Chrozophora rottleri* | Rottler's chrozophora | Euphorbiaceae |
| 89 | *Cichorium intybus* | Chicory | Asteraceae |
| 90 | *Cirsium arvense* | Canada thistle | Asteraceae |
| 91 | *Cissus quadrangularis* | *Hadijod* | Vitaceae |
| 92 | *Citrullus colocynthis* | Indrayan | Cucurbitaceae |
| 93 | *Cleome chelidonii* | Celandine spider flower | Cleomaceae |
| 94 | *Cleome gynandra* | African spider flower | Cleomaceae |
| 95 | *Cleome monophylla* | Spindle pod | Cleomaceae |
| 96 | *Cleome viscosa* | Tick weed | Cleomaceae |
| 97 | *Clerodendron infortunatum* | Hill glory bower | Lamiaceae |

| Sr.No | Botanical Name | Local Name | Family |
|---|---|---|---|
| | *Clerodendrum serratum* (L.) | Bleeding-heart | |
| 98 | *Clitoria ternatea* | Asian pigeonwings | Fabaceae |
| 99 | *Cocculus hirsutus* | Ink berry | Menispermaceae |
| 100 | *Colocosia esculenta* | Kochai | Asclepiadacea |
| 101 | *Commelina benghalensis* | | Commalinaceae |
| 102 | *Commelina diffusa* | Climbing dayflower | Commalinaceae |
| 103 | *Commelina forskaolii* | | Commalinaceae |
| 104 | *Convolvulus arvensis* | Field bindweed | Convolvulaceae |
| 105 | *Convolvulus microphyllus* | Shankhapushpi | Convolvulaceae |
| 106 | *Conyza bonaariensis* | Asthmaweed | Asteraceae |
| 107 | *Conyza canadensis* | Canadian horseweed | Asteraceae |
| 108 | *Corchorus aestuans* | East Indian jew's mallow | Malvaceae |
| 109 | *Corchorus capsularis* | White jute | Malvaceae |
| 110 | *Corchorus fascicularis* | Tall wild jute | Malvaceae |
| 111 | *Corchorus olitorius* | Jew's mallow | Malvaceae |
| 112 | *Corchorus trilocularis* | Cotton weed | Malvaceae |
| 113 | *Coronopus didymus* | Lesser swine-cress | Brassicaceae |
| 114 | *Cosmos sulphureus* | Yellow cosmos | Asteraceae |
| 115 | *Costus speciosus* | Keokandh | Zinziberaceae |
| 116 | *Crotalaria medicaginea* | Trefoil rattlepod | Fabaceae |
| 117 | *Crotalaria prostrata* | Rattlepod | Fabaceae |
| 118 | *Crotalaria sagittalis* | Arrowhead rattlebox | Fabaceae |
| 119 | *Crotalaria sericea* | Bansan | Fabaceae |
| 120 | *Crotalaria verrucosa* | Blue rattlesnake | Fabaceae |
| 121 | *Croton bonplandianum* | Three-leaved caper | Euphorbiaceae |
| 122 | Curculigo orchioides | Kali musli | Hypoxidaceae |
| 123 | *Curcuma amada* | Jangli haldi | Zinziberaceae |
| 124 | *Cuscuta reflexa* | Amarbel | Convolvulaceae |
| 125 | *Cyanotis axillaris* | Spreading dayflower | Commalinaceae |
| 126 | *Cyathula prostrat* | Pasture weed | Amaranthaceae |
| 127 | *Cynotis cristata* | Crested cat ears | Commalinaceae |
| 128 | *Datura metal* | Datura | Solanaceae |
| 129 | *Datura stramonium* | Datura | Solanaceae |
| 130 | *Desmodium gangeticum* | Sal leaved desmodium | Fabaceae |
| 131 | *Desmodium laxiflorum* | Loose flowered | Fabaceae |
| 132 | *Desmodium motorium* | Telegraph plant | Fabaceae |
| 133 | *Desmodium triflorum* | Three flowered tickerfoil | Fabaceae |
| 134 | *Digera arvensis* | False amaranth | Amaranthaceae |
| 135 | *Dioscorea deamona* | Koliyapad | Dioscoreaceae |
| 136 | *Dioscorea pentaphylla* | Dukarkand | Dioscoreaceae |
| 137 | *Diplocyclos palmatus* | Native bryony | Euphorbiaceae |
| 138 | *Dyschoriste depressa* | | Acanthaceae |
| 139 | *Echinops echinatus* | Indian globethistle | Asteraceae |
| 140 | *Eclipta alba* | False daisy | Asteraceae |
| 141 | *Eclipta prostata* | | Asteraceae |
| 142 | *Emilia sonchifolia* | Red tassel flower | Asteraceae |
| 143 | *Eranthemum pullchellum* | Putus | Acanthaceae |
| 144 | *Eryngium foetidum* | Wild coriander | Apiaceae |
| 145 | *Euphorbia dracunculoides* | Dragon spurge | Euphorbiaceae |
| 146 | *Euphorbia geniculata* | Wild poinsettia | Euphorbiaceae |
| 147 | *Euphorbia hirta* | Asthma herb | Euphorbiaceae |
| 148 | *Euphorbia hypericifolia* | Graceful sandmat | Euphorbiaceae |
| 149 | *Euphorbia indica* | | Euphorbiaceae |
| 150 | *Euphorbia microphylla* | | Euphorbiaceae |
| 151 | *Euphorbia nerrifolia* | Sehund | Euphorbiaceae |
| 152 | *Euphorbia thymifolia* | Gulf sandmart | Euphorbiaceae |
| 153 | *Evolvulus nummularius* | Roundleaf bindweed | Convolvulaceae |
| 154 | *Evovulus alsinoides* | Shankpushpi | Convolvulaceae |

| Sr.No | Botanical Name | Local Name | Family |
|---|---|---|---|
| 155 | *Foeniculum vulgare* | Sauf | Apiaceae |
| 156 | *Galium aparine* | Stickywilly | Rubiaceae |
| 157 | *Gardenia turgida* | Thandla | Rubiaceae |
| 158 | *Glycyrrihiza glabra* | Mulethi | Fabaceae |
| 159 | *Gnaphalium polycephalum* | White balsam | Asteraceae |
| 160 | *Gomphorena decumbens* | Prostrate globe | Amaranthaceae |
| 161 | *Grengea maderaspatana* | | Asteraceae |
| 162 | *Helicterus isora* | Aaithi | Sterculiaceae |
| 163 | *Heliotropium indicum* | Indian heliotrope | Borginaceae |
| 164 | *Heliotropium ovalifolium* | Grey leaf heliotrope | Borginaceae |
| 165 | *Hemidesmus indicus* | Indian sarsaparilla | Asclepiadacea |
| 166 | *Hibiscus lobatus* | Lobed leaf mallow | Malvaceae |
| 167 | *Hibiscus rosa sinensis* | Gudhal | Malvaceae |
| 168 | *Hibiscus panduriformis* | Yellow hibiscus | Malvaceae |
| 169 | *Hyptis suaveolens* | Pignut | Lamiaceae |
| 170 | *Indigofera cordifolia* | Heart leaf indigo | Fabaceae |
| 171 | *Indigofera linifolia* | | Fabaceae |
| 172 | *Indigofera linnaei* | Birdsville indigo | Fabaceae |
| 173 | *Indoneesiella echiodes* | False waterwillow | Acanthaceae |
| 174 | *Ionidium suffruticosum* | Spade flower | Violaceae |
| 175 | *Iopomoea pes-tigridis* | Tiger foot morning glory | Convolvulaceae |
| 176 | *Ipomea aquatica* | Water spinach | Convolvulaceae |
| 177 | *Ipomea coccinea* | Red star | Convolvulaceae |
| 178 | *Ipomoea cairica* | Cairo morning glory | Convolvulaceae |
| 179 | *Ipomoea hederacea* | Ivy leaf morning glory | Convolvulaceae |
| 180 | *Ipomoea obscura* | Obscure morning glory | Convolvulaceae |
| 181 | *Ipomoea pes-caprae* | Goat's foot | Convolvulaceae |
| 182 | *Ipomoea turbinata* | Lilac bell | Convolvulaceae |
| 183 | *Jasminum grandiflorum* | Chameli | Oleaceae |
| 184 | *Kalanchoe laciniata* | Pusudi | Crassulaceae |
| 185 | *Lannea grandis* | Modga | Anacardiaceae |
| 186 | *Lathyrus aphaca* | Yellow pea | Fabaceae |
| 187 | *Launaea nudicaulis* | Bold-leaf launaeae | Asteraceae |
| 188 | *Launaea sarmentosa* | Beach launaea | Asteraceae |
| 189 | *Lawsonia inermis* | Mehendi | Malvaceae |
| 190 | *Leonitis nepetaefolia* | | Lamiaceae |
| 191 | *Lepidium sativum* | Pepper grass | Brassicaceae |
| 192 | *Leucas aspera* | Common leucas | Lamiaceae |
| 193 | *Leucas cephalotus* | Lion's ear | Lamiaceae |
| 194 | *Leucas martinicensis* | Whitewort | Lamiaceae |
| 195 | *Leucas zeylanica* | Ceylon slitwort | Lamiaceae |
| 196 | *Ludwigia octovalvis* | Lajalu/ Life plant | Onagraceae |
| 197 | *Medicago denticulate* | | Fabaceae |
| 198 | *Meliotus indica* | | Fabaceae |
| 199 | *Mentha arvensis* | Mint | Lamiaceae |
| 200 | *Mimosa pudica* | Touch me not | Fabaceae |
| 201 | *Mitragyna parviflora* | Bhilari | Rubiaceae |
| 202 | *Mollugo pentaphylla* | | Molluginaceae |
| 203 | *Monochoria vaginalis* | | Pontedriaceae |
| 204 | *Mucuna pruriens* | Kewanch | Fabaceae |
| 205 | *Mycrotyloma uniflorum* | Kulthi | Fabaceae |
| 206 | *Nyctanthes arbortritis* | Harsringar | Oleaceae |
| 207 | *Ocimum basilicum* | Dauna | Lamiaceae |
| 208 | *Ocimum sanctum* | Tulsi | Lamiaceae |
| 209 | *Oxalis corniculata* | Khattibuti | Oxalidaceae |
| 210 | *Parthenium hysterophorus* | Congress grass | Asteraceae |
| 211 | *Peucedanum nagpurense* | Tejraj | Apiaceae |
| 212 | *Phylanthus fraternus* | Chhoti amla | Euphorbiaceae |

| Sr.No | Botanical Name | Local Name | Family |
|---|---|---|---|
| 213 | *Plumbago zeylanica* | Chitwar | Plumbaginaceae |
| 214 | *Portulaca oleracea* | Common purslane | Portulaceaeae |
| 215 | *Psorelia corylifolia* | Bakuchi | Fabaceae |
| 216 | *Pueraria tuberosa* | Vidarikand | Fabaceae |
| 217 | *Punica granatum* | Anar | Puniacaceae |
| 218 | *Randia dumetorum* | Morba | Rubiaceae |
| 219 | *Roulfia serpentina* | Sarpagandha | Apocynaceae |
| 220 | *Rubia cordifolia* | Manjita | Rubiaceae |
| 221 | *Ruellia tubarosa* | | Acanthaceae |
| 222 | *Sida acuta* Burm. | Broom weed | Malvaceae |
| 223 | *Sida cordifolia* | Bariyari | Malvaceae |
| 224 | *Smilax macrophylla* | Ramdatoon | Liliaceae |
| 225 | *Solanum nigrum* | Makoi | Solanaceae |
| 226 | *Spergula arvensis* | Corn spurry | Caryophyllaceae |
| 227 | *Sphaeranthus indicus* | Gorkhmundi | Asteraceae |
| 228 | *Sphenoclea zeylanica* | Chickenspike | Spenocleaceae |
| 229 | *Spilanthus oleiracea* | Akarkara | Asteraceae |
| 230 | *Tagetes patula* | Chandeni genda | Asteraceae |
| 231 | *Tephrosea purpurea* | Sarponkh | Fabaceae |
| 232 | *Thevetia peruviana* | Kaner | Araceae |
| 233 | *Tinospora cordifalia*<br>*Glinus lotoides* L. | Giloy<br>Lotus sweetjuice | Minispermaceae |
| 234 | *Trianthema portulacastrum* | Horse purslane | Aizoaceae |
| 235 | *Tridax procumbans* | Coat buttons | Asteraceae |
| 236 | *Vetiveria zizanioides* | Birni | Poaceae |
| 237 | *Vicia sativa* | Common vetch | Fabaceae |
| 238 | *Vitex nigundo* | Nirgundi | Verbenaceae |
| 239 | *Wendlandia exserta* | Tilai | Rubiaceae |
| 240 | *Withnania somnifera* | Ashwagandh | Solanaceae |
| 241 | *Woodfordia fruiticosa* | Dhawai | Malvaceae |
| 242 | *Xeromphis spinosa* | Mainpha | Rubiaceae |

## TABLE-3.9.6
## LIST OF GRAMINOIDS (GRASSES AND SEDGES) FOUND IN THE STUDY AREA

| Sr. No | Scientific Name | Family |
|---|---|---|
| 1 | *Aeluropus lagopoides* | Poaceae |
| 2 | *Alloteropsis cimicina* | Poaceae |
| 3 | *Apluda mutica* | Poaceae |
| 4 | *Aristida adscensionis* | Poaceae |
| 5 | *Aristida funiculata* | Poaceae |
| 6 | *Aristida hystrix* | Poaceae |
| 7 | *Aristida setacea* | Poaceae |
| 8 | *Arundinella setosa* | Poaceae |
| 9 | *Bothriochloa pertusa* | Poaceae |
| 10 | *Brachiaria distachya* | Poaceae |
| 11 | *Brachiaria ramosa* | Poaceae |
| 12 | *Brachiaria reptans* | Poaceae |
| 13 | *Bulbostylis barbata* | Cyperaceae |
| 14 | *Cenchrus ciliaris* | Poaceae |
| 15 | *Chloris barbata* | Poaceae |
| 16 | *Chloris gayana* | Poaceae |
| 17 | *Chloris montana* | Poaceae |
| 18 | *Chloris virgata* | Poaceae |
| 19 | *Chrysopogon montanus* | Poaceae |
| 20 | *Chrysopogon aciculatus* | Poaceae |

| Sr. No | Scientific Name | Family |
|---|---|---|
| 21 | *Chrysopogon fulvus* | Poaceae |
| 22 | *Chrysopogon verticillatus* | Poaceae |
| 23 | *Coix lacryma-jobi* | Poaceae |
| 24 | *Cymbopogon coloratus* | Poaceae |
| 25 | *Cymbopogon flexuosus* | Poaceae |
| 26 | *Cymbopogon nardus* | Poaceae |
| 27 | *Cynodon barberi* | Poaceae |
| 28 | *Cynodon dactylon* | Poaceae |
| 29 | *Cyperus compressus* | Cyperaceae |
| 30 | *Cyperus diffusus* | Cyperaceae |
| 31 | *Cyperus esculentus* | Cyperaceae |
| 32 | *Cyperus iria* | Cyperaceae |
| 33 | *Cyperus rotundus* | Cyperaceae |
| 34 | *Cyperus squarrosus* | Cyperaceae |
| 35 | *Cyperus triceps* | Cyperaceae |
| 36 | *Dactyloctenium aegyptium* | Poaceae |
| 37 | *Dichanthium annulatum* | Poaceae |
| 38 | *Digitaria ciliaris* | Poaceae |
| 39 | *Digitaria longiflora* | Poaceae |
| 40 | *Digitaria sanguinalis* | Poaceae |
| 41 | *Dinebra retroflexa* | Poaceae |
| 42 | *Echinochloa colona* | Poaceae |
| 43 | *Echinochloa crusgalli* | Poaceae |
| 44 | *Enteropogon monostachyos* | Poaceae |
| 45 | *Eragrostis aspera* | Poaceae |
| 46 | *Eragrostis ciliata* | Poaceae |
| 47 | *Eragrostis coarctata* | Poaceae |
| 48 | *Eragrostis diarrhena* | Poaceae |
| 49 | *Eragrostis maderaspatana* | Poaceae |
| 50 | *Eragrostis pilosa* | Poaceae |
| 51 | *Eragrostis tenella* | Poaceae |
| 52 | *Eragrostis viscosa* | Poaceae |
| 53 | *Eriochloa procera* | Poaceae |
| 54 | *Fimbristylis dichotoma* | Cyperaceae |
| 55 | *Fimbristylis miliacea* | Cyperaceae |
| 56 | *Fimbristylis ovata* | Cyperaceae |
| 57 | *Heteropogon contortus* | Poaceae |
| 58 | *Imperata cylindrica* | Poaceae |
| 59 | *Ischaemum pilosum* | Poaceae |
| 60 | *Ischaemum ciliare* | Poaceae |
| 61 | *Ischaemum indicum* | Poaceae |
| 62 | *Ischaemum laxum* | Poaceae |
| 63 | *Iseilema laxum* | Poaceae |
| 64 | *Iseilema prostratum* | Poaceae |
| 65 | *Panicum brevifolium* | Poaceae |
| 66 | *Panicum maximum* | Poaceae |
| 67 | *Panicum psilopodium* | Poaceae |
| 68 | *Panicum repens* | Poaceae |
| 69 | *Paspalidium flavidum* | Poaceae |
| 70 | *Pennisetum purpureum* | Poaceae |
| 71 | *Perotis indica* | Poaceae |
| 72 | *Perotis latifolia* | Poaceae |
| 73 | *Phragmites karka* | Poaceae |
| 74 | *Saccharum munja* | Poaceae |
| 75 | *Saccharum spontaneum* | Poaceae |
| 76 | *Schima sulcatum* | Poaceae |
| 77 | *Schima nervosum* | Poaceae |
| 78 | *Setaria glauca* | Poaceae |

| Sr. No | Scientific Name | Family |
|---|---|---|
| 79 | *Setaria intermedia* | Poaceae |
| 80 | *Setaria italica* | Poaceae |
| 81 | *Sorghum halepense* | Poaceae |
| 82 | *Sporobolus coromandelianus* | Poaceae |
| 83 | *Sporobolus indicus* | Poaceae |
| 84 | *Sporobolus maderaspatanus* | Poaceae |
| 85 | *Sporobolus tremulus* | Poaceae |
| 86 | *Themeda triandra* | Poaceae |
| 87 | *Themeda quadrivalis* | Poaceae |
| 88 | *Themeda arundinacea* | Poaceae |
| 89 | *Thysanolaena maxima* | Poaceae |
| 90 | *Tragus roxburghii* | Poaceae |
| 91 | *Vetiveria zizanoides* | Poaceae |
| 92 | *Fimbristylis umbellata* | Cyperaceae |
| 93 | *Kyllinga nemorales* | Cyperaceae |
| 94 | *Schoenoplectus articulatus* | Cyperaceae |

*Terrestrial Fauna of the Buffer Zone*

Unlike plants, as the animals are capable of moving from place to place either for food or shelter or mate, it is not proper to list them separately for core and buffer areas. Hence, common check lists have been prepared based on primary data and reliable secondary data. Primary data is based on direct observation, indirect or circumstantial evidence such as foot prints, feathers, skin, hair, hooves etc. Based on the biogeographical information systems, Phytogeographical and Zoogeographical information systems; state level data bases of fauna and published reports as well as the information provided by local teachers, lists of Mammals, Birds, Reptiles and Amphibians are compiled and presented as 7 (Mammals), 8 (Aves), 9 (Reptiles) and 10 (Amphibians). Among the Mammals rodents and primates were noticed. Among the birds, crows, sparrows, parrots, mynas, cattle egrets and pigeons were common and fairly widespread. The core area as well as the buffer zone do not support any REET species. All the species spotted or recorded or reported from the study area are common and widespread. The list of mammals recorded in the study area is given in **Table-3.9.7.** The list of birds reported in the study area is given in **Table-3.9.8.** The list of reptiles recorded in the study area is given in **Table-3.9.9.** The list of amphibians spotted in the study area is given in **Table-3.9.10.**

**TABLE-3.9.7**
**LIST OF MAMMALS EITHER SPOTTED OR RECORDED OR REPORTED FROM THE STUDY AREA**

| Sr. No | Scientific Name | Common Name | Family | IUCN / WPA |
|---|---|---|---|---|
| 1 | *Axis axis* | Chital / Spotted deer | Cervidae | LC / III |
| 2 | *Bandicota bengalensis* | Lesser Bandicoot Rat | Muridae | LC / V |
| 3 | *Bandicota indica* | Greater Bandicoot Rat | Muridae | LC / V |
| 4 | *Canis aureus* | Jackal | Canidae | LC / I |
| 5 | *Cynopterus brachyotus* | Indian Fruit Bat | Muridae | LC / IV |
| 6 | *Felis chaus* | Wild Cat | Felidae | LC / I |
| 7 | *Funambulus palmarum* | Indian Palm Squirrel | Rhinolophidae | LC / V |
| 8 | *Herpestes edwardsii* | Indian Mongoose | Herpestidae | LC / IV |
| 9 | *Hipposideros ater* | Leaf Nose Bat | Hipposideridae | LC / IV |

| Sr. No | Scientific Name | Common Name | Family | IUCN / WPA |
|---|---|---|---|---|
| 10 | *Lepus nigricollis* | Indian Hare | Hyaenidae | LC / IV |
| 11 | *Macaca mulatta* | Rhesus Monkey | Cercopithecidae | LC / II |
| 12 | *Mus musculus* | House /Albino mouse | Leporidae | LC / V |
| 13 | *Presbytis entellus* | Grey Languor | Cercopithecidae | LC / II |
| 14 | *Rattus norvegicus* | Albino/Brown rat | Muridae | LC / V |
| 15 | *Rattus rattus* | House rat | Muridae | LC / V |
| 16 | *Rhinolophus rouxii* | Horse Shoe Bat | Pteropodidae | LC / IV |
| 17 | *Sus scrofa* | Wild boar | Soricidae | LC / III |
| 18 | *Vulpes bengalensis* | Bengal Fox | Canidae | LC / II |

## TABLE-3.9.8
## LIST OF BIRDS EITHER SPOTTED OR REPORTED FROM THE STUDY AREA

| Sr. No | Latin Name | Common Name | IUCN / WPA Schedule |
|---|---|---|---|
| 1 | *Acridotheres tristis* | Common myna | LC / IV |
| 2 | *Aegithinia tiphia* | Common Iora | LC / IV |
| 3 | *Alcedo atthis* | Small blue kingfisher | LC / IV |
| 4 | *Andeolv grayii* | Pond heron | LC / IV |
| 5 | *Bubulcus ibis* | Cattle Egret | LC / IV |
| 6 | *Ceryle rudis* | Lesser pied Kingfisher | LC / IV |
| 7 | *Columba livia* | Blue rock pigeon | LC / IV |
| 8 | *Coracias benghalensis* | Indian roller | LC / IV |
| 9 | *Corvus splendens* | House crow | LC / V |
| 10 | *Dendrocitta vagabunda* | Indian tree pie | LC / IV |
| 11 | *Dendrocopus marhatensis* | Maratha Woodpecker | LC / IV |
| 12 | *Dicrurus macrocercus* | Black drongo | LC / IV |
| 13 | *Egretta garzetta* | Little egret | LC / IV |
| 14 | *Halcyon smyrnensis* | White-Breasted King fisher | LC / IV |
| 15 | *Merops orientalis* | Little Green Bee Eater | LC / IV |
| 16 | *Milvus migrans* | Black kite (Common) | LC / IV |
| 17 | *Motacilla alba* | White wagtail | LC / IV |
| 18 | *Oriolus oriolus* | Golden Oriole | LC / IV |
| 19 | *Passer domesticus* | House sparrow | LC / IV |
| 20 | *Phalacrocorax carbo* | Large Cormorant | LC / IV |
| 21 | *Phalacrocorax niger* | Little cormorant | LC / IV |
| 22 | *Psittacula cyanocephala* | Blossom headed Parakeet | LC / IV |
| 23 | *Psittacula krameri* | Rose-Ringed Parakeet | LC / IV |
| 24 | *Pycnonotus cafer* | Red-vented bulbul | LC / IV |
| 25 | *Saxicolodies fulicata* | Indian robin | LC / IV |
| 26 | *Streptopelia chinensis* | Spotted dove | LC / IV |
| 27 | *Sturnus contra* | Pied myna | LC / IV |
| 28 | *Sturnus pagodrum* | Brahminy myna | LC / IV |
| 29 | *Turdoides caudatus* | Common babbler | LC / IV |
| 30 | *Tyto alba* | Barn owl | LC / IV |
| 31 | *Upupa epops* | Common hoopoe | LC / IV |

## TABLE-3.9.9
## LIST OF REPTILES EITHER SPOTTED OR RECORDED OR REPORTED FROM THE STUDY AREA INCLUDING THE CORE AREA

| Sr. No | Scientific Name | Common Name | Family | IUCN/WPA |
|---|---|---|---|---|
| 1 | Argyrogena fasciolata | Banded Racer | Colubridae | LC / II |
| 2 | *Boiga forsteni* | Forsten's Cat Snake | Colubridae | LC / II |
| 3 | Boiga triconata | Common Cat Snake | Colubridae | LC / II |

| Sr. No | Scientific Name | Common Name | Family | IUCN/WPA |
|---|---|---|---|---|
| 4 | *Bungarus caeruleus* | Krait | Elapidae | LC / II |
| 5 | *Bungarus fasciatus* | Banded Krait | Elapidae | LC / II |
| 6 | *Calotes versicolor* | Garden lizard | Agamidae | LC / II |
| 7 | *Chamaeleo zeylanicus* | Chamaeleon | Chamaeleonidae | LC / II |
| 8 | *Coelognathus helenus* | Common Trinkat | Colubridae | LC / II |
| 9 | *Coelognathus helenus* | Copper Headed Trinket | Colubridae | LC / II |
| 10 | *Echis carinata* | Saw Scaled Viper | Varanidae | LC / II |
| 11 | *Enhydris enhydris* | Rainbow water snake | Colubridae | LC / II |
| 12 | *Eryx johnii* | Red Sand Boa | Boidae | LC / II |
| 13 | Eutropis carinata | Indian Mabuya | Scincidae | LC / IV |
| 14 | *Hemidactylus frenatus* | House gecko/Wall lizard | Gekkonidae | LC / II |
| 15 | Lycodon capusinus | Common Wolf Snake | Colubridae | LC / II |
| 16 | *Macropisthodon plumbicolor* | Green Keelback | Colubridae | LC / II |
| 17 | *Naja naja* | Cobra | Elapidae | LC / II |
| 18 | Natrix natrix | Water snake | Colubridae | LC / II |
| 19 | *Oligodon arnensis* | Common Kukri Snake | Colubridae | LC / II |
| 20 | *Oligodon taeniolatus* | Russell's Kukri Snake | Colubridae | LC / II |
| 21 | *Psammophis leithii* | Leith' Sand Snake | Colubridae | LC / II |
| 22 | *Ptyas mucosa* | Indian rat snake | Colubridae | LC / I |
| 23 | *Python molurus* | Indian Rock Python | Pythonidae | VU / I |
| 24 | *Sibynophis subpunctatus* | Dumeril's Black Headed Snake | Colubridae | LC / II |
| 25 | *Varanus bengalensis* | Varanus | Varanidae | VU / I |
| 26 | *Vipera russelli* | Russel's Viper | Varanidae | LC / I |

## TABLE-3.9.10
## LIST OF AMPHIBIANS EITHER SPOTTED OR REPORTED OR RECORDED FROM THE STUDY

| Sr. No | Scientific Name | Common Name | Family |
|---|---|---|---|
| 1 | *Bufo stomasticus* | Indian Marbeled Toad | Bufonidae |
| 2 | *Duttaphrynus melanostictus* | Asian Common Toad | Bufonidae |
| 3 | *Fejervarya orissaensis* | Orissa Frog | Dicroglossidae |
| 4 | *Fejervarya limnocharis* | Paddy field Frog | Dicroglossidae |
| 5 | *Fejervarya syhadrensis* | Long legged cricket Frog | Dicroglossidae |
| 6 | *Hoplobatrachus crassus* | Jerdon's Bull Frog | Dicroglossidae |
| 7 | *Hoplobatrachus tigerinus* | Indian Bull Frog | Dicroglossidae |
| 8 | *Sphaerotheca breviceps* | Indian Burrowing Frog | Dicroglossidae |
| 9 | *Sphaerotheca dobsonii* | Dobson,s Burrowing Frog | Dicroglossidae |
| 10 | *Euphlyctis cyanophlyctis* | Indian Skipper Frog | Dicroglossidae |
| 11 | *Microhyla ornata* | Ornate narrow mouthed Frog | Microhylidae |
| 12 | *Uperodon globulosus* | Narrow mouthed frog | Microhylidae |
| 13 | *Uperodon systoma* | Marbeled Balloon Frog | Microhylidae |
| 14 | *Kaloula taprobanica* | Painted Frog | Microhylidae |
| 15 | *Hy arana malabarica* | Fungoid frog | Ranidae |
| 16 | *Polypedates maculatus* | Common Indian tree Frog | Rhacophoridae |

## TABLE-3.9.11
## LIST OF SCHDULE -I FAUNA SPECIES REPORTED FROM STUDY AREA

| Sr. No | Scientific Name | Common Name | Family | IUCN/WPA | Type |
|---|---|---|---|---|---|
| 1 | *Canis aureus* | Jackal | Canidae | LC / I | Mammal |
| 2 | *Felis chaus* | Wild Cat | Felidae | LC / I | Mammal |
| 3 | *Ptyas mucosa* | Indian rat snake | Colubridae | LC / I | Reptile |
| 4 | *Python molurus* | Indian Rock Python | Pythonidae | NT / I | Reptile |
| 5 | *Varanus bengalensis* | Varanus | Varanidae | NT / I | Reptile |
| 6 | *Vipera russelli* | Russel's Viper | Varanidae | LC / I | Reptile |

*Aquatic Flora and Fauna*

The aquatic environment is provided by the Lilagarh nadi, Kurung nadi, Arpa nadi, Kurung left canal and the water storage reservoirs of the thermal power plant. The list of water bodies found in the buffer zone as given in **Table-3.9.12.** A list of aquatic and semiaquatic Macrophytes found in the study area is given in **Table-3.9.13**. A list of fishes introduced or caught or reported from the water bodies is given in **Table-3.9.14.** There are no REET species and the area is not a centre for any commercial fisheries.

## TABLE-3.9.12
## WATER BODIES IN BUFFER ZONE

| Sr. No | Forest Block | Distance (km) | Direction |
|---|---|---|---|
| 1 | Kurung left canal | - | W |
| 2 | Lilagarh river | 3.0 | E |
| 3 | Kurung nadi | 3.5 | W |
| 4 | Arpa nadi | 8.8 | SW |

## TABLE-3.9.13
## LIST OF AQUATIC AND SEMIAQUATIC MACROPHYTES

| Sr. No | Botanical Name | Common Name | Family |
|---|---|---|---|
| 1 | *Alternanthera philoxeroides* | Alligator weed / Pig Weed | Amaranthaceae |
| 2 | *Alternanthera sessilis* | Sessile joyweed | Amaranthaceae |
| 3 | *Ammannia baccifera* | Blistering Ammannia | Lythraceae |
| 4 | *Arundo donax* | Baranal | Poaceae |
| 5 | *Brachiaria mutica* | Paragrass / Buffalo grass | Poaceae |
| 6 | *Chloris barbata* | Swollen fingergrass / Plush Grass. | Poaceae |
| 7 | *Commelina diffusa* | Climbing Dayflower | Commelinaceae |
| 8 | *Cynodon dactylon* | Bermuda Grass / Lawn grass | Poaceae |
| 9 | *Cyperus bulbosus* | Australian Bush Onion | Cyperaceae |
| 10 | *Cyperus difformis* | Small-flowered umbrella sedge | Cyperaceae |
| 11 | *Cyperus rotundus* | Common Nut Sedge / Nut grass | Cyperaceae |
| 12 | *Dactyloctenium aegyptium* | Crowfoot Grass | Poaceae |
| 13 | *Echinochloa colona* | Jungle rice | Poaceae |
| 14 | *Eclipta prostrata* | False Daisy / Trailing eclipta | Asteraceae |
| 15 | *Eichhornia crassipes* | Common water-hyacinth | Pontederiaceae |
| 16 | *Enicostemma axillare* | Indian Whitehead | Gentianaceae |
| 17 | *Hydrilla verticillata* | Waterweed / Water thyme | Hydrocharitaceae |

| Sr. No | Botanical Name | Common Name | Family |
|---|---|---|---|
| 18 | *Hygrophila auriculata* | Temple plant / Marsh Barbel | Acanthaceae |
| 19 | *Ipomoea aquatica* | Water Morning Glory | Convolvulaceae |
| 20 | *Ipomoea carnea* | Bush Morning Glory | Convolvulaceae |
| 21 | *Kyllinga bulbosa .* | Bulbous blue grass | Cyperaceae |
| 22 | *Lemna minor* | Common Duck weed | Lemnaceae |
| 23 | *Ludwigia adscendens* | Water Primrose / Water Dragon | Onagraceae |
| 24 | *Ludwigia perennis* | Creeping Water Primrose | Onagraceae |
| 25 | *Neulmbo nucifera* | Indian lotus | Nymphaeaceae |
| 26 | *Neptunia prostrata* | Garden puff | Mimosaceae |
| 27 | *Nymphoides cristata* | Crested Floating Heart | Gentianaceae |
| 28 | *Nymphoides hydrophylla* | Banana Lilly | Gentianaceae |
| 29 | *Ottelia alismoides* | Duck lettuce | Hydrocharitaceae |
| 30 | *Paspalum repens* | Water Paspalum | Poaceae |
| 31 | *Phragmites karka* | Common reed | Poaceae |
| 32 | *Pistia stratiotes* | Water lettuce | Araceae |
| 33 | *Polygala arvensis* | Field Milkwort | Polygalaceae |
| 34 | *Pontederia cordata* | Pickerel weed | Pontederiaceae |
| 35 | *Sagittaria guayanensis* | Guyanese Arrowhead | Alismataceae |
| 36 | *Schoenoplectiella articulata* | Common reed sedge | Cyperaceae |
| 37 | *Schoenoplectus lacustris* | Common Club-rush | Cyperaceae |
| 38 | *Schoenoplectus subterminalis* | Water bulrush | Cyperaceae |
| 39 | *Schoenoplectus tabernaemontani* | Soft stem bulrush | Cyperaceae |
| 40 | *Sporobolus coromandelianus* | Small drop seed | Poaceae |
| 41 | *Typha angustata* | Cattail | Typhaceae |
| 42 | *Vallisneria natans* | Eel grass | Hydrocharitaceae |

## TABLE-3.9.14
## LIST OF FISHES REPORTED IN THE STUDY AREA

| Sr. No | Scientific Name | Common Name | WPA Schedule |
|---|---|---|---|
| 1 | *Anabas testudineus* | Keu | IV |
| 2 | *Anguilla bengalensis* | Indian Mottled Eel | IV |
| 3 | *Catla catla* | Catla | IV |
| 4 | *Channa punctatus* | Daulla / Murrel | IV |
| 5 | *Channa striatus* | Striped Snakehead | IV |
| 6 | *Cirrhinus mrigala* | Mirgal | IV |
| 7 | *Clarias batrachus* | Mangur / Cat fish | IV |
| 8 | *Clupisoma garua* | River Catfish | IV |
| 9 | *Labeo calbasu* | Kari | IV |
| 10 | *Labeo rohita* | Rohu | IV |
| 11 | *Macrognanthus aculeatum* | Bam/ Arelot | IV |
| 12 | *Mastocembelus armatus* | Bam/ Spiny Eel | IV |
| 13 | *Mystus cavasius* | Tengna | IV |
| 14 | *Oreochromis mossambicus* | Mozambique Tilapia | IV |
| 15 | *Oreochromis aureus* | Blue Tilapia | IV |
| 16 | *Oreochromis niloticus* | Nile Tilapia | IV |
| 17 | *Puntius sophore* | Pool Barb | IV |
| 18 | *Tilapia rendalli* | Red breast Tilapia | IV |

*Conclusions*

From the primary survey and as per forest department records and review of literature, there are no sanctuaries, national park, biosphere reserves in the study area. The study area does not have migratory corridors of any important species.

The study area did not record the presence of any critically threatened species in the study area. The records of Botanical Survey of India and forest department also did not indicate presence of any endangered or rare and vulnerable plant species in this area.

On comparison of the check list given in the Schedule-I of the Indian Wildlife Protection Act,1972 and the list of wildlife recorded in the study area, it can be concluded that six species belong to Schedule-I as per the Wildlife (Protection) Amendment Act, 2022.

## 3.10 Demography and Socio-Economics

The demographic and socio- economic conditions prevailing at the study area falls in 106 locations (Urban and Rural) which includes 104 rural villages belongs to Sipat and Bilaspur tehsils of Bilaspur district (2 urban locations belongs to Bilaspur tehsil) and Akaltara Tehsil of Janjgir-Champa district and of Chhattisgarh is analyzed. The socio-economic data forms the basis for developing a suitable enterprise social responsibility plan to address the needs of the population.

The project proponent is committed to take up the socio-economic development initiatives not only to minimize the negative impact on the population and also to improve the socio-economic status of population living in and around proposed expansion of 1x800 MW Sipat Super Thermal Power Project, (Stage-III) project study area as its sustained effort as part of Corporate Environment Responsibility-CER and Corporate Social Responsibility-CSR.

### 3.10.1 Methodology Adopted for the Study

The methodology adopted for the study mainly includes primary survey, review of published secondary data (District Census Statistical Handbooks- 2011 and Primary Census Abstract of Census-2011) with respect to population, density, household size, sex ratio, social stratification, literacy rate and occupational structure in the 10 km radius of study area.

### 3.10.2 Review of Demographic and Socio-Economic Profile-2011

The village wise demographic data of 106 locations (Urban and Rural) which includes 104 rural villages belongs to Sipat and Bilaspur tehsils of Bilaspur district (2 urban locations belongs to Bilaspur tehsil ) and Akaltara Tehsil of Janjgir-Champa district and of Chhattisgarh as per 2011 census are falling in study area of proposed 1x800 MW Sipat Super Thermal Power Project, (Stage-III) project at Sipat, as per the 2011 Village and ward wise population census is presented in **Annexure-XII.** The salient features of the demographic and socio-economic conditions are analyzed and described in the following sections.

3.10.3 Demography

**Distribution of Population**

As per 2011 census the study area consisted of 215675 persons inhabited in study area. The distribution of population in the study area is shown in **Table-3.10.1.**

**TABLE-3.10.1**
**DISTRIBUTION OF POPULATION**

| Sr No | Particulars | 0 to 3 | 3.0 to 7 | 7.0 to 10 | 0 to 10 | 0 to 3 | 3.0 to 7 | 7.0 to 10 | 0 to 10 |
|---|---|---|---|---|---|---|---|---|---|
| | | 2011 Census | | | | 2001 Census | | | |
| 1 | Total households | 10125 | 16397 | 20740 | 47262 | 6069 | 11385 | 13567 | 31021 |
| 2 | Total population | 46042 | 75152 | 94481 | 215675 | 30931 | 58875 | 72162 | 161968 |
| 3 | Male population | 23486 | 38254 | 47959 | 109699 | 15714 | 29691 | 36500 | 81905 |
| 4 | Female population | 22556 | 36898 | 46522 | 105976 | 15217 | 29184 | 35662 | 80063 |
| 5 | Total population 0 to 6 years | 7035 | 11633 | 14244 | 32912 | 5554 | 11182 | 13120 | 29856 |
| 6 | Male :population 0 to 6 years | 3603 | 5931 | 7304 | 16838 | 2840 | 5668 | 6592 | 15100 |
| 7 | Female population 0 to 6 years | 3432 | 5702 | 6940 | 16074 | 2714 | 5514 | 6528 | 14756 |
| 8 | % of 0 to 6 years population | 15.28 | 15.48 | 15.08 | 15.26 | 17.96 | 18.99 | 18.18 | 18.43 |
| 9 | Ave HH size | 4.55 | 4.58 | 4.56 | 4.56 | 5.10 | 5.17 | 5.32 | 5.22 |
| 10 | % of males to the total population | 51.01 | 50.90 | 50.76 | 50.86 | 50.80 | 50.43 | 50.58 | 50.57 |
| 11 | % of females to the total population | 48.99 | 49.10 | 49.24 | 49.14 | 49.20 | 49.57 | 49.42 | 49.43 |
| 12 | Total males population (Excluding 0 to 6 years Males) | 19883 | 32323 | 40655 | 92861 | 12874 | 24023 | 29908 | 66805 |
| 13 | Total females population (Excluding 0 to 6 years Females) | 19124 | 31196 | 39582 | 89902 | 12503 | 23670 | 29134 | 65307 |
| 14 | Total population (Excluding 0 to 6 years Population) | 39007 | 63519 | 80237 | 182763 | 25377 | 47693 | 59042 | 132112 |
| 15 | Child sex ratio (No of female children per 1000 male children) | 953 | 961 | 950 | 955 | 956 | 973 | 990 | 977 |
| 16 | Sex ratio (No females per 1000 males) | 962 | 965 | 974 | 968 | 971 | 985 | 974. | 978 |
| 17 | Density | 504 | 416 | 417 | 433 | 338 | 326 | 319 | 325 |

*Source: Census of India 2011*

- **Average Household Size**

The study area has a household size of 4.56 as per 2011 census.

- **Population Density**

The density of population reveals that the study area has an overall density of 433 persons per $km^2$ (PP $km^2$) as per 2011 census reports. 0-3 km population density is 504, 3-7 km population density is 416 and 7-10 km population is 417.

However, the major proportion of population are in and around the Sipat tehsil area is falling in 3-7 and 7-10 km radius of the project study area.

- **Rural and Urban Population**

Out of 2,15,675 total population of the study area 98.10 % (2,11,587) in rural area and 1.90 % (4088) in urban areas are residing as per 2011 census records. However, villages of Sipat and Bilaspur tehsils constitute about 83.94% (1,81,019 (1,19,927+61,092)). The study areas population is rapidly increasing in the study area. The consolidated rural and urban population details are presented in **Table-3.10.2.**

**TABLE-3.10.2**
**RURAL AND URBAN POPULATION PROPORTION**

| Sr. No | TALUKA | Rural Population | % | Urban Population | % | Total Population | % |
|---|---|---|---|---|---|---|---|
| 1 | Akaltara, Janjgir-Champa district, Chhattisgarh | 30568 | 14.17 | 0 | 0.00 | 30568 | 14.17 |
| 2 | Bilaspur, Bilaspur district, Chhattisgarh | 61092 | 28.33 | 4088 | 1.90 | 65180 | 30.22 |
| 3 | Sipat, Bilaspur district, Chhattisgarh | 119927 | 55.61 | 0 | 0.00 | 119927 | 55.61 |
| | Total | 2,11,587 | 98.10 | 4088 | 1.90 | 2,15,675 | 100.00 |

*Source: Census of India 2011*

- **Sex Ratio**

The configuration of male and female indicates that the males constitute to about 50.86% and females to 49.14% of the total population as per 2011 census records. The study area on an average has 968 females per 1000 males as per 2011 census reports. In comparison to the Bilaspur district sex ratio, (Bilaspur district 970) the study area has recorded slightly low sex ratio. The sex ratio in the study area directly and indirectly reveals certain geographical and sociological aspects in relation to male.

- **Child Sex Ratio**

The study area child sex ratio is 955 female children for 1000 male children in the study area. In comparison to the adult sex ratio, the child sex ratio is lessor and also lessor then the Bilaspur Child Sex Ratio (956) in the study area. Several reasons are attributed to the decline in the number of girls, neglect of the girl child, high maternal mortality and female infanticide. Some of the reasons for neglect of girl child and low child sex ratio are son preference and the belief that, it is only the son who can perform the last rites, that lineage and inheritance runs through the male line, sons will look after parents in old age, men are the bread winners etc. Exorbitant dowry demand is another reason for female foeticide/infanticide.

➢ **Reasons for Declining Sex Ratio**

- There are multiple factors behind the trend of declining sex ratio.
- Many studies have shown that illegal pre-natal sex determination is one of the reason for low sex ratio in India. Besides the misuse of the technology, the patriarchal societies in many parts of India have translated their prejudice and bigotry into a compulsive preference for boys and discriminations against the girl child; and
- Women work is always socially devalued with limited autonomy in decision-making processes. Patriarchy always maintains a strong hold on gender inequality. (Sex determination tests are seen as providing a 'reproductive choice' – a choice to decide to have a boy or a girl). Soon after the sex determining techniques, in 1983 Indian parliament banned the practice of sex determination in all public institutions. However, the prime legislation pre-natal diagnostic techniques act, passed in 1994, after a long campaign by the civil society and women organizations in the country.

3.10.4 Social Structure

In the study area, as per 2011 census, there is 27.44% Scheduled Castes (SC) population in the study area. 12.88% of population belongs to Scheduled Tribes (ST). The proportion of study areas SC's population is higher than the Bilaspur district SC population (Bilaspur district SC Proportion of population is 13.80%). Overall the data of social stratification reveals that the SC and ST % to population is more than 40%. The SC and ST community are marginalized and they are considered at low level of social strata and calls for a special attention in Social Impact Management Plan for improving their socio-economic status apart from preservation and protection of their art, culture and traditional rights of livelihood. The distribution of population by social structure is shown in **Table-3.10.3.**

**TABLE-3.10.3**
**DISTRIBUTION OF POPULATION BY SOCIAL STRUCTURE**

| Sr. No | Particulars | 0 to 3 km | 3 to 7 km | 7 to 10 km | 0 to 10 km | 0 to 3 km | 3 to 7 km | 7 to 10 km | 0 to 10 km |
|---|---|---|---|---|---|---|---|---|---|
| | | 2011 Census | | | | 2001 Census | | | |
| 1 | SC population | 14373 | 18632 | 26176 | 59181 | 9628 | 14242 | 18968 | 42838 |
| 2 | % of SC's to the Total population | 31.22 | 24.79 | 27.71 | 27.44 | 31.13 | 24.19 | 26.29 | 26.45 |
| 3 | Male SC | 7313 | 9510 | 13237 | 30060 | 4934 | 7277 | 9692 | 21903 |
| 4 | Female SC | 7060 | 9122 | 12939 | 29121 | 4694 | 6965 | 9276 | 20935 |
| 5 | ST population | 5276 | 12218 | 10282 | 27776 | 3205 | 9163 | 8243 | 20611 |
| 6 | Male ST | 2634 | 6241 | 5131 | 14006 | 1623 | 4505 | 4011 | 10139 |
| 7 | Female ST | 2642 | 5977 | 5151 | 13770 | 1582 | 4658 | 4232 | 10472 |
| 8 | % of ST's to the Total population | 11.46 | 16.26 | 10.88 | 12.88 | 10.36 | 15.56 | 11.42 | 12.73 |
| 9 | Total SC & ST's population | 19649 | 30850 | 36458 | 86957 | 12833 | 23405 | 27211 | 63449 |
| 10 | % of SC's & ST's to the total population | 42.68 | 41.05 | 38.59 | 40.32 | 41.49 | 39.75 | 37.71 | 39.17 |
| 11 | Total population | 46042 | 75152 | 94481 | 2,15,675 | 30931 | 58875 | 72162 | 1,61,968 |

*Source: Census of India 2011*

3.10.5 Literacy Levels

The data of study area reveals that literacy rate of 84.74% as per 2011 census, which is found to be better than the district rate of literacy (Bilaspur district 72.90%). The distribution of literates and literacy rate in the study area is presented in **Table-3.10.4.**

**TABLE-3.10.4**
**DISTRIBUTION OF LITERATE AND LITERACY RATES**

| Sr. No | Particulars | 0 to 3 km | 3 to 7 km | 7 to 10 km | 0 to 10 km | 0 to 3 km | 3 to 7 km | 7 to 10 km | 0 to 10 km |
|---|---|---|---|---|---|---|---|---|---|
| | | 2011 Census | | | | | | | |
| 1 | Male population | 23486 | 38254 | 47959 | 109699 | 15714 | 29691 | 36500 | 81905 |
| 2 | Female population | 22556 | 36898 | 46522 | 105976 | 15217 | 29184 | 35662 | 80063 |
| 3 | Total population | 46042 | 75152 | 94481 | 215675 | 30931 | 58875 | 72162 | 161968 |
| 4 | Male population (0-6 years) | 3603 | 5931 | 7304 | 16838 | 2840 | 5668 | 6592 | 15100 |
| 5 | Female population (0-6 years | 3432 | 5702 | 6940 | 16074 | 2714 | 5514 | 6528 | 14756 |
| 6 | Total population (0-6 Years) | 7035 | 11633 | 14244 | 32912 | 5554 | 11182 | 13120 | 29856 |
| 7 | Total population 7+ Years | 39007 | 63519 | 80237 | 182763 | 25377 | 47693 | 59042 | 132112 |
| 8 | Male literates 7+Years | 19883 | 32323 | 40655 | 92861 | 12874 | 24023 | 29908 | 66805 |
| 9 | Female literates7+Years | 19124 | 31196 | 39582 | 89902 | 12503 | 23670 | 29134 | 65307 |
| 10 | Total literates (7+ Years) | 39007 | 63519 | 80237 | 182763 | 25377 | 47693 | 59042 | 132112 |
| 12 | Male literacy rate (%) to the total literates | 50.97 | 50.89 | 50.67 | 50.81 | 50.73 | 50.37 | 50.66 | 50.57 |
| 13 | Female literacy rate (%) to the total literates | 49.03 | 49.11 | 49.33 | 49.19 | 49.27 | 49.63 | 49.34 | 49.43 |
| 14 | Average male literacy to the total population (%) | 43.18 | 43.01 | 43.03 | 43.06 | 41.62 | 40.80 | 41.45 | 41.25 |
| 15 | Average female literacy to the total population (%) | 41.54 | 41.51 | 41.89 | 41.68 | 40.42 | 40.20 | 40.37 | 40.32 |
| 16 | Total literacy rate (%) to the total population | 84.72 | 84.52 | 84.92 | 84.74 | 82.04 | 81.01 | 81.82 | 81.57 |

*Source: Census of India 2011*

The percentage of male literates to the total literates of the study area works out to be 50.81 %. The percentage of female literates to the total literates, which is an important indicator for social change, is observed to be 49.19 % in the study area as per 2011 census records.

3.10.6 Occupational Structure

The occupational structure of residents of work participation rate in the study area is studied with reference to main workers, marginal workers and non-workers. The main workers include 10 categories of workers defined by the Census department consisting of cultivators, agricultural laborers, those engaged in live-stock, forestry, fishing, mining and quarrying; manufacturing, processing and repairs in household industry; and other than household industry, construction, trade and commerce, transport and communication and other services.

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

Total work participation in the project study areas is 45.14 % and the non-workers constitute 54.86% of the total population respectively. The work participation of the study area is better than the Bilaspur district (44.09 %) work participation. The distribution of workers by occupation indicates that the non-workers are the predominant population. The main workers to the total workers are 54.91 % and the marginal workers constitute to 45.09 % to the total workers. The occupational structure of the study area is shown in **Table-3.10.5**

**TABLE-3.10.5**
**OCCUPATIONAL STRUCTURE**

| Sr. No | Particulars | 0 to 3 km | 3 to 7 km | 7 to 10 km | 0 to 10 km | 0 to 3 km | 3 to 7 km | 7 to 10 km | 0 to 10 km |
|---|---|---|---|---|---|---|---|---|---|
| | | 2011 Census | | | | 2001 Census | | | |
| 1 | Total population | 46042 | 75152 | 94481 | 215675 | 30931 | 58875 | 72162 | 161968 |
| 2 | Total workers | 19364 | 34298 | 43689 | 97351 | 12714 | 26758 | 30671 | 70143 |
| 3 | Male total workers | 12334 | 19906 | 26071 | 58311 | 7345 | 14500 | 17307 | 39152 |
| 4 | Female total workers | 7030 | 14392 | 17618 | 39040 | 5369 | 12258 | 13364 | 30991 |
| 5 | Work participation rate | 42.06 | 45.64 | 46.24 | 45.14 | 41.10 | 45.45 | 42.50 | 43.31 |
| 6 | Total main workers | 10503 | 19165 | 23792 | 53460 | 8952 | 14843 | 21503 | 45298 |
| 7 | Male main workers | 8044 | 13535 | 17137 | 38716 | 6078 | 10125 | 14328 | 30531 |
| 8 | Female main workers | 2459 | 5630 | 6655 | 14744 | 2874 | 4718 | 7175 | 14767 |
| 9 | % of main workers to total workers | 54.24 | 55.88 | 54.46 | 54.91 | 70.41 | 55.47 | 70.11 | 64.58 |
| 10 | Marginal workers | 8861 | 15133 | 19897 | 43891 | 3762 | 11915 | 9168 | 24845 |
| 11 | Male marginal workers | 4290 | 6371 | 8934 | 19595 | 1267 | 4375 | 2979 | 8621 |
| 12 | Female marginal workers | 4571 | 8762 | 10963 | 24296 | 2495 | 7540 | 6189 | 16224 |
| 13 | % of marginal workers to total workers | 45.76 | 44.12 | 45.54 | 45.09 | 29.59 | 44.53 | 29.89 | 35.42 |
| 14 | Non-workers | 26678 | 40854 | 50792 | 118324 | 18217 | 32117 | 41491 | 91825 |
| 15 | Male non-workers | 11152 | 18348 | 21888 | 51388 | 8369 | 15191 | 19193 | 42753 |
| 16 | Female non-workers | 15526 | 22506 | 28904 | 66936 | 9848 | 16926 | 22298 | 49072 |
| 17 | % of non-workers to total population | 57.94 | 54.36 | 53.76 | 54.86 | 58.90 | 54.55 | 57.50 | 56.69 |

*Source: Census of India 2011*

## 3.11 Traffic Study

The traffic studies have been conducted to know the prevailing traffic volumes on the roads in the study area. It is essential to consider these details for assessing the anticipated future traffic volumes as a part of overall impact assessment for the project.

The variations of traffic densities depend upon the working days and time and also vary in day and night times. In order to assess the prevailing traffic volumes on the roads, the survey was conducted during normal working days of the week by avoiding local holidays or abnormal situations to reflect the true picture of the traffic densities. The traffic study was conducted at one location for 24 hours.

### 3.11.1 Selection of Sampling Location

The traffic density study was conducted at State highway (Bilaspur to Baloda) route which is 1.0 km distance from the project site.

3.11.2 Methodology

*3.11.2.1 Vehicular Count*

The vehicles plying in both the directions were counted continuously for 24 hours at one location. The vehicles were counted every hour and recorded under respective category. The maximum traffic count in an hour is termed as peak hour traffic. The vehicles were categorized under various heads like trucks/tankers, buses, multi axles, cars, 2/3 wheelers, cycles and bullock carts.

*3.11.2.2 Categorization of Traffic*

The engine driven vehicles were categorized into various heads viz. light motor vehicles (LMV) as two wheelers (scooters, motor cycles etc.), three wheelers (auto rickshaws, 3-wheel tempo etc.), medium motor vehicles (cars, jeeps), tractors (6 wheelers), mini buses and mini trucks (8 wheelers), heavy motor vehicles such as buses, trucks and tankers (10 wheelers).

3.11.3 Results and Discussion-For Pre-Monsoon Season

The summary of daily traffic count for the location was monitored during the study period i.e for pre-monsoon season is summarized in **Table-3.11.1** and % of composition of the vehicles are given in the **Table-3.11.2.**

It was observed that the 2/3 wheelers, cars/jeeps and trucks/buses forms the major volume of the traffic.

*3.11.3.1 Presentation of Results*

The present level of traffic has been converted to Passenger Car Units (PCU) at this location as per the conversion factors stipulated by Indian Road Congress (IRC). The Passenger Car Unit (PCU) recorded at the selected traffic location, which is towards NH-200 route is about 2029 PCU.

**TABLE-3.11.1**
**TRAFFIC DENSITY (VEHICLES/DAY)-FOR PRE-MONSOON SEASON**

| Code | Location | Two Wheelers Scooter/Bikes | 3 Wheeler Auto Rickshaw | Four Wheeler Car/Jeep | Six wheeler Buses/ Truck | Heavy Vehicles | Total |
|---|---|---|---|---|---|---|---|
| T1 | SH (Bilaspur to Baloda) | 800 | 40 | 420 | 13 | 30 | 1303 |
| | SH (Baloda to Bilaspur) | 900 | 52 | 500 | 18 | 10 | 1480 |
| | Total No.of vehicles | 1700 | 92 | 920 | 31 | 40 | 2783 |
| | Total PCU'S | 850 | 46 | 920 | 93 | 120 | 2029 |

*Note: PCU rating: (2/3 wheelers: 0.5, Car/Jeep: 1.0, Tractor: 3.0, Buses: 3.0, Trucks/HMV: 3.0)*

**TABLE–3.11.2**
**COMPOSITION OF EXISTING TRAFFIC VOLUME**

| Code | Total Vehicles | No. of Vehicles | | | % Composition | | |
|---|---|---|---|---|---|---|---|
| | | LMV | MMV | HMV | LMV | MMV | HMV |
| T1 | 2783 | 1792 | 920 | 71 | 64.4 | 33.0 | 2.6 |

*Note: LMV-Light Motor Vehicles (scooter, motorcycle & auto rickshaw etc.)*
*MMV-Medium Motor Vehicles (car, jeep, tractor, mini bus, mini trucks)*
*HMV-Heavy Motor Vehicles (bus, trucks and tankers)*

*3.11.3.2 Adequacy of Existing Road Network in Study Area*

With present level of traffic on State highway Bilaspur to Baloda), the adequacy of road/highway has been estimated by comparison with the recommendations stipulated by Indian Road Congress (IRC). The total traffic load of 2029 PCU/day will be well within the IRC stipulated maximum load of 15000 PCU/day for a two lane highway.

3.11.4 Results and Discussion-For Winter Season

The summary of daily traffic count for the location was monitored during the study period i.e for winter season is summarized in **Table-3.11.3** and % of composition of the vehicles are given in the **Table-3.11.4.**

**TABLE-3.11.3**
**TRAFFIC DENSITY (VEHICLES/DAY)-FOR WINTER SEASON**

| Code | Location | Two Wheelers Scooter/Bikes | 3 Wheeler Auto Rickshaw | Four Wheeler Car/Jeep | Six wheeler Buses/ Truck | Heavy Vehicles | Total |
|---|---|---|---|---|---|---|---|
| T1 | SH (Bilaspur to Baloda) | 790 | 30 | 390 | 15 | 28 | 1253 |
| | SH (Baloda to Bilaspur) | 890 | 62 | 480 | 21 | 14 | 1467 |
| | Total No.of vehicles | 1680 | 92 | 870 | 36 | 42 | 2720 |
| | Total PCU'S | 840 | 46 | 870 | 108 | 126 | 1990 |

*Note: PCU rating: (2/3 wheelers: 0.5, Car/Jeep: 1.0, Tractor: 3.0, Buses: 3.0, Trucks/HMV: 3.0)*

**TABLE–3.11.4**
**COMPOSITION OF EXISTING TRAFFIC VOLUME**

| Code | Total Vehicles | No. of Vehicles | | | % Composition | | |
|---|---|---|---|---|---|---|---|
| | | LMV | MMV | HMV | LMV | MMV | HMV |
| T1 | 2720 | 1772 | 870 | 78 | 65.3 | 31.9 | 2.8 |

*Note: LMV-Light Motor Vehicles (scooter, motorcycle & auto rickshaw etc.)*
*MMV-Medium Motor Vehicles (car, jeep, tractor, mini bus, mini trucks)*
*HMV-Heavy Motor Vehicles (bus, trucks and tankers)*

*3.11.4.2 Adequacy of Existing Road Network in Study Area*

With present level of traffic on State highway Bilaspur to Baloda), the adequacy of road/highway has been estimated by comparison with the recommendations stipulated by Indian Road Congress (IRC). The total traffic load of 1990 PCU/day will be well within the IRC stipulated maximum load of 15000 PCU/day for a two lane highway.

## 3.12 Baseline Data Collection – (March 2023 to May 2023)

As the baseline data generation has become more than three years old, a fresh baseline monitoring was undertaken by NTPC through M/s. Mantec Consultants Pvt. Ltd. during Pre-monsoon season (March to May, 2023). The report is attached as **Annexure-XIII**. The monitoring data in respect of Air Quality, Water Quality, Noise Quality and Soil Quality are summarized is given in Table-3.12.1.

### 3.12.1 Meteorological Data Generated at Site

The meteorological parameters were recorded on hourly basis during the study period and comprises of wind speed, wind direction (from 0 to 360 degrees), temperature, relative humidity and rainfall. The meteorological parameters have been recorded and are presented in **Table-3.12.1**.

**TABLE-3.12.1**
**SUMMARY OF THE METEOROLOGICAL DATA GENERATED AT SITE**

| Month | Temperature ($^0$C) | | Relative Humidity (%) | | Rainfall (mm) |
|---|---|---|---|---|---|
| | Max | Min | Max | Min | |
| **Pre-Monsoon Season** | | | | | |
| March, 2023 | 39.2 | 17.4 | 85 | 39 | 22.2 |
| April, 2023 | 43.6 | 18.8 | 84 | 42 | 41 |
| May, 2023 | 44.6 | 18.9 | 86 | 37 | 0 |
| **Range** | **17.4-44.6** | | **37.0-86.0** | | **63.2** |

### 3.12.2 Ambient Air Quality

Establishment of Ambient Air quality in core study area through primary data generation. A network of ten (10) ambient air-sampling locations was selected for assessment of the existing status of air environment within the study zone. The heights of the sampling stations were kept between 4 to 6 m from ground level. After reconnaissance of the area and observing the topographical features and review of the available meteorological data and local conditions the sampling sites were chosen which will be the representative of the local areas under study. Details of ambient air quality monitoring locations are given in **Table-3.12.2** and are shown in **Figure-3.12.1**. The ambient air sampling results are given in **Table-3.12.3.**

**TABLE-3.12.2**
**AMBIENT AIR SAMPLING LOCATIONS**

| Station Code | Name of the Station (AAQ) | Distance from the Plant Boundary (km) | Direction w.r.t Boundary | Zone | Remarks |
|---|---|---|---|---|---|
| AAQ1 | Plant site | - | - | Industrial | - |
| AAQ2 | Sipat | 1.3 | NW | Residential/Rural | Cross wind |
| AAQ3 | Nargara | 3.2 | N | Residential/Rural | Cross wind |
| AAQ4 | Bhadrapara | 3.3 | NE | Residential/Rural | Cross wind |
| AAQ5 | Sonthi | 8.6 | NE | Residential/Rural | Cross wind |
| AAQ6 | Darrabhata | 1.7 | E | Residential/Rural | Down wind |
| AAQ7 | Pachri | 9.2 | SE | Forest area | Cross wind |
| AAQ8 | Changaripara | 6.0 | E | Residential/Rural | Down wind |
| AAQ9 | Sukhripali | 4.5 | S | Residential/Rural | Cross wind |
| AAQ10 | Matiyari | 1.8 | W | Residential/Rural | Up wind |

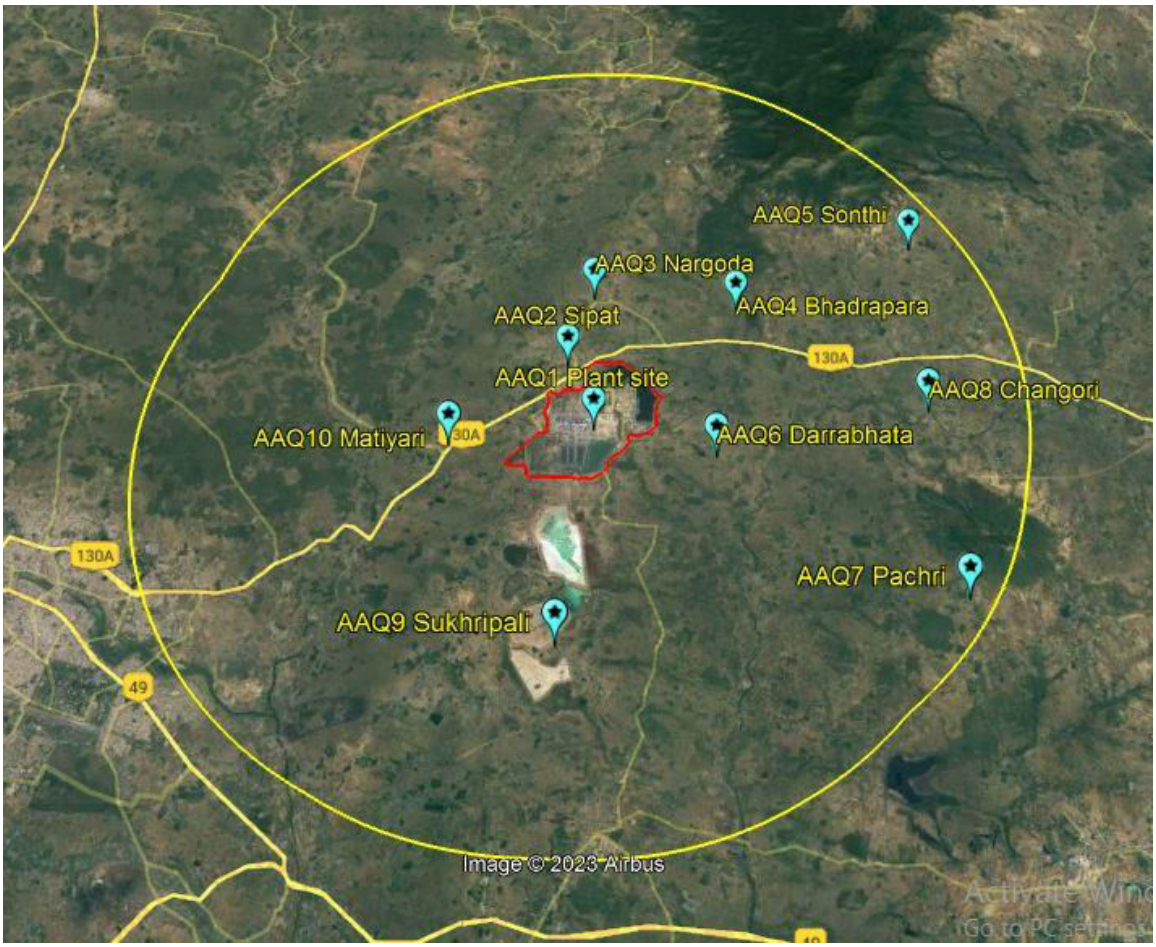



**FIGURE-3.12.1**
**AMBIENT AIR QUALITY MONITORING LOCATIONS**

## TABLE–3.12.3
## AMBIENT AIR QUALITY RESULTS-(MARCH-MAY 2023)

| Sr No. | Locations | | Parameters | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $PM_{10}$ ($\mu g/m^3$) | $PM_{2.5}$ ($\mu g/m^3$) | $SO_2$ ($\mu g/m^3$) | $NO_2$ ($\mu g/m^3$) | $NH_3$ ($\mu g/m^3$) | $O_3$ ($\mu g/m^3$) | CO ($mg/m^3$) | $C_6H_6$ ($\mu g/m^3$) | B(a)P ($\mu g/m^3$) | Pb ($\mu g/m^3$) | Ni ($ng/m^3$) | As ($ng/m^3$) | Hg ($\mu g/m^3$) |
| 1 | Plant site | Max | 74 | 44 | 19 | 32 | 30 | 38 | 0.81 | 0.73 | BDL | BDL | BDL | BDL | BDL |
| | | Min | 56 | 31 | 6 | 16 | 26 | 32 | 0.74 | 0.64 | BDL | BDL | BDL | BDL | BDL |
| 2 | Sipat | Max | 73 | 42 | 16 | 29 | 32 | 36 | 0.77 | 0.69 | BDL | BDL | BDL | BDL | BDL |
| | | Min | 50 | 30 | 6 | 18 | 26 | 30 | 0.68 | 0.62 | BDL | BDL | BDL | BDL | BDL |
| 3 | Nargara | Max | 73 | 51 | 17 | 23 | 29 | 33 | 0.68 | 0.64 | BDL | BDL | BDL | BDL | BDL |
| | | Min | 46 | 23 | 4 | 12 | 24 | 28 | 0.58 | 0.60 | BDL | BDL | BDL | BDL | BDL |
| 4 | Bhadrapara | Max | 71 | 43 | 16 | 28 | 27 | 39 | 0.79 | 0.71 | BDL | BDL | BDL | BDL | BDL |
| | | Min | 53 | 30 | 6 | 16 | 22 | 30 | 0.72 | 0.64 | BDL | BDL | BDL | BDL | BDL |
| 5 | Sonthi | Max | 76 | 45 | 19 | 31 | 28 | 44 | 0.72 | 0.65 | BDL | BDL | BDL | BDL | BDL |
| | | Min | 49 | 28 | 6 | 14 | 24 | 34 | 0.62 | 0.58 | BDL | BDL | BDL | BDL | BDL |
| 6 | Darrabhata | Max | 72 | 43 | 17 | 36 | 26 | 32 | 0.69 | 0.64 | BDL | BDL | BDL | BDL | BDL |
| | | Min | 52 | 30 | 7 | 18 | 23 | 26 | 0.64 | 0.56 | BDL | BDL | BDL | BDL | BDL |
| 7 | Pachri | Max | 73 | 44 | 22 | 31 | 33 | 39 | 0.71 | 0.65 | BDL | BDL | BDL | BDL | BDL |
| | | Min | 53 | 32 | 8 | 18 | 26 | 32 | 0.58 | 0.52 | BDL | BDL | BDL | BDL | BDL |
| 8 | Changaripara | Max | 74 | 46 | 26 | 37 | 34 | 40 | 0.82 | 0.72 | BDL | BDL | BDL | BDL | BDL |
| | | Min | 50 | 29 | 6 | 14 | 26 | 32 | 0.76 | 0.64 | BDL | BDL | BDL | BDL | BDL |
| 9 | Sukhripali | Max | 69 | 46 | 19 | 31 | 30 | 32 | 0.76 | 0.62 | BDL | BDL | BDL | BDL | BDL |
| | | Min | 48 | 24 | 6 | 17 | 25 | 28 | 0.68 | 0.56 | BDL | BDL | BDL | BDL | BDL |
| 10 | Matiyari | Max | 72 | 44 | 19 | 37 | 30 | 42 | 0.83 | 0.72 | BDL | BDL | BDL | BDL | BDL |
| | | Min | 50 | 29 | 7 | 18 | 24 | 30 | 0.74 | 0.64 | BDL | BDL | BDL | BDL | BDL |
| | | **Range** | **46-76** | **23-51** | **04-26** | **12-37** | **22-34** | **26-44** | **0.58-0.83** | **0.52 - 0.73** | **BDL** | **BDL** | **BDL** | **BDL** | **BDL** |

Summary:

During the monitoring period (March-May 2023), it has been observed $PM_{10}$ for all the monitoring stations is ranging from 46 to 76 $\mu g/m^3$. $PM_{2.5}$ for all the monitoring stations ranging from 23 to 51 $\mu g/m^3$. $SO_2$ for all the monitoring stations is ranging from 04 to 26 $\mu g/m^3$. The concentration of $NO_2$ is observed to be in the range from 12-37 $\mu g/m^3$.

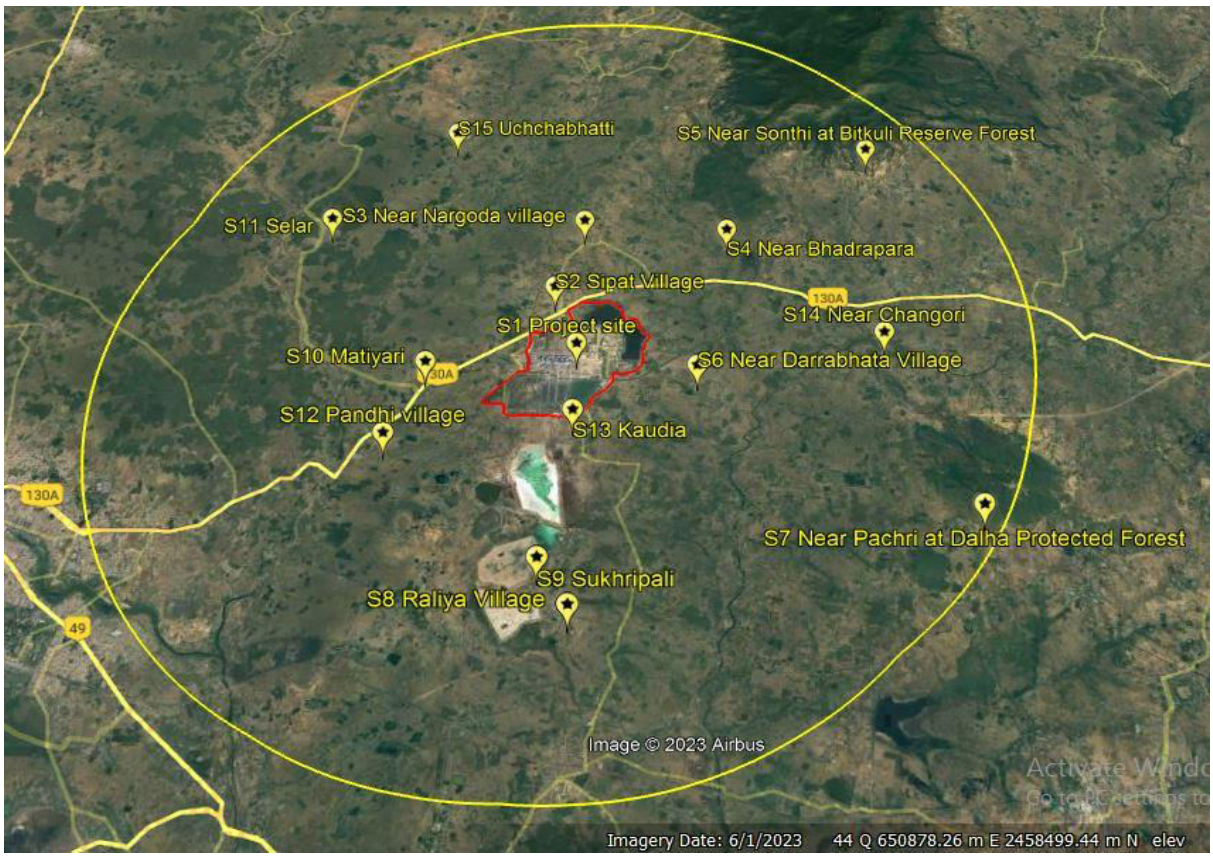
The concentrations of $PM_{2.5}$, $PM_{10}$, $SO_2$, $NO_2$, $O_3$, CO, $NH_3$, Pb, BaP, Hg, As, Ni and $C_6H_6$ are observed to be well within the NAAQ standards prescribed by Central Pollution Control Board (CPCB) for industrial and rural /residential zone.

### 3.12.2 Soil Quality

For land Environmental studies, 15 sampling sites were selected to understand physico-chemical and fertility status of the soil. This will establish the baseline characteristics and will facilitate identifying the contamination if any due to the proposed project. The sufficient soil samples were collected randomly at the depth of more than 30 cm and mixed up homogenously and packed in zip bag to avoid any loss of moisture content before analysis. The soil Quality monitoring locations is given in **Table-3.12.4** and are shown in **Figure-3.12.2.** The soil quality results are given in **Table-3.12.5 (A & B).**

## TABLE-3.12.4
## SOIL SAMPLING STATIONS

| Station Code | Name of the Station | Distance (km) | Direction | Zone |
|---|---|---|---|---|
| S1 | Project Site | - | - | Industrial |
| S2 | Sipat | 1.3 | NW | Agricultural |
| S3 | Nargora | 3.2 | N | Agricultural |
| S4 | Bhadrapara | 3.3 | NE | Agricultural |
| S5 | Near Sonthi at Bitkuli Reserve Forest | 8.6 | NE | Forest |
| S6 | Darrabhata | 1.7 | E | Agricultural |
| S7 | Near Pachri at Dalha Protected Forest | 9.2 | SE | Forest |
| S8 | Raliya | 5.7 | S | Agricultural |
| S9 | Sukhiripali | 4.5 | S | Agricultural |
| S10 | Matiyari | 1.8 | W | Agricultural |
| S11 | Selar | 6.4 | NW | Agricultural |
| S12 | Pandi | 2.3 | SW | Agricultural |
| S13 | Kaudia | 0.5 | S | Agricultural |
| S14 | Changaripara | 6.0 | E | Agricultural |
| S15 | Uchbhatti | 6.0 | NNW | Agricultural |




## FIGURE-3.12.2
## SOIL SAMPLING LOCATIONS

## TABLE-3.12.5(A)
## SOIL QUALITY RESULTS

| Sr. No. | Parameters | Locations | S1 | S2 | S3 | S4 | S5 | S6 | S7 |
|---|---|---|---|---|---|---|---|---|---|
| | | | Project Site | Sipat | Nargora | Bhadrapara | Near Sonthi at Bitkuli Reserve Forest | Darrabhata | Near Pachri at Dalha Protected Forest |
| | | Units | Value | Value | Value | Value | Value | Value | Value |
| 1 | pH | - | 7.42 | 7.46 | 7.36 | 7.28 | 7.44 | 7.52 | 7.38 |
| 2 | Classification | - | Red Soil | Red Soil | Red Soil | Red Soil | Red Soil | Red Soil | Red Soil |
| 3 | Conductivity | µmhos/cm | 364 | 384 | 378 | 342 | 366 | 338 | 352 |
| 4 | Texture | - | Sandy Loam | Sandy Loam | Sandy Loam | Sandy Loam | Sandy Loam | Sandy Loam | Sandy Loam |
| 5 | Sand | % | 64 | 62 | 60 | 62 | 56 | 66 | 62 |
| 6 | Clay | % | 16 | 18 | 16 | 18 | 20 | 18 | 22 |
| 7 | Silt | % | 20 | 20 | 24 | 20 | 24 | 16 | 16 |
| 8 | CEC | meq/100gm | 16.48 | 14.64 | 16.88 | 16.68 | 16.32 | 15.76 | 15.92 |
| 9 | Nitrogen | mg/100gm | 14.89 | 15.25 | 14.18 | 13.65 | 12.66 | 17.03 | 14.36 |
| 10 | Phosphorous | mg/100gm | 0.66 | 0.57 | 0.62 | 0.98 | 0.8 | 0.89 | 0.75 |
| 11 | Potassium | mg/100gm | 8.47 | 8.11 | 8.25 | 8.56 | 8.29 | 8.34 | 8.65 |
| 12 | Mercury | ppm | BDL | BDL | BDL | BDL | BDL | BDL | BDL |

## TABLE-3.12.5(B)
## SOIL QUALITY RESULTS

| Sr. No. | Parameters | Locations | S8 | S9 | S10 | S11 | S12 | S13 | S14 | S15 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Raliya | Sukhiripali | Matiyari | Selar | Pandi | Kaudia | Changaripara | Uchbhatti |
| | | Units | Value | Value | Value | Value | Value | Value | Value | Value |
| 1 | pH | - | 7.56 | 7.64 | 6.94 | 7.08 | 6.42 | 7.34 | 7.72 | 7.18 |
| 2 | Classification | - | Red Soil | Red Soil | Red Soil | Red Soil | Red Soil | Red Soil | Red Soil | Red Soil |
| 3 | Conductivity | µmhos/cm | 382 | 314 | 368 | 318 | 324 | 358 | 342 | 298 |
| 4 | Texture | - | Sandy Loam | Sandy Loam | Sandy Loam | Sandy Loam | Sandy Loam | Sandy Loam | Sandy Loam | Sandy Loam |
| 5 | Sand | % | 58 | 64 | 66 | 64 | 66 | 70 | 68 | 66 |
| 6 | Clay | % | 20 | 14 | 16 | 12 | 14 | 12 | 14 | 12 |
| 7 | Silt | % | 22 | 22 | 18 | 24 | 20 | 18 | 18 | 22 |
| 8 | CEC | meq/100gm | 15.48 | 14.12 | 12.84 | 9.68 | 9.88 | 11.76 | 11.68 | 10.48 |
| 9 | Nitrogen | mg/100gm | 15.43 | 14.8 | 15.69 | 13.1 | 13.9 | 15.2 | 14.9 | 13.7 |
| 10 | Phosphorous | mg/100gm | 0.71 | 0.93 | 0.84 | 0.71 | 0.8 | 0.62 | 0.93 | 0.84 |
| 11 | Potassium | mg/100gm | 8.38 | 8.69 | 8.65 | 8.65 | 9.99 | 8.38 | 10.34 | 8.74 |
| 12 | Mercury | ppm | BDL | BDL | BDL | BDL | BDL | BDL | BDL | BDL |

The textural classes of 15 soil samples are red soil. The pH ranges between 6.42 to 7.72 indicating soils are moderately acidic to neutral. The EC ranges between 298 to 384 µmhos/cm. The nitrogen in the 15 samples in the ranges between 12.66 to 17.03 mg/100gm. The phosphorus content of soil of 15 samples ranges between 0.57 to 0.98 mg/100gm. The Potassium content of 15 soil samples ranges between 8.11 to 10.34 mg/100gm. The CEC of the 15 samples ranges between 9.68 to 16.88 meq/100gm.

### 3.12.3 Water Quality

The following surface water bodies and ground water locations were selected for the evaluation of surface water quality depicted in **Table-3.12.6** and are shown in **Figure-3.12.3.** The water quality results are given is given in **Table-3.12.7 (A, B & C)** and **Table-3.12.8 (A, B & C).**

**TABLE-3.12.6**
**WATER SAMPLING LOCATIONS**

| Station Code | Location | Distance (km) | Direction |
|---|---|---|---|
| **Surface Water Locations** | | | |
| SW1 | At raw water reservoir at plant | - | - |
| SW2 | Kurung left bank canal | 0.5 | S |
| SW3 | Kurung river near Hardih village | 5.5 | WNW |
| SW4 | Kurung river near Khaira village | 5.6 | SW |
| SW5 | Lilagarh river near Darrabhata village | 3.8 | E |
| SW6 | Lilagarh river near Murpar village | 5.0 | SE |
| **Ground Water Locations** | | | |
| GW1 | Kaudia village | 0.5 | S |
| GW2 | Sipat village | 1.3 | NW |
| GW3 | Rank village near ash pond | 2.7 | S |
| GW4 | Sonthi village | 8.6 | NE |
| GW5 | Darrabhata village | 1.7 | E |
| GW6 | Reliya village near ash pond | 5.7 | S |

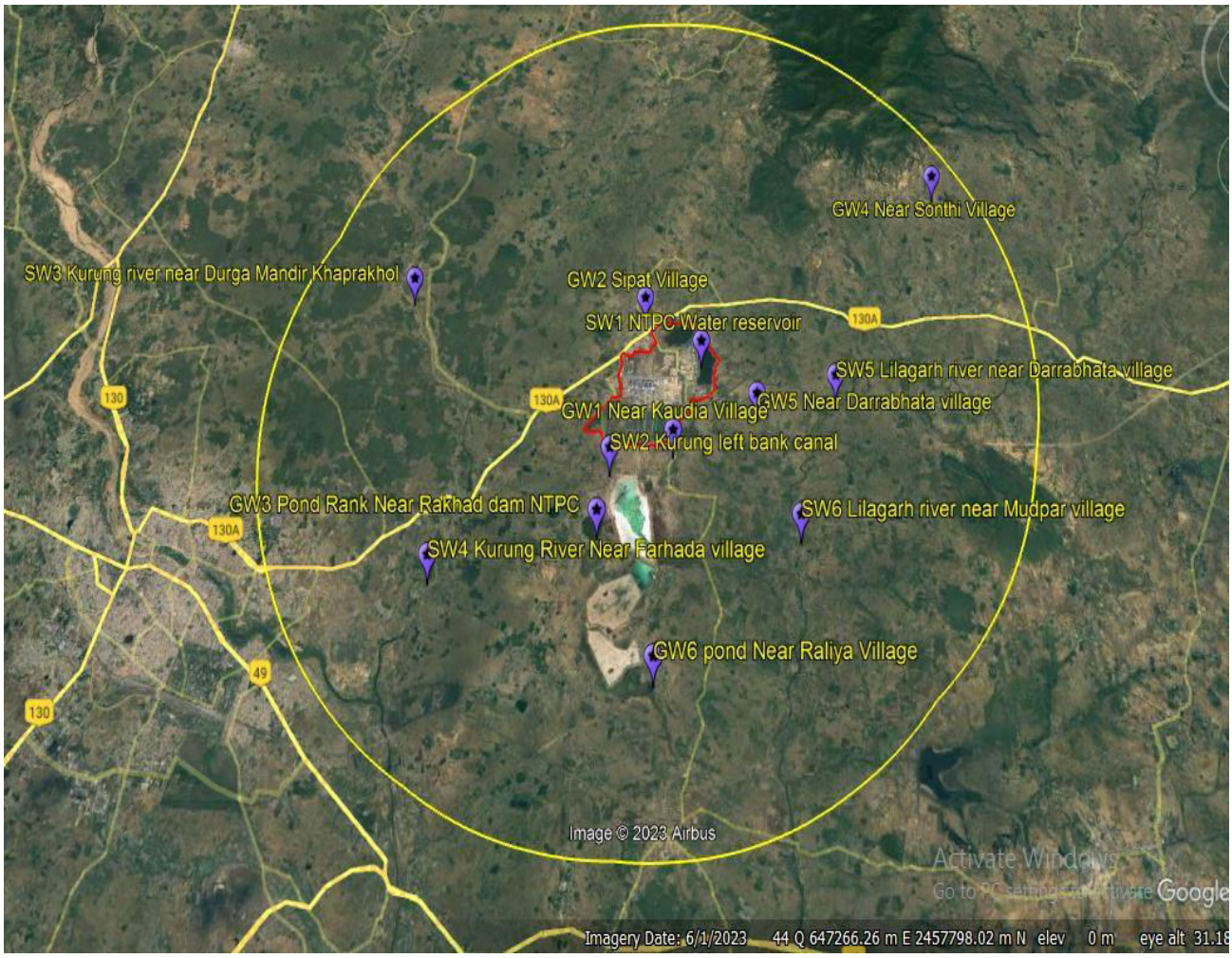



**FIGURE-3.12.3**
**WATER SAMPLING LOCATIONS**

## TABLE-3.12.7(A)
## GROUND WATER QUALITY

| March 2023 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Sr. No.** | **Parameters** | **Test Method** | **Units of Measurement** | **Kaudia village GW-1** | **Sipat village GW-2** | **Rank village near ash pond GW-3** | **Sonthi village GW-4** | **Darrabhata village GW-5** | **Reliya village GW-6** |
| 1 | Colour | IS : 3025 (Part-4) | Hazen Units | <5 | <5 | <5 | <5 | <5 | <5 |
| 2 | Odour | IS : 3025 (Part-5) | - | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable |
| 3 | Taste | IS : 3025 (Part-7&8) | - | Not done | Not done | Not done | Not done | Not done | Not done |
| 4 | pH | IS : 3025 (Part-11) | - | 6.93 | 6.92 | 6.94 | 7.04 | 6.69 | 7.11 |
| 5 | Temperature | IS : 3025 (Part-9) | °C | 23 | 25 | 22 | 24 | 23 | 24 |
| 6 | Conductivity | IS : 3025 (Part-14) | µmhos/cm | 661 | 676 | 912 | 786 | 1321 | 920 |
| 7 | Alkalinity as $CaCO_3$ | IS : 3025 (Part-23) | mg/l | 294 | 318 | 334 | 308 | 384 | 426 |
| 8 | Total Dissolved Solids | IS : 3025 (Part-16) | mg/l | 430 | 440 | 584 | 511 | 859 | 598 |
| 9 | Total Suspended Solids | IS : 3025 (Part-17) | mg/l | 4 | 5 | 6 | 7 | 9 | 8 |
| 10 | Total Hardness as $CaCO_3$ | IS : 3025 (Part-21) | mg/l | 318 | 266 | 438 | 336 | 602 | 446 |
| 11 | Calcium as Ca | IS : 3025 (Part-40) | mg/l | 76.8 | 67.2 | 108 | 83.2 | 152.8 | 117.6 |
| 12 | Magnesium as Mg | IS : 3025 (Part-46) | mg/l | 30.6 | 23.8 | 40.8 | 31.1 | 53.4 | 36.9 |
| 13 | Chloride as Cl | IS : 3025 (Part-32) | mg/l | 54 | 42 | 128 | 82 | 200 | 68 |
| 14 | Phosphate as PO4 | IS : 3025 (Part-31) | mg/l | 0.34 | 0.28 | 0.32 | 0.44 | 0.12 | 0.24 |
| 15 | Nitrate as $NO_3$ | IS : 3025 (Part-34) | mg/l | 8.2 | 7.2 | 7.8 | 8.6 | 6.2 | 8.6 |
| 16 | Sulphate as $SO_4$ | IS : 3025 (Part-24) | mg/l | 24 | 20 | 22 | 34 | 95 | 28 |
| 17 | Fluoride as F | IS : 3025 (Part-60) | mg/l | 0.36 | 0.22 | 0.34 | 0.12 | 0.14 | 0.32 |
| 18 | Phenolic Compound | IS : 3025 (Part-43) | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 19 | Silica as Si | IS : 3025 (Part-35) | mg/l | 1.8 | 1.4 | 2.6 | 1.2 | 1.8 | 1.8 |
| 20 | Oil & Grease | IS : 3025 (Part-39) | mg/l | BDL# | BDL# | BDL# | BDL# | BDL# | BDL# |
| 21 | Sodium as Na | IS : 3025 (Part-45) | mg/l | 26 | 52 | 32 | 46 | 55 | 35 |
| 22 | Potassium as K | IS : 3025 (Part-45) | mg/l | 2 | 4 | 3 | 4 | 5 | 4 |
| 23 | Dissolved Oxygen | IS : 3025 (Part-38) | mg/l | 8.2 | 7.6 | 6.8 | 7.2 | 7.1 | 7.1 |
| 24 | BOD | IS : 3025 (Part-44) | mg/l | <2 | <2 | <2 | <2 | <2 | <2 |
| 25 | COD | IS : 3025 (Part-58) | mg/l | <4 | <4 | <4 | <4 | <4 | <4 |
| 26 | Total Coliform | IS : 1622 : 1981 | MPN/100ml | Absent | Absent | Absent | Absent | Absent | Absent |
| 27 | Faecal Coliform | IS : 1622 : 1982 | MPN/100ml | Absent | Absent | Absent | Absent | Absent | Absent |

# BDL – Below Detectable Level

## TABLE-3.12.7(B)
## GROUND WATER QUALITY

| April 2023 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **SL. No.** | **Parameters** | **Test Method** | **Units of Measurement** | **Kaudia village GW-1** | **Sipat village GW-2** | **Rank village near ash pond GW-3** | **Sonthi village GW-4** | **Darrabhata village GW-5** | **Reliya village GW-6** |
| 1 | Colour | IS : 3025 (Part-4) | Hazen Units | <5 | <5 | <5 | <5 | <5 | <5 |
| 2 | Odour | IS : 3025 (Part-5) | - | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable |
| 3 | Taste | IS : 3025 (Part-7&8) | - | Not done | Not done | Not done | Not done | Not done | Not done |
| 4 | pH | IS : 3025 (Part-11) | - | 6.94 | 6.95 | 6.96 | 7.1 | 6.74 | 7.18 |
| 5 | Temperature | IS : 3025 (Part-9) | °C | 24 | 24 | 23 | 24 | 24 | 24 |
| 6 | Conductivity | IS : 3025 (Part-14) | µmhos/cm | 664 | 694 | 960 | 798 | 1352 | 964 |
| 7 | Alkalinity as $CaCO_3$ | IS : 3025 (Part-23) | mg/l | 298 | 322 | 344 | 312 | 392 | 436 |
| 8 | Total Dissolved Solids | IS : 3025 (Part-16) | mg/l | 436 | 450 | 622 | 524 | 880 | 612 |
| 9 | Total Suspended Solids | IS : 3025 (Part-17) | mg/l | 4 | 5 | 6 | 7 | 10 | 8 |
| 10 | Total Hardness as $CaCO_3$ | IS : 3025 (Part-21) | mg/l | 320 | 310 | 452 | 352 | 612 | 446 |
| 11 | Calcium as Ca | IS : 3025 (Part-40) | mg/l | 73.6 | 72.8 | 120 | 83.2 | 155.2 | 120 |
| 12 | Magnesium as Mg | IS : 3025 (Part-46) | mg/l | 28.18 | 31.1 | 52.2 | 34.02 | 54.4 | 30.61 |
| 13 | Chloride as Cl | IS : 3025 (Part-32) | mg/l | 58 | 44 | 134 | 88 | 202 | 74 |
| 14 | Phosphate as PO4 | IS : 3025 (Part-31) | mg/l | 0.38 | 0.32 | 0.42 | 0.5 | 0.12 | 0.37 |
| 15 | Nitrate as $NO_3$ | IS : 3025 (Part-34) | mg/l | 8.4 | 7.6 | 8 | 8.7 | 6.9 | 9 |
| 16 | Sulphate as $SO_4$ | IS : 3025 (Part-24) | mg/l | 30 | 22 | 28 | 36 | 104 | 32 |
| 17 | Fluoride as F | IS : 3025 (Part-60) | mg/l | 0.38 | 0.22 | 0.35 | 0.12 | 0.17 | 0.4 |
| 18 | Phenolic Compound | IS : 3025 (Part-43) | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 19 | Silica as Si | IS : 3025 (Part-35) | mg/l | 1.8 | 1.4 | 2.8 | 1.2 | 2 | 1.9 |
| 20 | Oil & Grease | IS : 3025 (Part-39) | mg/l | BDL# | BDL# | BDL# | BDL# | BDL# | BDL# |
| 21 | Sodium as Na | IS : 3025 (Part-45) | mg/l | 26 | 53 | 32 | 48 | 60 | 42 |
| 22 | Potassium as K | IS : 3025 (Part-45) | mg/l | 2 | 5 | 3 | 5 | 6 | 4 |
| 23 | Dissolved Oxygen | IS : 3025 (Part-38) | mg/l | 8.2 | 7.8 | 6.7 | 6.9 | 7 | 6.8 |
| 24 | BOD | IS : 3025 (Part-44) | mg/l | <4 | <2 | <2 | <2 | <2 | <2 |
| 25 | COD | IS : 3025 (Part-58) | mg/l | <4 | <4 | <4 | <4 | <4 | <4 |
| 26 | Total Coliform | IS : 1622 : 1981 | MPN/100ml | Absent | Absent | Absent | Absent | Absent | Absent |
| 27 | Faecal Coliform | IS : 1622 : 1982 | MPN/100ml | Absent | Absent | Absent | Absent | Absent | Absent |

# BDL – Below Detectable Level

## TABLE-3.12.7(C)
## GROUND WATER QUALITY

| May 2023 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **SL. No.** | **Parameters** | **Test Method** | **Units of Measurement** | **Kaudia village GW-1** | **Sipat village GW-2** | **Rank village near ash pond GW-3** | **Sonthi village GW-4** | **Darrabhata village GW-5** | **Reliya village GW-6** |
| 1 | Colour | IS : 3025 (Part-4) | Hazen Units | <5 | <5 | <5 | <5 | <5 | <5 |
| 2 | Odour | IS : 3025 (Part-5) | - | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable |
| 3 | Taste | IS : 3025 (Part-7&8) | - | Not done | Not done | Not done | Not done | Not done | Not done |
| 4 | pH | IS : 3025 (Part-11) | - | 7.42 | 6.64 | 7.34 | 7.26 | 7.42 | 7.16 |
| 5 | Temperature | IS : 3025 (Part-9) | °C | 28 | 29 | 30 | 28 | 30 | 28 |
| 6 | Conductivity | IS : 3025 (Part-14) | µmhos/cm | 646 | 650 | 800 | 737 | 1255 | 729 |
| 7 | Alkalinity as $CaCO_3$ | IS : 3025 (Part-23) | mg/l | 274 | 294 | 304 | 290 | 364 | 316 |
| 8 | Total Dissolved Solids | IS : 3025 (Part-16) | mg/l | 420 | 422 | 520 | 479 | 816 | 474 |
| 9 | Total Suspended Solids | IS : 3025 (Part-17) | mg/l | 3 | 4 | 5 | 6 | 8 | 7 |
| 10 | Total Hardness as $CaCO_3$ | IS : 3025 (Part-21) | mg/l | 312 | 258 | 368 | 324 | 556 | 314 |
| 11 | Calcium as Ca | IS : 3025 (Part-40) | mg/l | 77.6 | 68.0 | 94.4 | 87.2 | 154.4 | 84.0 |
| 12 | Magnesium as Mg | IS : 3025 (Part-46) | mg/l | 28.6 | 21.3 | 32.0 | 25.7 | 41.3 | 25.2 |
| 13 | Chloride as Cl | IS : 3025 (Part-32) | mg/l | 58 | 44 | 98 | 78 | 182 | 54 |
| 14 | Phosphate as PO4 | IS : 3025 (Part-31) | mg/l | 0.38 | 0.26 | 0.28 | 0.36 | 0.28 | 0.34 |
| 15 | Nitrate as $NO_3$ | IS : 3025 (Part-34) | mg/l | 8.4 | 7.4 | 7.6 | 5.4 | 6.8 | 7.8 |
| 16 | Sulphate as $SO_4$ | IS : 3025 (Part-24) | mg/l | 26 | 22 | 28 | 30 | 92 | 32 |
| 17 | Fluoride as F | IS : 3025 (Part-60) | mg/l | 0.32 | 0.28 | 0.32 | 0.22 | 0.26 | 0.34 |
| 18 | Phenolic Compound | IS : 3025 (Part-43) | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 19 | Silica as Si | IS : 3025 (Part-35) | mg/l | 1.6 | 1.2 | 2.2 | 1.4 | 1.6 | 2.0 |
| 20 | Oil & Grease | IS : 3025 (Part-39) | mg/l | BDL# | BDL# | BDL# | BDL# | BDL# | BDL# |
| 21 | Sodium as Na | IS : 3025 (Part-45) | mg/l | 24 | 48 | 36 | 40 | 58 | 42 |
| 22 | Potassium as K | IS : 3025 (Part-45) | mg/l | 2 | 4 | 4 | 4 | 5 | 4 |
| 23 | Dissolved Oxygen | IS : 3025 (Part-38) | mg/l | 8.4 | 7.4 | 6.2 | 7.3 | 7.8 | 7.6 |
| 24 | BOD | IS : 3025 (Part-44) | mg/l | <2 | <2 | <2 | <2 | <2 | <2 |
| 25 | COD | IS : 3025 (Part-58) | mg/l | <4 | <4 | <4 | <4 | <4 | <4 |
| 26 | Total Coliform | IS : 1622 : 1981 | MPN/100ml | Absent | Absent | Absent | Absent | Absent | Absent |
| 27 | Faecal Coliform | IS : 1622 : 1982 | MPN/100ml | Absent | Absent | Absent | Absent | Absent | Absent |

# BDL – Below Detectable Level

## TABLE-3.12.8(A)
## SURFACE WATER QUALITY

| March 2023 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Sr. No.** | **Parameters** | **Test Method** | **Units of Measurements** | **At raw water reservoir at plant (SW1)** | **Kurung left bank canal (SW2)** | **Kurung river near Hardih village (SW-3)** | **Kurung river near Khaira village (SW-4)** | **Lilagarh river near Darrabhata village (SW-5)** | **Lilagarh river near Murpar village (SW-6)** |
| 1 | Colour | IS : 3025 (Part-4) | Hazen Units | <5 | <5 | <5 | <5 | <5 | <5 |
| 2 | Odour | IS : 3025 (Part-5) | - | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable |
| 3 | Taste | IS : 3025 (Part-7&8) | - | Not done | Not done | Not done | Not done | Not done | Not done |
| 4 | pH | IS : 3025 (Part-11) | - | 7.36 | 7.06 | 7.04 | 7.34 | 7.35 | 7.24 |
| 5 | Temperature | IS : 3025 (Part-9) | °C | 25 | 25 | 27 | 26 | 26 | 26 |
| 6 | Conductivity | IS : 3025 (Part-14) | µmhos/cm | 376 | 405 | 282 | 365 | 290 | 369 |
| 7 | Alkalinity as $CaCO_3$ | IS : 3025 (Part-23) | mg/l | 144 | 128 | 86 | 152 | 114 | 122 |
| 8 | Total Dissolved Solids | IS : 3025 (Part-16) | mg/l | 244 | 263 | 183 | 237 | 189 | 240 |
| 9 | Total Suspended Solids | IS : 3025 (Part-17) | mg/l | 4 | 5 | 6 | 7 | 8 | 8 |
| 10 | Total Hardness as $CaCO_3$ | IS : 3025 (Part-21) | mg/l | 182 | 160 | 106 | 160 | 108 | 156 |
| 11 | Calcium as Ca | IS : 3025 (Part-40) | mg/l | 148 | 106 | 70 | 108 | 88 | 94 |
| 12 | Magnesium as Mg | IS : 3025 (Part-46) | mg/l | 34 | 54 | 36 | 52 | 20 | 62 |
| 13 | Chloride as Cl | IS : 3025 (Part-32) | mg/l | 22 | 44 | 18 | 22 | 18 | 44 |
| 14 | Phosphate as PO4 | IS : 3025 (Part-31) | mg/l | 0.34 | 0.52 | 0.48 | 0.28 | 0.24 | 0.42 |
| 15 | Nitrate as $NO_3$ | IS : 3025 (Part-34) | mg/l | 10.6 | 11.8 | 11.2 | 12.6 | 12.2 | 12.6 |
| 16 | Sulphate as $SO_4$ | IS : 3025 (Part-24) | mg/l | 28 | 28 | 32 | 18 | 12 | 18 |
| 17 | Fluoride as F | IS : 3025 (Part-60) | mg/l | 0.18 | 0.34 | 0.24 | 0.22 | 0.14 | 0.42 |
| 18 | Phenolic Compound | IS : 3025 (Part-43) | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 19 | Silica as Si | IS : 3025 (Part-35) | mg/l | 2.2 | 2.4 | 2.6 | 1.4 | 1.8 | 1.6 |
| 20 | Oil & Grease | IS : 3025 (Part-39) | mg/l | ND | ND | ND | ND | ND | ND |
| 21 | Sodium as Na | IS : 3025 (Part-45) | mg/l | 10 | 26 | 18 | 18 | 18 | 20 |
| 22 | Potassium as K | IS : 3025 (Part-45) | mg/l | 2 | 2 | 2 | 2 | 2 | 2 |
| 23 | Dissolved Oxygen | IS : 3025 (Part-38) | mg/l | 5.6 | 5.4 | 7.2 | 5.2 | 5.8 | 6.8 |
| 24 | BOD | IS : 3025 (Part-44) | mg/l | 5.8 | 7.2 | 4.6 | 6.8 | 6 | 4.8 |
| 25 | COD | IS : 3025 (Part-58) | mg/l | 38 | 54 | 36 | 32 | 50 | 44 |
| 26 | Total Coliform | IS : 1622 : 1981 | MPN/100ml | 2642 | 2826 | 2054 | 2842 | 1892 | 1364 |
| 27 | Faecal Coliform | IS : 1622 : 1982 | MPN/100ml | 1585 | 1684 | 1232 | 1705 | 974 | 818 |

## TABLE-3.12.8(B)
## SURFACE WATER QUALITY

| April 2023 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Sr. No.** | **Parameters** | **Test Method** | **Units of Measurements** | **At raw water reservoir at plant (SW1)** | **Kurung left bank canal (SW2)** | **Kurung river near Hardih village (SW-3)** | **Kurung river near Khaira village (SW-4)** | **Lilagarh river near Darrabhata village (SW-5)** | **Lilagarh river near Murpar village (SW-6)** |
| 1 | Colour | IS : 3025 (Part-4) | Hazen Units | <5 | <5 | <5 | <5 | <5 | <5 |
| 2 | Odour | IS : 3025 (Part-5) | - | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable |
| 3 | Taste | IS : 3025 (Part-7&8) | - | Not done | Not done | Not done | Not done | Not done | Not done |
| 4 | pH | IS : 3025 (Part-11) | - | 7.36 | 7.1 | 7.05 | 7.42 | 7.42 | 7.38 |
| 5 | Temperature | IS : 3025 (Part-9) | °C | 25 | 25 | 28 | 27 | 27 | 27 |
| 6 | Conductivity | IS : 3025 (Part-14) | µmhos/cm | 376 | 450 | 320 | 415 | 332 | 414 |
| 7 | Alkalinity as $CaCO_3$ | IS : 3025 (Part-23) | mg/l | 152 | 134 | 92 | 164 | 122 | 128 |
| 8 | Total Dissolved Solids | IS : 3025 (Part-16) | mg/l | 244 | 302 | 208 | 270 | 216 | 269 |
| 9 | Total Suspended Solids | IS : 3025 (Part-17) | mg/l | 4 | 6 | 7 | 8 | 8 | 8 |
| 10 | Total Hardness as $CaCO_3$ | IS : 3025 (Part-21) | mg/l | 196 | 172 | 118 | 174 | 122 | 166 |
| 11 | Calcium as Ca | IS : 3025 (Part-40) | mg/l | 152 | 114 | 78 | 116 | 94 | 102 |
| 12 | Magnesium as Mg | IS : 3025 (Part-46) | mg/l | 44 | 58 | 40 | 58 | 28 | 64 |
| 13 | Chloride as Cl | IS : 3025 (Part-32) | mg/l | 25 | 52 | 22 | 27 | 24 | 54 |
| 14 | Phosphate as PO4 | IS : 3025 (Part-31) | mg/l | 0.38 | 0.55 | 0.32 | 0.32 | 0.32 | 0.53 |
| 15 | Nitrate as $NO_3$ | IS : 3025 (Part-34) | mg/l | 11 | 12.2 | 11.6 | 13.1 | 12.4 | 13.2 |
| 16 | Sulphate as $SO_4$ | IS : 3025 (Part-24) | mg/l | 30 | 34 | 37 | 24 | 18 | 24 |
| 17 | Fluoride as F | IS : 3025 (Part-60) | mg/l | 0.22 | 0.38 | 0.35 | 0.27 | 0.17 | 0.45 |
| 18 | Phenolic Compound | IS : 3025 (Part-43) | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 19 | Silica as Si | IS : 3025 (Part-35) | mg/l | 2.3 | 2.7 | 2.7 | 1.7 | 2.3 | 1.9 |
| 20 | Oil & Grease | IS : 3025 (Part-39) | mg/l | ND | ND | ND | ND | ND | ND |
| 21 | Sodium as Na | IS : 3025 (Part-45) | mg/l | 12 | 30 | 24 | 25 | 26 | 23 |
| 22 | Potassium as K | IS : 3025 (Part-45) | mg/l | 2 | 3 | 2 | 2 | 2 | 2 |
| 23 | Dissolved Oxygen | IS : 3025 (Part-38) | mg/l | 6 | 5.8 | 7.4 | 5.6 | 6 | 7 |
| 24 | BOD | IS : 3025 (Part-44) | mg/l | 5.8 | 7.8 | 5 | 7.2 | 7.4 | 5.8 |
| 25 | COD | IS : 3025 (Part-58) | mg/l | 42 | 60 | 40 | 38 | 52 | 48 |
| 26 | Total Coliform | IS : 1622 : 1981 | MPN/100ml | 2530 | 2780 | 2530 | 2780 | 2120 | 1410 |
| 27 | Faecal Coliform | IS : 1622 : 1982 | MPN/100ml | 849 | 930 | 849 | 933 | 712 | 484 |

## TABLE-3.12.8(C)
## SURFACE WATER QUALITY

| May 2023 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Sr. No.** | **Parameters** | **Test Method** | **Units of Measurements** | **At raw water reservoir at plant (SW1)** | **Kurung left bank canal (SW2)** | **Kurung river near Hardih village (SW-3)** | **Kurung river near Khaira village (SW-4)** | **Lilagarh river near Darrabhata village (SW-5)** | **Lilagarh river near Murpar village (SW-6)** |
| 1 | Colour | IS : 3025 (Part-4) | Hazen Units | <5 | <5 | <5 | <5 | <5 | <5 |
| 2 | Odour | IS : 3025 (Part-5) | - | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable | Agreeable |
| 3 | Taste | IS : 3025 (Part-7&8) | - | Not done | Not done | Not done | Not done | Not done | Not done |
| 4 | pH | IS : 3025 (Part-11) | - | 7.42 | 7.16 | 7.02 | 7.48 | 7.62 | 7.54 |
| 5 | Temperature | IS : 3025 (Part-9) | °C | 28 | 29 | 28 | 30 | 28 | 27 |
| 6 | Conductivity | IS : 3025 (Part-14) | µmhos/cm | 354 | 361 | 264 | 345 | 299 | 350 |
| 7 | Alkalinity as $CaCO_3$ | IS : 3025 (Part-23) | mg/l | 128 | 118 | 80 | 134 | 108 | 104 |
| 8 | Total Dissolved Solids | IS : 3025 (Part-16) | mg/l | 230 | 235 | 171 | 224 | 194 | 227 |
| 9 | Total Suspended Solids | IS : 3025 (Part-17) | mg/l | 5 | 4 | 5 | 6 | 7 | 6 |
| 10 | Total Hardness as $CaCO_3$ | IS : 3025 (Part-21) | mg/l | 160 | 146 | 106 | 144 | 108 | 134 |
| 11 | Calcium as Ca | IS : 3025 (Part-40) | mg/l | 124 | 102 | 74 | 102 | 76 | 98 |
| 12 | Magnesium as Mg | IS : 3025 (Part-46) | mg/l | 36 | 44 | 32 | 42 | 32 | 36 |
| 13 | Chloride as Cl | IS : 3025 (Part-32) | mg/l | 24 | 38 | 18 | 26 | 24 | 40 |
| 14 | Phosphate as PO4 | IS : 3025 (Part-31) | mg/l | 0.14 | 0.34 | 0.38 | 0.24 | 0.26 | 0.44 |
| 15 | Nitrate as $NO_3$ | IS : 3025 (Part-34) | mg/l | 8.4 | 9.2 | 9.4 | 8.2 | 7.2 | 8.4 |
| 16 | Sulphate as $SO_4$ | IS : 3025 (Part-24) | mg/l | 30 | 24 | 30 | 20 | 20 | 26 |
| 17 | Fluoride as F | IS : 3025 (Part-60) | mg/l | 0.22 | 0.32 | 0.22 | 0.18 | 0.12 | 0.38 |
| 18 | Phenolic Compound | IS : 3025 (Part-43) | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 19 | Silica as Si | IS : 3025 (Part-35) | mg/l | 2.1 | 2.2 | 2.4 | 1.6 | 2.2 | 1.4 |
| 20 | Oil & Grease | IS : 3025 (Part-39) | mg/l | ND | ND | ND | ND | ND | ND |
| 21 | Sodium as Na | IS : 3025 (Part-45) | mg/l | 14 | 22 | 14 | 20 | 24 | 24 |
| 22 | Potassium as K | IS : 3025 (Part-45) | mg/l | 2 | 2 | 2 | 2 | 2 | 2 |
| 23 | Dissolved Oxygen | IS : 3025 (Part-38) | mg/l | 6.2 | 5.6 | 7.4 | 5.4 | 5.6 | 7.2 |
| 24 | BOD | IS : 3025 (Part-44) | mg/l | 5.4 | 7.0 | 4.2 | 7.2 | 6.2 | 4.6 |
| 25 | COD | IS : 3025 (Part-58) | mg/l | 42 | 52 | 40 | 36 | 52 | 42 |
| 26 | Total Coliform | IS : 1622 : 1981 | MPN/100ml | 2780 | 2210 | 2530 | 2120 | 1480 | 1750 |
| 27 | Faecal Coliform | IS : 1622 : 1982 | MPN/100ml | 999 | 788 | 849 | 698 | 486 | 542 |

The analysis results of ground water samples showed the pH in range of 6.64 to 7.42. The maximum value was observed at Kaudia (GW2) & Darrabhata (GW5) and the minimum value observed at Sipat (GW2). Colour of the samples ranged from <5 Hazen. Electrical conductivity of the samples ranged from 646 - 1352 µmhos/cm. The Total Dissolved Solids of the samples ranged from 420 to 880 mg/l. The maximum value was observed at Darrabhata (GW5) and the minimum value observed at Kaudia (GW1). Calcium concentrations ranged from 67.2 to 155.2 mg/l. Magnesium concentrations ranged from 21.3 – 54.4 mg/l. The Total Hardness of the samples ranged from 258 - 612 mg/l. The maximum total Hardness was observed at Darrabhata (GW5) and whereas the minimum value observed at Sipat (GW2).

*Surface Water Quality*

The analysis results of surface water samples indicate that the pH value was observed to be 7.02 to 7.62. Electrical conductivity of surface water samples was observed to be 264 to 450 µmhos/cm.

The total dissolved solids were observed about 171 to 302 mg/l. Total hardness was observed in the range of 106 to 196 mg/l. Sulphates were found to be in the range of 12 to 37 mg/l and Nitrates were found to be in the range of 7.2 to 13.2 mg/l which are within the prescribed limits only. Fluoride concentration was found to be 0.12 to 0.45 mg/l at all the locations.

### 3.12.4 Noise Levels

The fifteen locations of noise monitoring stations were selected in and around the project site and described in **Table-3.12.9.** The results of noise levels are given in **Table-3.12.10.** Noise Monitoring Locations are shown in **Figure-3.12.4**

**TABLE-3.12.9**
**NOISE MONITORING LOCATIONS**

| Location Code | Noise Sampling Location | Distance (km) | Direction | Zone |
|---|---|---|---|---|
| N1 | Existing plant site | - | - | Industrial |
| N2 | Project site | - | - | Industrial |
| N3 | Guri | 1.4 | NNE | Residential |
| N4 | Karra | 0.5 | E | Sensitive |
| N5 | Janji | 0.7 | W | Sensitive |
| N6 | Sipat | 1.3 | NW | Residential |
| N7 | Nargara | 3.2 | N | Residential |
| N8 | Bhadrapara | 3.3 | NE | Residential |
| N9 | Sonthi | 8.6 | NE | Residential |
| N10 | Darrabhata | 1.7 | E | Residential |
| N11 | Pachri | 9.2 | SE | Residential |
| N12 | Raliya | 5.7 | S | Residential |
| N13 | Sukhripali | 4.5 | S | Residential |
| N14 | Matiyari | 1.8 | W | Residential |
| N15 | Kaudia | 0.5 | S | Residential |

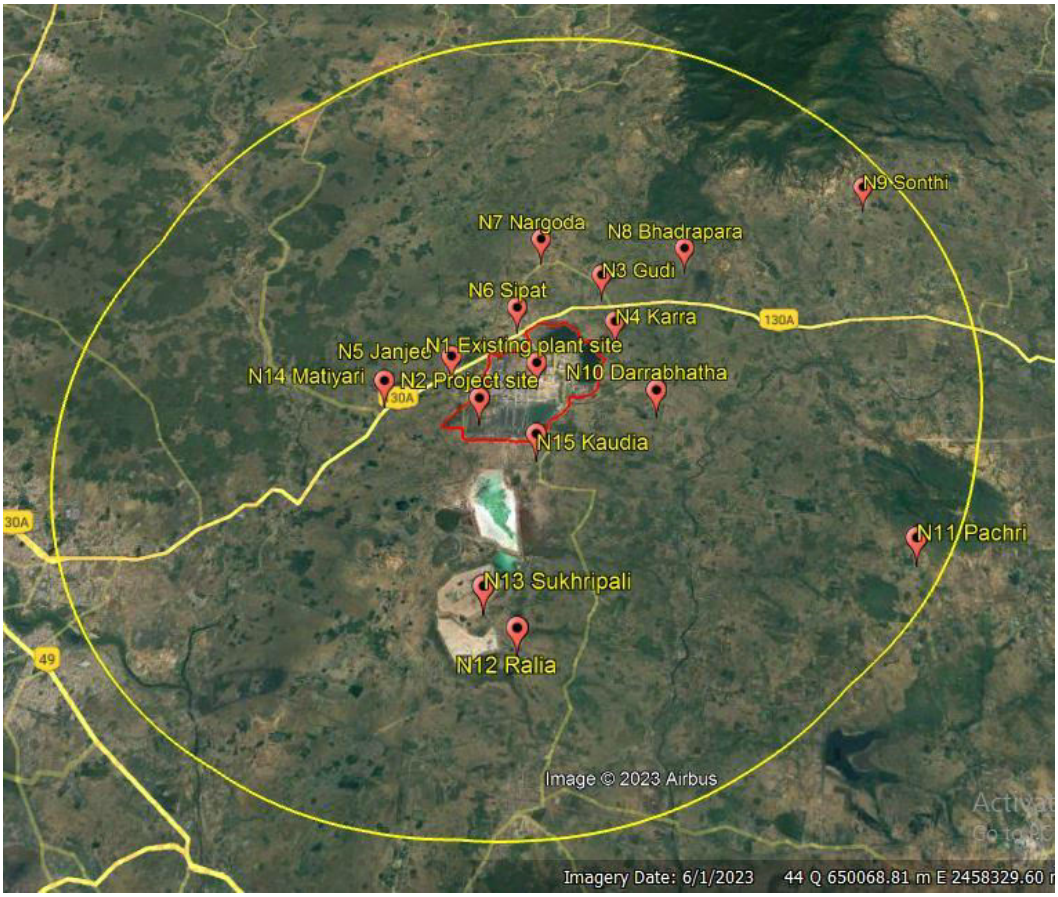



**FIGURE-3.12.4**
**NOISE MONITORING LOCATIONS**

**TABLE-3.12.10**
**NOISE LEVELS**

| Sr. No. | Location | Date of Sampling | Category of Area | Day dB (A) | Night dB (A) | Day (Ld) | Night (Ln) |
|---|---|---|---|---|---|---|---|
| 1 | Existing Plant Site | 17.03.2023 | Industrial Area | 75 | 70 | 62.8 | 47.2 |
| 2 | Project Site | 20.03.2023 | Industrial Area | 75 | 70 | 61.8 | 42.8 |
| 3 | Guri | 25.03.2023 | Residential Area | 55 | 45 | 44.6 | 35.8 |
| 4 | Karra | 28.03.2023 | Silence Zone | 50 | 40 | 46.2 | 41.5 |
| 5 | Janji | 18.03.2023 | Silence Zone | 50 | 40 | 48.5 | 40.2 |
| 6 | Sipat | 21.03.2023 | Residential Area | 55 | 45 | 40.8 | 37.4 |
| 7 | Nargara | 26.03.2023 | Residential Area | 55 | 45 | 43.5 | 38.6 |
| 8 | Bhadrapara | 06.05.2022 | Residential Area | 55 | 45 | 54.8 | 40.8 |
| 9 | Sonthi | 22.03.2023 | Residential Area | 55 | 45 | 46.2 | 41.6 |
| 10 | Darrabhata | 27.03.2023 | Residential Area | 55 | 45 | 52.6 | 42.8 |
| 11 | Pachri | 23.03.2023 | Residential Area | 55 | 45 | 48.6 | 38.9 |
| 12 | Raliya | 24.03.2023 | Residential Area | 55 | 45 | 50.4 | 39.4 |
| 13 | Sukhripali | 29.03.2023 | Residential Area | 55 | 45 | 55.6 | 45.8 |
| 14 | Matiyari | 30.03.2023 | Residential Area | 55 | 45 | 45.8 | 38.5 |
| 15 | Kaudia | 31.03.2023 | Residential Area | 55 | 45 | 49.2 | 40.5 |

*Noise Levels:* The day time noise levels are ranged from 40.8-62.8 dB (A). The night time noise levels are ranged from 35.8-47.2 dB (A).

# Chapter-4

# Anticipated Environmental Impacts and Mitigation Measures

# 4.0 ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

## 4.1 Identification of Impacts

Identification of impacts leads to quantification and evaluation of impacts and suggested mitigation measures. Although, in general, number of impacts have been identified while describing existing environmental status, it is necessary at this stage to identify the critical impacts that are likely to occur due to the proposed expansion of Sipat Super Thermal Power Project for various components of the environment.

The environmental impacts are categorized as primary or secondary. Primary impacts are those, which are attributed directly to the project and secondary impacts are those, which are indirectly induced and typically include the associated investment and changed pattern of social and economic activities by the proposed action.

The construction and operational phase of the proposed expansion project comprise various activities each of which may have an impact on some or other environmental parameters. Various impacts during the construction and operation phase on the environment have been studied to estimate the impacts on the environmental attributes and are discussed in the subsequent sections.

Expansion of power project by installing additional unit is environmentally compatible. As the activities related to development of site and establishment of infrastructure would be minimal, the impacts due to construction of Sipat STPP, Stage-III (1 x 800 MW) would also be minimum. The various measures proposed to be adopted to minimize the pollution from the project are discussed in subsequent sections.

## 4.2 Impacts during Construction Phase

The probable impacts during construction phase on various sectors of environment (such as air, water, soil, biotic, socio-economic environment etc. have been identified and listed in **Table-4.1**. The mitigation measures for significant impacts are also discussed in respective sections.

**TABLE-4.1**
**IDENTIFICATION OF CONSTRUCTION ACTIVITIES AND PROBABLE IMPACTS**

| Construction Activities | Sector | Probable Impacts |
|---|---|---|
| **A) Long Term Impacts** | | |
| Land acquisition (No Land is proposed to be acquired) | Land | • No significant change in land use pattern |
| | Socio-economics | • No displacements and loss of livelihood |
| **B) Short Term Impacts** | | |
| | Air | • Fugitive dust emissions |

| Construction Activities | Sector | Probable Impacts |
|---|---|---|
| Site clearing and levelling (cutting, stripping, excavation, earth movement, compaction) | | • Noise/ air emissions from construction equipment & machinery |
| | Water | • Run-off from construction area<br>• Run-off from vegetation stripped area |
| | Land | • Loss of fertile topsoil<br>• Change in drainage pattern |
| | Ecology | • Loss of vegetation<br>• Topographic transformations |
| Transportation and storage of construction material/ equipment | Air | • Noise and air emissions from vehicles<br>• Fugitive dust emissions due to traffic movement<br>• Spillage and fugitive emissions of construction materials |
| | Water | • Spillage of construction material and flow into streams<br>• Run-off from storage areas of construction material |
| | Soil | • Deposition of spilled construction material on soil |
| | Public utilities | • Increased flow of traffic<br>• Congestion on roads |
| Civil construction activities | Air | • Noise and air emissions from construction machinery<br>• Fugitive dust emissions due to movement of traffic |
| | Water | • Run-off from construction areas containing construction material |
| Mechanical & electrical erection activities | Air | • Noise & air emissions from machines/ activities |
| | Water | • Run-off from erection areas containing oils, paints |
| Influx of labour & Construction of temporary houses | Socio-economics | • Stress on infrastructure<br>• Stress on social relations |
| | Land | • Change in land use pattern of the area in labour colonies |
| | Water | • Sanitary effluents from labour colonies |
| Transportation and disposal of construction debris | Air | • Noise and air emissions from transport vehicles<br>• Fugitive dust emissions due to movement of traffic<br>• Spillage and fugitive emissions of debris materials |
| | Water | • Spillage/ spread of debris material and flow into streams<br>• Run-off from disposal areas |
| | Soil | • Spillage/ spread/ deposition of debris<br>• Conversion of land into waste land |

### 4.2.1 Impact on Topography & Land use

The major change in the topographical feature of area would be erection of power plant structures. There will be a permanent change.

This includes the activities related to leveling of site, construction of main plant and other related structures, erection of boilers, turbines and other related equipment. Further, the magnitude of the impacts is envisaged to be low, as the site and infrastructural facilities are fully developed under Stage-I.

The present land-use of the project site falls under industrial category. The proposed power plant will be set-up within the existing premises of Sipat STPP. The proposed project expansion is not likely to have any adverse impact on the surrounding land use during the construction period.

### 4.2.2 Impact on Soil

The Finished Ground Level (FGL) of the main plant area is 282m. The finished ground levels for various areas are as following:

- Main plant: RL(+)282 m;
- Cooling towers : RL(+) 282 m; and
- Railway siding & CHP: RL (+)282 m.

The levels are decided to optimize the quantity of borrow earth. The proposed levels are based on site leveling with cutting and filling and partly with borrow earth from outside plant. However, the areas under Sipat STPP Stage-III, shall require to be graded with minor earthwork, if necessary.

Construction activities involving leveling, excavation and removal of existing vegetation would invariably disturb the soil of the area. The impacts on soil during construction phase shall be mainly due to loss of top soil in the construction areas and contamination of the soils of surrounding area due to construction materials such as cement, sand etc. The disturbances would be more pronounced during the summer and monsoon seasons with strong rains. However, it shall be temporary and shall be confined to the areas of construction only. Generally, such disturbances are confined to the area of activity i.e. the main plant. Appropriate soil conservation measures associated with improved construction techniques would minimize such impacts. Timely afforestation activities would also contribute positively towards soil conservation.

Apart from localized construction impacts at the plant site, no adverse impacts on soil in the surrounding area are anticipated.

### 4.2.3 Impact on Air Quality

The main sources of emission during the construction period are the movement of equipment at site and dust emitted during the leveling, grading, earthwork and foundation works. The dust emitted during the above mentioned activities depend upon the type of soil being excavated and the ambient humidity levels. Dust will be generated during excavation and handling of earth and movement of vehicles and other equipment. The dust generated during the construction activities will however, settle quickly. Therefore, the impact will be for short duration and confined locally to the construction site. The composition of dust in this kind of operation is, however, mostly inorganic and non-toxic in nature.

The impact will be confined within the project boundary and is expected to be negligible outside the plant boundaries. Exhaust emissions from vehicles and equipment deployed during the construction phase is also likely to result in marginal increase in the levels of $NO_2$, PM and CO. The impact will be for short duration and confined within the project boundary and is expected to be negligible outside the plant boundaries. The impact will, however, be reversible, marginal and temporary in nature. Proper maintenance of vehicles and construction equipment will help in controlling the gaseous emissions. Water sprinkling on roads and construction site will prevent fugitive dust.

### 4.2.4 Impact on Water Quality

All the water required during construction phase will be drawn from Right Bank Canal (RBC) originating from Hasdeo barrage pondage and also groundwater is proposed to be utilized for the project during construction phase only. No ground water will be used during operation phase and hence no quantitative impact is envisaged on the ground water resources.

The present surface and ground water resources are likely to be contaminated due to non-point discharges of solids from soil loss and sewage generated from the construction work force stationed at the site. However, as the construction will be carried out on the flat terrain, the soil losses will be negligible.

Further, the construction will be more related to mechanical fabrication, assembly and erection; hence the water requirement would be meagre. Temporary sanitation facilities (septic tanks and soak pits) will be set-up for disposal of sanitary sewage generated by the work force like drivers etc. The overall impact on water environment during construction will be insignificant and can be controlled with proper mitigation measures.

### 4.2.5 Impact on Hydrology

Construction water will pass through an existing sedimentation tank to arrest sediments and treated water will be reused in water sprinkling. Discharge of this water into reservoir is not expected. As the construction activities will be confined to the existing project site only, no significant impact on the hydrogeology as part of the study area envisaged.

### 4.2.6 Impact on Noise Levels

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

Use of proper personal protective equipment will mitigate any significant impact of the noise generated by such equipment. Similarly, as the major work will be carried

out during the day time, the impact on the surrounding area due to the activity will be negligible.

4.2.7 Impact on Terrestrial Ecology

The initial construction works at the project site involves land clearance. During construction activities vegetation may be disturbed which can be considered insignificant. The removal of vegetation from the soil and loosening of the topsoil generally causes soil erosion. However, such impacts will be confined to the project site and will be minimized through paving and water sprinkling.

4.2.8 Impact on Aquatic Ecology

The run-off from construction area may lead to a short-term increase in suspended solids and decrease in dissolved oxygen near the discharge point in receiving water body. This may lead to a temporary decrease in the photosynthetic activity of phyto-planktons, rise in anaerobic conditions and food chain modification.

4.2.9 Impact on Local Infrastructure

A significant number of workers, comprising of skilled, semi-skilled and unskilled labourers, shall be employed by various contractors at site during the peak period of construction phase. Significant number of semiskilled and unskilled labourers would be recruited from the nearby areas by contractors. This would create temporary employment opportunities in the area.

Since most of the sizeable labor force will be drawn from neighborhood, no change in demographic profile is anticipated. Most of the construction work is labour intensive. As most of the jobs will be done by contractors, it will be ensured that the contractor's workers are provided with proper facilities including sanitation and drinking water supply.

During the construction phase, temporary labour colony will be constructed at the earmarked space for the labour force. The labour colony shall be provided with drinking water and sanitation facilities. Temporary toilets as per PHED norms will be constructed for the work force during construction period. Suitable septic tanks and soak pits of appropriate capacities will be constructed for treatment of sewage before disposal. Transportation of construction material and equipment shall increase the traffic on major roads but its affect will be for a temporary period.

4.2.10 Impact on Demography and Socio-Economics

The social impact during the construction stage will be beneficial in nature. During construction of the project, large number of people from neighborhood will be engaged by contractors on daily wages basis. Most of the construction work is labour intensive. Local people would be preferred for secondary employment with contracting agencies, depending upon their skill and experience. During construction, due to influx of labour, economic activities in surrounding areas will be increased.

The construction material like stone chips and sand may be procured locally. Thus there is possibility of generation of local trading opportunities for limited period of time.

## 4.3 Impacts During Operation Phase

After the proposed expansion the coal based power plant, operation will involve 3780 MW (Stage-I, Stage-II & Stage-III) of thermal power generation. The following activities related to the operational phase will have varying impacts on the environment and are considered for impact assessment:

- Land use;
- Soil quality;
- Topography and climate;
- Air quality;
- Water resources and quality;
- Solid waste;
- Noise levels;
- Terrestrial and aquatic ecology;
- Demography and socio-economics; and
- Infrastructural facilities.

Probable impacts on various sectors of environment during operation phase are given in **Table-4.2**. Further, the significance of these impacts is discussed in the subsequent sections.

**TABLE-4.2**
**IDENTIFICATION OF OPERATION AND MAINTENANCE ACTIVITIES AND PROBABLE IMPACTS**

| Operation and Maintenance Activities | Sector | Probable Impacts |
|---|---|---|
| Transportation of coal/ oil | Air | • Noise and air emissions from vehicles<br>• Fugitive dust emissions due to traffic movement<br>• Spillage and fugitive emissions of coal/ oil |
| | Water | • Spillage of coal/ oil and flow into streams |
| | Public utilities | • Increased flow of traffic<br>• Congestion on roads |
| Unloading, crushing and storage of crushed coal/ unloading and storage of oil | Air | • Noise and air emissions from vehicles<br>• Fugitive dust emissions from coal handling areas |
| | Water | • Effluents for CHP/ oil storage areas<br>• Effluents from dust extraction/ suppression systems<br>• Run-off from coal stock yard |
| Burning of fuel | Air | • Stack emissions (PM, $SO_2$ and $NO_2$) |
| Withdrawal of water | Water | • Reduced availability to downstream users<br>• Reduced flow in downstream direction/ change in regime |
| | Ecology | • Entrapment/ Impingement of organisms |

| Operation and Maintenance Activities | Sector | Probable Impacts |
|---|---|---|
| Water treatment for various uses | Water | • Generation of effluents and sludge from treatment plant<br>• Clarifier sludge<br>• Filter backwash<br>• DM plant regeneration waste<br>• Tube settler sludge |
| Power cycle | Water | • Discharge of blow down |
| Equipment cooling | Water/ Ecology | • Discharge of hot water containing chemicals/ biocide |
| Transportation, storage & use of chemicals/ $Cl_2O$ | Air/ Water | • Risks of accidental spillage/ waste of chemicals |
| Operation of transformers and switchyard | Water | • Generation of effluents containing oil |
| Maintenance (cleaning, over-haul, oil change, lubrication etc.) | Water | • Generation of effluents containing oil/ chemicals |
| Domestic use of water in plant and township | Water | • Generation of sanitary effluents |
| Transportation of lime | Air | • Minimal fugitive emissions due to rail transportation |
| Disposal and storage of gypsum | Water | • Generation of effluents and sludge |

### 4.3.1 Impact on Land Use

The land selected for proposed expansion of power plant project is within the premises of Sipat STPP, which is categorized as industrial area. As no additional land is proposed to be acquired for the project, there is no impact on land use due to the proposed expansion.

### 4.3.2 Impact on Soil

The impact on soil during operation of the project could result due to deposition of residual particulate matter and gaseous emissions on the soil. The soil within the deposition zone of pollutants may undergo physico-chemical changes due to deposition of PM (ash particles) and washout of gases ($SO_2$ and $NO_2$) during the rains. The impacts on soil due to operation of the power plant and gaseous emission are likely to be negligible as the incremental concentration of particulate matter (PM), $SO_2$ & $NO_2$levels are observed within limit.

The impact on the topsoil will be confined to the proposed main plant area and ash pond area. The probable sources of degradation of soil quality will be only due to generation of ash. The emissions of particles will be dispersed through tall chimney over wide area, causing little impact on soil. The fly ash arrested through ESP will be utilised and unutilised ash shall be led to ash pond. The ash pond will be designed in such a way that water will always cover the deposited ash and prevent fugitive dust. The air borne fugitive dust from the plant is likely to be deposited on the topsoil in the immediate vicinity of the plant boundary. However, the fugitive emissions are likely to be controlled to a great extent through proposed control measures like highly efficient electrostatic precipitators. However, it is advisable to

undertake periodic monitoring of soils at the maximum impact zone of the pollutants mentioned above.

4.3.3 Impact on Air Quality

The impacts of air pollution from a coal based thermal power plant on neighborhood air quality would depend upon various factors, viz. design capacity, process technology, quality of fuel (coal) used for combustion, operation &maintenance of process units and air pollution control equipment installed in the individual process units.

The severities of impacts on air environment from any thermal power project are also governed by terrain conditions around the project site and the prevailing micro-meteorological conditions in the project region. Generally, a thermal power project besides the main units like boilers, turbines also has several onsite and offsite facilities, viz. coal yard, conveyor system, coal crusher/pulverizes, coal handling (loading/unloading) etc. which also contribute to air pollution in the form of fugitive emissions.

The major air pollutants from a TPP are Particulate Matter (PM), $SO_2$, $NO_x$ and CO which are emitted continuously from the stacks (point sources), attached with coal combustion boilers. The fugitive emissions of coal dust are also contributed by coal handling activities at storage yard, wind erosion, spillages from conveyor system, pulverization etc.

The emissions from point sources at TPS are very important for impact assessment as these sources are comparatively large, continuous in nature and are released at higher elevations above ground level. The impacts on air environment from stacks depend on the quality of coal used and can extend to far distances depending on prevailing meteorological conditions.

Amongst the continuous point source emissions, PM, $SO_2$ and $NO_x$ will be of prime concern as they are emitted in large quantity depending on the type of coal used and efficiency of air pollution control equipment. As regards the fugitive emissions, the main pollutant required to be considered is coal dust from different sources.

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, AERMOD Version 7.1 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.

➢ ***Model Set-up***

The model set-up details are presented in **Table-4.3.**

**TABLE-4.3**
**MODEL SET-UP**

| Sr. No. | Parameter | Details |
|---|---|---|
| 1 | Model Name | AERMOD (Version 7.1) |
| 2 | Model Type | Steady state Gaussian plume air dispersion model |
| 3 | Topography | Rural, Flat |
| 4 | Averaging Time | 24 hours |
| 5 | Source Type | Point source |
| 6 | Boundary Limits | 10 km X 10 km |
| 7 | Co-ordinate System | Uniform Cartesian Grid |
| 8 | Receptor Height | Ground level |
| 9 | Anemometer | 10 m |
| 10 | Surface meteorological data | Site Specific data processed by AERMET |
| 11 | Upper air Data | Upper air Estimator using AERMET processor |

*4.3.3.1 Model Input Data*

For the modeling purpose, pollutants like PM, $SO_2$ and $NO_x$ are considered. These net emissions are calculated for modeling purpose. The proposed Sipat Stage-III (1 x 800 MW) will have all pollution control systems (ESP, FGD, NOx control). The details of the emissions envisaged are presented in **Table-4.4(A)** and **(B).** The modeling has been carried out for three seasons (pre-monsoon, post monsoon & winter season) which is given in **Annexure-XIV.**

**TABLE-4.4(A)**
**STACK EMISSIONS CHARACTERISTICS**

| Sr. No. | Parameters | Units | Values for Stage-III (1x 800 MW) | |
|---|---|---|---|---|
| | | | Case-I: With Emission Control as per New Emission Norms | Case-II: With Emission Control as per Old Emission Norms |
| 1 | Stack height | m | 150 | 150 |
| 2 | No. of flue per stack | No. | 1 | 1 |
| 3 | Number of stacks | no | 1 | 1 |
| 4 | Flue internal diameter at top | m | 9 | 9 |
| 5 | Flue gas velocity/flue | m/sec | 14 | 14 |
| 6 | Flue gas temperature/flue | °C | 60 | 60 |
| 7 | Volumetric flow rate | $Nm^3$/sec/flue | 670 | 670 |
| 8 | Rate coal consumption | TPH/flue | 490 WC (Worst coal) | 490 WC (Worst coal) |
| 9 | Sulphur in coal (maximum) | %wt/wt | 0.36 | 0.36 |
| 10 | **Emission Load** | | | |
| A | Particulate matter | g/s/flue | 21.10 (@ 30 mg/$Nm^3$) | 67.0 (@ 100 mg/$Nm^3$) |
| B | $SO_2$ | g/s/flue | 67.0 (@ 100 mg/$Nm^3$) | 980 (@ 0.36% Sulphur) |
| C | $NO_2$ | g/s/flue | 67.0 (@ 100 mg/$Nm^3$) | 481 (@260g/GJ) |

*Source: NTPC*

**TABLE-4.4(B)**
**THERMAL POWER PLANTS – EMISSION STANDARDS**

| Parameter | Standards |
|---|---|
| **TPPs (units) installed before 31st December 2003*** | |
| Particulate Matter | 100 mg/Nm$^3$ |
| Sulphur Dioxide ($SO_2$) | 600 mg/Nm$^3$ (Units Smaller than 500MW capacity units) |
| | 200 mg/Nm$^3$ (for units having capacity of 500MW and above) |
| Oxides of Nitrogen (NOx) | 600 mg/Nm$^3$ |
| Mercury (Hg) | 0.03 mg/Nm$^3$ (for units having capacity of 500MW and above) |
| | |
| **TPPs (units) installed after 1st January 2003, up to 31st December 2016*** | |
| Particulate Matter | 50 mg/Nm$^3$ |
| Sulphur Dioxide ($SO_2$) | 600 mg/Nm$^3$ (Units Smaller than 500MW capacity units) |
| | 200 mg/Nm$^3$ (for units having capacity of 500MW and above) |
| Oxides of Nitrogen (NOx) | 300 mg/Nm$^3$ |
| Mercury (Hg) | 0.03 mg/Nm$^3$ |
| | |
| **TPPs (units) to be installed from 1st January 2017**** | |
| Particulate Matter | 30 mg/Nm$^3$ |
| Sulphur Dioxide ($SO_2$) | 100 mg/Nm$^3$ |
| Oxides of Nitrogen (NOx) | 600 mg/Nm$^3$ |
| Mercury (Hg) | 0.03 mg/Nm$^3$ |

*Source: New Emission Standards vide Notification No. S.O. 3305(E) dated 07.12.2015*
**TPPs (units) shall meet the limits within two years from date of publication of this notification.*
***Includes all the TPPs (units) which have been accorded environmental clearance and are under construction".*

***Meteorological Data***

The hourly meteorological data recorded at site is converted to the mean meteorological hourly data as specified by CPCB and the same has been used in the model. In absence of site specific mixing heights, IMD publication has been referred for the mixing heights and the same is used in the model.

*4.3.3.2 Presentation of Results*

- **Proposed Incremental Concentration of Stage-III (1 x 800 MW) With & Without FGD and NOx Control System**

Two scenarios have been considered for proposed incremental concentration of Stage-III (1x 800 MW) with & without FGD.

**Scenario-1:** Proposed incremental concentration of Stage-III (1x800 MW) with FGD & NOx control as per new emission norms.

**Scenario-2:** Proposed incremental concentration of Stage-III (1x800 MW without FGD & NOx control.

The proposed incremental ground level concentrations for PM, $SO_2$ and $NO_x$ due to proposed Sipat STPP Stage-III (1x800 MW) are given below in **Table-4.5 (A).** The isopleths showing the proposed incremental concentrations for PM, $SO_2$ and $NO_x$ with FGD control are shown in **Figure-4.1, Figure-4.2** and **Figure-4.3**. The isopleths showing the proposed incremental concentrations $SO_2$ and $NO_x$ without control systems are shown in **Figure-4.4** & **Figure-4.5**. The predicted resultant incremental concentration is given in **Table-4.5 (B).**

**TABLE-4.5 (A)**
**PREDICTED 24-HOURLY SHORT TERM INCREMENTAL CONCENTRATIONS DUE TO PROPOSED SIPAT STAGE-III (1X800 MW) WITH & WITHOUT FGD & NOx CONTROL SYSTEM**

| Pollutant | Proposed Incremental Concentration ($\mu g/m^3$) | | Distance (km) | Direction |
|---|---|---|---|---|
| | Case-I | Case-II | | |
| PM | As per New Emission Norms | As per Old Emission Norms | | |
| | 0.74 | 2.48 | 1.0 | E |
| $SO_2$ | With FGD | Without FGD | | |
| | 2.48 | 30.0 | 1.0 | E |
| $NO_2$ | With NOx Control | Without NOx Control | | |
| | (@ 100 mg/Nm$^3$) | (@260g/GJ) | | |
| | 2.48 | 13.1 | 1.0 | E |
| | (@ 300 mg/Nm$^3$) | (@260g/GJ) | | |
| | 7.44 | 13.1 | 1.0 | E |
| | (@ 450 mg/Nm$^3$) | (@260g/GJ) | | |
| | 11.16 | 13.1 | 1.0 | E |

***Comments on Predicted Proposed Resultant Incremental Concentrations***

In the seasonal maximum incremental short-term 24-hourly ground level concentrations for PM, $SO_2$ and $NO_x$ with FGD control likely to be encountered for pre-monsoon season are 0.74 $\mu g/m^3$, 2.48 $\mu g/m^3$ and 2.48 $\mu g/m^3$. The ground level concentration without control systems for PM, $SO_2$ and $NO_x$ are 2.48 $\mu g/m^3$, 30.0 $\mu g/m^3$ and 13.1$\mu g/m^3$. The proposed resultant incremental concentrations for the period March 2019 to March 2020 are given in **Table-4.5 (B).**

**TABLE-4.5 (B)**
**PROPOSED RESULTANT CONCENTRATIONS DUE TO INCREMENTAL GLC's (WITH EMISSION CONTROL AS PER NEW EMISSION NORMS)**

| Pollutant | Baseline ($\mu g/m^3$) | Incremental ($\mu g/m^3$) | Resultant ($\mu g/m^3$) | NAAQS Limits (Industrial/Residential) ($\mu g/m^3$) |
|---|---|---|---|---|
| $PM_{10}$ | 67.9 | 0.74 | 68.64 | 100 |
| $SO_2$ | 19.0 | 2.48 | 21.48 | 80 |

| Pollutant | Baseline ($\mu g/m^3$) | Incremental ($\mu g/m^3$) | Resultant ($\mu g/m^3$) | NAAQS Limits (Industrial/Residential) ($\mu g/m^3$) |
|---|---|---|---|---|
| $NO_2$ | | **(@100 mg/Nm³)** | | |
| | 21.2 | 2.48 | 23.68 | 80 |
| | | **(@300 mg/Nm³)** | | |
| | 21.2 | 7.44 | 28.64 | 80 |
| | | **(@450 mg/Nm³)** | | |
| | 21.2 | 11.16 | 32.36 | 80 |

The resultant maximum ground level concentrations after operation of proposed Sipat Stage-III (1 x 800 MW) project shall be for PM-68.64 $\mu g/m^3$, $SO_2$-21.48 $\mu g/m^3$ and NOx–23.68 $\mu g/m^3$are well below than National Ambient Air Quality Standards (NAAQ), 2009. The proposed resultant incremental concentrations for the period March 2023 to May 2023 are given in **Table-4.5 (C).**

**TABLE-4.5 (C)**
**PROPOSED RESULTANT CONCENTRATIONS**
**DUE TO INCREMENTAL GLC's (WITH CONTROL)**

| Pollutant | Baseline ($\mu g/m^3$) | Incremental ($\mu g/m^3$) | Resultant ($\mu g/m^3$) | NAAQS Limits (Industrial/Residential) ($\mu g/m^3$) |
|---|---|---|---|---|
| $PM_{10}$ | 76 | 0.74 | 76.64 | 100 |
| $SO_2$ | 26 | 2.48 | 28.48 | 80 |
| $NO_2$ | | **(@100 mg/Nm³)** | | |
| | 37 | 2.48 | 39.48 | 80 |
| | | **(@300 mg/Nm³)** | | |
| | 37 | 7.44 | 44.44 | 80 |
| | | **(@450 mg/Nm³)** | | |
| | 37 | 11.16 | 48.16 | 80 |

***Source: Baseline data from Mantec***

The resultant maximum ground level concentrations after operation of proposed Sipat Stage-III (1 x 800 MW) project shall be for PM-76.64 $\mu g/m^3$, $SO_2$-28.48 $\mu g/m^3$ and NOx–39.48 $\mu g/m^3$ are well below than National Ambient Air Quality Standards (NAAQ), 2009.

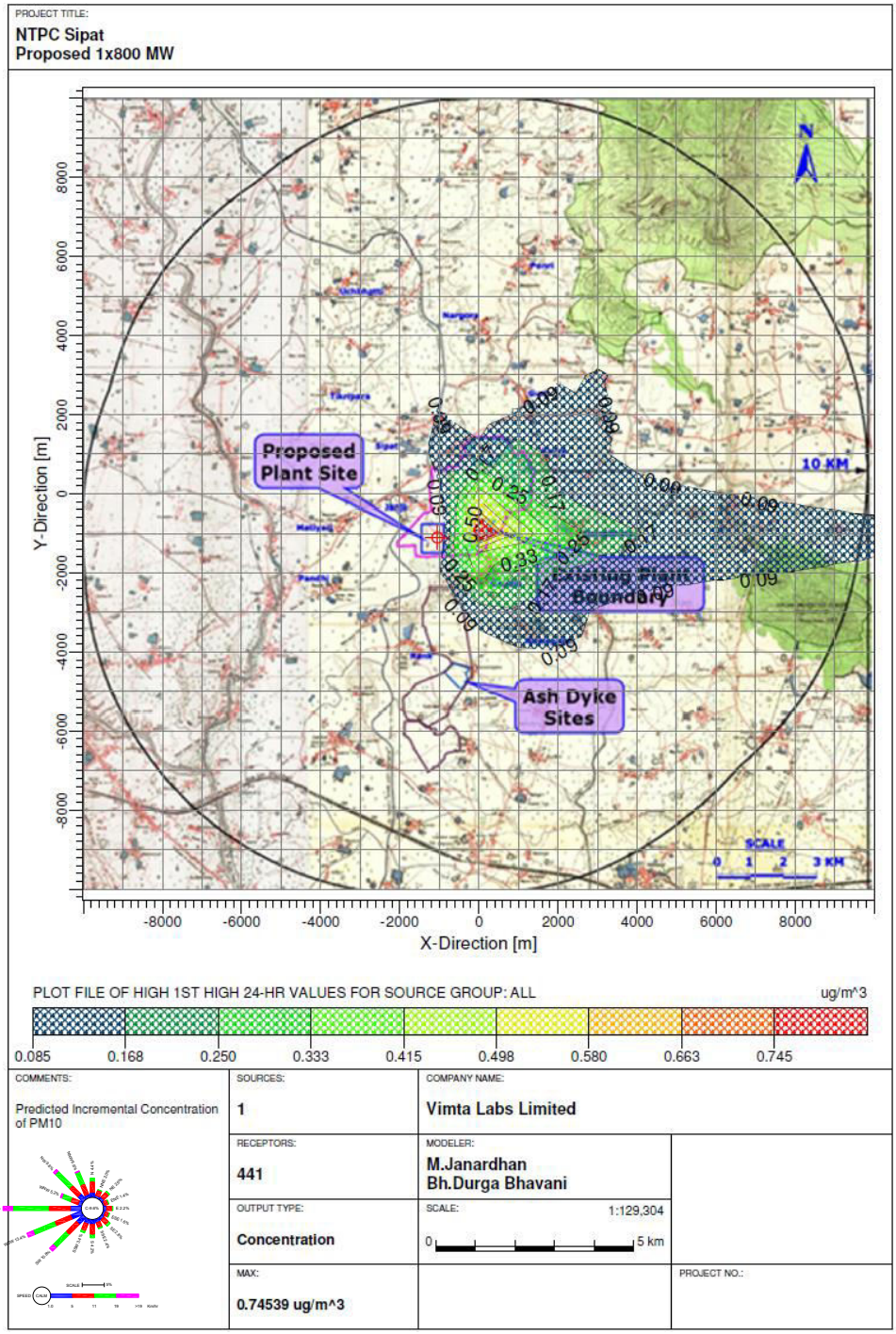



**FIGURE-4.1**
**SHORT TERM 24 HOURLY INCREMENTAL GLCS OF PM DUE TO PROPOSED 1X800 MW UNIT**

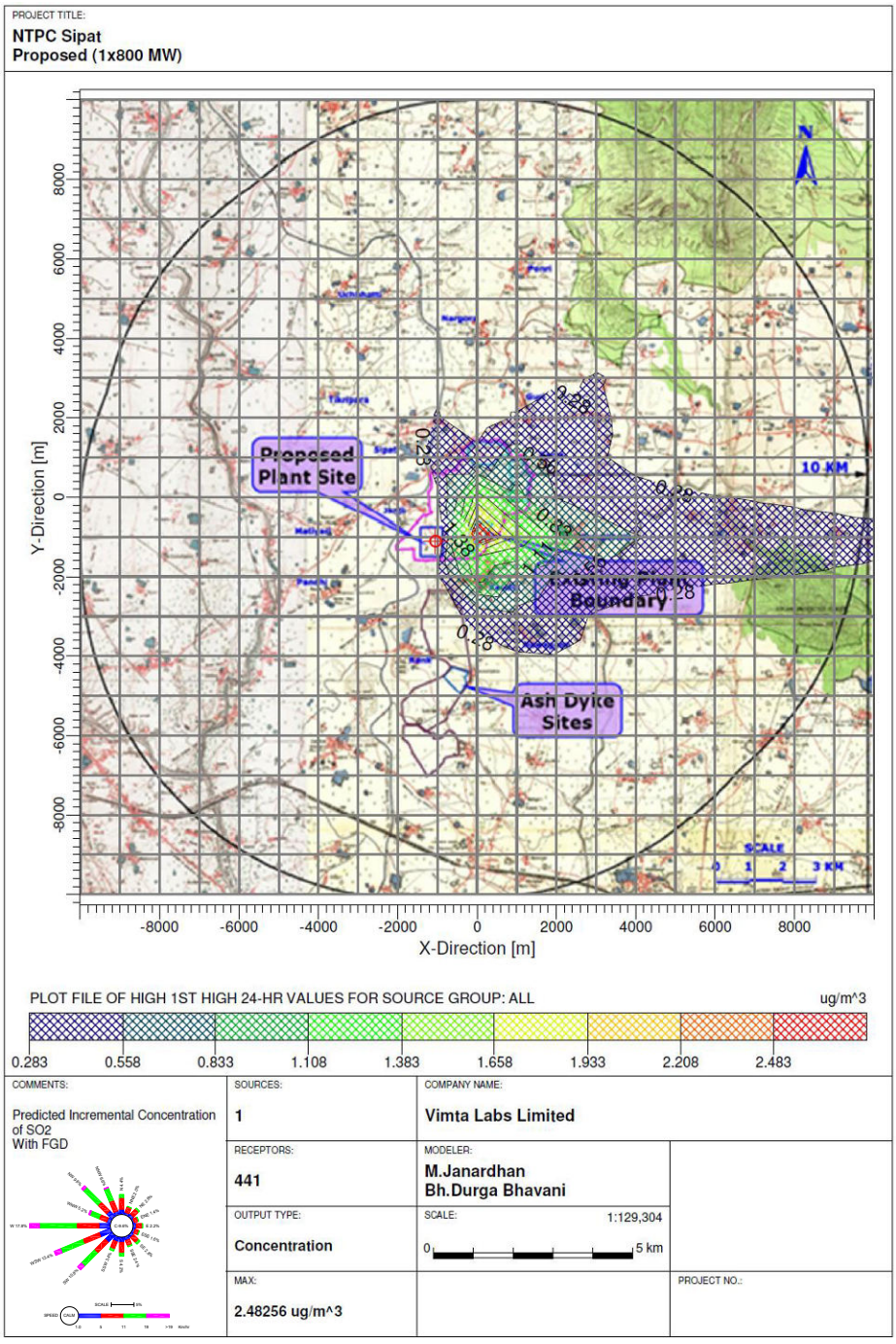



**FIGURE-4.2**
**CASE-I: SHORT TERM 24 HOURLY INCREMENTAL GLCS OF $SO_2$ DUE TO PROPOSED 1 X 800 MW UNIT WITH FGD**

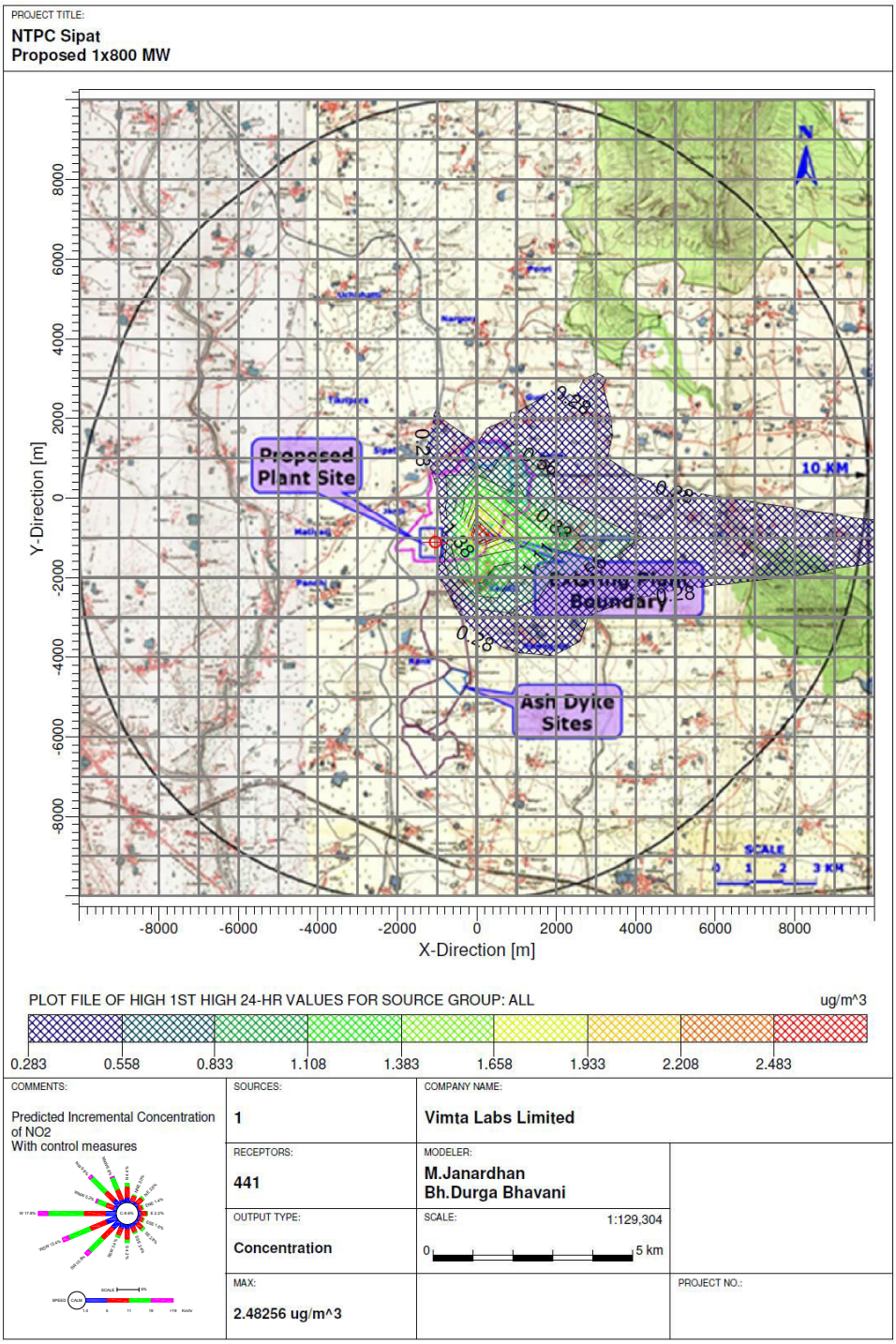



**FIGURE-4.3**

**CASE-I: SHORT TERM 24 HOURLY INCREMENTAL GLCS OF NOx WITH CONTROL**

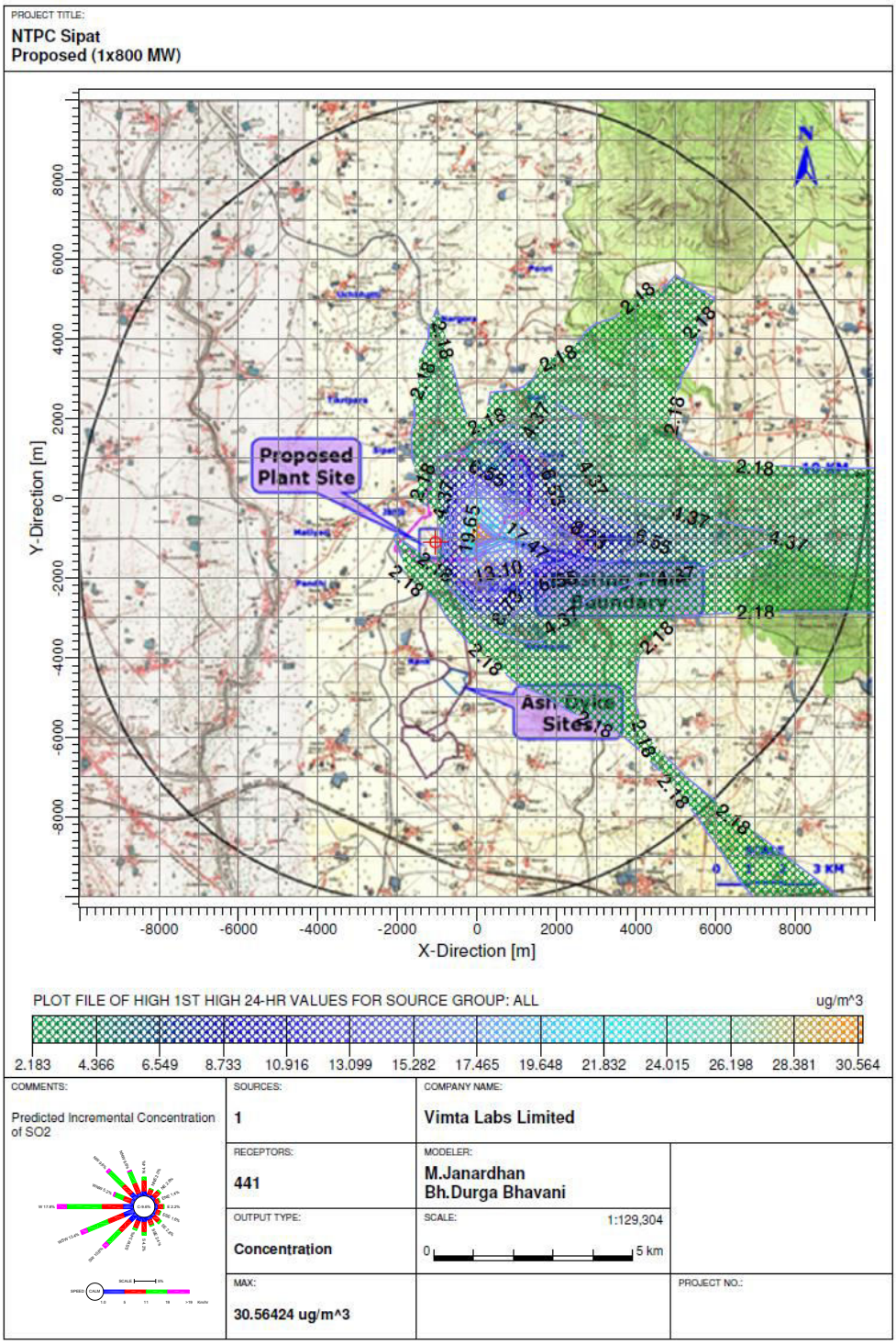



**FIGURE-4.4**
**CASE-II: SHORT TERM 24 HOURLY INCREMENTAL GLCS OF $SO_2$ WITHOUT CONTROL**

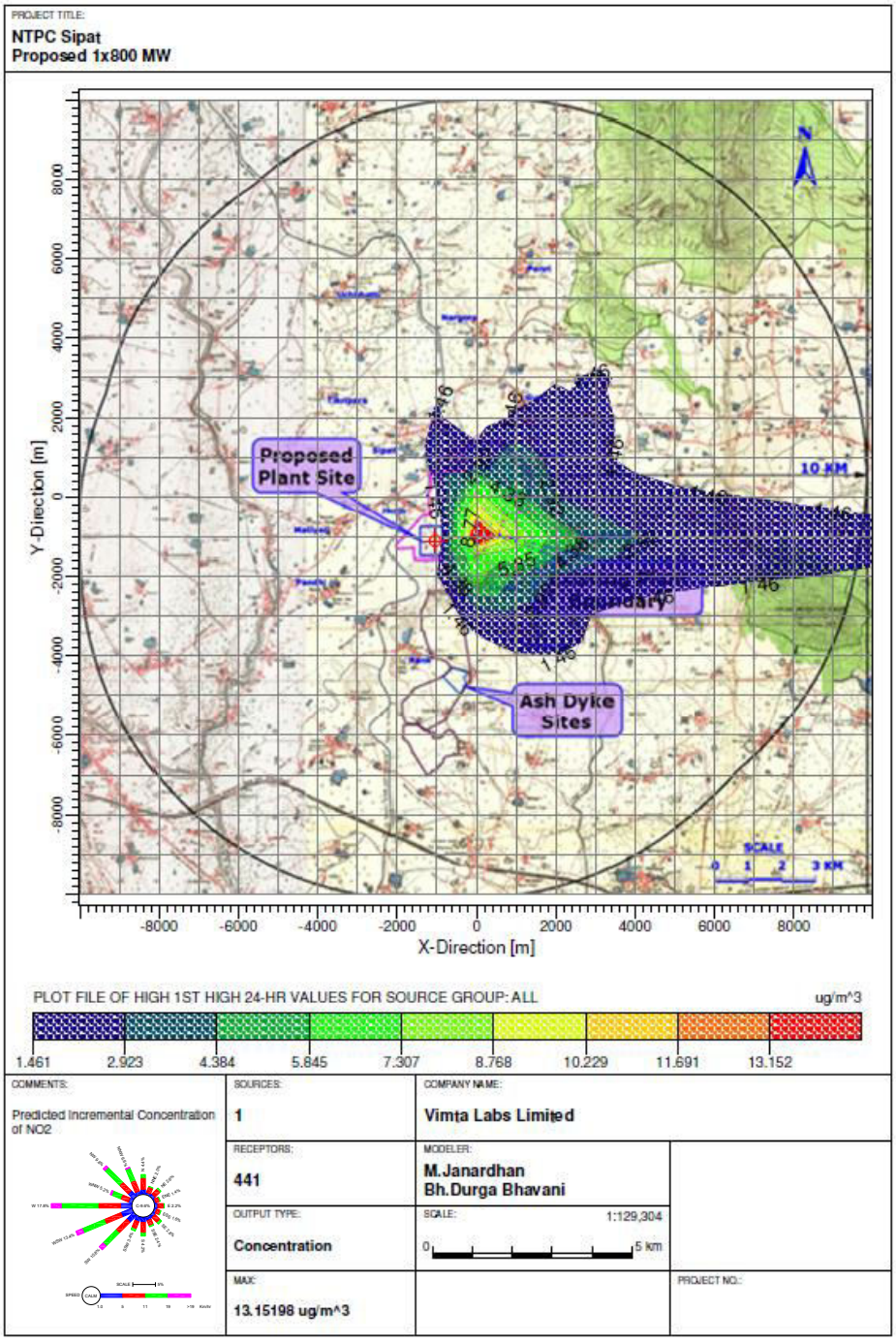



**FIGURE-4.5**
**CASE-II: SHORT TERM 24 HOURLY INCREMENTAL GLCS OF $NO_x$ WITHOUT CONTROL**

➢ **Cumulative Impact on Ambient Air Quality due to Major Industries within 10 km Radius Study Area**

There are no thermal power plants/ other major industries located within 10 km radius of Sipat STPS. Only a coal beneficiation plant of 3.6 MTPA is located at Hindadih village, Sipat tehsil, Bilaspur district about 3.3 km from Sipat STPS. As it is a coal washery, only fugitive emissions are generated from this industry which will be limited to boundary of industry only. No point source of emission involved in this coal beneficiation plant. Hence, there would be no contribution in cumulative impact on ambient air quality due to this industry. Three scenarios have been considered for cumulative air quality modelling.

Further, there is no proposal for establishment or expansion of any industry within 10 km. of Sipat STPS except for Sipat STPP, Stage-III.

The impacts of emissions from Sipat STPP Stage-I and II have already been reflected in Baseline Ambient Air Quality monitored during the study and the prediction of impacts should consider the emissions from Stage-III unit only. However, in compliance with the TOR Condition (iii) of TOR, a cumulative impact assessment has been done considering the emissions from Stage-I and II also.

The emission characteristics considered for existing units are presented in Table 4.4(a).

**TABLE-4.4(a)**
**STACK EMISSIONS CHARACTERISTICS FOR EXISTING UNITS**

| Sr. No. | Parameters | Units | Existing | |
|---|---|---|---|---|
| | | | Stage-II (2x 500 MW) | Stage-I (3 x 660 MW) |
| 1 | Stack height | m | 275 | 275 |
| 2 | No. of flue per stack | No. | 2 | 2+1 |
| 3 | Number of stacks | no | 1 | 2 |
| 4 | Flue internal diameter at top | m | 6.75 | 7.64 |
| 5 | Flue gas velocity/flue | m/sec | 21.73 | 23.6 |
| 6 | Flue gas temperature/flue | °C | 125 | 125 |
| 7 | Volumetric flow rate | $Nm^3$/sec/ flue | 845.0 | 996.58 |
| 8 | Rate coal consumption | TPH/flue | 380 | 454 |
| 9 | Sulphur in coal (maximum) | %wt/wt | 0.36 | 0.36 |
| 10 | **Emission Load** | | | |
| A | Particulate matter | g/s/flue | 17.46 | 24.29 |
| B | Sulphur dioxide ($SO_2$) | g/s/flue | 760 | 908 |
| C | Oxide of Nitrogen ($NO_2$) | g/s/flue | 327 | 390 |

*Source: NTPC*

For cumulative impact assessment, the following three scenarios have been considered:

1. **Scenario-1:** Cumulative incremental concentration of existing units of **Stage-I, II without/with** FGD & NOx control system;
2. **Scenario-2:** Cumulative incremental concentration of all stages (Stage-I, II & III) of Sipat project considering the existing units of **Stage-I, II & III with/without FGD & NOx control**; and

3. **Scenario-3:** Cumulative incremental concentration of **Stage-I & II without FGD & NOx control** & **Stage-III with FGD & NOx control.**

**Scenario-I**

A. Cumulative Incremental Concentration of Existing Units of Stage-I,II without/with FGD & NOx Control System

The cumulative impact due to existing units (Stage-I (3x660 MW) & Stage-II (2x500 MW)) likely to have significant impact on air quality has been carried out through air modelling. The input data for cumulative air modeling will be based on two scenarios as given below.

**Case-I:** Cumulative impact considering existing units Stage-I (3x660 MW) & Stage-II (2x500 MW) **without** FGD & NOx control System. Stack emission characteristics have been considered as given in **Table-4.4**.

**Case-II:** Cumulative impact due to incremental ground level concentration considering existing units (Stage-I [3x660 MW] & Stage-II [2x500 MW]) **with** FGD & NOx control System. Stack emission characteristics have been considered as given in **Table-4.4**.

The cumulative incremental ground level concentrations due to existing units of Stage-I, II **without/with** FGD & NOx control system regarding PM, $SO_2$ and $NO_X$ are given below in **Table-4.6**. The isopleths showing cumulative incremental concentration of existing units of Stage-I, II without/with FGD & NOx control system is given in **Figure-4.6** to **Figure-4.10.**

**TABLE-4.6**
**CUMULATIVE INCREMENTAL GROUND LEVEL CONCENTRATIONS (STAGE-I, II WITHOUT/WITH FGD & NOX CONTROL SYSTEM) (SCENARIO-I)**

| Stage-I, II without/with FGD & NOx Control System | | | | |
|---|---|---|---|---|
| | Case-I | Case-II | | |
| Pollutant | Incremental Concentration($\mu g/m^3$) | | Distance (km) | Direction |
| $PM_{10}$ | 0.71 | 0.71 | 2.0 | E |
| | Without FGD | With FGD | | |
| $SO_2$ | 28.19 | 2.36 | 2.0 | E |
| | Without Nox Control | With Nox Control | | |
| $NO_2$ | 12.14 | 2.36 | 2.0 | E |

- ***Observations on Cumulative Incremental Concentrations***

  Incremental Concentration due to Only Existing unit of Sipat Stage-I & II

  A perusal of **Table-4.6** reveals that the maximum incremental short-term 24-hourly ground level concentrations for PM, $SO_2$ and $NO_2$ only for Stage-I (3 x 660 MW) & II (2 x 500 MW) likely to be encountered during pre-monsoon season

without FGD & NOx control system are 0.71 µg/$m^3$, 28.19 µg/$m^3$ and 12.14 µg/$m^3$ respectively.

As NTPC has taken action to comply new emission standards, 2015, therefore maximum incremental short term 24 hourly ground level concentrations for PM, $SO_2$ and $NO_2$ only for Stage-I& II likely to be encountered during pre-monsoon season with FGD & NOx control system would be 0.71 µg/$m^3$, 2.36 µg/$m^3$ and 2.36 µg/$m^3$ respectively.

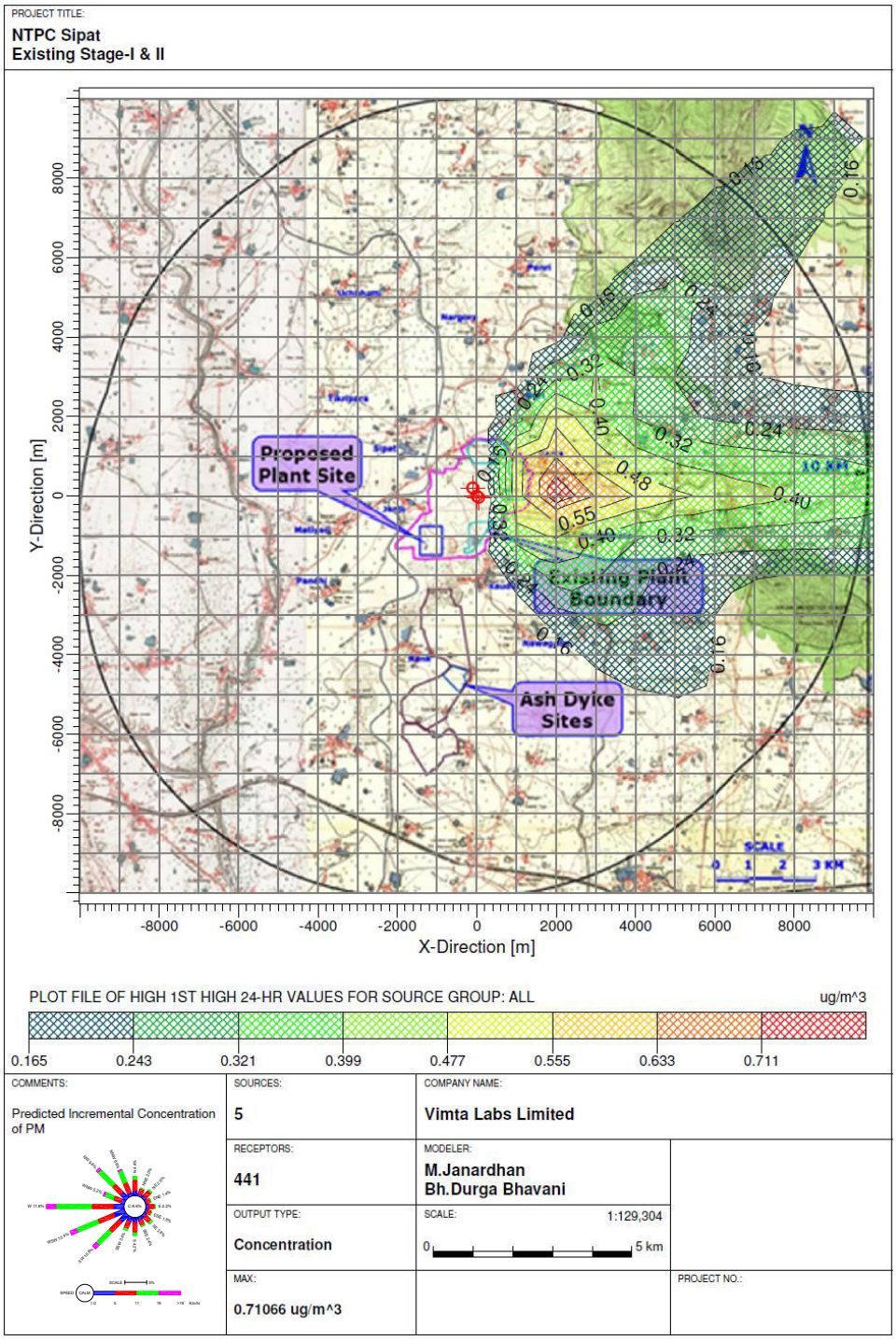



**FIGURE-4.6**
**SCENARIO-I: CUMULATIVE INCREMENTAL GLCS OF PM OF STAGE-I & II**

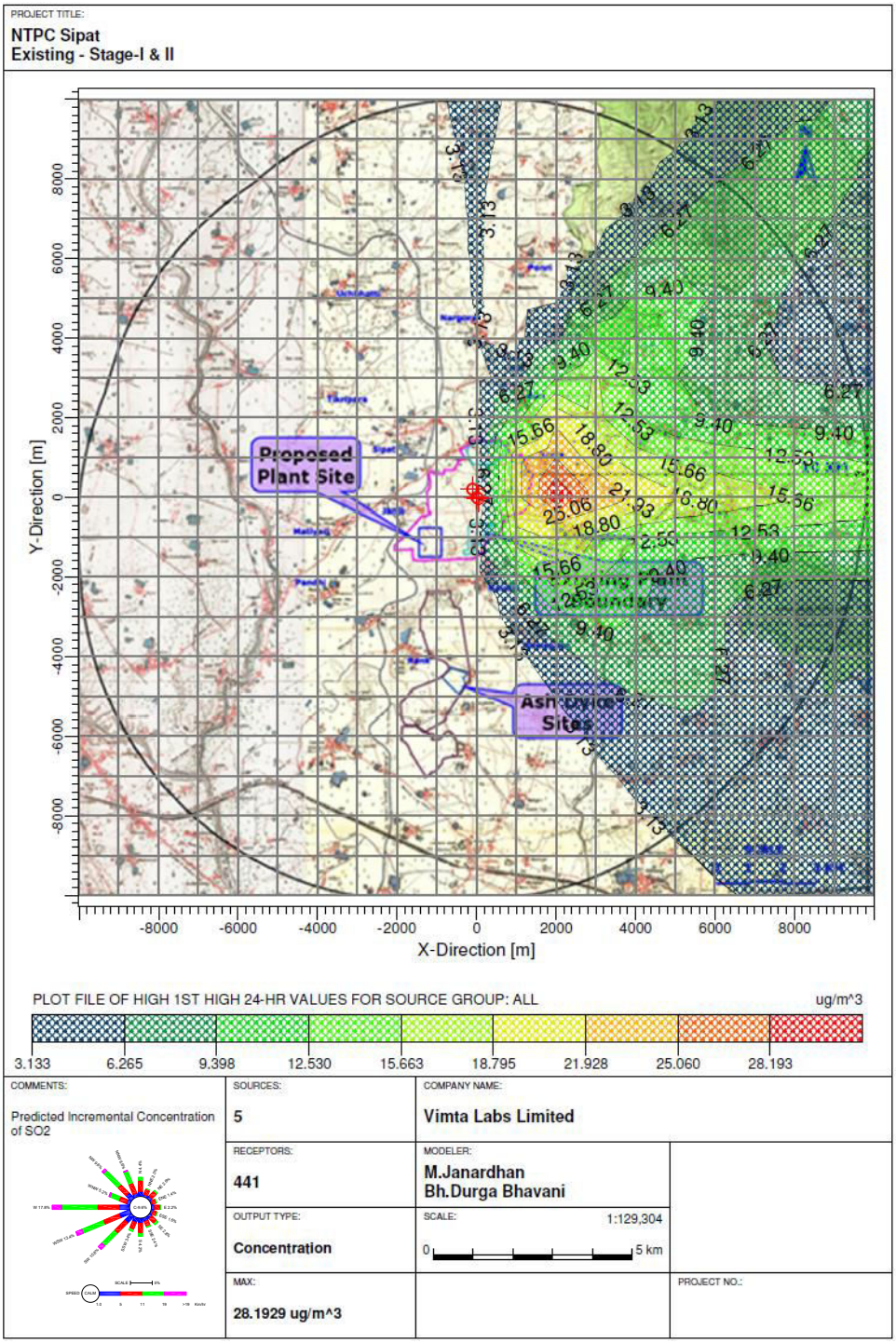



**FIGURE-4.7**
**SCENARIO-I (CASE-I): CUMULTAIVE INCREMENTAL GLCS OF $SO_2$ OF STAGE-I & II WITHOUT FGD**

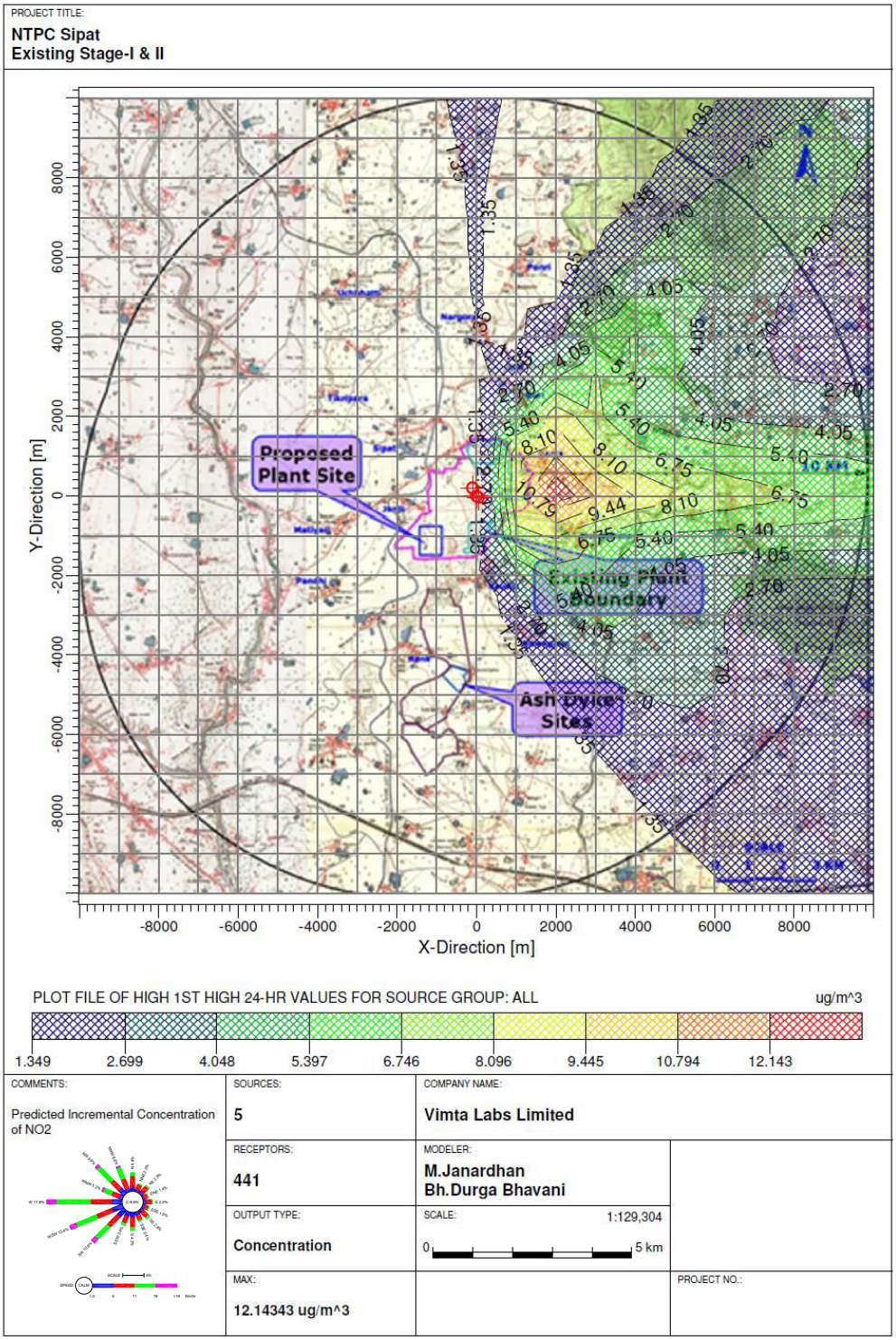



**FIGURE-4.8**
**SCENARIO-I (CASE-I): CUMULATIVE INCREMENTAL GLCS OF $NO_2$ OF STAGE-I & II WITHOUT NOx CONTROL**

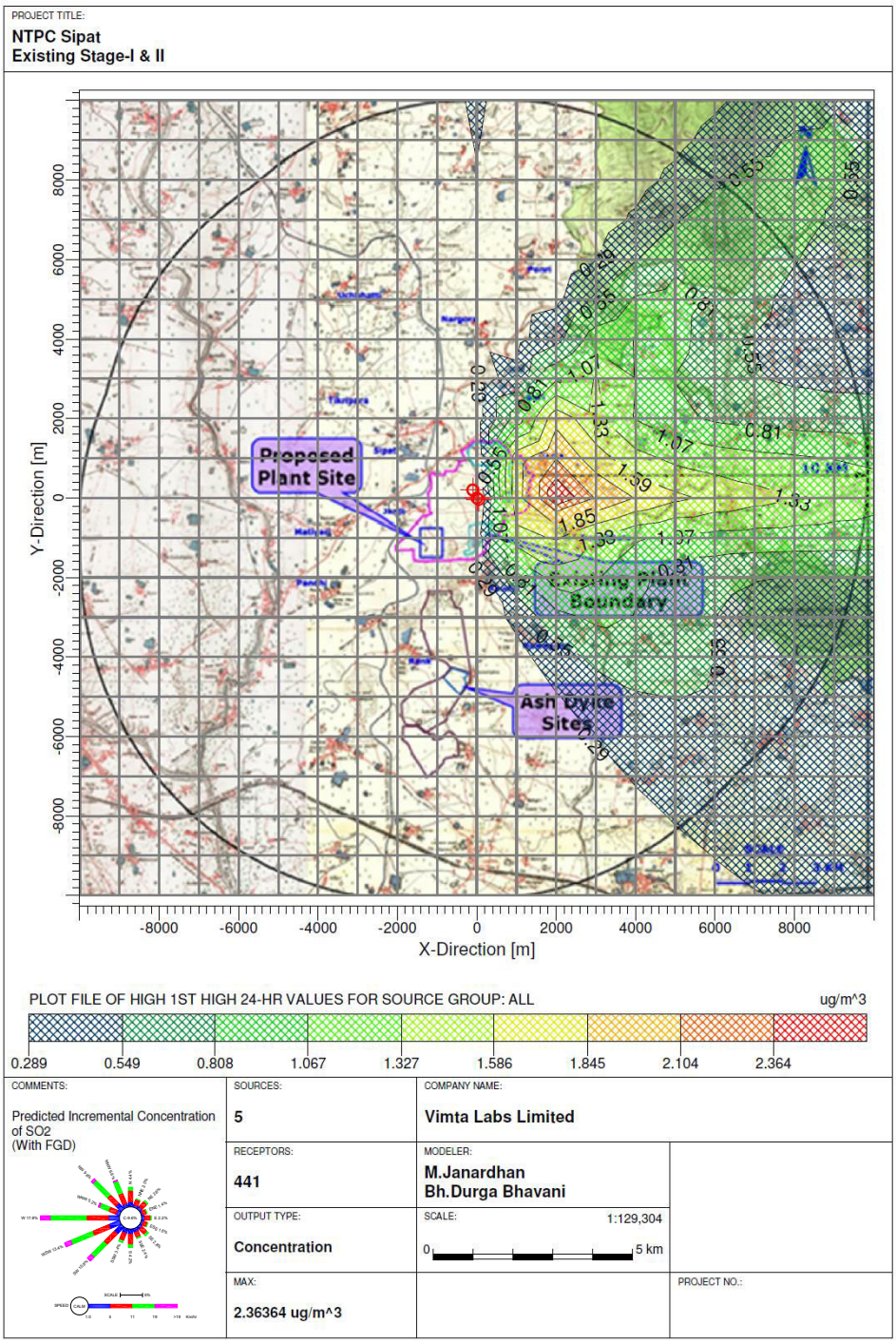



**FIGURE-4.9**
**SCENARIO-I (CASE-II): CUMULATIVE INCREMENTAL GLCS OF $SO_2$ OF STAGE-I & II WITH FGD**

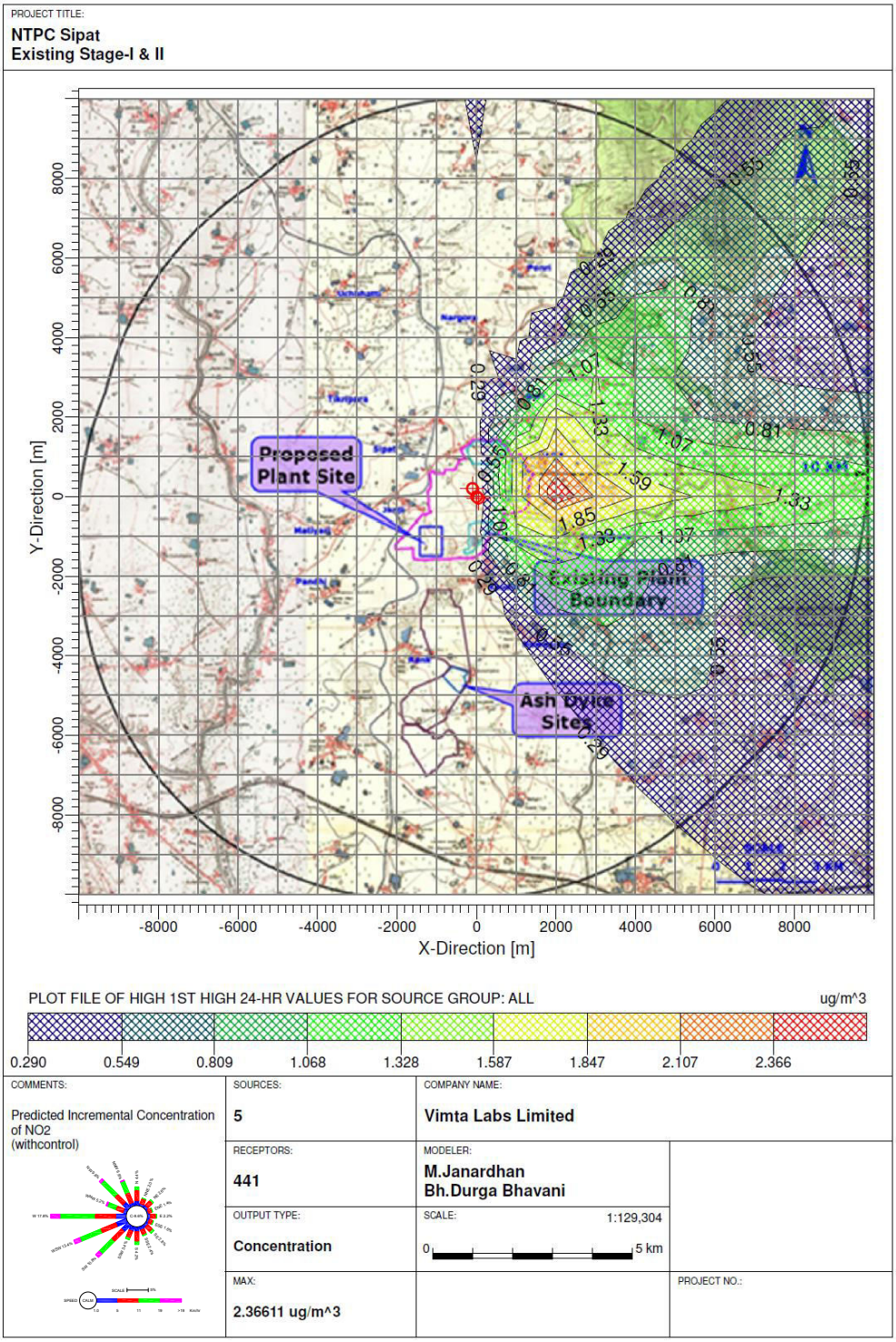



**FIGURE-4.10**
**SCENARIO-I (CASE-II): CUMULATIVE INCREMENTAL GLCS OF $NO_2$ OF STAGE-I& II WITH NOx CONTROL**

**Scenario-II**

B. Cumulative Incremental Concentration due to Existing unit of Sipat Stage-I & II and Proposed Sipat STPP Stage-III (1x800 MW) With & Without FGD & $NO_X$ Control

**Case-I**

Cumulative impact on maximum incremental short term 24 hourly ground level concentrations for PM, $SO_2$ and $NO_2$ due to all stages (Stage-I, II & III) of Sipat project considering the existing units of Stage-I & II, III without FGD & NOx control would be 0.89 µg/m$^3$, 36.30 µg/m$^3$ and 15.60 µg/m$^3$ respectively.

The isopleths showing cumulative concentrations due to all stages (Stage-I, II & III) of Sipat project showing the incremental concentrations for PM, $SO_2$ and NOx are shown in **Figure-4.11**, **Figure-4.12** and **Figure-4.13**.

**Case-II**

When proposed Stage-III (1x800 MW) will be operational, pollution control systems for gaseous emissions (FGD & NOx control) will also be operational. At this scenario, cumulative impact on maximum incremental short term 24 hourly ground level concentrations for PM, $SO_2$ and $NO_2$ due to all stages (Stage-I, II & III) of Sipat project considering the existing units of Stage-I & II with FGD & NOx control would be 0.89 µg/m$^3$, 2.99 µg/m$^3$ and 2.99 µg/m$^3$ respectively.

The isopleths showing cumulative concentrations due to all stages (Stage-I, II & III) of Sipat project showing the incremental concentrations with FGD and NOx control for PM, $SO_2$ and NOx are shown in **Figure-4.14** and **Figure-4.15**.

**TABLE-4.7**
**CUMULATIVE INCREMENTAL GROUND LEVEL CONCENTRATIONS**
**(STAGE-I, II & III WITH & WITHOUT FGD & NOX CONTROL)(SCENARIO-II)**

| Stage-I, II & III with & without FGD & NOx Control | | | | |
|---|---|---|---|---|
| | Case-I | Case-II | | |
| Pollutant | Incremental Concentration (µg/m$^3$) | | Distance (km) | Direction |
| $PM_{10}$ | 0.89 | 0.89 | 2.0 | E |
| | Without FGD | With FGD | | |
| $SO_2$ | 36.3 | 2.99 | 2.0 | E |
| | Without Nox Control | With Nox Control | | |
| $NO_2$ | 15.6 | 2.99 | 2.0 | E |

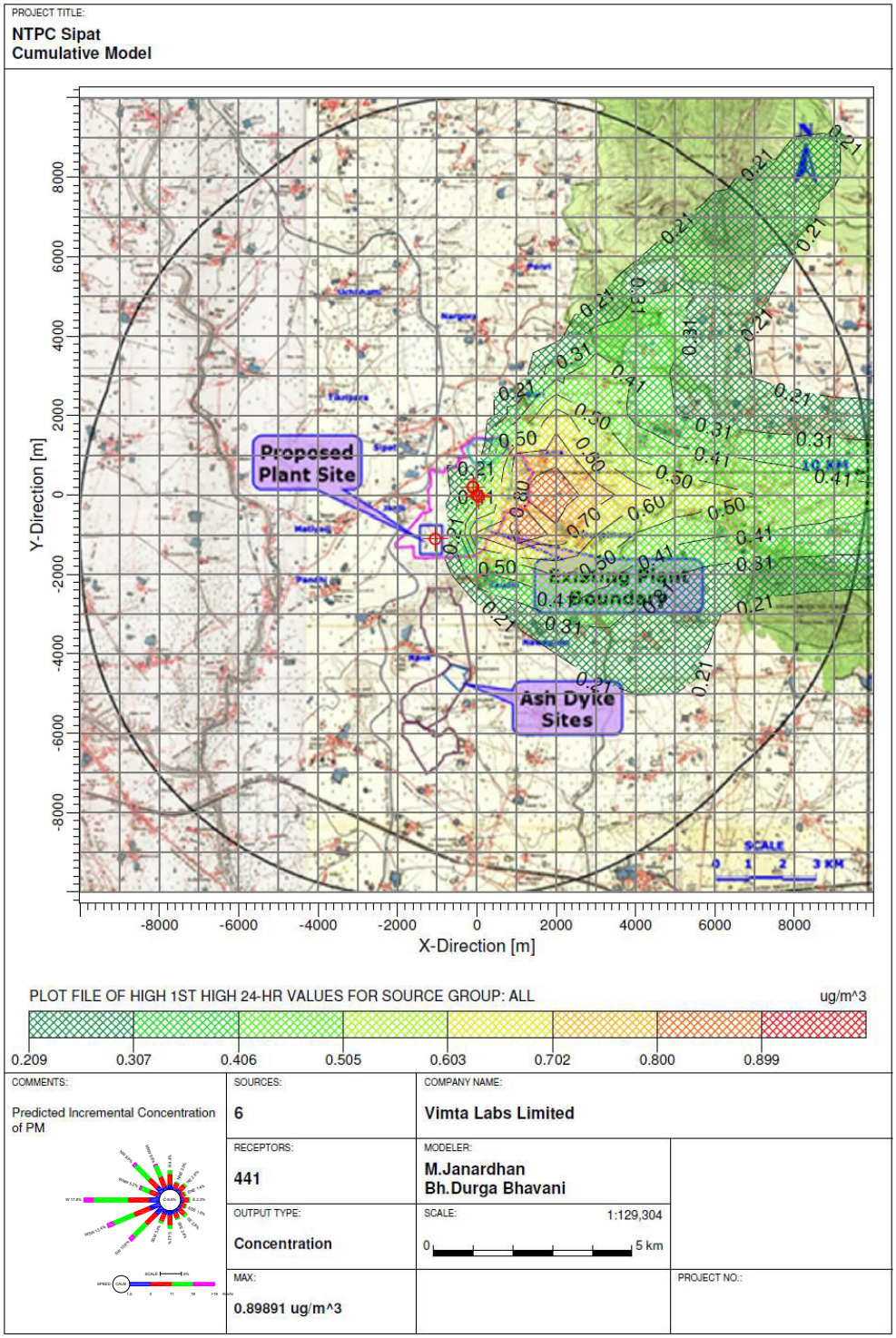



**FIGURE-4.11**
**SCENARIO-II: CUMULATIVE INCREMENTAL GLCS OF PM OF STAGE-I, II & III**

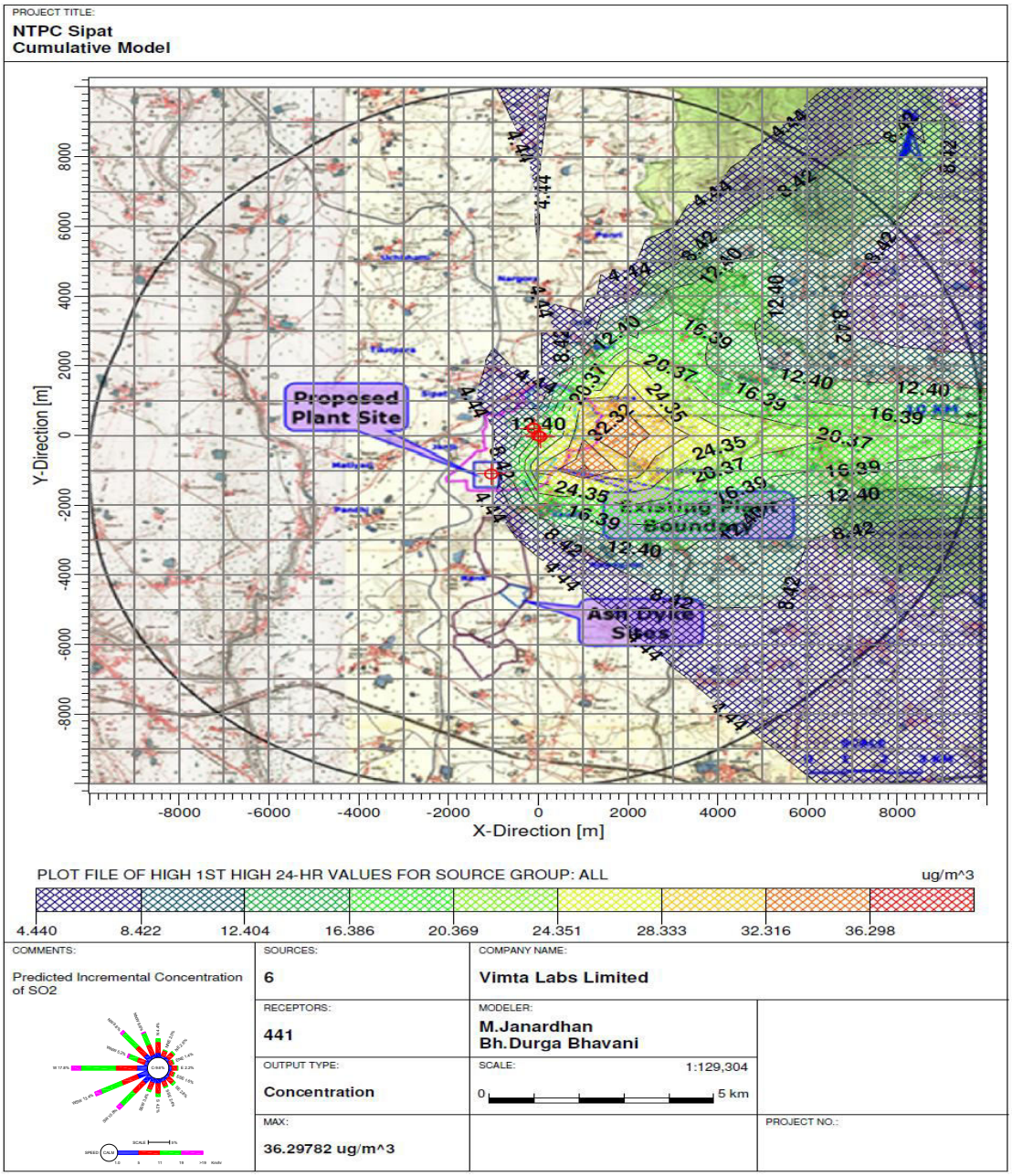



**FIGURE-4.12**
**SCENARIO-II (CASE-I): CUMULATIVE INCREMENTAL GLCS OF STAGE-I, II & III OF $SO_2$ WITHOUT FGD**

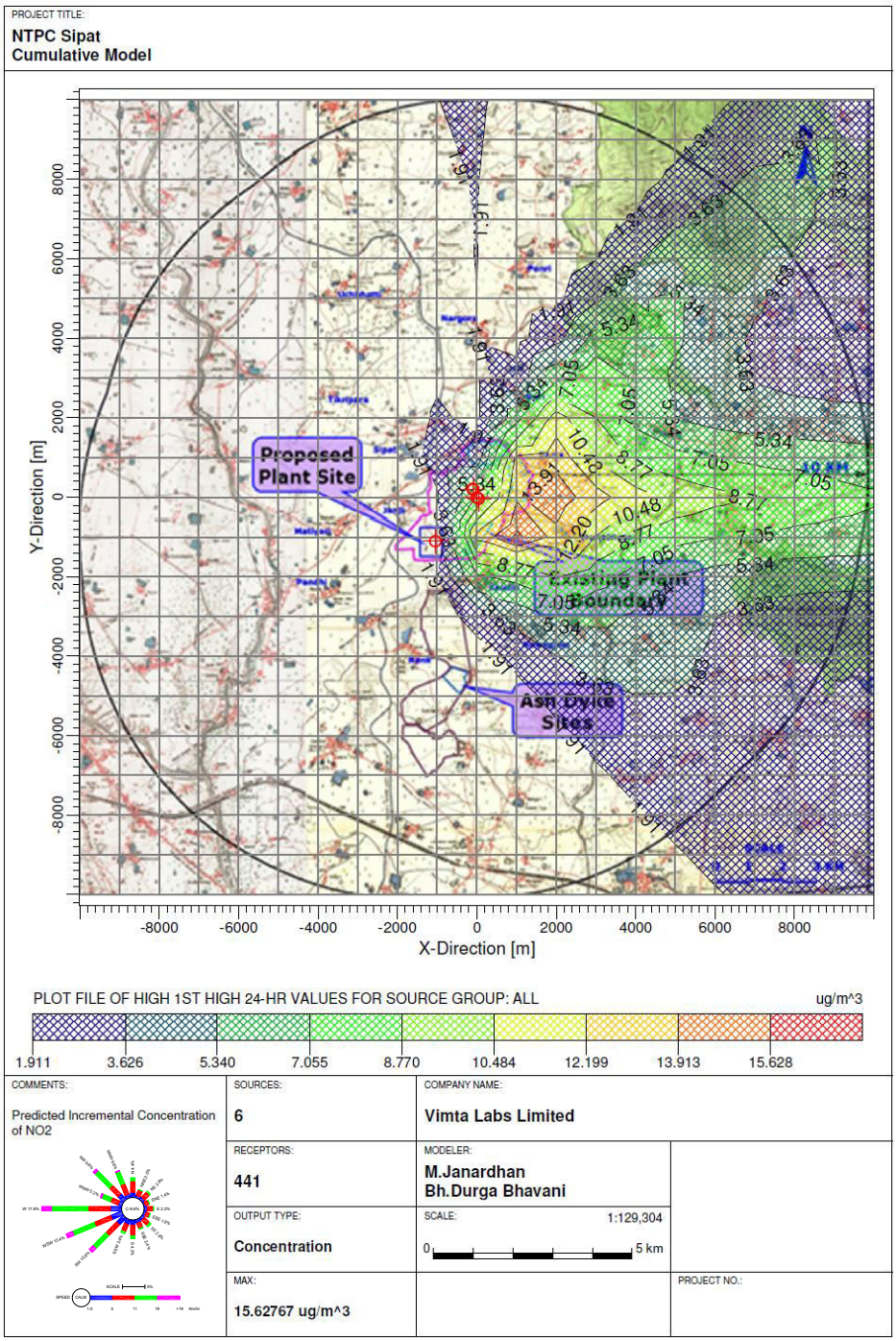



**FIGURE-4.13**
**SCENARIO-II(CASE-I): CUMULATIVE INCREMENTAL GLCS OFSTAGE-I, II & IIIOF $NO_2$ WITHOUT CONTROL**

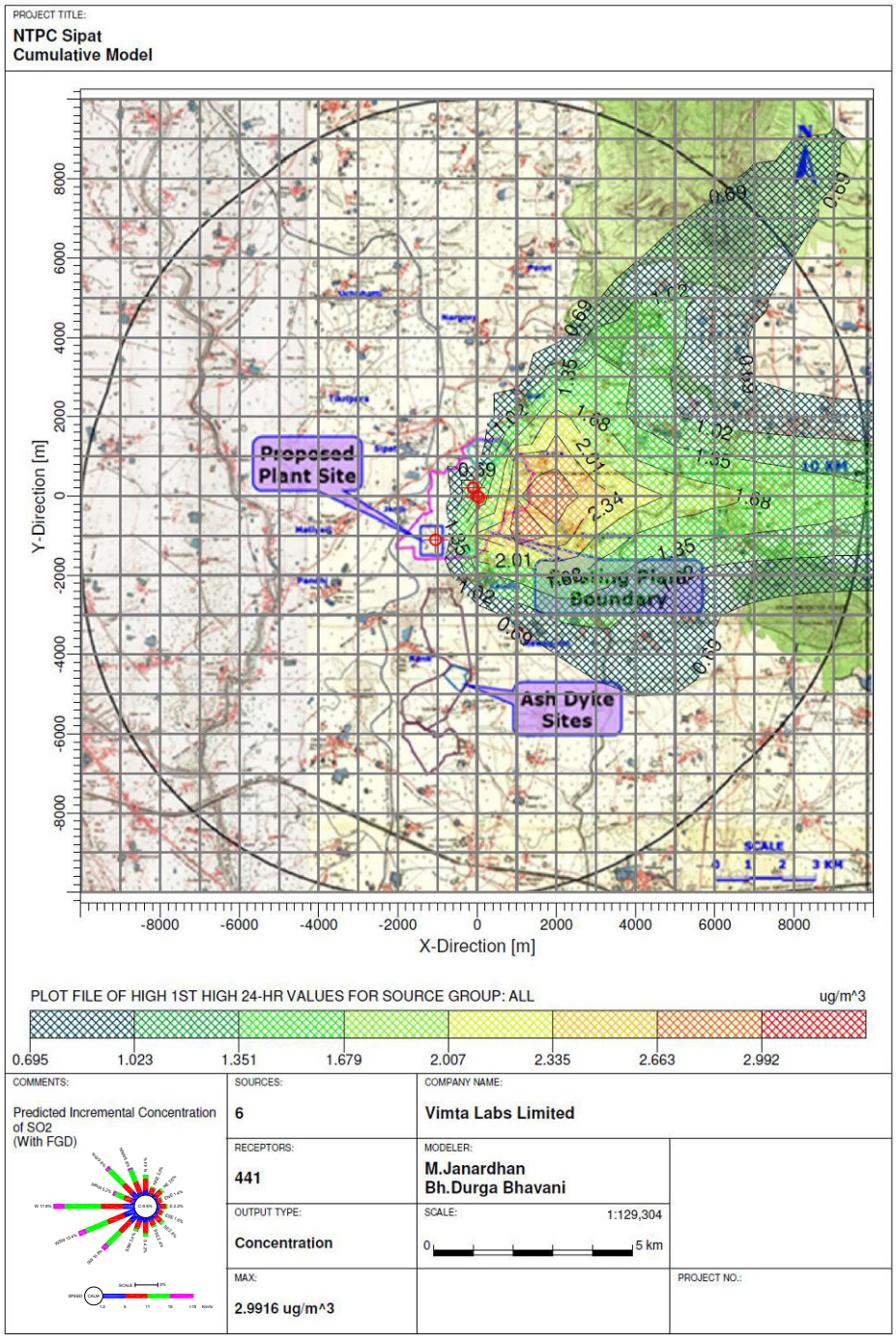



**FIGURE-4.14**
**SCENARIO-II(CASE-II): CUMULATIVE INCREMENTAL GLCS OFSTAGE-I, II & III OF $SO_2$ WITH FGD**

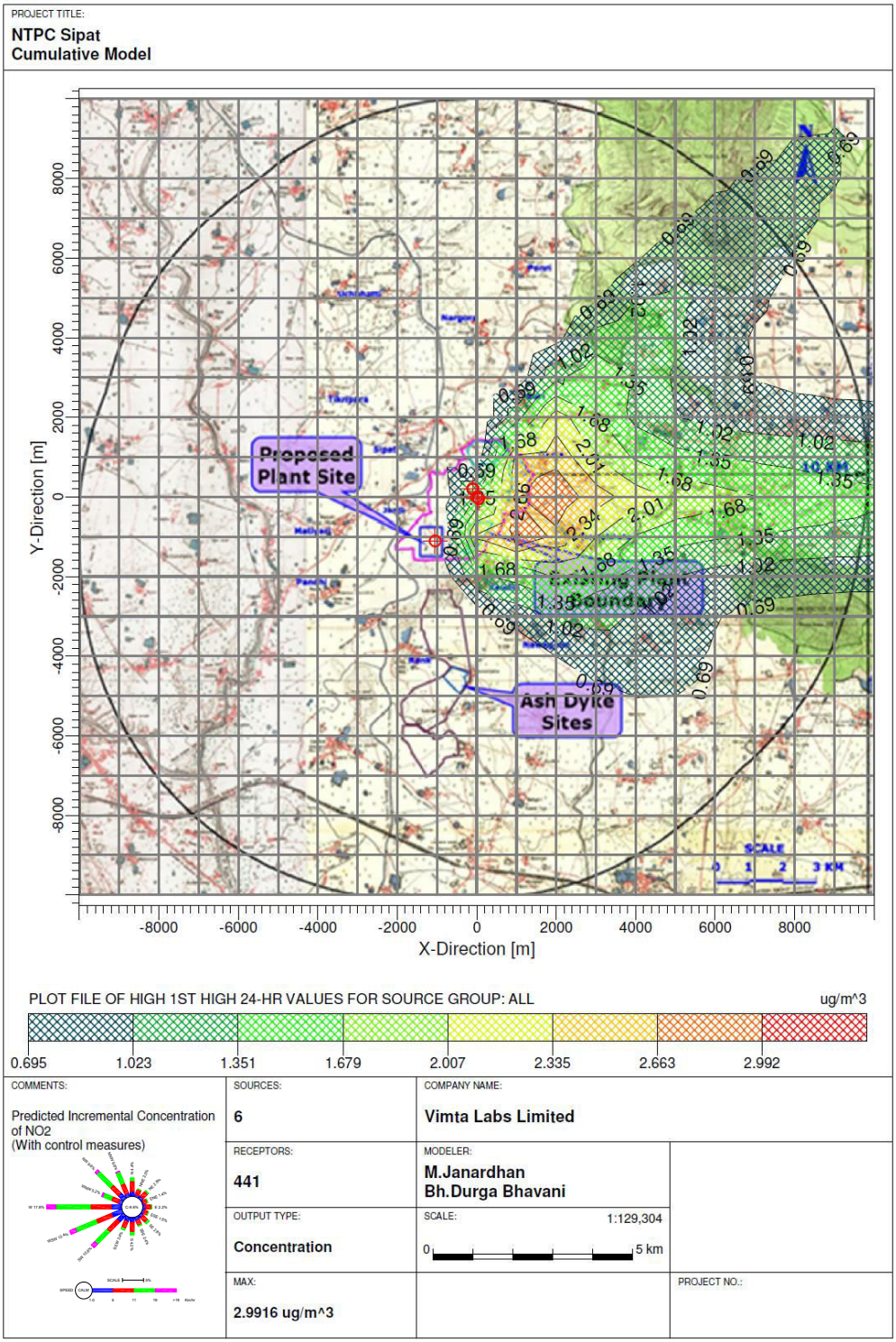



**FIGURE-4.15**
**SCENARIO-II(CASE-II): CUMULATIVE INCREMENTAL GLCS OFSTAGE-I, II & III OF $NO_2$ WITH CONTROL**

**Scenario-III:**

C. Cumulative Incremental Concentrations of Stage-I & II without FGD & Stage-III with FGD & NOx Control System

Cumulative impact on maximum incremental short-term 24-hourly ground level concentrations for PM, $SO_2$ and $NO_2$ due to all stages (Stage-I & II) without FGD of Sipat project considering the existing units of Stage-III with FGD & NOx control would be 0.89 µg/$m^3$, 28.7µg/$m^3$ and 12.6µg/$m^3$ respectively. The cumulative incremental concentrations for Stage-I & II without FGD & Stage-III with FGD & NOx control is given in **Table-4.8.** The isopleth showing cumulative incremental GLC of Stage-I & II without FGD & Stage-III with FGD is shown in **Figure-4.16** to **Figure-4.18.**

**TABLE-4.8**
**CUMULATIVE INCREMENTAL GROUND LEVEL CONCENTRATIONS**
**SCEANRIO-III**

| Incremental Concentration(µg/$m^3$) | | | | | | |
|---|---|---|---|---|---|---|
| | PM | $SO_2$ | | $NO_2$ | | Distance/Direction |
| | | Without FGD | With FGD | Without Control | With Control | |
| Stage-I & II without FGD, Stage-III with FGD | 0.89 | 28.7 | 0.067 | 12.6 | 0.015 | 2.0 km, E |

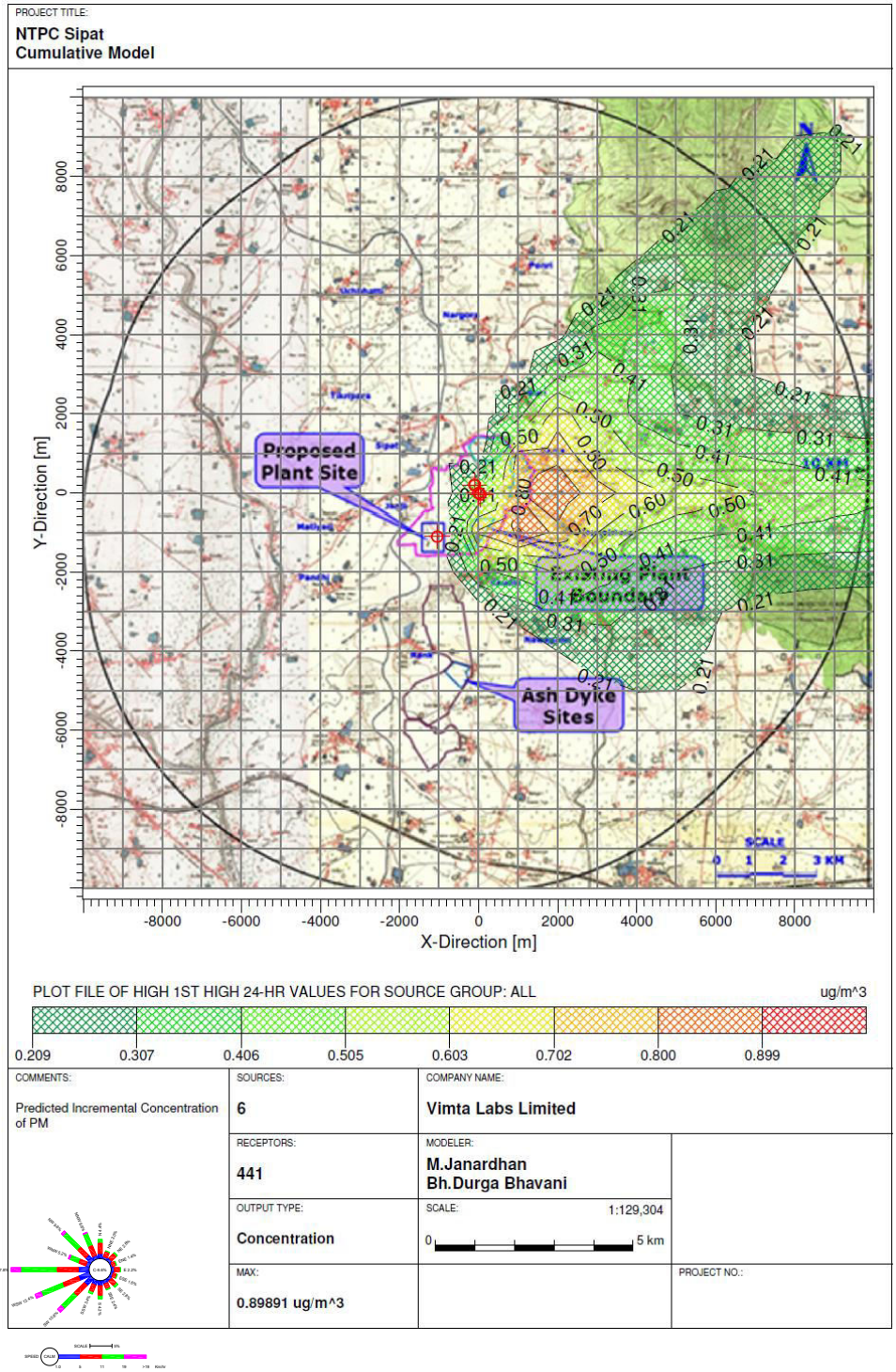



**FIGURE-4.16**
**SCENARIO-III-CUMULATIVE INCREMENTAL GLCS OF PM**

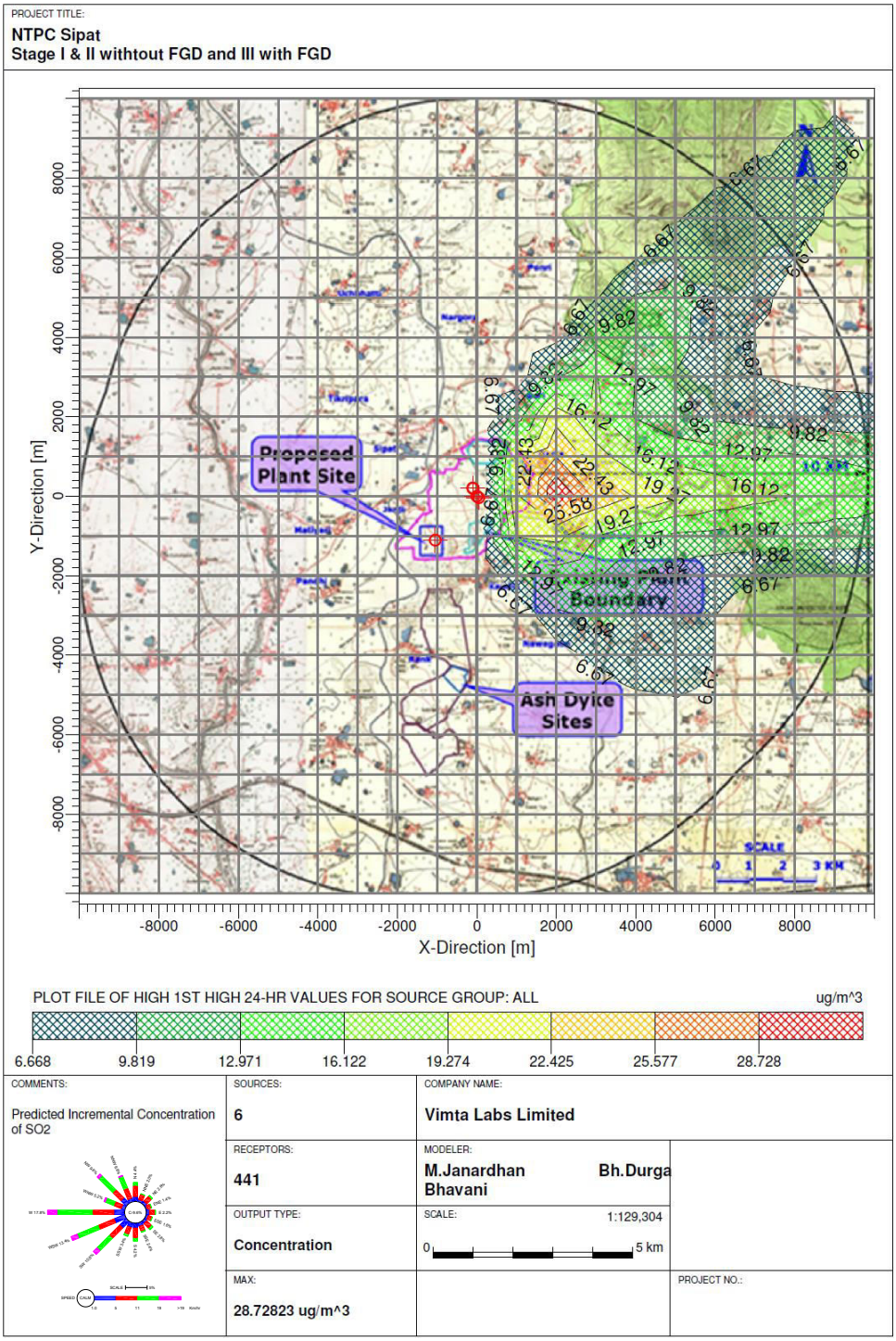



**FIGURE-4.17**

**SCENARIO-III: CUMULATIVE INCREMENTAL GLCS OF $SO_2$ OF STAGE-I & II WITHOUT FGD & STAGE-III WITH FGD**

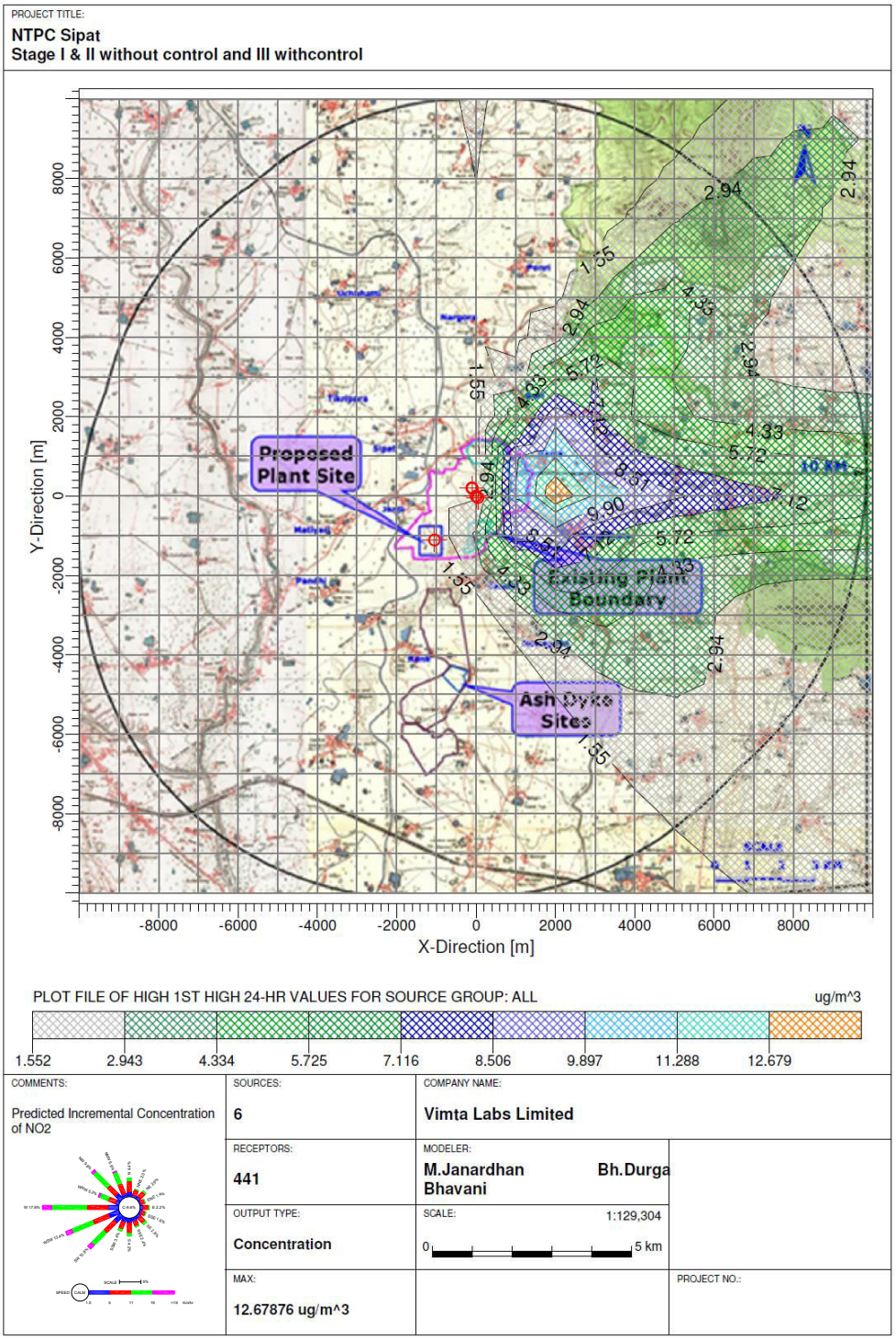



**FIGURE-4.18**

**SCENARIO-III : CUMULATIVE INCREMENTAL GLCS OF $NO_2$ OF STAGE-I& II WITHOUT NOX CONTROL & STAGE-III WITH NOx CONTROL**

The comparison of all the scenarios (I, II & III) of cumulative air quality modeling for PM, $SO_2$& $NO_X$ with & without FGD & $NO_X$ control systems is given in **Table-4.9.**

**TABLE-4.9**
**COMPARISON OF ALL THE SCENARIOS (I, II & III) OF CUMULATIVE AIR QUALITY MODELING**

| | $PM_{10}$ | $SO_2$ | | $NO_2$ | | Distance/ Direction |
|---|---|---|---|---|---|---|
| | | Without FGD | With FGD | Without Control | With Control | |
| Stage-III (1x800 MW) Only | 0.74 | 30.00 | 2.48 | 13.1 | 2.48 | 1.0 km, E |
| Existing (Stage-I & Stage-II) Only | 0.71 | 28.19 | 2.36 | 12.14 | 2.36 | 2.0 km, E |
| Stage-I, II & III | 0.89 | 36.3 | 2.99 | 15.6 | 2.99 | 2.0 km, E |
| Stage-I & II without FGD, Stage-III with FGD | 0.89 | 28.7 | 0.067 | 12.6 | 0.015 | 2.0 km, E |
| Maximum Predicted Value among all scenarios | 0.89 | 36.3 | | 15.6 | | |
| Maximum Value Observed During March, 2019 to March, 2020 | 67.9 | 19.0 | | 21.2 | | |
| **Resultant Concentration** | **68.79** | **55.3** | | **36.8** | | |
| Maximum Value Observed During March-May, 2023 | 76 | 26 | | 37 | | |
| **Resultant Concentration** | **76.89** | **62.3** | | **52.6** | | |
| **Values as per NAAQS, 2009** | **100** | **80** | | **80** | | |

It may be observed from the above that the resultant concentration of PM10, SO2 and NOx in all the three scenarios is likely to be well within the National Ambient Air Quality Standards, 2009.

However, in order to comply with new emission norms, NTPC has already awarded FGD package for Sipat Stage-I & II on 24.05.2019 & 06.10.2021. As per MoEF&CC Notification dated 05.09.2022, Sipat STPP falls under Category 'C' and the FGD needs to be installed before 31.12.2026. FGD in all the Units of Sipat STPP Stage-I & II shall be installed before 31.12.2026. These FGD Plants shall be commissioned before the commissioning of Stage-III unit.

After installation of FGD in existing units, significant reduction in $SO_2$ emissions will be achieved and it will bring down existing pollutants level than current levels.

Further, proposed Sipat STPP Stage-III unit has provision of FGD and NOx control system.

Therefore, the impact on ambient air quality shall be much lower than the values predicted above.

*4.3.3.4 Impact on Air Quality – Fugitive Emissions*

The fugitive dust emissions expected may be from coal storage yards, coal conveyor belt area, limestone handling area, ash dumping areas, transportation of fuel and solid waste.

In the proposed expansion project, coal handling plant and limestone handling plant will be properly operated with EMP suggested in this report, no major fugitive dust emissions are envisaged. Similarly, wet slurry system of ash disposal will be practiced and hence, no dust emissions are envisaged from ash dump areas. The fuel will be received through rail line and the solid waste (ash) will be sent to dyke areas through pipeline. Hence, no dust emissions from transportation are envisaged. Further, internal roads are to be asphalted to further reduce fugitive dust emissions.

The dust emissions, if any, from the above areas will be fugitive in nature. The dust emissions are likely to be confined to the place of generation only. The quantification of these fugitive emissions from the area sources is difficult as it depends on lot of factors such as dust particle size, specific gravity of dust particles, wind velocity, moisture content of the material and ambient temperatures etc. Also, there is a high level of variability in these factors. Hence, these are not amenable for mathematical dispersion modelling. However, by proper usage of dust suppression measures, dust generation and dispersions will be reduced.

4.3.4 Impacts During Operation Phase on Terrestrial Ecology

Particulates of ash/coal, sulphur dioxide and oxides of nitrogen are major pollutants of a coal based thermal power plant. The fly ash particles depending upon their size and weight settle down at varying distances on vegetation and soil surfaces in the prevailing wind direction. Deposition of fly ash on the soil alters its physical and chemical characteristics. Such edaphic changes may hamper plant growth at higher concentrations. Foliar deposition of fly ash interrupts gaseous exchange through stomata clogging, there by affecting plant growth.

The major effects of $SO_2$ on plants are foliar injury, changes in micro –morphology, plant growth and productivity. Paddy is fairly sensitive to $SO_2$.$NO_x$ is less phytotoxic than $SO_2$.

Coal dust and fly ash dust affect plant growth through clogging of stomatal pores on foliar surfaces. Coal dust is also likely to have an impact on vegetation around loading, unloading and stacking points.

The Air Pollution Tolerance Index (APTI) values for deciduous species like the one encountered in the study area including reserve/protected forest is almost double as there is a regular leaf fall every year. The new set of foliage will sustain incremental ground level concentrations of $SO_2$ and $NO_x$ predicted for the Sipat STPP Stage-III.

*4.3.4.1 Predicted Impacts on the Protected Forests in the Study Area*

There are no wildlife sanctuaries, national parks, biosphere reserves or migratory corridors of any sensitive species in the study area.

However, there are two forests in the study area i.e Bitkuli (Sonathi Pahar) Reserve Forest (3.7 km, NE), Dalha Protected Forest (7.0 km, ESE).

The maximum GLC's are occurring at forest locations (worst case meteorological condition period) from the plant boundary are estimated through dispersion modeling considering 150 m stack. The incremental and resultant ground level concentration's over protected forest area are determined and presented in **Table-4.10** below.

**TABLE-4.10**
**IMPACT ON AIR QUALITY ON PROTECTED FOREST AREA DUE TO PROPOSED PROJECT**

| Pollutant | Concentration ( µg/m³) | | | | |
|---|---|---|---|---|---|
| | Baseline (Max.) at AAQ Location | Incremental | Resultant Ground level Concentration | Distance approx. (km) from Project Site | Direction |
| **Pre-monsoon Season** | | | | | |
| **PM** | | | | | |
| Bitkuli (Sonathi Pahar) Reserve Forest (R.F) | 48.9 | 0.09 | 48.99 | 3.3 | NE |
| Dalha Protected Forest (P.F) | 41.3 | 0.09 | 41.39 | 9.2 | SE |
| **$SO_2$** | | | | | |
| Bitkuli (Sonathi Pahar) Reserve Forest (R.F) | 14.7 | 0.28 | 14.98 | 3.3 | NE |
| Dalha Protected Forest (P.F) | 10.2 | 0.28 | 10.48 | 9.2 | SE |
| **NOx** | | | | | |
| Bitkuli (Sonathi Pahar) Reserve Forest (R.F) | 16.3 | 0.28 | 16.58 | 3.3 | NE |
| Dalha Protected Forest (P.F) | 15.2 | 0.28 | 15.48 | 9.2 | SE |

From the above results, it can be found that the impact of air quality due to the proposed project on the protected/reserve forests is likely to be very minimal. Further, the resultant concentration of PM, $SO_2$ and $NO_x$ at Bitkuli (Sonathi Pahar) Reserve Forest and Dalha Protected Forest are well within the CPCB and NAAQ standards.

In view of above, no significant impacts are anticipated on these protected forests as the incremental ground level concentrations are negligible. Appropriate development of greenbelt development corridor will further attenuate the impacts of the air pollutants and will also act as a pollution sink.

*4.3.4.2 Impact on Aquatic Ecology*

No effluents shall be discharged from proposed project and the plant will be operated under Zero Liquid Discharge (ZLD) compliance. Hence, there will not be any adverse impact on the water bodies of the surrounding areas. The raw water will be sourced from right bank canal of Hasdeo barrage which will reduce the

entrapment of aquatic life into screens. There will be screens to prevent intake of any tiny zooplankton & phytoplankton in make-up water pump house.

4.3.5 Impact on Water Resources

- *Water Resources*

Water for the project is being pumped from the Hasdeo Right Bank Canal (RBC). Water is conveyed to the raw water reservoir from the canal via two 29 km long subsurface pipelines. The water requirement is estimated to be about 24 cusecs which is proposed to be drawn from the Right Bank Canal (RBC) originating from Hasdeo Barrage pondage. No additional water commitment is required for the expansion project.

However, the use of surface water resource for irrigation, municipal and industrial purposes is regulated by the Water Resource Department, Govt. of Chhattisgarh which allocates water considering other users. Water availability and source sustainability study have been described in Chapter-7. It provide inflow, storage capacity, water levels and other details of original water source (Hasdeo-Bango project). It also enumerate the list of competing users with Sipat STPP. The water requirement (2340 $m^3$/hr) for Stage-III unit will be met from the available committed quantity of 120 MCM from WRD, Govt. of Chhattisgarh accorded vide letter dated 26.11.2001 for Sipat STPS. The quantity of water allocation to Sipat STPS is only about 4 % out of total water allocation for various purposes.

It may, therefore, be concluded that the drawl of water for Sipat STPP, Stage-III (1 x 800 MW) does not pose any adverse impact on the availability of water to downstream users. Optimum COC has been kept to maximize recycle of cooling water and reduce the water consumption. The water system of the Sipat STPP Stage-III has been designed with Zero Liquid Discharge (ZLD) concept in order to reduce the quantity of effluents generated from the plant. The entire effluent generated from the Stage-I & Stage-II is being treated in existing effluent treatment plant and thereafter reused for various industrial purpose upto the maximum possible extent. The same will be implemented for the proposed expansion also.

- *Impact on Ground Water*

As no ground water is proposed to be used for plant during operation phase, there will be no impact on ground water resources during operation of the plant. Beside this, regular ground water monitoring shall be carried out nearby ash pond area.

- *Impact on Hydrology*

The storage at Hasdeo Barrage is confined within banks and therefore it shall not cause any submergence of land beyond the banks. The river carries sufficient flow during monsoon season.

Water resources department, Govt. of Chhattisgarh has already accorded commitment for Sipat STPP considering the downstream users. There is no

diversion of any stream or major nalla due to proposed Sipat STPP Stage-III. It may be concluded that the withdrawal of water for Sipat STPP Stage-III, shall not cause any adverse impact on the availability of water to downstream users.

No additional ash pond is proposed for Stage-III. Efforts shall be made to maximize the utilization of ash from proposed project. The ash pond area for Stage-I&II is 970.19 acres and ash from proposed Stage-III will be disposed only in these existing ash ponds.

*Wastewater Generation*
Wastewater will be generated from ash handling system, DM plant, boilers & filters from water treatment plant, colony and domestic waste. Besides, domestic wastewater from canteen and employees wash area will also be generated.

Clarifier sludge and tube settler sludge of about 79 $m^3$/hr will be used in ash handling. Ash water will be recirculated to avoid a major quantity of water for discharging into reservoir. The detailed break up of water balance and wastewater generation is given in Chapter-2.

The service water discharge of 90 $m^3$/hr will be treated in tube settlers and recycled in clarified water tank. Thus, Zero Liquid Discharge (ZLD)will be maintained from service water. Domestic sewage will be reused in plantation after treatment in existing STP.

The discharge from various water treatment units like clarifier CW, clarifier DM system, tube settlers and DM plant will be routed to ash handling system. DM plant discharge shall be treated in neutralization pit to adjust pH prior to using in ash handling unit. Since there is no effluent discharge from proposed project, the impact on water quality of surrounding water bodies will be insignificant.

### 4.3.6 Impact of Solid Waste

Ash generated due to combustion of coal will be the main industrial/ solid waste generated from the project.

About 80% of the ash shall be generated as fly ash while 20% of the ash shall be generated as bottom ash. With average annual coal requirement of 3.34 MTPA and average 39 % (Max) ash in coal, it is estimated that about 1.3 MTPA of ash shall be generated annually.

In addition, gypsum shall be generated as solid waste from FGD system, which shall be utilized/ disposed off in an environmentally suitable manner. The details of the solid waste generated in the plant are given in **Table-4.11**.

**TABLE-4.11**
**EXPECTED SOLID WASTE FROM PROPOSED EXPANSION PROJECT**

| Sr. No. | Plant | Quantity | Mode of Disposal |
|---|---|---|---|
| 1 | **Ash generation**<br><br>Fly ash | <br><br>1.04 MTPA | Ash will be supplied to cement industries and other users. In case the ash could not be lifted, |

| Sr. No. | Plant | Quantity | Mode of Disposal |
|---|---|---|---|
| | Bottom ash<br>Total ash | 0.26 MTPA<br>1.30 MTPA | the same will be disposed in ash pond using wet disposal method. |
| 2 | Gypsum generation | 600 tonnes /day | Byproduct used by cement industries |

4.3.7 Impact on Noise Levels

The main sources of noise and vibration during operations will be:

- Delivery of equipment and raw materials by trucks;
- Transfer of coal through railway line;
- Operation of generators and turbine inside the power house; and
- Operation of various pumps, fans and motors.

Scheduling deliveries to daytime as much as possible would minimize noise generation by truck movement. Turbines, cooling towers, transformers, compressors, pumps, vehicles and miscellaneous equipment during plant operation, will generate noise. However, proper acoustic enclosures would be provided to control the noise level within 80dB(A), as per the requirement of Occupational Safety and Health Administration Standard (OSHAS).

Also the adoption of modern building design and the use of sound absorbing materials will minimize noise and vibration from the powerhouse.

The noise levels at the source for these units will be in the range of 80-90 dB (A). The noise dispersion from the plant units has been computed based on the mathematical model.

The major noise generating sources from the proposed expansion plant are turbine, DG sets, cooling towers, CHP and compressors etc. These are considered as input to the noise model. Plantation will be done at all available spaces in project to reduce impact of noise.

*4.3.5.1 Noise Modeling for Plant Machinery*

The impact from a continuous stationary noise source at observer's place, considering the hemispherical propagation of sound waves is represented by the following equation:

**LR = LS + DI – 20 Log(r) – Ae – 8**

Where,

LR: Sound pressure level at a receptor located at radial 'r', dB (A)
LS: Sound pressure level at the source, dB (A)
DI: Directivity index of the source (for hemispherical radiation DI = 3dB(A)
R: Radial distance of the receptor from the source, m
Ae: represents excess attenuation of sound caused by the environmental conditions such as:

- Absorption in air;
- Effect of rain, snow and fog;
- Reflections and refractions at barriers and buildings;
- Effect of the terrain, grass, shrubs, trees etc.; and
- Effect of wind and temperature gradient.

The absorption of the sound is generally a complex phenomenon. In general, for homogeneous loss free atmosphere Ae = 0.

The cumulative impact of multiple stationary noise sources (through hemispherical wave propagation) at a particular place can be calculated by:

$$Lp\ (Total) = 10\ Log \left[ \sum_{i=1}^{N} 10^{(Lpi/10)} \right]$$

Lp (Total) is the resultant cumulative sound pressure level due to separate sources. The cumulative impact from different stationary noise sources at proposed project site has been predicted at 1m distance using the above model.

*4.3.5.2 Presentation of Results*

The noise levels at the plant boundaries are given below in **Table-4.12.**

**TABLE-4.12**
**PREDICTED NOISE LEVELS AT THE PLANT BOUNDARIES**

| Sr. No. | Direction | Noise Level in dB(A) |
|---|---|---|
| 1 | N | 30 |
| 2 | NE | 28 |
| 3 | E | 30 |
| 4 | SE | <30 |
| 5 | S | 30 |
| 6 | SW | <30 |
| 7 | W | 30 |
| 8 | NW | 28 |

The predicted noise levels at the boundary due to various plant activities do not exceed 30 dB (A). There will not be any adverse impact due to the noise generation on the habitations falling on the boundary of the proposed expansion project. It is seen from the simulation results that the noise levels are well within the CPCB standards. The noise contours are presented in **Figure-4.19.**

➢ **Impact on Work Zone**

There are no high noise equipment in the proposed expansion of power plant, except boilers. However, impacts on the working personnel are not expected to be significant on account of the high level of automation of the plant, which means that workers will be exposed for short duration only that too intermittently.

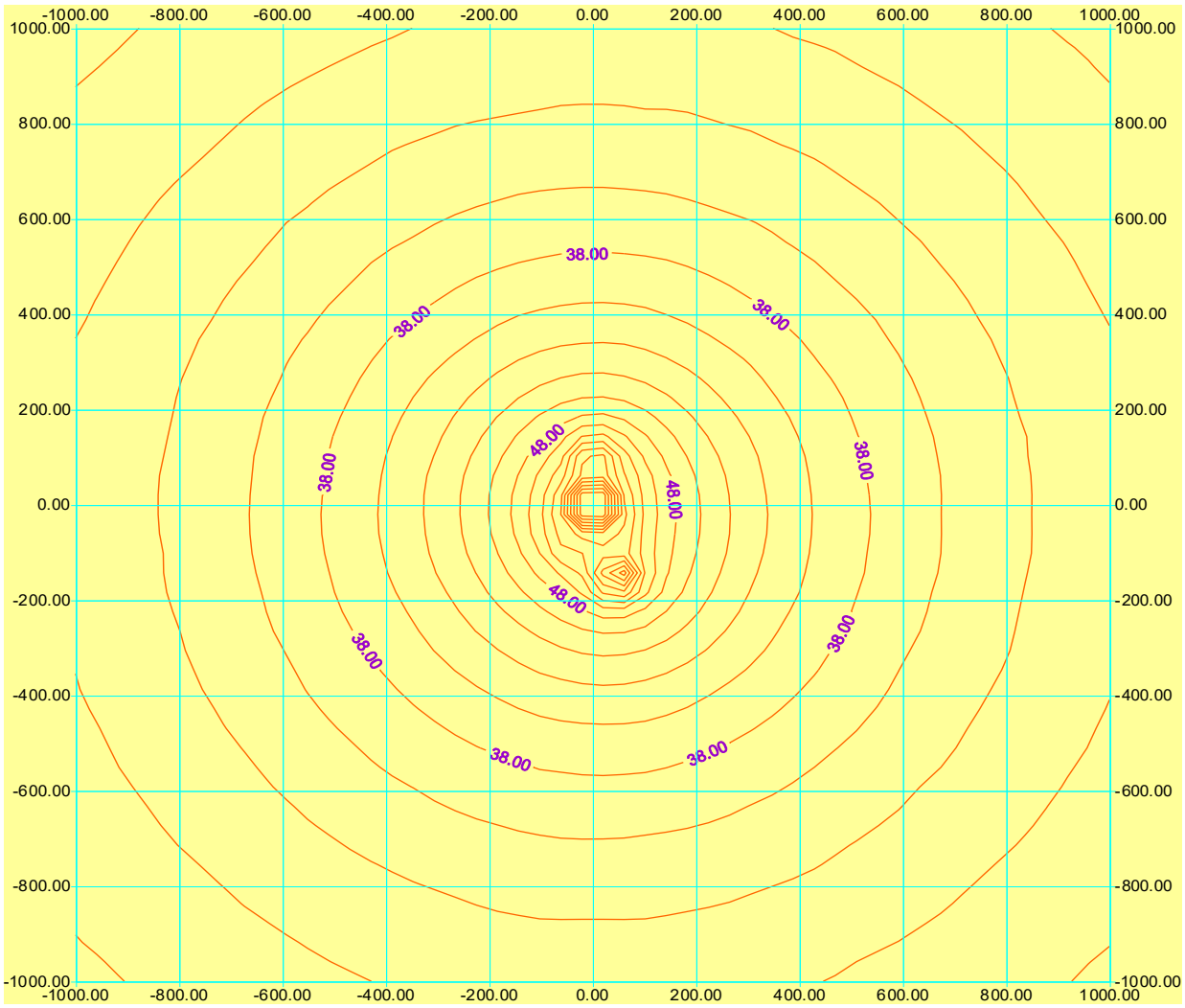



**FIGURE-4.19**
**NOISE DISPERSION CONTOURS**

*4.3.7.3 Impact on Work Zone and Community*

Boilers and cooling towers are the high noise generating equipment in the power plant. However, impacts on the working personnel are not expected to be significant on account of the high level of automation of the plant, which means that lesser man power near the equipment will be exposed for short duration only and that too intermittently with suitable protection equipment for working in noisy area. The noise generation during operational phase would be at source itself through different measures such as inspection, operation and maintenance at regular intervals. The noise control measures as described in EMP will be fully followed. The occupational noise exposure to the workers in the form of 8 hourly time weighted average will be maintained well within the prescribed OSHA

standards (<90 dB(A)). Hence, the impact on occupational health of workers would be less significant.
The cumulative incremental impact of all noise sources at boundary will range in between 48.6 dB (A) to 55.8 dB (A).

4.3.8 Impacts due to Transportation

Since coal will be transported using rail, no significant traffic movement due to this is envisaged in the proposed project on existing public road network. Water sprinkling on filled rail wagons shall be done at loading point, mid-way and unloading point to minimize fugitive emissions in coal transportation.

The various material like fuel oil, chemicals, spares etc. will be brought periodically by road network due to which vehicular traffic will increase intermittently. For transportation of limestone and gypsum about one truck per hour would be ply on roads (considering lime stone requirement about 8 tonne/ hour and gypsum generation 15 tonne /hour). NH-130 is passing about 14.0km north from plant site, which is adequate to cater to the additional traffic. The increased vehicular traffic will increase the job opportunity for drivers, attendants and technicians.

Effective implementation of the pollution emission compliance prescribed under Motor Vehicles Act by the transport authorities will minimize the vehicular pollution impact. It will be ensured that the vehicles will be always environmental compliant.

4.3.9 Impact on Occupational Health

The damage risk criteria as enforced by Occupational Safety and Health Administration (OSHA) to reduce hearing loss, stipulates that the noise levels upto 90 dB(A) are acceptable for 8hour working per shift per day.

Impacts on the working personnel are not expected to be significant on account of the high level of automation of the plant, which means that workers will be exposed for short duration only that too intermittently. Equipment will be provided with silencers/acoustic enclosures. Workers will be provided with necessary protection devices, eg. ear plugs, ear muffs etc.

4.3.10 Prediction of Impacts on Socio-Economics

The requirement of unskilled and semi-skilled manpower will be met from nearby villages during construction phase. The project will also help in generation of the indirect employment apart from direct employment. This will be a positive socio-economic development for the region. There will be a general upliftment of standard of living in the region. CSR/CER activities by proposed project will further contribute in development of area and improvement of social status of people.

4.3.11 Impacts on Public Health and Safety

The adverse impacts on ambient air and soil quality are predicted to be low and there will not be any process wastewater generation from the plant. The public health and safety is dependent on the effective implementation of control measures

suggested for pollution control. Further sanitation activities under CSR/CER will improve the public health.

## 4.4 Mitigation Measures during Construction Phase

During construction phase, the construction activities like site levelling, grading, transportation of the construction material cause various impacts on the surroundings. However, the construction phase impacts are temporary and localized phenomena except the permanent change in local landscape and land use pattern of the project site.

### 4.4.1 Land Environment

The earthen material generated during excavations and site grading periods, shall be properly dumped and slope stabilization shall be taken. The topsoil generated during construction shall be preserved and reused for plantations.

Natural drainage pattern will not be disturbed since no major water streams are passing through the project area.

### 4.4.2 Air Quality Management

The activities like site development, grading and vehicular traffic contribute to increase in PM and $NO_x$ concentrations. The mitigation measures recommended to minimize the impacts are:

- Water sprinkling in construction area;
- Asphalting the main approach road;
- Proper maintenance of vehicles and construction equipment; and
- Increased tree plantation in the area earmarked for greenbelt development.
- Covering of trucks/dumpers with tarpaulin/cloth sheets.

### 4.4.3 Water Quality Management

During construction period, the water quality is likely to be affected due to the construction work and loosening of topsoil. This is likely to increase the suspended solids in the run-off during heavy precipitation. In order to reduce the impact on water quality, temporary sedimentation tanks shall be constructed for the settlement of the suspended matter. There is no likelihood of ground water contamination as there will not be any process effluents during construction.

### 4.4.4 Noise Level Management

The noise impact on the surrounding population during the construction phase will be within the acceptable limits. High noise generating equipment, if used, shall not be operated during the night to eliminate any possible discomfort to the nearby residents. Community noise levels are not likely to be affected because of the vegetation and likely attenuation due to the physical barriers. The following recommendations shall be implemented:

- Provision for insulating caps and aids at the exit of noise source on the machinery;
- The use of damping materials such as thin rubber/lead sheet;
- Shielding the work places like compressors, generator shed;
- Adoption of shock absorbing techniques to reduce impact;
- Provision of inlet and outlet mufflers which are easy to design; and
- Provision of earmuffs to the workers and enforcement of its use by the workers.

### 4.4.5 Ecological Management

During construction activities vegetation may be disturbed which can be considered insignificant. Existing greenbelt area is about 326.23 acres has been developed in NTPC Sipat. Greenbelt/plantation will be developed to improve the aesthetic value in the area and to screen out the fugitive dust generated during construction at available spaces. The water requirement for the proposed project will be met through Hasdeo barrage pondage.

The aquatic life observed in the nearby streams/river is common in nature and these do not harbor any endangered species. No major impact is envisaged during the construction/operation phase of the project.

### 4.4.6 Social Community Management

Construction activities will generate employment of about 1000 workers. For construction work force, temporary sanitation facilities (septic tanks followed by soak pits) will be set-up for disposal of sanitary sewage. Similarly, rest rooms and canteen facilities will be provided for truck drivers during construction as well as operation phase of power plant.

## 4.5 Mitigation Measures during Operation Phase

During operation phase, the impacts on the various environmental attributes will be mitigated using appropriate pollution control equipment. The environment management plan prepared for the proposed expansion (Stage-III) aims at minimizing the pollution at source.

### 4.5.1 Air Pollution Mitigation Measures

Fugitive and stack emissions from the power plant will contribute to increase in concentrations of PM, $SO_2$ and $NO_x$ pollutants. The mitigative measures recommended in the plant are:

- Provision of water sprinkling system at raw material storage yard;
- Dust suppression system will be installed at all requisite points in CHP and coal stack yard, limestone handling plant, ash handling plant;
- Provision of dust extraction systems at dust generating source;
- Installation of high efficiency Electrostatic Precipitators (ESP) of efficiency more than 99.9% to limit the PM concentrations below 30 mg/$Nm^3$;
- Provision of flue stack of 150m height for wider dispersion of gaseous emissions;

- Provision of low $NO_x$ burners, Combustion staging based on creation of fuel rich combustion zone through separation of part of secondary air which is added downstream of main combustion zone as Over Fire Air (OFA); to control the $NO_x$ emissions
- Provision of Flue Gas Desulfurization (FGD) to control $SO_2$ emission to less than 100 mg/$Nm^3$;
- Design of control equipment to meet the standards stipulated by CREP& MOEF&CC; and
- Online opacity meter as well as flue gas flow rates and temperature measurement shall be provided for stack.

To control fugitive emissions, the following measures shall be adopted:

- Within and around the coal handling plant, coal dust extraction and suppression systems would be provided;
- Dust suppression system would be installed at all requisite points in limestone handling plant, ash handling plant, CHP and coal stack yard;
- All belt conveyors and transfer points will be covered. Similarly, ash handling plant would be equipped with dust extraction/suppression systems to prevent fugitive emissions;
- Provision and periodic inspections of mechanical seals in pumps;
- Preventive maintenance of valves, flanges, joints, roof vents of storage tanks; and
- Submerged filling of liquid fuel storage tanks.

### 4.5.2 Water Pollution Mitigation Measures

An effluent management scheme would be implemented with the objective of optimization of various water systems so as to reduce intake water requirement and achieve Zero Liquid Discharge (ZLD) from plant. The effluent management scheme would essentially involve collection, treatment and recirculation/recycling of various effluents. Adequate treatment facilities would be provided to all the waste streams emanating from the power plant to control water pollution. This would include physico-chemical and biological treatment for other effluents, as follows:

- The sludge from clarifiers/tube settlers of water pre-treatment & liquid effluent treatment plant shall be collected in a sump/pit and shall be pumped to ash slurry sump for disposal to ash dyke;
- The waste effluents from neutralization pits of DM plant and condensate polishing plant shall be collected in the respective neutralization pits and neutralized before pumping to ash slurry sump for final disposal;
- CW system blow down would be used for service water system, FGD& coal dust suppression system;
- Coal Slurry settling ponds shall be provided to remove coal particles from coal handling plant waste. Decanted water shall be recycled back for use in the coal dust suppression system;

- The treated effluents, conforming to the prescribed standards only shall be re-circulated and reused within the plant. Arrangements shall be made that plant effluents and storm water do not get mixed;
- Service water effluents from various areas shall be separately routed to a sump. From the sump the waste service water shall be pumped up to lamella clarifier/tube settler for treatment. Treated service water shall be sent back to service water tank & ash slurry sump to the extent possible for re-use;
- For oily wastes, oil water separators shall be provided. The separated oil shall be removed from the top, the water at the bottom shall be recycled or led to the plant effluent drain depending upon its quantity;
- Treated effluent/excess CW blow down (if any) shall be collected in ash slurry disposal sump. No effluent will be discharged from plant;
- Efficient operation of treatment plants would be ensured so that the quality of effluents conforms to the relevant standards prescribed by the regulatory agencies. All the treated effluents would be recycled and reused to achieve Zero Liquid Discharge (ZLD); and
- The treated sewage from Sewage Treatment Plant (STP) conforming to prescribed standards would be utilized for plantation or other purposes.

4.5.3 Noise Pollution Mitigation Measures

In the process, various equipments like pumps, cooling towers, compressors and boilers etc will generate the noise. Greenbelt, landscaping with horticulture at power block areas to reduce noise impacts is already being implemented. The recommendations to mitigate higher noise levels are:

Equipment's will be designed to conform to noise levels prescribed by regulatory authorities:

- Provision of acoustic barriers or shelters in noisy workplaces;
- Provision of hoods to noise generating equipment's like pumps;
- Provision of greenbelt/plantation to attenuate the noise levels; and
- Provision of personal protective equipment (PPE) such as earplugs, earmuffs to the workers working in high noise level area.

4.5.4 Solid Waste Management

- Fly Ash Generation

Ash generated due to combustion of coal will be the main industrial/ solid waste generated from the project. About 80% of the ash shall be generated as fly ash while 20% of the ash shall be generated as bottom ash.

The fly ash will be extracted in dry form from the electrostatic precipitator hoppers. This dry ash shall either be taken to buffer hoppers for its onward transportation in dry form for utilization or shall be slurrified in wetting units for its ultimate disposal

in ash disposal area. Dry extraction proposed for bottom ash also. It is envisaged to have disposal system sized for 100% generation of ash.

The ash management scheme for fly ash and bottom ash involves dry collection of fly ash, supply of ash to entrepreneurs for utilization, promoting ash utilization and safe disposal of unused ash. NTPC shall make maximum efforts to utilize the fly ash for various purposes. Unused fly ash and bottom ash shall be disposed off in the ash pond. A blanket of water shall be maintained over the entire ash pond to control fugitive dust emission. After the ash pond is abandoned, it shall be reclaimed through green vegetation. The unused ash will be taken to the existing ash pond of Stage-I&II.

- Gypsum Generation

Gypsum is generated from the FGD (Flue Gas Desulphurization) unit as a result of reaction of $SO_2$ with lime stone slurry to remove sulphur dioxide in the stack emissions. About 600 tonnes /day of gypsum per day will be generated from the proposed project. Gypsum which is in demand and value added product which shall be utilized to various end users like cement manufacturers, fertilizer industries, plasterboard manufacturers etc.

## 4.6 Summary of Environmental Impacts and Mitigation Measures during Construction and Operation Phase

Summary of environmental impacts and mitigation measures during construction and operational phase of the project is given in **Table-4.13.**

**TABLE-4.13**
**SUMMARY OF ANTICIPATED ADVERSE ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES DURING CONSTRUCTION & OPERATION PHASE**

| Discipline | Potential Negative Impacts | Probable Source | Mitigation Measures | Remarks |
|---|---|---|---|---|
| **Construction Phase** | | | | |
| Water quality | Increase in suspended solids due to soil run-off during heavy precipitation | Loose soil at construction site | During monsoon season run off from construction site will be routed to a temporary sedimentation tank for settlement of suspended solids. | - |
| Air quality | Increase in dust and $NO_2$concentration | Leveling activity and heavy vehicular movement | Sprinkling of water in the construction area and on unpaved roads. Proper maintenance of vehicles will be done. | The impact will be low, as the main approach road will be tarred. |
| Noise | Increase in noise level | Construction equipment | Equipment will be kept in good condition to keep the noise level within 90dB(A). | Workers will be Provided necessary protective equipment e.g. ear plug, earmuffs. |
| Terrestrial | Clearing of vegetation | Soil enabling | Landscaping and extensive | - |

| Discipline | Potential Negative Impacts | Probable Source | Mitigation Measures | Remarks |
|---|---|---|---|---|
| ecology | | activities | plantation will be done | |
| Socioeconomics | Influx of people | No displacements and loss of livelihood | During construction, due to influx of labour, economic activities in surrounding areas will be increased. | - |
| **Operation Phase** | | | | |
| Air Quality | Increase in PM, $SO_2$and NOx levels in ambient air | Stack emissions and lime stone handling plant, ash handling plant, coal stockyards at Coal Handling Plant (CHP). | High efficient ESPs will be installed to control particulates.<br><br>FGD system for $So_2$ control and Nox Control System.<br><br>Stack of150 m will be provided for the proper dispersion of pollutants. Motorable roads in the plant area will be paved to reduce dust emission.<br><br>Afforestation programs will be under taken around the plant area.<br><br>Dust suppression ensures will be implemented in the Lime stone handling plant, ash handling plant, coal handling plant and stock yards | The resultant air quality will conform to the Stipulated NAAQ standards.<br><br>Particulate emission from stack will be kept below 30mg/$Nm^3$, $So_2$ and $NO_2$ below 100 mg/$Nm^3$. |
| Water Quality | Deterioration of surface Water quality | Discharge from various plant units | Adequate treatment facilities will be provided so that the treated effluent conform to the regulatory standards. Zero Liquid Discharge (ZLD) System shall be installed. | Due to ZLD system, no effluent shall be discharged into natural water bodies. |
| Solid waste | Fly ash and bottom ash | Burning of coal | Fly ash will be supplied to cement industries and brick manufacturing units disposed in ash pond. | - |
| | Gypsum | From FGD | Gypsum will be supplied to cement and plastic industries | - |
| Ecology | | | | |
| a. Terrestrial | Impact on plant species | Emissions from stack | Emission will be controlled as well as dispersed through appropriate design. | As ambient air quality will be within limits by installing pollution control equipment's, no active injury to the vegetation is expected. |

| Discipline | Potential Negative Impacts | Probable Source | Mitigation Measures | Remarks |
|---|---|---|---|---|
| b. Aquatic | Impact on water bodies | Treated waste water from plant | The wastewater will be provided with adequate treatment and diluted in CMB and the treated Wastewater will be re-used for horticulture, ash handling and dust suppression. | As all the effluents will be treated to conform to prescribed limits and Zero Liquid discharge is envisaged therefore no significant impact on aquatic life is expected. |
| Noise | Increase in noise levels in the plant area. | Equipment in main plant and auxiliaries. | Equipment will be designed to conform to noise levels prescribed by regulatory agencies.<br><br>Provision of greenbelt and plantation would further help in attenuating noise. | Employees working in high noise areas would be provided earplugs/ earmuffs as protective device. |
| Demography and socio-economics | Strain on amenities like housing, water sources and sanitation, medical and infrastructure facilities. | Influx of people of proposed expansion of power plant employees as well as contractor's employees/ labourers. | Local population will be given preference in awarding work and employment through contractors. No significant impact is envisaged. | Overall socioeconomic status of the area is expected to improve by CSR/CER activities. |

# Chapter-5
# Analysis of Alternatives (Technology& Site)

# 5.0 ANALYSIS OF ALTERNATIVES (TECHNOLOGY & SITE)

## 5.1 Introduction

The Stage-I and II of the project is already under operation in the land acquired for the ultimate capacity of Sipat STPP. Since, it is an expansion project for implementing Stage-III (1x800) MW unit and no additional land is proposed to be acquired, alternate sites were not explored. The present site for Sipat STPP Stage-III (1x800 MW) is selected based on the following considerations:

- Availability of suitable and adequate land;
- Reliable source of water;
- Road and railway access;
- Facility for interconnection with transmission system for evacuation of power;
- Availability of infrastructural facilities; and
- Environmental aspects.

## 5.2 Power Plant Technology and Alternatives

Coal-fired power generation is achieved by coal combustion through a boiler, heating high-pressure water in a heat-transfer pipe by high-temperature combustion gas to produce steam that runs a turbine. The principle of thermodynamics states that power generation efficiency becomes higher as steam temperature and steam pressure increase. High-temperature, high-pressure steam is utilized to generate power is key to higher power-generation efficiency. Once it boils, water changes into steam. As pressure gets higher, the boiling point also increases. Once pressure reaches a critical point (374ºC, 22.1 MPa), water is turned into a supercritical fluid without boiling. A power-generation system utilizing a boiling phenomenon at a temperature lower than the critical point is called a subcritical pressure unit, and another utilizing the conditions exceeding the critical point is called a supercritical (SC) pressure unit; the latter system ensures higher efficiency.

The technology's developments in the past decades have primarily involved increasing plant thermal efficiencies by raising the steam pressure and temperature. Based on the differences in temperature and pressure, the technology is categorized into two tiers:

1. Sub-Critical;
2. Super-Critical (SC); and
3. Ultra Super Critical;

***Sub-Critical Units***

Sub-critical conditions occur when the steam pressure is below 221.2 bar (a) where mixture of steam and water co-exists. Typical steam pressures for sub critical units will be about 170 kg/cm²(a).

Subcritical power plant units in India operate at steam conditions 170 kg/cm²(a) main steam pressure and at 540°C main steam and reheat steam parameters at turbine inlet.

***Super-Critical Units***

Super-critical conditions occur when the boiler steam pressure increases above the critical pressure of 221.2 bar (a). Above this point, two phase mixtures of water and steam cease to exist and are replaced by a single supercritical fluid. This eliminates the need for water/steam separation in drums during operation, and allows a simpler separator to be employed during start-up conditions.

Supercritical technology operates above steam/water critical pressure of 221.2 bar (a) and 374.15°C.

Supercritical Steam Parameters:

Steam pressures up to 250 kg/cm²(a) and steam temperatures ranging from 538°C to 593°C at turbine inlet.

***Ultra Super Critical***

An ultra-super critical plant uses ultra-super critical (USC) steam parameters at the super heater outlet. Ultra-super critical technology in its some of its plants has steam parameters higher than supercritical/ sub-critical technology. In preliminary design consideration, main steam pressure will be 270 kg/cm$^2$(a) at HPT inlet, main steam temperature at HPT inlet will be 600$^o$ C and hot reheat steam temperature at IPT inlet will be 600$^o$ C.

Considering the advantages like better efficiency, lower carbon emissions NTPC has moved forward in adopting ultra-super critical technology (steam parameters of 270 kg/cm2(a)/600°C/600°C as MSP/MST/HRHT at turbine end). This technology units also offer flexibility of plant operation such as shorter start-up times, faster load change flexibility and better temperature control, better efficiency even at part load due to variable pressure operation and high reliability and availability of power plant.

# Chapter-6
# Environmental Monitoring Program

# 6.0 ENVIRONMENTAL MONITORING PROGRAM

## 6.1 Introduction

Regular monitoring of environmental parameters is of immense importance to assess the status of environment during project operation. With the knowledge of baseline conditions, the monitoring programme will serve as an indicator for any deterioration in environmental conditions due to construction and operation of the project, to enable taking up suitable mitigation steps in time to safeguard the environment. Monitoring is as important as that of control of pollution since the efficiency of control measures can only be determined by regular monitoring.

Generally, an impact assessment study is carried over short period of time and the data cannot bring out all variations induced by the natural or human activities. Therefore, regular monitoring programme of the environmental parameters is essential to take into account the changes in the environmental quality.

## 6.2 Environmental Monitoring and Reporting Procedure

In Sipat STPP, Online Continuous Emission Monitoring Systems (CEMS), Effluent Quality Monitoring Systems (EQMS) and Ambient Air Quality Monitoring System (AAQMS) are already installed under Stage-I & Stage-II. The continuous online emission and effluent monitoring data are being uploaded at Chhattisgarh Environment Conservation Board (CECB) and CPCB server as per the directions issued by CPCB to all SPCBs/ PCCs under Section 18 (1)(B) of Water Act and Air Act dated February 05, 2014. Stage- III unit shall also be equipped with similar system.

### 6.2.1 Objectives of Monitoring

The objectives of environmental post-project monitoring are to:

- Verify effectiveness of planning decisions;
- Measure effectiveness of operational procedures;
- Confirm statutory and corporate compliance; and
- Identify unexpected changes.

## 6.3 Monitoring Schedule

Environmental monitoring schedules are prepared covering various phases of project advancement, such as construction phase and regular operational phase.

### 6.3.1 Monitoring Schedule during Construction Phase

Ambient air quality & noise levels will be monitored regularly within the project site as per CPCB guidelines.

The ambient air quality monitoring shall be conducted at the construction site and one downwind location to assess the efficacy of the mitigation measures

undertaken during construction activity to control air emissions. The air quality parameters of $PM_{10}$, $PM_{2.5}$, $SO_2$, $NO_x$ and CO shall be monitored once a month.

The noise levels shall be monitored at the construction site and at the plant boundary once in six months till completion of construction activity.

### 6.3.2 Monitoring Schedule during Operational Phase

The attributes which merit regular monitoring based on the environment setting and nature of project activities are listed below:

- Source emissions and ambient air quality;
- Groundwater levels and ground water quality;
- Water and wastewater quality (water quality, effluent & sewage quality etc);
- Solid and hazardous waste characterisation (fly ash, bottom ash, oily wastes, ETP sludge, used and waste oil);
- Soil quality;
- Noise levels (equipment and machinery noise levels, occupational exposures and ambient noise levels);
- Ecological preservation and afforestation; and
- Socio economics survey of nearby villages.

The following routine monitoring programme as detailed in **Table-6.1** shall be implemented during operational phase of the project. In addition to the monitoring, the compliances to all Environment Clearance (EC) conditions and regular permits from Chhattisgarh Environment Conservation Board (CECB) /MoEF&CC shall be monitored and reported periodically.

**TABLE-6.1**
**ENVIRONMENT MONITORING DURING OPERATIONAL PHASE**

| Sr. No. | Potential Impact | Action to be Followed | Parameters for Monitoring | Frequency of Monitoring | Location |
|---|---|---|---|---|---|
| 1 | Air emissions | On-line continuous monitoring system shall be installed.<br>In addition, stack monitoring will be carried out manually. The stack shall be provided with sampling ports. | PM, $SO_2$, CO and NOx | Continuous recording of these parameters.<br>The manual stack monitoring shall be carried out once in a month. | Stack attached to power boiler |
| 2 | Ambient air quality | Ambient air quality within the premises of the proposed project by online CAAQMS and nearby habitations to be monitored by manual AAQ monitoring | $PM_{10}$, $PM_{2.5}$, $SO_2$, $NO_2$, CO and other parameters as per CPCB notification,2009 | As per CPCB/ CECB requirement or on weekly basis for manual monitoring. | Two locations outside premises (one location in upwind and two locations in downwind direction) or as recommended by CECB. |
| 3 | Meteorology | Meteorological station at Sipat STPP site. | Wind speed, direction, temperature, relative humidity and rainfall. | Continuous monitoring | One location in the project site |
| 4 | Noise levels in plant | Noise levels of the operating machinery to be recorded at 1 m distance. | $L_{max}$ and $L_{min}$ using noise meter | The noise levels shall be recorded every three month. | Material gate, admin gate, CHP, Turbine hall, B Type quarter |

| Sr. No. | Potential Impact | Action to be Followed | Parameters for Monitoring | Frequency of Monitoring | Location |
|---|---|---|---|---|---|
| 5 | Ambient noise levels | Ambient noise levels within plant and surrounding habitation | $L_{day}$, $L_{night}$. | The noise levels shall be recorded every six month. | Plant boundary, nearest habitation |
| 6 | Wastewater quality | Online pH, conductivity, temperature shall be monitored at CMB. | As per EPA Notification (S.R. 844 (E) dated 10/11/1996 | On-line continuous recording of pH, temperature, TSS<br><br>Other parameters once in a month | Discharge from CMB (to be recycled) |
| 7 | Water Quality | Water quality monitoring in the surrounding of the plant site. | Surface water and ground water quality as per IS-10500 | Once in a month | Ground and surface water quality |
| 8 | Soil Characteristics | To assess the fertility & nutrient status of the soil | Physico-chemical parameters and metals. | As per requirement | Plantation area within plant area.<br><br>Surrounding agricultural area and plantation. |
| 9 | Health | Employees and migrant labour health check ups | All relevant parameters including HIV | Regular check ups as per Factory Act | Population in the surrounding habitation and project. |
| 10 | Emergency preparedness, such as fire fighting | Fire protection and safety measures to take care of fire and explosion hazards, to be assessed and steps taken for their prevention. | Mock drill records, on site emergency plan, evacuation plan | Periodic during operation phase | - |
| 11 | Maintenance of flora and fauna | Vegetation, greenbelt / green cover development | Number of plants, species, diversity of plant species, Density of plant species. | As per requirement | Around the plant site. Assessment of greenbelt within the plant site. |
| 12 | Water consumption | Water consumption for various use | Water consumption | Online flow meter | Raw water inlet, intake of various systems as per requirement |
| 13 | Socioeconomic status | Need based assessment survey /Social Impact evaluation | Living standards / CER/CSR-CD Benefits | As per requirement | Nearby villages |

## 6.4 Monitoring Methods

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

### 6.4.1 Air Quality Monitoring and Data Analysis

#### *6.4.1.1 Stack Monitoring*

The emissions from the stack of Stage-I and Stage-II are being monitored regularly by third party and Online Continuous Emission Monitoring Systems (CEMS).

The emissions from the stack of Stage-III will also be monitored continuously. The exit gas temperature, velocity and pollutant concentrations shall be measured. Any unacceptable deviation from the design values shall be thoroughly examined and appropriate action shall be taken.

*6.4.1.2 Workspace Monitoring*

The concentration of air borne pollutants in the workspace/work zone environment shall be monitored periodically. If concentrations higher than threshold limit values are observed, the source of fugitive emissions shall be identified and necessary measures will be taken.

*6.4.1.3 Ambient Air Quality Monitoring*

The ground level concentrations of $PM_{10}$, $PM_{2.5}$, $SO_2$, $NO_2$ and CO in the ambient air shall be monitored at regular intervals. Any abnormal rise shall be investigated to identify the causes and appropriate action shall be initiated. Greenbelt shall be developed for minimising dust propagation. The ambient air quality data generated through Continuous Ambient Air Quality Monitoring System (CAAQMS) shall be transferred and processed in a centralised computer facility equipped with required software. Manual AAQ monitoring will be done at nearby area. Trend and statistical analysis shall be done and corrective measures will be taken accordingly.

Ambient air quality monitoring is being already carried out for Sipat Stage-I & II to monitor the level of pollutants. The same will be continued and further strengthened for Sipat Stage-III also.

6.4.2 Water and Wastewater Quality Monitoring

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

Methods prescribed in "Standard Methods for Examination of Water and Wastewater" prepared and published jointly by American Public Health Association (APHA), American Water Works Association (AWWA) are recommended.

*6.4.2.1 Monitoring of Wastewater Streams*

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

*6.4.2.2 Monitoring of Groundwater*

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

Ground water monitoring system has already been established around existing ash dykes at Sipat STPP. Same shall be used for ground water monitoring for Stage-III also, as no additional ash dyke is being constructed for Stage-III. However, the same shall be strengthend, if required.

### 6.4.3 Noise Levels

Noise levels in the work zone environment such as Admin Gate, Material Gate, CHP, Turbine Hall shall be monitored. The frequency shall be once in six months in the work zone. Similarly, ambient noise levels near habitations shall also be monitored once in six months. Audiometric tests should be conducted periodically for the employees working close to the high noise sources.

## 6.5 Reporting Schedule of the Monitoring Data

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

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

The frequency of reporting shall be on as per consent conditions (six monthly basis) to the State Pollution Control Board officials and to Regional Office of MOEF&CC. The environmental audit reports shall be prepared for the entire year of operations and shall be regularly submitted to regulatory authorities.

## 6.6 Infrastructure for Monitoring of Environment Protection Measures

*Environmental Management Group*

An Environmental Management Group (EMG) is working at existing Sipat STPP (Stage-I & II). Additional General Manager, EMG heads this group who is assisted by a Manager (EMG), and is responsible for the performance of environmental management at the plant for the protection of environment. EMG has trained manpower, equipment's for monitoring and other environmental related activities, to ensure compliance of statutory requirements. It collects all monitoring reports and forward regularly to Chhattisgarh Environment Conservation Board (CECB) and Regional Office of MoEF&CC. The same group would be strengthened for the proposed Stage-III project.

PA well-equipped laboratory with consumable items shall be provided for monitoring of environmental parameters in the site. Alternatively, monitoring can be outsourced to a recognized reputed laboratory. About Rs 1.0 crores cost provision has been made in feasibility report for environmental laboratory equipment in proposed Sipat STPP project.

The following equipment is given in **Table-6.2** and consumable items shall be made available in the site for environmental monitoring or alternatively the monitoring can be outsourced by engaging a reputed authorised environmental laboratory.

**TABLE-6.2**
**EQUIPMENT FOR ENVIRONMENT MONITORING**

| Name of Equipment | Purpose |
|---|---|
| Respirable dust samplers | AAQ monitoring |
| Stack monitoring | Particulate matter, $SO_2$, NOx and CO |
| Automatic weather monitor | Meteorological data collection at site |
| Sound level meter | Noise levels |
| UV – Spectro photo meter | Chemical analysis |
| Micro-balance | Chemical analysis |
| Refrigerator | Preserving samples |
| Oven | Heating |
| Thermometer | Temperature |
| pH meter | pH analysis |
| DO analyzer | DO analysis |
| Pipette box | Chemical analysis |
| Titration set up | Chemical analysis |
| Relevant Chemicals | Chemical analysis |

### Air Quality and Meteorology

High volume samplers and fine dust samplers, stack monitoring kit, personal dust sampler, central weather monitoring station, spectrophotometer (visible range), single pan balance, flame photometer, relevant chemicals as per IS:5182.

The thermal power station has already installed 03 Nos. Automatic Ambient Air Quality Monitoring Stations (AAQMS) and Continuous Emission Monitoring System (CEMS) for Stage-I & II and the same shall be used under Stage-III for Continuous Emission Monitoring System (CEMS). Figure 6.1 shows the photograph of the AAQMS with Meteorological Station and the Display Board at the main gate.











**FIGURE 6.1**
**AAQMS WITH MET STATION AND DISPLAY BOARD**

## Water and Wastewater Quality

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

BOD incubator, COD reflex set-up, refrigerator, oven, stop watch, thermometer, pH meter, distilled water plant, pipette box, titration set, dissolved oxygen analyser, relevant chemicals.

The Stage-I & II power plant already has 02 nos. Online Continuous Effluent Quality Monitoring System (CEQMS).




**Stage-I – EQMS**




**Stage-II – EQMS**




**Stage-I – EQMS**




**Stage-II – EQMS**

*Source: NTPC Sipat*

**FIGURE 6.2**
**PHOTOGRAPHS OF CONTINUOUS EFFLUENT QUALITY MONITORING SYSTEM (STAGE # I & II)**

## Noise Levels

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

It is recommended to integrate the post project monitoring mechanism of Stage-I & II with the requirements for Stage-III. Suitable augmentation and strengthening shall be taken up.

# Chapter-7
# Additional Studies

# 7.0 ADDITIONAL STUDIES

## 7.1 Public Consultation

NTPC Sipat STPP Stage-III (1x800 MW) submitted the application for public hearing to the Member Secretary Chhattisgarh Environmental Control Board (CECB) office on 13.07.2023. The public hearing was scheduled to be held on 27.09.2023, but postponed due to unavoidable reasons. Public Hearing was held on 11.12.2023 at 12:00 noon.

The advertisement for initial public hearing for Sipat Stage-III (1x800 MW) was published in the local newspaper Haribhoomi, Bilaspur & in the main edition of the national newspaper Hindustan Times, New Delhi on 25.08.2023 & second advertisement published on 25.11.2023. Accordingly public hearing was held on 11.12.2023 at 12:00 noon at the sports ground of Mandanlal Shukla Government college, Sipat village & Tehsil, Bilaspur District, Chhattisgarh. The proceeding of public hearing and other documents were forwarded by Member Secretary, CECB vide letter no: 8409/TS/CECB/2024, dated 19.01.2024 to MoEF&CC, New Delhi.

About 300 approx. members are attended the public hearing and 92 persons spoken during the public hearing and 93 written statements have been received during public consultation. The proceedings of public hearing and other documents like news clippings, objections/suggestion received regarding public hearing, reply of project proponent on main issues/quarries related to public hearing, proceedings of public hearing, attendance sheet, objections/suggestion received regarding public hearing in Head office, CECB, Videography are enclosed and response to point wise reply to information sort by CECB regarding public hearing, action plan are given in Addendum to EIA Report (Volume-III).

Action plan and budget allocation to resolves specific issues raised during the public hearing is given in **Table-7.1** & Activities planned under capital expenditure for Corporate Environment Responsibility (CER) is given in **Table -7.2**.

## TABLE-7.1
## ACTION PLAN TO RESOLVE SPECIFIC ISSUES RAISED DURING PUBLIC HEARING

| Sr.No | Proposed Works to address the issues raised during the PH | Estimated Cost (in Lakhs) | Estimated Time from the Award of the Project |
|---|---|---|---|
| 1 | Construction of Road from Bazaar Chowk to Lilagarh River in Darrabhata village | 60 | 2 Years |
| 2 | Construction of Culvert in Darrabhata village | 25 | 1 Years |
| 3 | Development of Stadium/Sports Ground in Sipat | 45 | 2 Years |
| 4 | Development of Stadium/Sports Ground in Baniyadih | 05 | 1 Years |
| 5 | Installation of Solar Street/High Mast Light in Sipat, Karra and other affected villages | 90 | 3 Years |
| 6 | Installation of Handpump in Darripara village | 03 | 1 Years |
| 7 | Medical Infrastructure in Sipat Community Health Centre (Upgradation of 100 Bed Hospital already built by State Govt.) | 100 | 2 Years |
| 8 | Renovation of School in Eramsahi village | 10 | 1 Years |
| 9 | Rejuvenation of Pond in Eramsahi village | 10 | 1 Years |
| 10 | Cement Concrete Roads in affected villages | 140 | 3 Years |
| 11 | Development of School Education Infrastructure in affected villages | 40 | 2-4 Years |
| 12 | Development of Drinking Water infrastructure, Rain Water Harvesting and Rejuvenation of Ponds in affected villages including Bandhwa Talao in Raank village. | 40 | 2 Years |
| 13 | Providing Taekwondo promotion support/infrastructure to Janji village | 02 | 1 Years |
| 14 | Development of Community Infrastructure in affected villages | 280 | 2-4 Years |
| | **Total** | **850** | |

**TABLE-7.2**
**ACTIVITIES PLANNED UNDER CAPITAL EXPENDITURE FOR CORPORATE ENVIRONMENTAL RESPONSIBILITY**

| Sr.No | Proposed Works | Estimated Cost (in Lakhs) | Estimated Time from the Award of the Project |
|---|---|---|---|
| 1 | Infrastructure Development – construction/renovation of community center buildings, boundary wall, Sanskritik Manch, Market Sheds, Parking Sheds, Cremation Grounds etc. in project affected villages | 330 | 2 -4 Years |
| 2 | Roads – Cement Concretization of existing village roads | 200 | 2 -4 Years |
| 3 | Sanitation – Construction/Repair of drains, Toilets and related infrastructure | 50 | 1 -3 Years |
| 4 | Water – Augmentation of Drinking Water facilities, Pond rejuvenation | 100 | 2 -4 Years |
| 5 | Health – Developing health infrastructure, conduct of medical camps etc. | 100 | 2 -4 Years |
| 6 | Education – Construction/Renovation of school buildings, classrooms, labs, parking sheds, playground, smart class, furniture etc. | 150 | 2 -4 Years |
| 7 | Welfare/Skill Development – Skill development trainings for increasing employability | 20 | 1 -3 Years |
| | **Total** | **950** | |

## 7.2 Risk Assessment and Disaster Management Plan

### 7.2.1 Introduction

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

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

In the sections below, the identification of various hazards, probable risks in the proposed power plant, maximum credible accident analysis, consequence analysis

are addressed which gives a broad identification of risks involved in the plant. The Disaster Management Plan (DMP) has been presented.

7.2.2 Approach to the Study

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

- Identification of potential hazard areas;
- Identification of representative failure cases;
- Visualization of the resulting scenarios in terms of fire (thermal radiation) and explosion;
- Assess the overall damage potential of the identified hazardous events and the impact zones from the accidental scenarios;
- Assess the overall suitability of the site from hazard minimization and disaster mitigation point of view;
- Furnish specific recommendations on the minimization of the worst accident possibilities; and
- Preparation of broad Disaster Management Plan (DMP), on-site and off-site emergency plan, which includes occupational and health safety plan.

## 7.3 Hazard Identification

This risk analysis covers the oil fuel storage system provided for the NTPC Sipat STPP Stage–III project.

### *Oil Fuel Storage Tanks*

Existing LDO unloading and storage facilities shall be used for new stage.

Details of oil storage at NTPC Sipat Stage–III are given in **Table-7.3**

**TABLE-7.3**
**DETAILS OF STORAGE TANKS**

| Description | No. of Tanks | Material Stored | Product Class | Capacity (KL) | Type of Tank |
|---|---|---|---|---|---|
| FO Tank | 1 | LDO | B | 2,400 | Cone roof tank |

### *Hazardous Properties of LDO*

Properties of Light Diesel Oil (LDO), a Class B petroleum product relevant to this risk analysis study are listed in **Table-7.4.**

**TABLE-7.4**
**HAZARDOUS PROPERTIES OF MATERIALS**

| Materials | Normal Boiling Point (°C) | Flash Point (°C) | Lower Flammable Limit (%) | Upper Flammable Limit (%) | Auto Ignition Temperature (°C) |
|---|---|---|---|---|---|
| LDO | 215-376 | 66 (min) | 0.6 | 6.0 | 225 |

***Consequence Analysis***

Damage Effects of Jet/ Pool Fire Radiation

The effect from jet fire and pool fire is thermal radiation intensity on the receptor surface as shown in **Table-7.5.**

**TABLE-7.5**
**DAMAGE EFFECTS DUE TO JET/ POOL FIRE RADIATION**

| Heat Radiation Intensity ($kW/m^2$) | Observed Effect |
|---|---|
| 4 | Sufficient to cause pain to personnel if unable to reach cover within 20 seconds; 0% lethality. |
| 12.5 | Minimum energy required for piloted ignition of wood, melting of plastic tubing. |
| 37.5 | Sufficient to cause damage to process equipment. |

Thermal radiation intensity exceeding 37.5 $kW/m^2$ may cause escalation due to damage of other equipment.

Thermal radiation intensity exceeding 12.5 $kW/m^2$ may cause ignition of combustibles on buildings and impairment of escape route.

Thermal radiation intensity exceeding 4 $kW/m^2$ may cause burn injury on personnel injury.

***Failure Scenarios for Risk Analysis***

Hazard analysis to estimate the extent of damage for the following identified credible failure scenarios.

*LDO Storage Tanks*

- Liquid spill outside the tank

Liquid spill from the tank into surrounding dyke area may occur due to the following causes:

  - Tank overfill event; and
  - Leak from flange joint connected to the tank.

In case of LDO spill in dyke, there is potential for dyke fire.

- Full surface fire

Ignition in the vapour space in the tank will result in surface fire and tank roof damage.

**Consequence Analysis Results**

Consequence analysis for the identified failure scenarios is carried out using the renowned PHAST software of DNV-GL. Results of consequence analysis are

summarized in **Table-7.6.** Graphical results of consequence analysis plotted on plant layout diagram are shown in the following **Figure-7.1 & Figure-7.2.**

## TABLE-7.6
## SUMMARY OF CONSEQUENCE ANALYSIS RESULTS

| Sr. No. | Description | Parameter Value | Downwind Distance from Tank/ Dyke Centre (metres) | | |
|---|---|---|---|---|---|
| | | | Weather (Wind speed & Stability) | | |
| | | | 2 m/s; F | 3 m/s; D | 5 m/s; D |
| 1. | Existing: FO Tank– Full Surface Fire | | | | |
| | Pool Fire Radiation Intensity | 4 kW/m$^2$ | 38 | 40 | 41 |
| | | 12.5 kW/m$^2$ | 17 | 17 | 18 |
| | | 37.5 kW/m$^2$ | Not reached | Not reached | Not reached |
| 2. | Existing: FO Tank – Dyke Fire | | | | |
| | Pool Fire Radiation Intensity | 4 kW/m$^2$ | 56 | 59 | 62 |
| | | 12.5 kW/m$^2$ | 23 | 23 | 24 |
| | | 37.5 kW/m$^2$ | Not reached | Not reached | Not reached |

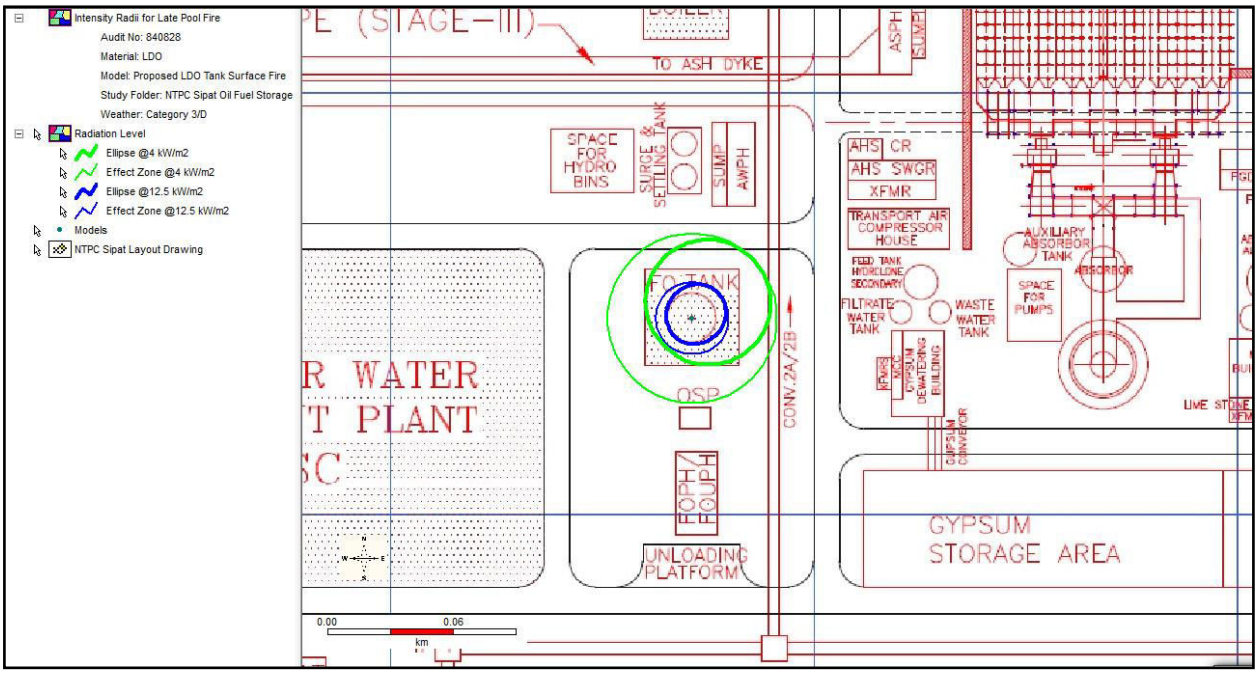



**FIGURE-7.1**
**FO TANK (STAGE – III) – FULL SURFACE FIRE**

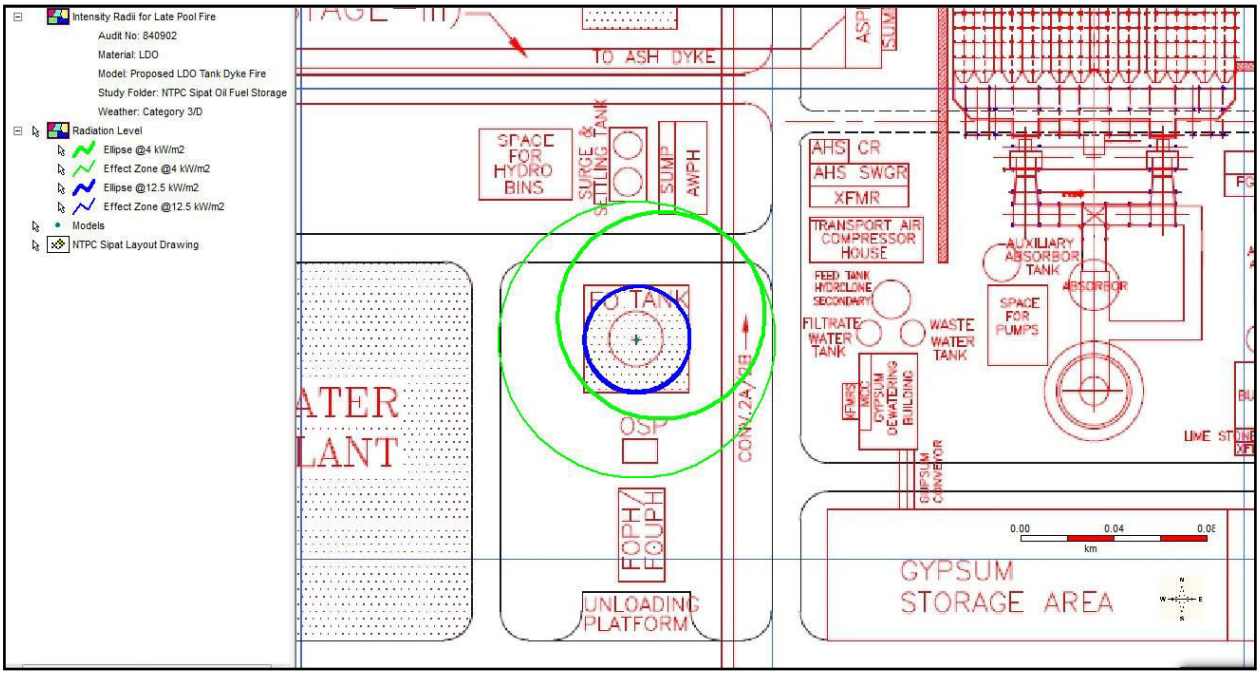



**FIGURE-7.2**
**FO TANK (EXISTING) – DYKE FIRE**

**Conclusions**

Review of the results of consequence analysis for maximum credible failure scenarios in the LDO storage tanks in NTPC Sipat STPP, Stage–III indicates the following points.

- In the case of spill and ignition of LDO (Class B petroleum product) the hazard is pool fire;
- Full surface fire in tank may be caused by ignition in the vapour space and damage of tank roof;
- In the case of tank full surface fire or dyke fire in FO tank of NTPC Sipat Stage–III, the pool fire radiation intensity of 37.5 kW/$m^2$, which can cause damage of equipment and third degree burn is not reached;
- In the case of tank surface fire or dyke fire in the FO tank of NTPC Sipat Stage–III, radiation intensity of 12.5 kW/$m^2$ does not impact the nearby equipment or building; and
- The coal handling conveyor 2A/2B of the proposed Sipat STPP, Stage–III project is located at a distance of about 37 m from the centre of FO Tank. In case of dyke fire around FO tank, the flame length will be about 40 m. The thermal radiation intensity at ground level will be about 9 kW/$m^2$. However, the thermal radiation intensity at 10 m elevation will exceed 12.5 kW/$m^2$ which can cause damage of conveyor system.

Recommendations

1. Considering the possibility of damage due to thermal radiation from dyke fire around FO tank, it is recommended to maintain a distance of not less than 50 m between conveyor system and centre of FO tank;
2. Foam system should be provided for fire protection in LDO storage as per OISD standards; and
3. Tank dyke drains are to be provided with isolation valves, which should be kept closed except during rain.

➢ **Risk Assessment for Worst Case Scenarios**

In order to ensure the safety management for the proposed Sipat STPP Stage-III, risk analysis study has been undertaken for the worst case scenarios such as boiler failure, so that necessary mitigation measures are implemented right from the initial stage of the project.

## ➢ Objectives & Methodology

*Objectives*

The objectives of this study are as follows:

- Identification of the worst case scenarios in the proposed Sipat STPP, Stage-III thermal power plant;
- Carrying out risk assessment for the identified worst case scenarios; and
- Recommendations for suitable mitigation measures to reduce the risk.

## ➢ Methodology

Risk analysis for the worst case scenarios consists of the following steps:

- Identify the sections of the plant with large inventory of hazardous materials and severe process conditions;
- Identify the specific failure scenarios in each section;
- Assess the risk for each failure scenario by analyzing the consequences and likelihood;
- Select the worst case scenarios which have high risk potential; and
- Formulate recommendation for risk mitigation.

Risk is the combination of severity of the harm and likelihood of occurrence of the harm. The risk may be to people, asset, environment or business reputation. Qualitative risk assessment for a process unit is carried out using a risk matrix. Normally a 5 x 5 risk assessment matrix recommended by Energy Institute, UK is used. This is shown in the below **Table-7.7.**

**TABLE-7.7**
**RISK ASSESSMENT MATRIX**

| Risk Assessment Matrix | | | | | | |
|---|---|---|---|---|---|---|
| Severity | Consequences (Injury/ Damage) | Likelihood | | | | |
| | | A | B | C | D | E |
| | | Not heard in the Industry | Happened in the Industry | Happened more than once per year in the Industry | Happened more than once per year in the Company | Happened Frequently at the Location |
| 1 | Slight | | | | | |
| 2 | Minor | | **Low Risk** | | | |
| 3 | Moderate | | | **Medium Risk** | | |
| 4 | Major | | | | **High Risk** | |
| 5 | Massive | | | | | |

When the assessed risk is low (indicated by green colour), the existing safeguards may be adequate but continuous improvement is to be maintained.

When the assessed risk is medium (indicated by yellow colour), the risk is to be controlled to As Low as Reasonably Practical (ALARP) by additional or improved safeguards if necessary.

When the assessed risk is high, (indicated by red colour), tolerability of the risk is to be endorsed by the management. Normally operation in this risk level is not acceptable. The system needs to be engineered to bring the risk down to lower level.

- **Risk Assessment for Worst Case Scenarios**

*Plant Sections for Risk Analysis*

NTPC Sipat Stage–III ultra-super critical thermal power plant contains the following major units:

- Coal handling plant and pulverized coal system;
- Fuel Oil (LDO) storage;
- Boiler furnace with pulverized coal burners;
- Boiler pressure part with ultra-supercritical boiler;
- Boiler bottom ash handling system;
- Water treatment plant; and
- Cooling water system.

- ***Risk Assessment***

Detailed work sheet for risk assessment for major failure scenarios in the plant sections listed above are enclosed at **Annexure–XV.** Results of risk assessment are summarized in the following **Table-7.8.**

**TABLE-7.8**
**RESULTS OF RISK ASSESSMENT**

| Plant Section | Major Failure Scenario | Risk Assessment Matrix | | |
|---|---|---|---|---|
| | | S | L | R |
| Coal handling plant and pulverized coal system | Coal pile fire | 2 | D | Medium |
| | Coal dust explosion in mill/ bunker | 4 | C | Medium |
| Fuel Oil (LDO) Storage | Oil pool fire | 3 | B | Low |
| | Tank surface fire | 3 | B | Low |
| Boiler Furnace with Pulverized Coal Burners | Overpressure in boiler furnace | 3 | B | Low |
| | Furnace explosion | 4 | B | Medium |
| Pressure parts of Ultra Super Critical Boiler | Rupture of boiler pressure part (steam side) | 5 | C | High |
| Boiler bottom ash handling system | Blockage in boiler bottom ash system | 4 | B | Medium |
| Water treatment plant | Large spill of acid | 4 | B | Medium |
| Cooling water system | Breakage of chlorine pipe | 3 | C | Medium |

***Worst Case Scenario***

Based on the risk assessment for all major failure scenarios in the plant, it is observed that the worst case scenario is the rupture of boiler pressure part (steam side).

*Recommendations for Risk Mitigation*

The following measures are recommended for mitigation of the risks identified in the sections of the power plant based on ultra super critical technology:

Coal Handling Plant

1. Consider suitable heat sensor for detecting pieces of smoldering coal on moving conveyor for activating sprinklers;
2. Consider provision of CO gas detectors to activate inert gas purging in coal mill and bunkers. This is to prevent explosion in coal mill or bunker; and
3. Provide trolley mounted DCP extinguishers in FO storage area.

Fuel Oil (LDO) Storage

4. Provide trolley mounted DCP extinguishers in FO storage area.

*Pressure Part in Steam Side of Ultra Supercritical Boiler*

5. Considering the use of highly specialized alloys developed to withstand the very high pressure and temperature conditions in the boiler, it would be necessary to implement rigorous Positive Material Identification (PMI) programme during boiler construction and maintenance. This is to make it certain that only the metal components of specified composition are used in the boiler.

   It would be necessary to use NDT procedures such as phased array and Time of Flight Diffraction (TOFD) techniques allowing for a three dimensional view of welds.

### 7.3.1 Coal Handling Plant - Dust Explosion

Coal dust when dispersed in air and ignited would explode. Crusher house and conveyor systems are most susceptible to this hazard. To be explosive, the dust mixture should have:

- Particles dispersed in the air with minimum size (typical figure is 400 microns);
- Dust concentration must be reasonably uniform; and
- Minimum explosive concentration for coal dust (33 % volatiles) is 50 gm/$m^3$.

Failure of dust extraction and suppression systems may lead to abnormal conditions and may increase the concentration of coal dust to the explosive limits. Sources of ignition present are incandescent bulbs with the glasses of bulkhead fittings missing, electric equipment and cables, friction, spontaneous combustion in accumulated dust.

Dust explosions may occur without any warnings with maximum explosion pressure upto 6.4 bar. Another dangerous characteristic of dust explosions is that it sets off secondary explosions after the occurrence of the initial dust explosion. Many a times the secondary explosions are more damaging than primary ones.

The dust explosions are powerful enough to destroy structures, kill or injure people and set dangerous fires likely to damage a large portion of the coal handling plant including collapse of its steel structure which may cripple the lifeline of the power plant.

Stockpile areas shall be provided with automatic garden type sprinklers for dust suppression as well as to reduce spontaneous ignition of the coal stockpiles. Necessary water distribution network for drinking and service water with pumps, piping, tanks, valves etc will be provided for distributing water at all transfer points, crusher house, control rooms etc.

A centralized control room with microprocessor based control system (PLC) has been envisaged for operation of the coal handling plant. Except for locally controlled equipment like traveling tripper, dust extraction/ dust suppression / ventilation equipment, sump pumps, water distribution system etc, all other in-line equipment will be controlled from the central control room but will have provision for local control as well. All necessary interlocks, control panels, MCC's, mimic diagrams etc will be provided for safe and reliable operation of the coal handling plant.

*7.3.2.1 Control Measures for Coal Yards*

The total quantity of coal shall be stored in separate stockpiles, with proper drains around to collect washouts during monsoon season.

Water sprinkling system shall be installed on stocks of coal in required scales to prevent spontaneous combustion and consequent fire hazards. The stock geometry shall be adopted to maintain minimum exposure of stockpile areas towards predominant wind direction.

7.3.2 Identification of Hazards

The various hazards associated, with the plant process apart from fuel storage have been identified and are outlined in **Table-7.9.**

**TABLE-7.9**
**HAZARD ANALYSIS FOR PROCESS IN POWER PLANT**

| Sr. No. | Blocks/Areas | Hazards Identified |
|---|---|---|
| 1 | Coal storage in open yard | Fire, spontaneous combustion |
| 2 | Coal handling plant including bunker area | Fire and/or dust explosions |
| 3 | Boilers | Fire (mainly near oil burners), steam explosions, fuel explosions |
| 4 | Steam turbine generator buildings | Fires in –<br><br>a) Lube oil system |

| Sr. No. | Blocks/Areas | Hazards Identified |
|---|---|---|
| | | b) Cable galleries<br>c) Short circuits in:<br>i)Control rooms<br>ii) Switch-gears<br><br>Explosion due to leakage of hydrogen and fire following it. |
| 5 | Switch-yard control room | Fire in cable galleries and switchgear/control room |
| 6 | LDO tank farms | Fire |

7.3.3 Hazardous Events with Greatest Contribution to Fatality Risk

The hazardous event scenarios likely to make the greatest contribution to the risk of potential fatalities are summarized in **Table-7.10**. 'Onsite facility' refers to the operating site at plant site, whereas 'offsite facility' refers to transport and handling systems, which are away from the operating site.

**TABLE-7.10**
**HAZARDOUS EVENTS CONTRIBUTING TO RISK AT ON-SITE FACILITY**

| Hazardous Event | Risk Rank | Consequences of Interest |
|---|---|---|
| Onsite vehicle impact on personnel | 3 | Potential for single fatalities, onsite impact only |
| Entrapment/struck by Machinery | 3 | Potential for single fatalities, onsite impact only |
| Fall from heights | 3 | Potential for single fatalities, onsite impact only |
| Electrocution | 3 | Potential for single fatalities, onsite impact only |
| Storage tank rupture and fire | 3 | Potential for multiple fatalities, onsite impact only |

7.3.4 Risk Assessment Summary

The preliminary risk assessment has been completed for the proposed power plant and associated facilities and the broad conclusions are as follows:

- There will be no significant community impacts or environmental damage consequences; and
- The hazardous event scenarios and risks in general at this facility can be adequately managed to acceptable levels by performing the recommended safety studies as part of detailed design, applying recommended control strategies and implementing a safety management system.

7.3.5 Risk Reduction Opportunities

The following opportunities shall be considered as a potential means of reducing identified risks during the detailed design phase:

- Buildings and plant structures shall be designed for floods and seismic events to prevent structural collapse and integrity of weather (water) proofing for storage of dangerous goods;

- Provision for adequate water capacity to supply fire protection systems and critical process water;

- Isolate people from load carrying/mechanical handling systems, vehicle traffic and storage and stacking locations;
- Installation of fit-for-purpose access ways and fall protection systems to facilitate safe access to fixed and mobile plant;
- Provision and integrity of process tanks, waste holding tanks and bunded areas as per relevant standards;
- Containment of hazardous materials;
- Security of facility to prevent unauthorized access to plant, introduction of prohibited items and control of onsite traffic; and
- Development of emergency response management systems commensurate with site specific hazards and risks (fire, explosion, rescue and first aid).

## 7.4 Disaster Management Plan

Disasters

A serious disruption of the functioning of a community or a society causing widespread human, material, economic, or environmental losses that exceed the ability of the affected community or society to cope using its own resources. Disasters could be categorized into:

**1. Natural Disasters**:

A natural disaster is the result of a natural phenomenon (e.g., flood, tornado, earthquake, land slide etc). It leads to financial, environmental or human losses. The resulting loss depends on the vulnerability of the affected population to resist the hazard, also called their resilience. The vulnerability of Sipat area for natural disasters are as follow:

*Earthquake:* Whole Bilaspur district falls under Zone-II. Hence following measures has been suggested:

- Identify places in the plant as well as house that can provide cover during an earthquake;
- Take shelters under strong things like table, bed etc. during earth quake; and
- If you are not certain about the damage to your building, evacuate carefully.

Flood: Sipat region is not vulnerable from flood. However, as precautionary measures, the provision of well-designed storm water drainage system in plant and township will be made to prevent flood. Arrangements including stocking of disinfectants for disinfecting water sources after the flood should be done.

Cyclone, Storm and T-Sunami: As the Sipat region is not located nearby seashore, hence neither there is any history of cyclone, storm or T-Sunami in

study area nor it has vulnerability from these disasters. In view of above, it may be concluded that Sipat region is not highly vulnerable from natural disasters.

Man-made Disasters: Man-made disasters are of an anthropogenic origin and exemplify some of the terrible accidents that have resulted from human being's interaction with artificial environment, which they themselves have created. Industrial accidents are one good example of manmade disasters.

### 7.4.1 Industrial Disasters

Industrial hazards are threats to people and life-support systems that arise from the mass production of goods and services. When these threats exceed human coping capabilities or the absorptive capacities of environmental systems they give rise to industrial *disasters*. Industrial hazards can occur at any stage in the production process, including processing, manufacture, transportation, storage, use, and disposal. Losses generally involve the release of damaging substances (e.g. chemicals, radioactivity, and genetic materials) or damaging levels of energy from industrial facilities or equipment into surrounding environments. This usually occurs in the form of explosions, fires, spills, leaks, or wastes. Releases may occur because of factors that are internal to the industrial system (e.g. engineering flaws) or they may occur because of external factors (e.g. extremes of nature).

Disasters occur throughout the world, but their economic and social impacts have been increasing and are generally much greater in developing countries than in developed ones. The disproportionate effect on developing countries has many explanations. Lack of development itself contributes to disaster impacts, both because the quality of construction often is low and building codes, land registration processes, and other regulatory mechanisms are lacking, as well as because numerous other development priorities displace attention from the risks presented by natural or man-made events.

### 7.4.2 Objectives of DMP

Sipat has adequate capability to protect is property and manpower in the event of any emergency, as discussed is following sections. The same will be extended for Stage-III (1 x 800 MW) also. The summary of disaster management plan is given in Hindi & English is given in **Annexure-XVI.**

- **Fire Fighting Capacity**

The plant is well equipped with fire protection systems and it has a full-fledged fire station under the control of Central Industrial Security Force (fire wing). The fire wing of CISF is headed by Asst. Commandant and has supporting staff at various levels. The fire control room is manned in three shifts round the clock. The fire station at NTPC Sipat is equipped with all necessary safety and firefighting equipment including self-contained breathing apparatus sets, aluminized fiber glass suits, asbestos suits. etc.

Various equipment/systems available with fire station at Sipat are as follows:

The fire station is equipped with various firefighting equipment such as foam tender, water tender, DCP tender, mini tender, portable pumps, pump mounted jeep, blower exhauster, B.A. set etc. to handle the fire promptly and actively.

Fire water pumps connected with a main header from where hydrant lines got different plant areas through loop lines and hydrant valves, hydrant landing valves/yard hydrant fitted at various locations of the plant which are manually operated, whenever water is required for firefighting work;

In addition to firefighting equipment, a large number of portable and mobile fire extinguishers of various types and capacities ($CO_2$, DCM, FOAM type) have been installed at all locations of the plant include Mina plant, control rooms, switch Gears, Laboratories, off sites, administration building etc.

Heavy Fuel Oil (HFO) tanks have been provided with fixed foam system and medium velocity spray system. A mixture of water and form concentrate, thrown on to the top surface of oil converts into foam to extinguish the fire;

Conveyors and transfer points, breaker house and crusher houses of coal handling plants are protected with automatic medium velocity water spray system;

Smoke detection system consisting of ionization and photo electric type and linear heat sensing cable detectors are provided for cable galleries along with thermoelectric activated sprinkler system complete with quartzite bulb sprinklers.

In all the units at boiler fronts automatic heat detection cum high velocity water spray system is provided;

In all the unit control rooms, ionization type smoke detectors and photoelectric type smoke detectors are provided;

Smoke detection and alarm system with ionization type detectors are provided in switch gear rooms, CHP control rooms and switch yard control rooms. Fire detection and alarm system with infrared type detectors are provided for coal conveyors.

### ❖ Medical Assistance Capabilities

NTPC Sipat has its own hospital, situated in the central place in township. It is sufficiently equipped with necessary facilities, such as ambulances (available round the clock), doctors including specialists and a paramedical staff. It has all the facilities for management of general diseases and emergency including industrial accidents. Apart from the hospital, first aid boxes are available in plant in all major sections/departments. A large number of trained first aiders are available in all the sections of the plant.

### ❖ Communication System

Communication system at Sipat includes:

- Public address system in the main plant area and portable PA system at fire station;
- Auto emergency alarm in chlorine handling area;
- Telephone and intercom facilities at all desks and with officials;
- Intercom telephone connections with facilities of incoming P&T call at residences to all officers and other important persons;
- P&T (STD) telephone, fax, internet facilities in the project; and
- Mobile phones are also provided at all important officials.

### ❖ Emergency Power Supply

Emergency lights are provided at all vulnerable points for lighting arrangements as well as to operate basic minimum equipment for operating the plant safely. All units are provided with DG sets and battery system which come on auto in case of power failure. More than one supply through different transmission system is also provided to ensure electric supply without fail.

### ❖ Emergency Safety Equipment

Various emergency safety equipment (such as self-contained breathing apparatus, canister gas masks, emergency suits, gum boots, face shield, hand gloves, aprons, chlorine sealing kit etc) are made available in areas like water treatment plant, fuel oil pump house, shift charge engineer office, safety office and fire station etc.

### ❖ Alarm

NTPC Sipat is equipped with various alarm systems to denote different kinds of emergencies and restoration of normalcy. The purpose of the alarm is to advice all persons on the outburst of major emergency, the level of emergency (first, second or third level) and end of emergency. The emergency alarm is located at central place and the control and operation switch is under fire station control room in-charge. The alarm code is such that the nature of emergency can be distinguished.

### ❖ Emergency Control Center

The Emergency Control Centre (ECC) consists of one or more rooms located in an area that offers minimal risk to being directly exposed to possible accidents. Three ECCs have been identified, and one of them is manned round the clock by the main controller, the officials nominated as key personnel and Sr. Executives of outside services called in for assistance. No other person shall have access to the control center. ECC is equipped with adequate means of communication (Intercoms, P&T Telephone, Telex and Fax, Wireless, Walkie Talkie) to areas

inside and outside the work together with relevant data of personal protective equipment and equipment to assist those manning the center and to enable them to plan accordingly. ECC keeps the following data handy:

- Master plan of the facility;
- Layout of facility, equipment and storage;
- Layout of fire water system and other sources of water supply;
- Availability and location of firefighting equipment and material;
- Layout of fire extinguishers indicating their types and numbers;
- First aid boxes;
- Availability and location of personal protective equipment (PPE);
- Self-Contained breathing apparatus sets and the spare cylinders
- External telephones;
- List of important telephone numbers, both internal and external, displayed on the wall;
- Stretchers;
- Transport facility;
- Assembly points along with escape routes;
- Extra copies of the facility layout used for spot marking of affected areas, movement of vehicles, problem areas, evacuated areas, etc;
- Details of hazardous substances along with the material safety data sheets;
- Telephone directory both local as well as of the surrounding district;
- General stationery like paper, pencil etc;
- Nominal roll and addresses of all permanent employees;
- List of employees especially with their blood groups;
- Details of all contractors and their employees;
- List of first aiders and emergency squad members;
- Public Address System (PAS); and
- Two copies of the Risk Assessment report and on site emergency plans.

### ❖ Evacuation and Assembly Points

In an emergency, it may be necessary to evacuate personnel from affected areas and as precautionary measure, non-essential workers from areas likely to be affected should the emergency escalate. The evacuation will be effected on getting necessary message from incident controller. On evacuation, all the persons shall assemble at pre-identified and notified assembly points.

### ❖ Action Plan for on-site Emergency

*Identification of Responsibilities*

The on-site disaster management plan identifies Main Controller (General Manager), Incident Controller (AGM/DGM), Field Operation Controller (next in Command), designated key personnel of emergency control centre (Sr. Supdts/Engineers-in-Charge of Operation, electrical maintenance, mechanical maintenance, control and instrumentation and chemistry; Heads of personnel/industrial relations/labour welfare/safety/technical services; Chief Medical Officer: Commandant/Asst. Commandant/Fire Officer from CISF; engineer-in-charge of Auto Base; Public relation officer etc). The plan also specifies responsibilities of these personnel in case of an emergency and draws as

action plan to be followed. It also specifies the responsibilities for Declaration of Emergency and giving All Clear Signal. The lit of key personnel and their phone numbers is informed to all concerned suitably.

Based on the intensity of the emergency, they decide the actions needed to shut down plant, evacuate personnel, carry out emergency repair works, arrange supplies of equipment and personnel, carry out atmospheric tests, provide catering facilities, liaison with police, informing relative of the victims, briefing press media etc.

Main Controller and Incident Controller area assisted by two support teams as follows

| | |
|---|---|
| Support Team to Main Controller (MC) | Consisting of heads of Personnel, Materials and Finance divisions; to function in consultation with MC for the following<br><br>Contacting statutory authorities;<br>Arranging for relievers and catering facilities<br>Giving information to media;<br>Contacting medical centers and nursing homes;<br><br>Providing all other support, as necessary<br><br>• Arranging for urgently required materials through cash purchase or whatever means:<br><br>• Arranging funds for various relief measures as well as emergency purchase of materials, sending his representative for emergency purchase. |
| Support Team to Work Incident Controller (WIC) | Consisting of Sr. Manager (Admn.), Sr. Supdt. (Operation), Sr. Supdt. (Elect. Maintenance), Sr. Supdt. (Mech. Maintenance) and any more persons depending upon the need to assist the WIC in manning communication and passing instructions to the teams. One Steno Secretary shall also be available with WIC for recording all information coming in and instructions going out. |

In addition to the support teams mentioned above, there is a team for each functional area, as described below:

| | |
|---|---|
| Task Force | • To identify source of hazard and try to neutralize/contain it;<br>• To isolate remaining plant and keep that in safe conditions;<br>• To organize safe shutdown of plant, if necessary;<br>• To organize all support services like operation of the fire pumps, sprinkler system etc. |
| Maintenance team | • Attend to all emergency maintenance jobs on top priority;<br>• To take steps to contain or reduce the level of hazard created due to disaster;<br>• To organize additional facilities as desired. |
| Fire Fighting team | • To rush to fire sport and extinguish fire;<br>• To seek help from outside firefighting agencies;<br>• To evacuate persons effected. |
| Auto Base team | • To make the auto base vehicles ready to proceed for evacuation or other duties, when asked for; |

| | |
|---|---|
| | • To send at least one mechanic at the site of incidence where he may help in attending minor defects in ambulance, fie tenders or other vehicles;<br>• To arrange petrol/diesel supply;<br>• Make all arrangements regarding transportation. |
| Communication team | • To maintain the communication network in working condition;<br>• To attend urgent repairs in the communication system, if required;<br>• To arrange messengers for conveying urgent messages when needed;<br>• To help NTPC Authorities to communicate with external or internal authorities/officials. |
| Safety team | • To arrange required safety equipment<br>• To record accidents;<br>• To collect and preserve evidences in connection with accident injuries<br>• To guide authorities on all safety related issues. |
| Medical team | • To arrange first aid material/stretchers immediately and reach site of incident;<br>• To arrange for immediate medical attention;<br>• To arrange for sending the casualties to various hospitals and nursing homes etc.<br>• To ask for specific medical assistance from outside through Medical Specialist in consultation with MC/WIC. |
| Monitoring team | • To measure gas concentrations at various places, in case of gas leakage. |

❖ Essential Staff

In plant area immediately affected or likely to be affected, as decided by the Main Controller, efforts will be needed to make shut down and make process units safe. This work is carried out by plant supervisors and essential operations provided they can do it without exposing themselves to undue risk. Some workers/supervisors are also required to help the above works, for example- attendants, messengers, drivers, first aiders, and

Steno-typists etc. are essential staff and it is the responsibility of the work Incident Controllers to identify the essential staff from a task force and ask them to report at defined plant control centers so that they can be readily contacted. It is also the responsibility of the work incident controller to remove all non–essential staff from, the assembly points.

❖ First Information

The first person who observes/identifies the emergency informs by shouting and by telephone to the shift engineer and fire station about the hazard. The shift engineer informs the Main Controller, Work Incident Controller and also telephone operator, who communicates it to all key officers about the emergency.

❖ **Evaluation of Functioning of Disaster Management Plan**

In order to evaluate the functioning and effectiveness of procedures laid down in Disaster Management Plan, regular mock drills are conducted. The mock drills are carried out step by step as stated below:

| | |
|---|---|
| First step | Test the effectiveness of communication |
| Second step | Test the speed of mobilization of the plant emergency teams |

| | |
|---|---|
| Third step | Test the effectiveness of search, rescue and treatment of casualties |
| Fourth step | Test emergency isolation and shut down and remedial measures taken on the system |
| Fifth step | Conduct a full rehearsal of all actions to be taken during an emergency |

There are two types of mock drills recommended in the Disaster Management Plan (DMP)-Full Mock Drill (Conducted once in 6 months) and Disaster Management Efficacy Drill (conducted once in 3 months). The details of these drills are presented in following sections.

❖ **Full Mock Drill**

This is conducted with Plant Head as Chairman; Head of O&M as Vice Chairman; Heads of Operation, Maintenance, Medical, Personnel, CISF, Auto Base and Materials as Members and Head of Safety as Convener and it tests the following:

- Functioning of emergency control center, specifically availability of all facilities etc. as mentioned in the DMP and its functional healthiness;
- To evaluate communication of the DMP to all segments of employees, to familiarize them about their responsibilities in case of any disaster including evaluation of behavior of employees and others;
- To ensure that all facilities as required under the plan from within or from nearby industries/aid center under mutual assistance scheme or otherwise are available;
- To ensure that the necessities under material assistance scheme is properly documented and the concerned employees are fully aware in this regard; and
- To ensure that employees that are fully aware to fight any emergency like sealing of chlorine leakage, firefighting and other such causes.

❖ **Disaster Management Efficacy Drill**

It is conducted with Head of O&M as Chairman and Heads of Personnel, Communication, CISF and Medical as Members and Head of Safety as Convener and it tests the following:

- All employees are trained about their responsibilities/duties. They all are aware about evacuation routes, direction of evacuation, equipment used during evacuation;
- All employees are fully trained to rescue their colleagues, who may be affected due to cause of disaster. In case they are unable to rescue their colleagues, they should know to whom they have to inform about such persons;
- All employees are fully trained in first aid and use of desired equipments including breathing apparatus. First Aid boxes etc. are available at the desired location;
- All warning alarms are functional. Public Address System is in healthy condition;

- All telephone lines/communication system are provided in control rooms and there is no removal of the facilities (as prescribed) for the control rooms;
- It is very clear amongst the concerned managers who shall call for assistance under mutual aid scheme or the facilities from within;
- It is clear at the plant, who shall declare emergency; and
- It is clear at the plant, who shall inform the District Authorities, State Authorities and Corporate Center.

The disaster management plan is periodically updated based on experiences gained from the mock drills.

❖ **Off Site Emergency Plan**

The following conditions can ordinarily constitute an off-site emergency at NTPC Sipat:

- Heavy release of chlorine, due to rupture of value or rupture of the shell, explosion in chlorine cylinder due to fire, terrorist activities or otherwise; resulting in its spread to neighboring areas; and
- 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 is ordinarily nominated by State Government to prepare off-site emergency plan.

The District Collector or his nominated representative is the team leader of planning team, who conducts 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, police and members drawn from Medical Services, Factory Inspectorate, State Pollution Control Board, Industries and transport. In addition to these members, there are co-opted members from district authorities concerned, civil defense, publicity department, Municipal Corporation, and non-officials such as elected representative (MPs, MLAs, voluntary organization, Non-Governmental Organization etc.).

❖ **Post Emergency Relief to the Victims**

The Public Liability Insurance Act, 1991 states that the owner who has control over handling hazardous substances has 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 invites applications for relief, conducts an enquiry into the claims and arranges payment of the relief amount to the victims**.**

### ❖ Safety Policy of NTPC

NTPC recognizes and accepts its responsibility for establishing and maintaining a safe working environment for all its employees. This responsibility arises from:

- Company's moral responsibility to its employees, to provide the best practicable conditions of work from the point of view of health and safety;
- The obligations to consultant with its staff and their representative to implement policies and procedures developed as a result of discussions; and
- Statutory responsibility in respect of health, safety and welfare of employees emanating from relevant legislations such as the Factories Act, The Indian Electricity Act, The Explosive Act, The Boiler Act etc.

### ❖ Responsibilities of the NTPC

NTPC takes all such steps which are reasonably practicable to ensure best possible conditions of work, and with this view in the end, the company takes the responsibilities:

- To allocate sufficient resources to provide and maintain safe and healthy conditions of work;
- To take steps to ensure that all known safety factors are taken into account in the design, construction, operation and maintenance of plants, machinery and equipment;
- To ensure that adequate that safety instructions are given to all employees;
- To provide wherever necessary protective equipment, safety appliances and clothing, and to ensure their proper use;
- To inform employees about materials, equipment or processes used in their work which are known to be potentially hazardous to health or safety;
- To keep all operations and methods of work under regular review for making necessary changes from the point of view of safety in the light of experience and up to date knowledge;
- To provide appropriate facilities for first aid, prompt treatment of injuries and illness at work;
- To provide appropriate instruction, training, retraining and supervision in health and safety and first aid and ensure that adequate publicity is given to these matters;
- To ensure proper implementation of fire prevention and an appropriate firefighting service, together with training facilities for personnel involved in this service;
- To ensure that professional advice is made available wherever potentially hazardous situations exist or might arise;

- To organize collection, analysis and presentation of data on accident sickness and incident involving personal injury to health with a view to taking corrective, remedial and preventive action;
- To promote through the establishment machinery, joint consultation in health and safety matters to ensure effective participation by all employees;
- To publish/notify regulations, instructions, and notices in the common language of employees;
- To prepare separate safety rules for each type of occupation / process involved in a project;
- To ensure regular safety inspection by a competent person at suitable intervals of all buildings, equipment, work places and operations;
- To co-ordinate the activities of the company and of its contractors working on the Company's premises for the implementation and maintenance of safe system of work, to comply with their legal obligations with regard to the health, safety and welfare of their employees.

### ❖ Responsibilities of the Employees

The establishment and of best possible conditions of work is the responsibility of management. However, it is also necessary that each employee follows prescribed safe methods of work. He/she should take reasonable care for the health and safety of himself/herself and his/her fellow employees and of other persons who may be affected by his/her action at work. With this in mind, employees should be health and safety conclusion and:

| | |
|---|---|
| Report | Potential hazards |
| Observe | Safety rules, procedures and codes of practice |
| Use | With all reasonable care the tools, equipment, safety equipment and protective clothing provided by the NTPC |
| Participate | In safety training courses when called upon to do so. |
| Make Use | Of safety suggestions schemes |
| Take | An active and personal interest in promoting and safety at work |

### ❖ Responsibility for Implementation

- The ultimate responsibility for ensuring the implementation of the policy on health and safety at work resets on the NTPC Management – Human Resources Division at the corporate level and the concerned General Managers at the project/station level. The Officers–in-Charge of safety is functionally responsible to the corporate center for ensuring that the policy is promulgated, interpreted and carried out in the manner expected;
- Immediate responsibility for safety at work lies with manager/executives of each department/section who are primarily responsible to prevent accidents involving members of their staff and other persons. It is their responsibility to issue clear and explicit working instructions, compliance to the safety norms;
- Accept rules, procedures and codes of practice which are formulated with regard to health and safety consideration must be strictly observed by all

concerned. Contracting agencies executing works should be made responsibility, through various measures including appropriate provisions in the contract, for discharging their safety obligations;

- In designated hazard prone areas, the concerned executives are required to authorize, in writing, the commencement of any work and, before doing so, personally satisfy themselves that all necessary safety precautions have been carried out. Such executives must themselves be authorized, in writing as competent to perform these duties; and

- Safety officers are appointed to advise management on question of safety at work including advice on the application in particular local situations of the system of work implementation of company's rules and relevant codes of practices in consultation with area engineer. They are consulted in the interpretation of rules and codes being formulated by the corporate management and advice management in the investigation and analysis of accidents and circulation of appropriate statistics.

❖ **Major Site Incidents**

The General Manager ensures that plans are devised for action in the event of fire, major site incident or necessity for evacuation procedure. These plans are communicated to all staff and rehearsed from time to time:

- Firefighting training and the formation of fire-fighting team on a voluntary basis are encouraged by the management; and

- All accidents and dangerous occurrences are reported immediately to the General Manager who implements an established procedure to ensure that an investigation takes places and recommendations are made to prevent recurrence.

❖ **Reporting of Accidents and Dangerous Occurrences**

With a view to ensure prompt reporting of accidents and dangerous occurrences to comply with requirements/obligations under different statutes; and to inform the concerned authorities within the organization for keeping complete information of accidents for record and analysis and to take necessary preventive actions, a procedure for reporting of accidents dangerous occurrences has been framed. Separate procedures have been formulated for accidents causing injuries/facilities and for dangerous occurrences.

## 7.5 Occupational Health and Safety

Large industries, in general, and power plants in particular where multifarious activities are involved during construction, erection, testing, commissioning, operation and maintenance, employment, materials and machines as the basic inputs. Occupational health needs attention both during construction and erection and operation and maintenance phases. However, the problem varies both magnitude and variety in the above phases.

7.5.1 Construction and Erection Phase

The problems envisaged at construction and erection stage can mainly be due to accident, fugitive dust emissions and noise. To overcome these hazards, the contractors in charge of construction and erection activities have to maintain noise levels within threshold limit values and the workers should be provided with personnel protective equipment. Mobile water sprinkler and wet drilling will be used to control dust emissions.

7.5.2 Operation and Maintenance Phase

The problems envisaged during the operation and maintenance phase are accident, exposure to heat, noise, arc lights, chemicals etc. Suitable personnel protective equipment's should be provided to all workers, likely to be exposed to these situations. The working personnel should be given the personnel protective equipment as listed in **Table-7.11**. In addition, medical facilities should be made available round the clock for attending any medical emergency during construction and operation phases.

**TABLE-7.11**
**PERSONNEL PROTECTIVE EQUIPMENT**

| Protection For | Equipment | Protection Against |
|---|---|---|
| Head | Fire Helmet | Fall of objects / hitting against objects during construction, maintenance, etc. |
| | Electrical resistance helmet | Electrical shock |
| | Welder's leather cap | Splashing of liquid etc. |
| Eye | Panorama goggles with clear plastic vision | Oil and paint splashes, dust and chips |
| | Leather mask goggles | Foreign bodies entering the dyes and smoke. |
| | Spectacles type goggles with plain shatter proof lens | Foreign bodies entering the eyes and reflected arc rays |
| | Spectacle type goggles, with blue lens | High temperature flame during furnace work |
| | Panorama goggles with green plastic visor | Reflected arc rays during arc welding job. |
| Ear | Ear plugs or muffs | High noise level |
| Nose | Dust respirators | Fine dust particles |
| | Light fume mask | Acid fumes, vapours and gases (2.0%) |
| | Heavy fume mask | Toxic gases (0.1%) |
| | Canister gas mask | Acid fumes, vapours and gases (2.0%) |
| Face | Plastic face shield | Liquid chemicals, dust particles |
| | Welding helmet and shield | Welding fumes, sparks and UV rays |
| | Asbestos hood | Heat radiation during furnace work |
| Body | Leather apron | Falling of hot chips, slag's etc. |
| | Asbestos apron | Heat radiation |
| | PVC apron | Splashing of chemicals |
| | Safety Belt | Falling of persons from height |
| Hand | Leather gloves | Cuts due to handling |
| | Asbestos gloves | Heat radiation |
| | Acid and Alkali proof rubber gloves | Burns due to chemical handling |
| | Electrical resistance gloves | Electric shock |
| | Canvas gloves | Contact with oil, grease etc. |
| Leg | Leg guards | Welding sparks |
| | Leather safety boots | Striking by objects, fall of objects and stepping on sharp or hot objects. |
| | Asbestos safety boots | Eat radiation, stepping on hot or sharp objects, |

| | | |
|---|---|---|
| | | striking by stationary or moving objects |
| | Gum boots | Liquid splashing, in submerged area and chemically hazardous area |

In addition, medical facilities would be made available round the clock for attending any medical emergency during construction and operation phase.

### 7.5.3 Safety and Emergency Plan

Safety of both men and materials during construction and operation phases is of prime concern. Safety requirement during construction & erection, operation and maintenance phases are already covered in the safety policy with the following requirements:

- To allocate sufficient resources to maintain safe and healthy conditions of work.
- To take steps to ensure that all known safety factors are taken into account in the design, construction, operation and maintenance of plants, machinery and equipment.
- To ensure that adequate safety instructions are displayed at all appropriate places and explained to all employees in English/Hindi.
- To provide wherever necessary protective equipment, safety appliances and clothing, and to ensure their proper use.
- To inform employees about materials, equipment's or processes used in their work, which are known to be potentially hazardous to health or safety.
- To keep all operations and methods of work under regular review for making necessary changes from the point of view of safety in the light of experience and aptitude knowledge.
- To provide appropriate instruction, training, retraining and supervision to employees in health & safety, first aid and to ensure that adequate publicity is given to these matters.
- To ensure proper implementation of fire prevention methods and an appropriate firefighting service together with training facilities for personnel involved in this service.
- To organize collection, analysis and presentation of data on accident, sickness and incident involving personal injury or injury to health with a view to taking corrective, remedial and preventive action.
- To organize collection, analysis and preventive action.
- To promote through the established machinery, joint consultation in health and safety matters to ensure effective participation by all employees.
- To publish/notify regulations, instructions and notices in the common language of employees.

Separate safety rules should be prepared for each type of occupation / processes involved in the project in consultation with manufacturer / supplier of equipment and materials and regular safety inspection should be ensured by a competent person of all buildings, equipment, work places and operations.

7.5.4 Organizational set-up for Safety

*Construction and Erection Phase:*

A qualified and experienced Safety Officer will be posted at site. The responsibilities of the safety officers include identification of the hazardous conditions and unsafe acts of workers and advise on corrective action, organize training programmes and provide professional expert advice on various issues related to occupational safety and health. He will also responsible to ensure compliance of Safety Rules/Statutory provisions for safety. Safety officer of NTPC will coordinate with Contrator's Safety officers for implementation of safety measures and monitoring.

*Operation & Maintenance Phase:*

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

7.5.5 Safety Circle

In order to fully develop the capabilities of the employees in identification of hazardous processes and improving safety and health, Safety Circles should be constituted in each area of work, consisting of 5-6 employees from that area and it should meet for about an hour every week.

7.5.6 Safety Training

Safety training should be provided by the safety officers with the assistance of professionals in the area (e.g., Safety Experts at Corporate Centre & other Projects of NTPC, Safety Institutions, Academic Institutions etc.).

7.5.7 Identification of Work Related Occupational Health Hazards

Based on the preliminary identification, the major hazardous installation at power plant are storage of hydrogen, LDO. LDO is the secondary fuel for combustion support at low load and for start-up. Beside this source of long term health hazards are coal handling plants, ash handling plant, Ash disposal site etc. The major work related health hazards associated with activities in coal fired thermal power plants are fugitive dust emissions, Hazardous Material for Insulation, exposure to high heat, noise & vibrations, Storage and handling of Chemicals and waste handling etc.

7.5.8 Occupational Health Management Plan

*7.5.8.1 Preventive Measures for Occupational Health Hazards:*

**Dust Emissions**

To prevent fugitive dust emissions at coal handling plants and ash handling plants, dust suppressions and dust extraction system will be installed at dust prone areas. Sipat STPP Stage-III will have state of art technology for material handling, which

will reduce the physical contact of worker with coal/ash. Water sprinklers covered belt conveyer will be used to prevent generation of coal dust. Ash handling system will be fully automatic and equipped with compressed air pump and wet slurry pump. Ash utilization will be maximised to prevent dust emission in ash disposal sites. However, dust mask will be provided to manpower working in dust prone areas. PM levels will be monitored in dust prone areas.

**Hazardous Material for Insulation**

While handling such materials, the PPE should be provided to the workers as well as proper disposal of waste asbestos and glass wool should be ensured. All the hazardous areas will be marked with prominent display symbols.

**High Heat**

Stacked material, which can generate heat or can spontaneously ignite, will be inspected regularly to detect any fire. Material will be stacked with sufficient space in between the rows to permit free circulation of air and remove any heat if generated. Air-conditioning equipment will be inspected regularly, and defects are to be attended at once. Regular inspection and maintenance of pressure vessels and piping will be carried out. Training and PPE's will be given to workers for working in Air cooled Condensers area to mitigate high heat affect.

**High Noise & Vibrations**

Adequate protective measures in the form of earmuffs/ear plugs to the workers working in high noise areas need to be provided. In addition, reduction in noise levels in the high noise machinery areas shall be achieved by adoption of suitable preventive measures such as use of enclosures with suitable absorption material, etc. Work environment noise levels will be monitored periodically.

*7.5.8.2 Handling of Liquid Fuels, Chemicals and Wastes*

Following are the important considerations for loading/unloading of hazardous chemicals to prevent health hazards from chemicals & wastes.

1. Written instructions will be given which clearly define responsibilities for all personnel involved in loading/unloading operations
2. A responsible person normally a section supervisor on site will check that the quantity and type of fuel oil being transferred is suitable for the receiving tanks; Tanks will be checked to see how full they are before filling, and also during filling using the contents gauge. The maximum level device will be used to ensure overfilling does not occur;
3. The point of transfer, where connections and disconnection are made will be sited in a well-ventilated position;
4. Storage areas shall have appropriate signs and notices and be clearly marked-out, and all containers and packages should be clearly labeled;
5. All stocks of containers, drums and small packages shall be regularly inspected and Procedures shall be in place to deal with damaged or leaking containers;

6. Storage areas for oil, paint, chemical drums and bags, etc, shall be designed and operated to minimise the risk of releases to the environment. Storage areas shall be located away from watercourses and public access and should be protected against vandalism;
7. Flexible hoses used for conveying fuel oil to and from truck into fixed vessels will have a means of identification and will be examined for kinks and wear on every occasion prior to use. Hose fittings will be similarly examined;
8. In order to minimize the risk of accidental movement, the tanker will stand on a level site during loading or unloading. Checks will be placed against the vehicles wheels or other means provided to prevent vehicle movement prior to loading/unloading. These will only be removed when transfer is complete. The ground beneath the tanker will have a shallow gradient to a safe place to prevent any spillage from remaining under the vehicle;
9. The loading/unloading operation will only be carried out when it is safe to do so and where practical be separated from other traffic movement. Where vehicles or pedestrian are likely to pass by, physical barrier will be provided to deter them approaching the transfer operation; and
10. Consideration will be given to the provision of a driveway protection device such as self-sealing, breakaway, coupling connected to the flexible hose, means to shut emergency isolation valves on the fixed plant, etc.

*7.5.8.3 Other Preventive Measures for Safety and Health Hazards*

For the safety of man and material, various preventive measures will be taken. These are:

a. Periodical checking of electrical wiring, fittings, and equipment;
b. Immediate removal of all combustible and flammable material from the vicinity of sources of ignition;
c. All welding/cutting operations will be carried out taking suitable precautions under permit procedure in consultation with the office-in-charge of the plant and the fire and safety division;
d. All the pipelines and vessels will be clearly marked for its content and quantity and will also be colour coded for easy identification;
e. All plant equipment, lines, vessels and storages will be inspected in all shifts for leakage and release of inflammable liquids. Any such leakage, if found will be stopped and attended to at once;
f. All the hazardous areas will be marked with prominent display symbols;
g. Areas where spontaneous combustion is possible due to storage of material or in scrap yard will be inspected regularly for immediate control of fire on its outbreak;
h. Plant and machinery will be operated under close supervision. Any malfunction will be attended to at once before it can lead to breakdown, fire or any such dangerous occurrence;
i. Dry grass and vegetation will be cut as and when required;
j. Smoking will be prohibited in the plant premises. It may be allowed in the safe locations outside the plant area. All persons will be checked at plant gate for matches, lighters, beedi, cigarettes and other smoking materials;
k. Personal protective equipment (PPE) as given in Table 7.18 will be provided; and

l. Safety display boards should be provided wherever hazardous chemicals are used.

7.5.9 Occupational Health Monitoring, Awareness and Training

NTPC Sipat STPS already have a full-fledged hospital with adequate number of qualified medical staff which also act as occupational health centre. First aid facilities, medicines and ambulance to meet any emergency are already exists, which will be further strengthened. Medical check-up of all the employees will be done during the pre-employment time and thereafter at periodic intervals. Health records will be maintained for each employee. Regular health check-up will be carried out. The precautionary measures will be taken to avoid any occupational diseases.

The work environment will be monitored for occupational accidents, diseases and dangerous occurrences. A proper record of the same will be maintained. The following aspects will be adopted to ensure good health condition of employees.

- Pre- employment check-up;
- Awareness programme;
- Routine check-up; and
- Periodic vaccination programme etc.

*Occupational Health Monitoring for Workers:*

Engagement of contractual workers will be done only after proper health check-up and fitness certificate by approved medical practitioner through contractor.

Periodic medical examination (PME), as required under the Factories Act shall be undertaken. However, the investigations performed under the PME should be relevant to the job exposures. Since coal/ash handling workers are prone to dust exposure related diseases, due attention is required to those workers. In case of need, the frequency of PME may be scheduled, based on observation of the health check-up information. Providing PPE and re-locating of job for those workers may also be considered.

*Awareness Programmes and Training:*

Periodic awareness programmes regarding the health and safety with active involvement of the workers will be organized, covering each individual with the minimum annual average duration of 8 hours per worker. Regular community level awareness programmes may be organized in the vicinity of the plant for the family members of the workers. First-aid training will be imparted to workers on regular basis to provide immediate relief to accident victim.

7.5.10 Implementation of Occupational Health & Safety System

A comprehensive policy document on environment, health and safety specific to Sipat STPP Stage-III shall be framed. It will cover the legal provisions, management system, best practices, safe operating procedures, etc. for various areas of thermal

power plants. This will serve as a reference document for effective implementation of the provisions.

Participatory management regarding health and safety at plant level may be ensured. Safe methods shall be followed for the handling, collection and disposal of hazardous waste as recommended by government authorities and expert organizations like NIOH. The occupier of the NTPC Sipat (Head of Project) shall be responsible for the compliance of provisions of the Factories' Act for casual/contractual labour on health and safety issues. In case of women workers, the provisions of the Factories' Act, as applicable, shall be given attention.

7.5.11 Assessment of Endemic Diseases of Environmental Origin

*Endemic Diseases in the Area*

The general diseases in this area are Malaria, Pneumonia, Measles, Tuberculosis, Dengue & other diseases occurs majorly in villages (mentioned in descending order of occurrence). (Source: Need Assessment Survey Report).

CSR village health camps and eye camps are organized annually to cater to needs of surrounding population. Sipat area having DOTS CUM DMC at hospital to manage tuberculosis patients in our surrounding area. Project affected persons of existing plant have provided medical facilities at subsidized/free price.

*Action Plan to Mitigate the Endemic Diseases*

1. Conducting regular awareness camps in hospital for surrounding population;
2. Conducting regular mobile camps in hospital for surrounding population;
3. Admission, investigations, treatment and follow up of poor patients needing treatment under CSR head in our hospital;
4. Tobacco de-addiction center at our hospital giving awareness, counseling and treatment free of cost;
5. DOTS cum DMC at the hospital catering to tuberculosis patients in surrounding areas free of cost; and
6. Awareness sessions in surrounding school related to personal hygiene and infectious diseases in camps and surrounding area schools.

7.5.12 Medical Facilities and Health Infrastructure at Sipat STPS

Existing Sipat Super Thermal Power Station (STPS) has already full-fledged hospital to cater the health needs of employees of NTPC, CISF, PAPs and other nearby villages and the same will be extended after the proposed expansion also. The hospital has full time qualified doctors in various specialties, who are also trained in occupational health. Beside this other consultants are being outsourced to fulfil the health needs.

Sipat hospital have been serving employees and neighboring community since last 15 years. It is a multi-bedded hospital with 24 hour emergency services is run at present with regular doctors, administrative staff and regular Para medical staff.

7.5.13 Health and Safety Monitoring Plan

Regular health checkups/ occupational health checkups are done for employees and contract labor in existing NTPC hospital. Regular medical checkup of contract work force is carried out to access the healthy work environment and detection of earliest change in their health. The patients with abnormal findings are tracked and called for regular follow-ups and counselling.

The health of all employees engaged in proposed Stage-III shall be monitored once in a year for early detection of any ailment due to exposure to heat and noise.

## 7.6 Water Availability and Sufficiency Study

Water availability and source sustainability study has been carried out by collecting information from secondary sources. Hasdeo-Bango multipurpose project is primarily an irrigation project, which was started in the 1960's on the Hasdeo river in Bilaspur district of then Madhya Pradesh.

The main purpose of this project is to provide water for irrigation for all three crop seasons. The project was completed in 4 phases. In the first phase, the Hasdeo Barrage was constructed on Hasdeo river at Darri village near Korba town. In phase-II a canal system of 48 km was constructed (Central Water Commission Report, 2013). In Phase III and IV Minimato-Bango dam was built 42 km upstream of Hasdeo Barrage (Central Water Commission, 2013). This project has created an irrigation potential of 4,33,500 hectares and hydropower generation capacity of (40 X 3) MW (Central Water Commission Report, 2013). The project was completed in 2011.

The Hasdeo-Bango project irrigates through Akaltara branch canal system and Janjgir branch canal system. The command area of this project lies in Janjgir-Champa, Korba and Raigarh district. Industries also take water from these canals as per their allocation.

The initial capacity of Hasdeo-Bango was 3,040 MCM, which has been reduced to 2,894 MCM due to siltation.

The main objective of the Hasdeo-Bango project is to provide water for irrigation but it also has some other objectives. (Central Water Commission, 2013). The main objectives of this project are:

- To irrigate 4,33,500 ha agricultural land annually;
- To generate 120 MW hydropower;
- Cater the domestic water needs of Korba town; and
- To provide 441 MCM water for industrial needs.

The live capacity of Hasdeo-Bango reservoir is 2,894 MCM as per **Table-7.12** The original project document has clearly divided the water among industry, agriculture, domestic needs and estimated water losses as per the table below:

## TABLE-7.12
## WATER ALLOCATION AND LOSSES

| Sr.No | Purpose | Water Allotted (MCM) | Water Given Actual (MCM) |
|---|---|---|---|
| 1 | Agriculture | 1,810 | NA |
| 2 | Industry | 441 | 431.491 |
| 3 | Domestic purposes of Korba Town | 14 | 1.82 |
| 4 | Water Losses due to Evaporation | 229 | NA |
| 5 | Carry over | 600 | Depends on Year |

*Source: (Ministry of Water Resources, Government of Chhattisgarh)*

The amount of water for industry and domestic purposes is fixed. The water for irrigation has been calculated on the basis of crop pattern in the area, and the project document specifies that the project can irrigate 1,73,100 ha of land in the Rabi season and 2,47,400 ha rice crop in Kharif season.

The department of Water Resources states that it has ensured designated supply of water to all consumers. They have said agriculture is their first priority and they are supplying water to agriculture without any reduction in quota. The department also mentions that water losses may vary depending upon temperature and other environmental factors. Carry over means water reserved in dam for next year.

Hasdeo-Bango can allot up to 441 MCM water to industries. The Chief Engineer of the Hasdeo-Bango project states that it is currently allocating 431.5 MCM water to industries which is well in the limit decided in project documents. The details of water allocation to different industries are as following **Table-7.13.**

## TABLE-7.13
## DETAILS OF WATER ALLOCATION TO INDUSTRIES FROM HASDEO-BANGO PROJECT

| Sr. No | District | Company | Water Allotted (MCM) | Water Source |
|---|---|---|---|---|
| 1 | Korba | CG State Electricity Board (East), 440 MW | 21.00 | Hasdeo-Bango Project (Left bank Canal RD 3800 M Power Canal, Korba City) |
| 2 | Korba | CGState Electricity Board, (West), 840 MW | 23.00 | Hasdeo-Bango Project (Hasdeo-Bango Reservoir) |
| 3 | Korba | BALCO, Korba | 10.20 | Hasdeo-Bango Project (Left Bank Canal, Main Power Canal RD 2970, Korba City) |
| 4 | Korba | IOL (IBP),Gopalpur | 0.078 | Hasdeo-Bango Project (Hasdeo-Bango Reservoir near Goplapur Village) |
| 5 | Korba | SECL, Korba | 0.93 | Hasdeo-Bango Project (Left Main Canal, RD 4560 M, Korba City) |
| 6 | Korba | SECL, Kusmunda | 1.490 | Hasdeo-Bango Project (Right Bank Canal, RD 7200M Korba City) |
| 7 | Korba | SECL, Gevara | 1.260 | Hasdeo-Bango Project Right Bank Canal, RD 7200M Korba City) |
| 8 | Koba | BALCO Expansion (540 MW) | 24.00 | Hasdeo-Bango Project (Left Bank Canal, Main Power Canal RD 2970, |

| Sr. No | District | Company | Water Allotted (MCM) | Water Source |
|---|---|---|---|---|
| | | | | Korba City) |
| 9 | Korba | NTPC Korba (2100+500+270) MW Expansion + BCPP BALCO 2870 MW | 62+18+30= 110.00 | Hasdeo-Bango Project (Right bank Canal RD 1466M & 2250 M, Korba City) |
| 10 | Bilaspur | NTPC Sipat (2980MW) | 120.00 | Hasdeo=Bango Project (Right bank Canal, RD 37950 M) |
| 11 | Korba | Shyama Prasad Mukharjee CSEB (East), 500 MW | 21.00 | Hasdeo-Bango Project (Right bank Canala RD 3800 M, Korba City) |
| 12 | Korba | CSEB (West) 500 MW | 29.13 | Hasdeo-Bango Project (Hasdeo-Bango Reservoir village Darri) |
| 13 | Janjgir Chapa | KVK Bio Energy | 0.50 | Hasdeo-Bango Project (Akaltara Branch Canal) |
| 14 | Korba | CSEB South (1000 MW) | 40.00 | Hasdeo-Bango Project (Hasdeo-Bango Reservoir, village Darri) |
| 15 | Korba | Balco Power (1200 MW) | 32.00 | Hasdeo-Bango Project – 12 MCM ; Hasdeo River- 16 MCM ;Tan River – 4 MCM |
| | | **Total** | **431.491** | |

*Source: (Ministry of Water Resources, Government of Chhattisgarh)*

The water requirement (2340 $m^3$/hr) for (1x800) MW unit will be met from the available committed quantity of 93 MCM (10,616 $m^3$/hr) from WRD, Govt. of Chhattisgarh. Water system of Stage I & II will be optimized and saving in water thus achieved will be adequate for stage-III.

In view of above, it may be concluded that installation of Sipat STPP Stage-III (1x800 MW) will not have impact on competing users of water source.

## 7.7 Brief Summary of Social Impact Evaluation Study

NTPC Sipat STPS has contributed in development of the area and lifting of life standards of local people through CSR-CD activities since installation of plant. A Social Impact Evaluation (SIE) study was carried out through Institute of Rural Management, (IRMA), Anand to assess the socio-economic conditions of 27 villages and ascertain the impact of CSR-CD activities NTPC Sipat STPS. These 27 villages are those in which NTPC has conducted CSR activities during the three years of 2015 to 2018.

The SIE and NAS are supplement to each other. The NAS gives needs of the community, and the interventions gets designed on that basis. The SIE evaluates these interventions and gives an idea of the fresh needs.

The assessment of CSR-CD interventions in qualitative and quantitative measurement for 27 affected villages were recognized right from the outset. The participative methods used in this study are widely applicable to village systems and tribal/non tribal communities across India.

7.7.1 Methodology of Study

The planning team of IRMA had determined the appropriate assessment methods, outcome measures or indicators, information needs, and the techniques by which the data has been gathered and analyzed. Analysis was done on six focused area of CSR interventions i.e. education, community health, vocational training, disability, sports, infrastructure development. Sketching of the present scenario of the village by questioning about, demography, geography, socio economic profile, health and transportation etc. were made. Perceptions of key stake holders of village about activities done under 6 focused area and other visible and perceived impact were recorded. Stakeholder Analysis, Gender Analysis, community-based methods, consultation methods, observation and interview tools, participant observation semi-structured interviews focus group discussions, participatory methods has been done with structured & semi structured questionnaire targeting individual household, key stake holders (Sarpanch, Govt. officers, principals etc.), Self Help Groups (SHG), educationist, health assistants etc. Recommendations and decisions were given on the basis of analysis of data and outcome of survey. On the basis questionnaires developed, data from 638 individual respondents & more than 66 respondents (with respective stake holders) were collected.

7.7.2 Socio-Economic/Demographic Profile of Study Villages

The total population of the 27 study villages are 1,15,595, consists majority of OBC population with 46% (10,050), S.C., 24% (5,415), S.T. 23 % (5,018) & General 7 % (1,569). About 61 % household were below poverty line (BPL) and remaining 39 % were above poverty line (APL). The total population of the study villages are 1,15,595 including female 48 % (55,080) & male 52 % (60,515).
None of the respondents told that the village is developed. 77 % of the strata ranked their village as moderate developed. While 23% ranked their village as backward. As Ballarpur is also known as the cultural capital of the state an also boosts various cultural and social events. In spite of a number of tribes, castes & communities, its people share certain commonalities and a philosophy which is central to many tribal & non-tribal cultures; the veneration of natural resources – water, forests and land on which life is dependent.

7.7.3 Government Schemes Implementing in Villages

Ujjwala Yojna, Shouchalaya Nirman under Swachchha Bharat Abhiyan, Pradhan Mantri Awas Yojna, Mukhya Mantri Swasthya Yojna, Vriddha Pension Yojna, Sukhad Sahara Pension Yojna, Vidhwa Pension Yojna, Indira Gandhi Pension Yojna are different schemes being implementing through government for villagers.

7.7.4 Infrastructure Available

**Educational Institutes:** There are 143 anganwadis, 65 primary schools, 41 middle schools, 18 higher secondary school & 1 college in this 35 villages. majority of the building are pucca.

**Road & Transport:** Though road connecting villages to districts are made of

black top. Roads connecting villages to each other are mostly muddy & gravel roads. It becomes very tough to connect these villages in Rainy season. Approximately depth of 1 to 1, 5 feet in patches on the roads get covered in mud in villages viz. Utarda, Kukda, Nirtu, Sirli, Sirkikhurd & Newsa.

**Health Facilities:** Dhaniya, Sipat, Darrabhata, Pandhi & Newsa has sub primary health center, 162 no. of Mitanins are there for facilitating medical help. For purchasing medicines villagers need to go to Hardibazar, Jairamnagar, Sipat, Baloda, where as villages viz. Khamhariya, Dhaniya, Utarda, Janji, has small medical shops. Janji, Khamhariya, Bitkula, Dhaniya, Sipat, Pandhi has Veterinary Hospital in villages itself. Whereas other villagers go to Hardibazar, Jairamnagar & Sipat for veterinary hospitals. Community needs to go to Sipat, Pal &, Hardibazar to avail services of hospital.

**Water and Sanitation Facilities:** R.O. water plants are being established in 5 villages 7 schools i.e. Gatoura, Pandhi, Sipat, Sipat Nawadih & Janji by NTPC. There is a huge demand for improved drinking water facilities. Hand pumps, Bore well, community well, individual well etc. are available for drinking water facilities. This was found in the study that average 41.86% of the Household (H/H) have access to safe drinking water in terms of various available resources inside premises or near to house.

**Electricity:** It was observed that 12,658 H/H are electrified, whereas 8,681 no. of H/H has Ekalbatti connection & 446 no. of H/H are un-electrified, villages name Koudiya, Bitkula, Davandih, Sipat Nawadi, Khanda, Usalapur, Hardivishal, Janji, Sirli, Darrabhata, Newsa, Renki, Sirkikhurd. (There are some un-electrified H/H having illicit electricity connection, but responded as un-electrified H/H due to threat of legal actions).

**Community Buildings:** Majority of the villages have community building. However, some of them need repair & maintenance work. Some of the villages demanded for a community buildings as well. Study reveals that 77 % of the villages have community building. Though, in major affected villages are again in a higher side w.r.t. availability of community buildings.

### 7.7.5 Findings of Impact of CSR-CD Activities of NTPC Sipat STPS

**Rating of Development through NTPC under scale of 0-100:**

This was found that in overall development; contribution of NTPC goes like, 60.00 % of villages told to have 0-20 % development in villages through NTPC, 25.71 % villages told to have 21-40 % development through NTPC, 14.29 % villages told to have 41- 60 %, 0.00% villages told to have 61-80 % & 81-100 %.

Education: A significant positive change has been evolved in education. Overall assessment indicated a positive change in education pattern of the villages. Net enrollment ratio, No. of Students in schools & overall literacy rates are higher as compare to 2014. There is 3.89% decrease in school dropouts.

Health: Due to better health facilities IMR, MMR, U5MR, disease/epidemic outbreak is seen lower w.r.t. 2014. During last 3 years, comparatively better health facilities have been provided in villages. Majority of the responses were given for availability of average health facilities.

Disability: It was observed that equipment's for ease & comfort for the differently abled has been taken under CSR-CD program. They are given special attention by NTPC as well Government. Distribution of Tricycles, hearing aids, wheelchairs, Crutches in CSR activities have benefited these persons and made their life comfortable.

Infrastructure: Since the primary focus area of the CSR activity was Infrastructure development, many activities have been successfully accomplished. Rating given after analysis is mostly improved from deteriorated. Bazaar Shed comforts the green grocery sellers and other small merchants in Summer & Rain. Now the sitting arrangements are more organized. Community based drinking water availability is seen a significant increase. Though still the rank good was given less. But, increase in availability of community-based drinking water cannot be neglected. There are efforts made towards it which led the activities to success.

Employment: Organizing Employment fair and counseling to the rural youth has been helpful for seeking employment. Training on Computer, Skill Development, tailoring to women & Self Employment opened door for capacity enhancement and alternative income generation activities for poor marginalized farmers.

Conclusions: The villages studied have not proper infrastructure and lack of health facilities. NTPC's efforts through CSR activities have significantly contributed in development of infrastructure, education facilities, water & sanitation, employment etc.

## 7.8 Brief Summary of Need Based Assessment Survey Study

A need-based assessment Survey Study was carried out through Institute of Rural Management (IRMA), Anand. during 2022-23. It was a sincere attempt to make an in-depth study to make a plan for development of 36 affected Villages of three districts Korba (9 villages), Bilaspur (26 villages), and Janjgir-Champa (1 village) from NTPC, Sipat STPS. The tools used for collection of data are literature review, interviews with stake holders, Rapid Rural Appraisal (RRA) with key stake holders, Focused Group Discussions on 8 focused area of NTPC, Questionnaires and transact walk.

Village Wise Needs

Highest priority was given to infra structure development with 112 No. of needs in villages. Whereas VT, education, health, agriculture, disability & livestock had 36,31, 28, 18, 7, 5 & 4 no. of needs respectively as shown in **Figure-7.3.**

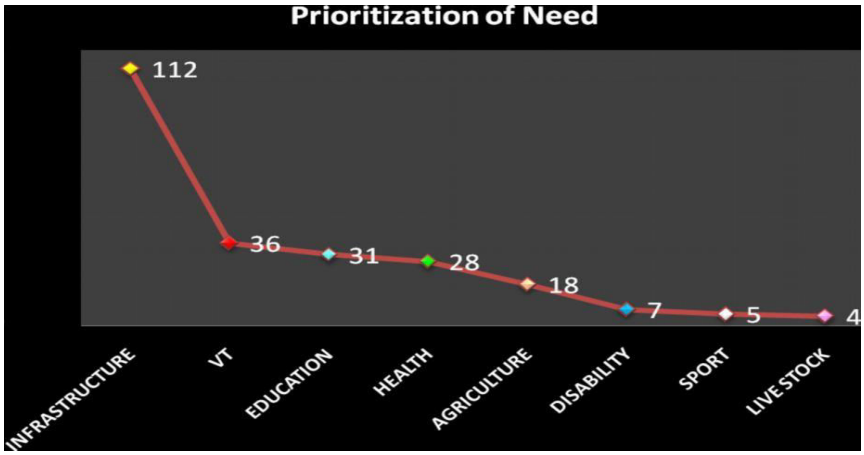



**FIGURE-7.3**
**PRIORITIZATION OF NEEDS IN VILLAGES**

Essence of the study is that there should be a long term and short terms programs need to be facilitated for effectiveness of the community development in the study area. The following issues were identified and prioritized accordingly.

**Short Terms Programs**

- Infrastructure development, education, vocational training, health, agriculture disability, sports and livestock.

**Long Term Programs**

- Infrastructure development, education, health, disability and sports.

The above prioritized needs have become the instrumental in planning the year wise CSR action from 2022-23 onwards. The CSR action plans have taken care the above said issues and implementing the programs in consultation with the program participants in 36 villages. In all the villages villagers were given due priority in effective implementation if the CSR planned activities every year.

## 7.9 Action Plan for Identification of Employable Youth and Employment Oriented Technical/Vocational/Training Programmes

NTPC-Sipat STPS continuing imparting vocational training every year, further, development of skills of villagers through training has been planned. NTPC-Sipat STPS continually imparting training on stitching & tailoring, computer training, beautician, agriculture training like fodder development, livestock training etc. to provide certain skill set for their livelihood. Beside this employment fair and carrier counseling is also helping youth to get jobs. Establishment of stitching centre for vocational trainings at village Rank has opened the self-employment of local women by Garment manufacturing/tailoring.

As per need based assessment survey study, after analysing, the life style and conditions of villages/hamlets, it can be said that root of all cause is poverty or vice

versa. The sources of income are very less, all though few people are skilled and enterprising but even they are totally unaware about commercial and market strategy. This major problem can be eliminated up to certain level by let them know some more sources of income generation and professionalism in particular field. It was observed that, construction & garment making trades were given highest ranking by villagers for VT courses. Information, communication technology, agriculture, animal husbandry & beauty & wellness trades were in priority with descending order.

NTPC-Sipat STPS is regularly imparting Vocational Training (VT) every year to the youths from nearby Govt. Institutes. Various skill development and training classes are conducted by NTPC. The details are given below:

- Computer training (under self-employment scheme)

  - 90 boys and 90 girls ~~are~~ participated and trained on computer skills; and
  - Under CSSDM scheme, 40 youths ~~are~~ trained on Tally and 20 youths ~~are~~ trained on accounting skills.
- Women empowerment (under self-employment scheme)

  - 160 ladies are participated and trained on tailoring skills;
  - Fruits and vegetable preservation skills trained for 120 persons;
  - Beauty parlor course for 40 Nos of ladies; and
  - Nursing aides for 100 Nos of ladies.

- Preparation for competitive exams.

These trained people are getting job opportunities in various organizations based on availability and suitability. These activities will continue and expected to increase during implementation of Sipat STPP Stage-III project.

The development of skills, entrepreneurship, capacity building and familiarization will be conducted in following phases with cooperation of various government agencies.

- Business awareness camps;
- Capacity building trainings;
- Entrepreneurship development programme; and
- Enterprise setting programme.

An action plan of proposed skill training programmes to be organized during construction & operation phases of the projected as per need based assessment survey, 2022 is as follows:

- It is recommended to open authorized Vocational Training Programs (VTP) centers holding more livelihood oriented trades viz. automotive repair, driving, medical & nursing, repair of agriculture equipment's under agriculture trade, construction, electronics, fabrication, beauty & wellness, garment making etc.
-

- In imparting training programme, tool kits, sewing machines and other machines will be distributed as per requirements and involvement of target groups.
- About Rs. 30.74 lakhs & Rs.18.69 has been incurred in FY 2020-21 & 2021-22 respectively on vocational training including computer courses w.r.t. DCA/PGDCA & material/equipment support after it for livelihood of rural youths and special classes/camps for Army/Navel /Air/Police force recruitment drive.
- Special emphasis shall be given to self-employment by providing capacity building training young girls and ladies. About Rs.13.22 lakhs budget has been kept in F.Y.2023-24 for vocational training for capacity building of local youth.
- Local farmers shall be given agriculture training in integrated livestock development centers and fodder multiplication centers.
- Beneficiaries (both men & women) from different villages will be identified and accordingly interested villagers will be involved for training and formation of SHGs.
- NTPC is committed for capacity building activities in a comprehensive manner to improve the employability of the affected persons/locals which will facilitate their gainful employment. Interested ITI/technical students of local area will be given practical training as per their qualification & skill set through different contractual agencies during construction & operation of project. The local people may have opportunity to be engaged, under different agencies, as per their qualification & skill set, during the project expansion activities of Sipat STPS.

## 7.10 Site Specific Wildlife Conversation Plan

There are no sanctuaries, national park, biosphere reserves in the study area. The study area does not have migratory corridors of any important species. The study area did not record the presence of any critically threatened species in the study area. The records of Botanical Survey of India and forest department also did not indicate presence of any endangered or rare and vulnerable plant species in this area.

On comparison of the check list given in the Schedule-I of the Indian Wildlife Protection Act,1972 and the list of wildlife recorded in the study area, it can be concluded that six species belong to Schedule-I, and rest of the species belong to Schedule-II of the Indian Wildlife (Protection) Act, 1972 and its amendments.

The identified Schedule-I species in the study area as per WPA is provided in **Table-7.14.**

**TABLE-7.14**
**IDENTIFIED SCHEDULE-I SPECIES IN THE CORE & BUFFER ZONE AS PER WPA**

| Sr. No | Scientific Name | Common Name | Family | IUCN/WPA |
|---|---|---|---|---|
| 1 | *Canis aureus* | Jackal | Canidae | LC / I |
| 2 | *Felis chaus* | Wild Cat | Felidae | LC / I |
| 3 | *Ptyas mucosa* | Indian rat snake | Colubridae | LC / I |
| 4 | *Python molurus* | Indian Rock Python | Pythonidae | VU / I |
| 5 | *Varanus bengalensis* | Varanus | Varanidae | VU / I |
| 6 | *Vipera russelli* | Russel's Viper | Varanidae | LC / I |

*Source: WLCP NTPC Sipat*

The detailed SSWLCP has been prepared along with budget provisions and the same has been enclosed in **Annexure-XI.**

**BUDGET FOR WILDLIFE CONSERVATION:**

The amount is given to the State Forest and wildlife department for the following purposes:

- To identify and engage the services of local wildlife lovers (as volunteers) for tracking any wildlife and wildlife related incidents in and around their locality and to report the same to the State Forest and wildlife department and to the EHS cell of the NTPC Sipat. The engaged volunteers will be paid a honorarium their service from the amount given by the NTPC Sipat.
- Any report received will be perused and investigated by the State Forest and wildlife department to find out whether it is true or not.
- This exercise shall be continued to know whether there is any genuine need for a Site-specific wildlife management plan.
- When it is decided to have such a plan, the NTPC Sipat and the State Forest and wildlife department shall engage the services of the Wildlife Institute of India (WII) or any agency or institute identified by the State Forest and wildlife department for examining the desirability, feasibility and finalization of the action plan based on monitoring
- The NTPC Sipat will contribute to the Wildlife Management fund along with other Industries and extend full support for implementation of the action plan.

**TABLE: 7.15**
**BUDGET FOR CONSERVATION PLAN (Rs in LAKHS)**

| Sr. No | Activity | 1st Yr | 2nd Yr | 3rd Yr | 4th Yr | 5th Yr | Total |
|---|---|---|---|---|---|---|---|
| 1 | Contributions to the Forest and Wildlife Department for implementation of conservation plans<br>Habitat improvement – Plantation<br>Renovation of water bodies | 10.00 | 10.00 | 10.00 | 10.00 | 10.00 | 50.00 |
| 2 | Awards and rewards for promoting the afforestation programs | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 5.00 |
| 3 | Awareness program, education and constitution of Eco-clubs in nearby villages | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 10.00 |
| 4 | Support to Forest Department for monitoring, rescue & rehabilitation of wildlife (Veterinary care, animal health, rescue, tools and equipments etc.) | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 15.00 |
| **Total** | | **16.00** | **16.00** | **16.00** | **16.00** | **16.00** | **80.00** |

*Source: WLCP NTPC Sipat*

# Chapter-8
# Project Benefits

# 8.0 PROJECT BENEFITS

The proposed expansion project by NTPC Ltd. would enable to meet part of the growing power demand in the state of Chhattisgarh as well as in India for irrigation, domestic and commercial purposes. Further, the proposed expansion of Sipat STPP Stage-III (1 x 800 MW) will result in improvement of infrastructure as well as upliftment of social structure in the area. The people residing in the nearby areas will be benefited indirectly. It is anticipated that the proposed expansion of power plant will provide benefits for the locals in two phases i.e. during construction phase as well as during operational stage.

## 8.1 Construction Phase

### 8.1.1 Employment

During the construction phase of the project, ample opportunities will be available with the contracting agencies and other associates where the Project Affected Families (PAFs) could seek employment. Further, opportunities are also available during the operational phase of the project. Keeping in view that the NTPC Projects are capital intensive with state-of-the-art technology and, therefore, do not offer much direct job opportunity, employment with NTPC would be severely restricted. Other self-employment options, award of petty contract and job with contracting agencies and cooperative societies, deployment of vehicles have been included as additional economic opportunities.

The major benefit due to the proposed expansion project will be in the sphere of generating temporary employment for a substantial number of personnel. During construction phase, there will be opportunities for local skilled and unskilled workers to be employed through contractors in the various construction related activities like material handling, operation of construction machinery, actual construction, painting, installation of plant machinery etc. Thus, the proposed project will benefit locals to some extent.

### 8.1.2 Community Services

CSR activities are being carried out in nearby villages which helps in bringing maximum value to the society and the organization. As per requirement, NTPC shall further develop necessary infrastructure like water supply, sewerage, medical facility, etc. for catering to the needs of the project personnel and their families. The local people will be indirectly benefited by these developments.

### 8.1.3 Transportation

NTPC Ltd. has laid roads around the project area and all surrounding villages are availing better and faster connectivity between them. Roads infrastructures are strengthened wherever required which facilitates smooth movement of villagers

## 8.2 Operational Phase

### 8.2.1 Population

NTPC may make efforts for provisions kept in conditions of contract to meet majority requirement of the unskilled work force of the contracting agencies preferably from amongst the PAFs and local population based on the suitability as may be judged by the contracting agencies. Preference is being given for PAPs workforce in other categories.

### 8.2.2 Education

Educational activities in and around the project area is being undertaken in consultation with stakeholders which includes scholarships and / or reimbursement of tuition fee for ITI / Polytechnic / Engineering / Medical / Pharmaceutical courses / coaching for above courses / Vocational training courses to enhance employability / educational tours / providing assistance in terms of textbooks / stationery etc / assistance to schools through NGOs / Panchayats or otherwise for enhancement of teacher / student ratio, organizing training programmes for developing special skills / modern trends in education like computer training, coaching for higher education etc in addition to infrastructural facilities related to above and for development of Educational Institutes. School fees at par with employees' children The wards of PAFs are being charged fees at par with NTPC employees' children in NTPC township schools.

### 8.2.3 Employment

During operation other facilities include self employment opportunities in the form of small contracts like vehicles deployment, gardening, etc. through PAP cooperative's, employment opportunities with contractors will be available for local people. Under capacity building programme, trainings will be provided in vocational programmes, fisheries and other local trades.

### 8.2.4 Improved Power Supply

Commissioning of Sipat, Stage-III (1x800 MW) will improve the power supply position which is vital for economic growth as well as improving the quality of life. The improved power supply will reduce the dependence of general public and commercial establishments on DG sets thereby reducing the noise pollution as well as air pollution at local levels.

### 8.2.5 CSR Activities/ Community Development Activities

The NTPC CSR policy is brought out to have a greater strategic orientation with more connection with stakeholders and an outcome centric approach. This CSR policy is intended to be in conformity with the provisions of Companies Act 2013 and DPE Guidelines on CSR, if any. However, new provisions shall be specifically incorporated in the policy as applicable from time to time.

8.2.6 CSR Initiatives

The proposed expansion of Sipat STPP Stage-III (1x800 MW) is located in remote rural areas which was socio-economically backward and deficient in the basic civic amenities. NTPC, as a responsible corporate citizen has been addressing the issue of community development through CSR in the neighbourhood area of its stations, which had been impacted due to establishment of the project. The photographs of CSR activities are given in **Figure-8.1 (A-H)**. Some of the community development initiatives undertaken by NTPC at Sipat are as follows:

**Education**

As corporate social responsibility various activities are being undertaken in the focused areas like Education, Water, Health and Sanitation, Infrastructure Development, Capacity Development etc, bringing maximum value to the society and the organization. The CSR activities are monitored in terms of impact and opportunity for improvement. These are useful in instilling confidence in stakeholders through effective communication. Education is one of the most important developmental pillars of any society. Recognizing the importance of education, NTPC stations all over the country are actively involved in the field of education. To enhance the overall literacy level and enrolment ratio in schools NTPC Sipat CSR program primarily focuses on Govt. Schools. The broad activities being undertaken are:

- Facilitating primary education through infrastructure development in nearby schools:
- Provision of equipment and aids for education;
- Special programs for education of the girl child through flagship GEM (Girl Empowerment Mission).
- Improving the existing infrastructure and providing study materials to the nearby schools;
- Construction of school buildings in 8 villages;
- Construction of girls toilets and urinals;
- Construction of Boundary wall in nearby schools -Gataura, Kaudiya, Sipat, Janji, Karra, Khanda etc
- Distribution of furniture, stationery items in nearby schools.
- Setting up of 'Library on the Wall', STEM Labs, STEM DIY Labs, BALA art, smart classes in government schools of nearby villages • Construction of sports facilities at schools / villages;
- Organization of rural sports for promotion of sports; and
- Distribution of sports items to youth clubs and schools.
- Installation of sanitary napkin vending machines in government schools
- 346 Girl students covered from 32 affected villages participated in GEM program.
- Through Girl Empowerment Mission (GEM) 2019 batch - 9 girls, GEM 2022 - 10 girls and GEM 2023 – 10 Girls, total 29 girls are being provided free education in Bal Bharati Public School, Sipat.

**Health**

NTPC is committed to provide quality services not only to its employees and their dependents but also to the people of the villages surrounding its project locations and communities at large. The following are the NTPC's initiatives in the area of health:

- Mobile van well equipped with the team of doctors, paramedical staffs, medicines.
- Organizing free check-up camps on eye care,
- NTPC has also been associated with government sponsored national education programmes like on TB, Pulse Polio Campaign, Malaria eradication etc.

**Infrastructure Development**

Connectivity, accessibility and the availability of basic facilities like safe drinking water etc. greatly enhance the chances of progress and development of any place. Major Community Development Works done by NTPC are given below:

- Construction of school building in the villages;
- Construction of community centers at village Sipat, Janji, Kaudia, Baniyadih, Raliya, Deori, Pandhi, Gatoura, Khamariya, Nevsa, Hardadih, Karra, Dhangaon, Khaira, Darrabhata etc.
- Construction of approach roads between Mopka – Sipat villages, Lagra – Gatoura villages and Janjhi-Kaudia villages • Renovation /deepening of ponds in villages -Karra,Renki,Uslapur, Sipat, Janji, Raliya , Kaudiya, Sikrikhurd, Udangi, etc.
- Construction of CC Roads, Water Bound Macadam road (WBM), Sampark Marg in nearby villages-Kukda, Gatoura, Sipat, Bhilai, Darrabhata, Kaudiya, Hardadih, Khanda, Dhaniya, Bitkula etc. Some of community development activities in nearby villages are given below:
- Construction of market with shed at Sirli, Dhaniya, Bitkula, Raliya, Khamariya, Khanda village etc.
- Construction of toilet & boundary wall for primary & Jr. High school Navadih at Sipat, Gatoura, , Parsahi, Baniyadih village;
- Construction of 15 Toilets along with urinals in nearby villages -Kutela, Ved Parsada, Gatoura, Kuli, Sipat, Kachhar
- Construction of water tank and tube well for water supply at Sipat, Pandhi village;
- Construction of stadium at Madai , Pipranar and Bitkula village; • Installation of hand pumps in nearby villages.
- Construction of community toilets in Heritage site Ratanpur.

**Special Ability**

As a part of our CSR program, NTPC distributes tri-cycles, wheel-chairs, blind sticks and hearing aids to Divyang Jan. A tailoring workshop was recently organized exclusively for Divyang Jans of nearby villages.

**Promoting Rural Spots**

Sports and games are very important for the all-round development of individuals.

- Sports meeting with local villages.
- NTPC Sipat has also committed for promoting football in collaboration with Chhattisgarh Football Association
- Football championship & coaching camps for Sr Mens, Junior boys and Sub-Junior boys are being organized at NTPC Sipat since 2016.

**Capacity Building Initiatives**

At NTPC, Corporate Social Responsibility (CSR) is about capacity building of society for sustainable development. Vocational Training programs under capacity building initiatives are implemented at Sipat as per following details:

**Vocational Training Programmes**

Vocational training occupies prime importance for the people of the rural areas because pursuing higher education for economically weaker sections on their own is very difficult. Vocational training is provided in commonly used trades, which are found to be very helpful in providing employment opportunity to the villagers of nearby community. It's equally suited for both the genders as women can become a source of additional income for the family and at the same time it ensures employment for the men folk. Trainings are imparted in various traits like motor winding, sewing and tailoring, beauty culture, motor driving, repairing, computer etc. on a regular basis. These courses are tied up with appropriate certifying bodies.

- Various skill development and training classes conducted by NTPC Sipat, the details are given below:
- Under CSSDM scheme, 40 youths are trained on Tally and 20 youths are trained on accounting skills.
- 50 youth including women from neighboring villages have undergone training in Fitter (25) and Electrician (25) trades through CRISP Bhopal.
- Training for Army, Police, Para-Military forces was given to 120 youth through CEDMAP.
- G-9 banana saplings (1000 nos. high yielding variety) was distributed to farmers of neighboring villages.
- Tailoring workshop was conducted for 160 ladies at Kaudia, Janji, Rank etc.
- Beauty parlor course for 40 ladies
- Computer training for village youths.
- Nursing training imparted to 100 ladies
- 20 divyangjans from nearby villages
- Training for retail sales associate for 60 villages youths
- Integrated Livestock Development Centre (ILDC) project in nearby villages
- Approx. 8000 villages from 04 ponds shall be benefitted

## FIGURE-8.1(A)

## PICTORIAL REPRESENTATION OF CSR THEMATIC AREAS

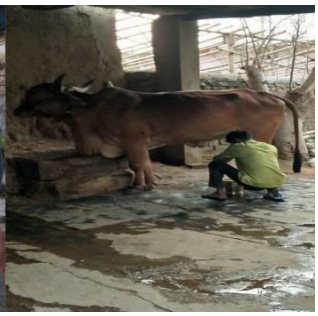
### EDUCATION

| S.No | Head | Picture |
|---|---|---|
| 1. | Set up of Science Technology Engineering Mathematics Lab (STEM) in Govt. High Schools |  |
| 2. | Construction of Boundary wall at Uttarda High School |  |

| S.No | Head | Picture |
|---|---|---|
| 3. | Solar Roof Top at MLS College, Sipat |  |
| 4. | SMART Class in Govt Schools |  |
| 5. | Vocational Training at CRISP Bhopal (Electrician and Fitter Batch)<br><br>All 25 participants of the Electrical batch have been 100% placed. |  <br>  |

| S.No | Head | Picture |
|---|---|---|
| | Girl Empowerment Mission (GEM) residential program for 04 weeks for 120 girls. |   |
| 7. | Workshop on Tailoring for Women of Nearby Villages |  |
| 8. | HEALTH<br>Free eye check up camp for school children |  |

| S.No | Head | Picture |
|---|---|---|
| 9. | Mobile Medical Health Unit covering all 36 villages |  |
| 10. | Infrastructure (Roads/Solar Lights etc.) |   |

| S.No | Head | Picture |
|---|---|---|
| 1. | Drinking Water Facility in nearby villages |  <br>  |
| 12. | Animal Health<br><br>(Integrated Livestock Development Centres)<br>➢ Artificial Insemination<br>➢ Fodder Multiplication Centres<br>➢ Distribution of Chaff cutters |  <br>  <br>  <br>  |

| S.No | Head | Picture |
|---|---|---|
| 13. | Initiatives for Divyang Jan<br>➢ Distribution of Tri-cycles/Artificial Limbs |  |
| 14. | Setting up of ITI at Baloda with State- of-the-Art facilities |   |
| 15. | Assistance to District Administration for COVID related initiatives |  |

8.2.7 CSR-CD Budget Expenditure

**TABLE-8.1**

**CSR EXPENDITURE FOR THE FINACIAL YEARS 2020 to 2023**

| **CSR expenditure for the FY 2020-21** | | |
|---|---|---|
| **Sr No.** | **Heads** | **Amount (Rs in Lakhs)** |
| | | |
| 1 | Animal Health | 23.69 |
| 2 | Art and Culture | 1.82 |
| 3 | Covid | 78.61 |
| 4 | Education | 172.14 |
| 5 | Health | 7.1 |
| 6 | Infrastructure | 33.85 |
| 7 | Others (Misc) | 0.7 |
| 8 | Roads | 44.99 |
| 9 | Sanitation | 4.63 |
| 10 | Vocational Training | 30.74 |
| 11 | Water | 23.4 |
| | **Total (Rs in Lakhs approx.)** | **421.67** |
| | | |
| **CSR expenditure for the FY 2021-22** | | |
| **Sl No.** | **Heads** | **Amount (Rs in Lakhs)** |
| | | |
| 1 | Animal Health | 7.91 |
| 2 | Art and Culture | 22.66 |
| 3 | Covid | 45.49 |
| 4 | Education | 58.82 |
| 5 | Health | 51.34 |
| 6 | Infrastructure | 43.87 |
| 7 | Others (Misc) | 5.46 |
| 8 | Physically Challenged Persons | 0.05 |
| 9 | Roads | 19.68 |
| 10 | Sanitation | 112.42 |
| 11 | Sports | 18.64 |
| 12 | Vocational Training | 18.69 |
| 13 | Water | 66.9 |
| | **Total (Rs in Lakhs approx.)** | **471.93** |

| CSR expenditure for the FY 2022-23 | | |
|---|---|---|
| **Sr No.** | **Heads** | **Amount (Rs in Lakhs)** |
| | | |
| 1 | Animal Health | 25.5 |
| 2 | Art and Culture | 10.04 |
| 3 | Covid | 4.59 |
| 4 | Education | 201.5 |
| 5 | Health | 49.16 |
| 6 | Infrastructure | 37.46 |
| 7 | Others (Misc) | 9.69 |
| 8 | Physically Challenged Persons | 1.00 |
| 9 | Roads | 74.17 |
| 10 | Sanitation | 41.78 |
| 11 | Sports | 27.50 |
| 12 | Vocational Training | 13.22 |
| 13 | Water | 79.41 |
| | **Total (Rs in Lakhs approx)** | **575.02** |

On an average NTPC is incurring an expenditure of Rs. 5 Cr/Annum during last three years. This will continue during construction phase of Stage-III. After commissioning of Stage-III (after 2029-30), the above expenditure shall be enhanced to Rs.8 Cr/Annum. The details CSR activities are given in Table -8.2 & Budget for community development works are given in Table-8.3.

**TABLE-8.2**
**CSR ACTIVITIES PLANNED AFTER COMMISSIONING OF STAGE-III**

| Sr.No | Proposed Works Under CSR/CER | Estimated Annual Expenditure (in Lakhs) |
|---|---|---|
| 1 | Education infrastructure | 100 |
| 2 | Education - Improving Learning Level | 50 |
| 3 | Medical – Mobile Medical Unit and Maternal and Child Health Care | 60 |
| 4 | Sanitation | 50 |
| 5 | Water | 50 |
| 6 | Infrastructure (other than road & drains) | 150 |
| 7 | Roads (Strategic) | 100 |
| 8 | Renewables (Strategic) | 50 |
| 9 | Sports, Cultural & Arts | 50 |
| 10 | Skill Development/Livelihood Promotion | 50 |
| 11 | Differently Abled Support & Assistance | 30 |
| 12 | Need Assessment Survey / Social Impact Evaluation Survey | 10 |
| 13 | Miscellaneous | 50 |
| | Total | 800 |

The activities proposed are tentative and shall be decided in consultation with district Administration and local stakeholder based on need and requirement under the ambit of Scheduled-VII of Companies Act (2013).

**TABLE-8.3**
**BUDGET FOR COMMUNITY DEVLOPMENT WORKS FOR SIPAT STPP OF STAGE-III**

| Sr No | CD/Activities | Expenditure in (Rs. Lakhs) | Major Activities Description |
|---|---|---|---|
| 1 | Infrastructure works | 600.00 | Construction /Renovation of community center building, boundary wall, sanskritik manch, community market sheds, parking shed, cremation Ghat etc. |
| 2 | Roads | 400.00 | Strengthening of roads of PAVs and vicinity areas. |
| 3 | Sanitation | 100.00 | Construction of drain, toilets and related infrastructure in PAVs and vicinity areas. |
| 4 | Water | 100.00 | Augumentation of drinking water facilities and construction/rejuvenation of ponds in PAVs and vicinity areas. |
| 5 | Health | 200.00 | Developing health infrastructure in PAVs and vicinity areas. |
| 6 | Education | 100.00 | Devloping education infrastructure including construction/renovation of class rooms/lab/parking shed/playground/ smart class rooms/ furniture etc. PAVs and vicinity areas. |
| 7 | Welfare/Skill development | 50.00 | Skill development in villages for the youth/women for the enhancement of their employability in PAVs and vicinity areas. |
| 8 | Miscellaneous activates | 250.00 | Miscellaneous works as per need and requirement in consultation with district administration/public representatives. |
| | Total | 1800.00 | |

# Chapter-9
# Environmental Cost Benefit Analysis

# 9.0 ENVIRONMENTAL COST BENEFIT ANALYSIS

The scope of the EIA/EMP has been prescribed vide the Terms of Reference (TOR) accorded by MOEF&CC vide Letter No. F.No. J-13012/02/209-IA.I(T) dated 03.05.2019 and the TOR has been amended on 08.08.2022 and are enclosed as **Annexure-I(A) & I(B).**

As per SO 1533 dated 14th September 2006, the chapter on environmental cost benefit analysis is to be prepared if prescribed at scoping stage.

This chapter has to be carried out if specifically required as per scoping. As this is not specifically mentioned in TOR, further detail study is not carried out.

However, Stage-III units based on Ultra Super Critical (USC) technology and fitted with FGD and De NOx system to meet the new emission norms shall be a model project with minimal emission of PM, $CO_2$, $SO_2$, $NO_x$ & minimal impact on environment.

## 9.1 Environmental Benefits

FGD system will be installed to meet new emission norms and reduce the emission levels from about $SO_2$ to 100 mg/$Nm^3$. High efficiency ESP will achieve the PM emissions up to 30 mg/$Nm^3$. Extensive plantation will be carried at surrounding villages of project which will improve the ecology and conserve biodiversity of the area.

NOx emission from the steam generator shall be reduced to the applicable standard by employing:

- Low NOx Burners (LNB) which reduces the air available to the fuel stream during the devolatilization process and thus reduces NOx production;
- Combustion staging which is based on creation of fuel rich combustion zone through separation of part of secondary air which is added downstream of main combustion zone as Over Fire Air (OFA); and

## 9.2 Cost Provision for Environmental Measures

A tentative cost provision Rs.1060.74 crores has been kept towards providing environmental measures is provided in **Table-9.1**. It includes installation and construction of various pollution control equipment & systems like FGD, ESP, De-NOx system, chimney, dust extraction & suppression system, sewerage collection and treatment, afforestation & plantation and Corporate Environmental Responsibility provision etc.

## TABLE-9.1
## DETAILS OF COST PROVISION FOR ENVIRONMENTAL MEASURES

| Sr. No | Item Description* | Capital Cost (Rs. in Crores) | Recurring Cost (Rs. In Crores) |
|---|---|---|---|
| 1 | Electrostatic precipitator and FGD | 173.25 | 3.47 |
| 2 | Chimney | 54.57 | 1.09 |
| 3 | Cooling towers incl. civil works | 134.56 | 2.69 |
| 4 | Ash handling | 397.78 | 7.96 |
| 5 | Dust extraction & suppression system | 1.00 | 0.02 |
| 6 | DM plant waste treatment systems | 2.60 | 0.05 |
| 7 | Sewerage collection, treatment & disposal | 2.10 | 0.04 |
| 8 | Environmental laboratory equipment | 1.00 | 0.02 |
| 9 | Green Belt, afforestation & landscaping | 10.00 | 0.20 |
| 10 | FGD | 283.88 | 5.68 |
| **Total** | | **1060.74** | **21.21** |

*Item Descriptions & their cost provisions are tentative and may vary.

# Chapter-10
# Environment Management Plan

## 10.0 ENVIRONMENT MANAGEMENT PLAN

Environment Management Plan (EMP) describes various pollution control systems and other measures envisaged for mitigating environmental impacts identified separately for construction and operation phases. Each of the mitigation measures has been assessed with respect to:

- Adoption of state-of-the-art technological measures;
- Identification of human resources for its effective implementation;
- Allocation of financial resources for its effective implementation; and
- Effectiveness of mitigation measures.

EMP specifies various technological measures for pollution prevention, waste minimization, end-of-pipe treatment, attenuation etc. proposed to be undertaken to mitigate the adverse environmental impacts on each sector of environment during each phase of the project i.e. construction phase and operation phase.

Apart from mitigation measures, EMP also includes institutional set-up for implementation of various measures, afforestation/plantation development plan, ash utilisation plan etc.

### 10.1 Proposed Management Plan During Construction Phase

The impacts of construction activities would be temporary and will reduce gradually with the completion of the construction activities. Various mitigation measures proposed to be implemented during construction phase are given in **Table-10.1**.

**TABLE-10.1**
**PROPOSED MITIGATION MEASURES TO BE IMPLEMENTED DURING CONSTRUCTION PHASE**

| Proposed Mitigation Measures | Responsibility for Implementation | Targets to Achieve | Risks and Consequence of Failure, if any |
|---|---|---|---|
| Water sprinkling in vulnerable areas | NTPC + Contractor | Control of fugitive dust from construction areas | Increase in PM emissions |
| Proper maintenance of vehicles & construction equipment | NTPC + Contractor | Control of vehicular emissions | Increase in gaseous pollutants. |
| Transportation of construction material in covered trucks, wherever possible | NTPC + Contractor | Control of fugitive dust during transportation | Increase in PM emissions |
| Proper maintenance of vehicles, equipment and machinery | Contractor | Control of ambient noise and in-plant noise levels | Increase in noise levels |
| Provision of acoustic covers/ enclosures on equipment and machinery, wherever possible | Contractor | Control of ambient and in-plant noise levels | Increase in noise levels |
| Provision of ear muffs/ | Contractor | Protection of workers | Health effects on |

| Proposed Mitigation Measures | Responsibility for Implementation | Targets to Achieve | Risks and Consequence of Failure, if any |
|---|---|---|---|
| earplugs to the workers in high noise areas and enforcement of its use | | | individual workers |
| Channelization and construction of temporary sedimentation tanks for effluents from construction area through network of drains. Construction of temporary sedimentation tanks for the effluents from construction area. | NTPC + Contractor | Control of suspended solids in effluents from construction area | Increase in total suspended solids in effluents |
| Provision of environmentally safe camping area for the migrant labourers | NTPC + Contractor | To provide clean & healthy living environment to work force | Unhealthy living conditions, spread of diseases |
| Arrangements for water supply and sanitation | NTPC + Contractor | To reduce stress on surrounding population | Stress on existing utilities, conflicts with local people |
| Disposal of surplus earth and construction debris/waste | NTPC + Contractor | Control of pollution | Air/ water pollution |
| Reclaiming of un-built area with appropriate vegetation/ landscaping | NTPC | Create a good visual environment aesthetics improvement | Unpleasant surroundings |

## 10.2 Proposed Management Plan During Operation Phase

The impacts of operation phase will be long term in nature. The various mitigation measures proposed to be implemented during operation phase of the proposed project is summarized in **Table-10.2**. The proposed mode of implementation and identification of human resources for the implementation of the same is provided in **Table-10.3**.

**TABLE-10.2**
**PROPOSED MITIGATION MEASURES TO BE IMPLEMENTED DURING OPERATION PHASE**

| Mitigation Measures Proposed | Responsibility for Implementation | Targets to Achieve | Risks and Consequence of Failure, if any |
|---|---|---|---|
| High efficiency ESPs | NTPC | To reduce the emission levels of particulate matter to 30 mg/Nm$^3$ | Increase in PM emissions |
| 150 m stack | NTPC | Wider dispersion of emitted air pollutants | Increase in ground level concentration of pollutants |
| FGD system | NTPC | To reduce the emission levels of $SO_2$ to 100 | Increase in $SO_2$ emissions |

| Mitigation Measures Proposed | Responsibility for Implementation | Targets to Achieve | Risks and Consequence of Failure, if any |
|---|---|---|---|
| | | $mg/Nm^3$ | |
| NOx emission reduction system | NTPC | To reduce the emission levels of $NO_x$ as per applicable norms | Increase in $NO_x$ emissions |
| Coal dust extraction and suppression systems | NTPC | Control of fugitive dust from coal handling plant | Increase in fugitive emissions |
| Water cover in dry areas of ash disposal site | NTPC | Control of fugitive dust from ash disposal area | Increase in fugitive emissions |
| Main plant effluent treatment plant | NTPC | Removal of suspended solids, oil and grease and neutralization of pH, to conform to regulatory standards and recycled. Plant is designed to achieve Zero Liquid Discharge (ZLD) from plant (except monsoon season). | Change in concentration / value and increase in physio chemical parameters |
| Sewage treatment plant | NTPC | Removal of suspended solids, oil and grease and organic matter to conform to regulatory standards. Treated water shall be utilized for plantation | Increase in concentration of pollutants specifically biological parameters |
| Optimization of raw water requirement | NTPC | To reduce the water consumption with dry mode ash disposal. | Increase in water consumption |
| Ash water treatment and recycle | NTPC | Removal of suspended solids for recycle of effluents into ash water system | Increase in quantity of ash (work zone) water tank overflow |
| Design of equipment | NTPC | To control noise levels to 90 dB(A) at 1 m distance | Increase in in-plant (work zone) and ambient noise levels |
| Provision of acoustic enclosures/ barriers/ shields to reduce noise | NTPC | Attenuation of noise in source receptor pathway | Increase in in-plant and ambient noise levels |
| Provision of personal protective equipment like ear plugs and ear muffs | NTPC | Protection of sensitive receptor | Health impact on workers in high noise areas |
| Dry collection of fly ash and supply of ash to entrepreneurs | NTPC | Facilitate supply of dry ash to entrepreneurs | Reduction in quantity of ash utilised |
| Ash utilisation | NTPC+ Other | Reduce land | Increased land |

| Mitigation Measures Proposed | Responsibility for Implementation | Targets to Achieve | Risks and Consequence of Failure, if any |
|---|---|---|---|
| | Entrepreneurs | requirement for ash disposal and pollution from ash disposal site | requirement |
| Disposal of unused ash | NTPC | Environmentally safe disposal of unused ash | _ |
| Disposal of gypsum from FGD | NTPC | Environmentally safe disposal | Mixing with other plant effluent. Land degradation |
| Mill rejects | NTPC | Reuse within plant/ sale to other industries for reuse | _ |
| Domestic solid waste | NTPC | Environmentally safe disposal of municipal waste from township | Air and water pollution, spread of disease vectors |
| CSR-CD/CER activities for infrastructure development, education, health, sanitation, capacity building etc. | NTPC | Socio-economic development of the vicinity area | Low standard of living and public unrest on the power plant |
| Afforestation/plantation (subject to space availability and feasibility) | NTPC | Ecosystem improvement, attenuation of air pollutants (PM, $SO_2$ and NOx) and noise in source receptor pathway | Reduction in aesthetics and living space Higher pollutants in the ambient air |
| Control of fire and explosion hazards | NTPC | Safety | Increased risk of fire and explosion |

## TABLE-10.3
## PROPOSED MODE OF IMPLEMENTATION AND IDENTIFICATION OF HUMAN RESOURCES FOR MITIGATION MEASURES FOR OPERATION PHASE

| Mitigation Measures | Mode of Implementation | Identification of Human Resources |
|---|---|---|
| **Air Environment** | | |
| High efficiency electrostatic precipitators | Integral part of main plant package | ESP maintenance group at site |
| 150 m high stack | Civil construction package | • Engg Group at Corporate office for inclusion in technical specification<br>• Operation & maintenance (O&M) group at site for construction |
| FGD system | Part of main plant package | Operation & maintenance (O&M) group at site |
| NOx emission reduction system | Part of main plant package | Operation & maintenance (O&M) group at site |
| Coal dust extraction and suppression systems | Integral part of main plant package | Coal handling group at site |

| Mitigation Measures | Mode of Implementation | Identification of Human Resources |
|---|---|---|
| Water cover over ash disposal area/ sprinklers in dry areas | Part of operation and maintenance system | Ash handling group at site |
| Reclamation of ash disposal area after abandonment | Part of operation and maintenance system | Ash handling & horticulture groups at site |
| **Water Environment** | | |
| Closed Cycle Cooling Towers | Part of Main Plant Package | O&M Group at Site |
| Main plant effluent treatment plant | Part of main plant package | O&M (Water treatment plant) group at site |
| Ash water recirculation | Part of main plant package | Ash handling group at site |
| Sewage treatment plant | Civil construction package | Township administration group at site |
| **Noise Environment** | | |
| Design of equipment | Included in technical specification | - |
| Provision of acoustic enclosures/ barriers/ shields to reduce noise | Part of main plant package | - |
| Provision of personal protective equipment's like ear plugs and ear muffs | To be provided to workers in high noise area | Safety group at site |
| **Solid Waste** | | |
| Dry fly ash collection and loading system | Part of main plant package | Ash handling group at site |
| Disposal of unused ash | Part of main plant package | Ash handling group at site |
| Ash disposal area | Civil construction package | Ash handling group at site |
| Gypsum disposal system from FGD | Part of main plant package | O & M group at site |
| Domestic solid waste | Civil package | Township administration group |
| Ash utilization | Ash utilization plan | Ash Utilization Group |
| **Socio-Economic** | | |
| CSR-CD/CER activities for infrastructure development, education, health, sanitation, capacity building etc. | Part of CSR-CD/CER | HR (CSR-CD) group at site |
| **Others** | | |
| Afforestation/plantation (subject to space availability and feasibility) | - | EMG/Horticulture group at site |
| Control of fire and explosion hazard | Part of main plant package | Safety group at site |
| Environmental lab. equipment | Part of main plant package/purchase from market | Env. management/ chemistry group at site |

### 10.2.1 Implementation Schedule of Mitigation Measures

The mitigation measures suggested above shall be implemented so as to reduce the impact on environment due to the operations of the proposed project. In order to facilitate easy implementation of mitigation measures, priority of implementation is given in **Table-10.4.**

**TABLE-10.4**
**IMPLEMENTATION SCHEDULE**

| Sr. No. | Recommendations | Time Requirement | Schedule |
|---|---|---|---|
| 1 | Air pollution control measures | Before commissioning of respective units | Immediate |
| 2 | Water pollution control | Before commissioning of the plant | Immediate |

| Sr. No. | Recommendations | Time Requirement | Schedule |
|---|---|---|---|
| | measures | | |
| 3 | Noise control measures | Along with the commissioning of the plant | Immediate |
| 4 | Ecological preservation and up gradation | Stage wise implementation | Immediate & progressive |

## 10.3 Institutional Set-Up for Environment Management

As per the present set-up, the environmental groups in NTPC have a three-tier organization structure, as given in **Table-10.5**.

**TABLE-10.5**
**ORGANISATION STRUCTURE OF NTPC FOR OVERALL ENVIRONMENT MANAGEMENT**

| | | |
|---|---|---|
| Corporate Centre | Engineering | Environmental Engineering Group |
| | Operations | Environmental Management Group |
| | | Ash Management Group |
| | | Safety |
| | Human Resources | Rehabilitation & Resettlement, CSR-CD Groups |
| | | Horticulture Group |
| | | Medical & Public Health |
| Regional Headquarters | Environmental Management | As coordinator |
| Projects | Coordinator | Environmental Management Group |
| | Operation & Maintenance | Chemistry Group |
| | | ESP maintenance Group/FGD Group/Township |
| | | Ash Utilization Group |
| | | Safety |
| | Human Resources | R&R, CSR-CD Group |
| | | Horticulture |
| | | Medical & Public Health |

The responsibility of environmental management of an operating station lies mainly with environmental management group at site, which acts as coordinator for environmental matters. This group is a nodal point for various groups at project, regional headquarters and corporate level as well as outside agencies like State Pollution Control Board, Central Pollution Control Board and Regional office of MoEF&CC. However, this group draws technical support from environmental engineering group, environmental management group and Rehabilitation & Resettlement groups at Corporate Centre. The functions of main groups are summarized in following sections.

### 10.3.1 Functions of Environmental Groups at Corporate Centre

**Environmental Engineering Group (EEG)**

- Associating in site selection for new projects with engineering services;
- EIA studies for new project sites and obtaining environmental clearances;
- Special studies relating to environmental problems;

- Interaction with MoEF&CC, State Pollution Control Boards and funding agencies for new projects;
- Provide assistance to sites in overcoming specific technical problems related to environment; and
- Implementation of NTPC Bio-diversity policy.

**Environment Management Group (EMG)**

- Coordination and monitoring with stations, regions, engineering division and other concerned agencies on all environmental matters concerning operating stations;
- Maintenance of an environment database, trend analysis of pollution monitoring data and prepare exception reports;
- Environmental audit of power stations;
- Providing operational feedback to engineering for carrying out necessary modifications in existing / future systems, overseeing implementation of modification / improvement programs;
- Providing corporate support to stations through organization of meetings on environment management, obtaining management approvals;
- Organizing training workshops, seminars etc; and
- Implementation of NTPC environment and water policies.

**Rehabilitation & Resettlement Group and CSR-CD Group**

- Socio-economic study for Project Affected Persons (PAPs) due to land acquisition activities;
- Rehabilitation and Resettlement (R&R) of PAPs for new projects (involving land acquisition activities);
- Policy review and ensuring implementation;
- Collection and collation of various statistics on R&R measures;
- Providing these statistics to various agencies;
- Need assessment survey for planning CD activities;
- Planning and approval of CSR-CD budget for operating station;
- Monitoring of CSR-CD activities;
- Finalization of the training programme in R&R, CSR-CD; and
- Implementation of CSR policy.

10.3.2 Functions of Environmental Groups at Site

**Environment Management Group (EMG) at Site**

- Obtaining consent orders from SPCB;
- Environmental monitoring;
- Analysis of environment data, reports, preparations and transmission of report to statutory authorities, Corporate Centre etc;
- Compliance with guidelines and statutory requirements;
- Coordination with statutory bodies, functional groups of the station, Corporate EMG / engineering etc;
- Interaction for evolving and implementation of modification programmes to improve the availability/efficiency of pollution control devices/systems;

- Environmental appraisal (Internal) and environmental audit; and
- Plantation and afforestation.

**Rehabilitation and Resettlement and CSR-CD Group**

- Preparation, implementation and follow-up of R&R plan;
- Preparation and implementation of CSR-CD/CER plan in consultation with state government and village development advisory committee;
- Conduct social impact evaluation study and need based assessment survey; and
- To strengthen the public image of the company in respect of social aspects and maintain good relationship with the community in the vicinity.

10.3.3 Environmental Management Group at Existing Sipat Power Plant

An Environmental Management Group (EMG) is working at existing Sipat power plant. Additional General Manager, EMG heads this group who is assisted by a Deputy General Manager (EMG) and is responsible for the performance of environmental management at the plant for the protection of environment. EMG has trained manpower, equipment's for monitoring and other environmental related activities, to ensure compliance of statutory requirements. It interacts regularly with the Chhattisgarh Environment Conservation Board (CECB) and MoEF&CC. The same group would be strengthened for the proposed Stage-III project.

## 10.4 Pollution Control and Mitigation Measures

The various environmental measures, pollution control systems and mitigation measures proposed to be adopted for the proposed expansions of Sipat STPP (1x800 MW) are as follows:

10.4.1 Air Pollution Control System

High efficiency Electrostatic precipitators (ESP) would be installed to control the emission of ash particles. The precipitators would be designed to limit the particulate emission up to 30 mg/Nm$^3$. To facilitate dispersion of emissions, a chimney of 150 m height is envisaged currently. The chimney shall be provided with personal access doors and sampling ports for continuous online monitoring along with regular manual monitoring of stack emissions. The following emission standards will be considered while design and operation of proposed plant.

**THERMAL POWER PLANTS – EMISSION STANDARDS**

| Parameter | Standards |
|---|---|
| **TPPs (units) installed before 31st December 2003*** | |
| Particulate Matter | 100 mg/Nm$^3$ |
| Sulphur Dioxide ($SO_2$) | 600 mg/Nm$^3$ (Units Smaller than 500MW capacity units) |
| | 200 mg/Nm$^3$ (for units having capacity |

| Parameter | Standards |
|---|---|
| | of 500MW and above) |
| Oxides of Nitrogen (NOx) | 600 mg/Nm$^3$ |
| Mercury (Hg) | 0.03 mg/Nm$^3$ (for units having capacity of 500MW and above) |
| | |
| **TPPs (units) installed after 1st January 2003, up to 31st December 2016*** | |
| Particulate Matter | 50 mg/Nm$^3$ |
| Sulphur Dioxide ($SO_2$) | 600 mg/Nm$^3$ (Units Smaller than 500MW capacity units) |
| | 200 mg/Nm$^3$ (for units having capacity of 500MW and above) |
| Oxides of Nitrogen (NOx) | 300 mg/Nm$^3$ |
| Mercury (Hg) | 0.03 mg/Nm$^3$ |
| | |
| **TPPs (units) to be installed from 1st January 2017**** | |
| Particulate Matter | 30 mg/Nm$^3$ |
| Sulphur Dioxide ($SO_2$) | 100 mg/Nm$^3$ |
| Oxides of Nitrogen (NOx) | 600 mg/Nm$^3$ |
| Mercury (Hg) | 0.03 mg/Nm$^3$ |

*Source: New Emission Standards vide Notification No. S.O. 3305(E) dated 07.12.2015*
**TPPs (units) shall meet the limits within two years from date of publication of this notification.*
***Includes all the TPPs (units) which have been accorded environmental clearance and are under construction".*

$SO_2$ emissions will be controlled by installing Flue Gas Desulphurization (FGD) system. NOx emission from the steam generator shall be controlled by employing low NOx burners (LNB), combustion staging and reducing NOx in the tail flue gas.

For control of fugitive dust emissions within and around the coal handling plant, dust extraction / suppression systems would be provided. Dust suppression system shall also be provided in the coal stockyard.

10.4.2 Water Pollution Control System

An effluent management scheme, consisting of collection, treatment, recirculation, recycle, disposal and reuse of effluents shall be implemented in order to optimize the make-up water requirement as well as liquid effluent generation and its recycle. The liquid effluents shall be collected and treated/ recycled as per the following design philosophy:

a. The sludge from clarifiers/tube settlers of water PT & LET plant shall be collected in a sump/pit and shall be pumped to ash slurry sump for disposal to ash dyke;
b. The waste effluents from neutralization pits of DM plant and condensate polishing plant shall be collected in the respective neutralization pits and neutralized before pumping to ash slurry sump for final disposal;

c. Coal slurry settling ponds shall be provided to remove coal particles from coal handling plant waste. Decanted water shall be recycled back for use in the coal dust suppression system;
d. To receive & treat excess storm water (considering rain storm condition), clarifier feed pumps, reactor clarifier, belt filter press, clarified water transfer pumps and required chemical storage & dosing system shall also be provided;
e. The treated effluents conforming to the prescribed standards only shall be re-circulated and reused within the plant. Arrangements shall be made that plant effluents and storm water do not get mixed;
f. Service water effluents from various areas shall be separately routed to a sump. From the sump the waste service water shall be pumped up to lamella clarifier/tube settler for treatment. Treated service water shall be sent back to service water tank & ash slurry sump to the extent possible for re-use; and
g. Treated effluents (if any) shall be collected in Central Monitoring Basin (CMB) and shall be recycled & re-used after clarification as mentioned above and if need be also treated for reduction of dissolved solids by means of UF & RO system for any left out effluent for probable use in DM/CW make-up.

Efficient operation of various treatment schemes shall be ensured so that the quality of treated effluent conforms to re-use requirement / prescribed by regulatory authorities. NTPC shall make efforts to achieve Zero Liquid Discharge (ZLD) of process wastewater from plant.

The sewage from plant and township shall be treated in existing sewage treatment plant. The treated effluent conforming to prescribed standards shall be utilized for plantation & horticulture to the extent possible.

### 10.4.3 Noise Pollution

The major noise generating sources are the turbines, turbo-generators, compressors, pumps, fans, coal handling plant etc. from where noise is continuously generated. Acoustic treatment, wherever required, shall be provided to control the noise level below 90 dB (A). Wherever required, the workers shall be provided with protective equipment such as ear plugs/ear muffs.
Proper acoustic enclosures in equipment, adoption of modern building design and the use of sound-absorbing materials will minimize noise and vibration from the powerhouse. Plantation will be done at available spaces, wherever feasible, to absorb noise.

### 10.4.4 Solid Waste Management

- Ash Utilization and Management

The Ministry of Environment, Forests and Climate Change (MoEF&CC) has issued a Gazette Notification dated 31-12-2021 in supersession of the Notification S.O. 763 (E), dated the 14th of September, 1999 except as respect things done before such supersession. The new notification stipulates that every coal or lignite based thermal power plant (including captive or co-generating stations or both) shall be

primarily responsible to ensure 100 per cent utilization of ash (fly ash, and bottom ash) generated by it in an eco-friendly manner.

The ash generated from coal or lignite based thermal power plants shall be utilized only for the following eco-friendly purposes, namely:

- Fly ash-based products viz. bricks, blocks, tiles, fibre cement sheets, pipes, boards, panels;
- Cement manufacturing, ready mix concrete;
- Construction of road and fly over embankment, Ash and Geo-polymer based construction material;
- Construction of dam;
- Filling up of low lying area;
- Filling of mine voids;
- Manufacturing of sintered or cold bonded ash aggregate;
- Agriculture in a controlled manner based on soil testing;
- Construction of shoreline protection structures in coastal districts.
- Export of ash to other countries.
- Any other eco-friendly purpose as notified from time to time.

Every coal or lignite based thermal power plant shall be responsible to utilize 100% ash (fly ash and bottom ash) generated during that year, however, in no case shall utilization fall below 80% in any year, and the thermal power plant shall achieve average ash utilization of 100% in a three-year cycle. 20% of ash generated in the final year of compliance cycle may be carried forward to the next cycle which shall be utilized in the next three years cycle along with the ash generated during that cycle.

Provided that the three years cycle applicable for the first time is extendable by one year for the thermal power plants where ash utilization is in the range of 60-80%, and two years where ash utilization is below 60% and for the purpose of calculation of percentage of ash utilization, the percentage quantity of utilization in the year 2021- 2022 shall be considered as per the table below:

| Utilization % of thermal power plants | First compliance Cycle to meet 100 % utilization | Second compliance cycle onwards, to meet 100 % utilization |
|---|---|---|
| >80 per cent | 3 years | 3 years |
| 60-80 per cent | 4 years | 3 years |
| <60 per cent | 5 years | 3 years |

The un-utilized accumulated ash i.e., legacy ash, which is stored before the publication of this notification, shall be utilized progressively by the thermal power plants in such a manner that the utilization of legacy ash shall be completed fully within ten years from the date of publication of this notification and this will be over and above the utilization targets prescribed for ash generation through current operations of that particular year:

Provided that the minimum quantity of legacy ash in percentages as mentioned below shall be utilized during the corresponding year and the minimum quantity of legacy ash is to be calculated based on the annual ash generation as per installed capacity of thermal power plant.

| **Year from date of publication** | **1st** | **2nd** | **3rd -10th** |
|---|---|---|---|
| Utilization of legacy ash (in % of Annual ash) | At least 20 % | At least 35 % | At least 50 % |

In order to utilize ash in these areas and also to comply the stipulations of MoEF&CC's Gazette Notification on fly ash dated 31-12-2021 and 30.12.2022 following actions would be taken up by NTPC:

- NTPC shall provide a system for 100% extraction of dry fly ash along with dedicated dry ash silos for storage of at least sixteen hours of ash based on installed capacity having separate access roads so as to ease the delivery of fly ash. Provision shall also be kept for segregation of coarse and fine ash, loading this ash to closed/ open trucks and also for loading fly ash into rail wagons. This will ensure availability of dry fly ash required for manufacture of Fly Ash based Portland Pozzolana Cement (FAPPC) for cement plants and Ready Mix Concrete plants.
- NTPC shall also promote, adopt and set up the ash-based product manufacturing facilities within its premises & fly ash brick thus produced shall be utilized in in-house construction works as well as for supply in the market on price.
- NTPC shall make efforts to motivate and encourage entrepreneurs to set up ash-based building products such as fly ash bricks, blocks tiles, fly ash based aggregate etc. in the vicinity of proposed power plant.
- To promote use of ash in agriculture/low lying areas/wasteland development-show case project shall be taken up in the vicinity of proposed thermal power station.
- NTPC shall make efforts with authorities of coal mines and other minerals mines for use of ash in reclamation of mines located within 300 km of proposed power station.
- All government/ private agencies responsible for construction/ design of buildings, road embankment, flyover bridges and reclamation/ development of low-lying areas within 300 km of the plant areas shall be persuaded to use ash and ash based products in compliance of MoEF&CC's Gazette Notification on fly ash.

With all the efforts mentioned above, it is expected that fly ash generated at proposed thermal power station shall be utilized in the areas of cement, concrete & building products manufacturing, road embankment construction, land development, mine filling, shoreline protection structure, agriculture etc.

The existing units (2980 MW) at Sipat produce about 51 lakh Cu M. ash per annum and present ash utilization is about 64-65%. In order to have maximum

ash utilization in various areas and also to comply the stipulations of MoEF&CC's Notification on ash utilization, following actions are being taken up by Sipat:

- Sipat have provided a system for extraction of dry fly ash along with dedicated dry ash silos having separate access roads so as to ease the delivery of fly ash. For evacuation dry fly ash in bulk, rail loading facility is being provided at Sipat.

- A pilot cum demonstration plant for manufacturing fly ash based Leight Weight Aggregate (LWA) with 50,000 MT per annum capacity is being set up at Sipat;

- For, fly ash brick manufacturing, mega brick plant with capacity approx. 3,20,000 bricks per day is operational within its premises;

- Sipat is making efforts to motivate and encourage entrepreneurs to set up ash based building products such as fly ash bricks, blocks tiles etc. in the vicinity. This is being done through organizing workshop/ users meet for potential users. For creating wide publicity, station is also giving Advertisement in newspapers, distribution of pamphlet/ booklets/ brochures etc. To promote use of ash in agriculture, kisan goshthi (farmers meet) are being organized in the vicinity;

- Ash filling in abandoned quarry and low-lying area development work is being done. Presently ash is being utilized in 6 different low lying areas development and in 4 abandoned stone quarries reclamation is being done. This will help to enhance ash utilization level at Sipat;

- A research project for manufacture of artificial sand from fly ash using geo-polymer technique through VNIT, Nagpur has been taken up. Separate bottom ash collection shall be made so as to make available bottom ash for stowing of underground mines located in the vicinity, for use of ash as drainage media in ash dyke raising & for other construction activities;

- All government/ private agencies responsible for construction/ design of buildings, road embankment, flyover bridges and reclamation/ development of low lying areas within 100 km of the plant areas are being persuaded to use ash and ash based products in compliance of MOEF&CC's Gazette Notification on fly ash;

- With all the efforts mentioned above, it is expected that fly ash generated at proposed unit shall be utilized in the areas of cement, concrete & building products manufacturing, road embankment construction, land development, agriculture etc.

The existing Ash utilization data for past 5 years is provided in **Table-10.6** & the proposed ash utilization plan is provided in **Table-10.7**

## TABLE-10.6
## ASH UTILIZATION DATA (FY 2017 – FY 2023)

| Year | FY 2018-19 | FY 2019-20 | FY 2020-21 | FY 2021-22 | FY 2021-22 | FY 2022-23 |
|---|---|---|---|---|---|---|
| Ash Generation (MT) | 4800059 | 4905238 | 5247332 | 5197660 | 4840402 | 4840403 |
| Area Development (MT) | 375533 | 14940 | 485106 | 340856 | 538894 | 538894 |
| Outside Bricks (in MT) | 316059 | 360075 | 329794 | 253626 | 270088 | 289609 |
| Own Brick plant (MT) | 6656 | 11693 | 5087 | 17701 | 19293 | 0 |
| Cement & Other Industries (MT) | 544020 | 506979 | 114427 | 68553 | 52629 | 52401 |
| Roads Construction (MT) | 109053 | 310461 | 1592712 | 679526 | 2179913 | 2179909 |
| Ash Dyke Raising (MT) | 584706 | 1049924 | 498040 | 911158 | 0 | 0 |
| Others (MT) | 441789 | 154355 | 673 | 808900 | 1816 | 1816 |
| Mines Filling (MT) | 0 | 0 | 0 | 0 | 52798 | 52797 |
| Total Ash Utilized (MT) | 2377817 | 2408429 | 3025839 | 3080320 | 3115431 | 3115426 |
| Ash Utilization (%) | 49.54 | 49.10 | 57.66 | 59.26 | 64 | 64.36 |

*Source: NTPC*

## TABLE-10.7
## ASH UTILIZATION PLAN FOR 05 YEARS

| Year | FY 2023- 24 | FY 2024-25 | FY 2025-26 | FY 2026-27 | FY 2027-28 |
|---|---|---|---|---|---|
| Ash Generation (MT) | 5145348 | 5145348 | 5145348 | 5145348 | 5145348 |
| Area Development (MT) | 862230 | 905342 | 950609 | 1235792 | 1606529 |
| Outside Bricks (MT) | 351114 | 351114 | 351114 | 421337 | 505605 |
| Own Brick plant (MT) | 20000 | 20000 | 20000 | 20000 | 20000 |
| Cement & Other Industries (MT) | 78944 | 86838 | 95522 | 124178 | 161432 |
| Roads Construction (MT) | 3705852 | 3705852 | 3705852 | 3335267 | 3001740 |
| Ash Dyke Raising (MT) | 0 | 0 | 0 | 0 | 0 |
| Others (MT) | 10000 | 11500 | 13225 | 15870 | 18251 |
| Mines Filling (MT) | 158394 | 190073 | 209080 | 271804 | 298985 |
| Total Ash Utilized (MT) | 5186534 | 5270719 | 5345402 | 5424248 | 5612541 |
| Ash Utilization (%) | 101 | 102 | 104 | 105 | 109 |

*Note on Ash Dyke Capacity at Sipat STPP*

In order to maximize the ash storage capacity within a given ash disposal area, NTPC adopts the practice of sequential raising of the ash dykes, as

shown in **Figure-10.1**. The starter dyke is constructed with natural earth while the subsequent raisings are constructed with pond ash itself. Raising with ash has double benefit – additional space is created due to excavation of ash for construction of dyke and additional space created due to new dyke.

There are three methods of ash dyke raising – upstream raising, downstream method of raising and center line method of raising. Upstream method is most commonly used in NTPC. However, as the raisings go up, the lagoon area and storage volume keeps on shrinking.

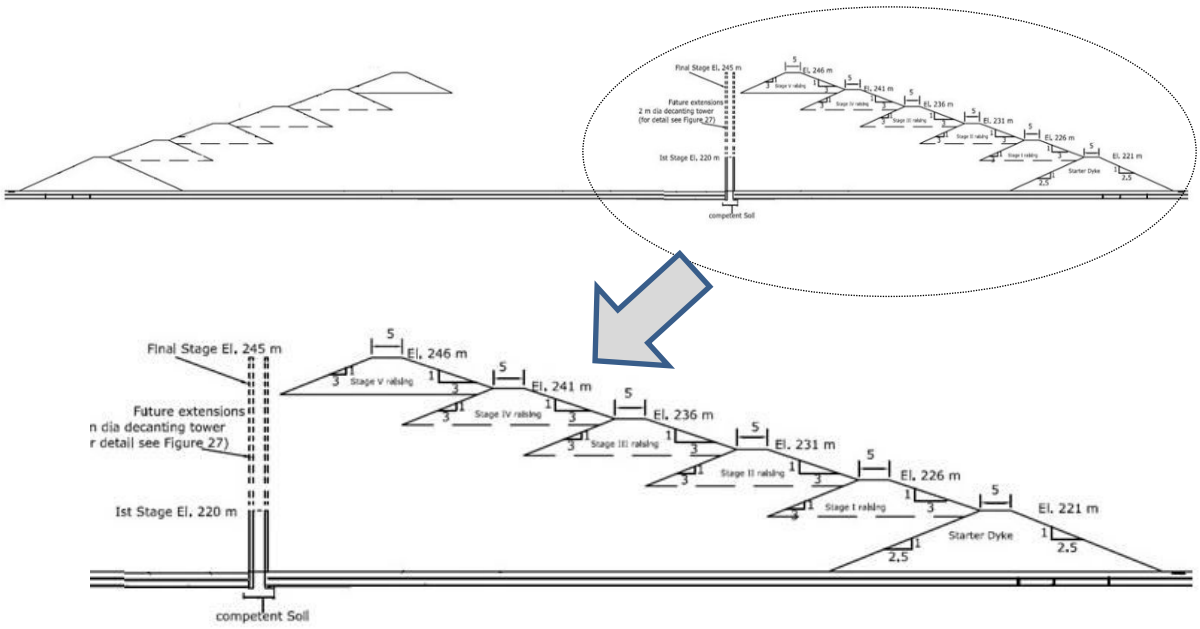



**FIGURE-10.1**
**SEQUENTIAL RAISING OF ASH DYKES**

Moreover, instead of constructing a single ash dyke over the entire area, multiple dykes are constructed to facilitate alternate filling and raising in stages. Sipat STPP has three dykes, each having a provision of three raising apart from starter dyke. The details of dykes are presented in **Table-10.1**. No additional land is envisaged for Stage-III (1x800MW). Existing ash dyke of Stage-I (Dyke-I&II) and Stage-II (Dyke-III) shall be used for ash disposal from Stage-III also. The details of existing dykes are as given in **Table-10.8.**

**TABLE-10.8**
**DETAILS OF EXISTING DYKES**

| Description | Dyke-I | Dyke-II | Dyke-III |
|---|---|---|---|
| Dyke area (Acres) | 454.67 | 366.40 | 244.86 |
| Total capacity (Up to 4th Raisings) (Lakh Cu. M.) | 293 | 207.10 | 175.50 |
| Capacity utilised till now (Lakh Cu. M.) | 179.34 | 89.09 | 123.17 |
| Balance available capacity (Lakh Cu. M.) | 113.66 | 118.01 | 52.33 |

The area and capacity of the three dykes may be summarized as follows:

- Total area of ash dykes at Sipat STPP: 970.19 Acres (Starter Dykes)
- Total capacity of ash dykes at Sipat STPP: 675.6 Lakh Cu. m. (After 4th raisings)
- Total capacity utilised = 391.6 Lakh Cu. m.
- Total balance capacity available = 284 lakh $m^3$
- Annual ash generation Stage-I &II = 51.0 Lakh $m^3$
- Annual ash utilisation = With sustained efforts 100 % ash utilization have been achieved from Dec 2022 onwards till June 2023 and Station is trying to maintain it. (AU for FY 22-23 was 64.36%)
- Annual ash disposal from Stage-I & II = 51 Lakh $m^3$
- Estimated annual Ash generation from Stage-III: 13 Lakh $m^3$

  It is evident from the above that the available dyke capacity of sufficient for ash disposal from existing as well as proposed unit-III.

➢ Gypsum Generation

Gypsum is generated from the FGD (Flue Gas Desulphurization) unit as a result of reaction of $SO_2$ with limestone slurry to remove sulphur dioxides in the stack emissions. About 600 tonnes per day, Gypsum will be generated from FGD system which shall be utilized by user industries like POP/wall board gypsum and cement industries etc.

### 10.4.5 Rainwater Harvesting

NTPC as an environmentally responsible company is working as a specific "Rain Water Harvesting Policy" of company. The rainwater harvesting will be planned as per said policy.

Groundwater Conditions in Sipat Area:

Depth to water level based on "*Groundwater year-book of Chhattisgarh, 2021-2022 and National Hydrograph stations of Sipat (pg. 104)",* the ground water level varies from 9.4 m bgl in pre-monsoon to 9.80-10.10 m bgl during post-monsoon. The maximum rising trend is observed in the Kota and followed by Sipat observation wells of Water resources department during this period. The rising trend is observed in the canal command area. Sipat STPS is located near the Right Bank Canal of Hasdeo Barrage. Stage of ground water development in Sipat Tehsil lies under 'SAFE' category.

Rainwater Harvesting in Proposed Sipat STPP

As the ground water conditions of Sipat area are good and levels of groundwater are satisfactory. There is no immediate need for recharging groundwater through rainwater harvesting. However, rainwater harvesting structures are proposed to collect rainwater at plant and reuse it in various plant use. The run-off water from the roof of the structures and paved areas will be collected through storm water

drainage system and led to rainwater harvesting structures. The final location of structures will be decided during detailed engineering of the project. The typical rainwater harvesting structure is shown in **Figure-10.2.**

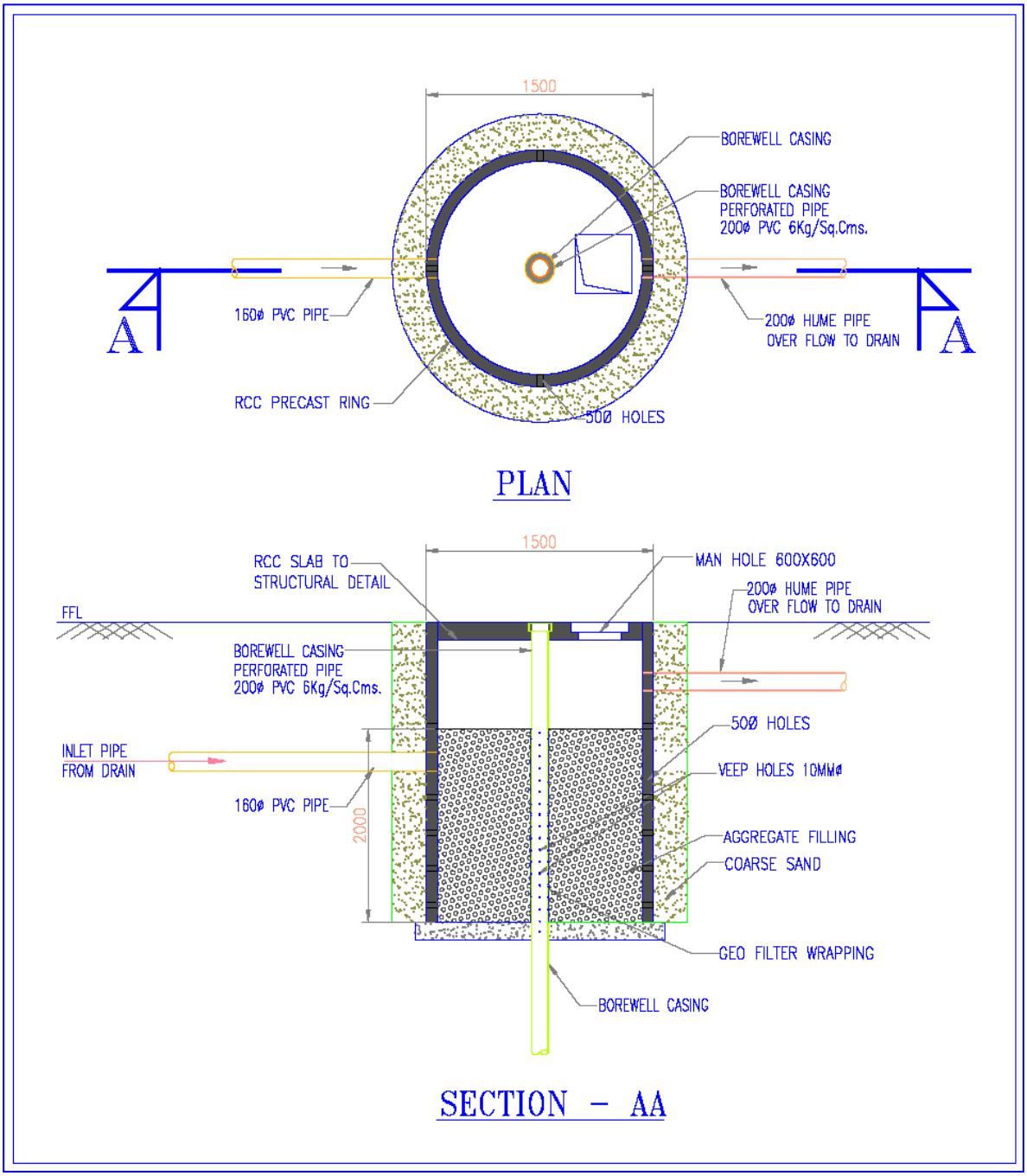



**FIGURE-10.2**
**TYPICAL GROUND RAINWATER HARVESTING STRUCTURE**

10.4.6 Rooftop Solar PV Plant (Estimated Capacity 400 kWp)

Solar PV Plant will be installed at the available on rooftop of all suitable buildings in power plant premises.

*Technical Requirements for Rooftop Solar PV Power Plant*

- Shade free Roof top area on TG building and all other buildings;
- Power evacuation system in the building; and
- Staircase and lift for carrying materials.

*Recommended Technology*

Crystalline Solar Photo Voltaic technology through solid-state device based DC-AC conversion.

*Proposed Scheme*

- Solar PV Plant on the technically suitable roof top of buildings in the premises of thermal power project to be developed under the EPC package which includes design, supply, erection, commissioning. The scope also includes one year operation and maintenance after commissioning;
- Solar PV panels are placed on the roof through mounting/supporting structure. The support structure should not disturb the water proofing of the roof;
- Approx. 15 square meter area per kW is required for roof top solar;
- Solar panel should be inclined at an techno-optimum angle facing towards south;
- The total generation is estimated to be approx. 1400 kWh per year from a solar PV roof top plant of 1 kW; and
- Lightning and earthing protection of the solar PV array
- Solar PV module cleaning system
- The Solar PV panels generates DC power which shall be converted to AC through string inverters or central inverter and shall be injected to nearest available LT/HT switchgear. Accordingly, provision of spare LT/HT module in the switchgear shall be made; and
- Metering for the purpose of monitoring of generation & internal accounting shall be done at the injection point in compliance to provisions of Central Electricity Authority (Installation and Operation of Meters) Amendment Regulations, 2013.

*Implementation Schedule*

Implementation schedule for "Roof Top Solar PV Plant" will be approximately 6 months from the Award of solar package by EPC contractor subject to availability of roofs identified in the tender documents. It will be commissioned before commercial operation of the last unit of the thermal project.

10.4.7 Construction Waste Management Plan

*Segregation and Storage of Construction Waste*

These wastes will be stored at source, i.e., at the point of generation by taking the following measures:

- Waste will be segregated the into four streams such as concrete, soil, steel, wood and plastics, bricks and mortar;
- All these wastes will be stored within the site itself. A proper screen will be provided so that the waste does not get scattered;
- The waste is segregated into different heaps as far as possible so that their further gradation and reuse is facilitated;
- Material, which can be sold will also be kept in separate heaps from those, which are to be landfilled; and
- The saleable material will be sold or reused by the agency. All debris transportation vehicles will be covered with tarpaulin sheet to prevent fugitive emissions during travelling.

10.4.8 Greenbelt/ Green cover Development Plan

*Objective*

A green belt has already been provided all around the project, covering both Stage-I and Stage-II units except switchyard side. In addition, large scale afforestation and green belt development activities shall be taken within all balance available spaces in plant and township areas. Beside this, mass plantation will be carried out at surrounding villages, after availability of district administration. The existing greenbelt details are given in **Table-10.9.** The existing greenbelt photographs are given in **Figure-10.3.**

**TABLE-10.9**
**DETAILS OF PLANTATION IN NTPC SIPAT**

| A. Plantation Details of Plant Premises | | | | | |
|---|---|---|---|---|---|
| **Sr. No** | **Year** | **Place** | **Agency** | **No. of Saplings** | **Area in Acres** |
| 1 | 2000-01 | Greenbelt area (Area-2) | CGRVVN Ltd | 50,000 | 50 |
| 2 | 2000-02 | Greenbelt (Area- 4,5 & 8) | CGRVVN Ltd | 1,00,000 | 100 |
| 3 | 2010-11 | Greenbelt | CGRVVN Ltd | 8,000 | 8 |
| 4 | 2011-12 | Greenbelt | Horticulture department | 4,000 | 4 |
| 5 | 2012-13 | Greenbelt (Area-4) | Horticulture department | 10,000 | 10 |
| 6 | 2014-15 | Greenbelt (Area-1) | Horticulture department | 1,000 | 1 |
| 7 | 2016-17 | Greenbelt (Area-1) | EMG Deptt | 850 | 0.85 |
| 8 | 2016-17 | Greenbelt (Area-7) | CGRVVN Ltd | 55,000 | 55 |
| 9 | 2017-18 | Greenbelt (Area-7) | CGRVVN Ltd, Bilaspur | 7,500 | 7.5 |
| 10 | 2017-18 | NTPC plant area | Other Dept | 1,614 | 1.614 |
| 11 | 2018-19 | Greenbelt area(Area-3) | CGRVVN Ltd, Bilaspur | 23,200 | 23.2 |
| 12 | 2018-19 | NTPC plant area | Other Department | 1,165 | 1.16 |

| | | | | | |
|---|---|---|---|---|---|
| 13 | 2019-20 | NTPC Greenbelt area | CGRVVN Ltd, Bilaspur | 7030 | 7.0 |
| | | Plant area | CGRVVN Ltd. | 822 | 0.75 |
| 14 | 2020-21 | Plant area | In-House | 2157 | 1.2 |
| 15 | 2021-22 | Plant area | In-House | 4431 | 2.0 |
| | | CISF Janji Colony | In-House | 1600 | 1.2 |
| 16 | 2022-23 | Switchyard area in plant | CGRVVN Ltd. | 7000 | 0.70 |
| | | CHP area in plant | In-House | 100 | 0.10 |
| Total plantation in plant area | | | | 2,85,469 | 261.16 |

**B. Plantation Details in Residential Area**

| Sr. No | Year | Place | Agency | No. of saplings | Area in acres |
|---|---|---|---|---|---|
| 1 | 2006-07 | CISF township, NTPC | CGRVVN Ltd | 10,000 | 10 |
| 2 | 2008-09 | NTPC township | CGRVVN Ltd | 15,000 | 15 |
| 3 | 2009-10 | NTPC township | Horticulture Dept, NTPC | 5,000 | 5 |
| 4 | 2011-12 | NTPC township | Horticulture Dept, NTPC | 1,500 | 1.5 |
| 5 | 2014-15 | NTPC township | Horticulture Dept, NTPC | 2580 | 2.58 |
| 6 | 2015-16 | NTPC township | Horticulture Dept, NTPC | 953 | 0.95 |
| 7 | 2016-17 | NTPC township | Horticulture Dept, NTPC | 2167 | 2.16 |
| 8 | 2017-18 | NTPC township | Horticulture Dept, NTPC | 479 | 0.479 |
| 9 | 2018-19 | NTPC township | Horticulture Dept, NTPC | 1180 | 1.18 |
| 10 | 2022-23 | NTPC township | Horticulture Dept, NTPC | 200 | 0.25 |
| Total plantation in residential area | | | | 39,059 | 38.85 |

**C. Plantation Details along MGR tracks**

| Sr. No | Year | Place | Agency | No. of saplings | Area in acres |
|---|---|---|---|---|---|
| 1 | 2018-19 | NTPC MGR track | CGRVVN Ltd | 23,918 | 5 km track length |
| | 2019-20 | NTPC MGR track | CGRVVN Ltd | 25,000 | 5 Km track length |
| | 2022-23 | NTPC MGR track | CGRVVN Ltd | 11,500 | 3 km track length |
| | | | | 60,418 | |

**D. Plantation Details of Ash Dyke Area**

| Sr. No | Year | Place | Agency | No. of saplings | Area covered, Acres |
|---|---|---|---|---|---|
| 1 | 2016-17 | Ash dyke area | AHP | 65 | 0.065 |
| 2 | 2018-19 | Ash dyke area | CGRVVN Ltd | 2250 | 2.25 |
| 3 | 2019-20 | Ash dyke area | CGRVVN Ltd | 5000 | 5.0 |
| 4 | 2021-22 | Ash dyke area | CGRVVN Ltd | 20000 | 20.0 |
| **Total plantation in ash dyke area** | | | | **27,315** | **27.31** |
| **Grand Total plantation in NTPC Sipat** | | | | **4,12,261** | |

The main objective of the green belt is to provide a barrier between the plant and the surrounding areas. The green belt helps to capture the fugitive emissions and to attenuate the noise generated in the plant apart from improving the aesthetics of the plant site.

As the sedimentation pattern of the pollutants, ambient and ground level concentration of pollutants are usually determined by the direction and speed of prevailing wind and vertical and horizontal thermal gradients prevailing in the area, the belt of plantations will be designed accordingly. The width of the tree belt depends on the gaseous emissions, availability of land and site characteristics etc.

Geometry of planting of tree is more important in order to have effective wind break by the plantation. For an effective green belt, a mixture of tree species is necessary, and some shrubs and grasses will be inter-cropped. As far as possible, there will be no gaps in the green belt. Where opening is imperative, alignments to roads will be such that open gaps are prevented to overcome funneling action of wind.

The trees will be planted in several rows with a tree density of not less than 2500 per ha trees having 3 tiers comprising of native species, as per ha with adequate width around the plant boundary and maintained as per CPCB guidelines. The inter-spaces will be planted with grasses, bushes and hedges. Greenbelt is thus a set of rows of trees planted in such a way that they form an effective barrier between the plant and the surroundings.

*Design of Greenbelt*

As already more than 4 lakhs trees have been planted by NTPC in its project and balance of plant facilities, therefore availability of land for new green belt is limited. A suitable size greenbelt, around the plant boundary shall be developed as greenbelt and green cover as per Central Pollution Control Board, PCB/ Ministry of Environment, Forest and Climate Change (MOEF&CC), New Delhi guidelines.

The plant density of not less 2000-2500 trees per hectare choosing native species was developed and further strengthening and development of the existing greenbelt is envisaged. Beside this, dense plantation shall be carried out at nearby areas and surrounding villages of project, if land provided by District administration.

The following shall be designed and implemented as per the latest CPCB guidelines. The broad aspects to be covered are given below:

- Shrubs and trees will be planted in encircling rows around the project site;
- The short trees (<10-m height) will be planted in the first rows (towards plant side) of the green belt. The tall trees (>10 m height) will be planted in the outer rows (away from plant side);
- Planting of trees in each row will be in staggered orientation (triangular form);
- The spacing between the trees will be maintained slightly less than the normal spaces, so that the trees may grow vertically and slightly increase the effective height of the green belt.

*Plant Species for Greenbelt*

While selecting the plant species for the proposed green belt, the following points will be taken into consideration:

- Should be a fast-growing type;
- Should have a thick canopy cover;
- Should be perennially green;
- Should be preferably of native origin; and

- Should have a large leaf area index.

*Recommended species in the Greenbelt Area*

The native species will be recommended to strengthen already existing greenbelt. The recommended species for the greenbelt development are given in **Table-10.10.**

**TABLE-10.10**
**LIST OF SPECIES SHOWING HIGH AIR POLLUTION TOLERANCE INDEX (APTI)**

| Sr. No | Scientific Name | Common Name | Family | Air Pollution Tolerance Index levels |
|---|---|---|---|---|
| 1 | *Albizia lebbeck* | Siris tree | Mimosaceae | For controlling Suspended Particulate Matter (SPM), $SO_2$, NOx and Noise |
| 2 | *Alstonia scholaris* | Saptaparni | Apocynaceae | For controlling Suspended Particulate Matter (SPM), $SO_2$, NOx and Noise |
| 3 | *Acacia catechu* | Khair | Mimosaceae | For controlling Suspended Particulate Matter (SPM), $SO_2$, NOx and Noise |
| 4 | *Azadirachta indica* | Neem | Meliaceae | For controlling Suspended Particulate Matter (SPM), $SO_2$, NOx and Noise |
| 5 | *Dalbergia sissoo* | Sissoo, Shisham | Fabaceae | For controlling Suspended Particulate Matter (SPM), $SO_2$, NOx and Noise |
| 6 | *Neolamarckia cadamba* | Kadam | Rubiaceae | For controlling Suspended Particulate Matter (SPM), $SO_2$, NOx and Noise |
| 7 | *Tamarindus indica* | Imli | Ceasalpinaceae | For controlling Suspended Particulate Matter (SPM), $SO_2$, NOx and Noise |
| 8 | *Terminalia tomentosa* | Saaj | Combretaceae | For controlling Suspended Particulate Matter (SPM), $SO_2$, NOx and Noise |
| 9 | *Ficus religiosa* | Peepal | Moraceae | For controlling Suspended Particulate Matter (SPM), $SO_2$, NOx and Noise |
| 10 | *Pongamia pinnata* | Karanj | Fabaceae | For controlling Suspended Particulate Matter (SPM), $SO_2$, NOx and Noise |
| 11 | *Madhuca indica* | Mahua | Sapotaceae | For controlling Suspended Particulate Matter (SPM), $SO_2$, NOx and Noise |
| 12 | *Gmelina arborea* | Gambar Teak | Lamiaceae | For controlling Suspended Particulate Matter (SPM), $SO_2$, NOx and Noise |
| 13 | *Bauhinia racemosa* | Kanchnar | Caesalpinaceae | For controlling Suspended Particulate Matter (SPM), $SO_2$, NOx and Noise |
| 14 | *Melia dubia* | Malabar Teak | Meliaceae | For controlling Suspended Particulate Matter (SPM), $SO_2$, NOx and Noise |
| 15 | *Shorea robusta* | Sal | Dipterocarpaceae | For controlling Suspended Particulate Matter (SPM), $SO_2$, NOx and Noise |
| 16 | *Peltophorum* | CopperPod | Leguminosae | For controlling Suspended |

| Sr. No | Scientific Name | Common Name | Family | Air Pollution Tolerance Index levels |
|---|---|---|---|---|
| | *pterocarpum* | /Peltophorum | | Particulate Matter (SPM), $SO_2$, NOx and Noise |
| 17 | *Nerium oleander* | Nerium | Apocynaceae | For controlling Suspended Particulate Matter (SPM), $SO_2$, NOx and Noise as shrub.<br><br>For also controlling - For Soil binding properties between the rows and controls erosion of the soil and it is excellent shrub species for greenbelt development. |
| 18 | *Vetiver zizanoides* | Vettiver | Poaceae | For soil binding properties between the rows and controls erosion of the soil. |
| 19 | *Phoenix acualis* | Dwarf Khajur | Areacaceae | For Soil binding properties between the rows and controls erosion of the soil and it is excellent shrub species for greenbelt development |
| 20 | *Cyperus rotundus* | Nut Grass | Cyperaceae | For Soil binding properties between the rows and controls erosion of the soil and it is excellent shrub species for greenbelt development |

All the above-mentioned species are ideally suited for the ecological habitat of tropical dry deciduous forests of Raigarh region, and they are all fast growing species, ideal for undertaking greenbelt plantations. The choosing of the species should be ratified by the Horticulturist of the project site and local forest department.

Their planting should be interspersed with each other to create mixed canopy of the plants and the ideal stance for planting all trees except *Ficus religiosa* is 3 X 3 m, for *Ficus* sp it is 5 X 5 m.

As per ha ideally 2500 saplings based on the chosen spacing between 3.0 X 3.0 m or 2.0 X 2.0 m between the plants, will accommodate optimum planting diversity of the plants.

The plants should be ideally 1 to 2 years old, chosen from notified social forest nurseries or private nurseries and care should be taken to adhere to the native and local species, avoiding as far as possible the planting of exotic species for the green belt development.

### 10.4.9 CSR/CD/CER Plan

No additional land is proposed to be acquired for the project. Hence, no R&R action plan is envisaged.

However, CSR-CD/CER activities will be carried out as per NTPC CSR &

sustainability policy in consultation with stakeholders. Detailed CSR activities undertaken by Sipat STPP are given in Chapter-8. CSR Expenditure during the year 2020-21, 2021-22 & 2022-23 are Rs.4.21 Crores, Rs.4.71 Crores & Rs.5.75 Crores respectively. Budget for Corporate Environmental Responsibility (CER) Activities shall be kept which will depend on actual capital project cost. The expenditure on CER activities shall be divided in 5 years (Project construction period).

*Monitoring of Implementation of CSR/CD/CER Plan*

The CSR activities by project will be monitored by Village Development Advisory Committee formulated by district administration for the project. The Committee has the representatives of administration, public representatives, local people including women and SC/ST representatives and project proponent. The annual social audit for the project would be carried out by NTPC during operational phase of the project.

Beside this, the CSR-CD plans is being generally monitored regularly at project, RHQ and corporate level as per the inbuilt system in place at NTPC.

### 10.4.10 House Keeping Plan

To maintain cleanliness and hygienic conditions in plant, proper housekeeping will be undertaken to care of the following:

- Regular cleaning of plant roads to avoid accumulation of dust;
- Developing a positive outlook among employees for keeping their workplace clean;
- Placing containers for collection of solid wastes and garbage at each office, plant units and residence;
- Maintaining proper storage of wastes materials;
- Maintaining hygienic conditions in canteens, drinking water source and toilets; and
- Engaging the authorized waste recyclers for recycle of waste as per statuary norms.








**FIGURE-10.3 (A)**
**EXISTING GREENBELT PHOTOGRAPHS**





**FIGURE-10.3 (B)**
**EXISTING GREENBELT PHOTOGRAPHS**

## 10.5 Cost Provision for Environmental Measures

A cost provision Rs. 1060.74 crores has been kept towards providing environmental measures and details are presented in **Table-10.11.**

**TABLE-10.11**
**DETAILS OF COST PROVISION FOR ENVIRONMENTAL MEASURES**

| Sr.No | Item Description* | Capital Cost (Rs. in Crores) |
|---|---|---|
| 1 | Electrostatic precipitator and FGD | 173.25 |
| 2 | Chimney | 54.57 |
| 3 | Cooling towers incl. civil works | 134.56 |
| 4 | Ash handling | 397.78 |
| 7 | Dust extraction & suppression system | 1.00 |
| 8 | DM plant waste treatment systems | 2.60 |
| 9 | Sewerage collection, treatment & disposal | 2.10 |
| 10 | Environmental laboratory equipment | 1.00 |
| 11 | Green Belt, afforestation & landscaping | 10.00 |
| 12 | FGD | 283.88 |
| **Total** | | **1060.74** |

*Item Descriptions & their cost provisions are tentative and may vary.
*Source: NTPC Sipat*

## 10.6 NTPC's Environmental Policy

NTPC has a well laid comprehensive Environmental Policy of NTPC published in July, 2022. The intent of this policy is to meet environmental expectations and provide actionable guidance, as NTPC strives to foster a culture of excellence and challenges itself for continual improvement. A copy of NTPC Environment Policy (2022) document is given in **Figure-10.4.**

A risk management committee comprises of members from senior functionaries of management as per provisions of Companies Act, 2016 has been constituted to establish system for reporting environment related parameters, deviations and constraints to management. Environmental risks perceived shall be reviewed through risk management mechanism for appropriate action.

Concerned group shall oversee compliance assurance of operating stations through reviews and appraisals. NTPC shall continue to identify all stakeholders and engage with them at appropriate levels, to exchange views on environmental concerns and mitigation measures thereof.

# Environment Policy-2022

## I. Purpose:

NTPC being the country's largest power generator, with its presence across the energy value chain, recognizes that protection of environment is essential for sustainable business.

In the context of this Policy, the definition of Environment covers all the domains of environment - physical, chemical, biological and socio- economic aspect.

NTPC hereby adopts Environment Policy-2021, superseding its earlier policy document of 2017.

The intent of this policy is to meet environmental expectations and provide actionable guidance, as NTPC strives to foster a culture of excellence and challenges itself for continual improvement.

*This document contains:*

*I. Purpose*

*II. Policy Statement*

*III. Applicability*

*IV. Principles*

*V. Institutional Framework*

*VI. Policy*

- *Stewardship*
- *Compliance & Assurance*
- *Stakeholder Engagement*
- *Capacity Building*

*VII. Review*

## II. Policy Statement:

"To provide cleaner energy by committing to the highest possible levels of performance in environmental compliance, practices and stewardship."

## III. Applicability:

This policy shall apply to all establishments of NTPC and each employee shall be made a partner in implementing the policy.

## IV. Principles:

This policy is based on the following principles:

1. Consideration of Environmental factors right from the stage of planning, design and operation of project/station to ensure that mandatory principles of conservation and sustainability are adhered to.

2. Adopting the best possible environment management practices and state-of the-art technology to minimize impact of business on Environment.

3. Adopting the latest, relevant and feasible Environmental Management Systems (EMS) at all operating stations to improve our environmental performance through more efficient use of resources and reduction of waste.

4. To commit as a responsible corporate citizen by striving to achieve and sett benchmarks not limited to statutory compliances.

5. Innovation by carrying out Research & Developmental activities, coupled with enablers leading to continual improvement.

6. Accepting accountability for all operations and expeditiously respond to any aberration.

7. Continuous monitoring and sharing of environmental indicators with stakeholders.

8. Develop each employee as an Environmental Steward by improving his/her awareness levels while soliciting their commitment.

## V. Institutional Framework:

Our three tier structure for environmental systems implementation is presented below:

1. Corporate Level Functions - Engineering, planning and monitoring

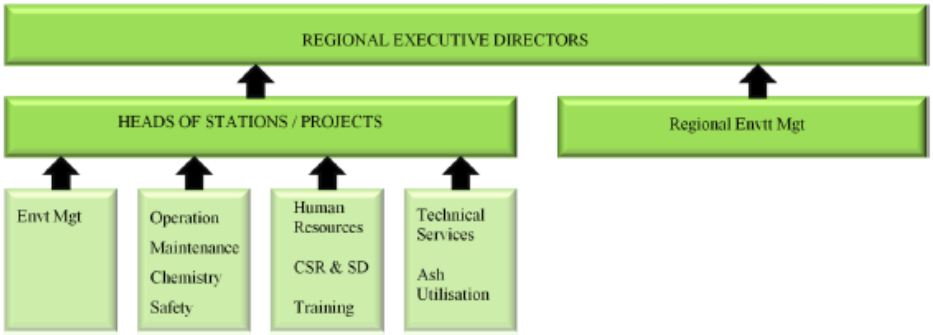
2. Regional Level Functions – Compliance monitoring, Facilitators to stations and Coordination between Stations & Corporate.

3. Stations: Functions - Execution and reporting






**FIGURE-10.4(A)**
**ENVIRONMENTAL POLICY**




Note: These charts do not reflect the organizational structure/reporting arrangement, but serve to identify responsible departments within NTPC.

## VI. Policy:

NTPC shall achieve these objectives by:

### 1. Stewardship:

NTPC shall:

a. Adopt a pro-active approach and place environmental aspects as one of the prime consideration in decision-making process.

b. Identify and manage environmental impacts due to business activities by adopting the latest environment management technologies and practices.

c. Act to manage risks, as identified by the Risk Management Committee (RMC)*.

d. Evaluate performance of our environment protection equipment, programs and practices with respect to legal provisions and prepare action plans for concerned functional groups.

e. Ensure efficient and optimal use of resources such as land, water, fuel, construction materials, oils, and chemicals etc, especially the non-renewable ones.

f. Spearhead waste management by adopting the 3Rs principle (Reduce, Re-use and Recycle) and safe disposal.

g. Adopt more environment friendly and energy-efficient inputs.



**FIGURE-10.4(B)**
**ENVIRONMENTAL POLICY**

h. Provide innovative technological solutions to environment related issues.

i. Benchmark parameters to establish and adopt best practices.

j. Take up environmentally befitting projects in areas of climate change, renewable energy, conservation and responsible consumption of natural resources under Sustainable Development initiatives.

k. Adopt principles of green procurement by incorporating appropriate provisions in contracts and procurements.

l. To formulate and adopt separate Policies for Ash utilisation, Rehabilitation & Resettlement, Community Development – Corporate Social Responsibility and Sustainable Development.

m. Creation of carbon sink by adding green cover in and around NTPC stations.

*RMC comprises of members from senior functionaries of management as per provisions of Companies Act 2016.

2. Compliance and Assurance:

a. NTPC shall continue to comply with all relevant environmental regulations, standards and other codes of practice, by operating and maintaining the assets within the boundary of permits, consents, and licenses.

b. The RMC shall establish systems for reporting environment related parameters, deviations and constraints to management of risks. Potential environmental risks shall be reviewed through a risk management mechanism for appropriate action.

c. The concerned departments shall oversee compliance assurance of operating stations through reviews and appraisals.

d. Requirement stipulated in all obtained clearances shall be complied with, including in new establishments and expansions.

3. Stakeholder Engagement:

NTPC shall continue to identify all stakeholders and engage with them at appropriate levels, to exchange views on environmental concerns and mitigation measures thereof.



**FIGURE-10.4(C)**
**ENVIRONMENTAL POLICY**

4. Capacity Building:

a. NTPC shall ensure all employees are made environmentally aware to enable them to integrate its principles into their activities and decisions by participating in suitable trainings/skill development programmes.

b. The Environment Management Group shall come up with focused requirements (including skill training and culture building), clearly bringing out the desired objectives, audience and responsibility.

## VII. Review:

This policy shall be reviewed at opportune time, but not later than once in three years.





**FIGURE-10.4(D)**
**ENVIRONMENTAL POLICY**

## 10.7 Vision Document of Sipat STPP, Stage-III (1x 800 MW))

The vision of Sipat STPP originates from the vision of the parent company, i.e. NTPC Limited:

"TO BE THE WORLD'S LEADING POWER COMPANY,
ENERGIZING INDIA'S GROWTH."

In order to realize the above, the company has adopted the following mission:

"PROVIDE RELIABLE POWER AND RELATED SOLUTIONS
IN AN ECONOMICAL, EFFICIENT AND ENVIRONMENT
FRIENDLY MANNER, DRIVEN BY INNOVATION AND
AGILITY."

**To accomplish the above vision and mission of Company, Sipat STPP has following vision:**

"To be the world's largest and best power producer, powering India's growth"

**Sipat STPP Vision**

"To be the leading power generating station in the country."

**Sipat STPP Mission**

"Provide Reliable Power to Customers at Competitive Price
in an Environment Friendly Manner, driven by innovation
and Safety."

Established in 1975, NTPC is India's largest power company today and establishment of Sipat STPP, Stage-III (1x800 MW) is another step towards achieving the mission of NTPC. In May, 2010, NTPC became a Maharatna company, one of the few companies to be awarded this status by Govt. of India. NTPC to be a 150 GW company by 2032 with diversified fuel mix and a 600+ BU company in terms of generation.

As on 1.12.2023 the installed capacity of NTPC Group is 73,874 MW (including 15,986 MW through JVs/Subsidiaries) comprising of 51 NTPC stations (27 coal based, 7 gas based, 1 hydro, 1 small hydro, and 15 solar PV) and 39 Joint Venture/Subsidiary stations (9 coal based, 4 gas based, 8 hydro, 1 small hydro, 14 solar PV and 4 wind). Although the company has installed capacity 17% of the

total national capacity. It contributes about 24% of total power generation due to its focus on high efficiency.

NTPC Sipat has an installed capacity of 2980 MW (3x660 MW+2x500 MW). NTPC, Sipat STPP, Stage-III has been conceived as a base load coal fired power project with a capacity of 800 MW (1x800 MW). This unit is expected to be more efficient coal based Ultra Super Critical Units, which shall also help reduce the $CO_2$ intensity of power generation.

Apart from generating reliable, quality power essential for the development of national economy, establishment of Sipat STPP, Stage-III shall also help in the growth of the Western region. The vision statements of Sipat STPP Stage-III may be derived as:

| | NTPC's Vision Statement | Sipat STPP Stage-III Vision Statement |
|---|---|---|
| 1 | Provide reliable power and related solutions in an economical manner | Sustainable power generation maintaining high standards of efficiency and financial strength, over the design life (25 years) and extended life of the project through suitable Renovation and Modernization Programmes from Time to Time. |
| 2 | Efficient and environment friendly manner, driven by innovation | Use of ultra super critical technology for power generation, compliance with environmental norms and conservation of natural resources like land, water, fuel. Large scale afforestation with local species around the project as far as possible. |
| 3 | Agility | Contribution in quick growth of company and increase community development & corporate social responsibility. |

Sipat STPP Stage-III is committed to supply quality power keeping in view of a cleaner and healthier environment around the project. The existing Sipat STPP project has created milestones in CSR/CD for welfare of society. The expansion project will adopt the vision of conservation of water sources, clean and calm surroundings, sustainable economic development, and natural resource conservation. Project shall strive to achieve the milestones under Corporate Environmental Responsibility Guidelines. A continuous surveillance program on all important environmental parameters is being framed from the pre-feasibility stage with reference to the prevailing national standards.

In order to translate the visions of NTPC and Sipat STPP Stage-III into reality, following specific programmes are envisaged:

| | Sipat STPP Stage-III's Vision Statement | Sipat STPP Stage-III's Specific Programmes |
|---|---|---|
| 1 | Sustainable power generation maintaining high standards of efficiency and financial strength, over the design life (25 years) and extended life of the project through suitable Renovation and Modernization Programmes from Time to Time | 1. Timely commissioning of the project.<br>2. Operation at high PLF<br>3. Continual improvement in efficiency and PLF through efficient operation and maintenance and renovation and modernization programmes from time to time gaining extended life of the project.<br>4. Certification of Project with ISO: 9001, OSHAS-18001, & 5S. |
| 2 | Use of Ultra Super Critical technology for power generation, compliance with environmental norms and conservation of natural resources like land, water, fuel etc. | 1. Develop and establish the Ultra Super Critical Technology<br>2. Commissioning of all pollution control systems (for air pollution control, water pollution control and noise pollution control) along with the commissioning of plant.<br>3. Implementation of Ash Utilization Plan.<br>4. Implementation of Zero Liquid Discharge (ZLD) System by recycling and reuse of effluents.<br>5. Compliance with Environmental Norms and Standards.<br>6. Certification of Project with ISO: 14001.<br>7. Surveillance of all important environmental parameters on a continuous basis and apply corrective measures.<br>8. Large scale afforestation around the project as an effective mitigation mechanism. |
| 3 | Implementation of NTPC Environmental and Water Policy. | 1. Design and construction of power project considering the objectives of these policies viz. NTPC Environmental and Water Policy.<br>2. Achieve stewardship in environmental protection. |
| 4 | Community Development & Corporate Social Responsibility | • Community Development Activities in the surrounding areas.<br>• Implementation of CSR Plan for local public as per details agreed with the State Govt. and other stakeholders.<br>• Activities under Corporate Social Responsibility for improving health care, capacity building, education etc. with special focus on women empowerment, physically challenged & economically weaker section of the Society.<br>• Skill based training to local employable youth<br>• Construction of Aganwadi building/additional rooms/renovation in Govt schools, playgrounds, scholarships, labs in Govt. schools, sports etc.<br>• Construction/renovation of village roads, drains, bus stops etc.<br>• Provision of drinking water by construction of Water tanks, pipelines, bore wells etc. in nearby villages.<br>• Provision of health services through medical camps, Up-gradation of medical facilities, mobile medical van veterinary etc.<br>• Assistance for construction of Toilets and other activities under 'Swachh Bharat Abhiyan', for implementation of sanitation activity in Govt. Schools.<br>• Electrification through Solar street lights & other solar equipment.<br>• Certification of Project with SA-8000 |

# Chapter-11
# Summary and Conclusions

# 11.0 SUMMARY & CONCLUSIONS

NTPC Limited (A Govt. of India Enterprise), is the largest power generating company in India. Government of India (GoI) set it up in November, 1975 with the objective of planning, promoting and organizing integrated development of thermal power in the country. NTPC was the first public sector company to be granted "Maharatna" status. NTPC is now emerging as a well-diversified company on its way of becoming an Integrated Power Major, having entered into hydro power, coal mining, power trading, equipment manufacturing, power distribution business and renewable energy generation.

Present installed capacity of NTPC Group is 73,874 MW (including 15,986 MW through JVs/Subsidiaries) comprising of 51 NTPC stations (27 coal based, 7 gas based, 1 hydro, 1 small hydro, and 15 solar PV) and 39 Joint Venture/Subsidiary stations (9 coal based, 4 gas based, 8 hydro, 1 small hydro, 14 solar PV and 4 wind).

Apart from integrated power development in the country, NTPC always focuses on adoption of efficient and clean technologies for power generation. Starting from sub-critical 200 MW/500 MW units, NTPC has adopted super-critical & ultra super critical units of 660/800 MW capacity.

NTPC Ltd is proposing for the expansion of existing Sipat Super Critical Thermal Power Plant by addition of 1x800 MW (Stage-III) Sipat Ultra Super Critical Technology Project to existing 2980 MW generation of Stage-I (3x660 MW) and Stage-II (2x500 MW) which is located in Sipat village, Matsuri Taluk, Bilaspur District, Chhattisgarh.

## 11.1 Purpose of the Report

As per Environmental Impact Assessment (EIA) Notification dated 14$^{th}$ September, 2006, commissioning or operation of thermal power plants (≥500 MW) falls under category 'A' under project [Type-1(D)] and requires prior Environmental Clearance (EC) to be obtained from MoEF&CC before the commencement of ground activity.

In line with the said notification, online application for TOR (Form-1 & Pre-feasibility report) for EIA study was submitted to MoEF&CC on 29.01.2019 vide online proposal no. IA/CG/THE/89473/2018. The Terms of Reference (TOR) for Advanced Ultra Super Critical (AUSC) Technology Demonstration Project was accorded by MOEF&CC vide letter J-13012/02/2019-IA.I (T) dated 03.05.2019. An Amendment in TOR was accorded by MOEF&CC vide letter J-13012/02/2019-IA.I(T) dated 08.08.2022 for setup 1x800 MW Sipat Ultra Super Critical Technology Project instead of earlier proposed AUSCTDP of 1X800 MW.

Comprehensive Environmental Impact Assessment (CEIA) report addresses the environmental impacts of the proposed expansion project and the mitigation measures. This report is prepared, based on the TOR conditions received from MoEF&CC. The Comprehensive Environmental Impact Assessment report (CEIA) has been prepared based on the TOR accorded by MoEF&CC.

Vimta Labs Limited, Hyderabad, an accredited agency with Quality Council of India (QCI) / National Accreditation Board of Education and Training (NABET) vide registration no. NABET/EIA/2326/RA0301 with validity up to 26.05.2026 is assigned by NTPC to undertake an Comprehensive Environmental Impact Assessment (CEIA) study and prepare Environment Management Plan (EMP) on various environmental components, which may be affected due to the impacts arising out of the proposed expansion of thermal power plant.

The main objective of conducting Comprehensive Environmental Impact Assessment (CEIA) study is to prevent or at least to considerably reduce activities that may have important harmful effects or consequences on the environment and protected areas, thus realising the principles of sustainable development, environmental integrity and pollution prevention.

In comprehensive environmental impact assessment, the effects of the present implementation plan are evaluated on the basis of the baseline environmental status.

The Comprehensive EIA Report was prepared by M/s. Vimta Labs Ltd based on data generated from March 2019 to March 2020. However, as the data has become more than three years old, one season (March 2023 – May 2023) additional data was generated by M/s. Mantec Consultants Ltd. (Accreditation No. QCI/NABET/ENV/ACO/21/ 1727) as a part of separate work awarded by NTPC SIPAT STPP Stage-III and supplemented in EIA Report.

NTPC Sipat Ultra Super Critical Technology Project Stage-III (1x800 MW) submitted the application for public hearing to the Member Secretary, Chhattisgarh Environment Conservation Board (CECB) office on 13.07.2023. The public hearing was initially scheduled on 27.09.2023 but postponed due to unavoidable reasons and was held on 11.12.2023 at 12:00 noon.

The advertisement for initial public hearing for Sipat Ultra Super Critical Technology Project Stage-III (1x800 MW) was published in the local newspaper Haribhoomi, Bilaspur & in the main edition of the national newspaper Hindustan Times, New Delhi on 25.08.2023 & second advertisement published on 25.11.2023. Accordingly public hearing was held on 11.12.2023 at 12:00 noon at the sports ground of Madan Lal Shukla Government college, Sipat village & Tehsil, Bilaspur District, Chhattisgarh. The proceeding of public hearing and other documents were forwarded by Member Secretary, CECB vide letter no: 8409/TS/CECB/2024, dated 19.01.2024 to MoEF&CC, New Delhi.

The proceedings of public hearing and other documents like news clippings, objections/suggestion received regarding public hearing, reply of project proponent on main issues/quarries related to public hearing, proceedings of public hearing, attendance sheet, objections/suggestion received regarding public hearing in Head office, CECB, Videography are enclosed and response to point wise reply to information sort by CECB regarding public hearing, action plan are given in Addendum to EIA Report.

The objective of comprehensive environmental impact assessment is "to provide a high level of protection of the environment and to include environmental aspects in preparation and adoption of management plan in order to promote sustainable development".

## 11.2 Environmental Setting

Sipat Ultra Super Critical Technology Project, Stage-III (1x800 MW) is an expansion project to be established within the existing premises of Sipat STPS, Stage-I (3x660 MW) and Stage-II (2x500 MW). The project is located in Bilaspur district of Chhattisgarh state situated near village Sipat. The site is bounded by latitude and longitude of $22^0$07'00" N to $22^0$08'53.40" N and $82^0$16'43" E to $82^0$18' 49.37" E respectively.

The topography of the project site is plain with minor undulation. Existing ground level elevation of the proposed thermal power plant ranges from 280 m to 287 m above mean sea level and the general slope is towards north to south.

The site is approximately 20.0 km from Bilaspur city and is approachable via Bilaspur-Baloda state highway, which passes through Sipat. The nearest village is Janj village which is about 0.7 km from the project site. The nearest railway station is Jairam Nagar which is about 3.0 km from the project site. The nearest commercial airport, Raipur is about 150 km from the project site.

The nearest reserve forests from the project site are Bitkuli (Sonathi Pahar) Reserved Forest (3.7 km, NE), Dalha Protected Forest (7.0 km, ESE). The nearest water bodies from the project site are Kurung left canal (adjacent to west side boundary), Lilagarh nadi (3.0 km, E), Kurung nadi (3.5 km, W) and Arpa nadi (8.8 km, SW). There is no national park, no wildlife sanctuary located within 10 km of radius of plant site.

About 160 acres of industrial land is available for locating the unit within the vacant space in the MGR bulb. The land in existing ash dyke is sufficient to accommodate the ash for additional 800 MW unit. Existing Sipat STPS, has already established a dedicated township. Additional quarters/facilities shall be constructed to accommodate staff of Stage-III. No additional land is proposed to be acquired for the project. The study area showing 10 km radius is shown in **Figure-11.1.**

## 11.3 Brief Description of Project

### 11.3.1 Nature of the Project

Sipat Ultra Super Critical Technology Project, Stage-III will be a pulverised coal fired thermal power project based on ultra-super critical boiler parameters. The proposal involves construction and operation of one unit of 800 MW. The main components of the project include:

- Steam generator, turbine generator and auxiliary units;
- Coal handling system including dust extraction and suppression system;
- Closed cycle cooling system with cooling towers;

- Water & effluent treatment system;
- Fire protection system;
- Air conditioning & ventilation system;
- Electrostatic precipitators, NOx control and Flue Gas Desulphurisation (FGD) system;
- Chimney;
- Limestone and gypsum storage and disposal facilities;
- Ash handling system with dry ash extraction and wet mix system, storage and disposal facilities; and
- Electrical Systems: Generator bus duct, transformers, switchgears, switch yard etc.

## 11.4 Salient Features

The salient features of the proposed expansion of Sipat Ultra Super Critical Technology Project Stage-III (1x800MW) are given in **Table-11.1.**

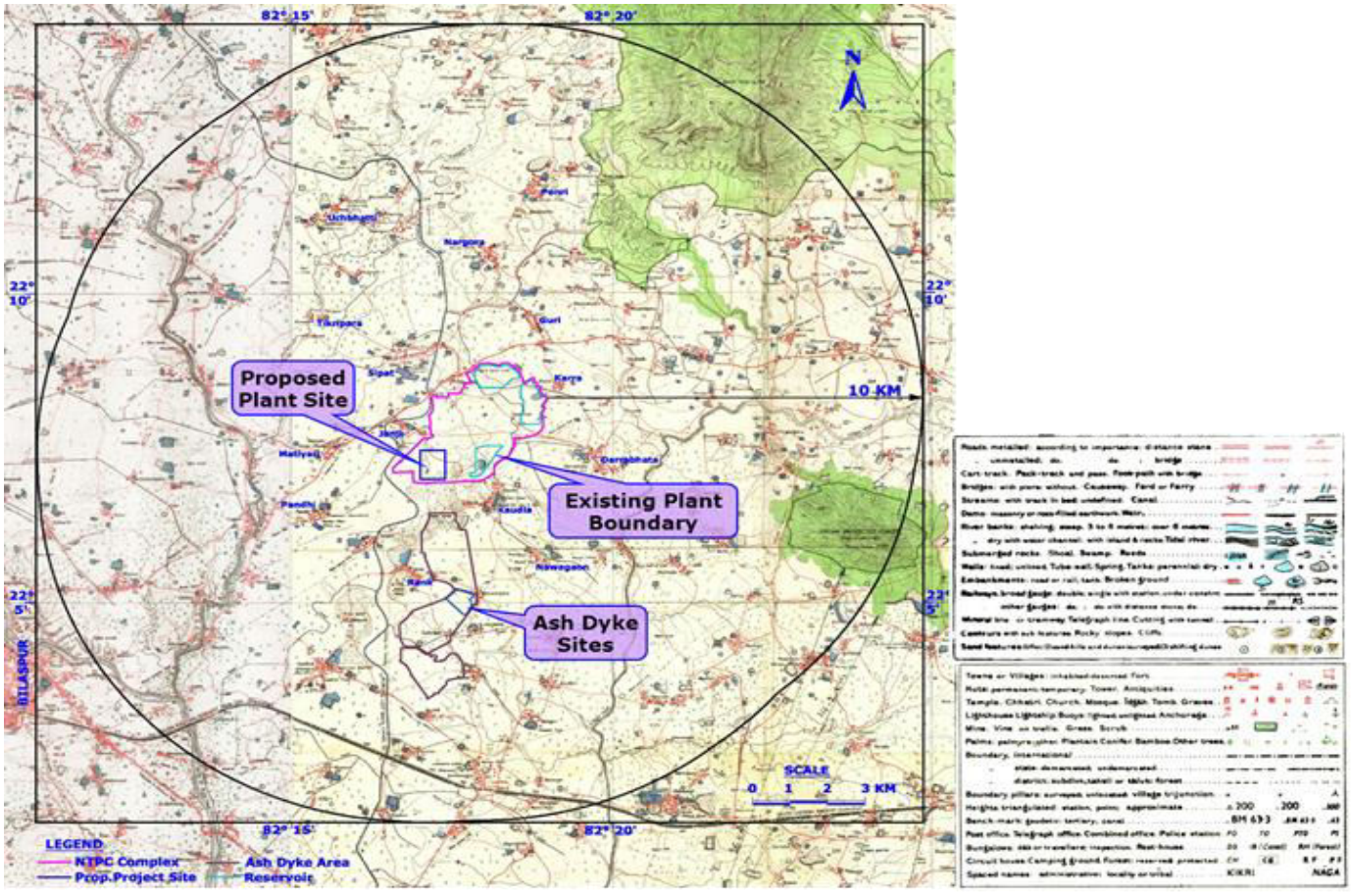



**FIGURE-11.1**
**STUDY AREA MAP (10 KM RADIUS)**

**TABLE-11.1**
**SALIENT FEATURES OF PROPOSED EXPANSION OF STPP PROJECT**

| Sr. No. | Particulars | Details |
|---|---|---|
| 1 | Stage- I<br>Stage- II<br><br><br>Stage-III | **Under Operation**<br>Stage-I: 1980 MW (3 x 660 MW) (Super Critical)<br>Stage-II: 1000 MW (2 x 500 MW) (Sub Critical)<br>**Proposed Expansion**<br>Stage-III: 800 MW (1x800 MW) (Ultra Super Critical) |
| 2 | Technology | Ultra Super Critical (USC) |
| 3 | Total area of the plant | 160 acres of land within the vacant space in MGR bulb.<br><br>No additional land is proposed to be acquired. |
| 4 | Fuel | Coal |
| A | Source of fuel | SLC (LT) in its meeting held on 21.02.2023 has recommended grant of coal linkage to Sipat-III (1x800 MW). |
| B | Fuel transportation | MGR/IR |
| C | Average fuel requirement (Coal) | 3.25 MTPA with 85 % PLF |
| D | Gross calorific value | 4000 Kcal/kg |
| E | Ash content | 39 % (Max) |
| F | Sulphur content | 0.36 % (Max) |
| 5 | Ash generation<br>Fly ash<br>Bottom ash<br>Total ash | <br>1.04 MTPA<br>0.26 MTPA<br>1.30 MTPA |
| 6 | Water requirement and its source | The water requirement will be about 2340 $m^3$/hr with ash water recirculation, which is proposed to be drawn from the Right Bank Canal (RBC) originating from Hasdeo barrage pondage.<br><br>No additional water commitment is required for the expansion project. The water requirement for Stage-II unit will be met from the available committed quantity of 120 MCM from WRD, Govt. of Chhattisgarh accorded vide letter dated 26.11.2001 for Sipat STPS. Water Allocation reduced to 93 MCM from 120 MCM vide letter dated 31.03.2018. Surplus water available is 23 Cusec which will be adequate for meeting the water requirements of Sipat Ultra Super Critical Technology Project Stage-III. |

| Sr. No. | Particulars | Details |
|---|---|---|
| 7 | Cooling system | Closed cycle cooling system with cooling towers |
| 8 | Power requirement and its source | Two number of 11 KV feeder shall be provided from existing 11 KV switchgear of Sipat STPP to meet the construction power requirement. |
| 9 | Power evacuation | 765 KV with appropriate transmission utility |
| 10 | Discharge | Zero Liquid Discharge (ZLD) System |
| 11 | Wastewater treatment | ETP & STP |
| 12 | Fire fighting system | Adequate firefighting systems as per Tariff Advisory Committee (TAC) and OISD guidelines will be provided |
| 13 | Project cost | Rs. 7,360.11 crores |
| 14 | Emission Norms to be followed | Proposed unit shall comply with the latest emission norms notified vide MoEF&CC Notification dated 07.12.2015 and its amendments. |

*Source: NTPC*

## 11.5 Resource Requirement

- *Land Requirement*

No additional land is proposed to be acquired for the project. The total land acquired under Stage-I & II is 4369 acres. Out of this, about 160 acres of land is available for locating the unit within the vacant space in the MGR bulb. One double lane Road Under Bridge (RUB) and four-lane road with a level crossing are available for access to this area. To transport the machinery and material up to proposed site a Road Over bridge (ROB) is proposed.

This space is adequate for locating the BTG & BOP facilities of 1x800 MW Sipat Ultra Super Critical Technology Project Stage-III. Unit can be easily connected to the existing 765 kV switchyard for power evacuation. The land in existing ash dyke is sufficient to accommodate the ash for additional 800 MW unit.

Ash dykes for Sipat STPP (2980 MW) shall be used for Stage-III also and no additional land is envisaged for the same.

- *Water Requirement & its Source*

The water requirement is estimated to be about 23 cusecs which is proposed to be drawn from the Right Bank Canal (RBC) originating from Hasdeo Barrage pondage. No additional water commitment is required for the expansion project.

The water requirement for Sipat Ultra Super Critical Technology Project Stage-III unit will be met from the available committed quantity of 120 MCM (134 Cusecs) from WRD, Govt. of Chhattisgarh accorded vide letter dated

26.11.2001 for Sipat STPS. Central Water Commission (CWC) vide letter dated 02.01.2002 had given its concurrence for 120 MCM water for Sipat STPP. The water commitment was later modified to 93 MCM (104 Cusecs). However, water system of stage I & II will be optimized and saving in water will be sufficient to meet the water requirement for Sipat stage-III.

- *Coal*

  Coal requirement for 800 MW Sipat STPP Stage-III unit will be about 3.25 MTPA at 85% PLF. Coal from coal blocks with GCV of 4000 Kcal/Kg has been considered for FR purpose.

  SLC (LT) in its meeting held on 21.02.2023 has recommended grant of coal linkage to Sipat Ultra Super Critical Technology Project Stage-III (1x800 MW).

- *Manpower Requirement*

  The proposed expansion power plant will require skilled, semi-skilled and unskilled personal during construction and operational phase. Many of the people from neighboring villages, as found suitable will get opportunity for indirect employment during construction and operational phase. The total manpower from various agencies during construction of Stage-III would be about 2000 (during peak deployment) and during operation period is estimated to be about 150. The approximate no. of NTPC employees during construction and operation phases are 56 and 203 respectively. However, the exact numbers may vary during construction and operation phases.

- *Power Requirement & Source*

  Two number of 11 kV feeder shall be provided from existing 11 KV switchgear of Sipat STPS to meet the construction power requirement.

- *Power Evacuation System*

  Step up/power evacuation voltage of the project is 765 kV in line with all other units of exiting Sipat STPP. The issue of power evacuation of the proposed project shall be taken up with appropriate Transmission Utility (STU or CTU) as per regulatory provision. The above scheme considered presently shall be reviewed based on the finalized ATS of the project.

## 11.6 Process Description

In a thermal power plant, the chemical energy of the fuel (coal) is first converted into thermal energy (during combustion), which is then converted into mechanical energy (through a turbine) and finally into electrical energy (through a generator). It has the following steps:

- The coal is transferred from the coal handling plant by conveyor belt to the coal bunkers, from where it is fed to the pulverizing mills, which grind it to fine powder. The finely powdered coal mixed with air is then blown into the boiler by a fan where it burns like a gas.

- The process of combustion releases thermal energy from coal. The boiler walls are lined with boiler tubes containing high quality de-mineralized water (known as boiler feed water). The combustion heat is absorbed by the boiler tubes and the heat converts the boiler feed water into steam at high pressure and temperature. The steam, discharged through nozzles on the turbine blades, makes the turbine to rotate, which in turn rotates the generator coupled to the end of the turbine. Rotation of generator produces electricity, which is passed to the step-up transformer to increase its voltage so that it can be transmitted efficiently. The power is evacuated via switchyard through a transmission system.

- During combustion, the non-combustible part of coal is converted into ash. A small part of ash (about 20%) binds together to form lumps, which fall into the ash pits at the bottom of the furnace. This part of ash, known as bottom ash is water quenched, ground and then conveyed to pits for subsequent disposal to ash disposal area or sale.

- Major part of the ash (about 80%) is in fine powder form, known as fly ash, and is carried out of the boiler along with the flue gas. The flue gas, after heat recovery, is passed through the electrostatic precipitators, where the ash is trapped by electrodes charged with high voltage electricity.

- The flue gases exiting from the Electrostatic Precipitators (ESPs) shall be treated in Flue Gas Desulphurisation (FGD) system and discharged through a tall chimney for wider dispersal of remaining ash particles and gases. Suitable system for control of NOx shall also be established. The ash collected in the ESP hoppers is extracted in dry form and conveyed to dry ash storage silos from where it is supplied to user industries.

- Any unused part of fly ash is mixed with water and conveyed to ash disposal area in a slurry form.

  The steam, after passing through the turbines, is condensed back into water in condensers and the same is re-used as a boiler feed water for making steam. The reasons for condensing and reusing the steam are following:

- The cost of boiler feed water is very high as it is very pure demineralised water hence reuse is economical.

- The use of condenser lowers the temperature at the exit end and hence increases the efficiency of the turbine.

- The condenser contains tubes through which cold water is constantly pumped. The steam passing around the tubes of condenser loses heat and condenses as water. During this process, the steam gets cooled while cooling water gets heated up (by about 10$^{o}$C). This hot water is cooled in a cooling tower and recycled for cooling.

  However, in order to control dissolved solids, a certain amount of blow down is required from the cooling towers, which is used in the plant for other usages such as service water, coal dust suppression etc.

## 11.7 Baseline Environmental Status

The baseline data monitoring studies have been carried out for one year from 20th March 2019 to 19th March 2020, covering all the seasons i.e post-monsoon season, winter season, pre-monsoon season and monsoon season.

As the baseline data generation has become more than three years old, a fresh baseline monitoring was undertaken by NTPC through MANTEC Consultants Pvt. Ltd. (QCI Accredited EIA Consultant at S.No.162 as per List of Accredited consultant Organizations / Rev.24 / July 05, 2022. NABET Accredited EIA Consultant, MoEF&CC and NABL approved Laboratory) during Pre-monsoon season (March to May 2023).

### 11.7.1 Meteorology

The meteorological parameters were recorded on hourly basis during the study period and comprises of parameters like wind speed, wind direction (from 0 to 360 degrees), temperature, relative humidity, atmospheric pressure, rainfall and cloud cover. The meteorological parameters have been recorded and are presented in **Table-11.2**.

**TABLE-11.2**
**SUMMARY OF THE METEOROLOGICAL DATA GENERATED AT SITE**

| Month | Temperature (°C) | | Relative Humidity (%) | | Rainfall (mm) |
|---|---|---|---|---|---|
| | Max | Min | Max | Min | |
| **Pre-Monsoon Season** | | | | | |
| March, 2019 | 43.1 | 16.5 | 52 | 37 | 0 |
| April, 2019 | 45.2 | 22.0 | 49 | 33 | 0 |
| May, 2019 | 46.2 | 24.9 | 54 | 38 | 0 |
| **Range** | **16.5-46.2** | | **33.0-54.0** | | **0** |
| **Monsoon Season** | | | | | |
| June, 2019 | 43.2 | 20.8 | 55 | 43 | 0 |
| July, 2019 | 38.6 | 19.4 | 88 | 73 | 30.6 |
| August, 2019 | 35.8 | 24.7 | 80 | 74 | 35.4 |
| September, 2019 | 35.9 | 24.5 | 82 | 75 | 98.0 |
| **Range** | **19.4-43.2** | | **43.0-88.0** | | **164.0** |
| **Post-Monsoon Season** | | | | | |
| October , 2019 | 36.9 | 19.2 | 73 | 62 | 40.2 |
| November 2019 | 30.1 | 14.5 | 65 | 56 | 6.5 |
| **Range** | **14.5-36.9** | | **56.0-73.0** | | **46.7** |
| **Winter Season** | | | | | |
| December 2019 | 30.9 | 23.5 | 80 | 73 | 28.0 |
| January 2020 | 28.9 | 18.2 | 75 | 61 | 20.2 |
| February 2020 | 35.1 | 13.5 | 66 | 55 | 5.5 |

| Month | Temperature ($^0$C) | | Relative Humidity (%) | | Rainfall (mm) |
|---|---|---|---|---|---|
| | Max | Min | Max | Min | |
| **Range** | **13.5-35.1** | | **55.0-80.0** | | **53.7** |
| | | | | | |
| **Pre-Monsoon Season carried out by MANTEC Consultancy** | | | | | |
| March, 2023 | 39.2 | 17.4 | 85 | 39 | 22.2 |
| April, 2023 | 43.6 | 18.8 | 84 | 42 | 41 |
| May, 2023 | 44.6 | 18.9 | 86 | 37 | 0 |
| **Range** | **17.4-44.6** | | **37.0-86.0** | | **63.2** |

The maximum and minimum temperatures recorded at site during study period were 46.2 $^0$C and 13.5 $^0$C. The relative humidity was observed to range from 33 % – 88 % during the study period. Predominant winds are mostly from W followed by WSW. Calm conditions prevailed for 9.6 % of the total time.

11.7.2 Ambient Air Quality

Ten ambient air quality locations were monitored in and around project site.

***Observations of AAQ Data (20th March 2019 - 19th March 2020)***

***Pre-Monsoon Season***

The minimum and maximum concentrations for $PM_{10}$ were recorded as 33.2 $\mu g/m^3$ and 66.9 $\mu g/m^3$. The minimum and maximum concentrations for $PM_{2.5}$ were recorded as 17.4 $\mu g/m^3$ and 39.0 $\mu g/m^3$.

The minimum and maximum concentrations for $SO_2$ were recorded as 8.1 $\mu g/m^3$ and 19.0 $\mu g/m^3$. The minimum and maximum concentrations for $NO_2$ were recorded as 10.9 $\mu g/m^3$ and 21.2 $\mu g/m^3$. The minimum and maximum CO concentrations were recorded as 151 $\mu g/m^3$ and 299 $\mu g/m^3$.

The concentrations of $PM_{2.5}$, $PM_{10}$, $SO_2$, $NO_2$, $O_3$, CO, $NH_3$, Pb, BaP, Hg, As, Ni and $C_6H_6$ are observed to be well within the NAAQ standards prescribed by Central Pollution Control Board (CPCB) for industrial and rural /residential zone.

***Monsoon Season***

The minimum and maximum concentrations for $PM_{10}$ were recorded as 20.0 $\mu g/m^3$ and 54.5 $\mu g/m^3$. The minimum and maximum concentrations for $PM_{2.5}$ were recorded as 16.0 $\mu g/m^3$ and 29.9 $\mu g/m^3$.

The minimum and maximum $SO_2$ concentrations were recorded as 8.8 $\mu g/m^3$ and 16.9 $\mu g/m^3$. The minimum and maximum $NO_2$ concentrations were recorded as

10.8 μg/m$^3$ and 17.5 μg/m$^3$. The minimum and maximum CO concentrations were recorded as 111 μg/m$^3$ and 269 μg/m$^3$.

The concentrations of $PM_{2.5}$, $PM_{10}$, $SO_2$, $NO_2$, $O_3$, CO, $NH_3$, Pb, BaP, Hg, As, Ni and $C_6H_6$ are observed to be well within the NAAQ standards prescribed by Central Pollution Control Board (CPCB) for industrial and rural /residential zone.

***Post Monsoon Season***

The minimum and maximum concentrations for $PM_{10}$ were recorded as 32.3 μg/m$^3$ and 63.7 μg/m$^3$. The minimum and maximum concentrations for $PM_{2.5}$ were recorded as 19.3 μg/m$^3$ and 31.1 μg/m$^3$.

The minimum and maximum $SO_2$ concentrations were recorded as 10.3 μg/m$^3$ and 19.3 μg/m$^3$. The minimum and maximum $NO_2$ concentrations were recorded as 12.4 μg/m$^3$ and 24.7 μg/m$^3$. The minimum and maximum CO concentrations were recorded as 147 μg/m$^3$ and 297 μg/m$^3$.

The concentrations of $PM_{2.5}$, $PM_{10}$, $SO_2$, $NO_2$, $O_3$, CO, $NH_3$, Pb, BaP, Hg, As, Ni and $C_6H_6$ are observed to be well within the NAAQ standards prescribed by Central Pollution Control Board (CPCB) for industrial and rural /residential zone.

***Winter Season***

The minimum and maximum concentrations for $PM_{10}$ were recorded as 31.9 μg/m$^3$ and 66.6 μg/m$^3$. The minimum and maximum concentrations for $PM_{2.5}$ were recorded as 20.6 μg/m$^3$ and 36.2 μg/m$^3$.

The minimum and maximum $SO_2$ concentrations were recorded as 11.4 μg/m$^3$ and 21.1 μg/m$^3$. The minimum and maximum $NO_2$ concentrations were recorded as 13.5 μg/m$^3$ and 26.6 μg/m$^3$. The minimum and maximum CO concentrations were recorded as 175 μg/m$^3$ and 359 μg/m$^3$.

The concentrations of $PM_{2.5}$, $PM_{10}$, $SO_2$, $NO_2$, $O_3$, CO, $NH_3$, Pb, BaP, Hg, As, Ni and $C_6H_6$ are observed to be well within the NAAQ standards prescribed by Central Pollution Control Board (CPCB) for industrial and rural /residential zone.

***Observations of AAQ Data (Pre-Monsoon Season-2023)***

During the monitoring period (March-May 2023), it has been observed $PM_{10}$ for all the monitoring stations is ranging from 46 to 76 μg/m$^3$. $PM_{2.5}$ for all the monitoring stations ranging from 23 to 51 μg/m$^3$. $SO_2$ for all the monitoring stations is ranging from 04 to 26 μg/m$^3$. The concentration of $NO_2$ is observed to be in the range from 12-37 μg/m$^3$.

11.7.3 Land Use

As per satellite imagery, the built-up land is 6.2 %, forest land occupies 7.7 %, agricultural land is about 68.2 %, water body is 7.4 % and remaining land is

either area available for cultivation or cultivable waste land. It can be observed that the study area is having predominantly agricultural land.

11.7.4 Soil Characteristics

- ***20th March 2019 - 19th March 2020***

**Pre-Monsoon Season**

The pH of the soil in the study area ranged from 7.16 to 8.23. The electrical conductivity was observed to be in the range of 59.6 µmhos/cm to 196.2 µmhos/cm. The nitrogen values range between 38.6 to 83.4 kg/ha. The phosphorus values range between 78.6 to 195.6 kg/ha. The potassium values range between 152.8 to 346.5 kg/ha. The chlorides were found to be in the range of 71.0 to 296 mg/kg of soil.

**Monsoon Season**

The pH of the soil in the study area ranged from 7.24 to 8.27. The electrical conductivity was observed to be in the range of 99.8 µs/cm to 205.6 µs/cm. The nitrogen values range between 48.6 to 83.6 kg/ha. The phosphorus values range between 92.6 to 196.2 kg/ha. The potassium values range between 186.5 to 302.4 kg/ha. The chlorides were found to be in the range of 108.0 to 268.0 mg/kg of soil

**Post-Monsoon Season**

The pH of the soil in the study area ranged from 7.52 to 8.19. The electrical conductivity was observed to be in the range of 104.8 µs/cm to 208.6 µs/cm. The nitrogen values range between 41.6 to 81.6 kg/ha. The phosphorus values range between 82.4 to 205.5 kg/ha. The potassium values range between 186.4 to 384.6 kg/ha. The chlorides were found to be in the range of 112 to 286.0 mg/kg of soil.

**Winter Season**

The pH of the soil in the study area ranged from 7.13 to 7.86. The electrical conductivity was observed to be in the range of 112.8 µs/cm to 212.6 µs/cm. The nitrogen values range between 41.6 to 86.4 kg/ha. The phosphorus values range between 94.6 to 216.5 kg/ha. The potassium values range between 208.6 to 376.8 kg/ha. The chlorides were found to be in the range of 102 to 294 mg/kg of soil. The analysis of soil samples does not indicate any external industrial contamination.

- ***Pre-Monsoon Season-2023***

The pH ranges between 6.42 to 7.72 indicating soils are moderately acidic to neutral. The EC ranges between 298 to 384 µmhos/cm. The nitrogen in the 15 samples in the ranges between 12.66 to 17.03 mg/100gm. The phosphorus content of soil of 15 samples ranges between 0.57 to 0.98 mg/100gm. The

Potassium content of 15 soil samples ranges between 8.11 to 10.34 mg/100gm. The CEC of the 15 samples ranges between 9.68 to 16.88 meq/100gm.

11.7.5 Water Quality

The baseline water quality status in the region is established by analysing samples at 12 locations consisting of six ground water samples and six surface water samples. The discussion on the analytical results of water samples is presented in the following sections:

- ***20th March 2019 - 19th March 2020***

***Pre-Monsoon Season***

*Surface Water Quality*

The pH value was observed to be in the range of 6.4 to 7.3. Electrical conductivity of surface water samples was observed to be in the range of 441 µS/cm to 892 µS/cm. The dissolved oxygen was observed in the range of 5.2 mg/l to 5.8 mg/l. The total hardness was found to be in the range of 135.35 mg/l to 225.18 mg/l. The chloride concentration was observed in the range of 86.2 mg/l to 205.2 mg/l and the sulphates were found to be in the range of 21.2 mg/l to 34.2 mg/l. Fluoride content was found to be in the range of 0.3 mg/l to 0.7 mg/l. Cyanides and phenolic compounds found to be below detection limits. Bacteriological studies revealed that the total coliform count is measured 1180-3640 MPN/100ml.

*Ground Water Quality*

The pH in range of 6.4 -7.4 which are with the specified standard limits of 6.5 to 8.5. Color and turbidity of the samples ranged from 2-7 Hazens and <1-5 NTU. Electrical conductivity of the samples ranged from 515-1432 µS/cm. The total hardness of the samples ranged from 160.5-386.9 mg/l.

Calcium and magnesium concentrations ranged from 31.8-86.8 mg/l and 19.2 - 42.6 mg/l. The total dissolved solids of the samples ranged from 293.7 -803.5 mg/l. Range of chlorides and sulphates concentrations at all the locations 105.4-284.6 mg/l and 14.8-82.6 mg/l. Fluoride concentration ranged from 0.4-0.7 mg/l and is found to be within the permissible limits. Nitrates are also found to be ranging in between 12.6–25.6 mg/l. Iron concentrations in ground water varied from 0.03-0.11 mg/l. Zinc levels varied from 0.02 mg/l to 0.11 mg/l. Aluminium concentration in ground water is <0.01-0.09 mg/l which are within the limits stipulated. All other metal concentrations are observed to be below detectable limits. The total coliform counts is absent in all the samples against the standard limit of 10 MPN/100 ml.

***Monsoon Season***

*Surface Water Quality*

The pH value was observed to be in the range of 6.2 to 7.6, which are well within the specified standards of 6.5 to 8.5.Electrical conductivity of surface water

samples was observed to be in the range of 475.6 µS/cm to 828.4 µS/cm. The dissolved oxygen was observed in the range of 5.0 mg/l to 5.8 mg/l. The total hardness was found to be in the range of 130 mg/l to 215.44 mg/l. The chloride concentration was observed in the range of 86.2 mg/l to 198.6 mg/l and the sulphates were found to be in the range of 20.3 mg/l to 36.4 mg/l. Fluoride content was found to be in the range of 0.3 mg/l to 0.7 mg/l. Cyanides and phenolic compounds found to be below detection limits. Bacteriological studies revealed that the total coliform count is measured 1820-3840 MPN/100ml.

*Ground Water Quality*

The pH is in range of 6.4 -7.6 which are with the specified standard limits of 6.5 to 8.5. Color and turbidity of the samples ranged from 2-6 Hazens and <1-3 NTU. Electrical conductivity of the samples ranged from 596.7-1462 µS/cm. The total hardness of the samples ranged from 169.02-837 mg/l. Calcium and magnesium concentrations ranged from 33.7-91.3 mg/l and 18.4-42.6 mg/l. The total dissolved solids of the samples ranged from 350.1 -851.7 mg/l. Range of chlorides and sulphates concentrations at all the locations 113.6-294.5 mg/l and 35.4-86.4 mg/l. Fluoride concentration ranged from 0.4-0.7 mg/l and is found to be within the permissible limits. Similarly, nitrates are also found to be ranging in between 10.4 – 26.9 mg/l. Iron concentrations in ground water varied from 0.01-0.11 mg/l. Zinc levels varied from 0.02 mg/l to 0.12 mg/l. Aluminium concentration in ground water is 0.02-0.11 mg/l which are within the limits stipulated. All other metal concentrations are observed to be below detectable limits. The total coliform counts are absent in all the samples against the standard limit of 10 MPN/100 ml.

***Post Monsoon Season***

*Surface Water Quality*

The pH value was observed to be in the range of 6.7 to 7.8, which are well within the specified standards of 6.5 to 8.5.Electrical conductivity of surface water samples was observed to be in the range of 521.4 µS/cm to 855.7 µS/cm. The dissolved oxygen was observed in the range of 5.1 mg/l to 5.6 mg/l.The total hardness was found to be in the range of 149.6 mg/l to 198.7 mg/l. The chloride concentration was observed in the range of 105.2-202.6 mg/l and the sulphates were found to be in the range of 22.8 mg/l to 37.4 mg/l. Fluoride content was found to be in the range of 0.5 mg/l to 0.7 mg/l. Cyanides and phenolic compounds found to be below detection limits. Bacteriological studies revealed that the total coliform count is measured 2060-3000 MPN/100ml.

*Ground Water Quality*

The pH is in range of 6.8 -7.7 which are with the specified standard limits of 6.5 to 8.5. Color and turbidity of the samples ranged from 2-7 Hazens and <1-3 NTU. Electrical conductivity of the samples ranged from 634.5-1411.7 µS/cm. The total hardness of the samples ranged from 188.6-364.3 mg/l. Calcium and magnesium

concentrations ranged from 40.8-79.6 mg/l and 20.8-43.2 mg/l respectively. The total dissolved solids of the samples ranged from 362.66 -808.16 mg/l. Range of chlorides and sulphates concentrations at all the locations 121.4-384.5 mg/l and 38.6-77.6 mg/l. Fluoride concentration ranged from 0.4-0.8 mg/l and is found to be within the permissible limits. Similarly, nitrates are also found to be ranging in between 9.4– 21.6 mg/l. Iron concentrations in ground water varied from 0.02-0.08 mg/l. Zinc levels varied from 0.02 mg/l to 0.14 mg/l. Aluminium concentration in ground water is 0.03-0.12 mg/l which are within the limits stipulated. All other metal concentrations are observed to be below detectable limits. The total coliform counts are absent in all the samples against the standard limit of 10 MPN/100 ml.

***Winter Season***

*Surface Water Quality*

The surface water sample analyses indicate that the pH value was observed to be in the range of 6.8 to 7.6, which are well within the specified standards of 6.5 to 8.5. Electrical conductivity of surface water samples was observed to be in the range of 516.2 µS/cm to 846.5 µS/cm. The dissolved oxygen was observed in the range of 5.1 mg/l to 5.7 mg/l. The total hardness was found to be in the range of 146.6 mg/l to 197.9 mg/l.

The chloride concentration was observed in the range of 112.6-202.6 mg/l and the sulphates were found to be in the range of 21.6 mg/l to 37.9 mg/l. Fluoride content was found to be in the range of 0.4 mg/l to 0.7 mg/l. Cyanides and phenolic compounds found to be below detection limits. Bacteriological studies revealed that the total coliform count is measured 2080-2920 MPN/100ml.

The surface water quality in the study area does not indicate any industrial contamination.

*Ground Water Quality*

The pH was observed in range of 6.8 -7.8 which are with the specified standard limits of 6.5 to 8.5. Color and turbidity of the samples ranged from 2-7 Hazens and <1 NTU. Electrical conductivity of the samples ranged from 634.5-1432.5 µS/cm. The total hardness of the samples ranged from 189.2-360.7 mg/l. Calcium and magnesium concentrations ranged from 40.8-82.8 mg/l and 20.4-40.5 mg/l. The total dissolved solids of the samples ranged from 359.8 -803.9 mg/l. Range of chlorides and sulphates concentrations at all the locations 123.6-334.2 mg/l and 37.4-78.4 mg/l. Fluoride concentration ranged from 0.4-0.7 mg/l and is found to be within the permissible limits. Nitrates are also found to be ranging in between 12.6–22.2 mg/l. Iron concentrations in ground water varied from 0.02-0.11 mg/l. Zinc levels varied from 0.03 mg/l to 0.13 mg/l. Aluminium concentration in ground water is 0.02-0.11 mg/l which are within the limits stipulated. All other metal concentrations are observed to be below detectable limits. The total coliform counts are absent in all the samples against the standard limit of 10 MPN/100 ml.

- ***Pre-Monsoon Season-2023***

*Surface Water Quality*

The analysis results of surface water samples indicate that the pH value was observed to be 7.02 to 7.62. Electrical conductivity of surface water samples was observed to be 264 to 450 µmhos/cm. The total dissolved solids were observed about 171 to 302 mg/l. Total hardness was observed in the range of 106 to 196 mg/l. Sulphates were found to be in the range of 12 to 37 mg/l and Nitrates were found to be in the range of 7.2 to 13.2 mg/l which are within the prescribed limits only. Fluoride concentration was found to be 0.12 to 0.45 mg/l at all the locations.

*Ground Water Quality*

The analysis results of ground water samples showed the pH in range of 6.64 to 7.42. Colour of the samples ranged from <5 Hazen. Electrical conductivity of the samples ranged from 646 - 1352 µmhos/cm. The Total Dissolved Solids of the samples ranged from 420 to 880 mg/l. Calcium concentrations ranged from 67.2 to 155.2 mg/l. Magnesium concentrations ranged from 21.3 – 54.4 mg/l. The Total Hardness of the samples ranged from 258 - 612 mg/l.

11.7.6 Noise Levels

The noise monitoring has been conducted for determination of noise levels at fifteen locations in the study area.

- ***20th March 2019 - 19th March 2020***

***Pre-Monsoon Season***

The day time noise levels at all the locations were ranged in between 37.9 dB(A) to 51.8 dB(A). The nighttime noise levels were ranged in between 34.9 to 48.6 dB (A).

**Monsoon Season**

The day time noise levels at all the locations were ranged in between 40.3 dB(A) to 50.0 dB(A). The night time noise levels were ranged in between 36.4 to 46.9 dB (A).

**Post-Monsoon Season**

The day time noise levels at all the locations were ranged in between 39.9 dB(A) to 49.0 dB(A). The night time noise levels were ranged in between 36.9 to 45.8 dB (A).

**Winter Season**

The day time noise levels at all the locations were ranged in between 39.2 to 49.9 dB(A). The night time noise levels were ranged in between 35.6 to 46.9 dB (A).

Noise monitoring results reveal that the ambient noise levels in all the locations are well within the limits as per NAAQS with respect to noise 14.02.2000. The higher range can be attributed to local industrial and commercial activities.

- ***Pre-Monsoon Season-2023***

The day time noise levels at all the locations were ranged in between 40.8 to 62.8 dB(A). The night time noise levels were ranged in between 35.8 to 47.2 dB (A).

11.7.7 Flora and Fauna

From the primary survey and as per forest department records and review of literature, there are no sanctuaries, national park, biosphere reserves in the study area. The study area does not have migratory corridors of any important species.

On comparison of the check list given in the Schedule-I of the Indian Wildlife Protection Act, 1972 and the list of wildlife recorded in the study area, it can be concluded that six (06) species belong to Schedule-I as per Wildlife Amendment Act, 2022 and allotted a budget of Rs.80 Lakhs for 5 years.

| Sr. No | Scientific Name | Common Name | Family | IUCN/WPA |
|---|---|---|---|---|
| 1 | *Canis aureus* | Jackal | Canidae | LC / I |
| 2 | *Felis chaus* | Wild Cat | Felidae | LC / I |
| 3 | *Ptyas mucosa* | Indian rat snake | Colubridae | LC / I |
| 4 | *Python molurus* | Indian Rock Python | Pythonidae | VU / I |
| 5 | *Varanus bengalensis* | Varanus | Varanidae | VU / I |
| 6 | *Vipera russelli* | Russel's Viper | Varanidae | LC / I |

## 11.8 Anticipated Environmental Impacts and Mitigation Measures

11.8.1 Impact on Land Use

The land selected for proposed expansion of power plant project is within the premises of Sipat STPP, which is categorized as industrial area. As no additional land is proposed to be acquired for the project, there is no impact on land use due to the proposed expansion.

There is no additional ash pond for Stage-III expansion project. The ash pond for stage-I & II will be used for Stage-III also. The present land use of the area falls under industrial category. The project site will not be having any adverse impact on the surrounding land use during the operation period.

11.8.2 Impact on Soil

The impact on soil during operation of the project could result due to deposition of residual particulate matter and gaseous emissions on the soil. The soil within the deposition zone of pollutants may undergo physico-chemical changes due to deposition of PM (ash particles) and washout of gases ($SO_2$ and $NO_2$) during the

rains. The impacts on soil due to operation of the power plant and gaseous emission are likely to be negligible as the incremental concentration of PM, $SO_2$ & $NO_2$ levels are observed within limit.

11.8.3 Impact on Air Quality

The major air pollutants from a power project are Particulate Matter (PM), $SO_2$, and $NO_2$ which are emitted continuously from the stacks (point sources), attached with coal combustion boilers. The fugitive emissions of coal dust are also contributed by coal handling activities at storage yard, wind erosion, spillages from conveyor system, pulverization etc.

Prediction of impacts on air environment has been carried out employing mathematical model based on a steady state Gaussian plume dispersion model. The incremental concentrations when superimposed over the existing maximum baseline concentrations, the resultant concentrations are observed to be within the permissible levels for residential/rural conditions.

| | **$PM_{10}$** | **$SO_2$** | | **$NO_2$** | | **Distance/ Direction** |
|---|---|---|---|---|---|---|
| | | **Without FGD** | **With FGD** | **Without Control** | **With Control** | |
| Maximum Predicted Value due to Stage-I, II & III among all scenarios | 0.89 | 36.3 | 2.99 | 15.6 | 2.99 | 2.0 km, E |
| Maximum Value Observed During March, 2019 to March, 2020 | 67.9 | 19.0 | 19.0 | 15.6 | 15.6 | |
| **Resultant Concentration** | **68.79** | **55.3** | 21.99 | 21.2 | 18.59 | |
| Maximum Value Observed During March-May, 2023 | 76 | 26 | 26 | **36.8** | 36.8 | |
| **Resultant Concentration** | **76.89** | **62.3** | 28.99 | 52.6 | 39.79 | |
| **Values as per NAAQS, 2009** | **100** | **80** | 80 | 80 | 80 | |

The mitigative measures recommended for control of air pollution in the plant are:

- Installation of ESP of efficiency more than 99.99% to limit the particulate matter (PM) concentrations below 30 mg/$Nm^3$;
- Installation of Flue Gas De-sulfurization (FGD) system;
- Combustion control for $NO_x$ (Low $NO_x$ burner/ Combustion staging);
- Provision of single flue stack of 150 m height for dispersion of gaseous emissions;
- Online flue gas monitors as well as flue gas flow rates and temperature measurement shall be provided for all stacks;
- Dust suppression and extraction system in coal handling plant;
- Provision of water sprinkling system at raw material storage yard; and
- Asphalting of the roads within the plant area.

The incremental concentrations when superimposed over the existing maximum baseline concentrations, the resultant concentrations are observed to be within the permissible levels for residential/rural conditions.

11.8.4 Impact on Water Resources

- *Water Resources*

Make up water requirement for this project would be about 2340 $m^3$/hr. Sipat STPP will abstract its entire water requirement from the Hasdeo Right Bank Canal (RBC).

Since there will be no effluent discharge from proposed project, the impact on water quality of surrounding water bodies will be insignificant.

- *Impact on Ground Water*

As no ground water is proposed to be used for plant during operation phase, there will be no impact on ground water resources during operation of the plant. Beside this, regular ground water monitoring shall be carried out nearby ash pond area.

- *Impact on Hydrology*

The storage at Hasdeo Barrage is confined within banks and therefore it shall not cause any submergence of land beyond the banks. The river carries sufficient flow during monsoon season.

Water resources department, Govt. of Chhattisgarh has already accorded commitment for Sipat STPP considering the downstream users. There is no diversion of any stream or major nalla due to proposed Sipat STPP Stage-III. It may be concluded that the withdrawal of water for Sipat STPP Stage-III, shall not cause any adverse impact on the availability of water to downstream users.

No additional ash pond is proposed for Stage-III. Efforts shall be made to maximize the utilization of ash from proposed project. The ash pond area for Stage-I&II is 970.19 acres and ash from proposed Stage-III will be disposed only in these existing ash ponds.

- *Water Pollution Mitigation Measures*

An effluent management scheme, consisting of collection, treatment, recirculation and disposal of effluents shall be implemented in order to optimize the makeup water requirement as well as liquid effluent generation. The detail of water system for the project is described as follows:

- The filter backwash water of PT plant shall be collected and recycled back to the DM clarifier;
- The sludge from clarifiers of water PT plant shall be collected in a sump/ pit and shall be pumped to bottom ash slurry sump for disposal to bottom ash dyke;
- The waste effluents from neutralization pits of DM plant and condensate polishing plant shall be collected in the respective neutralization pits and neutralized before pumping to the ash slurry sump before final disposal;

- A coal settling pond shall be provided to remove coal particles from coal handling plant waste. Decanted water shall be pumped back to the coal dust suppression system;
- Service water effluent collected from plant drains shall be led to a sump. From the sump the service water shall be pumped upto tube settler/ clarifier for treatment of suspended solids. Treated service water shall be sent back to service water tank to the extent possible for re-use;
- All the plant liquid effluents shall be mixed in Central Monitoring Basin (CMB) and finally to ETP/Recycling point;
- The plant shall have two different systems for ash disposal - conventional wet ash slurry disposal system with Ash Water Recirculation System (AWRS) for Bottom Ash and High Concentration Slurry Disposal System (HCSD) for fly ash. HSCD system will require less quantity of water and there will be no effluent from the fly ash disposal site;
- Efficient operation of various treatment schemes shall be ensured so that the quality of treated effluent from CMB conforms to relevant standards, prescribed by regulatory agencies. The treated effluents shall be recycled/reused to the existing plant water system; and
- The sewage from plant and township shall be treated in a sewage treatment plant. The treated effluent conforming to prescribed standards shall be utilized for plantation to the extent possible.

### 11.8.5 Impact of Solid Waste

Ash generated due to combustion of coal will be the main industrial/ solid waste generated from the project.

About 80% of the ash shall be generated as fly ash while 20% of the ash shall be generated as bottom ash. With average annual coal requirement of 3.34 MTPA and average 39 % (Max) ash in coal, it is estimated that about 1.3 MTPA of ash shall be generated annually.

In addition, gypsum shall be generated as solid waste from FGD system, which shall be utilized/ disposed off in an environmentally suitable manner. The details of the solid waste generated in the plant are given in **Table-11.3**.

**TABLE-11.3**
**EXPECTED SOLID WASTE FROM PROPOSED EXPANSION PROJECT**

| Sr. No. | Plant | Quantity | Mode of Disposal |
|---|---|---|---|
| 1 | **Ash generation**<br><br>Fly ash | <br><br>1.04 MTPA | Ash will be supplied to cement industries and other users. In case the ash could not be lifted, the same will be disposed in ash pond |

| Sr. No. | Plant | Quantity | Mode of Disposal |
|---|---|---|---|
| | Bottom ash<br>Total ash | 0.26 MTPA<br>1.30 MTPA | using wet disposal method. |
| 2 | Gypsum generation | 600 tonnes /day | Byproduct used by cement and other industries |

### 11.8.6 Impact on Noise Levels

The main sources of noise and vibration during operations will be:

- Delivery of equipment and raw materials by trucks;
- Transfer of coal through railway line;
- Operation of generators and turbine inside the power house; and
- Operation of various pumps, fans and motors.

Scheduling deliveries to daytime as much as possible would minimize noise generation by truck movement. Turbines, transformers, compressors, pumps, vehicles and miscellaneous equipment during plant operation, will generate noise. However, proper acoustic enclosures would be provided to control the noise level within 80 dB(A), as per the requirement of Occupational Safety and Health Administration Standard (OSHA). The predicted noise levels at the boundary due to various plant activities do not exceed 30 dB (A). Hence, there will not be any adverse impact due to the noise generation on the habitations falling on the boundary of the proposed expansion project.

Noise Pollution Mitigation Measures

In the process, various equipment's like pumps, compressors and boilers etc will generate the noise. Greenbelt, landscaping with horticulture at power block areas to reduce noise impacts is already being implemented. The recommendations to mitigate higher noise levels are:

Equipment's should be designed to conform to noise levels prescribed by regulatory authorities:

- Provision of acoustic barriers or shelters in noisy work places;
- Provision of hoods to noise generating equipments like pumps;
- Provision of thick greenbelt to attenuate the noise levels; and
- Provision of personal protective equipment (PPE) such as earplugs, earmuffs to the workers working in high noise level area.

### 11.8.7 Impacts on Socio-Economics

The requirement of unskilled and semi-skilled manpower will be met from nearby villages during construction phase. The project will also help in generation of the indirect employment apart from direct employment. There will be a positive socio-economic development for the region. There will be a general upliftment of

standard of living in the region. CSR/CER activities by proposed project will further contribute in development of area and improvement of social status of people.

## 11.9 Environmental Monitoring Program

Post project environmental monitoring is important in terms of evaluating the performance of pollution control equipment installed in the project. The sampling and analysis of the environmental attributes will be as per the guidelines of CPCB/ Chhattisgarh Environment Conversation Board (CECB). The frequency of air, noise, surface water and ground water sampling and location of sampling being as per the directives of CECB.

## 11.10 Risk Assessment and Disaster Management Plan

Risk assessment has been carried out to quantify the extent of damage and suggest recommendations for safety improvement for the proposed expansion project. Risk mitigation measures based on consequence analysis and engineering judgments are incorporated in order to improve overall system safety and mitigate the effects of major accidents.

An effective Disaster Management Plan (DMP) to mitigate the risks involved is in place for proposed expansion of power plant. This plan defines the responsibilities and resources available to respond to the different types of emergencies envisaged. Training exercises will be held to ensure that all personnel are familiar with their responsibilities and that communication links are functioning effectively.

## 11.11 Project Benefits

Proposed expansion of 1x800 MW (Stage-III) Sipat Ultra Super Critical Technology Project is a based on Ultra Super Critical technology, which is higher efficiency power generation technology with an overall benefit of conservation of resources and reduction in pollution load per unit of electricity generated.

In addition, there will be beneficial impact of proposed expansion project on the civic amenities, as corporate social responsibility various activities will be started like welfare for poor/widows/physically challenged persons, capacity building programs, sports events, assistance to government schools, scholarships will be done. For community development trainings will be provided for woman for self-employment, community toilets, drinking water facilities etc. A separate budget will be made for these activities during operation of plant. Medical camps/health awareness camp will be organized in nearby villages for the state of Chhattisgarh.

NTPC, as a responsible corporate citizen has been addressing the issue of community development through CSR in the neighborhood area of its stations, which had been impacted due to establishment of the project. The requirement of unskilled and semi-skilled manpower will be met from nearby villages during construction phase. The project will also help in generation of the indirect employment apart from direct employment. There will be a positive socio-

economic development for the region. There will be a general upliftment of standard of living in the region. CSR/CER activities by proposed project will further contribute to development of area and improvement of social status of people.

CSR activities are undertaken on major focus areas like Health & Sanitation, Drinking Water, Education, Infrastructure Development, Vocational Training Programmes & Capacity Building Initiatives, Promoting Rural Sports, Assistance to Divyang Jan, training to farmers etc.

At Sipat STPP, CSR-CD Budget Expenditure of Rs. 421.67 lakhs, Rs. 471.93 lakhs, & Rs.575.02 lakhs have been incurred in FY 2020-21, 2021-22 & 2022-23 respectively. Proposed expenditure on CSR-CD activities during the year 2023-24 is Rs.1800 lakhs. The CSR-CD Budget shall be suitably enhanced during construction and operation of Stage-III.

## 11.12 Environmental Cost

A cost provision Rs. 1060.74 crores have been kept towards providing environmental measures.

## 11.13 Conclusions

The proposed project would be significant to meet the power demand and self-reliance in power sector. The proposed expansion project would have minimal impacts on the environment. However, with proper and judicious implementation of the mitigation and environment management measures, the impacts can be further minimized and can be maintained well within the permissible limits specified by the regulatory authorities.

Thus, it can be concluded that with the strict implementation of the pollution control and mitigation measures, with proper environment management system in place the proposed expansion project will be beneficial to the society and will contribute to the economic development of the state in particular and the country in general.

# Chapter-12
# Disclosure of Consultants

# 12.0 DISCLOSURE OF CONSULTANTS ENGAGED

## 12.1 Introduction

The Comprehensive EIA Report was prepared by M/s. Vimta Labs Ltd (NABET accreditation vide certificate number NABET/AA/1922/RA 0226 which is valid upto May 27, 2023 and extended upto 22nd July 2023. And further, reaccreditation No. NABET/EIA/2326/RA 0301 validity upto 26th May 2026) based on data generated from March 2019 to March 2020.

Since, M/s. Vimta Labs Limited is suspended to present before EAC. One season's additional data from March to May 2023 was generated by M/s. Mantec Consultants Pvt. Ltd. (Accreditation No. NABET/EIA/2023/RA 0205), and validated the EIA report.

## 12.2 Mantec Consultants Pvt. Ltd., - Environmental Consultant

Mantec Consultants Pvt. Ltd., established in 1979, is a multi-disciplinary consulting firm offering infrastructural, environmental, management, technical and IT services. Our team consists of technical and management experts coming from the top echelons of various professional services. The in-house capabilities are augmented and strengthened by our panel of associates who are well known experts in their respective fields.

We provide a complete range of environmental and social impact assessment services with an expert In-house team of professionals and associates. Mantec is an ISO 9001:2015 & OHSAS certified company, having a full-fledged Environmental Laboratory duly recognized by the Ministry of Environment Forest & Climate Change (MoEF&CC) and accredited by NABL (National Accreditation Board for Testing Calibration Laboratory). We are accredited by NABET/QCI for conducting the EIA studies.

Commitment to excellence has been the company's credo since the day of its inception and forms the central emphasis in all our operations.

### 12.2.1 Services Offered

We Mantec is providing various environmental services in more than 15 industries/sectors including infrastructure, mining, irrigation, river valley projects, power plants, refineries, ports, airports, highways, residential colonies, hazardous waste sites, forestry and rural development projects etc.

List of Services Offered

- Environmental Impact Assessment Studies
- Environment Management Plans
- Social Impact Assessment Studies
- Rehabilitation and Resettlement Studies and Resettlement Action Plans
- Safety Audits & Environmental Audits

- Risk Analysis and Disaster Management Plans
- Environmental Monitoring of Air, Water, Noise, Soil, Solid and Wastes
- Environmental Monitoring of Industrial emissions, industrial effluents, ambient air etc.
- Waste Water Management Both domestic (sewage) and industrial
- Ground & Surface Water Treatment and Supply
- Design and implementation of Wastewater Treatment Plants as well as Common Effluent Treatment Plants
- Studies on River, Lake and Forest ecosystems
- Watershed and Waste land management
- Solid Waste Management including Hazardous and Biomedical Waste Management
- Oil Spill Response
- Rehabilitation of Mines
- Remote sensing and GIS survey

12.2.2 Laboratory Facilities and Equipments

Our Environmental Laboratory is recognized by MoEF&CC and Accredited by NABL. List of Lab Equipments used for various Monitoring and Analysis is provided in **Table-12.1**

**TABLE-12.1**
**LIST OF MONITORING/ANALYSIS ACTIVITY WITH LAB EQUIPMENTS**

| Monitoring & Analytical Capabilities for; | Lab Equipments |
|---|---|
| • Ambient Air<br>• Stack Gas emissions<br>• Process and work zone<br>• Indoor Air<br>• Volatile organic compounds (VOC's)<br>• PAH's in Ambient Air<br>• Hydrocarbon in Ambient Air and Stack<br>• Heavy metals in Ambient Air, water, Soil<br>• Ultimate and proximate analysis. (C.H.N.S.O)<br>• Air Modeling<br>• Drinking Water, Raw Water and Process Water Analysis<br>• ETP and STP Water Analysis<br>• Soil, Sludge and Hazardous Waste Analysis | • Dust Samplers and $PM_{2.5}$ Sampler<br>• Stack Monitoring Kit<br>• Organic Vapor Sampler<br>• Non-Dispersive Infrared Spectrophotometer (NDIR)<br>• Atomic Absorption Spectrophotometer<br>• Gas Chromatograph<br>• UV Spectrophotometer<br>• Flame Photometer<br>• Mercury Analyser<br>• COD Digester<br>• Micro meteorological Station<br>• ICP OES<br>• ORSAT<br>• CO Analyzer<br>• Bacteriological Chamber<br>• Digital Ultrasonic<br>• Multigas Analyzer |

12.2.3 Address & Contacts

**Head Office:**
805 Vishal Bhawan, 95 Nehru Place, New Delhi, 110019.
Phone: 91-11-26429293/4/5 Fax: 91-11-26842531
E-Mail: envmantec@yahoo.co.in

**Environment Division:**
D-36, Sector-VI, Noida- 210 301
Email: *mantec@vsnl.com*
Ph: 0120 – 4215804, 4215000, Fax: 0120 – 4215809

12.2.4 Esteemed Clientele

| Sr. No | Clientele | Sr. No | Clientele |
|---|---|---|---|
| 1 | BHARAT HEAVY ELECTRICALS LIMITED | 32 | EXOTICA HOUSING LTD. |
| 2 | BHARAT ELECTRONICS LIMITED | 33 | LOUIS BERGER GROUP |
| 3 | FCI ARAVALI GYPSUM AND MINERALS INDIA LIMITED | 34 | AMBUJA CEMENT |
| 4 | HINDUSTAN PETROLEUM CORPORATION LIMITED | 35 | WAPCOS LTD. |
| 5 | INDIAN OIL CORPORATION LIMITED | 36 | INDIAN COUNCIL OF FORESTRY RESEARCH AND EDUCATION |
| 6 | NTPC LIMITED | 37 | IL&FS TRANSPORTATION NETWORK LTD. |
| 7 | NATIONAL HYDROELECTRIC POWER CORPORATION | 38 | THDC INDIA LTD. |
| 8 | INDIAN COUNCIL OF FORESTRY RESEARCH AND EDUCATION | 39 | MADHYA PRADESH ROAD DEVELOPMENT CORPORATION |
| 9 | ISHIKA FERTILIZER LIMITED | 40 | VEDANTA RESOURCES |
| 10 | JAI PRAKASH ASSOCIATES | 41 | RAVI TAWI IRRIGATION COMPLEX, GOVT. OF J&K |
| 11 | JUBILANT AGRI AND CONSUMERS PVT. LTD. | 42 | INSTITUTE OF CHEMICAL TECHNOLOGY |
| 12 | TATA CHEMICALS LIMITED | 43 | JHARKHAND ISPAT PVT LTD |
| 13 | NATIONAL HIGHWAY AUTHORITY OF INDIA | 44 | KARNATAKA VETERINARY ANIMAL AND FISHERIES SCIENCES UNIVERSITY |
| 14 | NATIONAL FERTILIZERS LIMITED | 45 | ESSAR STEEL INDIA LTD |
| 15 | PUNJAB ALKALIES AND CHEMICALS LTD. | 46 | WELCOME FOOTWEAR |
| 16 | RAJASTHAN STATE MINES AND MINERALS INDIA LIMITED | 47 | COIM INDIA PVT. LTD. |
| 17 | MYSORE MINERALS LIMITED | 48 | HARYANA STATE ROADS AND BRIDGES DEVELOPMENT CORPORATION LIMITED |
| 18 | KANDLA PORT TRUST | 49 | ULTRATECH CEMENT LTD. |
| 19 | KARNATAKA POWER CORPORATION LIMITED | 50 | AXISCADES ENGINEERING TECHNOLOGIES LTD. |
| 20 | KUMAON MANDAL VIKAS NIGAM LIMITED | 51 | INVESTIGATION DESIGN & RESEARCH BOARD (IDRB), KERALA |
| 21 | SAURASHTRA CHEMICALS LIMITED, GUJARAT | 52 | WATER RESOURCE DEPARTMENT, RAJASTHAN |
| 22 | UTTARAKHAND FOREST DEVELOPMENT CORPORATION | 53 | BHARAT PETROLEUM CORPORATION LIMITED |
| 23 | SUMAN ENTERPRISES | 54 | ADOR FONTECH LTD. |

| Sr. No | Clientele | Sr. No | Clientele |
|---|---|---|---|
| 24 | JAI YAMUNA JI DEVELOPERS | 55 | PUBLIC WORKS DEPARTMENT DELHI |
| 25 | MARKANDESHWAR CONSTRUCTION COMPANY | 56 | THE INDIAN EXPRESS |
| 26 | M.P. STATE MINING CORPORATION LTD. | 57 | WATER RESOURCES DEPARTMENT, GOVT. OF JHARKHAND |
| 27 | JINDAL MECTEC PVT. LTD. | 58 | SUN PETRO CHEMICALS PVT.LTD. |
| 28 | HARYANA MINING CO. | 59 | TANCEM |
| 29 | ELDECO INFRASTRUCTURE | 60 | FCI ARAVALI |
| 30 | ANSAL PROPERTY & INFRASTRUCTURE | 61 | SATLUJ JAL VIDYUT NIGAM (SJVN) |
| 31 | DELHI STATE INDUSTRIAL AND INFRASTRUCTURE DEVELOPMENT CORPORATION (DSIIDC) | | |

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NABET

## National Accreditation Board for Education and Training

# Certificate of Accreditation

**Mantec Consultants Pvt. Ltd., Noida**

D-36, Sector-6, Noida, Uttar Pradesh-110019

*The organization is accredited as **Category-A** under the QCI-NABET **Scheme for Accreditation of EIA Consultant Organization, Version 3**: for preparing EIA/EMP reports in the following Sectors.*

| S. No | Sector Description | Sector (as per) | | Cat. |
|---|---|---|---|---|
| | | NABET | MoEFCC | |
| 1. | Mining of minerals-opencast mining only | 1 | 1 (a) (i) | A |
| 2. | Offshore and onshore oil and gas exploration, development & production | 2 | 1 (b) | A |
| 3. | River Valley projects | 3 | 1 (c) | A |
| 4. | Thermal power plants | 4 | 1 (d) | A |
| 5. | Petroleum refining industry | 10 | 4 (a) | A |
| 6. | Chemical fertilizers | 16 | 5 (a) | A |
| 7. | Pesticides industry and pesticide specific intermediates (excluding formulations) | 17 | 5 (b) | A |
| 8. | Synthetic organic chemicals industry | 21 | 5 (f) | A |
| 9. | Oil & gas transportation pipeline (crude and refinery/ petrochemical products), passing through national parks/ sanctuaries/coral reefs /ecologically sensitive areas including LNG terminal | 27 | 6 (a) | A |
| 10. | Isolated storage & handling of Hazardous chemicals | 28 | - | B |
| 11. | Air ports | 29 | 7 (a) | A |
| 12. | Ports, harbours, break waters and dredging | 33 | 7 (e) | A |
| 13. | Highways | 34 | 7 (f) | A |
| 14. | Common Municipal Solid Waste Management Facility (CMSWMF) | 37 | 7 (i) | B |
| 15. | Building and construction projects | 38 | 8 (a) | B |
| 16. | Townships and Area development projects | 39 | 8 (b) | B |

***Note: Names of approved EIA Coordinators and Functional Area Experts are mentioned in RAAC minutes dated September 15, 2023, and Supplementary Assessment minutes dated December 22, 2023 posted on QCI-NABET website.***

*The Accreditation shall remain in force subject to continued compliance to the terms and conditions mentioned in QCI-NABET's letter of accreditation bearing no QCI/NABET/ENV/ACO/23/2942 dated October 11, 2023. The accreditation needs to be renewed before the expiry date by Mantec Consultants Pvt. Ltd., Noida following due process of assessment.*

**Issue Date**
**January 31, 2024**

**Valid up to**
**April 20, 2026**

**Mr. Ajay Kumar Jha**
**Sr. Director, NABET**

**Certificate No.**
**NABET/EIA/23-26/RA 0305_Rev.01**

**Prof (Dr) Varinder S Kanwar**
**CEO-NABET**

*For the updated List of Accredited EIA Consultant Organizations with approved Sectors please refer to QCI-NABET website.*

**NABET CERTIFICATE**