एनटीपीसी
NTPC

एनटीपीसी लिमिटेड
NTPC Limited
(A Govt. of India Enterprise)

NTPC/KGN/EMG/EC-MOEF/HYC/2025

Date: 10/06/2025

To
Additional Principal Chief Conservator of Forests (C),
Ministry of Environment, Forest and Climate Change,
Regional Office (WZ), Kendriya Paryavaran Bhawan,
E-5 Arera Colony, Link Road-3,
Ravishankar Nagar,
Bhopal-462016, Madhya Pradesh
Email id- rowz.bpl-mef@nic.in

Sub: Submission of 20th Half Yearly Environmental Clearance Compliance Report of Khargone Super Thermal Power Project (2x660 MW) at Village Selda & Dalchi, Khargone, Madhya Pradesh by NTPC Ltd.

EC Ref: J-13012/54/2010-1A. II (T), Dated-31.03.2015

Dear Sir,

With reference to the above-mentioned subject matter and EC reference, please find enclosed the half yearly compliance status report to the stipulated conditions of Environmental Clearance for the period (**Oct'2024-Mar'2025**).

Submitted for your kind information and records please

Thanking you,

Yours sincerely,

(Ashish Kumar Agarwal)
AGM (Ash & Envt. Mgmt.)

Encl. as above

Copy to:

1. The Member Secretary,
Central Pollution Control Board,
Email-mscb.cpcb@nic.in

2. The Member Secretary,
Madhya Pradesh Pollution Control Board,
Email- ms-mppcb@mp.gov.in

NTPC एनटीपीसी

खरगोन Khargone

KHARGONE SUPER THERMAL POWER PROJECT (2x660 MW)
HALF YEARLY COMPLIANCE REPORT OF ENVIRONMENTAL CLEARANCE CONDITIONS
(For the period October'2024 - March'2025)

(EC Ref.-MOEF&CC Letter No. J- 13012/54/2010-IA. II (T) Dated 31st March 2015)

Sl. N.	EC condition	Compliance Status
A	**MOEF & EC- Specific Conditions:**	
i	Coal transportation shall be by Rail only. An additional EIA shall be carried out and an EMP shall be prepared for laying down the rail line and alternate mode of transportation, in case rail line gets delayed. The EIA/EMP shall be submitted to the Ministry within one year of issuing the EC.	Complied Rail network for NTPC-Khargone has been established and entire coal is being transported by railway route only.
ii	The Sulphur and Ash content of coal shall not exceed 0.5% and 43% respectively. In case of variation of quality at any point of time, fresh reference shall be made to the Ministry for suitable amendments in the environmental clearance.	Compliance assured MOEF&CC Vide Office Memorandum dated 11.11.2020 has modified this condition. The project proponent has to only inform to the Regional Office of MOEF&CC regarding the change in coal source and quality. Please refer Annexure-1 for change in coal source and quality
iii	Latest authenticated satellite imagery shall be submitted to the Regional Office of the Ministry on an annual basis to monitor the environmental alterations of the area.	Complied Satellite imagery of NTPC-Khargone and its vicinity land area is regularly submitted to the Regional Office of the MOEF&CC annually. Satellite imagery for 2024, was submitted along with Half-yearly Compliance report dated 16.12.2024.
iv	Vision document specifying prospective plan for the site shall be formulated and submitted to the Regional Office of the Ministry within six months.	Complied Vision document specifying prospective plan of the project was submitted to the Regional Office of the MOEF&CC at Bhopal vide NTPC letter dated 07.09.2015.
v	Harnessing solar power within the premises of the plant particularly at available roof tops shall be carried out and status of implementation including actual generation of solar power shall be submitted along with half yearly monitoring report.	Complied For harnessing solar power, Roof-top and Land mounted solar power plants with total capacity of 1654 KW installed & operational within plant & township premises

		Actual generation of solar power during the FY 2024-25 up to Mar'25 is 2189321 KWH.
vi	One twin flue stack of 275 m height shall be provided with continuous on-line monitoring system of $S0_x$, $N0_x$ and **PM2.5 & *PM10.* Exit velocity of flue gases shall not be less than 22 m/sec. In addition to the regular parameters, Mercury emission form stack shall also be monitored of six-monthly basis. *As per EC Amendment letter by MOEF & CC dated 22.01.2022 the condition is modified as "*PM in stack emission" in place of PM2.5 & PM10*	Complied One twin-flue stack of 275 m height provided for both units. Continuous online emission monitoring system (CEMS) facilities also provided for monitoring of SO2, NOx and PM. Separate stacks of height 150 m also provided for FGD units of respective Unit-1 & Unit-2. Continuous online emission monitoring system (CEMS) facilities also provided for monitoring of SO2, NOx and PM at FGD Stacks. Exit velocity of flue gases being maintained above 22 m/sec in boiler attached stacks. Mercury emission from stack also being monitored periodically. Please refer Annexure-2, Environment Monitoring Report for Mercury emission report from stack for the reporting period.
vii	High Efficiency Electrostatic Precipitators (ESPs) shall be installed to ensure that particulate emission does not exceed 50 mg/Nm^3. Adequate dust extraction system such as cyclones/bag filters and water spray system to control fugitive emissions in dusty areas such as in coal handling and ash handling points, transfer areas and other vulnerable dusty areas shall be provided.	Complied High Efficiency Electrostatic Precipitators (ESPs) designed for a guaranteed efficiency of 99.97% provided and operational. The particulate emissions are controlled and maintained within prescribed norms of 30 mg/Nm^3 in compliance to MOEF&CC notification dated 07.12.2015, for revised emission norms for TPPs. Adequate dust extraction system and water spray system also provided to control fugitive emissions at coal handling, coal stockyard, ash handling area, transfer points and other vulnerable dusty areas. Please refer Annexure-2, Environment Monitoring Report for Particulate Matter emission from stack for the reporting period.
viii	COC of at least 5.0 shall be adopted.	Compliance assured Closed cycle cooling water re-circulation system is implemented to meet prescribed COC, for the conservation/optimization of water requirement.

ix	Monitoring of surface water quantity and quality shall be conducted regularly and records shall be maintained. The monitoring points shall be located between the plant and drainage in the direction of flow of ground water and records shall be maintained. The monitored data shall be submitted to the Ministry every six months.	Complied Regular monitoring of surface water being carried out through MOEF&CC accredited and NABL certified third party laboratory. Records are being maintained and monitoring reports regularly submitted to Regional Office of the MOEF&CC at every six months. Please refer Annexure-2, Environment Monitoring Report for Surface water reports for the reporting period
x	Monitoring for heavy metals in ground water in the vicinity of plant shall also be undertaken and monitoring report shall be submitted to the ministry every six months.	Complied Regular monitoring of heavy metals in ground water is being carried out through MOEF&CC accredited and NABL certified third party laboratory. Monitoring reports regularly submitted to Regional Office of the MOEF&CC at every six months. Please refer Annexure-2, Environment Monitoring Report for Heavy metals in ground water reports for the reporting period
xi	A well-designed rainwater harvesting system shall be put in place within six months, which shall comprise of rainwater collection from the built up and open area in the plant premises and records shall be kept for the quantity of water harvested every year and its use.	Complied Well-designed, CGWA approved rainwater harvesting system, comprise of rainwater collection from the built-up area, open area & storm water of the capacity 0.36 MCM is installed at plant premises. Records for the harvested quantity of water every year being maintained. Rainwater harvested is fully used to recharge the ground water through recharge pits as per the approved scheme.
xii	No water bodies including natural drainage system in the area shall be disturbed due to activities associated with the setting up/ operation of the power plant.	Compliance assured
xiii	Hydro geology of the area shall be reviewed annually through an institute/ organization of repute to assess impact of surface water and ground water (especially around ash dyke). In case, any deterioration is observed specific mitigation measures shall be undertaken immediately. Reports/data of water quality shall be submitted to the Regional Office of the Ministry every six months.	Complied Baseline Hydro-geological study was carried out through National Institute of Hydrology (NIH), Roorkee. Annual review of hydro geology to assess impact of surface water and ground water (especially around ash dyke) has been also carried out through an institute/ organization of repute. Reports of surface and ground water quality are regularly submitted under hydrogeology review study report to the

		Regional Office of the MOEF&CC at every six months. Please refer Annexure-3 for the Final Report of hydrogeology review study submitted by M/s IIT-Roorkee for year 2024
xiv	Wastewater generated from the plant shall be treated before discharge to comply with the standards prescribed by the SPCB/CPCB.	Complied Effluent Management Scheme implemented with the objective to treat the entire wastewater as per the prescribed statutory standards of MPPCB/CPCB. It is to be submitted that during normal course of operations, zero liquid discharge being adopted based on maximum recycle/reuse of wastewater for various plant usage.
xv	Additional soil for levelling of the proposed site, if require shall be taken from within the sites (to the extent possible) so that natural drainage system of the area is protected.	Complied For levelling of site all additional soil being taken from within the sites only (to the extent possible) with all necessary precautions to protect natural drainage system of the area.
xvi	Fly ash shall be collected in dry from and storage facility (silos) shall be provided. Un-utilized fly ash shall be disposed off in the ash pond in the form of slurry. Mercury and other heavy metals (As, Hg, Cr, Pb etc.) will be monitored in the effluents emanating from the ash pond and in the bottom ash also. No ash shall be disposed off in low-lying area.	Complied An ash management & disposal scheme is implemented consisting of dry ash extraction system (DAES) for dry collection of fly ash with adequate storage facility (silos) to supply ash to entrepreneurs for utilization. Un-utilized ash is being safely disposed in the ash pond in the form of slurry. Two different systems are being provided for ash disposal: Conventional wet slurry disposal system with ash water re-circulation for bottom ash and High Concentration Slurry Disposal (HCSD) system for fly ash disposal. Mercury & other heavy metals (As, Hg, Cr, Pb etc.) are regularly monitored in the ash water emanating from ash pond and in the bottom ash. No ash is being disposed off in low-lying area at present. Prior permission shall be obtained for ash disposal in low-lying area. Please refer Annexure-2, Environment Monitoring Report for Mercury & Heavy metals report in ash water & bottom ash for the reporting period

xvii	Fugitive emission of fly ash (dry or wet) shall be controlled such that no agricultural or non-agricultural land is affected. Damage to any land shall be mitigated and suitable compensation shall be provided in consultation with the local Panchayat.	Complied & Noted Dust suppression system comprising of water spray nozzles are provided all around the ash ponds for effective control of fugitive emission of fly ash. Additionally, localized dust suppression measures also installed inside ash pond. Further, closed trucks/ bulkers/covered vehicle/closed BLC container railway wagons are being used for transportation of fly ash to avoid fugitive dust emission. Dust extraction system at coal crusher house, Dry Fog Dust Suppression at Coal transfer points, Dust suppression system at Wagon tipplers, Dust suppression water spray nozzles around the coal stock yards provided for the control of fugitive emission. Dust suppression system comprising of water spray nozzles around the ash pond provided to control the fugitive dust emissions.
xviii	Ash pond shall be line with HDPE/LDPE lining or any other suitable impermeable media so that no leaching takes place at any point of time. Adequate safety measures shall also be implemented to protect the ash dyke from getting breached.	Complied To avoid any leaching and ground water contamination from ash slurry, suitable impermeable media lining provided in ash dyke. Bottom ash lagoons are lined with suitable impermeable media i.e., bentonite blended clay in order to achieve the required permeability. In HSCD lagoon the disposed layers of ash are solidified and there is very less free water. Overflow lagoon of ash dyke is also lined with impervious thick liner of 300 mm at bottom. The structure of ash dykes has been designed, constructed, and being operated as per state-of-the-art engineering practices for the design and construction of earth dams with adequate factor of safety. Ash dyke being constructed considering the seismic parameters in its design. Regular monitoring and inspection of ash dykes and an emergency response system will ensure that there are no risks of failure as apprehended. Further, in compliance to MOEF&CC Gazette Notification dtd. 31.12.2021, an annual certification of ash dyke also being done as per guidelines issued by Central Pollution Control (CPCB) & Central Electricity Authority

		(CEA). Certification report submitted to the MOEF&CC, CPCB, CEA & MPPCB. Please refer Annexure-4, for Ash Dyke Certification for 2024-25
xix	A long-term study of radioactivity and heavy metals contents of coal to be used shall be carried out through a reputed institute and results shall be analyzed every two years and shall be reported to the Ministry along with the monitoring reports. Thereafter, mechanism for * *in-built continuous monitoring* for radioactivity and heavy metals in coal and fly ash (including bottom ash) shall be put in place. *As per EC Amendment letter by MOEF & CC dated 22.01.2022 the condition is modified as *"regular periodical monitoring"* in place of in-built continuous monitoring.	Complied Radioactivity content monitoring of coal & ash has been carried out annually, through Board of Radiation & Isotope Technology (BRIT) under Dept. of Atomic Energy, Govt. of India. Periodical monitoring reports of Radioactivity content in coal & ash samples are regularly submitted along with Half-yearly compliance report. Please refer Annexure-5, for Annual Radioactivity content report in coal & ash. Further, Regular periodical monitoring of Heavy metals content of coal has been also carried out through MOEF&CC accredited and NABL certified third party laboratory. Reports are regularly submitted to the Regional office of MOEF&CC along with half-yearly compliance reports. Please refer Annexure-2, Environment Monitoring Report for Heavy metals contents in coal & ash for the reporting period
xx	Green belt of least 50m width consisting of three tiers of plantations of native species around the plant shall be raised. Wherever 50m width is not feasible, an adequate justification shall be submitted to the Ministry and appropriate width not less than 20m shall be planted. Tree density shall not be less than 2500 per ha with survival rate not less than 80%.	Compliance assured. Green belt of 50m width is being carried out at most of the locations, consisting of native plantation species, at all available spaces inside and around the plant and township premises. Green belt of at least 20m width is also planted at some locations wherever, land not suitable or available for plantations. Efforts have been made to maintain the prescribed tree density with survival rate not less than 80%. Additional tree plantations also being carried out at available spaces and roadsides, at inside and around the plant and township premises. Further tree plantation being taken up at external forest land and Govt. land to enhance the green cover. Avenue plantation along the approach roads and ash dyke also being taken up. Cumulative 5.07 lakhs tree have been planted till date at inside and outside the NTPC-Khargone premises through Govt.

		agencies i.e. Madhya Pradesh Rajya Van Vikas Nigam Ltd. and Rural Engineering Services depts. under Govt. of Madhya Pradesh.
xxi	Green belt shall also be developed around the ash pond over and above the Green Belt around the plant boundary.	Complied Tree plantation around the ash pond, along peripheral roads has been planted.
xxii	CSR schemes identified based on need-based assessment shall be implemented in consultation with the village Panchayat and the District Administration starting from the development of project itself. As part of CSR, prior identification of local employable youth the eventual employment in the project after imparting relevant training shall be also undertaken. Company shall provide separate budget for community development activities and income generation programs.	Compliance assured Need Assessment Survey (NAS) completed in Dec'2022 by M/s Grant Thornton. NTPC Khargone entered CSR phase from mid of May'2024. The total budget sanctioned is Rs. 5.43 Cr for various CSR activities. Out of Rs. 5.43 Cr. total approved budget of CSR an amount of Rs. 2.261 Cr. is utilized and activities for Rs. 2.58 Cr. in progress. Whereas the works for balance amount utilization is under award process. Please refer to Annexure-6 for Community Development activities undertaken in during the reporting period
xxiii	For periodic monitoring of CSR activities, a CSR Committee or a Social Audit committee or a suitable credible external agency shall be appointed. CSR activities shall also be evaluated by an independent external agency. This evaluation shall be both concurrent (every six months) and final.	Compliance assured NTPC Khargone entered CSR phase from mid of May'2024. The Social Impact Evaluation (SIE) Study is carried out every three years and has been completed in Aug'23 by Indian Institute of Corporate Affairs. Please refer Annexure-7 for the Social Impact Evaluation (SIE) Study.
xxiv	An Environmental Cell comprising of at least one expert in environmental science/ engineering, ecology, occupational health, and social science shall be created preferably at the project site itself and shall be headed by an officer of appropriated seniority and qualification. It shall be ensured that the Head of the cell shall directly report to the Head of the Plant who would be accountable for implementation of environmental regulations and social impact improvement/ mitigation measures.	Complied An Environment Management Group (EMG) with qualified team, headed by AGM (TS) and reporting to the Head of Plant, is already functional at the Khargone station. EMG is responsible for implementation and compliance of environmental stipulations and ensure mitigation measures.

B	MOEF & CC- General Conditions:	Status as on Implementation
i	Space for FGD shall be provided for future installation, if required.	Complied Space kept for FGD is utilized in FGD installation. FGD installation completed and available for both Units. Date of Operations (ODe) for FGD: Unit-1 and FGD: Unit-2 are 25.05.2023 & 08.12.2023 respectively.
ii	The treated effluents conforming to the prescribed standards under Environment (Protection) Act 1986 only shall be re-circulated and reused within the plant. Arrangements shall be made that effluents and storm water do not get mixed.	Complied Effluent treatment system comprising of effluent treatment plant, neutralization pit, oil & grease separator, settling ponds and cooling towers etc. provided to treat effluents conforming the prescribed standards. An integrated scheme for treatment, recycle and reuse of effluents is implemented. Cooling water blow down is reused in CHP, AHP, FGD and firefighting. Ash water effluent recirculation also being provided for reuse in ash handling purpose. Provision also made for treatment, recirculation & reuse of effluents from coal handling plant. Further, Zero Liquid Discharge (ZLD) scheme is implemented for recycle & reuse of wastewater generated, thereby reducing, and optimizing the quantities of water requirement. Independent plant effluent drainage system provided to ensure that plant effluents do not mix with storm water drainage.
iii	A sewage treatment plant shall be provided (as applicable) and the treated sewage shall be used for raising greenbelt/plantation.	Complied Sewage treatment plant (STP) provided to treat sewage effluents emanating from plant and township. The STP treated water, conforming to prescribed standards utilized for raising greenbelt/plantation.
iv	Adequate safety measures shall be provided in the plant area to check/ minimize spontaneous fires in coal yard, especially during summer season. Copy of these measures with full details along with location, plant layout etc. as and when finalized, shall be submitted to the ministry as well as to the regional office of the Ministry.	Complied Adequate no. of Fire Spray & Hydrant system covering the entire power station including all the auxiliaries and buildings in the plant area is provided as per fire safety requirements. The system is adequately equipped with piping, hydrants, valves, instrumentation, hoses, nozzles, hose boxes/stations etc.

		Safety measures details already submitted along with Half-yearly compliance report dated 22.04.2019.
v	Separate storage facilities for auxiliary liquid fuel such as LDO/HFO/LSHS shall be made in the plant area in consultation with Department of Explosives, Nagpur. Sulphur content in the liquid fuel will not exceed 0.5%. Provisions of the Manufacture, Storage and Import of Hazardous Chemical Rules and the Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996 shall be applicable as per the quantity stored. Disaster Management System shall be established as per the Disaster Management Plan to meet any eventuality in case of an accident taking place due to storage of oil.	Compliance assured Storage facility designed and provided for LDO as auxiliary liquid fuel, inside plant area conforming to the adequate safety standard and where risk is minimal. Necessary license has been obtained from Petroleum & Explosive Safety Organization under Ministry of Commerce & Industry. Sulphur content in LDO being ensured within limits. Detailed Disaster Management Plan (DMP) & Risk assessment including fire and explosion issues is prepared and finalized in consultation with Department of Explosives. Regular mock drills being conducted as per plan in order to address any eventuality in case of an accident.
vi	First Aid and sanitation arrangements shall be made for the drivers and other contract workers during construction phase.	Complied Adequate arrangements for first aid, health & safety, and sanitation for workers have been provided and compliance ensured.
vii	Noise levels from turbines in work zone shall be limited to 85 dB (A) from source. For people working in the high noise area, requisite personal protective equipment like earplugs/earmuffs etc. shall be provided. Workers engaged in noisy areas such as turbine area, air compressors etc. shall be periodically examined to maintain audiometric record and for treatment for any hearing loss including shifting to non-noisy/less noisy areas.	Complied Design specification for the equipment has been made to comply with the stipulations. Noise levels from turbines in work zone being maintained within prescribed limits of 85 dB (A) from source. Personal Protective Equipment (PPE's) are also being provided to personnel working in high noise areas. Workers of turbine generator area, compressor area and other high noise area being provided with appropriate ear protection devices. Periodic health examination of workers also being done.
viii	Regular monitoring of ambient air ground level concentration of SO_2, $N0_x$, $PM_{2.5}$ & PM_{10} and Hg shall be carried out in the impact zone of the project and record shall be maintained. In case these levels exceed the prescribed limits, necessary control measures shall be taken immediately. The location of the monitoring stations and frequency of monitoring shall be decided in consultation with SPCB.	Complied Three nos. of CAAQMS stations have been installed at main-plant and township locations in consultation with MPPCB for regular monitoring of ambient air quality and record is maintained. Adequate control measures have also been ensured to control the exceedance if any. Additionally, one CAAQMS station is also installed at Khargone city as per directions from MPPCB.

	Monitoring reports shall be submitted to the Regional Office of this Ministry every six months. The data shall also be uploaded on the website of the company.	Regular monitoring of ambient air quality also carried out periodically through MOEF&CC accredited and NABL certified third party laboratory. Reports are regularly submitted to the Regional Office of MOEF&CC. Online ambient air monitoring data also being uploaded on NTPC-Khargone Intranet webpage. Please refer Annexure-2, Environment Monitoring Report for ambient air quality reports for the reporting period. Online ambient air monitoring data also being uploaded on NTPC-Khargone Intranet webpage.
ix	Fly Ash generated shall be utilized 100% from the 4th year of operation of the power plant. Status of fly ash utilization shall be reported each year to the Regional Office of the Ministry.	Complied Ash utilization plan has been prepared and all efforts are being made to achieve the targets in compliance to MOEF&CC, Fly ash Gazette Notification dated 03.11.2009, 31.12.2021 and its amendments, notifications thereafter. Annual compliance status of fly ash utilization being submitted regularly to the Regional office of MOEF&CC. Please refer Annexure-8 for Annual compliance report (ACR) of Ash Utilization for the FY 2024-25
x	Provision shall be made for the housing of construction labor (as applicable) within the site with all necessary infrastructures and facilities such as fuel for cooking, mobile toilets, mobile STP, safe drinking water, medical health care, crèche etc. The housing may be in the form of temporary structure to be removed after the completion of the project.	Compliance assured Labor colony with necessary infrastructure facilities had been provided for construction labor during construction phase and was kept under the scope of EPC contractor. Whereas NTPC ensures effective compliance of the said stipulations.
xi	The project proponent shall advertise in at least two local newspapers widely circulated in the region around the project, one of which shall be in the vernacular language of the locality concerned within seven days from the date of receipt of this clearance letter, informing that the project has been accorded environmental clearance and copies of clearance letter are available with the State Pollution Control Board/Committee and may also be see at Website of the Ministry of	Complied The information of Environmental Clearance was published in two newspapers widely circulated in the region are- 1. Hindustan Times (English) on dated 04.04.2015. and 2. Nai-Dunia (Hindi) on dated 04.04.2015.

	Environment and Forests at: http://envfor.nic.in.	
xii	A copy of the clearance letter shall be sent by the proponent to concerned Panchayat, Zila Parisad/ Municipal Corporation, urban local body and the Local NGO, if any, from whom suggestions/representations, if any, received while processing the proposal. The clearance letter shall also be put on the website of the Company by the proponent.	Complied Copy of clearance letter were sent vide our letter dated 06.04.2015 to Sarpanch of village Panchayat of Selda & Dalchi village, CEO of Khargone Distt & CEO of Khargone Municipal Corporation. The Environmental Clearance is uploaded on the NTPC Ltd. website.
xiii	The proponent shall upload the status of compliance of the stipulated environmental clearance conditions, including results of monitored data on their website and shall update the same every six months. It shall simultaneously be sent to the Regional Office of MOEF, the respective Zonal Office of CPCB and the SPCB.	Complied The latest status report of Compliance to the stipulated Environmental Clearance (EC) conditions is regularly uploaded on NTPC website. Compliance status report also submitted to the Regional Office of the MOEF&CC and offices of CPCB & MPPCB regularly at every six months.
v	The criteria pollutant levels namely; SPM, RSPM ($PM_{2.5}$ & PM_{10}), SO_2, NO_x (ambient levels as well as stack emissions) shall be displayed at a convenient location near the main gate of the company in the public domain.	Complied The criteria pollutant levels as prescribed, for ambient air as well as stack emissions are displayed at a convenient location near the main gate of the company in the public domain.
xv	The environment statement for each financial year ending 31st March in Form-V as prescribed under the Environment (Protection) Rules, 1986, as amended subsequently, shall be submitted by the project proponent to the concerned State Pollution Control Board. The same shall also be uploaded on the website of the company along with the status of compliance of environmental clearance conditions and shall also be sent to the respective Regional Offices of the Ministry by e-mail.	Complied Environment Statement for each financial year ending 31st March in Form-V has been regularly submitted to the M.P. Pollution Control Board & Regional Office of the MOEF&CC timely by September every year. Environmental statement along with the status of compliance of status environmental clearance conditions, is being regularly updated on the NTPC website. Please refer Annexure-9 for Annual Environment Statement (Form-V) of the FY 2024-25.
xvi	The project proponent shall submit six monthly reports on the status of the implementations of the stipulated environmental safeguards to the Ministry of Environment and Forests, its Regional Office, Central Pollution Control Board and State Pollution Control Board. The project proponent	Complied Six monthly compliance status report of EC conditions regularly submitted to the Regional Office of MOEF&CC, CPCB & MPPCB. Compliance report of the environmental clearance conditions are also uploaded on the NTPC website periodically.

	shall upload the status of compliance of the environmental clearance conditions on their website and update the same every six months and simultaneously send the same by email to the Regional office, Ministry of Environment and Forests.	
xvii	Regional office of the Ministry of Environment & Forests will monitor the implementation of the stipulated conditions. A complete set of documents including Environmental Impact Assessment Report and Environment Management plan along with the additional information submitted from time to time shall be forwarded to the Regional Office for their use during monitoring.	Complied A complete set of documents including Environmental Impact Assessment (EIA) Report and Environment Management Plan (EMP) along with the additional information/clarifications was already submitted to Regional Office (Western Zone) of the MOEF&CC at Bhopal on 05.10.2015
xviii	The details of the funds along with item-wise break-up of Rs.1421.2 crores allocated for implementation of environmental protection measures shall be submitted to the Ministry. This cost shall be included as part of the project cost. The funds earmarked for the environment protection measures shall not be diverted for other purposes and year-wise expenditure shall be reported to the Ministry.	Compliance assured The requisite funds for environmental mitigation measures have been included in the project cost. Financial provision stipulated towards environmental mitigate measures were not diverted for other purposes.
xix	The project authorities shall inform the Regional Office as well as the Ministry regarding the date of financial closure and final approval of the project by the concerned authorities and the dates of start of land development work and commissioning of plant.	Complied Site leveling/ Land development work started on July 17^{th}, 2015. Trial operation commissioning of Unit#1 (660 MW) achieved on 29/09/2019 and Commercial Date of Operation (COD) declared from 01/02/2020. Trial operation commissioning of Unit#2 (660 MW) achieved on 24/03/2020 and Commercial Date of Operation (COD) declared from 04/04/2020.
xx	Full cooperation shall be extended to the Scientists/officers from the Ministry / Regional Office of the Ministry/ CPCB /SPCB who would be monitoring the compliance of environmental status.	Noted

COMPLIANCE REPORT OF ADDITIONAL CONDITIONS

(EC Amendment vide MOEF&CC Letter Dated 22nd August 2019)

A	MOEF & EC- Specific Conditions:	Compliance Status
1	While commissioning the proposed project, the compliance of revised emission norms vide Notification dated 07.12.2015 for the parameters PM: 30 mg/Nm3; S02: 100 mg/Nm3; NOx: 100 mg/Nm3 and Hg: 0.03 mg/Nm3 shall be achieved along with specific water consumption as per the notification vide dated 28.06.2018. The FGD System, NOx control measures such as SCR/ SCNR/ DeNOx burners shall be installed to achieve the revised emission norms.	Compliance assured NTPC-Khargone ensures compliance to all standards as stipulated in the revised emission norms vide referred MOEF&CC Notification dated 07.12.2015 and its amendments thereafter. Particulate Matter (PM) emissions from boiler stacks being complied within prescribed new emission norms (30 mg/Nm3) FGD plants installed, commissioned & available for both Unit-1 & Unit-2 for SO2 emission being complied within prescribed new emission norms (100 mg/Nm3) Low NOx burners with Over Fire Air (OFA) combustion system also provided in both Units, for NOx emission control. However, the matter for NOx emission compliance by TPPs commissioned after 2017 is under sub judice at Hon'ble Supreme Court of India. As per the direction of Hon'ble Supreme Court, a committee comprising of EPCA (CAQM), CPCB, MoEF&CC and MoP is deliberating on the issue. Mercury emission from stacks is complied with in prescribed norms. Specific water consumption (SWC) being maintained within prescribed norms of 3.0 m3/mwhr as per the MOEF&CC notification dated 28.06.2018. SWC in the FY: 2024-25 is reported as 2.80 m3/mwh. Whereas CPCB-Task Force vide his letter dtd. 13.12.2021, for the categorization of TPPs in line with MOEF&CC Notification dated 31/03/2021, had classified both units of NTPC-Khargone under Category-C for the compliance to the revised emission norms ensured by Dec'24. Whereas, as per MOEF&CC Notification dtd.05.09.2022, SO2 emissions timeline for compliance (Non-retiring units) is extended up to Dec'2026 for Category-C TPPs includes both units for NTPC-Khargone.

2	The status of installation of FGD and De-NOx/SCR/SNCR control systems to comply with new emission norms for both units shall be submitted.	Compliance assured For SO2 emission control, Erection & Commissioning of FGD plants completed and available for both Units. Dates of Operation (ODe) for FGD: Unit-1 and FGD: Unit-2 are 25.05.2023 & 08.12.2023 respectively. For NOx emission control, Low NOx Burners with Over Fire Air (OFA) combustion control system (air/fuel ratio optimization around the burner) is provided in both units. However, the matter for NOx emission compliance by TPPs commissioned after 2017 is under sub judice at Hon'ble Supreme Court of India. As per the direction of Hon'ble Supreme Court, a committee comprising of EPCA (CAQM), CPCB, MoEF&CC and MoP is deliberating on the issue.
3	The detailed progress report of construction of proposed project shall be submitted to the Ministry and its Regional Office along with six monthly compliance report till both units are commissioned.	Complied Both Unit#1 and Unit#2 were commissioned and under commercial operation from 01/02/2020 & 04/04/2020 respectively.
4	As per the Revised Tariff Policy notified of Ministry of Power issued vide dated 28.01.2016, project proponent shall explore the use of treated sewage water from the Sewage Treatment Plant of Municipality/ local bodies/ similar organization located within 50 km radius of the proposed power project to minimize the water drawl from surface water bodies. The details of Sewage Treatment Plants located within 50 km radius along with the capacities shall be submitted.	Noted & Compliance assured
5	Daily quantity of (Average, minimum and maximum) fresh water withdrawn from Narmada River at Omkareshwar Dam for the plant purpose shall be submitted along with six monthly compliance report.	Noted & Compliance assured Please refer Annexure-10 for fresh water withdrawn data for the reporting period

COMPLIANCE REPORT OF ADDITIONAL CONDITIONS

(EC Amendment vide MOEF&CC Letter Dated 22nd January 2022)

A	MOEF & EC- Specific Conditions:	Compliance Status
i	24x7 online Continuous monitoring system for ambient air quality parameters SOx, NOx and PM shall be established with connected server to CPCB and SPCB.	Complied Continuous Ambient Air Quality Monitoring Stations (CAAQMS) have been installed and 24x7 online connectivity of the same also established up to the MPPCB and CPCB.

ANNEXURE-1

Reporting Format for Change in Coal Source

Name: Khargone Super Thermal Power Project (2x660 MW), NTPC Limited
Dates of EC & Amendments: EC Ref.-J- 13012/54/2010-IA. II (T) Dated 31.03.2015,
Amendment Dtd.22.08.2019 & 22.01.2022
Compliance Reporting Period: Oct'24 to Mar'25

S.No.	Description	Detials of Coal Source (As per EC)	Detials of Coal Source (As per FSA)	Change in Coal Source, if any
1	Coal Linkage Source (Coalfeild/Coalmine)	Pakri Barwadih	For U#1- MCL For U#2- WCL/SECL	For U#1- 17.01.2023 For U#2- 06.06.2024
2	Annual Contracted Quantity (MMT)	6.5 MMT	For U#1- MCL 3.33 MMT For U#2- WCL/SECL, 2.62/2.82 MMT	
3	Distance of Coal Source from the Plant (Km)	1326 Km (Avg)	For U#1- MCL 1185 Km (Avg) For U#2- WCL/SECL, 634 Km (Avg)/896Km(Avg)	
4	Mode of Trasportation (Rail/Road/Others)	Rail	Rail	
5	Total Quantity of Domestic Coal received during the period (MMT)		2.68	
6	Average Coal Qualityof Domestic Coal Consumed during period:-			
a)	*Ash Content (%)*		43.5	
b)	*Sulphur (%)*		0.4	
c)	*Moisture (%)*		4.59/12.02	
d)	*Calorific Value (kcal/kg)*		3121	
7	% Blending of Imported Coal, if any and Averrage Coal Quality of Imported Coal Consumed:-		0.27	
a)	*Ash Content (%)*		4.56	
b)	*Sulphur (%)*		0.44	
c)	*Moisture (%)*		6.0/25.58	
d)	*Calorific Value (kcal/kg)*		4150	

Note: In Case of there is no change in linkage/FSA source, coulmn (5) may be filled as 'No Change"

ANNEXURE-2

Environment Monitoring Report

Industry: **NTPC Ltd. Khargone Super Thermal Power Project**
Period: **Oct'24 to Mar'25**
Laboratory **M/s Hubert Enviro Care Systems Pvt. Ltd**
(MOEF&CC Accredited and NABL Lab)

Stack Emission Monitoring Report

For the period of Oct'24-Mar'25

Boiler-Stacks	Parameter	PM	SO2	NOx	Hg
	Unit	mg/Nm3	mg/Nm3	mg/Nm3	mg/Nm3
Unit-1	Avg	22	1254	425	<0.01
	Min	17	1186	401	<0.01
	Max	29	1341	443	<0.01
Unit-2	Avg	23	1498	397	<0.01
	Min	20	1210	353	<0.01
	Max	28	2063	440	<0.01

FGD-Stacks	Parameter	PM	SO2	NOx	Hg
	Unit	mg/Nm3	mg/Nm3	mg/Nm3	mg/Nm3
FGD-1: Unit-1	Avg	6	17	373	<0.01
	Min	6	11	355	<0.01
	Max	7	23	391	<0.01
FGD-2: Unit-2	Avg	6	17	317	<0.01
	Min	4	10	302	<0.01
	Max	9	21	339	<0.01

Ambient Air Monitoring Report

For the period of Oct'24-Mar'25

Location	Nr. Main Gate/West Boundary				
Parameter	S0x	NOx	PM10	PM2.5	CO
Unit	ug/m3	ug/m3	ug/m3	ug/m3	mg/m3
Avg	11.0	21.2	60.5	30.4	0.5
Min	6.1	16.8	37.1	23.8	0.4
Max	14.2	25.8	78.1	39.4	0.6
Location	Nr. DM Plant/Gate-3				
Parameter	S0x	NOx	PM10	PM2.5	CO
Unit	ug/m3	ug/m3	ug/m3	ug/m3	mg/m3
Avg	12.3	23.1	53.0	25.6	0.4
Min	10.2	20.2	29.7	15.4	0.4
Max	14.9	27.4	67.0	34.2	0.5
Location	At Township				
Parameter	S0x	NOx	PM10	PM2.5	CO
Unit	ug/m3	ug/m3	ug/m3	ug/m3	mg/m3
Avg	11.3	21.7	52.1	26.3	0.4
Min	8.8	17.6	38.6	16.8	0.4
Max	13.8	24.7	66.3	31.3	0.5
Location	At Dalchi Village				
Parameter	S0x	NOx	PM10	PM2.5	CO
Unit	ug/m3	ug/m3	ug/m3	ug/m3	mg/m3
Avg	12.6	23.1	62.9	29.8	0.5
Min	11.3	18.7	38.1	17.0	0.5
Max	14.0	26.8	76.4	35.2	0.6

Surface Water Analysis Report					
For the period of Oct'24-Mar'25					
Parameter	**Location**	**Vill.-Selda**	**Vill.-Dalchi**	**Vill.-Katora**	**Vill.-Jirbhar**
PH	_	7.63	7.84	7.92	7.92
TDS	mg/L	381	496	395	365
TSS	mg/L	32.0	8	13.9	9
BOD	mg/L	3.0	2	4	2
COD	mg/L	24.0	8	16	20
O&G	mg/L	<4	<4	<4	<4
Chlorides	mg/L	59.4	64.3	79.2	44.5
Sulphates	mg/L	83.3	61.9	58.5	109.5
Ca	mg/L	72.1	104.2	28.2	60.1
Mg	mg/L	31.6	19.4	29.2	29.2
Cd	mg/L	<0.001	<0.001	<0.001	<0.001
As	mg/L	<0.005	<0.005	<0.005	<0.005
Hg	mg/L	<0.005	<0.005	<0.005	<0.005
Pb	mg/L	<0.005	<0.005	<0.005	<0.005

Narmada River-Surface Water Analysis Report					
For the period of Oct'24-Mar'25					
Parameter	**Location**	**Narmada Upward to Intake**	**Narmada Downward to Intake**		
PH	_	8.08	8.01		
TDS	mg/L	198	191		
TSS	mg/L	5.0	2		
BOD	mg/L	<1	<1		
COD	mg/L	<4	<4		
O&G	mg/L	<4	<4		
Chlorides	mg/L	38.9	39.9		
Sulphates	mg/L	20.6	19.1		
Ca	mg/L	28.9	28.9		
Mg	mg/L	8.8	10.2		
Cd	mg/L	<0.001	<0.001		
As	mg/L	<0.005	<0.005		
Hg	mg/L	<0.005	<0.005		
Pb	mg/L	<0.005	<0.005		

Ground Water Analysis Report					
For the period of Oct'24-Mar'25					
Parameter	**Location**	**Vill.-Dalchi (Nr. Ash Dyke)**	**Vill.-Selda**	**Vill.-Khedi**	**Vill.-Aarsi**
PH	_	7.3	7.5	7.0	7.7
TDS	mg/L	662	566	556	431
COD	mg/L	<4	<4	<4	<4
Chlorides	mg/L	103.9	99.5	79.2	59.4
Sulphates	mg/L	99.1	121.4	50.2	37.1
Ca	mg/L	136.5	112.2	136.3	74.1
Mg	mg/L	14.6	41.3	36.5	14.6
Cd	mg/L	<0.001	<0.001	<0.001	<0.001
As	mg/L	<0.005	<0.005	<0.005	<0.005
Hg	mg/L	<0.005	<0.005	<0.005	<0.005
Pb	mg/L	<0.005	<0.005	<0.005	<0.005

Ash Effluent Water Analysis Report

For the period of Oct'24-Mar'25

Parameter	Unit	Avg	Min	Max	
PH		7.5	7.1	7.9	
TDS	mg/L	876	810	950	
TSS	mg/L	12.7	6.0	22.0	
As	mg/L	0.0	0.0	0.0	
Hg	mg/L	0.0	0.0	0.0	
Cr	mg/L	0.0	0.01	0.01	
Pb	mg/L	0.1	0.10	0.10	
Cd	mg/L	0.0	0.01	0.01	

Bottom Ash Analysis Report-Heavy Metals

For the period of Oct'24-Mar'25

Parameter	Unit	Result
Pb	mg/L	<0.1
Cr-T	mg/L	0.31
Cu	mg/L	<0.1
Zn	mg/L	<0.1
Ni	mg/L	<0.1
As	mg/L	<0.1
Hg	mg/L	<0.1
Cd	mg/L	<0.1
Mg	mg/L	<0.1
Co	mg/L	<0.1

Coal Analysis Report-Heavy Metals

For the period of Oct'24-Mar'25

Parameter	Unit	Result
Pb	mg/kg	13.3
Cr-T	mg/kg	7.2
Cu	mg/kg	99.8
Zn	mg/kg	36.6
Ni	mg/kg	6.4
As	mg/kg	0.2
Hg	mg/kg	0.10
Co	mg/kg	1.4

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-52316

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

Name of the Client	: M/s. NTPC LTD.,	ULR	: TC1231025000013565F
		Report No.	: HECS/AP/035/170325
		Sample ID No	: 170325063
		Sampling Date	: 13/03/2025 To 14/03/2025
Address of the Client	: Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India		
Group	: Atmospheric Pollution	Received Date	: 17/03/2025
Sample Name	: Ambient Air	Commenced Date	: 17/03/2025
Sample Mark	: NA	Completed On	: 21/03/2025
Sample Reference	: NA	Report Date	: 21/03/2025
Sample Drawn By	: M/s.Hubert Enviro care Systems (P) Ltd.	Sample qty	: NA
Sample Location	: Near Western Boundary		
Environmental Condition	: Temperature (°C) : 30.0 | Humidity (%) : 54.0		
Sampling Method & Plan	: IS 5182 Part-5 & Part 14		

S.No.	Test Parameters	Units	Results	Test Method	NAAQ Standards : 2009	
Discipline : Chemical						
1	Lead	µg/m3	BLQ (LOQ: 0.002)	HECS-G/INS/SOP/ 041 Issue No.01 Issue Date:01.03.2021	1 (24 hours)	0.5 (Annual)
2	Arsenic	ng/m3	BLQ (LOQ: 2.0)	HECS-G/INS/SOP/ 041 Issue No.01 Issue Date:01.03.2021	6 (Annual)	6 (Annual)
3	Nickel	ng/m3	BLQ (LOQ: 2.0)	HECS-G/INS/SOP/ 041 Issue No.01 Issue Date:01.03.2021	20 (Annual)	20 (Annual)
4	Benzene	µg/m3	BLQ (LOQ: 0.1)	IS 5182 Part 11: 2006	5 (Annual)	5 (Annual)
5	Benzo (a) pyrene	ng/m³	BLQ (LOQ: 0.1)	IS : 5182 Part 12: 2004	1 (Annual)	1 (Annual)
6	Ammonia as NH3	µg/m³	8.35	IS 5182 (Part 25) 2018	400 (24 hours)	100 (Annual)
7	Carbon Monoxide (CO)	mg/ m³	0.55	IS 5182 (Part 10) Clause 4 1999	4 (1 hours)	2 (8 hours)
8	Nitrogen dioxides as NO2	µg/m³	25.82	IS 5182 (Part 6) 2006	80 (24 hours)	40 (Annual)
9	Ozone as O3	µg/m³	16.90	IS 5182 (Part 9) 1974	180 (1 hours)	100 (8 hours)
10	Particulate matter (Size less than 10 µm)	µg/m³	74.14	IS 5182 (Part 23) 2006	100 (24 hours)	60 (Annual)
11	Particulate matter (Size less than 2.5 µm)	µg/m³	32.70	IS 5182 (Part 24) 2019	60 (24 hours)	40 (Annual)
12	Sulphur dioxide as SO2	µg/m³	11.52	IS 5182 (Part 2) 2001	80 (24 hours)	50 (Annual)

Note:- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, µg/m³- Micrograms per cubic meter, mg/m³-Milligrams per cubic meter, ng/m³-Nanograms per cubic meter.

Remarks: The Tested Parameters as above are within the Limits of NAAQ Standards 2009.

End Report

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12318

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR : TC1231025000013563F
Report No : HECS/AP/033/170325
Sample ID No : 170325061
Sampling Date : 14/03/2025 To 15/03/2025

Name of the Client : **M/s. NTPC LTD.,**

Address of the Client : **Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India**

Group : **Atmospheric Pollution**
Sample Name : **Ambient Air**
Sample Mark : NA
Sample Reference : NA
Sample Drawn By : M/s.Hubert Enviro care Systems (P) Ltd.
Sample Location : **At Township**
Environmental Condition : **Temperature (°C) : 33.0 | Humidity (%) : 54.0**
Sampling Method & Plan : **IS 5182 Part-5 & Part 14**

Received Date : 17/03/2025
Commenced Date : 17/03/2025
Completed On : 21/03/2025
Report Date : 21/03/2025
Sample qty : NA

S.No.	Test Parameters	Units	Results	Test Method	NAAQ Standards : 2009	
Discipline : Chemical						
1	Lead	µg/m3	BLQ (LOQ: 0.002)	HECS-G/INS/SOP/ 041 Issue No.:01 Issue Date:01.03.2021	1 (24 hours)	0.5 (Annual)
2	Arsenic	ng/m3	BLQ (LOQ: 2.0)	HECS-G/INS/SOP/ 041 Issue No.:01 Issue Date:01.03.2021	6 (Annual)	6 (Annual)
3	Nickel	ng/m3	BLQ (LOQ: 2.0)	HECS-G/INS/SOP/ 041 Issue No.:01 Issue Date:01.03.2021	20 (Annual)	20 (Annual)
4	Benzene	µg/m3	BLQ (LOQ: 0.1)	IS 5182 Part 11: 2006	5 (Annual)	5 (Annual)
5	Benzo (a) pyrene	ng/m³	BLQ (LOQ: 0.1)	IS : 5182 Part 12: 2004	1 (Annual)	1 (Annual)
6	Ammonia as NH3	µg/m³	7.40	IS 5182 (Part 25) 2018	400 (24 hours)	100 (Annual)
7	Carbon Monoxide (CO)	mg/ m³	0.46	IS 5182 (Part 10) Clause 4 1999	4 (1 hours)	2 (8 hours)
8	Nitrogen dioxides as NO2	µg/m³	22.38	IS 5182 (Part 6) 2006	80 (24 hours)	40 (Annual)
9	Ozone as O3	µg/m³	13.52	IS 5182 (Part 9) 1974	180 (1 hours)	100 (8 hours)
10	Particulate matter (Size less than 10 µm)	µg/m³	57.90	IS 5182 (Part 23) 2006	100 (24 hours)	60 (Annual)
11	Particulate matter (Size less than 2.5 µm)	µg/m³	26.58	IS 5182 (Part 24) 2019	60 (24 hours)	40 (Annual)
12	Sulphur dioxide as SO2	µg/m³	12.05	IS 5182 (Part 2) 2001	80 (24 hours)	50 (Annual)

Note:- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, µg/m³- Micrograms per cubic meter, mg/m³-Milligrams per cubic meter, ng/m³-Nanograms per cubic meter.

Remarks: The Tested Parameters as above are within the Limits of NAAQ Standards 2009.

End Report

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

		ULR	: TC1231025000013564F
		Report No	: HECS/AP/034/170325
Name of the Client	: M/s. NTPC LTD.,	Sample ID No	: 170325062
		Sampling Date	: 14/03/2025 To 15/03/2025
Address of the Client	: Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India		
Group	: Atmospheric Pollution	Received Date	: 17/03/2025
Sample Name	: Ambient Air	Commenced Date	: 17/03/2025
Sample Mark	: NA	Completed On	: 21/03/2025
Sample Reference	: NA	Report Date	: 21/03/2025
Sample Drawn By	: M/s.Hubert Enviro care Systems (P) Ltd.	Sample qty	: NA
Sample Location	: Near Gate No 03		
Environmental Condition	: Temperature (°C) : 30.0 | Humidity (%) : 54.0		
Sampling Method & Plan	: IS 5182 Part-5 & Part 14		

S.No.	Test Parameters	Units	Results	Test Method	NAAQ Standards : 2009	
Discipline : Chemical						
1	Lead	µg/m3	BLQ (LOQ: 0.002)	HECS-G/INS/SOP/ 041 Issue No.:01 Issue Date:01.03.2021	1 (24 hours)	0.5 (Annual)
2	Arsenic	ng/m3	BLQ (LOQ: 2.0)	HECS-G/INS/SOP/ 041 Issue No.:01 Issue Date:01.03.2021	6 (Annual)	6 (Annual)
3	Nickel	ng/m3	BLQ (LOQ: 2.0)	HECS-G/INS/SOP/ 041 Issue No.:01 Issue Date:01.03.2021	20 (Annual)	20 (Annual)
4	Benzene	µg/m3	BLQ (LOQ: 0.1)	IS 5182 Part 11: 2006	5 (Annual)	5 (Annual)
5	Benzo (a) pyrene	ng/m³	BLQ (LOQ: 0.1)	IS : 5182 Part 12: 2004	1 (Annual)	1 (Annual)
6	Ammonia as NH3	µg/m³	6.56	IS 5182 (Part 25) 2018	400 (24 hours)	100 (Annual)
7	Carbon Monoxide (CO)	mg/ m³	0.63	IS 5182 (Part 10) Clause 4 1999	4 (1 hours)	2 (8 hours)
8	Nitrogen dioxides as NO2	µg/m³	20.82	IS 5182 (Part 6) 2006	80 (24 hours)	40 (Annual)
9	Ozone as O3	µg/m³	14.16	IS 5182 (Part 9) 1974	180 (1 hours)	100 (8 hours)
10	Particulate matter (Size less than 10 µm)	µg/m³	60.28	IS 5182 (Part 23) 2006	100 (24 hours)	60 (Annual)
11	Particulate matter (Size less than 2.5 µm)	µg/m³	27.35	IS 5182 (Part 24) 2019	60 (24 hours)	40 (Annual)
12	Sulphur dioxide as SO2	µg/m³	13.46	IS 5182 (Part 2) 2001	80 (24 hours)	50 (Annual)

Note:- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, µg/m³- Micrograms per cubic meter, mg/m³-Milligrams per cubic meter, ng/m³-Nanograms per cubic meter.

Remarks: The Tested Parameters as above are within the Limits of NAAQ Standards 2009.

End Report

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

Name of the Client	: M/s. NTPC LTD.,	ULR	: TC1231025000013566F
		Report No.	: HECS/AP/036/170325
		Sample ID No	: 170325064
		Sampling Date	: 14/03/2025 To 15/03/2025
Address of the Client	: Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India		
Group	: Atmospheric Pollution	Received Date	: 17/03/2025
Sample Name	: Ambient Air	Commenced Date	: 17/03/2025
Sample Mark	: NA	Completed On	: 21/03/2025
Sample Reference	: NA	Report Date	: 21/03/2025
Sample Drawn By	: M/s.Hubert Enviro care Systems (P) Ltd.	Sample qty	: NA
Sample Location	: At Dalchi Village		
Environmental Condition	: Temperature (°C) : 33.0 | Humidity (%) : 54.0		
Sampling Method & Plan	: IS 5182 Part-5 & Part 14		

S.No.	Test Parameters	Units	Results	Test Method	NAAQ Standards : 2009	
Discipline : Chemical						
1	Lead	µg/m3	BLQ (LOQ: 0.002)	HECS-G/INS/SOP/ 041 Issue No.:01 Issue Date:01.03.2021	1 (24 hours)	0.5 (Annual)
2	Arsenic	ng/m3	BLQ (LOQ: 2.0)	HECS-G/INS/SOP/ 041 Issue No.:01 Issue Date:01.03.2021	6 (Annual)	6 (Annual)
3	Nickel	ng/m3	BLQ (LOQ: 2.0)	HECS-G/INS/SOP/ 041 Issue No.:01 Issue Date:01.03.2021	20 (Annual)	20 (Annual)
4	Benzene	µg/m3	BLQ (LOQ: 0.1)	IS 5182 Part 11: 2006	5 (Annual)	5 (Annual)
5	Benzo (a) pyrene	ng/m³	BLQ (LOQ: 0.1)	IS : 5182 Part 12: 2004	1 (Annual)	1 (Annual)
6	Ammonia as NH3	µg/m³	9.40	IS 5182 (Part 25) 2018	400 (24 hours)	100 (Annual)
7	Carbon Monoxide (CO)	mg/ m³	0.5	IS 5182 (Part 10) Clause 4 1999	4 (1 hours)	2 (8 hours)
8	Nitrogen dioxides as NO2	µg/m³	26.82	IS 5182 (Part 6) 2006	80 (24 hours)	40 (Annual)
9	Ozone as O3	µg/m³	17.53	IS 5182 (Part 9) 1974	180 (1 hours)	100 (8 hours)
10	Particulate matter (Size less than 10 µm)	µg/m³	76.40	IS 5182 (Part 23) 2006	100 (24 hours)	60 (Annual)
11	Particulate matter (Size less than 2.5 µm)	µg/m³	35.19	IS 5182 (Part 24) 2019	60 (24 hours)	40 (Annual)
12	Sulphur dioxide as SO2	µg/m³	14.02	IS 5182 (Part 2) 2001	80 (24 hours)	50 (Annual)

Note:- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, µg/m³- Micrograms per cubic meter, mg/m³-Milligrams per cubic meter, ng/m³-Nanograms per cubic meter.

Remarks: The Tested Parameters as above are within the Limits of NAAQ Standards 2009.

End Report

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12210

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR : TC1231025000013230F
Report No. : HECS/AP/039/170325
Sample ID No : 170325067
Sampling Date : 15/03/2025

Name of the Client : **M/s. NTPC LTD.,**

Address of the Client : **Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India**

Group : **Atmospheric Pollution**
Sample Name : **Ambient Noise Levels (Excluding vibration)**
Sample Mark : **Noise**
Sample Reference : **NA**
Sample Drawn By : **M/s.Hubert Enviro care Systems (P) Ltd.**
Sample Location : **NA**
Environmental Condition : **Temperature (°C) : 30.0 | Humidity (%) : 54.0**
Sampling Method & Plan : **IS 9989:1981**

Received Date : 17/03/2025
Commenced Date : 17/03/2025
Completed On : 18/03/2025
Report Date : 18/03/2025
Sample qty : NA

S.No	Location	Day Noise Level in dB(A)	Night Noise Level in dB(A)
Discipline : Chemical			
1	Near DG Set No.1	59.7	52.2
2	Near Material Gate No.3	58.2	50.9
3	Near Main Gate No.1	57.4	47.6
4	Near Township	50.2	42.8

Note :- Day time-06.00AM to 10.00PM, Night time-10.00PM to 06.00AM

Limits set by CPCB:

i.	Industrial Area	: Day Time-75 dB (A);	Night Time-70 dB (A).
ii.	Commercial Area	: Day Time-65 dB (A);	Night Time-55 dB (A).
iii.	Residential Area	: Day Time-55 dB (A);	Night Time-45 dB (A).
iv.	Silence Zone	: Day Time-50 dB (A);	Night Time-40 dB (A).

Remarks:- The noise level meets the requirement of CPCB Limits.

End of Report

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR	: TC1231025000013735F
Report No.	: HECS/AP/038/170325
Sample ID No	: 170325066
Sampling Date	: 15/03/2025
Name of the Client	: M/s. NTPC LTD.,
Address of the Client	: Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India
Group	: Atmospheric Pollution
Sample Name	: Stack Emission
Sample Mark	: FGD Stack Unit II
Sample Reference	: F8419
Sample Drawn By	: M/s.Hubert Enviro care Systems (P) Ltd.
Sample Location	: NA
Environmental Condition	: Temperature (°C) : 30.0 | Humidity (%) : 54.0
Sampling Method & Plan	: IS 11255
Sampling Time	: 12.25 PM-01.18PM
Received Date	: 17/03/2025
Commenced Date	: 17/03/2025
Completed On	: 22/03/2025
Report Date	: 22/03/2025
Sample qty	: NA

Stack Details

S.No.	Particulars	Units	Stack Specification
1	Stack Height	Meter	150.0
2	Stack Diameter	Meter	8.0

Discipline : Chemical

S.No.	Test Parameters	Units	Results	Test Method	CPCB Standards
1	Flue Gas Velocity	m/sec	13.6	IS 11255 (Part 3) 2008	-
2	Particulate matter (PM)	mg/Nm³	8.56	IS 11255 Part 1 1985	CNTE 150
3	Sulphur dioxide (SO2)	mg/Nm³	21.28	IS 11255 (Part 2) 1985	-
4	Nitrogen dioxide (NO2)	mg/Nm³	315.90	IS 11255 (Part 7) 2005	
5	Carbon dioxide(CO2)	%	13.9	IS 13270 Clause 4 1992	-
6	Oxygen (O2)	%	7.0	IS 13270 Clause 4 1992	-
7	Flue Gas Temperature	°C	68.0	IS 11255 (Part 3) 2008	-

Note:- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, CNTE- Concentration not to Exceed,

mg/Nm³- Milligrams per Normal cubic meter, °C- Degree Celsius,m/s- Meter per second, % V/V - Percentage, NA - Not Applicable.

Remarks: The Tested Parameters as above are within the Limits of CPCB Stack Emission Standards.

***-Values of PM, SO2, NOx are Corrected with reference conditions of STP (25oC, 1 bar), dry and 6% O2.**

End of Report*

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS, FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

		Report No.	: HECS/AP/038/170325N
Name of the Client	: M/s. NTPC LTD.,	Sample ID No	: 170325066
		Sampling Date	: 15/03/2025
Address of the Client	: Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India		
Group	: Atmospheric Pollution	Received Date	: 17/03/2025
Sample Name	: Stack Emission	Commenced Date	: 17/03/2025
Sample Mark	: FGD Stack Unit II	Completed On	: 22/03/2025
Sample Reference	: NA	Report Date	: 22/03/2025
Sample Drawn By	: M/s.Hubert Enviro care Systems (P) Ltd.	Sample qty	: NA
Sample Location	: NA		
Environmental Condition	: Temperature (°C) : 30.0 | Humidity (%) : 54.0		
Sampling Method & Plan	: IS 11255		
Sampling Time	: 12.25 PM-01.18PM		

Discipline : Chemical

S.No.	Test Parameters	Units	Results	Test Method	CPCB Standards
1	Mercury	mg/Nm³	BLQ (LOQ: 0.1)	USEPA Method 0060 :1996	-
2	Flue Gas Discharge (Flow Rate)	Nm³/hr	1951589.0	IS 11255 (Part 3) 2008	-

Note:- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, Nm³/hr - Normal cubic meter per hour, mg/Nm³- Milligrams per Normal cubic meter.

End of Report

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR : TC1231025000013734F
Report No. : HECS/AP/037/170325
Sample ID No : 170325065
Sampling Date : 15/03/2025

Name of the Client : M/s. NTPC LTD.,
Address of the Client : Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India
Group : Atmospheric Pollution
Sample Name : Stack Emission
Sample Mark : Boiler Stack Unit 1
Sample Reference : F8402
Sample Drawn By : M/s.Hubert Enviro care Systems (P) Ltd.
Sample Location : NA
Environmental Condition : Temperature (°C) : 30.0 | Humidity (%) : 54.0
Sampling Method & Plan : IS 11255
Sampling Time : 04.00PM-04.35 PM

Received Date : 17/03/2025
Commenced Date : 17/03/2025
Completed On : 22/03/2025
Report Date : 22/03/2025
Sample qty : NA

Stack Details

S.No.	Particulars	Units	Stack Specification
1	Stack Height	Meter	275.0
2	Stack Diameter	Meter	8.0

Discipline : Chemical

S.No.	Test Parameters	Units	Results	Test Method	CPCB Standards
1	Flue Gas Velocity	m/sec	22.6	IS 11255 (Part 3) 2008	-
2	Particulate matter (PM)	mg/Nm³	19.5	IS 11255 Part 1 1985	CNTE 150
3	Sulphur dioxide (SO2)	mg/Nm³	1186.0	IS 11255 (Part 2) 1985	-
4	Nitrogen dioxide (NO2)	mg/Nm³	428.0	IS 11255 (Part 7) 2005	-
5	Carbon dioxide(CO2)	%	13.2	IS 13270 Clause 4 1992	-
6	Oxygen (O2)	%	7.7	IS 13270 Clause 4 1992	-
7	Flue Gas Temperature	°C	147.0	IS 11255 (Part 3) 2008	-

Note:- CNTE- Concentration not to Exceed, mg/Nm³- Milligrams per Normal cubic meter, °C- Degree Celsius, m/s- Meter per second, % V/V – Percentage.

Remarks: The Tested Parameters as above are within the Limits of CPCB Stack Emission Standards.

***-Values of PM, SO2, NOx are Corrected with reference conditions of STP (25oC, 1 bar), dry and 6% O2.**

End of Report

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS, FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

Report No.	: HECS/AP/037/170325N
Name of the Client	: M/s. NTPC LTD.,
Sample ID No	: 170325065
Sampling Date	: 15/03/2025
Address of the Client	: Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India
Group	: Atmospheric Pollution
Received Date	: 17/03/2025
Sample Name	: Stack Emission
Commenced Date	: 17/03/2025
Sample Mark	: Boiler Stack Unit I
Completed On	: 22/03/2025
Sample Reference	: F8402
Report Date	: 22/03/2025
Sample Drawn By	: M/s.Hubert Enviro care Systems (P) Ltd.
Sample qty	: NA
Sample Location	: NA
Environmental Condition	: Temperature (°C) : 30.0 | Humidity (%) : 54.0
Sampling Method & Plan	: IS 11255
Sampling Time	: 04.00PM-04.35 PM

S.No.	Test Parameters	Units	Results	Test Method
Discipline : Chemical				
1	Mercury	mg/Nm³	BLQ (LOQ: 0.01)	USEPA Method 0060 :1996
2	Flue Gas Discharge (Flow Rate)	Nm³/hr	2516566.0	IS 11255 (Part 3) 2008

Note:- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, Nm³/hr - Normal cubic meter per hour, mg/Nm³- Milligrams per Normal cubic meter.

End of Report

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR : TC1231025000013738F
Report No : HECS/PE/017/170325
Sample ID No : 170325070
Sampling Date : 15/03/2025

Name of the Client : M/s. NTPC LTD.,
Address of the Client : Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India
Group : Pollution & Environment
Sample Name : Waste Water
Sample Mark : Main Plant Effluent Water
Sample Reference : NA
Sample Drawn By : M/s.Hubert Enviro care Systems (P) Ltd.
Sample Location : NA
Environmental Condition : Temperature (°C) : 28.0 | Humidity (%) : 57.0
Sampling Method & Plan : IS 17614 (Part-10) : 2021

Received Date : 17/03/2025
Commenced Date : 17/03/2025
Completed On : 22/03/2025
Report Date : 22/03/2025
Sample qty : 2 Litres

S.No.	Test Parameters	Units	Results	Test Method
Discipline : Chemical				
1	Arsenic	mg/l	BLQ (LOQ: 0.005)	USEPA 200.8 Revision 5.4: 1994
2	Cadmium	mg/l	BLQ (LOQ: 0.01)	USEPA 200.8 Revision 5.4: 1994
3	Chromium	mg/l	BLQ (LOQ: 0.01)	USEPA 200.8 Revision 5.4: 1994
4	Copper	mg/l	BLQ (LOQ: 0.1)	USEPA 200.8 Revision 5.4: 1994
5	Manganese	mg/l	BLQ (LOQ: 0.1)	USEPA 200.8 Revision 5.4: 1994
6	Nickel	mg/l	BLQ (LOQ: 0.1)	USEPA 200.8 Revision 5.4: 1994
7	Selenium	mg/l	BLQ (LOQ: 0.005)	USEPA 200.8 Revision 5.4: 1994
8	Zinc	mg/l	BLQ (LOQ: 0.1)	USEPA 200.8 Revision 5.4: 1994
9	Ammonia as NH3	mg/l	BLQ (LOQ 0.1)	IS 3025 (Part 34) Clause 2.3 1988
10	Ammonical Nitrogen as NH3-N	mg/l	BLQ (LOQ 0.1)	IS 3025 (Part 34) Clause 2.5 1988
11	Bio-Chemical Oxygen Demand(BOD) 3	mg/l	5.0	IS 3025 (Part 44) 1993
12	Boron as B	mg/l	BLQ (LOQ 0.1)	IS 3025 (Part 57) Clause 6 2021
13	Chemical Oxygen Demand (COD)	mg/l	28.0	IS 3025 (Part 58) 2006
14	Chloride as Cl-	mg/l	186.99	IS 3025 (Part 32) Clause 2 1988
15	Colour	Hazen	BLQ(LOQ 1.0)	IS 3025 (Part 4) Clause 2.4 2021
16	Cyanide as CN	mg/l	BLQ (LOQ 0.01)	IS 3025 Part 27 Clause 2 1986
17	Fluorides as F	mg/l	BLQ (LOQ 0.1)	APHA 23 rd Edn. 4500 D-F Spadns
18	Free Residual Chlorine	mg/l	BLQ (LOQ 0.1)	IS 3025 (Part 26) Clause 5 2021

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR : TC1231025000013738F
Report No. : HECS/PE/017/170325
Sample ID No : 170325070
Sampling Date : 15/03/2025

Name of the Client : M/s. NTPC LTD.,

Address of the Client : Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India

Group : Pollution & Environment
Sample Name : Waste Water
Sample Mark : Main Plant Effluent Water
Sample Reference : NA
Sample Drawn By : M/s.Hubert Enviro care Systems (P) Ltd.
Sample Location : NA
Environmental Condition : Temperature (°C) : 28.0 | Humidity (%) : 57.0
Sampling Method & Plan : IS 17614 (Part-10) : 2021

Received Date : 17/03/2025
Commenced Date : 17/03/2025
Completed On : 22/03/2025
Report Date : 22/03/2025
Sample qty : 2 Litres

S.No.	Test Parameters	Units	Results	Test Method
19	Hexavalent Chromium as Cr6+	mg/l	BLQ (LOQ 0.05)	IS 3025 (Part 52) Clause 6 2003
20	Iron as Fe	mg/l	BLQ (LOQ 0.02)	IS 3025 (Part 53) Clause 6 2003
21	Nitrate Nitrogen as N	mg/l	1.54	IS:3025 (Part 34) Clause 3.3 1988
22	Odour	-	Disagreeable	IS 3025 (Part 5) 1983
23	Oil and grease	mg/l	BLQ (LOQ 4.0)	IS : 3025 (Part 39) Clause 5 2021
24	pH value @ 25 ° C	-	7.18	IS 3025 (Part 11) Clause 2 2022
25	Phenolic compound	mg/l	BLQ (LOQ 0.01)	IS 3025 (Part 43) Clause 5 1992
26	Dissolved Phosphate as P	mg/l	BLQ (LOQ 0.1)	APHA 23 rd Edn. 4500 P-B,D 2017
27	Residual Sodium Carbonate	mEq/L	BLQ (LOQ 0.1)	IS:11624 1986
28	Sodium as Na	mg/l	60.0	IS: 3025 (Part 45) Clause 5 1993
29	Sulphate as SO42-	mg/l	110.64	IS:3025 (Part 24) Clause 4 1986
30	Sulphide as S2-	mg/l	BLQ (LOQ 1.0)	IS 3025 (Part 29) Clause 2 1986
31	Temperature	°C	27.4	IS:3025 (Part 09) 1984
32	Total dissolved solids @ 180° C	mg/l	856.0	IS 3025 (Part 16) 1984
33	Total Kjeldahl Nitrogen as N	mg/l	BLQ (LOQ 0.1)	IS 3025 (Part 34) Clause 5.3 1988
34	Total suspended solids @ 105° C	mg/l	4.0	IS: 3025 (Part 17) 1984

Note:- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, mg/l - Milligrams per liter.

End Report

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS, FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

		Report No	: HECS/PE/017/170325/N
Name of the Client	: **M/s. NTPC LTD.,**	Sample ID No	: **170325070**
		Sampling Date	: **15/03/2025**
Address of the Client	: **Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India**		
Group	: **Pollution & Environment**	Received Date	: **17/03/2025**
Sample Name	: **Waste Water**	Commenced Date	: **17/03/2025**
Sample Mark	: **Main Plant Effluent Water**	Completed On	: **22/03/2025**
Sample Reference	: NA	Report Date	: **22/03/2025**
Sample Drawn By	: M/s.Hubert Enviro care Systems (P) Ltd.	Sample qty	: **2 Litres**
Sample Location	: NA		
Environmental Condition	: **Temperature (°C) : 28.0** | **Humidity (%) : 57.0**		
Sampling Method & Plan	: **IS 17614 (Part-10) : 2021**		

S.No.	Test Parameters	Units	Results	Test Method
Discipline : Chemical				
1	Mercury	mg/l	BLQ (LOQ: 0.1)	USEPA 200.8 Revision 5.4: 1994
2	Lead	mg/l	BLQ (LOQ: 0.1)	USEPA 200.8 Revision 5.4: 1994
3	Bio assay	%	90.0	IS 6582 (Part 2) 2001

Note:- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, mg/l - Milligrams per liter.

End Report

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12318

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR	: TC1231025000013567F
Report No.	: HECS/PE/021/170325
Sample ID No	: 170325074
Sampling Date	: 15/03/2025
Name of the Client	: M/s. NTPC LTD.,
Address of the Client	: Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India
Group	: Pollution & Environment
Sample Name	: Waste Water
Sample Mark	: STP Outlet
Sample Reference	: NA
Sample Drawn By	: M/s.Hubert Enviro care Systems (P) Ltd.
Sample Location	: At Plant
Environmental Condition	: Temperature (°C) : 28.0 | Humidity (%) : 57.0
Sampling Method & Plan	: IS 17614 (Part-10) : 2021
Received Date	: 17/03/2025
Commenced Date	: 17/03/2025
Completed On	: 20/03/2025
Report Date	: 21/03/2025
Sample qty	: 2 Litres

S.No.	Test Parameters	Units	Results	Test Method	CPCB Limits
Discipline : Chemical					
1	Ammonical Nitrogen as NH3-N	mg/l	1.08	IS 3025 (Part 34) Clause 2.5 1988	NA
2	Bio-Chemical Oxygen Demand(BOD) 3 days @27 °C	mg/l	3.0	IS 3025 (Part 44) 1993	20
3	Chemical Oxygen Demand (COD)	mg/l	16.0	IS 3025 (Part 58) 2006	NA
4	Odour	-	Agreeable	IS 3025 (Part 5) 1983	NA
5	Oil and grease	mg/l	BLQ (LOQ 4.0)	IS : 3025 (Part 39) Clause 5 2021	NA
6	pH value @ 25 °C	-	7.30	IS 3025 (Part 11) Clause 2 2022	5.5 - 9.0
7	Dissolved Phosphate as P	mg/l	BLQ (LOQ 0.1)	APHA 23 rd Edn. 4500 P-B.D 2017	NA
8	Sulphide as S2-	mg/l	BLQ (LOQ 1.0)	IS 3025 (Part 29) Clause 2 1986	NA
9	Temperature	°C	27.2	IS:3025 (Part 09) 1984	NA
10	Total dissolved solids @ 180° C	mg/l	696.0	IS 3025 (Part 16) 1984	NA
11	Total Nitrogen as N	mg/l	3.48	HECS-G/ENV/WW/SOP/004 Issue No.:01 Issue Date:02.07.2020	NA
12	Total suspended solids @ 105° C	mg/l	2.0	IS: 3025 (Part 17) 1984	50

Note:- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, mg/l - Milligrams per liter.
Remarks: STP Outlet as above parameters meets CPCB Standards.

End Report

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR : TC1231025000013569F
Report No. : HECS/PE/023/170325
Sample ID No : 170325076
Sampling Date : 15/03/2025

Name of the Client : **M/s. NTPC LTD.,**
Address of the Client : **Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India**

Received Date : 17/03/2025
Commenced Date: 17/03/2025
Completed On : 20/03/2025
Report Date : 21/03/2025
Sample qty : 100ml

Group : **Pollution & Environment**
Sample Name : **Effuluents& Waste**
Sample Mark : **STP Outlet**
Sample Reference : NA
Sample Drawn By : M/s.Hubert Enviro care Systems (P) Ltd.
Sample Location : At Plant
Environmental Condition : Temperature (°C) : 22.0 | Humidity (%) : 45.0
Sampling Method & Plan : APHA 23rd Edition Part 9260

S.No.	Test Parameters	Units	Results	Test Method	CPCB Limits
Discipline : Biological					
1	Faecal Coliform	MPN/100ml	49	APHA 23rd Edition Part 9221	1000

Note:- MPN-Most Propable Number.

Remarks: STP Outlet as above parameters meets CPCB Standards.

End of Report

21/3/2025

Jisha S Prakash
Microbiology-Head
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

		ULR	: TC1231025000013568F
		Report No.	: HECS/PE/022/170325
Name of the Client	: **M/s. NTPC LTD.,**	Sample ID No	: 170325075
		Sampling Date	: 15/03/2025
Address of the Client	: **Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India**		
Group	: **Pollution & Environment**	Received Date	: 17/03/2025
Sample Name	: **Waste Water**	Commenced Date	: 17/03/2025
Sample Mark	: **STP Outlet**	Completed On	: 20/03/2025
Sample Reference	: **NA**	Report Date	: 21/03/2025
Sample Drawn By	: **M/s.Hubert Enviro care Systems (P) Ltd.**	Sample qty	: 2 Litres
Sample Location	: **At Township**		
Environmental Condition	: **Temperature (°C) : 30.0 | Humidity (%) : 54.0**		
Sampling Method & Plan	: **IS 17614 (Part -10) : 2021**		

S.No.	Test Parameters	Units	Results	Test Method	CPCB Limits
Discipline : Chemical					
1	Ammonical Nitrogen as NH3-N	mg/l	3.42	IS 3025 (Part 34) Clause 2.5 1988	NA
2	Bio-Chemical Oxygen Demand(BOD) 3 days @27 ° C	mg/l	4.0	IS 3025 (Part 44) 1993	20
3	Chemical Oxygen Demand (COD)	mg/l	24.0	IS 3025 (Part 58) 2006	NA
4	Odour	-	Agreeable	IS 3025 (Part 5) 1983	NA
5	Oil and grease	mg/l	BLQ (LOQ 4.0)	IS : 3025 (Part 39) Clause 5 2021	NA
6	pH value @ 25 ° C	-	7.12	IS 3025 (Part 11) Clause 2 2022	5.5 - 9.0
7	Dissolved Phosphate as P	mg/l	BLQ (LOQ 0.1)	APHA 23 rd Edn. 4500 P-B,D 2017	NA
8	Sulphide as S2-	mg/l	BLQ (LOQ 1.0)	IS 3025 (Part 29) Clause 2 1986	NA
9	Temperature	°C	27.6	IS:3025 (Part 09) 1984	NA
10	Total dissolved solids @ 180° C	mg/l	852.0	IS 3025 (Part 16) 1984	NA
11	Total Nitrogen as N	mg/l	9.14	HECS-G/ENV/WW/SOP/004 Issue No.01 Issue Date:02.07.2020	NA
12	Total suspended solids @ 105° C	mg/l	4.0	IS: 3025 (Part 17) 1984	50

Note:- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, mg/l - Milligrams per liter.
Remarks: STP Outlet as above parameters meets CPCB Standards.

End Report

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR : TC1231025000013570F
Report No : HECS/PE/024/170325
Sample ID No : 170325077
Sampling Date : 15/03/2025

Name of the Client : M/s. NTPC LTD.,

Address of the Client : Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India

Group : Pollution & Environment
Sample Name : Effuluents&Waste
Sample Mark : STP Outlet
Sample Reference : NA
Sample Drawn By : M/s.Hubert Enviro care Systems (P) Ltd.
Sample Location : At Township
Environmental Condition : Temperature (°C) : 22.0 | Humidity (%) : 45.0
Sampling Method & Plan : APHA 23rd Edition Part 9260

Received Date : 17/03/2025
Commenced Date : 17/03/2025
Completed On : 20/03/2025
Report Date : 21/03/2025
Sample : 100ml

S.No.	Test Parameters	Units	Results	Test Method	CPCB Limits
Discipline : Biological					
1	Faecal Coliform	MPN/100ml	33	APHA 23rd Edition Part 9221	1000

Note:- MPN-Most Propable Number.

Remarks: STP Outlet as above parameters meets CPCB Standards.

End of Report

21/3/2025

Jisha S Prakash
Microbiology-Head
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR : TC1231025000013739F
Report No. : HECS/PE/018/170325
Sample ID No : 170325071
Sampling Date : 15/03/2025

Name of the Client : **M/s. NTPC LTD.,**
Address of the Client : **Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India**
Group : **Pollution & Environment**
Sample Name : **Waste Water**
Sample Mark : **Ash Pond**
Sample Reference : **NA**
Sample Drawn By : **M/s.Hubert Enviro care Systems (P) Ltd.**
Sample Location : **NA**
Environmental Condition : **Temperature (°C) : 28.0 | Humidity (%) : 57.0**
Sampling Method & Plan : **IS 17614 (Part-10) : 2021**

Received Date : 17/03/2025
Commenced Date : 17/03/2025
Completed On : 22/03/2025
Report Date : 22/03/2025
Sampleqty : 2 Litres

S.No.	Test Parameters	Units	Results	Test Method
Discipline : Chemical				
1	Arsenic	mg/l	BLQ (LOQ: 0.005)	USEPA 200.8 Revision 5.4: 1994
2	Cadmium	mg/l	BLQ (LOQ: 0.01)	USEPA 200.8 Revision 5.4: 1994
3	Chromium	mg/l	BLQ (LOQ: 0.01)	USEPA 200.8 Revision 5.4: 1994
4	Oil and grease	mg/l	BLQ (LOQ 4.0)	IS : 3025 (Part 39) Clause 5 2021
5	pH value @ 25 ° C	-	7.70	IS 3025 (Part 11) Clause 2 2022
6	Phosphate as PO43-	mg/l	BLQ (LOQ 0.2)	HECS-G/ENV/WW/SOP/006 Issue No.01 Issue Date:02.07 2020
7	Temperature	°C	27.6	IS:3025 (Part 09) 1984
8	Total dissolved solids @ 180° C	mg/l	814.0	IS 3025 (Part 16) 1984
9	Total suspended solids @ 105° C	mg/l	6.0	IS: 3025 (Part 17) 1984

Note:- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, mg/l - Milligrams per liter.

End Report

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS, FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

Report No : HECS/PE/018/170325/N
Sample ID No : 170325071
Sampling Date : 15/03/2025

Name of the Client : M/s. NTPC LTD.,
Address of the Client : Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India
Group : Pollution & Environment
Sample Name : Waste Water
Sample Mark : Ash Pond
Sample Reference : NA
Sample Drawn By : M/s.Hubert Enviro care Systems (P) Ltd.
Sample Location : NA
Environmental Condition : Temperature (°C) : 28.0 | Humidity (%) : 57.0
Sampling Method & Plan : IS 17614 (Part-10) : 2021

Received Date : 17/03/2025
Commenced Date : 17/03/2025
Completed On : 22/03/2025
Report Date : 22/03/2025
Sample qty : 2 Litres

S.No.	Test Parameters	Units	Results	Test Method
Discipline : Chemical				
1	Mercury	mg/l	BLQ (LOQ: 0.1)	USEPA 200.8 Revision 5.4: 1994
2	Lead	mg/l	BLQ (LOQ: 0.1)	USEPA 200.8 Revision 5.4: 1994

Note:- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, mg/l - Milligrams per liter.

End Report

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR : TC1231025000005385F
Report No. : HECSL/WT/007/250125
Sample ID No : 250125057
Sampling Date : 24/01/2025

Name of the Client : **M/s. NTPC LTD.,**

Address of the Client : **Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India**

Group : **Water**
Sample Name : **Surface Water**
Sample Mark : **Pond 1**
Sample Reference : **NA**
Sample Drawn By : **M/s.Hubert Enviro care Systems (P) Ltd.**
Sample Location : **Selda**
Environmental Condition : **Temperature (°C) : 22.0 | Humidity (%) : 45.0**
Sampling Method & Plan : **IS 17614 (Part -1) : 2021**

Received Date : 25/01/2025
Commenced Date : 25/01/2025
Completed On : 30/01/2025
Report Date : 04/02/2025
Sample qty : 2 Litres

S.No.	Test Parameters	Units	Results	Test Method
Discipline : Chemical				
1	Ammonical Nitrogen as NH3-N	mg/l	0.52	IS 3025 Part 34 Sec 2: 2021
2	Biological Oxygen Demand (BOD)@ 27°C For 3 days	mg/l	3.0	IS 3025 Part 44: 1993
3	Boron as B	mg/l	BLQ(LOQ:0.1)	IS 3025 Part 57: 2021 (Curcumin Method)
4	Calcium as Ca	mg/l	72.14	IS 3025 Part 40: 1991(EDTA Titrimetric Method)
5	Chemical Oxygen Demand (COD)	mg/l	24.0	IS 3025 Part 58: 2006
6	Chloride as Cl	mg/l	59.38	IS 3025 Part 32: 1988 (Argentometric Method)
7	Colour	Hazen units	BLQ(LOQ:1.0)	IS 3025 Part 4: 2021
8	Dissolved oxygen	mg/l	6.2	IS 3025 Part 38: 1989
9	Electrical Conductivity at 25°C	µS/cm	720.0	IS:3025 Part 14: 2013
10	Fluoride as F	mg/l	0.35	APHA 23rd edition Method 4500 F -B,D: 2017
11	Iron as Fe	mg/l	0.715	IS 3025 Part 53: 2003
12	Nitrate as NO3	mg/l	4.67	APHA 23rd edition Method 4500 NO3B: 2017
13	Nitrate Nitrogen as NO3-N	mg/l	1.02	IS 3025 Part 34 Sec 3: 2021
14	Odour		Agreeable	IS 3025 Part 5: 2018

HUBERT ENVIRO CARE SYSTEMS (P) LTD. Chennai 600 032

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR	: TC1231025000005385F
Report No	: HECSL/WT/007/250125
Sample ID No	: 250125057
Sampling Date	: 24/01/2025
Received Date	: 25/01/2025
Commenced Date	: 25/01/2025
Completed On	: 30/01/2025
Report Date	: 04/02/2025
Sample qty	: 2 Litres

Name of the Client	: M/s. NTPC LTD.,
Address of the Client	: Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India
Group	: Water
Sample Name	: Surface Water
Sample Mark	: Pond 1
Sample Reference	: NA
Sample Drawn By	: M/s.Hubert Enviro care Systems (P) Ltd.
Sample Location	: Selda
Environmental Condition	: Temperature (°C) : 22.0 | Humidity (%) : 45.0
Sampling Method & Plan	: IS 17614 (Part -1) : 2021

S.No.	Test Parameters	Units	Results	Test Method
15	Oil and Grease	mg/l	BLQ(LOQ:4.0)	IS 3025 Part 39: 2021
16	pH at 25°C		7.63	IS 3025 Part 11: 2022 (Electrometric Method)
17	Total dissolved solids	mg/l	381.0	IS 3025 Part 16: 1984
18	Carbonate	mg/l	BLQ(LOQ:1.0)	IS 3025 Part 51: 2001
19	Magnesium as Mg	mg/l	31.59	IS 3025 Part 46: 1994 (Volumetric Method using EDTA)
20	Phenolic compounds as C6H5OH	mg/l	BLQ(LOQ:0.001)	IS 3025 Part 43:Sec 1: 2022
21	Phosphate as PO4	mg/l	0.053	APHA 23rd edition Method 4500-P B.D: 2017
22	Dissolved phosphate as PO4	mg/l	0.031	APHA 23rd edition Method 4500-P B.D: 2017
23	Potassium as K	mg/l	3.0	IS 3025 Part 45: 1993
24	Residual Sodium Carbonate	mg/l	BLQ(LOQ:1.0)	IS 11624: 2019
25	Sodium Adsorption Ratio(SAR)	Square root of (millimole/litre)	0.738	IS 11624: 2019
26	Sodium as Na	mg/l	30.0	IS 3025 Part 45: 1983
27	Sulphate as SO4	mg/l	83.34	IS 3025 Part 24 Sec 1: 2022
28	Temperature(°C)	°C	26.8	IS 3025 Part 9: 1984
29	Total alkalinity as CaCO3	mg/l	140.0	IS 3025 Part 23: 1986
30	Total Suspended Solids	mg/l	32.0	IS 3025 Part 17: 1984

HUBERT ENVIRO CARE SYSTEMS (P) LTD. Chennai 600 032

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR : TC1231025000005385F
Report No : HECSL/WT/007/250125
Sample ID No : 250125057
Sampling Date : 24/01/2025

Name of the Client : **M/s. NTPC LTD.,**
Address of the Client : **Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India**
Group : **Water**
Sample Name : **Surface Water**
Sample Mark : **Pond 1**
Sample Reference : **NA**
Sample Drawn By : **M/s.Hubert Enviro care Systems (P) Ltd.**
Sample Location : **Selda**
Environmental Condition : **Temperature (°C) : 22.0 | Humidity (%) : 45.0**
Sampling Method & Plan : **IS 17614 (Part -1) : 2021**

Received Date : 25/01/2025
Commenced Date : 25/01/2025
Completed On : 30/01/2025
Report Date : 04/02/2025
Sample qty : 2 Litres

S.No.	Test Parameters	Units	Results	Test Method
31	Turbidity	NTU	31.7	IS 3025 Part 10: 1984
32	Arsenic	mg/l	BLQ (LOQ: 0.005)	USEPA 200.8 : 1994
33	Cadmium	mg/l	BLQ (LOQ: 0.001)	USEPA 200.8 : 1994
34	Chromium	mg/l	BLQ (LOQ: 0.01)	USEPA 200.8 : 1994
35	Copper	mg/l	BLQ (LOQ: 0.01)	USEPA 200.8 : 1994
36	Lead	mg/l	BLQ (LOQ: 0.005)	USEPA 200.8 : 1994
37	Mercury	mg/l	BLQ (LOQ: 0.0005)	USEPA 200.8 : 1994
38	Zinc	mg/l	BLQ (LOQ: 0.01)	USEPA 200.8 : 1994

Note :- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, mg/l- Milligrams per litre.

End Report

HUBERT ENVIRO CARE SYSTEMS (P) LTD Chennai 600 032

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR	: TC1231025000004046F
Report No	: HECSL/WT/019/250125
Sample ID No	: 250125069
Sampling Date	: 24/01/2025
Name of the Client	: M/s. NTPC LTD.,
Address of the Client	: Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India
Group	: Water
Sample Name	: Surface Water
Sample Mark	: Pond 1
Sample Reference	: NA
Sample Drawn By	: M/s.Hubert Enviro care Systems (P) Ltd.
Sample Location	: Selda
Environmental Condition	: Temperature (°C) : 22.0 | Humidity (%) : 45.0
Sampling Method & Plan	: HECS-G/MICRO/SOP/004
Received Date	: 25/01/2025
Commenced Date	: 25/01/2025
Completed On	: 01/02/2025
Report Date	: 01/02/2025
Sample qty	: 100ml

S.No.	Test Parameters	Units	Results	Test Method
Discipline : Biological				
1	Faecal Coliform	MPN/100ml	33	IS 1622 : 1981
2	Total Coliform	MPN/100ml	141	IS 1622 : 1981

Note:- MPN - Most Probable Number, < 2 is Considered as Absent.

End of Report

HUBERT ENVIRO CARE SYSTEMS (P) LTD. Chennai 600 032

Jisha S Prakash
Microbiology-Head
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR : TC1231025000005386F
Report No : HECSL/WT/008/250125
Sample ID No : 250125058
Sampling Date : 24/01/2025

Name of the Client : M/s. NTPC LTD.,
Address of the Client : Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India
Group : Water
Sample Name : Surface Water
Sample Mark : Pond 2
Sample Reference : NA
Sample Drawn By : M/s.Hubert Enviro care Systems (P) Ltd.
Sample Location : Dalchi
Environmental Condition : Temperature (°C) : 22.0 | Humidity (%) : 45.0
Sampling Method & Plan : IS 17614 (Part -1) : 2021

Received Date : 25/01/2025
Commenced Date : 25/01/2025
Completed On : 04/02/2025
Report Date : 04/02/2025
Sample qty : 2 Litres

S.No.	Test Parameters	Units	Results	Test Method
Discipline : Chemical				
1	Ammonical Nitrogen as NH_3-N	mg/l	BLQ(LOQ:0.02)	IS 3025 Part 34 Sec 2: 2021
2	Biological Oxygen Demand (BOD)@ 27°C For 3 days	mg/l	BLQ(LOQ:2.0)	IS 3025 Part 44: 1993
3	Boron as B	mg/l	BLQ(LOQ:0.1)	IS 3025 Part 57: 2021 (Curcumin Method)
4	Calcium as Ca	mg/l	104.21	IS 3025 Part 40: 1991(EDTA Titrimetric Method)
5	Chemical Oxygen Demand (COD)	mg/l	BLQ(LOQ:4.0)	IS 3025 Part 58: 2006
6	Chloride as Cl	mg/l	64.33	IS 3025 Part 32: 1988 (Argentometric Method)
7	Colour	Hazen units	BLQ(LOQ:1.0)	IS 3025 Part 4: 2021
8	Dissolved oxygen	mg/l	6.3	IS 3025 Part 38: 1989
9	Electrical Conductivity at 25°C	µS/cm	870.0	IS:3025 Part 14: 2013
10	Fluoride as F	mg/l	0.43	APHA 23rd edition Method 4500 F -B,D: 2017
11	Iron as Fe	mg/l	BLQ(LOQ:0.01)	IS 3025 Part 53: 2003
12	Nitrate as NO_3	mg/l	43.87	APHA 23rd edition Method 4500 NO3B: 2017
13	Nitrate Nitrogen as NO_3-N	mg/l	9.65	IS 3025 Part 34 Sec 3: 2021
14	Odour		Agreeable	IS 3025 Part 5: 2018

HUBERT ENVIRO CARE SYSTEMS (P) LTD. Chennai 600 032

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR	: TC1231025000005386F
Report No	: HECSL/WT/008/250125
Sample ID No	: 250125058
Sampling Date	: 24/01/2025
Received Date	: 25/01/2025
Commenced Date	: 25/01/2025
Completed On	: 04/02/2025
Report Date	: 04/02/2025
Sample qty	: 2 Litres

Name of the Client	: M/s. NTPC LTD.,
Address of the Client	: Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India
Group	: Water
Sample Name	: Surface Water
Sample Mark	: Pond 2
Sample Reference	: NA
Sample Drawn By	: M/s.Hubert Enviro care Systems (P) Ltd.
Sample Location	: Dalchi
Environmental Condition	: Temperature (°C) : 22.0 | Humidity (%) : 45.0
Sampling Method & Plan	: IS 17614 (Part -1) : 2021

S.No.	Test Parameters	Units	Results	Test Method
15	Oil and Grease	mg/l	BLQ(LOQ:4.0)	IS 3025 Part 39: 2021
16	pH at 25°C		7.84	IS 3025 Part 11: 2022 (Electrometric Method)
17	Total dissolved solids	mg/l	496.0	IS 3025 Part 16: 1984
18	Carbonate	mg/l	BLQ(LOQ:1.0)	IS 3025 Part 51: 2001
19	Magnesium as Mg	mg/l	19.44	IS 3025 Part 46: 1994 (Volumetric Method using EDTA)
20	Phenolic compounds as C6H5OH	mg/l	BLQ(LOQ:0.001)	IS 3025 Part 43:Sec 1: 2022
21	Phosphate as PO4	mg/l	0.029	APHA 23rd edition Method 4500-P B,D: 2017
22	Dissolved phosphate as PO4	mg/l	BLQ(LOQ:0.02)	APHA 23rd edition Method 4500-P B,D: 2017
23	Potassium as K	mg/l	2.0	IS 3025 Part 45: 1993
24	Residual Sodium Carbonate	mg/l	BLQ(LOQ:1.0)	IS 11624: 2019
25	Sodium Adsorption Ratio(SAR)	Square root of (millimole/litre)	0.71	IS 11624: 2019
26	Sodium as Na	mg/l	30.0	IS 3025 Part 45: 1983
27	Sulphate as SO4	mg/l	61.86	IS 3025 Part 24 Sec 1: 2022
28	Temperature(°C)	°C	26.9	IS 3025 Part 9: 1984
29	Total alkalinity as CaCO3	mg/l	220.0	IS 3025 Part 23: 1986
30	Total Suspended Solids	mg/l	8.0	IS 3025 Part 17: 1984

HUBERT ENVIRO CARE SYSTEMS (P) LTD
Chennai 600 032

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR : TC1231025000005386F
Report No : HECSL/WT/008/250125
Sample ID No : 250125058
Sampling Date : 24/01/2025

Name of the Client : M/s. NTPC LTD..

Address of the Client : Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India

Group : Water
Sample Name : Surface Water
Sample Mark : Pond 2
Sample Reference : NA
Sample Drawn By : M/s.Hubert Enviro care Systems (P) Ltd.
Sample Location : Dalchi
Environmental Condition : Temperature (°C) : 22.0 | Humidity (%) : 45.0
Sampling Method & Plan : IS 17614 (Part -1) : 2021

Received Date : 25/01/2025
Commenced Date : 25/01/2025
Completed On : 04/02/2025
Report Date : 04/02/2025
Sample qty : 2 Litres

S.No.	Test Parameters	Units	Results	Test Method
31	Turbidity	NTU	8.2	IS 3025 Part 10: 1984
32	Arsenic	mg/l	BLQ (LOQ: 0.005)	USEPA 200.8 : 1994
33	Cadmium	mg/l	BLQ (LOQ: 0.001)	USEPA 200.8 : 1994
34	Chromium	mg/l	BLQ (LOQ: 0.01)	USEPA 200.8 : 1994
35	Copper	mg/l	BLQ (LOQ: 0.01)	USEPA 200.8 : 1994
36	Lead	mg/l	BLQ (LOQ: 0.005)	USEPA 200.8 : 1994
37	Mercury	mg/l	BLQ (LOQ: 0.0005)	USEPA 200.8 : 1994
38	Zinc	mg/l	BLQ (LOQ: 0.01)	USEPA 200.8 : 1994

Note :- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, mg/l- Milligrams per litre.

End Report

HUBERT ENVIRO CARE SYSTEMS (P) LTD. Chennai 600 032

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR : TC1231025000004047F
Report No : HECSL/WT/020/250125
Sample ID No : 250125070
Sampling Date : 24/01/2025

Name of the Client : M/s. NTPC LTD.,
Address of the Client : Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India

Received Date : 25/01/2025
Commenced Date : 25/01/2025
Completed On : 01/02/2025
Report Date : 01/02/2025
Sample qty : 100ml

Group : Water
Sample Name : Surface Water
Sample Mark : Pond 2
Sample Reference : NA
Sample Drawn By : M/s.Hubert Enviro care Systems (P) Ltd.
Sample Location : Dalchi
Environmental Condition : Temperature (°C) : 22.0 | Humidity (%) : 45.0
Sampling Method & Plan : HECS-G/MICRO/SOP/004

S.No.	Test Parameters	Units	Results	Test Method
Discipline : Biological				
1	Faecal Coliform	MPN/100ml	22	IS 1622 : 1981
2	Total Coliform	MPN/100ml	109	IS 1622 : 1981

Note:- MPN - Most Probable Number, < 2 is Considered as Absent.

End of Report

HUBERT ENVIRO CARE SYSTEMS (P) LTD Chennai 600 032

Jisha S Prakash
Microbiology-Head
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

		ULR	: TC1231025000005387F
		Report No	: HECSL/WT/009/250125
		Sample ID No	: 250125059
Name of the Client	: **M/s. NTPC LTD.,**	Sampling Date	: 24/01/2025
Address of the Client	: **Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India**		
Group	: **Water**	Received Date	: 25/01/2025
Sample Name	: **Surface Water**	Commenced Date	: 25/01/2025
Sample Mark	: **Pond 3**	Completed On	: 30/01/2025
Sample Reference	: **NA**	Report Date	: 04/02/2025
Sample Drawn By	: **M/s.Hubert Enviro care Systems (P) Ltd.**	Sample qty	: 2 Litres
Sample Location	: **Katora**		
Environmental Condition	: **Temperature (°C) : 22.0 | Humidity (%) : 45.0**		
Sampling Method & Plan	: **IS 17614 (Part -1) : 2021**		

S.No.	Test Parameters	Units	Results	Test Method
Discipline : Chemical				
1	Ammonical Nitrogen as NH3-N	mg/l	0.63	IS 3025 Part 34 Sec 2: 2021
2	Biological Oxygen Demand (BOD)@ 27°C For 3 days	mg/l	4.0	IS 3025 Part 44: 1993
3	Boron as B	mg/l	BLQ(LOQ:0.1)	IS 3025 Part 57: 2021 (Curcumin Method)
4	Calcium as Ca	mg/l	28.05	IS 3025 Part 40: 1991(EDTA Titrimetric Method)
5	Chemical Oxygen Demand (COD)	mg/l	16.0	IS 3025 Part 58: 2006
6	Chloride as Cl	mg/l	79.18	IS 3025 Part 32: 1988 (Argentometric Method)
7	Colour	Hazen units	BLQ(LOQ:1.0)	IS 3025 Part 4: 2021
8	Dissolved oxygen	mg/l	5.9	IS 3025 Part 38: 1989
9	Electrical Conductivity at 25°C	µS/cm	741.0	IS:3025 Part 14: 2013
10	Fluoride as F	mg/l	0.37	APHA 23rd edition Method 4500 F -B,D: 2017
11	Iron as Fe	mg/l	0.78	IS 3025 Part 53: 2003
12	Nitrate as NO3	mg/l	7.12	APHA 23rd edition Method 4500 NO3B: 2017
13	Nitrate Nitrogen as NO3-N	mg/l	1.56	IS 3025 Part 34 Sec 3: 2021
14	Odour		Agreeable	IS 3025 Part 5: 2018

HUBERT ENVIRO CARE SYSTEMS (P) LTD. Chennai 600 032

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR : TC1231025000005387F
Report No : HECSL/WT/009/250125
Sample ID No : 250125059
Sampling Date : 24/01/2025

Name of the Client : M/s. NTPC LTD.,
Address of the Client : Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India
Group : Water
Sample Name : Surface Water
Sample Mark : Pond 3
Sample Reference : NA
Sample Drawn By : M/s.Hubert Enviro care Systems (P) Ltd.
Sample Location : Katora
Environmental Condition : Temperature (°C) : 22.0 | Humidity (%) : 45.0
Sampling Method & Plan : IS 17614 (Part -1) : 2021

Received Date : 25/01/2025
Commenced Date : 25/01/2025
Completed On : 30/01/2025
Report Date : 04/02/2025
Sample qty : 2 Litres

S.No.	Test Parameters	Units	Results	Test Method
15	Oil and Grease	mg/l	BLQ(LOQ:4.0)	IS 3025 Part 39: 2021
16	pH at 25°C		7.92	IS 3025 Part 11: 2022 (Electrometric Method)
17	Total dissolved solids	mg/l	395.0	IS 3025 Part 16: 1984
18	Carbonate	mg/l	BLQ(LOQ:1.0)	IS 3025 Part 51: 2001
19	Magnesium as Mg	mg/l	29.16	IS 3025 Part 46: 1994 (Volumetric Method using EDTA)
20	Phenolic compounds as C6H5OH	mg/l	BLQ(LOQ:0.001)	IS 3025 Part 43:Sec 1: 2022
21	Phosphate as PO4	mg/l	0.13	APHA 23rd edition Method 4500-P B,D: 2017
22	Dissolved phosphate as PO4	mg/l	0.11	APHA 23rd edition Method 4500-P B,D: 2017
23	Potassium as K	mg/l	4.0	IS 3025 Part 45: 1993
24	Residual Sodium Carbonate	mg/l	BLQ(LOQ:1.0)	IS 11624: 2019
25	Sodium Adsorption Ratio(SAR)	Square root of (millimole/litre)	1.25	IS 11624: 2019
26	Sodium as Na	mg/l	40.0	IS 3025 Part 45: 1983
27	Sulphate as SO4	mg/l	58.51	IS 3025 Part 24 Sec 1: 2022
28	Temperature(°C)	°C	26.9	IS 3025 Part 9: 1984
29	Total alkalinity as CaCO3	mg/l	240.0	IS 3025 Part 23: 1986
30	Total Suspended Solids	mg/l	13.9	IS 3025 Part 17: 1984

HUBERT ENVIRO CARE SYSTEMS (P) LTD. Chennai 600 032

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR : TC1231025000005387F
Report No. : HECSL/WT/009/250125
Sample ID No : 250125059
Sampling Date : 24/01/2025

Name of the Client : M/s. NTPC LTD.,

Address of the Client : Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India

Group : Water
Sample Name : Surface Water
Sample Mark : Pond 3
Sample Reference : NA
Sample Drawn By : M/s.Hubert Enviro care Systems (P) Ltd.
Sample Location : Katora
Environmental Condition : Temperature (°C) : 22.0 | Humidity (%) : 45.0
Sampling Method & Plan : IS 17614 (Part -1) : 2021

Received Date : 25/01/2025
Commenced Date : 25/01/2025
Completed On : 30/01/2025
Report Date : 04/02/2025
Sample qty : 2 Litres

S.No.	Test Parameters	Units	Results	Test Method
31	Turbidity	NTU	62.5	IS 3025 Part 10: 1984
32	Arsenic	mg/l	BLQ (LOQ: 0.005)	USEPA 200.8 : 1994
33	Cadmium	mg/l	BLQ (LOQ: 0.001)	USEPA 200.8 : 1994
34	Chromium	mg/l	BLQ (LOQ: 0.01)	USEPA 200.8 : 1994
35	Copper	mg/l	BLQ (LOQ: 0.01)	USEPA 200.8 : 1994
36	Lead	mg/l	BLQ (LOQ: 0.005)	USEPA 200.8 : 1994
37	Mercury	mg/l	BLQ (LOQ: 0.0005)	USEPA 200.8 : 1994
38	Zinc	mg/l	BLQ (LOQ: 0.01)	USEPA 200.8 : 1994

Note :- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, mg/l- Milligrams per litre.

End Report

HUBERT ENVIRO CARE SYSTEMS (P) LTD. Chennai 600 032

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR	: TC1231025000004048F
Report No.	: HECSL/WT/021/250125
Sample ID No	: 250125071
Sampling Date	: 24/01/2025
Name of the Client	: M/s. NTPC LTD.,
Address of the Client	: Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India
Group	: Water
Sample Name	: Surface Water
Sample Mark	: Pond 3 Katora
Sample Reference	: NA
Sample Drawn By	: M/s.Hubert Enviro care Systems (P) Ltd.
Sample Location	: Katora
Environmental Condition	: Temperature (°C) : 22.0 | Humidity (%) : 45.0
Sampling Method & Plan	: HECS-G/MICRO/SOP/004
Received Date	: 25/01/2025
Commenced Date	: 25/01/2025
Completed On	: 01/02/2025
Report Date	: 01/02/2025
Sample qty	: 100ml

S.No.	Test Parameters	Units	Results	Test Method
Discipline : Biological				
1	Faecal Coliform	MPN/100ml	22	IS 1622 : 1981
2	Total Coliform	MPN/100ml	120	IS 1622 : 1981

Note:- MPN - Most Probable Number, < 2 is Considered as Absent.

End of Report

HUBERT ENVIRO CARE SYSTEMS (P) LTD. Chennai 600 032

Jisha S Prakash
Microbiology-Head
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR	: TC1231025000005388F
Report No	: HECSL/WT/010/250125
Sample ID No	: 250125060
Sampling Date	: 24/01/2025
Name of the Client	: M/s. NTPC LTD.,
Address of the Client	: Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India
Group	: Water
Sample Name	: Surface Water
Sample Mark	: Jirbhar Pond
Sample Reference	: NA
Sample Drawn By	: M/s.Hubert Enviro care Systems (P) Ltd.
Sample Location	: NA
Environmental Condition	: Temperature (°C) : 22.0 | Humidity (%) : 45.0
Sampling Method & Plan	: IS 17614 (Part -1) : 2021
Received Date	: 25/01/2025
Commenced Date	: 25/01/2025
Completed On	: 30/01/2025
Report Date	: 04/02/2025
Sample qty	: 2 Litres

S.No.	Test Parameters	Units	Results	Test Method
Discipline : Chemical				
1	Ammonical Nitrogen as NH3-N	mg/l	0.36	IS 3025 Part 34 Sec 2: 2021
2	Biological Oxygen Demand (BOD)@ 27°C For 3 days	mg/l	2.0	IS 3025 Part 44: 1993
3	Boron as B	mg/l	BLQ(LOQ:0.1)	IS 3025 Part 57: 2021 (Curcumin Method)
4	Calcium as Ca	mg/l	60.12	IS 3025 Part 40: 1991(EDTA Titrimetric Method)
5	Chemical Oxygen Demand (COD)	mg/l	20.0	IS 3025 Part 58: 2006
6	Chloride as Cl	mg/l	44.53	IS 3025 Part 32: 1988 (Argentometric Method)
7	Colour	Hazen units	BLQ(LOQ:1.0)	IS 3025 Part 4: 2021
8	Dissolved oxygen	mg/l	6.3	IS 3025 Part 38: 1989
9	Electrical Conductivity at 25°C	µS/cm	684.0	IS:3025 Part 14: 2013
10	Fluoride as F	mg/l	0.31	APHA 23rd edition Method 4500 F -B,D: 2017
11	Iron as Fe	mg/l	0.11	IS 3025 Part 53: 2003
12	Nitrate as NO3	mg/l	2.17	APHA 23rd edition Method 4500 NO3B: 2017
13	Nitrate Nitrogen as NO3-N	mg/l	BLQ(LOQ:1.0)	IS 3025 Part 34 Sec 3: 2021
14	Odour		Agreeable	IS 3025 Part 5: 2018

HUBERT ENVIRO CARE SYSTEMS (P) LTD. Chennai 600 032

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

		ULR	: TC1231025000005388F
		Report No	: HECSL/WT/010/250125
		Sample ID No	: 250125060
Name of the Client	: M/s. NTPC LTD.,	Sampling Date	: 24/01/2025
Address of the Client	: Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India		
Group	: Water	Received Date	: 25/01/2025
Sample Name	: Surface Water	Commenced Date	: 25/01/2025
Sample Mark	: Jirbhar Pond	Completed On	: 30/01/2025
Sample Reference	: NA	Report Date	: 04/02/2025
Sample Drawn By	: M/s.Hubert Enviro care Systems (P) Ltd.	Sample qty	: 2 Litres
Sample Location	: NA		
Environmental Condition	: Temperature (°C) : 22.0 | Humidity (%) : 45.0		
Sampling Method & Plan	: IS 17614 (Part -1) : 2021		

S.No.	Test Parameters	Units	Results	Test Method
15	Oil and Grease	mg/l	BLQ(LOQ:4.0)	IS 3025 Part 39: 2021
16	pH at 25°C		7.92	IS 3025 Part 11: 2022 (Electrometric Method)
17	Total dissolved solids	mg/l	365.0	IS 3025 Part 16: 1984
18	Carbonate	mg/l	BLQ(LOQ:1.0)	IS 3025 Part 51: 2001
19	Magnesium as Mg	mg/l	29.16	IS 3025 Part 46: 1994 (Volumetric Method using EDTA)
20	Phenolic compounds as C6H5OH	mg/l	BLQ(LOQ:0.001)	IS 3025 Part 43:Sec 1: 2022
21	Phosphate as PO4	mg/l	BLQ(LOQ:0.02)	APHA 23rd edition Method 4500-P B.D: 2017
22	Dissolved phosphate as PO4	mg/l	BLQ(LOQ:0.02)	APHA 23rd edition Method 4500-P B.D: 2017
23	Potassium as K	mg/l	2.0	IS 3025 Part 45: 1993
24	Residual Sodium Carbonate	mg/l	BLQ(LOQ:1.0)	IS 11624: 2019
25	Sodium Adsorption Ratio(SAR)	Square root of (millimole/litre)	0.58	IS 11624: 2019
26	Sodium as Na	mg/l	22.0	IS 3025 Part 45: 1983
27	Sulphate as SO4	mg/l	109.5	IS 3025 Part 24 Sec 1: 2022
28	Temperature(°C)	°C	26.7	IS 3025 Part 9: 1984
29	Total alkalinity as CaCO3	mg/l	105.0	IS 3025 Part 23: 1986
30	Total Suspended Solids	mg/l	9.0	IS 3025 Part 17: 1984

HUBERT ENVIRO CARE SYSTEMS (P) LTD Chennai 600 032

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR : TC1231025000005388F
Report No. : HECSL/WT/010/250125
Sample ID No : 250125060
Sampling Date : 24/01/2025

Name of the Client : M/s. NTPC LTD.,
Address of the Client : Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India
Group : Water
Sample Name : Surface Water
Sample Mark : Jirbhar Pond
Sample Reference : NA
Sample Drawn By : M/s.Hubert Enviro care Systems (P) Ltd.
Sample Location : NA
Environmental Condition : Temperature (°C) : 22.0 | Humidity (%) : 45.0
Sampling Method & Plan : IS 17614 (Part -1) : 2021

Received Date : 25/01/2025
Commenced Date : 25/01/2025
Completed On : 30/01/2025
Report Date : 04/02/2025
Sample qty : 2 Litres

S.No.	Test Parameters	Units	Results	Test Method
31	Turbidity	NTU	4.1	IS 3025 Part 10: 1984
32	Arsenic	mg/l	BLQ (LOQ: 0.005)	USEPA 200.8 : 1994
33	Cadmium	mg/l	BLQ (LOQ: 0.001)	USEPA 200.8 : 1994
34	Chromium	mg/l	BLQ (LOQ: 0.01)	USEPA 200.8 : 1994
35	Copper	mg/l	BLQ (LOQ: 0.01)	USEPA 200.8 : 1994
36	Lead	mg/l	BLQ (LOQ: 0.005)	USEPA 200.8 : 1994
37	Mercury	mg/l	BLQ (LOQ: 0.0005)	USEPA 200.8 : 1994
38	Zinc	mg/l	BLQ (LOQ: 0.01)	USEPA 200.8 : 1994

Note :- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, mg/l- Milligrams per litre.

End Report

HUBERT ENVIRO CARE SYSTEMS (P) LTD. Chennai 600 032

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR : TC1231025000004049F
Report No : HECSL/WT/022/250125
Sample ID No : 250125072
Sampling Date : 24/01/2025

Name of the Client : M/s. NTPC LTD.,
Address of the Client : Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India
Group : Water
Sample Name : Surface Water
Sample Mark : Jirbhar Pond
Sample Reference : NA
Sample Drawn By : M/s.Hubert Enviro care Systems (P) Ltd.
Sample Location : NA
Environmental Condition : Temperature (°C) : 22.0 | Humidity (%) : 45.0
Sampling Method & Plan : HECS-G/MICRO/SOP/004

Received Date : 25/01/2025
Commenced Date : 25/01/2025
Completed On : 01/02/2025
Report Date : 01/02/2025
Sample qty : 100ml

S.No.	Test Parameters	Units	Results	Test Method
Discipline : Biological				
1	Faecal Coliform	MPN/100ml	21	IS 1622 : 1981
2	Total Coliform	MPN/100ml	148	IS 1622 : 1981

Note:- MPN - Most Probable Number, < 2 is Considered as Absent.

End of Report

HUBERT ENVIRO CARE SYSTEMS (P) LTD.
Chennai
600 032

Jisha S Prakash
Microbiology-Head
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru VI Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR : TC1231025000005531F
Report No. : HECSL/WT/011/250125
Sample ID No : 250125061
Sampling Date : 24/01/2025

Name of the Client : M/s. NTPC LTD.,
Address of the Client : Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India
Group : Water
Sample Name : Surface Water
Sample Mark : Up Stream Narmada River Omkoreshwar
Sample Reference : NA
Sample Drawn By : M/s.Hubert Enviro care Systems (P) Ltd.
Sample Location : NA
Environmental Condition : Temperature (°C) : 22.0 | Humidity (%) : 45.0
Sampling Method & Plan : IS 17614 (Part -1) : 2021

Received Date : 25/01/2025
Commenced Date : 25/01/2025
Completed On : 30/01/2025
Report Date : 04/02/2025
Sample qty : 2 Litres

S.No.	Test Parameters	Units	Results	Test Method
Discipline : Chemical				
1	Ammonical Nitrogen as NH3-N	mg/l	0.31	IS 3025 Part 34 Sec 2: 2021
2	Biological Oxygen Demand (BOD)@ 27°C For 3 days	mg/l	BLQ(LOQ:1.0)	IS 3025 Part 44: 1993
3	Boron as B	mg/l	BLQ(LOQ:0.1)	IS 3025 Part 57: 2021 (Curcumin Method)
4	Calcium as Ca	mg/l	28.85	IS 3025 Part 40: 1991(EDTA Titrimetric Method)
5	Chemical Oxygen Demand (COD)	mg/l	12.0	IS 3025 Part 58: 2006
6	Chloride as Cl	mg/l	38.9	IS 3025 Part 32: 1988 (Argentometric Method)
7	Colour	Hazen units	BLQ(LOQ:1.0)	IS 3025 Part 4: 2021
8	Dissolved oxygen	mg/l	6.3	IS 3025 Part 38: 1989
9	Electrical Conductivity at 25°C	µS/cm	373.0	IS:3025 Part 14: 2013
10	Fluoride as F	mg/l	BLQ(LOQ:0.2)	APHA 23rd edition Method 4500 F -B,D: 2017
11	Iron as Fe	mg/l	0.087	IS 3025 Part 53: 2003
12	Nitrate as NO3	mg/l	2.95	APHA 23rd edition Method 4500 NO3B: 2017
13	Nitrate Nitrogen as NO3-N	mg/l	BLQ(LOQ:1.0)	IS 3025 Part 34 Sec 3: 2021
14	Odour		Agreeable	IS 3025 Part 5: 2018

HUBERT ENVIRO CARE SYSTEMS (P) LTD Chennai 600 032

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR : TC1231025000005531F
Report No : HECSL/WT/011/250125
Sample ID No : 250125061
Sampling Date : 24/01/2025

Name of the Client : M/s. NTPC LTD.,
Address of the Client : Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India
Group : Water
Sample Name : Surface Water
Sample Mark : Up Stream Narmada River Omkoreshwar
Sample Reference : NA
Sample Drawn By : M/s.Hubert Enviro care Systems (P) Ltd.
Sample Location : NA
Environmental Condition : Temperature (°C) : 22.0 | Humidity (%) : 45.0
Sampling Method & Plan : IS 17614 (Part -1) : 2021

Received Date : 25/01/2025
Commenced Date : 25/01/2025
Completed On : 30/01/2025
Report Date : 04/02/2025
Sample qty : 2 Litres

S.No.	Test Parameters	Units	Results	Test Method
15	Oil and Grease	mg/l	BLQ(LOQ:4.0)	IS 3025 Part 39: 2021
16	pH at 25°C		8.08	IS 3025 Part 11: 2022 (Electrometric Method)
17	Total dissolved solids	mg/l	198.0	IS 3025 Part 16: 1984
18	Carbonate	mg/l	BLQ(LOQ:1.0)	IS 3025 Part 51: 2001
19	Magnesium as Mg	mg/l	8.75	IS 3025 Part 46: 1994 (Volumetric Method using EDTA)
20	Phenolic compounds as C6H5OH	mg/l	BLQ(LOQ:0.001)	IS 3025 Part 43:Sec 1: 2022
21	Phosphate as PO4	mg/l	BLQ(LOQ:0.02)	APHA 23rd edition Method 4500-P B,D: 2017
22	Dissolved phosphate as PO4	mg/l	BLQ(LOQ:0.02)	APHA 23rd edition Method 4500-P B,D: 2017
23	Potassium as K	mg/l	BLQ(LOQ:1.0)	IS 3025 Part 45: 1993
24	Residual Sodium Carbonate	mg/l	BLQ(LOQ:1.0)	IS 11624: 2019
25	Sodium Adsorption Ratio(SAR)	Square root of (millimole/litre)	0.21	IS 11624: 2019
26	Sodium as Na	mg/l	5.0	IS 3025 Part 45: 1983
27	Sulphate as SO4	mg/l	20.58	IS 3025 Part 24 Sec 1: 2022
28	Temperature(°C)	°C	26.9	IS 3025 Part 9: 1984
29	Total alkalinity as CaCO3	mg/l	110.0	IS 3025 Part 23: 1986
30	Total Suspended Solids	mg/l	5.0	IS 3025 Part 17: 1984

HUBERT ENVIRO CARE SYSTEMS (P) LTD. Chennai 600 032

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

		ULR	: TC1231025000005531F
		Report No	: HECSL/WT/011/250125
Name of the Client	: M/s. NTPC LTD.,	Sample ID No	: 250125061
		Sampling Date	: 24/01/2025
Address of the Client	: Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India		
Group	: Water	Received Date	: 25/01/2025
Sample Name	: Surface Water	Commenced Date	: 25/01/2025
Sample Mark	: Up Stream Narmada River Omkoreshwar	Completed On	: 30/01/2025
Sample Reference	: NA	Report Date	: 04/02/2025
Sample Drawn By	: M/s.Hubert Enviro care Systems (P) Ltd.	Sample qty	: 2 Litres
Sample Location	: NA		
Environmental Condition	: Temperature (°C) : 22.0 | Humidity (%) : 45.0		
Sampling Method & Plan	: IS 17614 (Part -1) : 2021		

S.No.	Test Parameters	Units	Results	Test Method
31	Turbidity	NTU	1.9	IS 3025 Part 10: 1984
32	Arsenic	mg/l	BLQ (LOQ: 0.005)	USEPA 200.8 : 1994
33	Cadmium	mg/l	BLQ (LOQ: 0.001)	USEPA 200.8 : 1994
34	Chromium	mg/l	BLQ (LOQ: 0.01)	USEPA 200.8 : 1994
35	Copper	mg/l	BLQ (LOQ: 0.01)	USEPA 200.8 : 1994
36	Lead	mg/l	BLQ (LOQ: 0.005)	USEPA 200.8 : 1994
37	Mercury	mg/l	BLQ (LOQ: 0.0005)	USEPA 200.8 : 1994
38	Zinc	mg/l	BLQ (LOQ: 0.01)	USEPA 200.8 : 1994

Note :- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, mg/l- Milligrams per litre.

End Report

HUBERT ENVIRO CARE SYSTEMS (P) LTD. Chennai 600 032

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR : TC1231025000004050F
Report No. : HECSL/WT/023/250125
Sample ID No : 250125073
Sampling Date : 24/01/2025

Name of the Client : M/s. NTPC LTD.,
Address of the Client : Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India

Received Date : 25/01/2025
Commenced Date : 25/01/2025
Completed On : 01/02/2025
Report Date : 01/02/2025
Sample qty : 100ml

Group : Water
Sample Name : Surface Water
Sample Mark : Up Stream Narmada River Omkoreshwar
Sample Reference : NA
Sample Drawn By : M/s.Hubert Enviro care Systems (P) Ltd.
Sample Location : NA
Environmental Condition : Temperature (°C) : 22.0 | Humidity (%) : 45.0
Sampling Method & Plan : HECS-G/MICRO/SOP/004

S.No.	Test Parameters	Units	Results	Test Method
Discipline : Biological				
1	Faecal Coliform	MPN/100ml	27	IS 1622 : 1981
2	Total Coliform	MPN/100ml	175	IS 1622 : 1981

Note:- MPN - Most Probable Number, < 2 is Considered as Absent.

End of Report

1/2/2025

HUBERT ENVIRO CARE SYSTEMS Chennai 600 032

Jisha S Prakash
Microbiology-Head
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR : TC1231025000005532F
Report No : HECSL/WT/012/250125
Sample ID No : 250125062
Sampling Date : 24/01/2025

Name of the Client : M/s. NTPC LTD.,
Address of the Client : Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India
Group : Water
Sample Name : Surface Water
Sample Mark : Down Stream Narmada River Omkoreshwar
Sample Reference : NA
Sample Drawn By : M/s.Hubert Enviro care Systems (P) Ltd.
Sample Location : NA
Environmental Condition : Temperature (°C) : 22.0 | Humidity (%) : 45.0
Sampling Method & Plan : IS 17614 (Part -1) : 2021

Received Date : 25/01/2025
Commenced Date : 25/01/2025
Completed On : 04/02/2025
Report Date : 04/02/2025
Sample qty : 2 Litres

S.No.	Test Parameters	Units	Results	Test Method
Discipline : Chemical				
1	Ammonical Nitrogen as NH3-N	mg/l	0.12	IS 3025 Part 34 Sec 2: 2021
2	Biological Oxygen Demand (BOD)@ 27°C For 3 days	mg/l	BLQ(LOQ:2.0)	IS 3025 Part 44: 1993
3	Boron as B	mg/l	BLQ(LOQ:0.1)	IS 3025 Part 57: 2021 (Curcumin Method)
4	Calcium as Ca	mg/l	28.85	IS 3025 Part 40: 1991(EDTA Titrimetric Method)
5	Chemical Oxygen Demand (COD)	mg/l	4.0	IS 3025 Part 58: 2006
6	Chloride as Cl	mg/l	39.89	IS 3025 Part 32: 1988 (Argentometric Method)
7	Colour	Hazen units	BLQ(LOQ:1.0)	IS 3025 Part 4: 2021
8	Dissolved oxygen	mg/l	6.4	IS 3025 Part 38: 1989
9	Electrical Conductivity at 25°C	µS/cm	378.0	IS:3025 Part 14: 2013
10	Fluoride as F	mg/l	BLQ(LOQ:0.2)	APHA 23rd edition Method 4500 F -B,D: 2017
11	Iron as Fe	mg/l	0.041	IS 3025 Part 53: 2003
12	Nitrate as NO3	mg/l	3.19	APHA 23rd edition Method 4500 NO3B 2017
13	Nitrate Nitrogen as NO3-N	mg/l	BLQ(LOQ:1.0)	IS 3025 Part 34 Sec 3: 2021
14	Odour		Agreeable	IS 3025 Part 5: 2018

HUBERT ENVIRO CARE SYSTEMS (P) LTD Chennai 600 032

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR : TC1231025000005532F
Report No : HECSL/WT/012/250125
Sample ID No : 250125062
Sampling Date : 24/01/2025

Name of the Client : **M/s. NTPC LTD..**
Address of the Client : **Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India**
Group : **Water**
Sample Name : **Surface Water**
Sample Mark : **Down Stream Narmada River Omkoreshwar**
Sample Reference : **NA**
Sample Drawn By : **M/s.Hubert Enviro care Systems (P) Ltd.**
Sample Location : **NA**
Environmental Condition : **Temperature (°C) : 22.0 | Humidity (%) : 45.0**
Sampling Method & Plan : **IS 17614 (Part -1) : 2021**

Received Date : 25/01/2025
Commenced Date : 25/01/2025
Completed On : 04/02/2025
Report Date : 04/02/2025
Sample qty : 2 Litres

S.No.	Test Parameters	Units	Results	Test Method
15	Oil and Grease	mg/l	BLQ(LOQ:4.0)	IS 3025 Part 39: 2021
16	pH at 25°C		8.01	IS 3025 Part 11: 2022 (Electrometric Method)
17	Total dissolved solids	mg/l	191.0	IS 3025 Part 16: 1984
18	Carbonate	mg/l	BLQ(LOQ:1.0)	IS 3025 Part 51: 2001
19	Magnesium as Mg	mg/l	10.2	IS 3025 Part 46: 1994 (Volumetric Method using EDTA)
20	Phenolic compounds as C6H5OH	mg/l	BLQ(LOQ:0.001)	IS 3025 Part 43:Sec 1: 2022
21	Phosphate as PO4	mg/l	BLQ(LOQ:0.02)	APHA 23rd edition Method 4500-P B,D: 2017
22	Dissolved phosphate as PO4	mg/l	BLQ(LOQ:0.02)	APHA 23rd edition Method 4500-P B,D: 2017
23	Potassium as K	mg/l	BLQ(LOQ:1.0)	IS 3025 Part 45: 1993
24	Residual Sodium Carbonate	mg/l	BLQ(LOQ:1.0)	IS 11624: 2019
25	Sodium Adsorption Ratio(SAR)	Square root of (millimole/litre)	0.20	IS 11624: 2019
26	Sodium as Na	mg/l	5.0	IS 3025 Part 45: 1983
27	Sulphate as SO4	mg/l	19.11	IS 3025 Part 24 Sec 1: 2022
28	Temperature(°C)	°C	26.8	IS 3025 Part 9: 1984
29	Total alkalinity as CaCO3	mg/l	112.0	IS 3025 Part 23: 1986
30	Total Suspended Solids	mg/l	BLQ(LOQ:2.0)	IS 3025 Part 17: 1984

HUBERT ENVIRO CARE SYSTEMS (P) LTD Chennai 600 032

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

Name of the Client	: M/s. NTPC LTD..	ULR	: TC1231025000005532F
		Report No.	: HECSL/WT/012/250125
		Sample ID No	: 250125062
		Sampling Date	: 24/01/2025
Address of the Client	: Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India		
Group	: Water	Received Date	: 25/01/2025
Sample Name	: Surface Water	Commenced Date	: 25/01/2025
Sample Mark	: Down Stream Narmada River Omkoreshwar	Completed On	: 04/02/2025
Sample Reference	: NA	Report Date	: 04/02/2025
Sample Drawn By	: M/s.Hubert Enviro care Systems (P) Ltd.	Sample qty	: 2 Litres
Sample Location	: NA		
Environmental Condition	: Temperature (°C) : 22.0 | Humidity (%) : 45.0		
Sampling Method & Plan	: IS 17614 (Part -1) : 2021		

S.No.	Test Parameters	Units	Results	Test Method
31	Turbidity	NTU	BLQ(LOQ:0.1)	IS 3025 Part 10: 1984
32	Arsenic	mg/l	BLQ (LOQ: 0.005)	USEPA 200.8 : 1994
33	Cadmium	mg/l	BLQ (LOQ: 0.001)	USEPA 200.8 : 1994
34	Chromium	mg/l	BLQ (LOQ: 0.01)	USEPA 200.8 : 1994
35	Copper	mg/l	BLQ (LOQ: 0.01)	USEPA 200.8 : 1994
36	Lead	mg/l	BLQ (LOQ: 0.005)	USEPA 200.8 : 1994
37	Mercury	mg/l	BLQ (LOQ: 0.0005)	USEPA 200.8 : 1994
38	Zinc	mg/l	BLQ (LOQ: 0.01)	USEPA 200.8 : 1994

Note :- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, mg/l- Milligrams per litre.

End Report

HUBERT ENVIRO CARE SYSTEMS (P) LTD Chennai 600 032

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR	: TC1231025000004051F
Report No.	: HECSL/WT/024/250125
Sample ID No	: 250125074
Sampling Date	: 24/01/2025
Received Date	: 25/01/2025
Commenced Date	: 25/01/2025
Completed On	: 01/02/2025
Report Date	: 01/02/2025
Sample qty	: 100ml

Name of the Client	: M/s. NTPC LTD.,
Address of the Client	: Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India
Group	: Water
Sample Name	: Surface Water
Sample Mark	: Down Stream Narmada River Omkoreshwar
Sample Reference	: NA
Sample Drawn By	: M/s.Hubert Enviro care Systems (P) Ltd.
Sample Location	: NA
Environmental Condition	: Temperature (°C) : 22.0 | Humidity (%) : 45.0
Sampling Method & Plan	: HECS-G/MICRO/SOP/004

S.No.	Test Parameters	Units	Results	Test Method
Discipline : Biological				
1	Faecal Coliform	MPN/100ml	34	IS 1622 : 1981
2	Total Coliform	MPN/100ml	212	IS 1622 : 1981

Note:- MPN - Most Probable Number, < 2 is Considered as Absent.

End of Report

HUBERT ENVIRO CARE SYSTEMS (P) LTD. Chennai 600 032

Jisha S Prakash
Microbiology-Head
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR : TC1231025000005379F
Report No : HECSL/WT/001/250125
Sample ID No : 250125051
Sampling Date : 24/01/2025

Name of the Client : M/s. NTPC LTD.,
Address of the Client : Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India
Group : Water
Sample Name : Ground Water
Sample Mark : Borewell
Sample Reference : NA
Sample Drawn By : M/s.Hubert Enviro care Systems (P) Ltd.
Sample Location : At Selda
Environmental Condition : Temperature (°C) : 22.0 | Humidity (%) : 45.0
Sampling Method & Plan : IS 17614 (Part -1) : 2021

Received Date : 25/01/2025
Commenced Date : 25/01/2025
Completed On : 04/02/2025
Report Date : 04/02/2025
Sample qty : 2 Litres

S.No.	Test Parameters	Units	Results	Test Method
Discipline : Chemical				
1	Boron as B	mg/l	BLQ(LOQ:0.1)	IS 3025 Part 57 -Curcumin Method: 2021
2	Calcium as Ca	mg/l	112.24	IS 3025 Part 40: 1991(EDTA Titrimetric Method)
3	Carbonate	mg/l	BLQ(LOQ:1.0)	IS 3025 Part 51: 2001
4	Chemical Oxygen Demand (COD)	mg/l	BLQ(LOQ:4.0)	IS 3025 Part 58: 2006
5	Chloride as Cl	mg/l	99.48	IS 3025 Part 32: 1988 (Argentometric Method)
6	Colour	Hazen units	BLQ(LOQ:1.0)	IS 3025 (Part4): 2021
7	Electrical Conductivity at 25°C	µS/cm	975.0	IS 3025 Part-14: 2013
8	Fluoride as F	mg/l	0.45	APHA 23rd edition (Method 4500F- B . D): 2017
9	Iron as Fe	mg/l	BLQ(LOQ:0.01)	IS 3025 (Part 53): 2003
10	Magnesium as Mg	mg/l	41.31	IS 3025 Part 46: 1994 (Volumetric Method using EDTA)
11	Nitrate as NO3	mg/l	9.60	APHA 23rd edition (Method 4500 NO3B): 2017
12	Nitrite as NO2	mg/l	BLQ(LOQ:0.005)	IS 3025 : Part 34 : Sec 3: 2021 (Spectrophotometric Method)
13	Odour	-	Agreeable	IS 3025 (Part 5): 2018

HUBERT ENVIRO CARE SYSTEMS (P) LTD Chennai 600 032

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

		ULR	: TC1231025000005379F
		Report No	: HECSL/WT/001/250125
		Sample ID No	: 250125051
Name of the Client	: **M/s. NTPC LTD.,**	Sampling Date	: 24/01/2025
Address of the Client	: **Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India**		
Group	: **Water**	Received Date	: 25/01/2025
Sample Name	: **Ground Water**	Commenced Date	: 25/01/2025
Sample Mark	: **Borewell**	Completed On	: 04/02/2025
Sample Reference	: **NA**	Report Date	: 04/02/2025
Sample Drawn By	: **M/s.Hubert Enviro care Systems (P) Ltd.**	Sample qty	: 2 Litres
Sample Location	: **At Selda**		
Environmental Condition	: **Temperature (°C) : 22.0 | Humidity (%) : 45.0**		
Sampling Method & Plan	: **IS 17614 (Part -1) : 2021**		

S.No.	Test Parameters	Units	Results	Test Method
14	pH at 25°C	-	7.51	IS 3025(Part 11) : 2022 (Electrometric method)
15	Potassium as K	mg/l	2.0	IS 3025 Part 45: 1993 (Flame emission Photometric Method)
16	Sodium as Na	mg/l	28.0	IS 3025 Part 45: 1993 (Flame emission Photometric Method)
17	Sulphate as SO4	mg/l	121.36	IS 3025 Part 24 Sec 1: 2022(Turbidity Method)
18	Temperature(°C)	°C	26.9	IS 3025 (Part 9): 1984
19	Total alkalinity as CaCO3	mg/l	150.0	IS 3025 (Part 23): 1986
20	Total dissolved solids	mg/l	566.0	IS 3025 (Part 16): 1984
21	Phosphate as PO4	mg/l	BLQ(LOQ:0.02)	IS 3025 Part 31 Sec 1: 2022 (Stannous Chloride method)
22	Arsenic	mg/l	BLQ (LOQ: 0.005)	USEPA 200.8 : 1994
23	Cadmium	mg/l	BLQ (LOQ: 0.001)	USEPA 200.8 : 1994
24	Chromium	mg/l	BLQ (LOQ: 0.01)	USEPA 200.8 : 1994
25	Copper	mg/l	BLQ (LOQ: 0.01)	USEPA 200.8 : 1994
26	Lead	mg/l	BLQ (LOQ: 0.005)	USEPA 200.8 : 1994
27	Mercury	mg/l	BLQ (LOQ: 0.0005)	USEPA 200.8 : 1994
28	Zinc	mg/l	BLQ (LOQ: 0.01)	USEPA 200.8 : 1994

Note :- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, mg/l- Milligrams per litre.

End Report

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR : TC1231025000004040F
Report No. : HECSL/WT/013/250125
Sample ID No : 250125063
Sampling Date : 24/01/2025

Name of the Client : M/s. NTPC LTD.,
Address of the Client : Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India
Group : Water
Sample Name : Ground Water
Sample Mark : Borewell
Sample Reference : NA
Sample Drawn By : M/s.Hubert Enviro care Systems (P) Ltd.
Sample Location : At Selda
Environmental Condition : Temperature (°C) : 22.0 | Humidity (%) : 45.0
Sampling Method & Plan : HECS-G/MICRO/SOP/004

Received Date : 25/01/2025
Commenced Date : 25/01/2025
Completed On : 27/01/2025
Report Date : 28/01/2025
Sample qty : 100ml

S.No.	Test Parameters	Units	Results	Test Method
Discipline : Biological				
1	Faecal Coliform	MPN/100ml	<2	IS 1622 : 1981
2	Total Coliform	MPN/100ml	<2	IS 1622 : 1981

Note:- MPN - Most Probable Number, < 2 is Considered as Absent.

End of Report

28/1/25

Jisha S Prakash
Microbiology-Head
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR : TC1231025000005380F
Report No : HECSL/WT/002/250125
Sample ID No : 250125052
Sampling Date : 24/01/2025

Name of the Client : M/s. NTPC LTD.,

Address of the Client : Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India

Group : Water
Sample Name : Ground Water
Sample Mark : Borewell
Sample Reference : NA
Sample Drawn By : M/s.Hubert Enviro care Systems (P) Ltd.
Sample Location : At Dalchi
Environmental Condition : Temperature (°C) : 22.0 | Humidity (%) : 45.0
Sampling Method & Plan : IS 17614 (Part -1) : 2021

Received Date : 25/01/2025
Commenced Date : 25/01/2025
Completed On : 04/02/2025
Report Date : 04/02/2025
Sample qty : 2 Litres

S.No.	Test Parameters	Units	Results	Test Method
Discipline : Chemical				
1	Boron as B	mg/l	BLQ(LOQ:0.1)	IS 3025 Part 57 -Curcumin Method 2021
2	Calcium as Ca	mg/l	136.47	IS 3025 Part 40: 1991(EDTA Titrimetric Method)
3	Carbonate	mg/l	BLQ(LOQ 1.0)	IS 3025 Part 51: 2001
4	Chemical Oxygen Demand (COD)	mg/l	BLQ(LOQ 4.0)	IS 3025 Part 58: 2006
5	Chloride as Cl	mg/l	103.92	IS 3025 Part 32: 1988 (Argentometric Method)
6	Colour	Hazen units	BLQ(LOQ:1.0)	IS 3025 (Part4): 2021
7	Electrical Conductivity at 25°C	µS/cm	1128.0	IS 3025 Part-14: 2013
8	Fluoride as F	mg/l	0.48	APHA 23rd edition (Method 4500F- B , D): 2017
9	Iron as Fe	mg/l	0.045	IS 3025 (Part 53): 2003
10	Magnesium as Mg	mg/l	14.58	IS 3025 Part 46: 1994 (Volumetric Method using EDTA)
11	Nitrate as NO3	mg/l	4.35	APHA 23rd edition (Method 4500 NO3B): 2017
12	Nitrite as NO2	mg/l	BLQ(LOQ 0.005)	IS 3025 : Part 34 : Sec 3: 2021 (Spectrophotometric Method)
13	Odour	-	Agreeable	IS 3025 (Part 5): 2018

HUBERT ENVIRO CARE SYSTEMS (P) LTD. Chennai 600 032

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR : TC1231025000005380F
Report No : HECSL/WT/002/250125
Sample ID No : 250125052
Sampling Date : 24/01/2025

Name of the Client : M/s. NTPC LTD.,

Address of the Client : Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India

Group : Water
Sample Name : Ground Water
Sample Mark : Borewell
Sample Reference : NA
Sample Drawn By : M/s.Hubert Enviro care Systems (P) Ltd.
Sample Location : At Dalchi
Environmental Condition : Temperature (°C) : 22.0 | Humidity (%) : 45.0
Sampling Method & Plan : IS 17614 (Part -1) : 2021

Received Date : 25/01/2025
Commenced Date : 25/01/2025
Completed On : 04/02/2025
Report Date : 04/02/2025
Sample qty : 2 Litres

S.No.	Test Parameters	Units	Results	Test Method
14	pH at 25°C	-	7.32	IS 3025(Part 11) : 2022 (Electrometric method)
15	Potassium as K	mg/l	16.0	IS 3025 Part 45: 1993 (Flame emission Photometric Method)
16	Sodium as Na	mg/l	40.0	IS 3025 Part 45: 1993 (Flame emission Photometric Method)
17	Sulphate as SO4	mg/l	99.11	IS 3025 Part 24 Sec 1: 2022(Turbidity Method)(Turbidity Method)
18	Temperature(°C)	°C	26.8	IS 3025 (Part 9): 1984
19	Total alkalinity as CaCO3	mg/l	140.0	IS 3025 (Part 23): 1986
20	Total dissolved solids	mg/l	662.0	IS 3025 (Part 16): 1984
21	Phosphate as PO4	mg/l	BLQ(LOQ:0.02)	IS 3025 Part 31 Sec 1: 2022 (Stannous Chloride method)
22	Arsenic	mg/l	BLQ (LOQ: 0.005)	USEPA 200.8 : 1994
23	Cadmium	mg/l	BLQ (LOQ: 0.001)	USEPA 200.8 : 1994
24	Chromium	mg/l	BLQ (LOQ: 0.01)	USEPA 200.8 : 1994
25	Copper	mg/l	BLQ (LOQ: 0.01)	USEPA 200.8 : 1994
26	Lead	mg/l	BLQ (LOQ: 0.005)	USEPA 200.8 : 1994
27	Mercury	mg/l	BLQ (LOQ: 0.0005)	USEPA 200.8 : 1994
28	Zinc	mg/l	BLQ (LOQ: 0.01)	USEPA 200.8 : 1994

Note :- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, mg/l- Milligrams per litre.

End Report

HUBERT ENVIRO CARE SYSTEMS (P) LTD Chennai 600 032

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR : TC1231025000004041F
Report No : HECSL/WT/014/250125
Sample ID No : 250125064
Sampling Date : 24/01/2025

Name of the Client : **M/s. NTPC LTD.,**

Address of the Client : **Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India**

Received Date : 25/01/2025
Commenced Date : 25/01/2025
Completed On : 27/01/2025
Report Date : 28/01/2025
Sample qty : 100ml

Group : **Water**
Sample Name : **Ground Water**
Sample Mark : **Borewell at Dalchi**
Sample Reference : **NA**
Sample Drawn By : **M/s.Hubert Enviro care Systems (P) Ltd.**
Sample Location : **At Dalchi**
Environmental Condition : **Temperature (°C) : 22.0 | Humidity (%) : 45.0**
Sampling Method & Plan : **HECS-G/MICRO/SOP/004**

S.No.	Test Parameters	Units	Results	Test Method
Discipline : Biological				
1	Faecal Coliform	MPN/100ml	<2	IS 1622 : 1981
2	Total Coliform	MPN/100ml	<2	IS 1622 : 1981

Note:- MPN - Most Probable Number, < 2 is Considered as Absent.

End of Report

Jisha S Prakash
Microbiology-Head
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR : TC1231025000005381F
Report No : HECSL/WT/003/250125
Sample ID No : 250125053
Sampling Date : 24/01/2025

Name of the Client : M/s. NTPC LTD.,
Address of the Client : Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India

Group : Water
Sample Name : Ground Water
Sample Mark : Borewell
Sample Reference : NA
Sample Drawn By : M/s.Hubert Enviro care Systems (P) Ltd.
Sample Location : At Khadi
Environmental Condition : Temperature (°C) : 22.0 | Humidity (%) : 45.0
Sampling Method & Plan : IS 17614 (Part -1) : 2021

Received Date : 25/01/2025
Commenced Date : 25/01/2025
Completed On : 04/02/2025
Report Date : 04/02/2025
Sample qty : 2 Litres

S.No.	Test Parameters	Units	Results	Test Method
Discipline : Chemical				
1	Boron as B	mg/l	BLQ(LOQ:0.1)	IS 3025 Part 57 -Curcumin Method: 2021
2	Calcium as Ca	mg/l	136.27	IS 3025 Part 40: 1991(EDTA Titrimetric Method)
3	Carbonate	mg/l	BLQ(LOQ:1.0)	IS 3025 Part 51: 2001
4	Chemical Oxygen Demand (COD)	mg/l	BLQ(LOQ:4.0)	IS 3025 Part 58: 2006
5	Chloride as Cl	mg/l	79.18	IS 3025 Part 32: 1988 (Argentometric Method)
6	Colour	Hazen units	BLQ(LOQ:1.0)	IS 3025 (Part4): 2021
7	Electrical Conductivity at 25°C	µS/cm	1023.0	IS 3025 Part-14: 2013
8	Fluoride as F	mg/l	0.43	APHA 23rd edition (Method 4500F- B , D): 2017
9	Iron as Fe	mg/l	0.256	IS 3025 (Part 53): 2003
10	Magnesium as Mg	mg/l	36.45	IS 3025 Part 46: 1994 (Volumetric Method using EDTA)
11	Nitrate as NO_3	mg/l	28.96	APHA 23rd edition (Method 4500 NO3B): 2017
12	Nitrite as NO_2	mg/l	BLQ(LOQ:0.005)	IS 3025 : Part 34 : Sec 3: 2021 (Spectrophotometric Method)
13	Odour		Agreeable	IS 3025 (Part 5): 2018

HUBERT ENVIRO CARE SYSTEMS (P) LTD. Chennai 600 032

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

		ULR	:	TC1231025000005381F
		Report No.	:	HECSL/WT/003/250125
Name of the Client	: **M/s. NTPC LTD.,**	Sample ID No	:	250125053
		Sampling Date	:	24/01/2025
Address of the Client	: **Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India**			
Group	: **Water**	Received Date	:	25/01/2025
Sample Name	: **Ground Water**	Commenced Date	:	25/01/2025
Sample Mark	: **Borewell**	Completed On	:	04/02/2025
Sample Reference	: **NA**	Report Date	:	04/02/2025
Sample Drawn By	: **M/s.Hubert Enviro care Systems (P) Ltd.**	Sample qty	:	2 Litres
Sample Location	: **At Khadi**			
Environmental Condition	: **Temperature (°C) : 22.0 | Humidity (%) : 45.0**			
Sampling Method & Plan	: **IS 17614 (Part -1) : 2021**			

S.No.	Test Parameters	Units	Results	Test Method
14	pH at 25°C	-	6.98	IS 3025(Part 11) : 2022 (Electrometric method)
15	Potassium as K	mg/l	3.0	IS 3025 Part 45: 1993 (Flame emission Photometric Method)
16	Sodium as Na	mg/l	45.0	IS 3025 Part 45: 1993 (Flame emission Photometric Method)
17	Sulphate as SO4	mg/l	50.17	IS 3025 Part 24 Sec 1: 2022(Turbidity Method)
18	Temperature(°C)	°C	26.9	IS 3025 (Part 9): 1984
19	Total alkalinity as CaCO3	mg/l	230.0	IS 3025 (Part 23): 1986
20	Total dissolved solids	mg/l	556.0	IS 3025 (Part 16): 1984
21	Phosphate as PO4	mg/l	0.09	IS 3025 Part 31 Sec 1: 2022 (Stannous Chloride method)
22	Arsenic	mg/l	BLQ (LOQ: 0.005)	USEPA 200.8 : 1994
23	Cadmium	mg/l	BLQ (LOQ: 0.001)	USEPA 200.8 : 1994
24	Chromium	mg/l	BLQ (LOQ: 0.01)	USEPA 200.8 : 1994
25	Copper	mg/l	BLQ (LOQ: 0.01)	USEPA 200.8 : 1994
26	Lead	mg/l	BLQ (LOQ: 0.005)	USEPA 200.8 : 1994
27	Mercury	mg/l	BLQ (LOQ: 0.0005)	USEPA 200.8 : 1994
28	Zinc	mg/l	BLQ (LOQ: 0.01)	USEPA 200.8 : 1994

Note :- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, mg/l- Milligrams per litre.

End Report

HUBERT ENVIRO CARE SYSTEMS (P) LTD. Chennai 600 032

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR : TC1231025000004042F
Report No. : HECSL/WT/015/250125
Sample ID No : 250125065
Sampling Date : 24/01/2025

Name of the Client : **M/s. NTPC LTD.,**

Address of the Client : **Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India**

Group : **Water**
Sample Name : **Ground Water**
Sample Mark : **Borewell at Khadi**
Sample Reference : **NA**
Sample Drawn By : **M/s.Hubert Enviro care Systems (P) Ltd.**
Sample Location : **At Khadi**
Environmental Condition : **Temperature (°C) : 22.0 | Humidity (%) : 45.0**
Sampling Method & Plan : **HECS-G/MICRO/SOP/004**

Received Date : 25/01/2025
Commenced Date : 25/01/2025
Completed On : 27/01/2025
Report Date : 28/01/2025
Sample qty : 100ml

S.No.	Test Parameters	Units	Results	Test Method
Discipline : Biological				
1	Faecal Coliform	MPN/100ml	<2	IS 1622 : 1981
2	Total Coliform	MPN/100ml	<2	IS 1622 : 1981

Note:- MPN - Most Probable Number, < 2 is Considered as Absent.

End of Report

Jisha S Prakash
Microbiology-Head
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR : TC1231025000005383F
Report No. : HECSL/WT/005/250125
Sample ID No : 250125055
Sampling Date : 24/01/2025

Name of the Client : **M/s. NTPC LTD.,**

Address of the Client : **Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India**

Group : **Water**
Sample Name : **Ground Water**
Sample Mark : **Borewell**
Sample Reference : **NA**
Sample Drawn By : **M/s.Hubert Enviro care Systems (P) Ltd.**
Sample Location : **At Aarsi Village**
Environmental Condition : **Temperature (°C) : 22.0 | Humidity (%) : 45.0**
Sampling Method & Plan : **IS 17614 (Part -1) : 2021**

Received Date : 25/01/2025
Commenced Date : 25/01/2025
Completed On : 04/02/2025
Report Date : 04/02/2025
Sample qty : 2 Litres

S.No.	Test Parameters	Units	Results	Test Method
Discipline : Chemical				
1	Boron as B	mg/l	BLQ(LOQ:0.1)	IS 3025 Part 57 -Curcumin Method: 2021
2	Calcium as Ca	mg/l	72.14	IS 3025 Part 40: 1991(EDTA Titrimetric Method)
3	Carbonate	mg/l	BLQ(LOQ:1.0)	IS 3025 Part 51: 2001
4	Chemical Oxygen Demand (COD)	mg/l	BLQ(LOQ:4.0)	IS 3025 Part 58: 2006
5	Chloride as Cl	mg/l	59.38	IS 3025 Part 32: 1988 (Argentometric Method)
6	Colour	Hazen units	BLQ(LOQ:1.0)	IS 3025 (Part4): 2021
7	Electrical Conductivity at 25°C	µS/cm	745.0	IS 3025 Part-14: 2013
8	Fluoride as F	mg/l	0.35	APHA 23rd edition (Method 4500F- B , D): 2017
9	Iron as Fe	mg/l	BLQ(LOQ:0.01)	IS 3025 (Part 53): 2003
10	Magnesium as Mg	mg/l	14.58	IS 3025 Part 46: 1994 (Volumetric Method using EDTA)
11	Nitrate as NO3	mg/l	13.63	APHA 23rd edition (Method 4500 NO3B): 2017
12	Nitrite as NO2	mg/l	BLQ(LOQ:0.005)	IS 3025 : Part 34 : Sec 3: 2021 (Spectrophotometric Method)
13	Odour		Agreeable	IS 3025 (Part 5): 2018

HUBERT ENVIRO CARE SYSTEMS (P) LTD. Chennai 600 032

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR	: TC1231025000005383F
Report No	: HECSL/WT/005/250125
Sample ID No	: 250125055
Sampling Date	: 24/01/2025
Name of the Client	: M/s. NTPC LTD.,
Address of the Client	: Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India
Group	: Water
Received Date	: 25/01/2025
Sample Name	: Ground Water
Commenced Date	: 25/01/2025
Sample Mark	: Borewell
Completed On	: 04/02/2025
Sample Reference	: NA
Report Date	: 04/02/2025
Sample Drawn By	: M/s.Hubert Enviro care Systems (P) Ltd.
Sample qty	: 2 Litres
Sample Location	: At Aarsi Village
Environmental Condition	: Temperature (°C) : 22.0 | Humidity (%) : 45.0
Sampling Method & Plan	: IS 17614 (Part -1) : 2021

S.No.	Test Parameters	Units	Results	Test Method
14	pH at 25°C	-	7.69	IS 3025(Part 11) : 2022 (Electrometric method)
15	Potassium as K	mg/l	2.0	IS 3025 Part 45: 1993 (Flame emission Photometric Method)
16	Sodium as Na	mg/l	28.0	IS 3025 Part 45: 1993 (Flame emission Photometric Method)
17	Sulphate as SO4	mg/l	37.10	IS 3025 Part 24 Sec 1: 2022 (Turbidity Method)
18	Temperature(°C)	°C	26.8	IS 3025 (Part 9): 1984
19	Total alkalinity as CaCO3	mg/l	250.0	IS 3025 (Part 23): 1986
20	Total dissolved solids	mg/l	431.0	IS 3025 (Part 16): 1984
21	Phosphate as PO4	mg/l	BLQ(LOQ:0.02)	IS 3025 Part 31 Sec 1: 2022 (Stannous Chloride method)
22	Arsenic	mg/l	BLQ (LOQ: 0.005)	USEPA 200.8 : 1994
23	Cadmium	mg/l	BLQ (LOQ: 0.001)	USEPA 200.8 : 1994
24	Chromium	mg/l	BLQ (LOQ: 0.01)	USEPA 200.8 : 1994
25	Copper	mg/l	BLQ (LOQ: 0.01)	USEPA 200.8 : 1994
26	Lead	mg/l	BLQ (LOQ: 0.005)	USEPA 200.8 : 1994
27	Mercury	mg/l	BLQ (LOQ: 0.0005)	USEPA 200.8 : 1994
28	Zinc	mg/l	BLQ (LOQ: 0.01)	USEPA 200.8 : 1994

Note :- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, mg/l- Milligrams per litre.

End Report

HUBERT ENVIRO CARE SYSTEMS Chennai 600 032

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

TC-12310

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

ULR : TC1231025000004044F
Report No : HECSL/WT/017/250125
Sample ID No : 250125067
Sampling Date : 24/01/2025

Name of the Client : M/s. NTPC LTD.,
Address of the Client : Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India
Group : Water
Sample Name : Ground Water
Sample Mark : Borewell at Aarsi Village
Sample Reference : NA
Sample Drawn By : M/s.Hubert Enviro care Systems (P) Ltd.
Sample Location : At Aarsi Village
Environmental Condition : Temperature (°C) : 22.0 | Humidity (%) : 45.0
Sampling Method & Plan : HECS-G/MICRO/SOP/004

Received Date : 25/01/2025
Commenced Date : 25/01/2025
Completed On : 27/01/2025
Report Date : 28/01/2025
Sample qty : 100ml

S.No.	Test Parameters	Units	Results	Test Method
Discipline : Biological				
1	Faecal Coliform	MPN/100ml	<2	IS 1622 : 1981
2	Total Coliform	MPN/100ml	<2	IS 1622 : 1981

Note:- MPN - Most Probable Number, < 2 is Considered as Absent.

End of Report

Jisha S Prakash
Microbiology-Head
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS, FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

Name of the Client	: **M/s. NTPC LTD.,**	Report No	: **HECS/PE/17/250125**
		Sample ID No	: **250125092**
Address of the Client	: **Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India**	Sampling Date	: **24/01/2025**
Group	: **Pollution & Environment**	Received Date	: **25/01/2025**
Sample Name	: **Ash Group**	Commenced Date	: **25/01/2025**
Sample Mark	: **Fly Ash**	Completed On	: **03/02/2025**
Sample Reference	: **NA**	Report Date	: **03/02/2025**
Sample Drawn By	: **M/s.Hubert Enviro care Systems (P) Ltd.**	Sample qty	: **1 Kg**
Sample Location	: **NA**		
Environmental Condition	: **Temperature (°C) : 26.0 | Humidity (%) : 52.0**		
Sampling Method & Plan	: **Inhouse Method**		

S.No.	Test Parameters	Units	Results	Test Method
Discipline : Chemical				
1	Zinc	mg/kg	BLQ(LOQ: 0.1)	HECS-G/INS/SOP/042
2	Chromium	mg/kg	0.43	HECS-G/INS/SOP/042
3	Copper	mg/kg	BLQ(LOQ: 0.1)	HECS-G/INS/SOP/042
4	Cadmium	mg/kg	BLQ(LOQ: 0.1)	HECS-G/INS/SOP/042
5	Nickel	mg/kg	BLQ(LOQ: 0.1)	HECS-G/INS/SOP/042
6	Cobalt	mg/kg	BLQ(LOQ: 0.1)	HECS-G/INS/SOP/042
7	Manganese	mg/kg	BLQ(LOQ: 0.1)	HECS-G/INS/SOP/042
8	Arsenic	mg/kg	BLQ(LOQ: 0.1)	HECS-G/INS/SOP/042
9	Lead	mg/kg	BLQ(LOQ: 0.1)	HECS-G/INS/SOP/042
10	Mercury	mg/kg	BLQ(LOQ: 0.1)	HECS-G/INS/SOP/042
11	pH	-	6.52	IS 2720 (Part 26) 1987

Note:- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, , mg/kg- milligram per kilogram

End of Report

HUBERT ENVIRO CARE SYSTEMS (P) LTD. Chennai 600 032

Dr. Rajkumar Samuel
Director Technical
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS, FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

Name of the Client	: M/s. NTPC LTD.,	Report No.	: HECS/PE/18/250125
		Sample ID No	: 250125093
Address of the Client	: Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India	Sampling Date	: 24/01/2025
Group	: Pollution & Environment	Received Date	: 25/01/2025
Sample Name	: Ash Group	Commenced Date	: 25/01/2025
Sample Mark	: Bottom Ash	Completed On	: 03/02/2025
Sample Reference	: NA	Report Date	: 03/02/2025
Sample Drawn By	: M/s.Hubert Enviro care Systems (P) Ltd.	Sample qty	: 1 Kg
Sample Location	: NA		
Environmental Condition	: Temperature (°C) : 26.0 | Humidity (%) : 52.0		
Sampling Method & Plan	: Inhouse Method		

S.No.	Test Parameters	Units	Results	Test Method
Discipline : Chemical				
1	Zinc	mg/kg	BLQ(LOQ: 0.1)	HECS-G/INS/SOP/042
2	Chromium	mg/kg	0.31	HECS-G/INS/SOP/042
3	Copper	mg/kg	BLQ(LOQ: 0.1)	HECS-G/INS/SOP/042
4	Cadmium	mg/kg	BLQ(LOQ: 0.1)	HECS-G/INS/SOP/042
5	Nickel	mg/kg	BLQ(LOQ: 0.1)	HECS-G/INS/SOP/042
6	Cobalt	mg/kg	BLQ(LOQ: 0.1)	HECS-G/INS/SOP/042
7	Manganese	mg/kg	BLQ(LOQ: 0.1)	HECS-G/INS/SOP/042
8	Arsenic	mg/kg	BLQ(LOQ: 0.1)	HECS-G/INS/SOP/042
9	Lead	mg/kg	BLQ(LOQ: 0.1)	HECS-G/INS/SOP/042
10	Mercury	mg/kg	BLQ(LOQ: 0.1)	HECS-G/INS/SOP/042
11	pH	-	6.96	IS 2720 (Part 26) 1987

Note:- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, , mg/kg- milligram per kilogram

End of Report

HUBERT ENVIRO CARE SYSTEMS (P) LTD. Chennai 600 032

D.Anusuya
Lab Manager
Authorized Signatory

Hubert Enviro Care Systems (P) Ltd.
A-21, III Phase, Thiru Vi Ka Industrial Estate,
Guindy, Chennai - 600 032.
Ph: 42985555 / 43635555 Fax : 42985500
E-mail : labsales@hecs.in

Laboratory Services Division
(Chemical & Biological Testing)
Recognized by CPCB (MoEF & CC)
BIS, FSSAI Notified Laboratory
ISO 9001, 14001 & 45001 Certified.

TEST REPORT

Report No : HECS/PE/016/250125
Sample ID No : 250125091
Sampling Date : 24/01/2025

Name of the Client : M/s. NTPC LTD.,
Address of the Client : Khargone Super Thermal Power Station, Khargone, Madhya Pradesh, India
Group : Pollution & Environment
Sample Name : Coal
Sample Mark : Coal
Sample Reference : NA
Sample Drawn By : M/s.Hubert Enviro care Systems (P) Ltd.
Sample Location : NA
Environmental Condition : Temperature (°C) : 26.0 | Humidity (%) : 52.0
Sampling Method & Plan : Inhouse Method

Received Date : 25/01/2025
Commenced Date : 25/01/2025
Completed On : 03/02/2025
Report Date : 03/02/2025
Sample qty : 1 Kg

S.No.	Test Parameters	Units	Results	Test Method
Discipline : Chemical				
1	Chromium	mg/kg	7.15	HECS-G/INS/SOP/042
2	Cobalt	mg/kg	1.44	HECS-G/INS/SOP/042
3	Copper	mg/kg	99.82	HECS-G/INS/SOP/042
4	Nickel	mg/kg	6.43	HECS-G/INS/SOP/042
5	Arsenic	mg/kg	0.22	HECS-G/INS/SOP/042
6	Lead	mg/kg	13.27	HECS-G/INS/SOP/042
7	Zinc	mg/kg	36.57	HECS-G/INS/SOP/042
8	Mercury	mg/kg	BLQ(LOQ 0.1)	HECS-G/INS/SOP/042
9	Nitrogen	%	1.18	Inhouse method
10	Ash	%	39.4	Inhouse method
11	Sulphur	%	0.48	Inhouse method
12	Carbon	%	46.22	Inhouse method
13	Hydrogen	%	2.98	Inhouse method

Note:- BLQ - Below the Limit of Quantification, LOQ- Limit of Quantification, , % percentage, mg/kg- milligram per kilogram

End of Report

Dr. Rajkumar Samuel
Director Technical
Authorized Signatory

HUBERT ENVIRO CARE SYSTEMS (P) LTD. Chennai 600 032

Annexure-3

Final Report

Review of Hydrogeology to Assess Impact of NTPC Khargone on Surface and Ground Regime (Especially around Ash Dyke) and Propose Specific Mitigation Measures

(After completion and incorporation of Pre and Post-monsoon analysis for 2023 and 2024)

Submitted to

NTPC Khargone Super Thermal Power Station

Village: Selda & Dalchi, Tehsil: Badwah, District: Khargone, Madhya Pradesh

Submitted by
Prof. Manoj Kumar Jain (PI)
Prof. Brijesh Kumar Yadav (Co-PI)

DEPARTMENT OF HYDROLOGY
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE
ROORKEE (UTTARAKHAND), INDIA

FEBRUARY 2025

Title	Review of Hydrogeology to Assess Impact of NTPC Khargone on Surface water and Ground Regime (Especially around Ash Dyke) and Propose Specific Mitigation Measures.
	A study conducted by Department of Hydrology, Indian Institute of Technology Roorkee, Roorkee – 247667 (Uttarakhand)
Client	NTPC Limited
Disclaimer	While every opportunity has been taken to ensure the accuracy of the material presented in this document, IIT-Roorkee cannot be held responsible for errors or omissions but reserve the right to provide further clarification or consultation. The opinion contained in this report is our personal, professional opinion and should not be considered as the opinion of IIT Roorkee.
Document No.	HYD-6009/22-23/FR
NTPC PO No.	4000294217-037-1019
Consultants	Prof. Manoj Kumar Jain, Department of Hydrology Prof. Brijesh K. Yadav, Department of Hydrology Indian Institute of Technology, Roorkee, Uttarakhand 247667, India
Quality Assurance	Prof. Manoj Kumar Jain, Department of Hydrology Prof. Brijesh K. Yadav, Department of Hydrology Department of Hydrology, Indian Institute of Technology Roorkee, Roorkee – 247667, Uttarakhand, India
Date	4 February 2025

EXECUTIVE SUMMARY

The study team from the Department of Hydrology, IIT Roorkee visited the NTPC Khargone, and its nearby areas along with the required instruments during April 25 – 30, 2023, October 9 – 13, 2023, May 5 – 9, 2024, and September 25 – 29, 2024 to undertake a survey of the power station area, ash dyke and other surrounding areas of the power station. The team identified relevant observation points in all directions for sample collection of surface and groundwater resources. Water samples were collected from the identified existing open wells, handpumps, tube wells, piezometers, ponds, reservoirs, rivers within a 10 km radius and ash dyke, NTPC station area, surface water reservoirs etc. The depth of the groundwater table was also measured using the existing open wells and piezometers available in and around the power station boundary. Some water quality parameters were measured in situ during the field visit, and the remaining were analysed in the laboratories of the Department of Hydrology and Institute Instrumentation Centre (IIC) of IIT Roorkee. A summary of the field surveys and a detailed analysis of collected data for the pre-and post-monsoon seasons for two years (2023 and 2024) are presented in this final report.

CONTENTS

EXECUTIVE SUMMARY 1

1 INTRODUCTION AND OBJECTIVES OF THE STUDY 10

1.1 Objectives 11

1.2 Extent & Scope of the Study 11

1.2.1 Literature Review 12

1.2.2 Field Studies 12

2 DESCRIPTION OF THE STUDY AREA 14

2.1 General 14

2.2 Location and Extent of Study Area 15

2.3 Topography of the Study Area 18

2.4 Drainage of the Study Area 18

2.5 Soil and Vegetation 18

2.6 Land use / Land Cover 19

3 RECONNAISANCE SURVEY 23

4 FIELD INVESTIGATIONS 24

4.1 Pre-monsoon 2023 field investigations 24

4.2 Post-monsoon 2023 field investigations 24

4.3 Pre-monsoon 2024 field investigations 25

4.4 Post-monsoon 2024 field investigations 25

5 GROUNDWATER LEVEL AND FLOW DIRECTION 27

5.1 Groundwater level observations during Pre-Monsoon 2023 season 27

5.2 Groundwater level observations during the post-monsoon 2023 season 32

5.3 Groundwater level observations during pre-monsoon 2024 season 37

5.4 Groundwater level observations during post-monsoon 2024 season 42

5.5 Analysis of Groundwater level trend with previous reports 46

6 SURFACE WATER QUALITY AT IDENTIFIED LOCATIONS AND CURRENT SOURCES OF CONTAMINATION, IF ANY. 49

6.1 Surface Water Quality during Pre-monsoon 2023 Season 49

6.2 Surface Water Quality during Post-monsoon 2023 Season 55

6.3 Surface Water Quality during Pre-monsoon 2024 Season 58

6.4 Surface Water Quality during Post-monsoon 2024 Season 61

6.5 Overall Analysis of Surface Water Quality during the study period 64

7 GROUNDWATER QUALITY AT IDENTIFIED LOCATIONS AND CURRENT SOURCES OF CONTAMINATION. 65

7.1 Groundwater Quality for Pre-monsoon 2023 Season 65

7.2 Groundwater Quality for Post-monsoon 2023 Season 71

7.3 Groundwater Quality for Pre-monsoon 2024 Season 76

7.4 Groundwater Quality for Post-monsoon 2024 Season 79

8 Estimated Contribution of Rainwater harvesting done at NTPC plant to the groundwater recharge 83

8.1 Monitoring of groundwater level and quality for observation points inside and adjacent to the plant 84

9 ANALYSIS OF SOIL CHEMICAL PROPERTIES.. 90

9.1 Soil Chemical Properties during pre-monsoon 2023 season....................................... 91

9.2 Soil Chemical Properties during the post-monsoon 2023 season 96

9.3 Soil Chemical Properties during pre-monsoon 2024 Season 98

9.4 Soil Chemical Properties during post-monsoon 2024 Season 101

10 ISOTOPE DATA ANALYSIS 104

10.1 Isotope Analysis for Pre-monsoon Season... 105

10.2 Isotope Analysis for Post-monsoon Season **106**

11 SUMMARY AND CONCLUSION* *108

Reference 111

Appendix-A: Photograph of water sampling sites 112

Ground water sampling sites 112

Surface water sampling sites 125

Soil sampling sites 130

Piezometers sampling sites 134

LIST OF TABLES

Table 1. Details of groundwater level monitoring stations during pre-monsoon of 2023. 27

Table 2. Measured groundwater level at identified locations in the area during the pre-monsoon season (April 2023). 29

Table 3. Details of groundwater level monitoring stations during the post-monsoon 2023 season. 32

Table 4. Measured groundwater level at identified locations in the area during the post-monsoon season (October 2023). 35

Table 5. Details of groundwater level monitoring stations during the pre-monsoon 2024 season. 37

Table 6. Measured groundwater level at identified locations in the area during the pre-monsoon season of 2024). 40

Table 7. Measured groundwater level at identified locations in the area during the post-monsoon season 2024). 42

Table 8 Groundwater level fluctuation in the buffer zone and trend based on pre and post monsoon water table data observed in year 2024. 47

Table 9. Groundwater level fluctuation in the buffer zone and trend based on pre and post monsoon water table data observed in year 2023. 48

Table 10. Groundwater level fluctuation in the buffer zone and trend based secondary data collected in year 2018 during pre and post monsoon period. 48

Table 11. Surface water sampling sites in a 10 km buffer (pre-monsoon 2023). 50

Table 12. Physical parameters in surface water samples during the pre-monsoon season of April (2023); pH in standard units. 51

Table 13. Mean concentration (in ppm) of heavy metals in the surface water samples and their comparison with BIS limits 10500:2012 during pre-monsoon season of April (2023) 53

Table 14. Mean concentration (in mg/L) of major ions in surface water samples and their comparison with BIS limits of IS 10500:2012 during pre-monsoon season of April (2023) 54

Table 15. Surface water sampling sites in a 10 km buffer (post-monsoon 2023) 55

Table 16. Physical parameters in surface water samples during the post-monsoon season of 2023; pH in standard units. 56

Table 17. Mean concentration (in ppm) of heavy metals in the surface water samples and their comparison with BIS limits 10500:2012 during post-monsoon season of 2023 57

Table 18. Mean concentration (in mg/L) of major ions in surface water samples and their comparison with BIS limits of IS 10500:2012 during post-monsoon 2023 season. 58

Table 19.Physical parameters in surface water samples during the pre-monsoon season of 2024; pH in standard units 60

Table 20. Mean concentration (in ppm) of heavy metals in the surface water samples and their comparison with BIS limits 10500:2012 during pre-monsoon season 2024 60

Table 21. Mean concentration (in mg/L) of major ions in surface water samples and their comparison with BIS limits of IS 10500:2012 during pre-monsoon season 2024 61

Table 22 Physical parameters in surface water samples during the post-monsoon season of September, 2024; pH in standard units 62

Table 23 Mean concentration (in ppm) of heavy metals in the surface water samples and their comparison with BIS limits 10500:2012 during post-monsoon season September 2024 63

Table 24 Mean concentration (in mg/L) of major ions in surface water samples and their comparison with BIS limits of IS 10500:2012 during post-monsoon season September 2024 63

Table 25. Location of collected groundwater samples in the study area during the pre-monsoon period (April 2023) for In-situ/Ex-situ analyses. 65

Table 26. Measured values of physical parameters (DO, TDS, EC, pH, Hardness and Temperature) in the groundwater samples during the pre-monsoon 2023 season from In-situ analysis. 68

Table 27. Mean concentration (in mg/L) of major ions in Groundwater samples and their comparison with BIS limits during pre-monsoon 2023 season. 70

Table 28. Mean concentration (in ppm) of heavy metals in the groundwater samples and their comparison with BIS limits during the pre-monsoon 2023 season. 71

Table 29. Location of collected groundwater samples in the study area during the post-monsoon 2023 season for In-situ/Ex-situ analyses. 72

Table 30. Measured values of physical parameters (DO, TDS, EC, pH, Hardness and Temperature) in the groundwater samples during the post-monsoon 2023 season from In-situ analysis. 73

Table 31. Mean concentration (in mg/L) of major ions in Groundwater samples and their comparison with BIS limits of IS 10500:2012 during post-monsoon 2023 season. 74

Table 32. Mean concentration (in ppm) of heavy metals in the groundwater samples and their comparison with BIS limits 10500:2012 during post-monsoon 2023 season 75

Table 33. Measured values of physical parameters (DO, TDS, EC, pH, Hardness and Temperature) in the groundwater samples during the pre-monsoon. May 2024 season from In-situ analysis 77

Table 34. Mean concentration (in mg/L) of major ions in Groundwater samples and their comparison with BIS limits during pre-monsoon May 2024 season 78

Table 35. Mean concentration (in ppm) of heavy metals in the groundwater samples and their comparison with BIS limits during the pre-monsoon May 2024 season. 79

Table 36 Measured values of physical parameters (DO, TDS, EC, pH, Hardness, and Temperature) in the groundwater samples during the post-monsoon September 2024 season from In-situ analysis 81

Table 37 Mean concentration (in mg/L) of major ions in Groundwater samples and their comparison with BIS limits during post-monsoon September 2024 season 82

Table 38 Mean concentration (in ppm) of heavy metals in the groundwater samples and their comparison with BIS limits during the post-monsoon September 2024 season....... 82

Table 39. Salient details of observation wells for groundwater level monitoring inside and adjacent to the plant 84

Table 40. Measured groundwater level at identified locations inside and adjacent to the plant 85

Table 41. Salient information of the groundwater quality observation points inside and adjacent to the plant. 85

Table 42. Measured values of physical parameters (DO, TDS, EC, pH, Hardness and Temperature) in the groundwater samples inside and adjacent to the plant 86

Table 43. Mean concentration (mg/l) of major ions in groundwater samples inside and adjacent to the plant and their comparison with BIS limits 87

Table 44. Mean concentration (in ppm) of heavy metals in groundwater samples inside and adjacent to the plant and their comparison with BIS limits 89

Table 45. Details of soils samples and their location name with geo-coordinates in the study area 93

Table 46. Mean concentration of major ions in soil samples during the pre-monsoon 2023 season (April 2023) (ions in mg/g, EC in µs/cm, pH in standard unit) 94

Table 47. Mean concentration of heavy metals in the soil samples during the pre-monsoon 2023 season (April 2023). 95

Table 48. Mean concentration of major ions in soil samples during the post-monsoon season of 2023 (ions in mg/g, EC in µs/cm, pH in standard unit) 97

Table 49. Mean concentration of heavy metals in the soil samples during post-monsoon 2023 season. 98

Table 50. Mean concentration of major ions in soil samples during the pre-monsoon season May 2024 (ions in mg/g, EC in µs/cm, pH in standard unit) 100

Table 51. Mean concentration of heavy metals in the soil samples during the pre-monsoon seasons of 2024. 101

Table 52 Mean concentration of major ions in soil samples during the post-monsoon season of 2024 (ions in mg/g, EC in µs/cm, pH in standard unit) 102

Table 53 Mean concentration of heavy metals in the soil samples during post-monsoon 2024 season 103

Table 54 Characteristic isotope lines of GMWL, LMWL, and groundwater samples for Pre-monsoon 2023 105

Table 55 Characteristic isotope lines of GMWL, LMWL, and groundwater samples for post-monsoon 2023 season. 107

LIST OF FIGURES

Figure 1. Index map showing location of NTPC Khargone STPP. 15

Figure 2. Image showing NTPC Khargone Super Thermal Power Station 16

Figure 3. The boundary of NTPC Khargone Super Thermal Power Station along with a 10 km buffer marked on Survey of India toposheets. 17

Figure 4. DEM of the Study Area 20

Figure 5. Slope map of the study area. 21

Figure 6. Drainage map of the study area. 22

Figure 7. Some field photographs of reconnaissance survey during February 2023 23

Figure 8. Map showing spatial variation of water table depth below ground level for pre-monsoon 2023 season. 30

Figure 9. Map depicting ground water table contours and flow direction in the study area during Pre-monsoon 2023. 31

Figure 10. Map showing the spatial variation of water table depth below ground level for the post-monsoon 2023 season. 34

Figure 11. Map depicting groundwater table contours and flow direction in the study area during the post-monsoon 2023 season. 36

Figure 12. Map showing the spatial variation of water table depth below ground level for the pre-monsoon 2024 season. 39

Figure 13 Map depicting groundwater table contours and flow direction in the study area during the pre-monsoon season of year 2024. 41

Figure 14. Map showing the spatial variation of water table depth below ground level for the post-monsoon 2024 season 44

Figure 15. Map depicting groundwater table contours and flow direction in the study area during the post-monsoon season of year 2024 45

Figure 16. Map depicting the location of surface water sampling points during pre-monsoon 2023. 52

Figure 17. Groundwater sampling points during the pre-monsoon 2023 season. 67

Figure 18. Soil sampling points within the 10 km buffer zone of power station site in the study area 92

Figure 19. Isotopic characterization for Groundwater samples collected from piezometers (06), handpump (07), tube-wells (02), and the open well (01) for Pre-monsoon 2023. 106

Figure 20. Isotopic characterization for Groundwater samples collected from piezometers (06), handpump (07), tube-wells (02), and the open well (01) for Post-monsoon 2023. 107

1 INTRODUCTION AND OBJECTIVES OF THE STUDY

NTPC Limited is operating Khargone Super Thermal Power Station (KhSTPS) of capacity 1320 MW (2x660 MW) near villages Selda and Dalchi in Sanawad Tehsil of Khargone District of Madhya Pradesh to meet the power demand of Western Region states like MP, Gujrat, Chhattisgarh, Maharashtra, Goa and Daman & Diu. It is a coal-based thermal power station based on environmentally friendly ultra-supercritical technology. The coal requirement of 6.6 MTPA for the power station is brought from the CIL Subsidiaries, SECL, NCL & NTPC Captive mines through a railway line.

The makeup water requirement for the power station is about 3700 cum/hr with an ash water recirculation system. The water requirement is being met from the Omkareshwar dam, located at a distance of about 45 km from the power station. The Govt. of Madhya Pradesh has accorded a commitment for 40 MCM of water from the Narmada River for the project.

The major objective of this power project is to improve the power supply in Madhya Pradesh. 50% of the power generated from the station has been allocated to Madhya Pradesh State, 16.5% to Maharastra, 13.3% to Gujarat, 4% to Chhattisgarh, 0.7 % to Goa, DD & DNH. 15% of power is kept as unallocated at the disposal of the Government of India (GoI) to meet short-term emergencies, deficits of beneficiary states and allocation to other willing states of Western Region. This is subject to the approval of GoI.

The Khargone Super Thermal Power Station (KhSTPS) is located at a distance of about 105 Kms from Indore, about 30 Kms from Sanawad town, about 42 km from Barwah and at a distance of about 15 km from Bedia (on Sanawad-Khargone Road).

Khargone city is about 40 km from the project site. The KhSTPS is approachable from Sanawad on Indore – Khandwa State Highway through the PWD road. The nearest Railway Station is Sanawad on Indore – Khandwa which is about 32 Km. Khandwa is on the main line of the Central Railway on the Mumbai-Itarsi section. The Airport at Indore is located about 105 km from the study site.

Narmada River is passing at about 15 Km (North) from the project site. The KhSTPS is located geographically at (Lat 22°04’06.6” N; Long 75°51’18.4” E) on Survey of India (SoI) toposheet No. 46N/16.

The specific condition no. (xiii) under Environmental Clearance (EC) accorded by The Ministry of Environment, Forest and Climate Change (MoEF&CC) vide letter Ref. No. J-13012/54/2010-IA.II(T), dtd. 31/03/2015 stipulates, "Hydrogeology of the area shall be reviewed annually through an institute/organisation of repute to assess the impact of surface water and groundwater (especially around ash dyke). In case, any deterioration is observed, specific mitigation measures shall be undertaken immediately. Reports/data of water quality shall be submitted to the Regional Office of the Ministry every six months. "In view of the above, NTPC issued an NIT No. NTPC/USSC-CPG2/9900248178 dated 15.10.2022 for Review of hydrogeology to assessment to assess impact of NTPC-Khargone on surface water and ground regime (especially around ash dyke). The Department of Hydrology, Indian Institute of Technology Roorkee, Roorkee participated in the tender process and the consultancy was successfully awarded to IITR by NTPC Khargone vide PO No. 4000294217-037-1019.

1.1 Objectives

The objectives of the study shall be as follows:

a. To assess and review the impact of Khargone STPS (2x660 MW) on soil, surface water and groundwater regime (especially around the ash dyke).
b. To suggest mitigation measures for remediation of surface water and groundwater regime, if any.

1.2 Extent & Scope of the Study

The geographical extent of the study area shall consist of an area within 10 km from the periphery of the project components (Main plant, Ash Pond area & Township). In addition, the source of water, location of the intake point, and type of intake structures (barrage, dam, intake well, intake channel etc.) shall also be covered in the study, even if located beyond 10 km and significant for identification of the impact due to

NTPC Khargone. Further, any significant surface or groundwater body located within 10-15 Km which is likely to influence the project/get influenced from the project shall also be covered.

The scope of the project will be as follows.

1.2.1 Literature Review

The consultant has to undertake a detailed literature search for the documents/ reports already available for the study area with various agencies such as the Geological Survey of India, the State Department of Geology and Mining, Central and State Water Boards, State Water Resources/Irrigation departments, Central Water Commission, India Meteorological Department etc. Based on the review of the literature available, the consultant shall make a detailed plan for the study covering all the objectives.

1.2.2 Field Studies

1.2.2.1 Hydro-geological investigations

i. Preparation of groundwater flow direction map in Pre-monsoon and post-monsoon periods.

ii. Analysis of soil chemical properties, like EC, pH, major ions (Na, K, Ca, Mg, Fe, CO_3, HCO_3, Cl, SO_4, NO_3, F^-, and PO_4), and Heavy metals (Cd, Zn, Hg, As, Cr, Pb etc.) at 10 selected locations at surface, 30 cm and 60 cm depth.

1.2.2.2 Surface water quality monitoring around the Ash-pond

i. Water quality parameters like pH, EC, DO, BOD, COD, major cations (Na, K, Ca, Mg, and Fe etc.), major anions (CO_3, HCO_3, Cl, SO_4, NO_3, F^-, and PO_4 etc.) and Heavy metals (Cd, Zn, Hg, As, Cr, Pb etc.) during Pre and Post monsoon seasons at 16 locations (including water bodies i.e. streams and ponds especially near ash pond, water bodies within 10 km, samples from ash ponds and raw water reservoir).

1.2.2.3 Groundwater monitoring network around the Ash-pond

(To check leachability from ash pond):

i. Design of the groundwater level and quality observation network.

ii. Regular monitoring of groundwater level shall be carried out in network of existing wells and piezometers in the vicinity of the ash pond for Pre-monsoon and post-monsoon. Water table monitoring and depletion status in and around the project area.

iii. Water quality parameters like, pH, EC, TDS, DO, Major cations (Na, K, Ca, Mg, and Fe etc.), major anions (CO_3, HCO_3, Cl, SO_4, NO_3, F^-, and PO_4.), heavy metals (Cd, Zn, Hg, As, Cr, Pb etc.) and isotope monitoring during Pre & Post monsoon seasons at 16 locations (including 6 piezometers and 10 existing hand pumps and/or bore wells).

2 DESCRIPTION OF THE STUDY AREA

2.1 General

Khargone Super Thermal Power Station (KhSTPS) is a coal-based thermal power project located at villages Selda and Dalchi in the Khargone district of Madhya Pradesh. It is the country's first ultra-supercritical thermal power project generating 1.32GW power using 2X660MW ultra-supercritical coal-fired units. It is the first ultra-supercritical coal-fired unit in the country built on engineering, procurement, and construction (EPC) basis. The project received environmental clearance in March 2015, while site preparation works were started in July 2015. NTPC commissioned the first 660MW unit of the Khargone power station in August 2019, and the second unit of similar capacity was commissioned in April 2020.

The total quantum of land acquired for the power station, ash dyke and township is 428.899 Hectares (1059.498 Acres), comprising of 317.19 Hectares (783.7904 Acres) of private land and 111.709 Hectares (276.039 Acres) Govt. land and is in NTPC possession. In addition, land of about 115 Hectares (about 284 acres) has been acquired for the makeup water pipeline corridor.

While developing the details of water system for the project, utmost care has been taken to minimise water requirement as well as effluent generation. The main features of the water system shall include: (i) Re-circulating type C.W. system with cooling towers / Open System complying with MOEF requirements. (ii) In case of Cooling Towers, utilisation of Cooling Tower blow down for Coal dust suppression and extraction system, Service water system, Ash handling and Firefighting. (iii) Recycle and reuse of effluents from coal dust suppression and extraction system and service water system. (iv) Ash water recirculation system, and (v) Recirculation of filter backwash to clarifier inlet. An effluent management scheme consisting of collection, treatment, recirculation, and disposal of effluents has been implemented in order to optimise the makeup water requirement as well as liquid effluent generation.

2.2 *Location and Extent of Study Area*

The study area for this study consists of an area within 10 km of distance from the periphery of the power station, ash pond, and township. In addition, the source of water and location of the intake point, type of intake structures (barrage, dam, intake well, intake channel etc.) shall also be covered for the study, even if located beyond 10 km and significant for identification of the impact due to NTPC Khargone. Further, any significant surface or groundwater body located within 10-15 km which is likely to influence the project/get influenced from the project shall also be covered. The index map showing the location of the NTPC Khargone power station is depicted in Figure 1. An image showing the NTPC Khargone power station is shown in Figure 2, and the 10 km radius from the NTPC power station marked on a topographic map is shown in Figure 3.

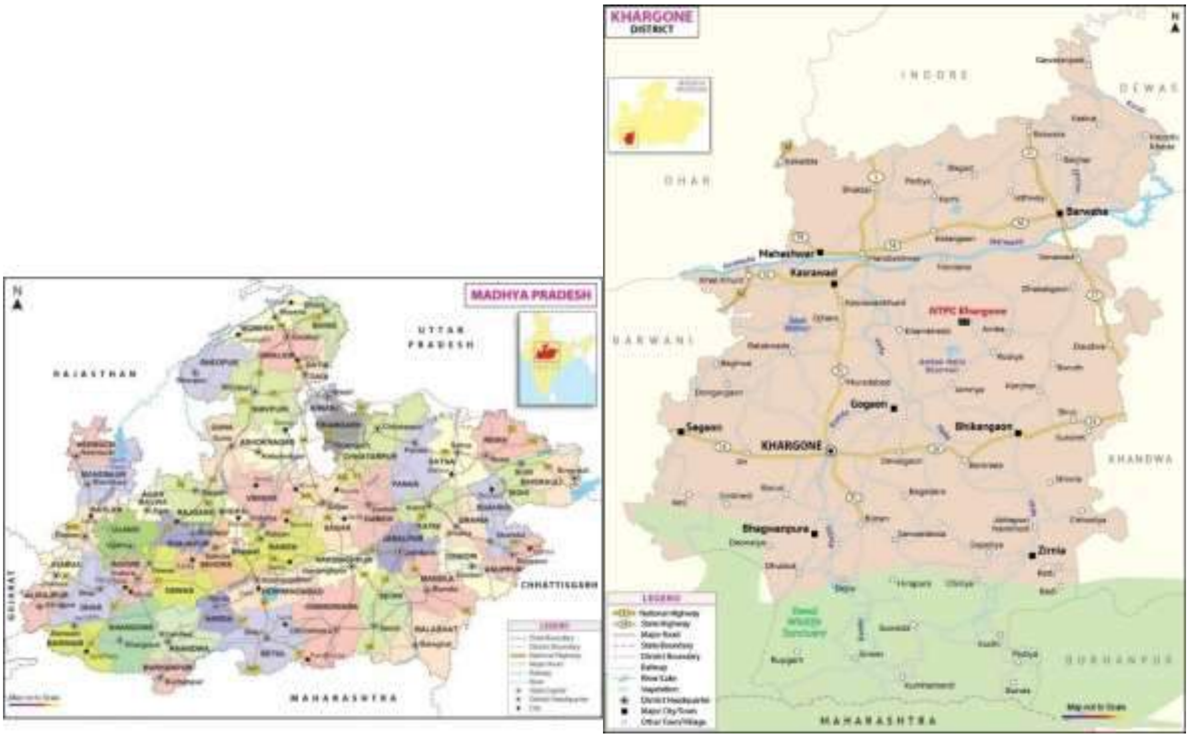


Figure 1. Index map showing location of NTPC Khargone STPP.

Figure 2. Image showing NTPC Khargone Super Thermal Power Station

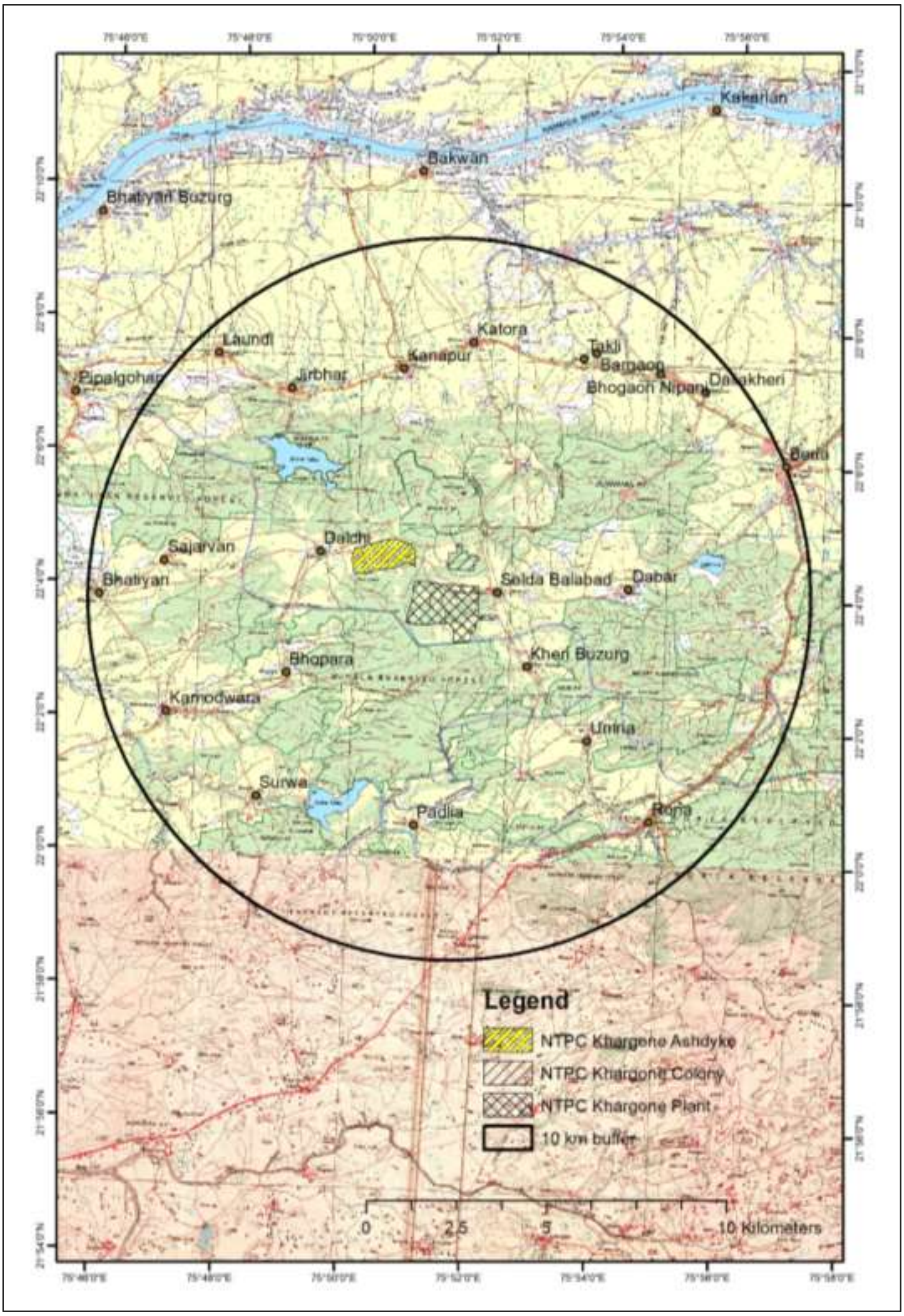


Figure 3. The boundary of NTPC Khargone Super Thermal Power Station along with a 10 km buffer marked on Survey of India toposheets.

2.3 *Topography of the Study Area*

The general topography of the study area was studied using the Survey of India toposheets 46O/13 & 46N/16, shown in Figure 3 and 1 arc second SRTM Digital Elevation Model (DEM) obtained from the Earth Explorer Website (https://earthexplorer.usgs.gov/). The DEM was processed in ArcGIS 10.8. The DEM of the study area is shown in Figure 4. The topography of the area is fairly undulating. The maximum and minimum elevation ranges between 240 and 260 m above mean sea level (amsl). The project area is a part of North Khargone tehsil, District Khargone, MP, which lies on the Deccan Plateau and has an average altitude of 250 m. The general slope of the area is towards the northwest. The general gradient of the area is towards NNW. The slope map of the study area is shown in Figure 5, which clearly shows the undulating topography of the area.

2.4 *Drainage of the Study Area*

The drainage map of the study area has been prepared using SRTM DEM, shown in Figure 4. The DEM was processed in ArcGIS 10.8 to generate the drainage map of the study area. The generated drainage map of the area is shown in Figure 6. In general, the drainage pattern of the study area is dendritic in nature. The Narmada River flows about 11.5 km in the North direction from the power station area. The Vamsali and Ambak Rivers, both tributaries of the Narmada River, mainly drain the area. The flow pattern in the 10 km circle of the study area is seen to have two distinct patterns. One flows towards the eastern side and the other towards the western side. The NTPC power station is located in the watershed draining towards the eastern watershed, while the ash dyke is located in the watershed draining towards the western side. Few water bodies could also be seen in the study area, mostly used for agricultural purposes by local farmers.

2.5 *Soil and Vegetation*

Generally, there are five types of soils, namely Kali I, (0-1 metre below ground level (mbgl)) and Kali II (1-2 mbgl) (2-3 mbgl) Halkikhardri and Bardi. These soils are classified as medium black cotton soils containing 50% silt and clay together. Alluvial soil is found on both sides of the river Narmada and has some patches along its tributaries.

The study area has sparse vegetation, mainly open scrub type. The land area around the NTPC Khargone project does not have dense vegetation cover. Various kinds of trees, herbs, shrubs, climbers and grasses surround the area near the project.

*2.6 **Land use / Land Cover***

The Main Land use pattern of the district comprises agricultural land, Forest, Fallow and settlement. Most part of the surrounding area of the project is covered by agricultural land, supporting single to multi crop pattern.

Broadly, the various land uses of the study area could be grouped under five categories, namely, Agricultural land (51.6%), Forest (27.7%), Settlement (2.3%), Waterbodies (3.6%), and barren land (14.8%).

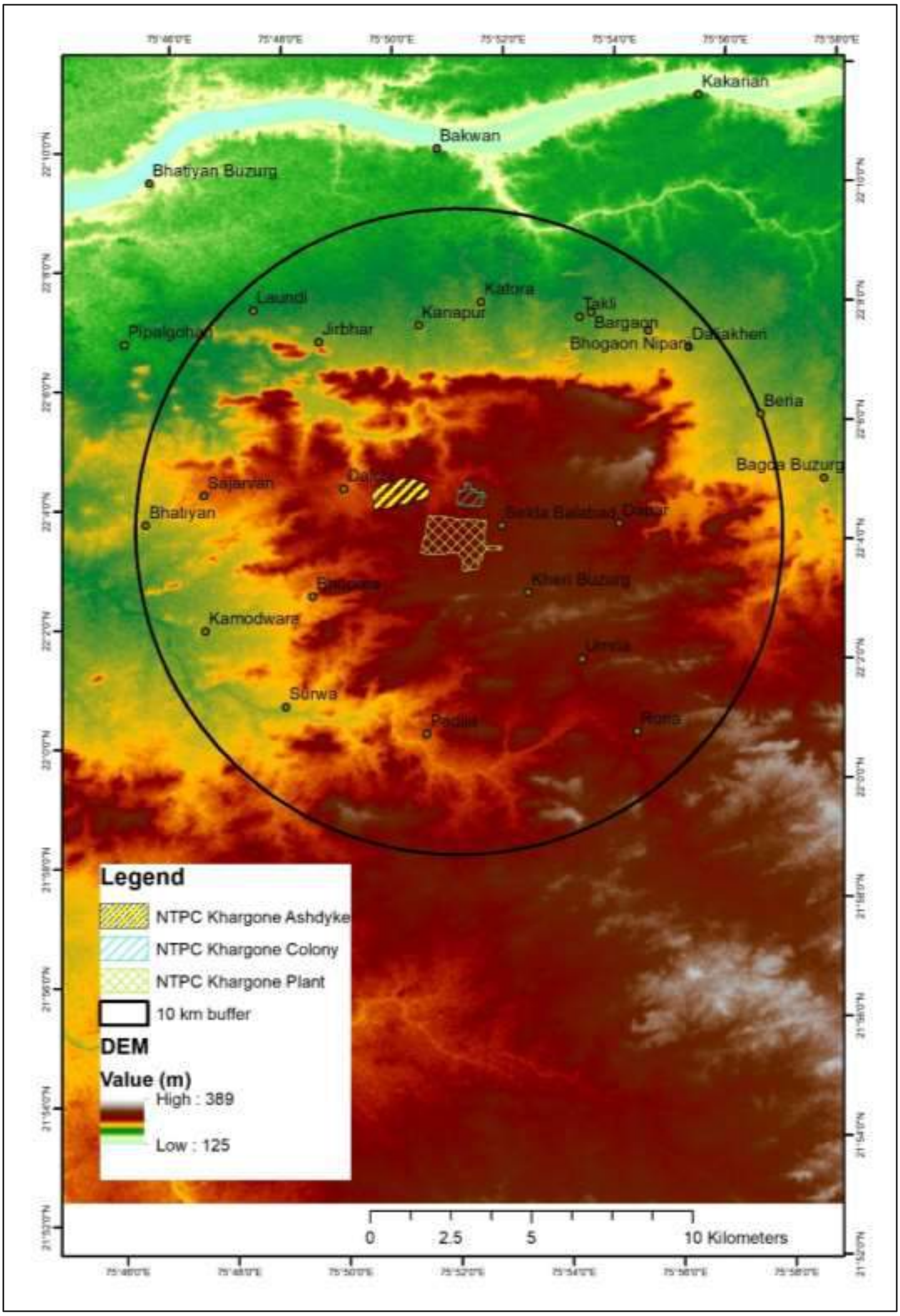


Figure 4. DEM of the Study Area

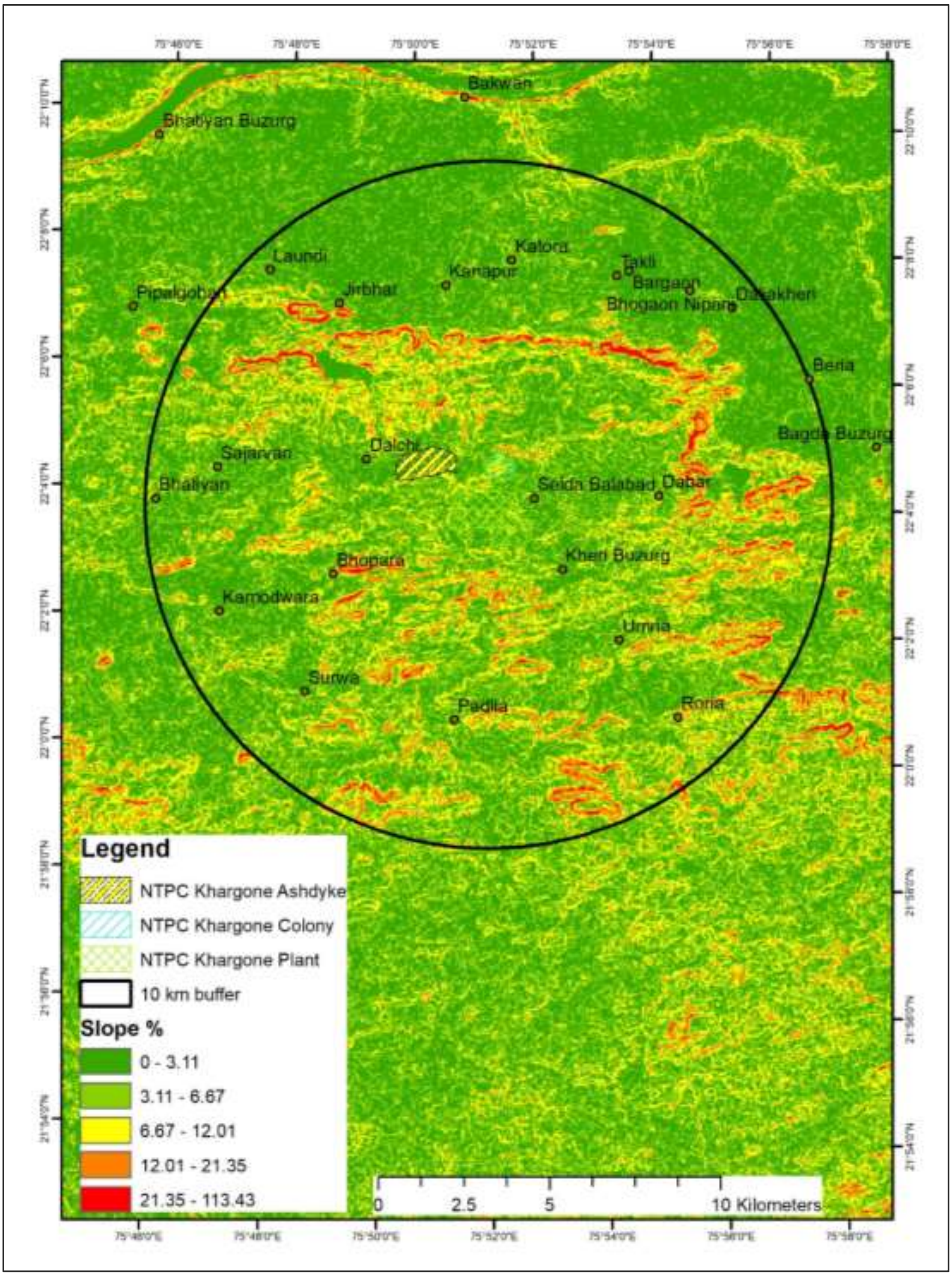


Figure 5. Slope map of the study area.

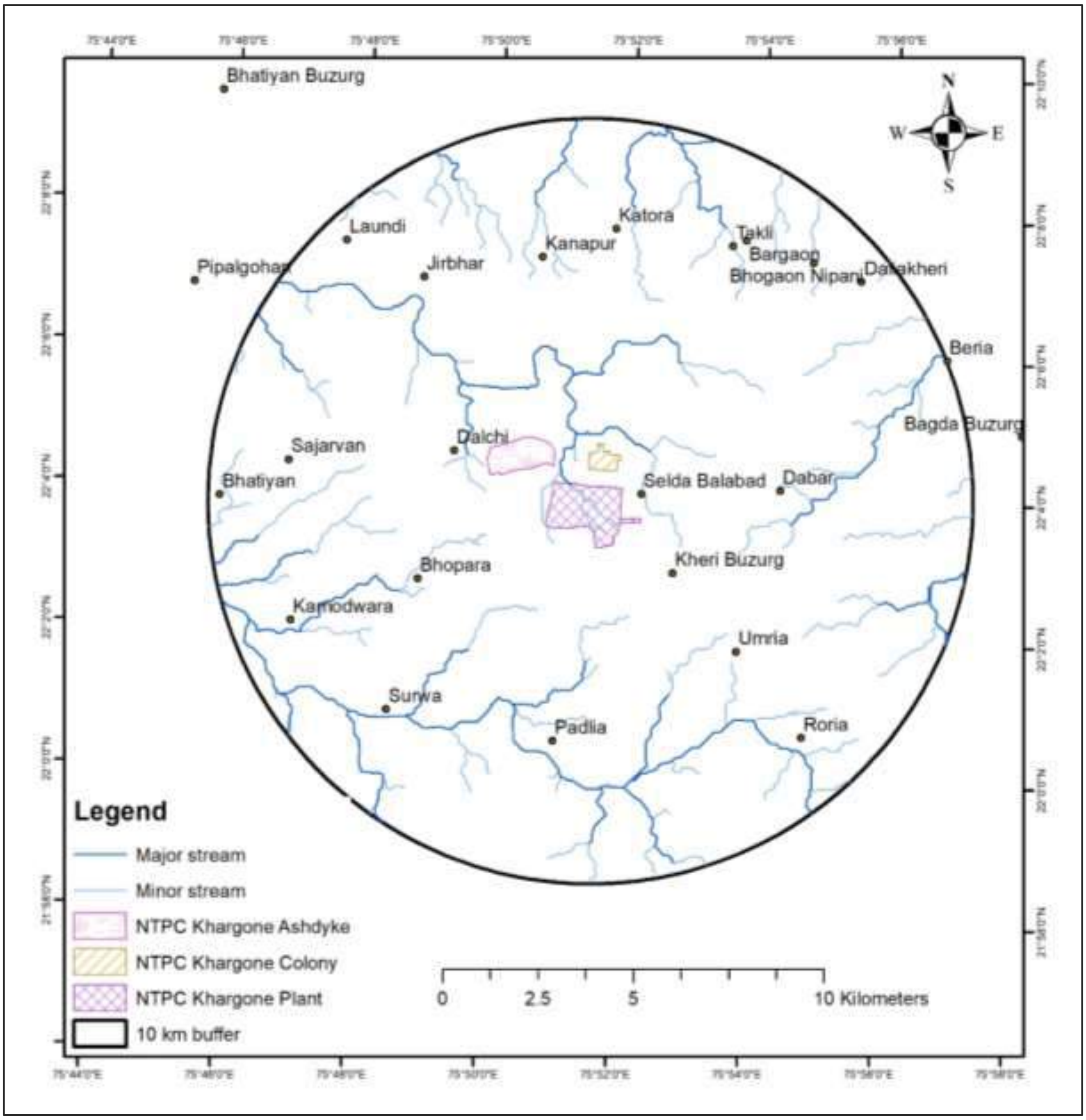


Figure 6. Drainage map of the study area.

3 RECONNAISANCE SURVEY

A field visit to the NTPC Khargone was undertaken by Prof. Manoj Kumar Jain, Profesor, IIT Roorkee during February 2023. A reconnaissance survey of the study area was undertaken during this visit. A meeting was also held with officials of NTPC to discuss the fieldwork, proposed methodology and upcoming pre-monsoon visit. Some photographs of the reconnaissance field visit are shown in Figure 7.

Figure 7. Some field photographs of reconnaissance survey during February 2023

4 FIELD INVESTIGATIONS

4.1 Pre-monsoon 2023 field investigations

A site visit was undertaken for pre-monsoon sampling and field investigations by the IIT Roorkee team during April 25 – 30, 2023. During this field visit, the following field works were undertaken.

i. Surface water sampling from 12 locations of surface water, including samples from various sources such as river water, lagoons, raw water reservoirs and ponds/lakes for studying surface water quality.

ii. Ground water sampling from 18 locations, including samples from various sources such as hand pumps, tube wells, open wells, and seepage nalah.

iii. Ground water levels monitoring at 16 locations, including hand pumps, tube wells, and open wells.

iv. Collection of soil samples from 11 locations.

v. In-situ determination of latitude, longitude, and elevation (altitude) for the various sampling locations.

vi. Site photograph during sampling. The site photographs are provided in Appendix-I.

4.2 Post-monsoon 2023 field investigations

A site visit was undertaken for post-monsoon 2023 sampling and field investigations by the IIT Roorkee team during October 9 – 13, 2023. During this field visit, the following field works were undertaken.

vii. Surface water sampling from 12 locations of surface water, including samples from various sources such as river water, lagoons, raw water reservoirs and ponds/lakes for studying surface water quality.

viii. Ground water sampling from 18 locations, including samples from various sources such as hand pumps, tube wells, open wells, and seepage nalah.

ix. Ground water levels monitoring at 16 locations, including hand pumps, tube wells, and open wells.

x. Collection of soil samples from 11 locations.

xi. In-situ determination of latitude, longitude, and elevation (altitude) for the various sampling locations.

xii. Site photograph during sampling. The site photographs are provided in the Appendix-I.

*4.3 **Pre-monsoon 2024 field investigations***

A site visit was undertaken for pre-monsoon 2024 sampling and field investigations by the IIT Roorkee team during May 5 – 9, 2024. During this field visit, the following field works were undertaken.

xiii. Surface water sampling from 12 locations of surface water, including samples from various sources such as river water, lagoons, raw water reservoirs and ponds/lakes for studying surface water quality.

xiv. Groundwater sampling from 18 locations, including samples from various sources such as hand pumps, tube wells, open wells, and seepage nalah.

xv. Groundwater level monitoring at 16 locations, including hand pumps, tube wells, and open wells.

xvi. Collection of soil samples from 11 locations.

xvii. In-situ determination of latitude, longitude, and elevation (altitude) for the various sampling locations.

xviii. Site photograph during sampling. The site photographs are provided in Appendix-I.

*4.4 **Post-monsoon 2024 field investigations***

A site visit was undertaken for post-monsoon 2024 sampling and field investigations by the IIT Roorkee team during September 25 – 29, 2024. During this field visit, the following field works were undertaken.

xix. Surface water sampling from 12 locations of surface water, including samples from various sources such as river water, lagoons, raw water reservoirs and ponds/lakes for studying surface water quality.

xx. Groundwater sampling from 18 locations, including samples from various sources such as hand pumps, tube wells, open wells, and seepage nalah.

xxi. Groundwater level monitoring at 16 locations, including hand pumps, tube wells, and open wells.

xxii. Collection of soil samples from 11 locations.

xxiii. In-situ determination of latitude, longitude, and elevation (altitude) for the various sampling locations.

xxiv. Site photograph during sampling. The site photographs are provided in Appendix I.

5 GROUNDWATER LEVEL AND FLOW DIRECTION

The groundwater level is a key parameter for evaluating spatial and temporal changes in groundwater environments. The groundwater level is governed by various factors. Any phenomenon that produces pressure change within an aquifer result in the change of groundwater level. These changes in groundwater level can be a result of changes in storage, amount of discharge and recharge, variation of stream stages and evaporation. To define the present hydro-geological scenario of the study area, the groundwater table is measured directly at various locations available within the study area to prepare the water table contour and flow direction maps.

5.1 Groundwater level observations during Pre-Monsoon 2023 season

In the present study, groundwater level monitoring for the pre-monsoon season of 2023 was carried out during April 25 – 30, 2023, at 20 locations in existing open/tube wells and piezometers. Figure 9 provides the location map of the groundwater level monitoring stations used for measuring water levels during the pre-monsoon 2023 visit. The details of the monitoring stations are provided in Table 1.

Table 1. Details of groundwater level monitoring stations during pre-monsoon of 2023.

S.No.	Site Code	Latitude (˚E)	Longitude (˚N)	Location and source	Ground Elevation (m amsl)
1	KHR-5	22.12494	75.8952	Inside Primary School, Vill Badgaon, Handpump	192
2	KHR-5A	22.12407	75.89518	Adjacent to main road, Vill Badgaon, open well	190
3	KHR-7A	22.12314	75.7963	Londhi village, open well	189
4	KHR-7B	22.12126	75.79317	Londhi village, open well	192
5	KHR-13	22.06608	75.87139	Adjoining of NTPC Community Centre Near New Hanumaan Temple, open well	263
6	KHR-15A	22.07092	75.85599	Near Bhilal Baba Temple, opp cooling tower, Near NTPC Gate no. 1, below mango tree, open well	247
7	KHR-16A	22.07912	75.80412	Adjacent to Gangour thermal power station road	238
8	KHR-18	22.06295	75.85256	Well inside power station, open well	249
9	KHR-20A	22.0833	75.8515	Maal Singh Jhapdiya Well, Jamniya village, open well	231
10	KHR-21 (N1)	22.12321	75.90812	Adjacent to pipalgone road, open well	198
11	KHR-22 (N2)	22.11305	75.92877	Adjacent to pipalgone road, open well	206
12	KHR-23 (N3)	22.10902	75.93549	Adjacent to pipalgone road, open well	198
13	KHR-24 (N4)	22.04485	75.87855	Adjacent to Umaria road, open well	273

14	KHR-26 (N6)	21.99242	75.86363	in the field adjacent to Padaliya road, open well	228
15	KHR-Pz1	22.07826	75.8367	Peizometer 1, Ash Dyke	241
16	KHR-Pz2	22.07721	75.83306	Peizometer 2, Ash Dyke	239
17	KHR-Pz3	22.07476	75.83177	Peizometer 3, Ash Dyke	234
18	KHR-Pz4	22.07289	75.83233	Peizometer 4, Ash Dyke	230
19	KHR-Pz5	22.07055	75.83277	Peizometer 5, Ash Dyke	236
20	KHR-Pz6	22.07089	75.83548	Peizometer 6, Ash Dyke	238

The water level below the ground surface was measured using a dip-meter with a water level indicator. DGPS Survey was carried out in the earlier study by NIH at most of these locations, and based on the DGPS data, elevation of the location was determined. The elevation data was used to determine the water level elevation above the mean sea level (amsl). The water level data (both below the ground level and above mean sea level) is presented in Table 2. The spatial variation of water depth below the ground surface is also shown in Figure 8.

The measured depth to the groundwater table has been used as a base parameter to delineate the groundwater flow pattern in and around the NTPC power station. The groundwater contour map (Figure 9) was prepared by using measured water table depth data listed in Table 2 pre-monsoon 2023 season. Figure 9 was produced using the feature of ArcMap in which vector field rendering (arrow representation) was performed for better visualisation of flow direction. The thinning method uses a vector averaging procedure to calculate the direction and magnitude for each pixel to generate the flow map. Figure 9 suggests that the groundwater generally flows in two distinct patterns. The groundwater flow in the area to the north of the power station flows northwards towards Narmada River, and the groundwater in the area to the southern side of the power station flows towards south and southwest direction. A slight variation in the movement of groundwater around the power station site seems to be due to a dense network of measuring wells. Secondary porosities like weathering, fracturing, faulting, and other lineaments in the study area can also cause such flow variations. The groundwater table contour map of the area is found mostly in line with its surface drainage pattern.

Table 2. Measured groundwater level at identified locations in the area during the pre-monsoon season (April 2023).

S.No.	Site Code	Latitude (˚E)	Longitude (˚N)	Location and source	Depth to water table (m)	Water Table Elevation (m amsl)
1	KHR-5	22.12494	75.8952	Vill Badgaon, Handpump	2.2	189.8
2	KHR-5A	22.12407	75.89518	Adjacent to main road, Vill Badgaon, open well	3.6	186.4
3	KHR-7A	22.12314	75.7963	Londhi village, open well	6.6	182.4
4	KHR-7B	22.12126	75.79317	Londhi village, open well	6.78	185.22
5	KHR-13	22.06608	75.87139	Adjoining of NTPC Community Centre Near New Hanumaan Temple, open well	7.9	255.1
6	KHR-15A	22.07092	75.85599	Near Bhilal Baba Temple, opp cooling tower, Near NTPC Gate no. 1, below mango tree, open well	1.55	245.45
7	KHR-16A	22.07912	75.80412	Adjacent to Gangour thermal power station road	12.4	225.6
8	KHR-18	22.06295	75.85256	Well inside power station, open well	4.56	244.44
9	KHR-20A	22.0833	75.8515	Maal Singh Jhapdiya Well, Jamniya village, open well	1.5	229.5
10	KHR-21 (N1)	22.12321	75.90812	Adjacent to pipalgone road, open well	5.2	192.8
11	KHR-22 (N2)	22.11305	75.92877	Adjacent to pipalgone road, open well	5.4	200.6
12	KHR-23 (N3)	22.10902	75.93549	Adjacent to pipalgone road, open well	2.3	195.7
13	KHR-24 (N4)	22.04485	75.87855	Adjacent to Umaria road, open well	9	264
14	KHR-26 (N6)	21.99242	75.86363	in the field adjacent to Padaliya road, open well	2.9	225.1
15	KHR-Pz1	22.07826	75.8367	Peizometer 1, Ash Dyke	2.7	238.3
16	KHR-Pz2	22.07721	75.83306	Peizometer 2, Ash Dyke	12.33	226.67
17	KHR-Pz3	22.07476	75.83177	Peizometer 3, Ash Dyke	3.3	230.7
18	KHR-Pz4	22.07289	75.83233	Peizometer 4, Ash Dyke	3.5	226.5
19	KHR-Pz5	22.07055	75.83277	Peizometer 5, Ash Dyke	9.4	226.6
20	KHR-Pz6	22.07089	75.83548	Peizometer 6, Ash Dyke	9.5	228.5

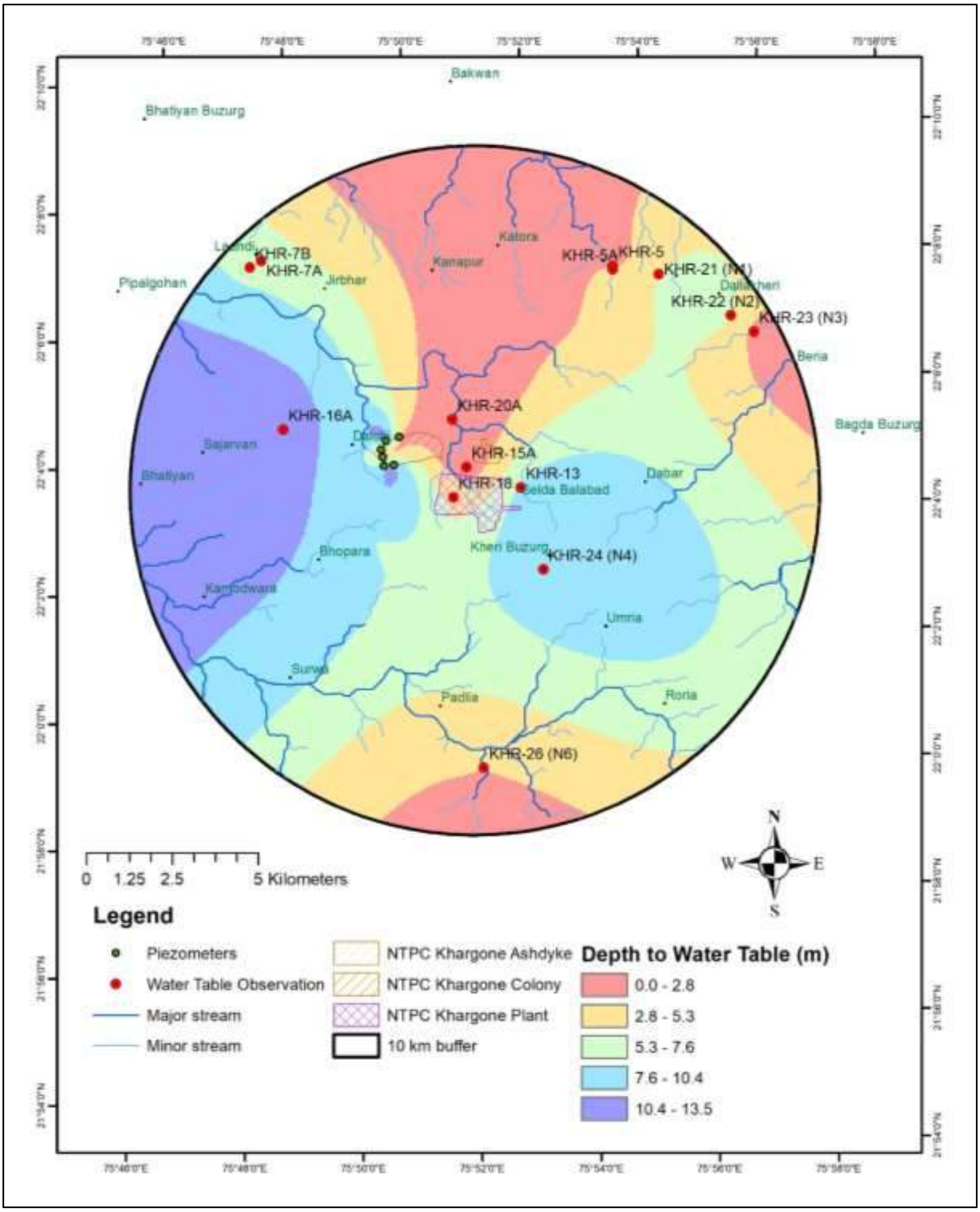


Figure 8. Map showing spatial variation of water table depth below ground level for pre-monsoon 2023 season.

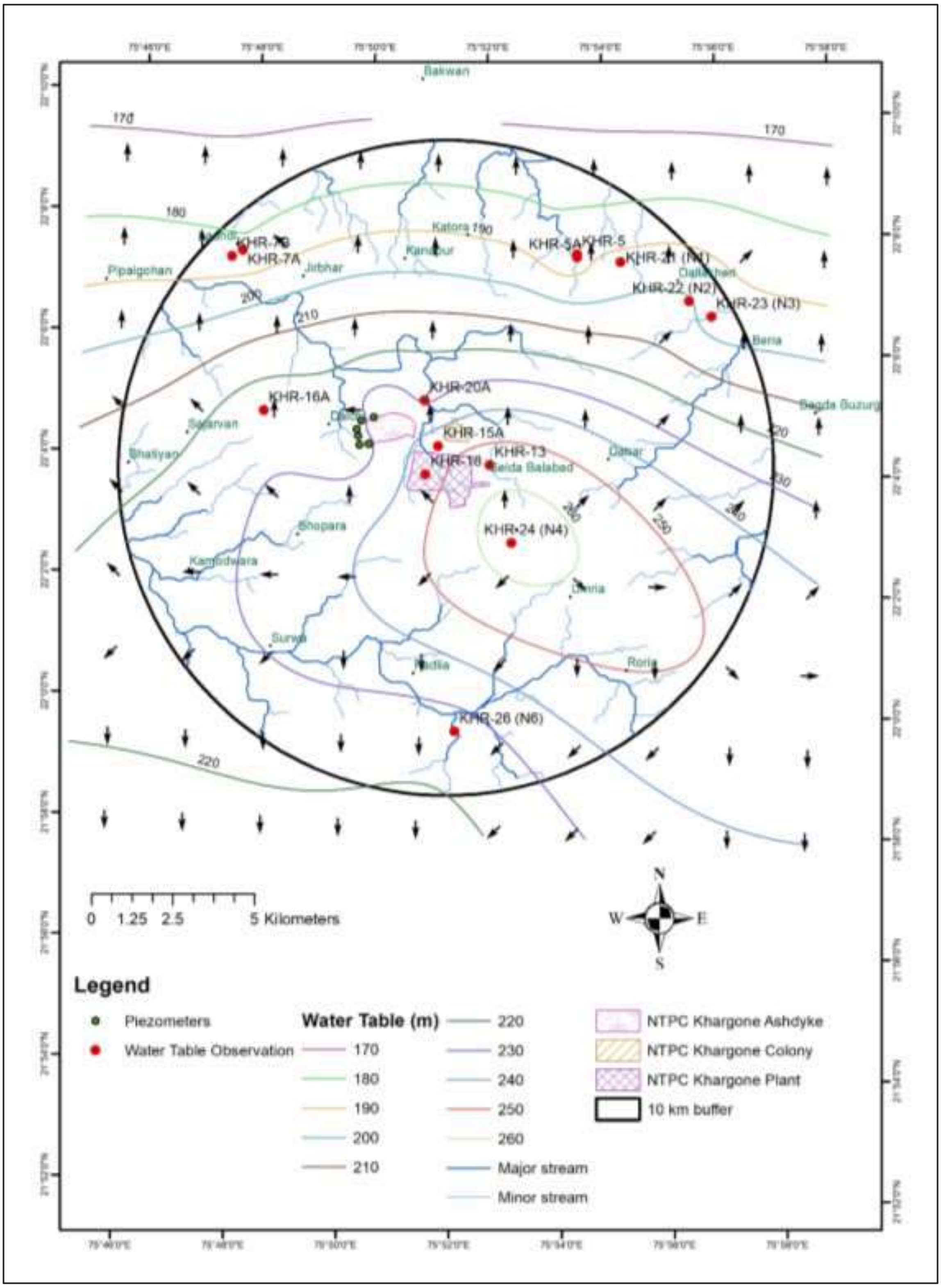


Figure 9. Map depicting ground water table contours and flow direction in the study area during Pre-monsoon 2023.

5.2 *Groundwater level observations during the post-monsoon 2023 season*

The groundwater level monitoring for the post-monsoon season of 2023 was carried out during October 9-13, 2023, at 29 locations using existing open/tube wells and piezometers. Two of the existing open wells (KHR-15 and KHR-61AE) were skipped during this post-monsoon season due to an unforeseen situation at the sampling time. Figure 10 provides the location map of the groundwater level monitoring stations used for measuring water levels during the post-monsoon 2023 visit. The details of the monitoring stations are provided in Table 3.

Table 3. Details of groundwater level monitoring stations during the post-monsoon 2023 season.

S.No.	Site Code	Latitude (˚E)	Longitude (˚N)	Location and source	Elevation
1	KHR-4	22.068803	75.862023	Between NTPC & Town ship, opposite to Boundary Pillar S.N. 230-240	254
2	KHR-5	22.12494	75.8952	Vill Badgaon, Handpump	192
3	KHR-5A	22.12407	75.89518	Adjacent to main road, Vill Badgaon, open well	190
4	KHR-6A	22.12545	75.84165	Well in the field, Vill Kanapur	188
5	KHR-7A	22.12314	75.7963	Londhi village, open well	189
6	KHR-7B	22.12126	75.79317	Londhi village, open well	192
7	KHR-8A	22.10271	75.75548	Karan Gangle Handpump, Pipalgone village.	185
8	KHR-10A	22.04086	75.81116	Near Anganwadi Kendra, Bhopada	219
9	KHR-13	22.06608	75.87139	Adjoining of NTPC Community Centre Near New Hanumaan Temple, open well	Discarded
10	KHR-15A	22.07092	75.85599	Near Bhilal Baba Temple, opp cooling tower, Near NTPC Gate no. 1, below mango tree, open well	247
11	KHR-16A	22.07912	75.80412	Adjacent to Gangour thermal power station road	Discarded
12	KHR-18	22.06295	75.85256	Well inside power station, open well	249
13	KHR-20A	22.0833	75.8515	Maal Singh Jhapdiya Well, Jamniya village, open well	231
14	KHR-21	22.12321	75.90812	Adjacent to pipalgone road, open well	198
15	KHR-22	22.11305	75.92877	Adjacent to pipalgone road, open well	206
16	KHR-23	22.10902	75.93549	Adjacent to pipalgone road, open well	198
17	KHR-24	22.04485	75.87855	Adjacent to Umaria road, open well	273

18	KHR-25	22.02839	75.89527	In front of Rewa Gurjar Dharamshala, Gram panchayat office, Umaria	251
19	KHR-26	21.99242	75.86363	In the field adjacent to Padaliya road, open well	228
20	KHR-27	22.00855	75.90918	Rodiya Bus Stop, Near Teashop	245
21	KHR-28	21.97891	75.86348	Ahirkheda, Near Patrol pump	244
22	KHR-29	22.02219	75.87928	Sala Village, Shivram well	248
23	KHR-30	22.04405	75.85148	Umardad, Adjacent to road	270
24	KHR-31	22.065	75.88535	Dabar	269
25	KHR-32	22.10956	75.96084	Bediya	192
26	KHR-Pz1	22.07826	75.8367	Peizometer 1, Ash Dyke	241
27	KHR-Pz2	22.07721	75.83306	Peizometer 2, Ash Dyke	239
28	KHR-Pz3	22.07476	75.83177	Peizometer 3, Ash Dyke	234
29	KHR-Pz4	22.07289	75.83233	Peizometer 4, Ash Dyke	230
30	KHR-Pz5	22.07055	75.83277	Peizometer 5, Ash Dyke	236
31	KHR-Pz6	22.07089	75.83548	Peizometer 6, Ash Dyke	238

The measured depth to the groundwater table has been used as a base parameter to delineate the groundwater flow pattern in and around the NTPC power station. The depth to groundwater table map is depicted in Figure 10. The groundwater contour map (Figure 11) was produced using the feature of ArcMap, in which vector field rendering (arrow representation) was performed to better visualise flow direction. Figure 11 suggests that the groundwater generally flows in two distinct patterns, similar to the pre-monsoon period. The groundwater flow in the area to the north of the power station flows northwards towards the Narmada River, and the groundwater in the southern side of the power station flows towards the south and southwest direction. A slight variation in the movement of groundwater around the power station site is due to different water use/recharge through a dense network of measuring wells. In general, the groundwater table contour map of the area is found mostly in line with its surface drainage pattern. Table 4 shows the measured groundwater level at identified locations in the area during the post-monsoon season (October 2023). Figure 11 shows the map depicting ground water table contours and flow direction in the study area during the post-monsoon 2023.

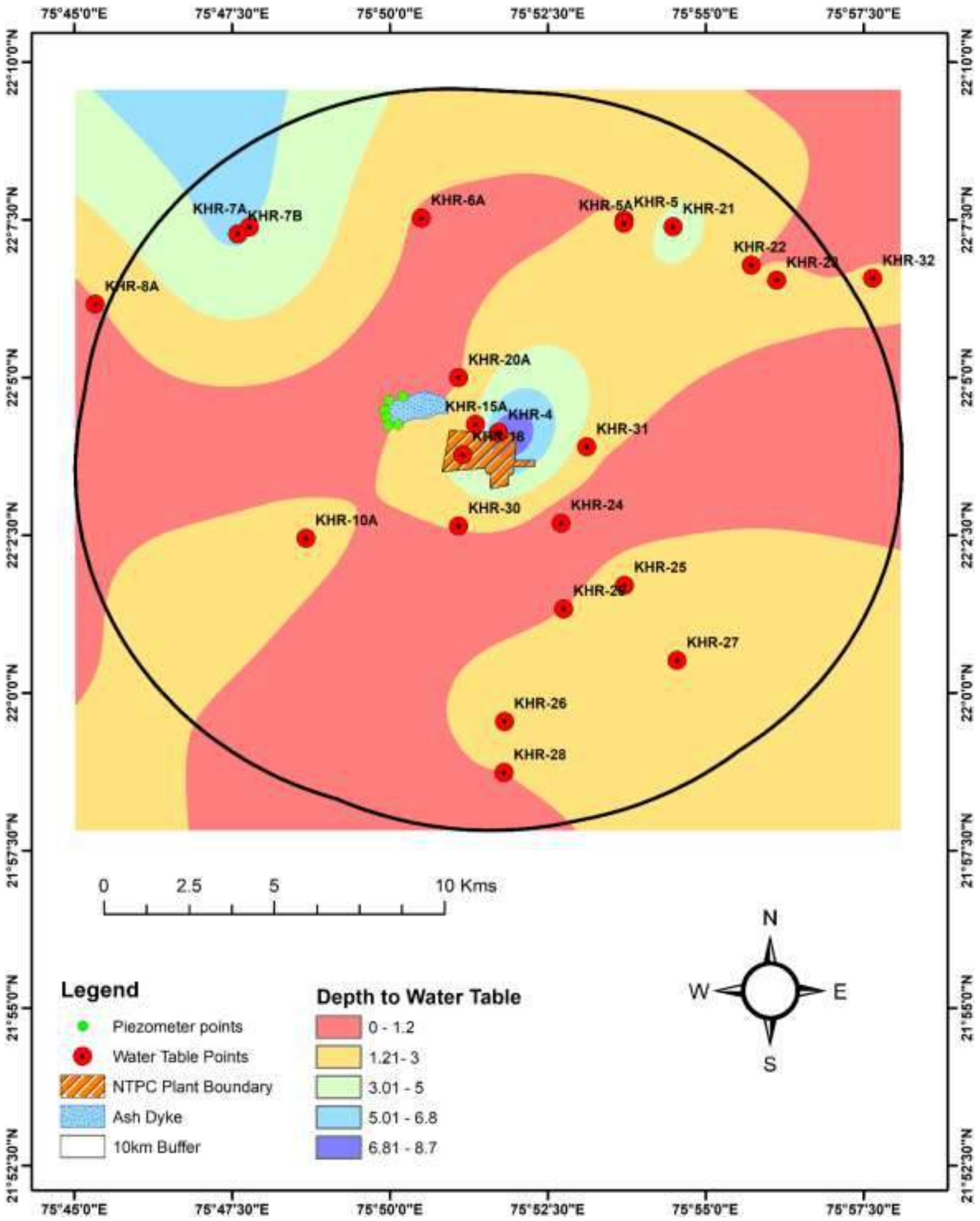


Figure 10. Map showing the spatial variation of water table depth below ground level for the post-monsoon 2023 season.

Table 4. Measured groundwater level at identified locations in the area during the post-monsoon season (October 2023).

S.No.	Site Code	Latitude (˚E)	Longitude (˚N)	Depth to water table (m)	Water Table Elevation (m amsl)
1	KHR-4	22.068803	75.862023	8.68	245.32
2	KHR-5	22.12494	75.8952	1.1	190.9
3	KHR-5A	22.12407	75.89518	2.25	187.75
4	KHR-6A	22.12545	75.84165	1.02	186.98
5	KHR-7A	22.12314	75.7963	5	184
6	KHR-7B	22.12126	75.79317	5.2	186.8
7	KHR-8A	22.10271	75.75548	1.09	183.91
8	KHR-10A	22.04086	75.81116	1.8	217.2
9	KHR-13	22.06608	75.87139	**Discarded**	
10	KHR-15A	22.07092	75.85599	1.78	245.22
11	KHR-16A	22.07912	75.80412	**Discarded**	
12	KHR-18	22.06295	75.85256	4.1	244.9
13	KHR-20A	22.0833	75.8515	1.1	229.9
14	KHR-21	22.12321	75.90812	3.38	194.62
15	KHR-22	22.11305	75.92877	1.22	204.78
16	KHR-23	22.10902	75.93549	1.42	196.58
17	KHR-24	22.04485	75.87855	0.3	272.7
18	KHR-25	22.02839	75.89527	2	249
19	KHR-26	21.99242	75.86363	2.62	225.38
20	KHR-27	22.00855	75.90918	2.6	242.4
21	KHR-28	21.97891	75.86348	1.2	242.8
22	KHR-29	22.02219	75.87928	1.2	246.8
23	KHR-30	22.04405	75.85148	1.3	268.7
24	KHR-31	22.065	75.88535	2	267
25	KHR-32	22.10956	75.96084	1.3	190.7
26	KHR-Pz1	22.07826	75.8367	2.1	238.9
27	KHR-Pz2	22.07721	75.83306	9.27	229.73
28	KHR-Pz3	22.07476	75.83177	2.42	231.58
29	KHR-Pz4	22.07289	75.83233	1.2	228.8
30	KHR-Pz5	22.07055	75.83277	7.1	228.9
31	KHR-Pz6	22.07089	75.83548	5.5	232.5

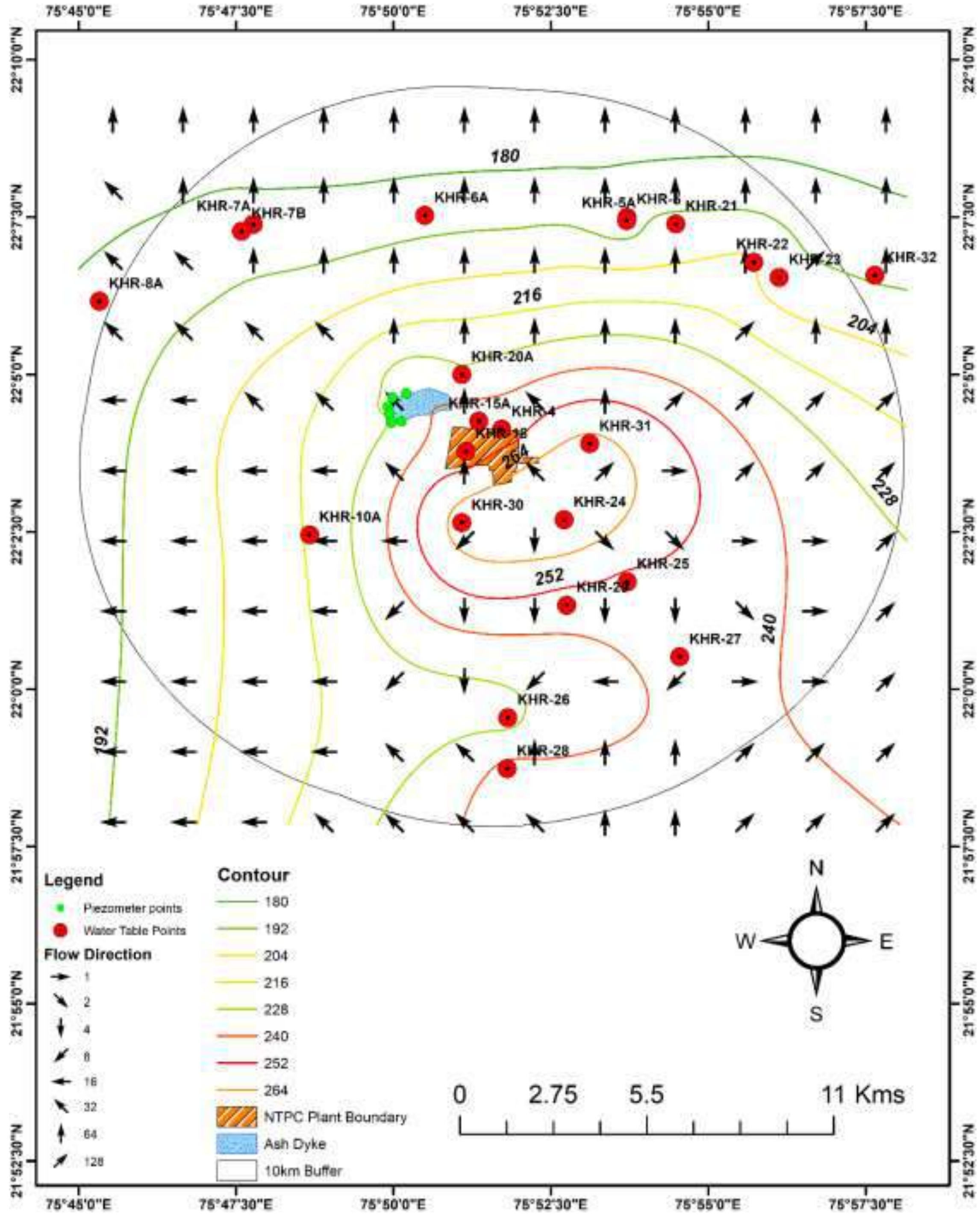


Figure 11. Map depicting groundwater table contours and flow direction in the study area during the post-monsoon 2023 season.

5.3 *Groundwater level observations during pre-monsoon 2024 season*

In the present study, groundwater level monitoring for the pre-monsoon season of 2024 was carried out during May 5 – 9, 2024, at 28 locations in existing open/tube wells and piezometers. Figure 12 provides the location map of the groundwater level monitoring stations used for measuring water levels during the pre-monsoon 2024 visit. The details of the monitoring stations are provided in Table 5.

Table 5. Details of groundwater level monitoring stations during the pre-monsoon 2024 season.

S. No.	Site Code	Latitude (˚E)	Longitude (˚N)	Location and source	Elevation
1.	KHR-2	22.06227	75.76610	Aanganwadi & School Compound Near Hanuman Mandir, Vill Bhatyaan Khurd	201
2.	KHR-4	22.068803	75.862023	Between NTPC & Town ship, opp Boundary Piller S.N. 230-240	254
3.	KHR-5A	22.12407	75.89518	Adjacent to main road, Vill Badgaon, open well	190
4.	KHR-6A	22.12545	75.84165	Well in the field, Vill Kanapur	188
5.	KHR-7A	22.12314	75.7963	Londhi village, open well	189
6.	KHR-7B	22.12126	75.79317	Londhi village, open well	192
7.	KHR-10	22.04086	75.81116	Near Anganwadi Kendra, Bhopada	219
8.	KHR-15A	22.07092	75.85599	Near Bhilal Baba Temple, opp cooling tower, Near NTPC Gate no. 1, below mango tree, open well	247
9.	KHR-16A	22.07912	75.80412	Adjacent to Gangour thermal power station road	238
10.	KHR-18	22.06295	75.85256	Well inside power station, open well	249
11.	KHR-20	22.0833	75.8515	Mall Singh Jhapdiya Well, Jamniya village, open well	231
12.	KHR-21	22.12321	75.90812	Adjacent to pipalgone road, open well	198
13.	KHR-22	22.11305	75.92877	Adjacent to pipalgone road, open well	206
14.	KHR-23	22.10902	75.93549	Adjacent to pipalgone road, open well	198
15.	KHR-24	22.04485	75.87855	Adjacent to Umaria road, open well	273
16.	KHR-25	22.02839	75.89527	In front of Rewa Gurjar Dharamshala, Gram panchayat office, Umaria	251
17.	KHR-26	21.99242	75.86363	in the field adjacent to Padaliya road, open well	228
18.	KHR-27	22.021429	75.879967	Adjacent to road nimori	245
19.	KHR-28	21.97891	75.86348	Adjacent to Padaliya road, open well	244
20.	KHR-29	21.978471	75.862909	Adjacent to Khargone Sanawad Road Near IOC Petrol Pump	248
21.	KHR-30	22.04404	75.85192	Adjacent to Umerdad road	250
22.	KHR-31	22.065	75.88535	Adjacent to Gangour Thermal Plant Rd	269
23.	KHR-32	22.10956	75.96084	Adjacent to Khargone - Sanawad Rd, Amarpura	192
24.	KHR-Pz1	22.07826	75.8367	Piezometer 1, Ash Dyke	241
25.	KHR-Pz2	22.07721	75.83306	Piezometer 2, Ash Dyke	239
26.	KHR-Pz3	22.07476	75.83177	Piezometer 3, Ash Dyke	234
27.	KHR-Pz4	22.07289	75.83233	Piezometer 4, Ash Dyke	230
28.	KHR-Pz5	**Piezometer was found Damaged**			
29.	KHR-Pz6	22.07089	75.83548	Piezometer 6, Ash Dyke	238

The water level below the ground surface was measured using a dip-meter with a water level indicator. DGPS Survey was carried out in the earlier study by NIH at most of these locations, and based on the DGPS data, elevation of the location was determined. The elevation data were used to determine the water level elevation above the mean sea level (amsl). The water level data (both below the ground level and above mean sea level) is presented in Table 5. The spatial variation of water depth below the ground surface is also shown in Figure 12.

The measured depth to the groundwater table has been used as a base parameter to delineate the groundwater flow pattern in and around the NTPC power station. The groundwater contour map (Figure 13) was prepared by using measured water table depth data listed in Table 5 for the pre-monsoon 2024 season. Figure 13 was produced using the feature of ArcMap in which vector field rendering (arrow representation) was performed for better visualisation of flow direction. The thinning method uses a vector averaging procedure to calculate the direction and magnitude for each pixel to generate the flow map. Figure 13 suggests that the groundwater generally flows in two distinct patterns. The flow pattern was similar to the observed pattern of previous year (2023) pre-monsoon season as discussed in section 5.1.

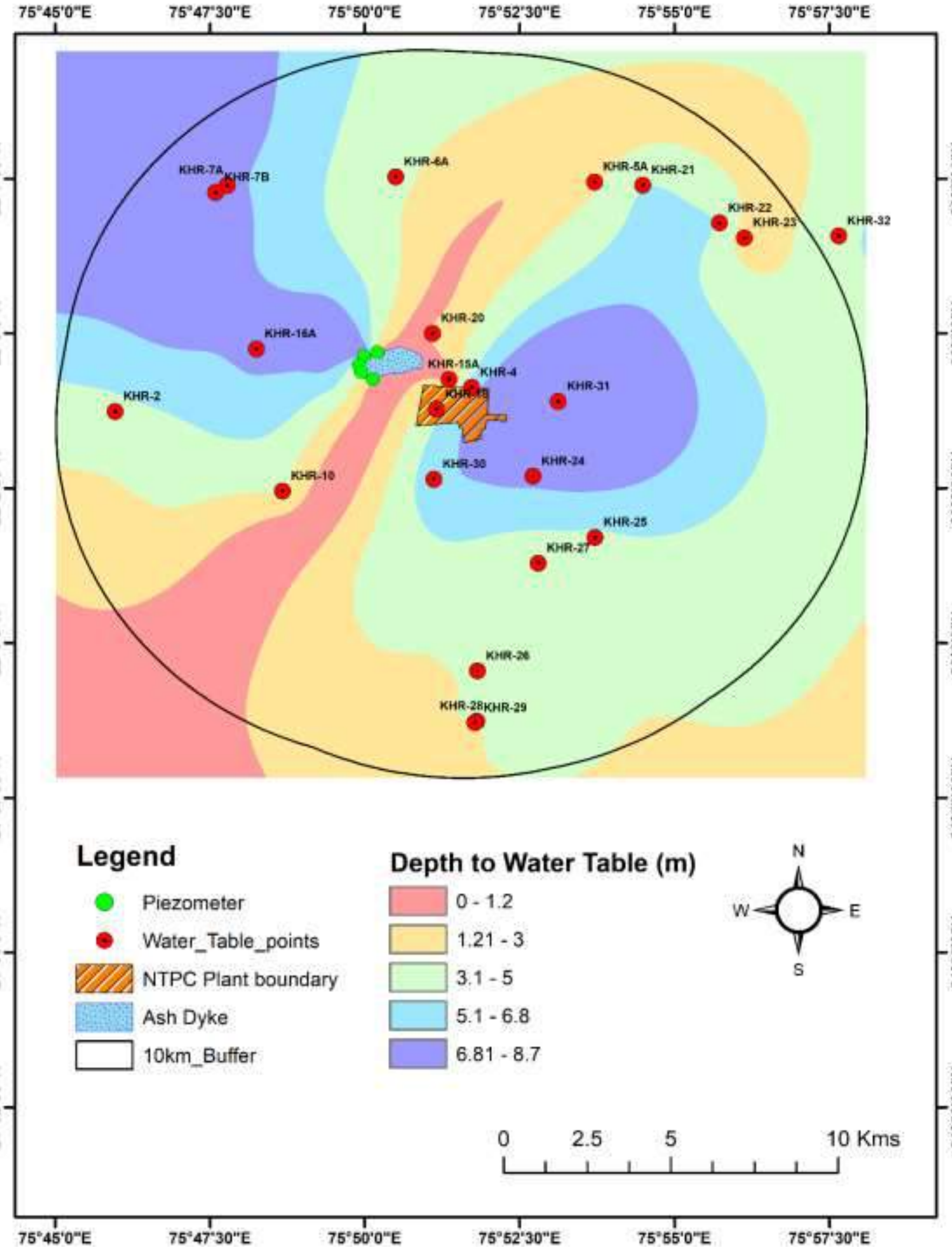


Figure 12. Map showing the spatial variation of water table depth below ground level for the pre-monsoon 2024 season.

Table 6. Measured groundwater level at identified locations in the area during the pre-monsoon season of 2024).

S. No.	Site Code	Latitude (˚E)	Longitude (˚N)	Location and source	Depth to water table (m)	Water Table Elevation (m amsl)
1.	KHR-2	22.06227	75.76610	Aanganwadi & School Compound Near Hanuman Mandir, Vill Bhatyaan Khurd	4.48	196.52
2.	KHR-4	22.068803	75.862023	Between NTPC & Town ship, opp Boundary Piller S.N. 230-240	6	248
3.	KHR-5A	22.12407	75.89518	Adjacent to main road, Vill Badgaon, open well	2.74	187.26
4.	KHR-6A	22.12545	75.84165	Well in the field, Vill Kanapur	3.42	184.58
5.	KHR-7A	22.12314	75.7963	Londhi village, open well	7.4	181.6
6.	KHR-7B	22.12126	75.79317	Londhi village, open well	8.25	183.75
7.	KHR-10	22.04086	75.81116	Near Anganwadi Kendra, Bhopada	2.95	216.05
8.	KHR-15A	22.07092	75.85599	Near Bhilal Baba Temple, opp cooling tower, Near NTPC Gate no. 1, below mango tree, open well	1.50	245.5
9.	KHR-16A	22.07912	75.80412	Adjacent to Gangour thermal power station road	7.12	230.88
10.	KHR-18	22.06295	75.85256	Well inside power station, open well	4.3	244.7
11.	KHR-20	22.0833	75.8515	Mall Singh Jhapdiya Well, Jamniya village, open well	1.42	229.58
12.	KHR-21	22.12321	75.90812	Adjacent to pipalgone road, open well	4.94	193.06
13.	KHR-22	22.11305	75.92877	Adjacent to pipalgone road, open well	4.68	201.32
14.	KHR-23	22.10902	75.93549	Adjacent to pipalgone road, open well	2.2	195.8
15.	KHR-24	22.04485	75.87855	Adjacent to Umaria road, open well	7.3	265.7
16.	KHR-25	22.02839	75.89527	In front of Rewa Gurjar Dharamshala, Gram panchayat office, Umaria	4.7	246.3
17.	KHR-26	21.99242	75.86363	in the field adjacent to Padaliya road, open well	3.42	224.58
18.	KHR-27	22.021429	75.879967	Adjacent to road nimori	3.85	241.15
19.	KHR-28	21.97891	75.86348	Adjacent to Padaliya road, open well	4.1	239.9
20.	KHR-29	21.978471	75.862909	Adjacent to Khargone Sanawad Road Near IOC Petrol Pump	2.5	245.5
21.	KHR-30	22.04404	75.85192	Adjacent to Umerdad road	6.1	243.9
22.	KHR-31	22.065	75.88535	Adjacent to Gangour Thermal Plant Rd	10.42	258.58
23.	KHR-32	22.10956	75.96084	Adjacent to Khargone - Sanawad Rd, Amarpura	4.59	187.41
24.	KHR-Pz1	22.07826	75.8367	Piezometer 1, Ash Dyke	1.50	239.5
25.	KHR-Pz2	22.07721	75.83306	Piezometer 2, Ash Dyke	8.90	230.1
26.	KHR-Pz3	22.07476	75.83177	Piezometer 3, Ash Dyke	3.14	230.86
27.	KHR-Pz4	22.07289	75.83233	Piezometer 4, Ash Dyke	4.32	225.68
28.	KHR-Pz5	**Piezometer was found Damaged**				
29.	KHR-Pz6	22.07089	75.83548	Piezometer 6, Ash Dyke	1.02	236.98

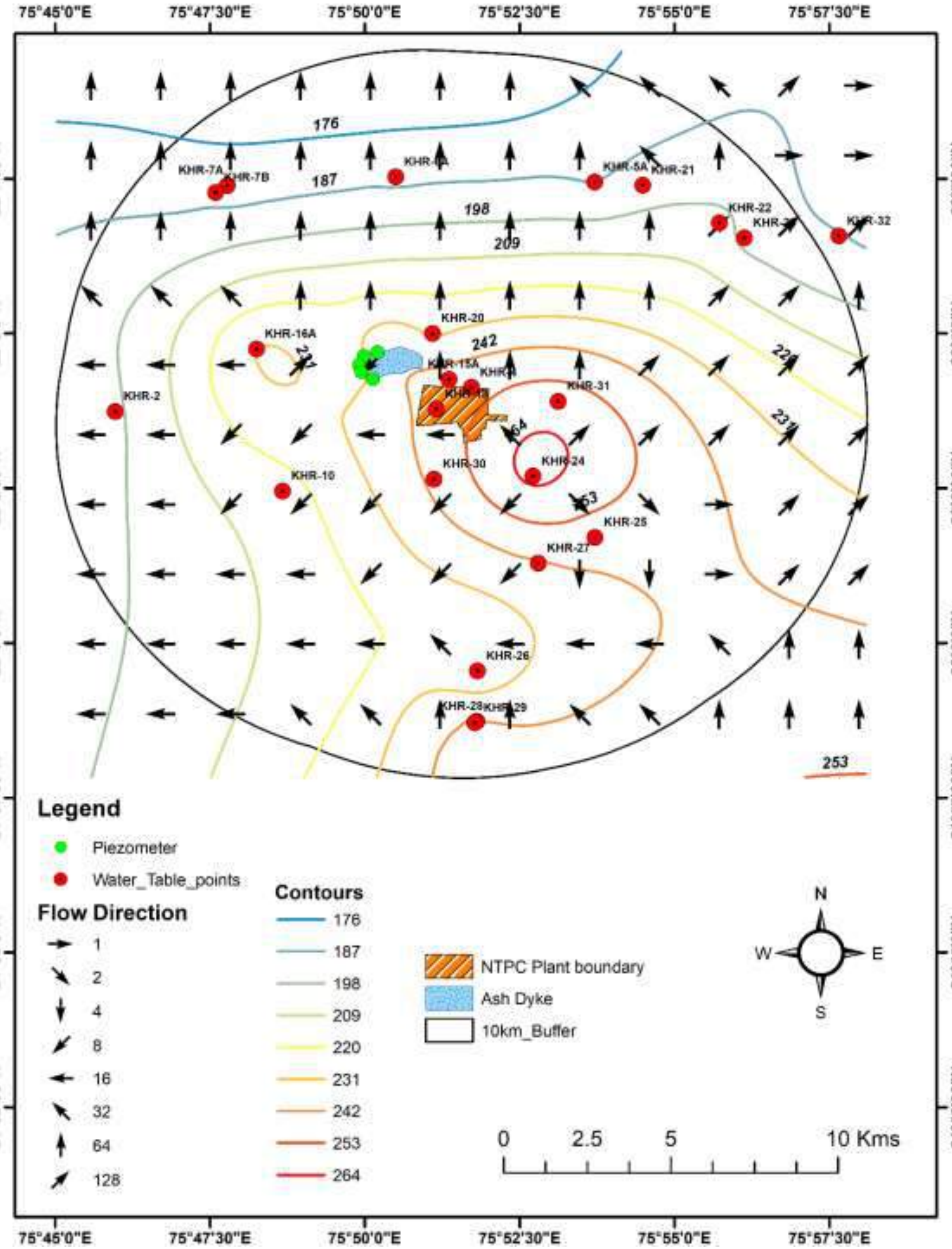


Figure 13 Map depicting groundwater table contours and flow direction in the study area during the pre-monsoon season of year 2024.

5.4 *Groundwater level observations during post-monsoon 2024 season*

In the present study, groundwater level monitoring for the post-monsoon season of 2024 was carried out during September 25 – 29, 2024 at 21 locations in existing open/tube wells and piezometers. Figure 14 provides the location map of the groundwater level monitoring stations used for measuring water levels during the post-monsoon 2024 visit. The details of the monitoring stations are provided in Table 7.

Table 7. Measured groundwater level at identified locations in the area during the post-monsoon season 2024).

S.No.	Site Code	Latitude (˚E)	Longitude (˚N)	Depth to water table (m)	Water Table Elevation (m amsl)
1	KHR-4	22.068803	75.862023	NA	--
2	KHR-5	22.12494	75.8952	NA	--
3	KHR-5A	22.12407	75.89518	1.23	188.77
4	KHR-6A	22.12545	75.84165	1.54	186.46
5	KHR-7A	22.12314	75.7963	4.90	183.1
6	KHR-7B	22.12126	75.79317	NA	--
7	KHR-8A	22.10271	75.75548	1.18	183.91
8	KHR-10A	22.04086	75.81116	1.18	217.2
9	KHR-13	22.06608	75.87139	4.15	263
10	KHR-15A	22.07092	75.85599	1.72	245.22
11	KHR-16A	22.07912	75.80412	3.91	238
12	KHR-18	22.06295	75.85256	4.0	244.9
13	KHR-20A	22.0833	75.8515	1.2	229.9
14	KHR-21	22.12321	75.90812	2.05	194.62
15	KHR-22	22.11305	75.92877	1.03	204.78
16	KHR-23	22.10902	75.93549	1.00	196.58
17	KHR-24	22.04485	75.87855	NA	--
18	KHR-25	22.02839	75.89527	1.75	249
19	KHR-26	21.99242	75.86363	2.55	225.38
20	KHR-27	22.00855	75.90918	0.7	242.4
21	KHR-28	21.97891	75.86348	0.5	242.8
22	KHR-29	22.02219	75.87928	1.40	246.8
23	KHR-30	22.04405	75.85148	1.45	268.7
24	KHR-31	22.065	75.88535	3.72	267
25	KHR-32	22.10956	75.96084	2.34	190.7
26	KHR-Pz1	22.07826	75.8367	1.82	238.9
27	KHR-Pz2	22.07721	75.83306	9.20	229.73
28	KHR-Pz3	22.07476	75.83177	2.32	231.58
29	KHR-Pz4	22.07289	75.83233	1.35	228.8
30	KHR-Pz5	22.07055	75.83277	NA	--
31	KHR-Pz6	22.07089	75.83548	5.60	232.5

The measured depth to the groundwater table has been used as a base parameter to delineate the groundwater flow pattern in and around the NTPC power station. The depth to groundwater table map is depicted in Figure 14. The groundwater contour map (Figure 15) was produced using ArcMap, in which vector field rendering (arrow representation) was performed to visualise flow direction better. Figure 15 suggests that the groundwater generally flows in two distinct patterns, similar to the pre-monsoon period. The groundwater flow in the area to the north of the power station flows northwards towards the Narmada River, and the groundwater in the southern side of the power station flows towards the south and southwest direction. A slight variation in the movement of groundwater around the power station site is due to different water use/recharge Table 7 shows the measured groundwater level at identified locations in the area during the post-monsoon season of 2024. Figure 15 shows the map depicting ground water table contours and flow direction in the study area during the post-monsoon 2024. In general, the groundwater table contour map of the area is found mostly in line with its surface drainage pattern and does not change significantly from the year 2023 to 2024.

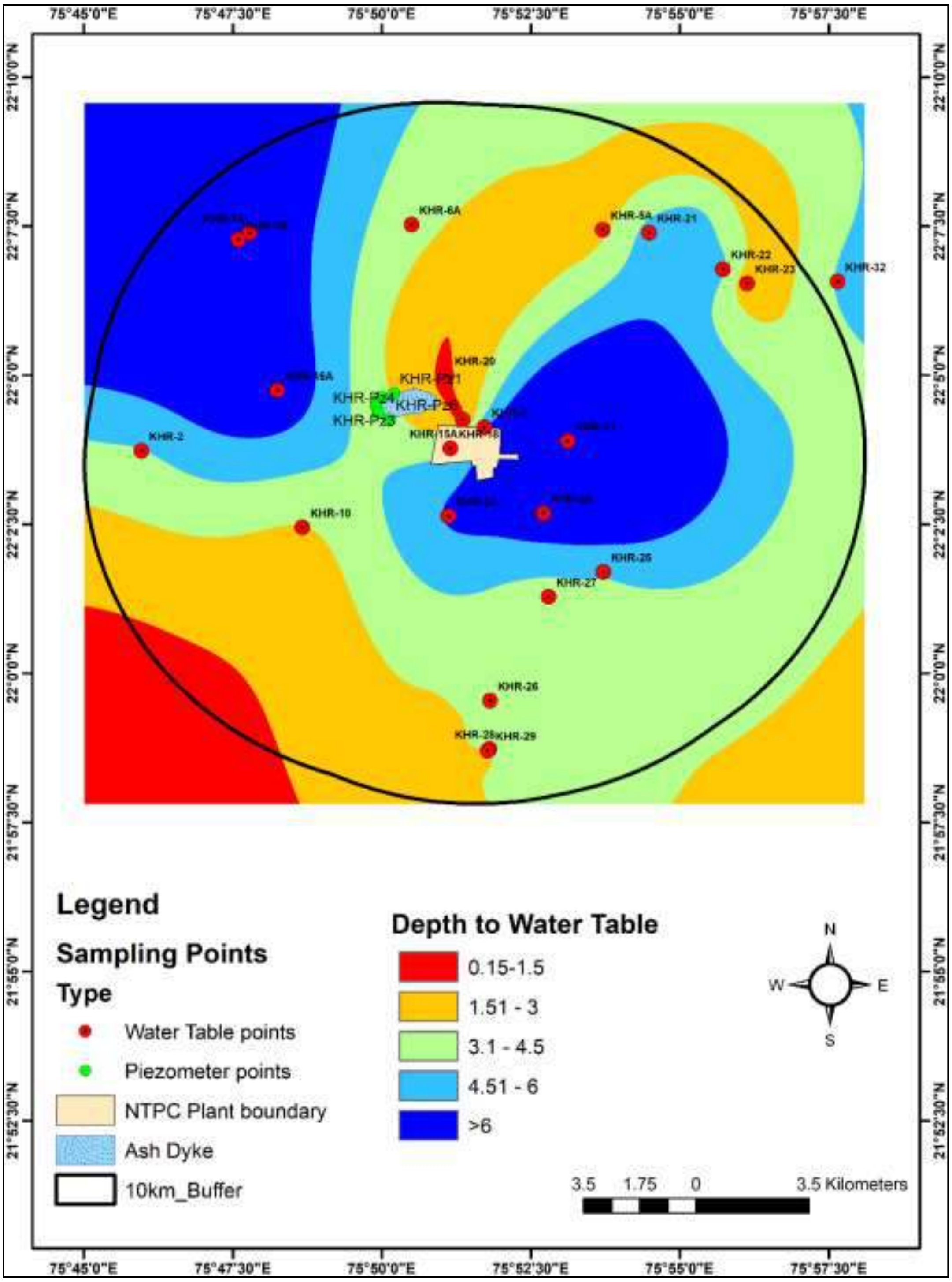


Figure 14. Map showing the spatial variation of water table depth below ground level for the post-monsoon 2024 season

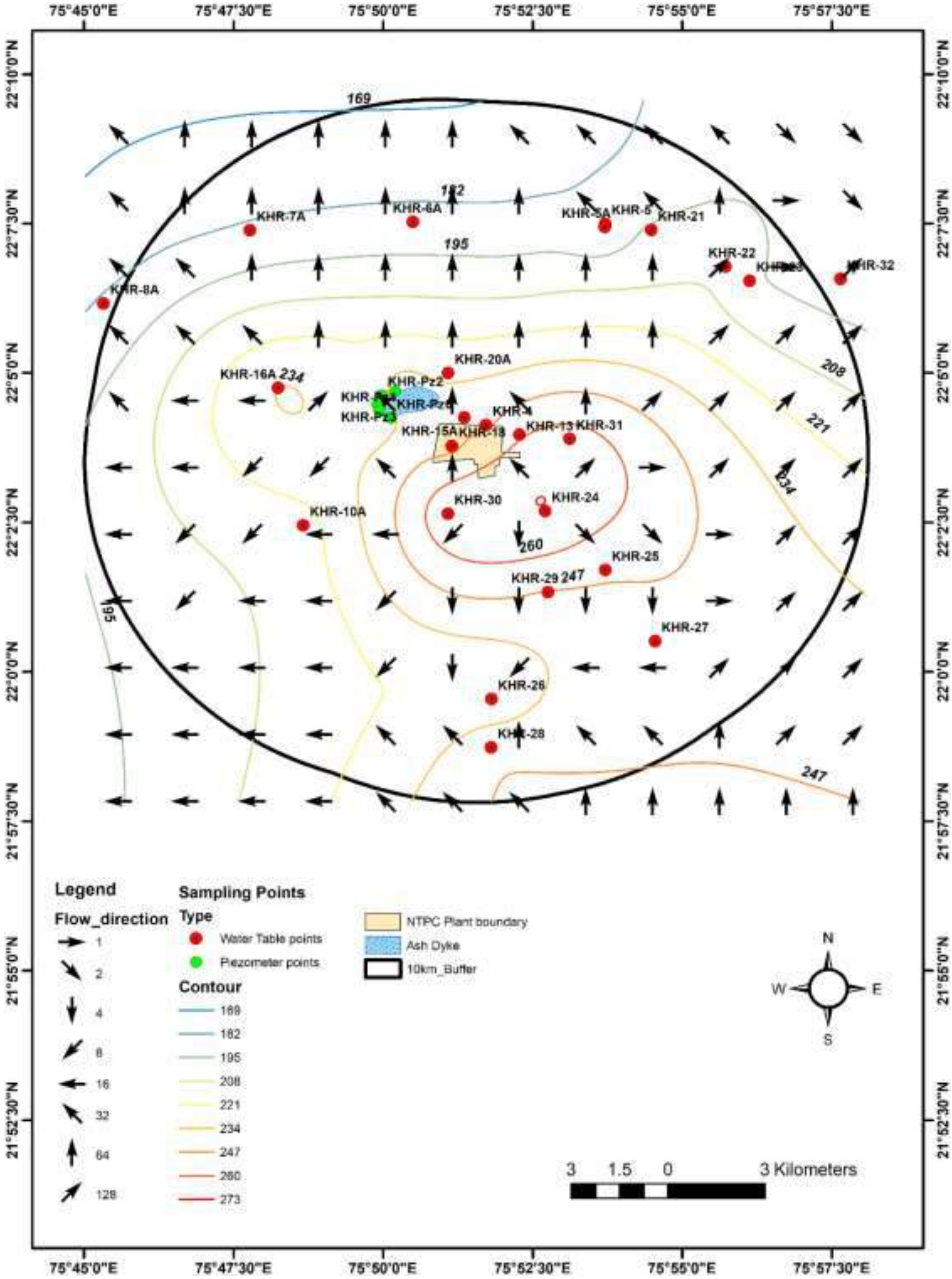


Figure 15. Map depicting groundwater table contours and flow direction in the study area during the post-monsoon season of year 2024

5.5 *Analysis of Groundwater level trend with previous reports*

Table 8 provides data on groundwater level fluctuations in a buffer zone, highlighting pre- and post-monsoon water table depths, fluctuations, and trends for various observation points in 2024. Most sites show a rise in water levels post-monsoon, indicating effective groundwater recharge, with the highest rise (9.02 m) observed at KHR-29. However, some sites, such as KHR-16A, KHR-31, KHR-Pz2, and KHR-Pz6, show a fall in water levels, possibly due to local hydrological factors or extraction. The comparison of groundwater level data between pre and post-monsoon periods is essential for hydrogeological studies. This comparative analysis provides valuable insights into the seasonal fluctuations and dynamics of groundwater resources. By examining the changes in water levels before and after the monsoon, we may determine trends and identify potential influences on aquifer recharge or depletion, and assess the overall health of groundwater systems. This assessment is particularly crucial for understanding the impact of seasonal variations on water availability and can help in adopting sustainable water resource management strategies. The analysis involves collecting groundwater level data during both pre-monsoon and post-monsoon seasons, calculating the differences or fluctuations between these periods, and interpreting the results to draw meaningful conclusions about groundwater storage and flow regimes.

The groundwater table data presented in the Table 9 pertains to various monitoring sites, each identified by a unique site code, latitude and longitude coordinates for the year 2023. The dataset encompasses measurements during both pre-monsoon (PreM) and post-monsoon (PostM) seasons, with associated fluctuation values denoting the difference between these seasons. Fluctuation in groundwater can be positive to negative, representing rise and decline in groundwater levels, respectively. KHR-5 demonstrates a rise in groundwater levels from PreM (2.2 m) to PostM (1.1 m). Similarly, KHR-7A and KHR-7B both experience a rise in groundwater levels post-monsoon, with fluctuations of 1.6 and 1.58 meters, respectively. On the other hand, KHR-15A observes a minor fall with a fluctuation of -0.23 m. These diverse trends underscore the complex and heterogeneous nature of groundwater dynamics of the study area.

Groundwater level fluctuation in the buffer zone and trend based secondary data were also collected by National Institute of Hydrology (NIH)- Roorkee in year 2018 during pre-and post-monsoon periods. Amba site experiences a substantial fluctuation of 16.8 m, signalling a noteworthy increase. Similarly, Dabhad, Dalchi, Bhatyan Khurd, Pipalgon, Londhi, Kanapur, Badgaon, Satkhali, Padliya Gawli, and others locations showcase substantial fluctuations, all indicative of a rise in groundwater level during the post-monsoon season. Notably, Satkhali demonstrates the highest fluctuation of 24.7 m. This positive trend suggests an overall rise in the water table over the specified period. However, it is crucial to note a significant limitation in the interpretation of the findings. The data sets presented in Table 10 were collected from diverse sources, including tube wells, bore wells, and handpumps, by the NIH Roorkee in 2018. This heterogeneity in data collection methods and sources introduces a notable challenge in directly comparing the water level measurements for precise assessment. The variability in measurement techniques and instrument types used for tube wells, bore wells, and handpumps can lead to some other disparities in the reported data, making it difficult to establish a direct and meaningful comparison. Moreover, the data collected by NIH in year 2022 is available only for the pre -monsoon period. Therefore, a meaningful comparison could not be established among the years.

Table 8 Groundwater level fluctuation in the buffer zone and trend based on pre and post monsoon water table data observed in year 2024.

S. No.	Site Code	Latitude	Longitude	Pre M	Post M	Fluctuation	Trend
1	KHR-4	22.068803	75.862023	4.48	NA	-	-
2	KHR-5	22.12494	75.89520	6	NA	-	-
3	KHR-5A	22.12407	75.89518	2.74	1.23	0.5	Rise
4	KHR-6A	22.12545	75.84165	3.42	1.54	1.88	Rise
5	KHR-7A	22.12314	75.79630	7.4	4.90	2.5	Rise
6	KHR-7B	22.12126	75.79317	8.25	NA	-	-
7	KHR-8A	22.10271	75.75548	2.95	1.18	1.77	Rise
8	KHR-10A	22.04086	75.81116	1.50	1.18	0.32	Rise
9	KHR-13	22.06608	75.87139	7.12	4.15	2.97	Rise
10	KHR-15A	22.07092	75.85599	4.3	1.72	2.58	Rise
11	KHR-16A	22.07912	75.80412	1.42	3.91	-2.49	fall
12	KHR-18	22.06295	75.85256	4.94	4.0	0.94	Rise
13	KHR-20A	22.08330	75.8515	4.68	1.2	3.48	Rise
14	KHR-21	22.12321	75.90812	2.2	2.05	0.15	Rise
15	KHR-22	22.11305	75.92877	7.3	1.03	6.27	Rise
16	KHR-23	22.10902	75.93549	4.7	1.00	3.7	Rise
17	KHR-24	22.04485	75.87855	3.42	NA	-	-

18	KHR-25	22.02839	75.89527	3.85	1.75	2.1	Rise
19	KHR-26	21.99242	75.86363	4.1	2.55	1.55	Rise
20	KHR-27	22.00855	75.90918	2.5	0.7	1.8	Rise
21	KHR-28	21.97891	75.86348	6.1	0.5	5.6	Rise
22	KHR-29	22.02219	75.87928	10.42	1.40	9.02	Rise
23	KHR-30	22.04405	75.85148	4.59	1.45	3.14	Rise
24	KHR-31	22.06500	75.88535	1.50	3.72	-2.22	fall
25	KHR-32	22.10956	75.96084	8.90	2.34	6.56	Rise
26	KHR-Pz1	22.07826	75.83670	3.14	1.82	1.32	Rise
27	KHR-Pz2	22.07721	75.83306	4.32	9.20	-4.88	fall
28	KHR-Pz3	22.07476	75.83177	4.48	2.32	2.16	Rise
29	KHR-Pz4	22.07289	75.83233	6	1.35	4.65	Rise
30	KHR-Pz5	22.07055	75.83277	NA	NA	-	-
31	KHR-Pz6	22.07089	75.83548	1.02	5.60	-4.58	fall

Table 9. Groundwater level fluctuation in the buffer zone and trend based on pre and post monsoon water table data observed in year 2023.

S.No.	**Site Code**	**Latitude**	**Longitude**	PreM	Post M	Fluctuation	Trend
1	KHR-4	22.068803	75.862023	NA	8.68	-	-
2	KHR-5	22.12494	75.8952	2.2	1.1	1.1	Rise
3	KHR-5A	22.12407	75.89518	3.6	2.25	1.35	Rise
4	KHR-6A	22.12545	75.84165	NA	1.02	-	-
5	KHR-7A	22.12314	75.7963	6.6	5	1.6	Rise
6	KHR-7B	22.12126	75.79317	6.78	5.2	1.58	Rise
7	KHR-8A	22.10271	75.75548	NA	1.09	-	-
8	KHR-10A	22.04086	75.81116	NA	1.8	-	-
9	KHR-13	22.06608	75.87139	7.9	Discarded	**-**	-
10	KHR-15A	22.07092	75.85599	1.55	1.78	-0.23	fall
11	KHR-16A	22.07912	75.80412	12.4	Discarded	**-**	-
12	KHR-18	22.06295	75.85256	4.56	4.1	0.46	Rise
13	KHR-20A	22.0833	75.8515	1.5	1.1	0.4	Rise
14	KHR-21	22.12321	75.90812	5.2	3.38	1.82	Rise
15	KHR-22	22.11305	75.92877	5.4	1.22	4.18	Rise
16	KHR-23	22.10902	75.93549	2.3	1.42	0.88	Rise
17	KHR-24	22.04485	75.87855	9	0.3	8.7	Rise
18	KHR-25	22.02839	75.89527	NA	2	-	-
19	KHR-26	21.99242	75.86363	2.9	2.62	0.28	Rise
20	KHR-27	22.00855	75.90918	NA	2.6	-	-
21	KHR-28	21.97891	75.86348	NA	1.2	-	-
22	KHR-29	22.02219	75.87928	NA	1.2	-	-
23	KHR-30	22.04405	75.85148	NA	1.3	-	-
24	KHR-31	22.065	75.88535	NA	2	-	-
25	KHR-32	22.10956	75.96084	NA	1.3	-	-
26	KHR-Pz1	22.07826	75.8367	2.7	2.1	0.6	Rise
27	KHR-Pz2	22.07721	75.83306	12.33	9.27	3.06	Rise
28	KHR-Pz3	22.07476	75.83177	3.3	2.42	0.88	Rise
29	KHR-Pz4	22.07289	75.83233	3.5	1.2	2.3	Rise
30	KHR-Pz5	22.07055	75.83277	9.4	7.1	2.3	Rise
31	KHR-Pz6	22.07089	75.83548	9.5	5.5	4	Rise

Table 10. Groundwater level fluctuation in the buffer zone and trend based secondary data collected in year 2018 during pre and post monsoon period.

S.No.	**Site**	**Latitude**	**Longitude**	**PreM**	**PosM**	**Fluctuation**	**Trend**
1	Amba	75.94472	22.0434	20.192	3.392	16.8	Rise
2	Dabhad	75.90045	22.06681	26.234	8.934	17.3	Rise
3	Dalchi	75.82992	22.07724	38.317	16.817	21.5	Rise
4	Bhatyan Khurd	75.76541	22.05257	26.288	7.888	18.4	Rise
5	Pipalgon	75.7546	22.10257	26.027	5.327	20.7	Rise
6	Londhi	75.79397	22.12351	21.228	3.828	17.4	Rise

7	Kanapur	75.84291	22.12278	24.51	3.71	20.8	Rise
8	Badgaon	75.89517	22.125	19.947	1.447	18.5	Rise
9	Satkhali	75.88277	21.99955	49.277	24.577	24.7	Rise
10	Padliya Gawli	75.85117	22.00762	23.197	5.597	17.6	Rise
11	Ahirkheda	75.86368	21.97928	26.463	9.163	17.3	Rise
12	Umariya	75.89675	22.02771	34.067	14.067	20	Rise
13	Bhopada	75.81374	22.0421	27.499	5.499	22	Rise
14	Khedi Buzurg	75.87746	22.04958	29.144	14.344	14.8	Rise
15	Bakava	75.85374	22.16816	26.807	9.107	17.7	Rise
16	Bhatud	75.93065	22.10305	30.998	0.798	30.2	Rise
17	Peer Baba Mazar	75.83866	22.1375	24.489	6.089	18.4	Rise
18	Lachhora	75.92346	22.07634	22.696	3.696	19	Rise
19	Pokhar	75.83076	21.99802	24.14	6.34	17.8	Rise
20	Sala Khurd	75.87948	22.02154	38.346	17.146	21.2	Rise
21	Dudgaon	75.945	22.1024	18.934	2.434	16.5	Rise
22	Kharadi	75.84705	22.02258	47.172	8.072	39.1	Rise
23	Mardaliya	75.95227	22.0791	48.978	3.078	45.9	Rise
24	Bet Dabhad-Selda	75.88542	22.065	25.68	12.48	13.2	Rise
25	Plant Area	75.862	22.06884	21.856	8.656	13.2	Rise

6 SURFACE WATER QUALITY AT IDENTIFIED LOCATIONS AND CURRENT SOURCES OF CONTAMINATION, IF ANY.

The study team visited KhSTPS Khargone to collect surface water samples in 10 km buffer zone from the power station area, ash dyke and surrounding area during pre- and post-monsoon periods. During the site survey, the team identified several observation points for data collection of surface water within a 10 km radius of the power station area.

6.1 Surface Water Quality during Pre-monsoon 2023 Season

The team visited KhSTPS Khargone during April 25 – 30, 2023, to undertake a pre-monsoon survey and collection of surface water samples in 10 km buffer zone from the power station area, ash dyke and surrounding area. Surface water samples were collected from identified locations to identify the current sources of contamination, if any. Salient details such as sample code, station name, location, and type of analysis for which surface water sample is collected during the pre-monsoon 2023 visit are listed in Table 11. The geographical location of surface water sampling points for pre-monsoon 2023 sampling points is shown in Figure 16. The collected samples were analysed for required water quality parameters. COD and BOD are measured through the oxidation-titration method. In the In-situ analysis of the samples, pH, TDS (Total dissolved solids), EC (Electrical Conductivity), DO (Dissolved Oxygen), and temperature were measured at the water collection site using a multi-meter electrode. Measured values of physical parameters like DO, TDS, EC, pH, Temperature, COD, BOD, and Hardness (COD, BOD, Hardness, DO, and TDS in mg/L; EC in mS/cm; pH in the standard unit and temperature in °C) during the pre-monsoon season are listed in Table 12*.* The pH values ranged from 6.86 to 8.58, with a mean value of 7.9. The sample collected from the Ambak reservoir has the highest pH level, i.e., 8.58. TDS concentrations ranged from 120 mg/L to 570 mg/L, with an average value of 287.9 mg/L. DO concentrations ranged from 3.8 mg/L to 15 mg/L, with a mean value of 7.2 mg/L. The EC concentration ranged from 0.25 ms/cm to 1.16 ms/cm, with an average value of 0.6 ms/cm. Hardness ranged from 162.9 mg/L to 625.1 mg/L in the pre-monsoon 2023 period, with an average value of 321.4 mg/L. COD and BOD are also determined in surface water samples during the pre-monsoon season, where the BOD ranged from 4 mg/L to 16 mg/L with a mean value of 10.1mg/L while COD ranged from 36 mg/L to 112 mg/L with an average of 66.4 mg/L. The temperature of the surface water samples ranged from 27.1°C to 34.2°C with a mean value of 30.5°C.

Table 11. Surface water sampling sites in a 10 km buffer (pre-monsoon 2023)

S.No	Code	Latitude	Longitude	Station Name	Type of Analysis	Type of Site
1	KHR-51	22.07047	75.858149	Pond Between NTPC Power station & Township	In-situ and Ex-situ	Surface water
2	KHR-52	22.12206	75.842803	Near Health Centre along Main road, Vill Kanapur	In-situ and Ex-situ	Surface water
3	KHR-53	22.104185	75.812277	Jirbhar lake	In-situ and Ex-situ	Surface water
4	KHR-54A	22.158804	75.76167	Narmada River Downstream	In-situ and Ex-situ	Surface water
5	KHR-55	22.006354	75.848828	Ambak Resevoir	In-situ and Ex-situ	Surface water
6	KHR-56	22.075493	75.927687	Lachhora Talab	In-situ and Ex-situ	Surface water
7	KHR-57	22.115246	75.866087	Kattora Pond, Shelda Power station-Kattora Road	In-situ and Ex-situ	Surface water
8	KHR-58	22.07323	75.833941	OFL Ash Dyke	In-situ and Ex-situ	Surface water
9	KHR-59	22.073978	75.839568	Lagoon 1 Ash Dyke	Dried up	Surface water
10	KHR-60	22.07661	75.8332	Lagoon 2 Ash Dyke	In-situ and Ex-situ	Surface water
11	KHR-61	22.06741	75.860638	Raw water reservoir inside power station	In-situ and Ex-situ	Surface water
12	KHR-61Ae	22.063462	75.855098	Aerated water from raw water reservoir	In-situ and Ex-situ	Surface water
13	KHR-62	22.07441	75.850902	Below tower line on road crossing near power station	In-situ and Ex-situ	Surface water

14	KHR-63	22.1927	75.97763	Narmada River upstream, Toksar	In-situ and Ex-situ	Surface water
15	KHR-64	22.00772	75.90917	Ambak River, Khargone-Sanawad road	In-situ and Ex-situ	Surface water

Table 12. Physical parameters in surface water samples during the pre-monsoon season of April (2023); pH in standard units.

S.No.	Code	DO (mg/L)	TDS (mg/L)	EC mS/cm)	pH (Range)	Temp (°C)	BOD (mg/L)	COD (mg/L)	Hardness (mg/L)
1	KHR-51	9.62	400	0.81	8.45	34.2	9	39	532
2	KHR-52		450	0.9	8.45	32.5	14	103	401
3	KHR-53	3.78	300	0.61	7.66	28.4	15	68	400
4	KHR-54A	6.36	140	0.29	6.86	29.8	6	65	193
5	KHR-55	8.48	120	0.25	**8.58**	32.3	9	52	172
6	KHR-56	5.28	220	0.45	8.12	30.2	6	59	281
7	KHR-57	6.46	160	0.33	8.08	32.9	10	66	215
8	KHR-58	7.04	570	1.16	8.06	30	16	48	300
9	KHR-59				**Dried**				
10	KHR-60	7.02	540	1.08	8.32	29.7	14	65	392
11	KHR-61	5.85	130	0.27	8.2	28.6	7	41	163
12	KHR-61Ae	8.3	160	0.33	7.87	28.7	4	36	203
13	KHR-62	5.98	470	0.95	7.45	32.9	14	112	625
14	KHR-63	7.3	150	0.32	7.72	27.1	9	84	222
15	KHR-64	4.82	220	0.44	7.44	30	8	91	401
BIS Limits	**AL**	**NS**	**500**	**NS**	**6.5-8.5**	**NS**	**NS**	**NS**	**200**
	PL		**2000**		**NR**				**600**

Notations: NS-Not specified; NR-No relaxation; ND- Not Detected; AL-Acceptable Limit; PL-Permissible Limit; BDL: Below detection limit

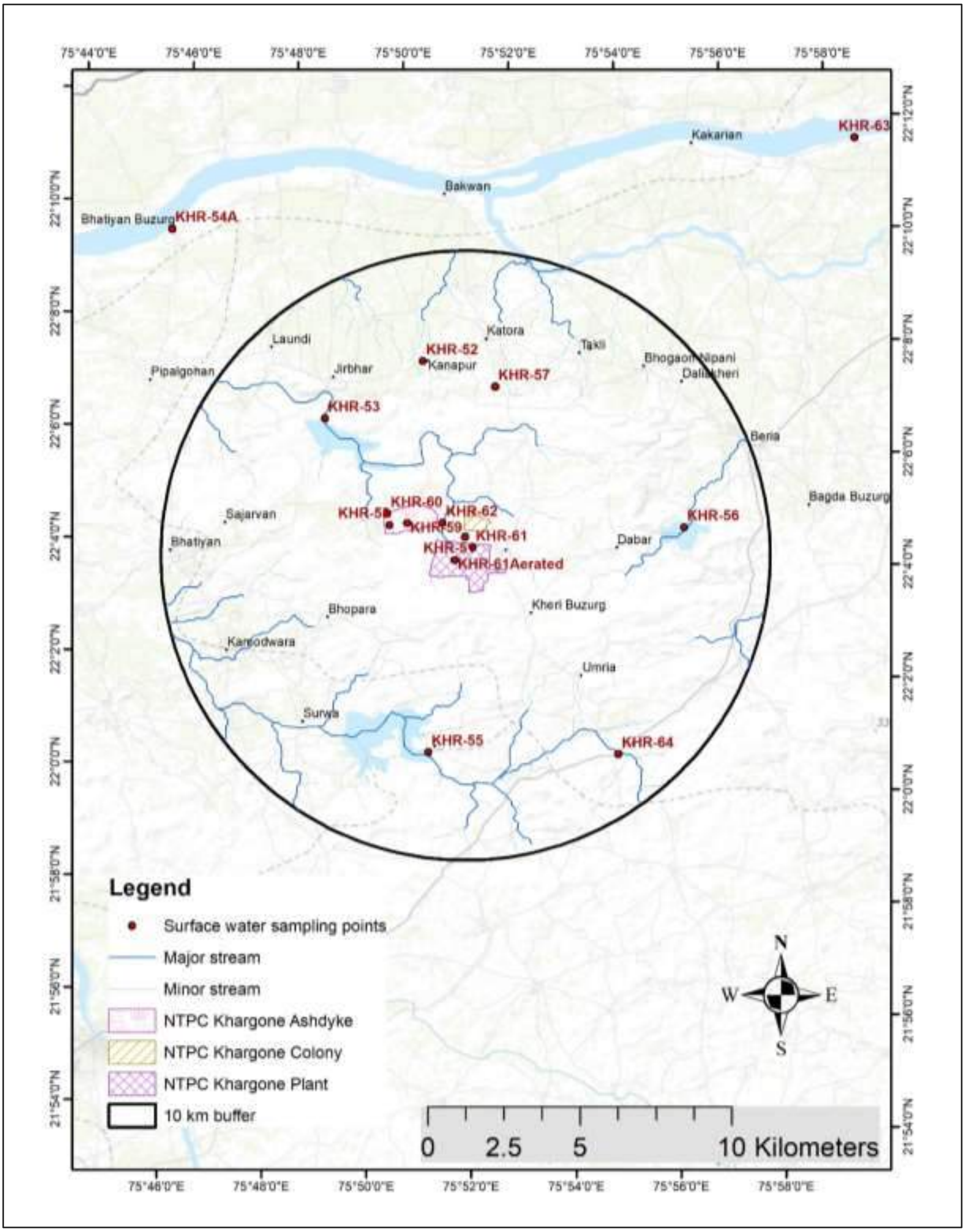


Figure 16. Map depicting the location of surface water sampling points during pre-monsoon 2023.

The mean concentration of heavy metals in the collected surface water samples and their comparison with BIS limits 10500:2012 during the pre-monsoon season (April 2023) is listed in Table 13. The concentration of arsenic (As) ranged from 0.005 ppm to 0.02 ppm, with an average value of 0.008 ppm. Pb concentration varied between 0.001-0.002 ppm with an almost insignificant mean value. The concentration of Cd, Cr, Cu, Zn, Se, and Fe ranged between 0.0003- 0.0004 ppm, 0.006-0.011 ppm, 0.031-0.043 ppm, 0.062-0.105 ppm, BDL-0.014, 0.1-2.1, respectively. Mercury (Hg) was below detectable limits in the surface water samples in the pre-monsoon 2023 period.

Table 13. Mean concentration (in ppm) of heavy metals in the surface water samples and their comparison with BIS limits 10500:2012 during pre-monsoon season of April (2023)

S.No.	Code	As	Hg	Pb	Cd	Cr	Cu	Zn	Se	Fe
1	KHR-51	0.006	BDL	0.001	0.0004	0.01	0.04	0.08	0.001	**1.1**
2	KHR-52	0.009	BDL	0.002	0.0003	0.01	0.04	0.08	0.002	**1.2**
3	KHR-53	0.008	BDL	0.002	0.0003	0.01	0.04	0.11	BDL	0.1
4	KHR-54	0.006	BDL	0.001	0.0003	0.01	0.03	0.08	0.002	0.1
5	KHR-55	0.007	BDL	0.002	0.0004	0.01	0.04	0.09	0.001	0.1
6	KHR-56	0.008	BDL	0.002	0.0003	0.01	0.04	0.10	0.001	**0.5**
7	KHR-57	0.005	BDL	0.001	0.0003	0.01	0.03	0.08	BDL	**0.4**
8	KHR-58	0.014	BDL	0.002	0.0003	0.01	0.04	0.06	0.011	0.1
9	KHR-59					**Dried**				
10	KHR-60	**0.020**	BDL	0.002	0.0003	0.01	0.04	0.09	**0.014**	**2.1**
11	KHR-61	0.007	BDL	0.001	0.0003	0.01	0.04	0.09	0.001	0.1
12	KHR-61Ae	0.007	BDL	0.002	0.0004	0.01	0.04	0.07	0.001	0.1
13	KHR-62	0.007	BDL	0.001	0.0003	0.01	0.03	0.09	0.003	0.1
14	KHR-63	0.007	BDL	0.002	0.0003	0.01	0.04	0.08	0.002	0.1
15	KHR-64	0.006	BDL	0.001	0.0003	0.01	0.03	0.08	0.001	0.5
BIS (IS:10500-2012)	**AL**	**0.01**	**0.001**	**0.01**	**0.003**	**0.05**	**0.05**	**5**	**0.01**	**0.3**
	PL	**0.05**	**NR**	**NR**	**NR**	**NR**	**1.5**	**15**	**NR**	**NR**

Notations: NS-Not specified; NR-No relaxation; ND- Not Detected; AL-Acceptable Limit; PL- Permissible Limit; BDL: Below detection limit

Ion Chromatography (IC) analysis was performed to measure the concentration of anions such as nitrate (NO_3^-), phosphate (PO_4^-), chloride (Cl^-), fluoride (F^-), bromide (Br^-) and sulfate (SO_4^{2-}). Prior to IC analysis, samples were diluted to a suitable degree with MQ water. After that, the samples were filtered through a 0.2µm filter before their analysis. Moreover, cations such as calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^+), and potassium (K^+) were measured using MPAES at the Institute Instrumentation

Center (IIC) of IIT Roorkee. The concentrations of major ions in surface water samples and their comparison with BIS limits is listed in Table 14. In the pre-monsoon 2023 season, F^- concentration ranges between 0.2-3.1 mg/L with an average value of 0.7 mg/L. The concentration of Cl^- ranged from 7.9 to 91.9 mg/L, with an average value of 36.3 mg/L. The concentration of NO_3^- ranged from BDL to 25.6 mg/L, with an average value of 4.5 mg/L. SO_4^{2-} levels ranged from 15.3 to 942.3 mg/L with an average value of 185.9 mg/L. Ca^{2+} levels ranged from 40.1 mg/L to 190.8 mg/L, with an average value of 79.2 mg/L. The concentration of K^+ ranged from 1.8 mg/L to 97.6 mg/L with an average value of 11.7 mg/L. The concentration of Mg^{2+} ranged from 11.4 mg/L to 57.5 mg/L with an average value of 30.1 mg/L. Na^+ level ranged from 21.5 mg/L to 142.7 mg/L with an average value of 59.1 mg/L. The HCO_3 concentration ranged from 101 mg/L to 542 mg/L, with an average value of 205.5 mg/L.

Table 14. Mean concentration (in mg/L) of major ions in surface water samples and their comparison with BIS limits of IS 10500:2012 during pre-monsoon season of April (2023)

Sr. No.	Code	F^-	Cl^-	Br^-	NO_3^-	PO_4^-	SO_4^{2-}	Ca^{2+}	K^+	Mg^{2+}	Na^+	HCO_3^-	CO_3^-
1	KHR-51	0.4	85.3	ND	1.8	ND	304.5	118.3	9.0	57.5	99.9	175	ND
2	KHR-52	0.4	90.1	ND	1.0	ND	67.4	74.8	97.6	51.9	142.7	365	ND
3	KHR-53	0.4	31.2	ND	8.6	ND	128	100.9	4.0	36.1	58.4	154	ND
4	KHR-54	0.2	10	ND	2.7	ND	15.3	56.7	3.6	12.5	25.2	193	ND
5	KHR-55	0.3	7.9	ND	1.5	ND	19.5	43.1	2.7	15.6	26.6	159	ND
6	KHR-56	0.5	20.6	ND	3.5	ND	57.3	61.0	4.1	31.2	57.6	542	ND
7	KHR-57	0.5	8.9	ND	4.0	ND	26.8	57.9	2.3	17.1	28.8	210	ND
8	KHR-58	**3.1**	77.0	ND	3.2	ND	**942.3**	40.1	13.3	48.6	87.8	112	ND
9	KHR-59						**DRIED**						
10	KHR-60	**2.3**	37.5	ND	1.6	ND	**566.9**	75.4	14.7	49.4	91.2	101	ND
11	KHR-61	0.3	8.7	ND	BDL	ND	29.1	46.4	2.0	11.4	31.8	153	ND
12	KHR-61Ae	0.3	8.7	ND	BDL	ND	22.1	58.9	2.6	13.6	21.5	136	ND
13	KHR-62	0.5	91.9	ND	7.8	ND	378	190.8	1.8	36.1	88.5	182	ND
14	KHR-63	0.3	9.1	ND	2.1	ND	15.5	66.5	2.9	13.6	26.5	210	ND
15	KHR-64	0.5	21	ND	25.6	ND	29.5	117.5	3.0	26.0	40.2	185	ND
BIS limits (IS:10500-2012)	**AL**	**1**	**250**	**NS**	**45**	**NS**	**200**	**75**	**NS**	**30**	**NS**	**NS**	**NS**
	PL	**1.5**	**1000**		**NR**		**400**	**200**		**100**			

Notations: NS-Not specified; NR-No relaxation; ND- Not Detected; AL-Acceptable Limit; PL-Permissible Limit; BDL: Below detection limit

6.2 *Surface Water Quality during Post-monsoon 2023 Season*

Surface water samples were collected from identified locations to identify the current sources of contamination in the post-monsoon 2023 season. Salient details such as sample code, station name, location, and type of analysis for which surface water samples were collected during the post-monsoon 2023 visit are listed in Table 15. The collected samples were analysed for required surface water quality parameters. Measured values of physical parameters like DO, TDS, EC, pH, Temperature, along with COD, BOD, and Hardness (in mg/L) else EC in mS/cm; pH in the standard unit and temperature in °C, during the post-monsoon season are listed in Table 16.

Table 15. Surface water sampling sites in a 10 km buffer (post-monsoon 2023)

S.No	Code	Latitude	Longitude	Station Name	Type of Analysis	Type of Site
1	KHR-51	22.07047	75.858149	Pond Between NTPC Power station & Township	In-situ and Ex-situ	Surface water
2	KHR-52	22.12206	75.842803	Near Health Centre along Main road, Vill Kanapur	In-situ and Ex-situ	Surface water
3	KHR-53	22.104185	75.812277	Jirbhar lake	In-situ and Ex-situ	Surface water
4	KHR-54A	22.158804	75.76167	Narmada River Downstream	In-situ and Ex-situ	Surface water
5	KHR-55	22.006354	75.848828	Ambak Resevoir	In-situ and Ex-situ	Surface water
6	KHR-56	22.075493	75.927687	Lachhora Talab	In-situ and Ex-situ	Surface water
7	KHR-57	22.115246	75.866087	Kattora Pond, Shelda Power station-Kattora Road	In-situ and Ex-situ	Surface water
8	KHR-58	22.07323	75.833941	OFL Ash Dyke	In-situ and Ex-situ	Surface water
9	KHR-59	22.073978	75.839568	Lagoon 1 Ash Dyke	Dried up	Surface water
10	KHR-60	22.07661	75.8332	Lagoon 2 Ash Dyke	In-situ and Ex-situ	Surface water
11	KHR-61	22.06741	75.860638	Raw water reservoir inside power station	In-situ and Ex-situ	Surface water
12	KHR-62	22.07441	75.850902	Below tower line on road crossing	In-situ and Ex-situ	Surface water
13	KHR-63	22.1927	75.97763	Narmada River upstream, Toksar	In-situ and Ex-situ	Surface water
14	KHR-64	22.00772	75.90917	Ambak River, Khargone-Sanawad road	In-situ and Ex-situ	Surface water

The pH values ranged from 6.94 to 8.32, with a mean value of 7.75. TDS concentrations ranged from 100 mg/L to 970 mg/L, with an average value of 337.69 mg/L. DO concentrations ranged from 3.8 mg/L to 10.08 mg/L, with a mean value of

7.41 mg/L. The EC concentration ranged from 0.21 ms/cm to 1.94 ms/cm, with an average value of 0.69 ms/cm. Hardness ranged from 84.42 mg/L to 338.50 mg/L in the post-monsoon period, with an average value of 168.50 mg/L. COD and BOD are also determined in surface water samples during the post-monsoon season, where the BOD ranged from 4 mg/L to 14 mg/L with a mean value of 8.38 mg/L while COD ranged from 26 mg/L to 111 mg/L with an average of 56.46 mg/L. The temperature of the surface water samples ranged from 26.70°C to 32.45°C with a mean value of 30.16°C.

Table 16. Physical parameters in surface water samples during the post-monsoon season of 2023; pH in standard units.

S.No.	Code	DO (mg/L)	TDS (mg/L)	EC (mS/cm)	pH (Range)	Temp (°C)	BOD (mg/L)	COD (mg/L)	Hardness (mg/L)
1	KHR-51	9.53	410	0.86	8.32	32.45	5	26	91
2	KHR-52	7.87	240	0.5	7.75	30.9	11	111	161
3	KHR-53	3.8	150	0.31	7.63	26.7	9	70	127
4	KHR-54A	7.23	160	0.32	6.94	27.3	5	60	135
5	KHR-55	8.74	220	0.45	7.89	32.2	10	35	155
6	KHR-56	10.08	130	0.26	8.12	29.2	4	33	84
7	KHR-57	7.57	120	0.24	7.99	30.7	12	41	106
8	KHR-58	7.2	970	1.95	7.51	30.4	14	46	262
9	KHR-59				DRIED				
10	KHR-60	7.21	970	1.95	7.66	30.5	10	56	338
11	KHR-61	6.2	100	0.21	8.27	31.7	9	39	88
12	KHR-62	6.32	410	0.83	7.43	29.6	6	92	320
13	KHR-63	6.5	230	0.47	7.41	29.3	5	67	210
14	KHR-64	8.09	280	0.57	7.8	31.1	9	58	113
BIS Limits	**AL**	**NS**	**500**	**NS**	**6.5-8.5**	**NS**	**NS**	**NS**	**200**
	PL		**2000**		**NR**				**600**

Notations: NS-Not specified; NR-No relaxation; ND- Not Detected; AL-Acceptable Limit; PL-Permissible Limit; BDL: Below detection limit

The mean concentration of heavy metals in the collected surface water samples and their comparison with BIS limits for post-monsoon 2023 season is listed in Table 17. The concentration of arsenic (As) ranged from 0.001 ppm to 0.004 ppm, with an average value of 0.001 ppm. Pb concentration varied between 0.002-0.007 ppm with an almost insignificant mean value of 0.003. The concentration of Cd, Cr, Cu, Se, and Fe ranged between 0.001- 0.002 ppm, 0.018-0.023 ppm, 0.003-0.150 ppm, BDL-0.010, 0.15-0.37, respectively.

Table 17. Mean concentration (in ppm) of heavy metals in the surface water samples and their comparison with BIS limits 10500:2012 during post-monsoon season of 2023

S.No.	Code	As	Hg	Pb	Cd	Cr	Cu	Zn	Se	Fe
1	KHR-51	0.001	ND	0.002	0.002	0.02	ND	ND	BDL	0.18
2	KHR-52	0.001	ND	0.007	0.002	0.02	0.01	ND	BDL	0.31
3	KHR-53	0.001	ND	0.003	0.002	0.02	0.01	ND	BDL	0.25
4	KHR-54	0.001	ND	0.003	0.001	0.02	0.01	ND	BDL	0.37
5	KHR-55	0.001	ND	0.003	0.002	0.02	0.15	ND	BDL	0.23
6	KHR-56	0.001	ND	0.004	0.002	0.02	ND	ND	BDL	0.20
7	KHR-57	0.001	ND	0.002	0.001	0.02	0.01	ND	BDL	0.21
8	KHR-58	0.003	ND	0.002	0.002	0.02	ND	ND	0.01	0.18
9	KHR-59	DRIED								
10	KHR-60	0.004	ND	0.002	0.002	0.02	ND	ND	0.01	0.18
11	KHR-61	0.001	ND	0.003	0.002	0.02	0.01	ND	BDL	0.23
12	KHR-62	0.001	ND	0.002	0.002	0.02	ND	ND	BDL	0.20
13	KHR-63	0.001	ND	0.002	0.002	0.02	0.01	ND	BDL	0.18
14	KHR-64	0.001	ND	0.002	0.001	0.02	0.01	ND	BDL	0.15
BIS (IS:10500-2012)	**AL**	**0.01**	**0.001**	**0.01**	**0.003**	**0.05**	**0.05**	**5**	**0.01**	**0.3**
	PL	**0.05**	**NR**	**NR**	**NR**	**NR**	**1.5**	**15**	**NR**	**NR**

Notations: NS-Not specified; NR-No relaxation; ND- Not Detected; AL-Acceptable Limit; PL- Permissible Limit; BDL: Below detection limit

The concentrations of major ions in surface water samples and their comparison with BIS limits for the post-monsoon season of 2023 is listed in Table 18. In the post-monsoon 2023 season, F^- concentration ranges between 0.3-8.4 mg/L with an average value of 1.2 mg/L. The concentration of Cl^- ranged from 30 to 280 mg/L, with an average value of 124.6 mg/L. The concentration of NO_3^- ranged from 1.6 to 6.7 mg/L, with an average value of 3.9 mg/L. SO_4^{2-} levels ranged from 6 to 386.2 mg/L with an average value of 80.4 mg/L. Ca^{2+} levels ranged from 15.75 mg/L to 81.45 mg/L, with an average value of 33.31 mg/L. The concentration of K^+ ranged from 0.04 mg/L to 3.07 mg/L with an average value of 0.5 mg/L. The concentration of Mg^{2+} ranged from 9.75 mg/L to 82.2 mg/L with an average value of 24.9 mg/L. Na^+ level ranged from 31.5 mg/L to 185.1 mg/L with an average value of 78.98 mg/L. The HCO_3^- concentration ranged from 105 mg/L to 450 mg/L, with an average value of 201.2 mg/L.

Table 18. Mean concentration (in mg/L) of major ions in surface water samples and their comparison with BIS limits of IS 10500:2012 during post-monsoon 2023 season.

Sr. No.	Code	F^-	Cl^-	Br^-	NO_3^-	PO_4^-	SO_4^{2-}	Ca^{2+}	K^+	Mg^{2+}	Na^+	HCO_3^-	CO_3^-
1	KHR-51	0.5	80	ND	1.6	ND	22.3	20.4	0.06	9.75	31.5	160	ND
2	KHR-52	0.3	90	ND	2.0	ND	6	30.9	1.55	20.4	88.8	340	ND
3	KHR-53	0.8	60	ND	2.3	ND	22.3	31.65	0.09	11.55	39.75	185	ND
4	KHR-54	0.6	100	ND	5.6	ND	188.9	23.4	3.07	18.6	185.1	190	ND
5	KHR-55	0.5	30	ND	6.7	ND	20.0	29.55	0.11	19.65	62.25	145	ND
6	KHR-56	0.8	240	ND	2.7	ND	9.1	15.75	0.07	10.95	40.65	450	ND
7	KHR-57	0.3	60	ND	3.7	ND	10.3	25.05	0.07	10.5	37.2	205	ND
8	KHR-58	**8.4**	170	ND	2.7	ND	198.6	24.1	0.43	63.6	119.55	125	ND
9	KHR-59						DRIED						
10	KHR-60	0.9	280	ND	4.1	ND	386.2	65.3	0.65	82.2	149.25	105	ND
11	KHR-61	0.9	110	ND	4.6	ND	8.0	18.9	0.1	9.9	43.35	165	ND
12	KHR-61Ae	0.6	200	ND	2.7	ND	90.9	81.45	0.05	28.35	99.45	195	ND
13	KHR-62	0.5	90	ND	5.1	ND	17.1	43.2	0.16	24.75	91.05	190	ND
14	KHR-63	0.5	110	ND	7.0	ND	65.4	23.4	0.04	13.35	38.85	160	ND
15	KHR-64	0.5	80	ND	1.6	ND	22.3	20.4	0.06	9.75	31.5	160	ND
BIS limits (IS:10500-2012)	**AL**	**1**	**250**	**NS**	**45**	**NS**	**200**	**75**	**NS**	**30**	**NS**	**NS**	**NS**
	PL	**1.5**	**1000**		**NR**		**400**	**200**		**100**			

Notations: NS-Not specified; NR-No relaxation; ND- Not Detected; AL-Acceptable Limit; PL-Permissible Limit; BDL: Below detection limit

6.3 *Surface Water Quality during Pre-monsoon 2024 Season*

The team visited KSTPS Khargone during May 5 – 9, 2024, to undertake a pre-monsoon survey and collection of surface water samples in 10 km buffer zone from the power station area, ash dyke and surrounding area. Surface water samples were collected from identified locations to identify the current sources of contamination, if any. The collected samples were analysed for required water quality parameters. COD and BOD are measured through the oxidation-titration method. In the In-situ analysis of the samples, pH, TDS (Total dissolved solids), EC (Electrical Conductivity), DO (Dissolved Oxygen), and temperature were measured at the water collection site using a multi-meter electrode. Measured values of physical parameters like DO, TDS, EC, pH, Temperature, COD, BOD, and Hardness (COD, BOD, Hardness, DO, and TDS in mg/L; EC in mS/cm; pH in the standard unit and temperature in °C) during the pre-monsoon season are listed in Table 19**.**

The pH values ranged from 7.55 to 8.38, with a mean value of 7.96. The sample collected from the Lachhora Talab (KHR-56) has the highest pH level, i.e., 8.38. TDS concentrations ranged from 120.00 mg/L to 1030.00 mg/L, with an average value of 364.17mg/L. DO concentrations ranged from 5.17 mg/L to 8.92 mg/L, with a mean value of 6.90mg/L. The EC concentration ranged from 0.26 ms/cm to 2.07 ms/cm, with an average value of 0.74 ms/cm. Hardness ranged from 150.00 mg/L to 520.00 mg/L in the pre-monsoon 2024 period, with an average value of 307.75 mg/L. COD and BOD are also determined in surface water samples during the pre-monsoon season, where the BOD ranged from 4.00 mg/L to 14.00 mg/L with a mean value of 11.83mg/L while COD ranged from 38.00 mg/L to 80.00 mg/L with an average of 55.33mg/L. The temperature of the surface water samples ranged from 27.5 °C to 33.9°C with a mean value of 30.32°C. The mean concentration of heavy metals in the collected surface water samples and their comparison with BIS limits 10500:2012 during the pre-monsoon season (May 2024) is listed in Table 20. The concentration of arsenic (As) ranged from 0.001 ppm to 0.010 ppm, with an average value of 0.003 ppm. Pb mean, min and max concentration 0.001 ppm. The concentration of Cd, Cr, Cu, Zn, Se, and Fe ranged between 0.0002 - 0.0004ppm, 0.008 -0.011ppm, 0.020 - 0.027ppm, 0.121- 0.152 ppm, BDL-0.01, 0.10-0.21, respectively. Mercury (Hg) was below detectable limits in the surface water samples in the pre-monsoon 2024 period.

Ion Chromatography (IC) analysis was performed to measure the concentration of anions such as nitrate (NO_3^-), phosphate (PO_4^-), chloride (Cl^-), fluoride (F^-), bromide (Br^-) and sulphate (SO_4^{2-}). Moreover, cations such as calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^+), and potassium (K^+) were measured using MPAES at the Institute Instrumentation Centre (IIC) of IIT Roorkee. The concentrations of major ions in surface water samples and their comparison with BIS limits is listed in Table 21. In the pre-monsoon 2024 season, F^- concentration ranges between 0.00- 3.52 mg/L with an average value of 0.73mg/L.

The concentration of Cl^- ranged from 8.21- 106.13mg/L, with an average value of 38.18mg/L. The concentration of NO_3^- ranged from 0.00- 7.59 mg/L, with an average value of 2.18mg/L. SO_4^{2-} levels ranged from 9.95- 977.53 mg/L with an average value of 162.65mg/L. Ca^{2+} levels ranged from 0.00- 96.30mg/L, with an average value of 33.81mg/L. The concentration of K^+ ranged from 1.20- 48.00 mg/L with an average value of 7.03mg/L. The concentration of Mg^{2+} ranged from 12.45- 96.15 mg/L with an average value of 35.95 mg/L. Na^+ level ranged from 6.30 - 30.60 mg/L with an average value of 15.04 mg/L. The HCO_3 concentration ranged from 98.00 536.00 mg/L, with an average value of 209.58 mg/L.

Table 19.Physical parameters in surface water samples during the pre-monsoon season of 2024; pH in standard units

S. No.	Code	DO (mg/L)	TDS (mg/L)	EC mS/cm)	pH (Range)	Temp (°C)	BOD (mg/L)	COD (mg/L)	Hardness (mg/L)
1	KHR -51	8.58	430	0.89	7.89	28.8	8	28	520
2	KHR -52	8.92	450	0.91	7.96	31.4	12	38	411
3	KHR -53	5.94	260	0.52	7.92	29.1	14	52	420
4	KHR -54	5.92	150	0.3	7.96	28.3	4	48	200
5	KHR -55	5.25	130	0.27	7.89	33.9	12	48	180
6	KHR -56	7.41	160	0.32	8.15	31.3	10	56	270
7	KHR -57	8.54	190	0.38	8.38	30.1	14	56	220
8	KHR -58	8.30	530	0.97	8.15	31.6	18	54	290
9	KHR -60	8.08	500	0.93	8.19	30.7	14	46	380
10	KHR -61	7.30	120	0.26	7.76	29.4	8	42	150
11	KHR -62	5.73	560	0.99	7.72	29.2	14	80	520
12	KHR -63	5.17	200	0.42	7.84	31.3	12	64	224
13	KHR -64	6.28	190	0.39	7.55	27.5	10	80	428
BIS Limits	**AL**	**NS**	**500**	**NS**	**6.5-8.5**	**NS**	**NS**	**NS**	**200**
	PL		**2000**		**NR**				**600**

Table 20. Mean concentration (in ppm) of heavy metals in the surface water samples and their comparison with BIS limits 10500:2012 during pre-monsoon season 2024

S. No.	Code	As	Hg	Pb	Cd	Cr	Cu	Zn	Se	Fe
1	KHR -51	0.001	ND	0.001	0.0004	0.01	0.02	0.14	0.001	0.1
2	KHR -52	0.003	ND	0.001	0.0003	0.01	0.02	0.13	0.001	0.2
3	KHR -53	0.001	ND	0.001	0.0004	0.01	0.02	0.15	0.001	0.1
4	KHR -54	0.002	ND	0.001	0.0003	0.01	0.02	0.12	0.001	0.1
5	KHR -55	0.001	ND	0.001	0.0004	0.01	0.03	0.12	0.001	0.1
6	KHR -56	0.002	ND	0.001	0.0004	0.01	0.03	0.14	0.001	0.1
7	KHR -57	0.002	ND	0.001	0.0003	0.01	0.02	0.12	0.000	0.1
8	KHR -58	0.005	ND	0.001	0.0003	0.01	0.02	0.13	0.001	0.1
9	KHR -60	0.010	ND	0.001	0.0003	0.01	0.02	0.15	**0.015**	0.2
10	KHR -61	0.002	ND	0.001	0.0003	0.01	0.02	0.13	0.001	0.1
11	KHR -62	0.001	ND	0.001	0.0002	0.01	0.02	0.15	0.003	0.2
12	KHR -63	0.002	ND	0.001	0.0003	0.01	0.02	0.13	0.002	0.1
13	KHR -64	0.002	ND	0.001	0.0004	0.01	0.02	0.13	0.001	0.1
BIS (IS:10500-2012)	**AL**	**0.01**	**0.001**	**0.01**	**0.003**	**0.05**	**0.05**	**5**	**0.01**	**0.3**
	PL	**0.05**	**NR**	**NR**	**NR**	**NR**	**1.5**	**15**	**NR**	**NR**

Notations: NS-Not specified; NR-No relaxation; ND- Not Detected; AL-Acceptable Limit; PL-

Permissible Limit; BDL: Below detection limit

Table 21. Mean concentration (in mg/L) of major ions in surface water samples and their comparison with BIS limits of IS 10500:2012 during pre-monsoon season 2024

Sr. No.	Code	F^-	Cl^-	Br^-	NO_3^-	PO_4^-	SO_4^{2-}	Ca^{2+}	K^+	Mg^{2+}	Na^+	HCO_3^-	CO_3^-
1	KHR -51	0.28	75.28	ND	0.00	ND	199.26	45.45	4.50	47.85	22.65	168	ND
2	KHR -52	0.25	106.13	ND	0.00	ND	60.63	25.20	48.00	43.35	30.60	356	ND
3	KHR -53	0.31	31.29	ND	2.56	ND	88.64	39.30	2.25	25.50	10.50	150	ND
4	KHR -54	0.00	10.94	ND	3.37	ND	13.28	27.90	3.45	12.45	6.90	208	ND
5	KHR -55	0.19	8.21	ND	2.18	ND	9.95	21.90	2.40	13.20	6.30	158	ND
6	KHR -56	0.38	18.14	ND	3.17	ND	22.75	21.30	2.25	22.80	12.30	536	ND
7	KHR -57	0.31	9.10	ND	0.00	ND	14.62	54.15	2.25	29.10	10.95	200	ND
8	KHR -58	**3.52**	86.08	ND	2.47	ND	**977.53**	0.00	7.95	96.15	27.75	110	ND
9	KHR -60	**2.53**	76.23	ND	1.49	ND	**679.48**	0.00	8.70	93.15	25.65	98	ND
10	KHR -61	0.50	12.47	ND	0.31	ND	41.53	51.90	2.40	24.45	7.80	148	ND
11	KHR -62	0.24	81.34	ND	0.00	ND	21.52	96.30	1.20	38.10	24.00	176	ND
12	KHR -63	0.58	8.31	ND	7.59	ND	10.91	37.05	1.35	15.60	8.85	200	ND
13	KHR -64	0.00	9.94	ND	3.04	ND	10.92	30.75	2.10	17.55	8.85	175	ND
BIS limits (IS:10500-2012)	**AL**	**1**	**250**	**NS**	**45**	**NS**	**200**	**75**	**NS**	**30**	**NS**	**NS**	**NS**
	PL	**1.5**	**1000**		**NR**		**400**	**200**		**100**			

Notations: NS-Not specified; NR-No relaxation; ND- Not Detected; AL-Acceptable Limit; PL- Permissible Limit; BDL: Below detection limit

6.4 *Surface Water Quality during Post-monsoon 2024 Season*

Surface water samples were collected from identified locations to identify the current sources of contamination in the post-monsoon 2024 season. Salient details such as sample code, station name, location, and type of analysis for which surface water samples were collected during the post-monsoon 2024 visit are listed in Table 15. The collected samples were analysed for required surface water quality parameters. Measured values of physical parameters like DO, TDS, EC, pH, Temperature, along with COD, BOD, and Hardness (in mg/L) else EC in mS/cm; pH in the standard unit and temperature in °C, during the post-monsoon season are listed in Table 22.

The pH values ranged from 6.2 to 8.5, with a mean value of 8.0. TDS concentrations ranged from 130 mg/L to 960 mg/L, with an average value of 336.36 mg/L. DO concentrations ranged from 3.26 mg/L to 9.17 mg/L, with a mean value of 6.94 mg/L. The EC concentration ranged from 0.27 ms/cm to 1.93 ms/cm, with an average value of 1.93 ms/cm. Hardness ranged from 140 mg/L to 540 mg/L in the post-monsoon period, with an average value of 313 mg/L. COD and BOD are also determined in surface water samples during the post-monsoon season, where the BOD ranged from 6 mg/L to 20 mg/L with a mean value of 13.83 mg/L while COD ranged from 24 mg/L to 76 mg/L with an average of 52.83 mg/L. The temperature of the surface water samples ranged from 28.3°C to 32°C with a mean value of 30.02°C.

The mean concentration of heavy metals in the collected surface water samples and their comparison with BIS limits for post-monsoon 2024 season is listed in Table 22. The concentration of arsenic (As) ranged from 0.000 ppm to 0.009 ppm, with an average value of 0.001 ppm. The concentration of chromium (Cr), ranged from 0.000 ppm to 0.011 ppm, with an average value of 0.006 ppm. Zn and Cd concentration varied between 0.000-0.002 ppm with an almost insignificant mean value of 0.001. The concentration of Selenium (Se), ranged from BDL to 0.005 ppm, with an average value of 0.001 ppm. The concentration of Fe, Cu, Hg, and Pb was not deteted.

The concentrations of major ions in surface water samples and their comparison with BIS limits for the post-monsoon season of 2024 is listed in Table 24. In the post-monsoon 2024 season, F^- concentration ranges between 0.20-6.40 mg/L with an average value of 1.01 mg/L. The concentration of Cl^- ranged from 28.18 to 287 mg/L, with an average value of 113.85 mg/L. The concentration of NO_3^- ranged from 1.20 to 6.26 mg/L, with an average value of 3.36 mg/L. SO_4^{2-} levels ranged from 4.28 to 368.20 mg/L with an average value of 85.47 mg/L. Ca^{2+} levels ranged from 16.28 mg/L to 99.56 mg/L, with an average value of 46.46 mg/L. The concentration of K^+ ranged from 0.00 mg/L to 6.43 mg/L with an average value of 2.37 mg/L. The concentration of Mg^{2+} ranged from 8.82 mg/L to 62.64 mg/L with an average value of 23.36 mg/L. Na^+ level ranged from 15.32 mg/L to 59.09 mg/L with an average value of 28.82 mg/L. The HCO_3^- concentration ranged from 114 mg/L to 288 mg/L, with an average value of 178.75 mg/L.

Table 22 Physical parameters in surface water samples during the post-monsoon season of September, 2024; pH in standard units

S. No.	Code	DO (mg/L)	TDS (mg/L)	EC mS/cm)	pH (Range)	Temp (°C)	BOD (mg/L)	COD (mg/L)	Hardness (mg/L)
1	KHR -51	9.26	270	0.54	8.62	30.20	12	32	490
2	KHR -52	8.78	310	0.62	8.71	31.20	16	76	402
3	KHR -53	4.47	330	0.64	7.48	28.30	12	38	410
4	KHR -54	6.90	130	0.28	6.15	30.20	6	24	180
5	KHR -55	3.26	260	0.53	7.78	29.60	14	56	190
6	KHR -56	7.20	170	0.35	8.50	30.20	12	48	260

7	KHR -58	9.17	960	1.93	8.48	30.90	16	52	210
8	KHR -60	7.54	510	1.04	8.46	32.00	20	60	290
9	KHR -61	7.55	130	0.27	8.32	29.50	16	52	360
10	KHR -62	6.55	460	0.92	7.82	30.00	10	32	140
11	KHR -63	7.89	170	0.34	8.30	28.30	16	72	540
12	KHR -64	7.00	270	0.56	8.16	27.00	14	54	214
BIS Limits	**AL**	**NS**	**500**	**NS**	**6.5-8.5**	**NS**	**NS**	**NS**	**200**
	PL		**2000**		**NR**				**600**

Table 23 Mean concentration (in ppm) of heavy metals in the surface water samples and their comparison with BIS limits 10500:2012 during post-monsoon season September 2024

S. No.	Code	Cr	Fe	Cu	Zn	As	Se	Cd	Hg	Pb
1	KHR-51	0.006	ND	ND	0.002	ND	BDL	0.002	ND	ND
2	KHR-52	0.005	ND	ND	ND	ND	BDL	0.002	ND	ND
3	KHR-53	0.004	ND	ND	0.002	ND	BDL	0.002	ND	ND
4	KHR-54	0.007	ND	ND	ND	ND	0.003	ND	ND	ND
5	KHR-55	0.006	ND	ND	ND	ND	BDL	ND	ND	ND
6	KHR-56	0.000	ND	ND	ND	ND	BDL	ND	ND	ND
7	KHR-58	0.006	ND	ND	0.002	0.002	0.005	ND	ND	ND
8	KHR-60	0.008	ND	ND	0.002	0.009	0.004	ND	ND	ND
9	KHR-61	0.009	ND	ND	ND	ND	BDL	ND	ND	ND
10	KHR-62	0.011	ND	ND	0.002	ND	BDL	ND	ND	ND
11	KHR-63	0.005	ND	ND	ND	ND	0.003	ND	ND	ND
12	KHR-64	0.005	ND	ND	ND	ND	BDL	ND	ND	ND
BIS (IS:10500-2012)	**AL**	**0.01**	**0.001**	**0.01**	**0.003**	**0.05**	**0.05**	**5**	**0.01**	**0.3**
	PL	**0.05**	**NR**	**NR**	**NR**	**NR**	**1.5**	**15**	**NR**	**NR**

Notations: NS-Not specified; NR-No relaxation; ND- Not Detected; AL-Acceptable Limit; PL-Permissible Limit; BDL: Below detection limit

Table 24 Mean concentration (in mg/L) of major ions in surface water samples and their comparison with BIS limits of IS 10500:2012 during post-monsoon season September 2024

Sr. No.	Code	F^-	Cl^-	Br^-	NO_3^-	PO_4^-	SO_4^{2-}	Na^+	K^+	Ca^{2+}	Mg^{2+}	HCO^-	CO_3^-
1	KHR -51	0.40	70.00	ND	1.20	ND	18.10	19.97	1.07	50.96	20.17	178.00	ND
2	KHR -52	0.20	60.00	ND	1.88	ND	4.28	42.92	1.46	49.10	30.19	288.00	ND
3	KHR -53	0.70	55.00	ND	2.10	ND	26.12	22.54	2.67	70.57	23.08	178.00	ND
4	KHR -54	0.50	88.12	ND	4.80	ND	168.28	15.32	6.43	32.11	8.82	210.00	ND
5	KHR -55	0.60	28.18	ND	5.90	ND	122.38	20.06	ND	53.58	20.36	144.00	ND
6	KHR -56	0.60	258.12	ND	3.00	ND	11.82	22.28	1.98	32.49	18.60	158.00	ND
7	KHR -58	6.40	158.12	ND	2.90	ND	200.26	59.09	4.02	25.22	62.64	211.00	ND
8	KHR -60	0.70	287.00	ND	3.10	ND	368.20	28.16	3.87	99.56	24.56	114.00	ND
9	KHR -61	0.80	88.89	ND	2.90	ND	12.28	40.23	0.23	16.28	9.12	144.00	ND
10	KHR -62	0.40	78.28	ND	4.20	ND	19.20	37.89	2.35	23.90	31.95	186.00	ND
11	KHR -63	0.40	112.18	ND	6.26	ND	56.38	16.59	1.67	38.61	10.69	178.00	ND
12	KHR -64	0.40	82.27	ND	2.10	ND	18.28	20.81	2.72	65.16	20.21	156.00	ND
BIS limits (IS:10500-2012)	**AL**	**1**	**250**	**NS**	**45**	**NS**	**200**	**75**	**NS**	**30**	**NS**	**NS**	**NS**
	PL	**1.5**	**1000**		**NR**		**400**	**200**		**100**			

Notations: NS-Not specified; NR-No relaxation; ND- Not Detected; AL-Acceptable Limit; PL- Permissible Limit; BDL: Below detection limit

6.5 *Overall Analysis of Surface Water Quality during the study period*

The water quality assessment across 2023 and 2024 revealed eleveated level of some elements. In pre-monsoon 2023, fluoride and sulfate levels exceeded acceptable limits in some locations. These trends continued in post-monsoon 2023, with significant increases in fluoride and sulfate concentrations. While pre-monsoon 2024 generally mirrored the previous year's trends, post-monsoon 2024 saw variability in fluoride, sulfate, and chloride levels with some exceedances, and also exhibited localized chromium contamination.

Overall, the water quality of most of the surface water samples was found to be well within the prescribed limits of BIS standards during the pre and post-monsoon 2023 season as well as pre and post-monsoon season 2024. The concentration of a few elements such as fluoride, sulphate and some heavy metals such as Fe, Se, and As was found to be slightly higher than the prescribed BIS limits of drinking water in ash dyke samples. They might seep into the subsurface area and ultimately pollute the groundwater in the near future if not managed properly. Also, the pH values were slightly high in samples collected from the ash dyke area; however, the overall pH range suggests that the surface water quality is slightly of alkaline nature in the present study area.

7 GROUNDWATER QUALITY AT IDENTIFIED LOCATIONS AND CURRENT SOURCES OF CONTAMINATION.

Groundwater sampling locations were identified based on the reconnaissance site survey of the power station area. The identified locations and probable sources of contamination were assessed thoroughly based on the groundwater chemical analysis of the study area. The groundwater samples were collected from existing handpumps, tube wells, piezometers and bore wells. Prior to collecting the samples, the purging of sources was performed for 10-15 minutes. Also, the sampling bottles were rinsed with the same water thrice while sampling. During the In-situ analysis of the groundwater samples, pH, TDS (Total dissolved solids), EC (Electrical Conductivity), DO (Dissolved Oxygen), and temperature were measured at the sample collection site using a multi-meter electrode. Thereafter, collected water samples were brought to the groundwater laboratory of IIT Roorkee for further analysis to determine its quality for domestic purposes.

7.1 Groundwater Quality for Pre-monsoon 2023 Season

The groundwater sampling for the pre-monsoon season was undertaken during April 25 – 30, 2023. Salient details such as sample code, station name, location, and type of analysis for which groundwater samples were collected are given in Table 25. The geographical location of groundwater sampling points during the pre-monsoon 2023 season is shown in Figure 17.

Table 25. Location of collected groundwater samples in the study area during the pre-monsoon period (April 2023) for In-situ/Ex-situ analyses.

S.No.	Code	Latitude	Longitude	Station Name	Type of Analysis	Type of Site
1	KHR-1	22.07775	75.83155	Vill. Dalchi	In-situ and Ex-situ	Hand pump
2	KHR-2	22.0609	75.7653	Vill. Bhatyaan Khurd	In-situ and Ex-situ	Hand pump
3	KHR-3	22.06926	75.85789	Near NTPC opp Bhilal Baba Temple, Gate No. 1	In-situ and Ex-situ	Hand pump
4	KHR-4	22.0688	75.86202	Between NTPC & Township	In-situ and Ex-situ	Hand pump
5	KHR-5	22.12494	75.8952	Inside Primary School, Vill Baddgaon	In-situ and Ex-situ	Hand pump
6	KHR-6	22.12242	75.84251	Opp. Madhya Pradesh Gramin Bank, Vill Kanapur	In-situ and Ex-situ	Hand pump
7	KHR-7	22.1235	75.794	In House of sh. Daya Ram, Vill Londhi (Jhirbar)	In-situ and Ex-situ	Hand pump
8	KHR-8A	22.10271	75.75548	Karan Gangle Handpump, Pipalgone village.	In-situ and Ex-situ	Hand pump
9	KHR-9A	22.10857	75.75845	Lokesh Rathore Tubewell, Pipalgaon	In-situ and Ex-situ	Tube well
10	KHR-10A	22.04086	75.81116	Near Roop Singh house, Bhopada	In-situ and Ex-situ	Hand pump

11	KHR-11	22.00759	75.85122	Near KHR 12, Hanuman Temple, Padaliya village	In-situ and Ex-situ	Hand pump
12	KHR-12	22.00728	75.85394	Padaliya village	In-situ and Ex-situ	Hand pump
13	KHR-13	22.06608	75.87139	Adjoining of NTPC Community Centre	In-situ and Ex-situ	Hand pump
14	KHR-14	22.0493	75.87783	Opp Gram Panchayat office. Vill Kheri Bujurg	In-situ and Ex-situ	Hand pump
15	KHR-15	22.06923	75.85798	Near Bhilal Baba Temple, Near NTPC Gate No. 1	In-situ and Ex-situ	Hand pump
16	KHR-17	22.06947	75.85227	Below Tower Line, North side of Power station,	In-situ and Ex-situ	Seepage
17	KHR-18	22.06295	75.85256	Well inside power station	In-situ and Ex-situ	Open well
18	KHR-19	22.07518	75.82482	Near Baba Ramdev Mandir, Dalchi	In-situ and Ex-situ	Hand pump
19	KHR-20	22.09205	75.84918	Below Tower Line, North side of Power station,	In-situ and Ex-situ	Hand pump
20	KHR-25	22.02839	75.89527	Rewa Gurjar Dharamshala, Umaria	In-situ and Ex-situ	Hand pump
21	KHR-Pz1	22.07826	75.8367	Piezometer 1, Ash Dyke	In-situ and Ex-situ	Piezometer
22	KHR-Pz2	22.07721	75.83306	Piezometer 1, Ash Dyke	In-situ and Ex-situ	Piezometer
23	KHR-Pz3	22.07476	75.83177	Piezometer 1, Ash Dyke	In-situ and Ex-situ	Piezometer
24	KHR-Pz4	22.07289	75.83233	Piezometer 1, Ash Dyke	In-situ and Ex-situ	Piezometer
25	KHR-Pz5	22.07055	75.83277	Piezometer 1, Ash Dyke	In-situ and Ex-situ	Piezometer
26	KHR-Pz6	22.07089	75.83548	Piezometer 1, Ash Dyke	In-situ and Ex-situ	Piezometer

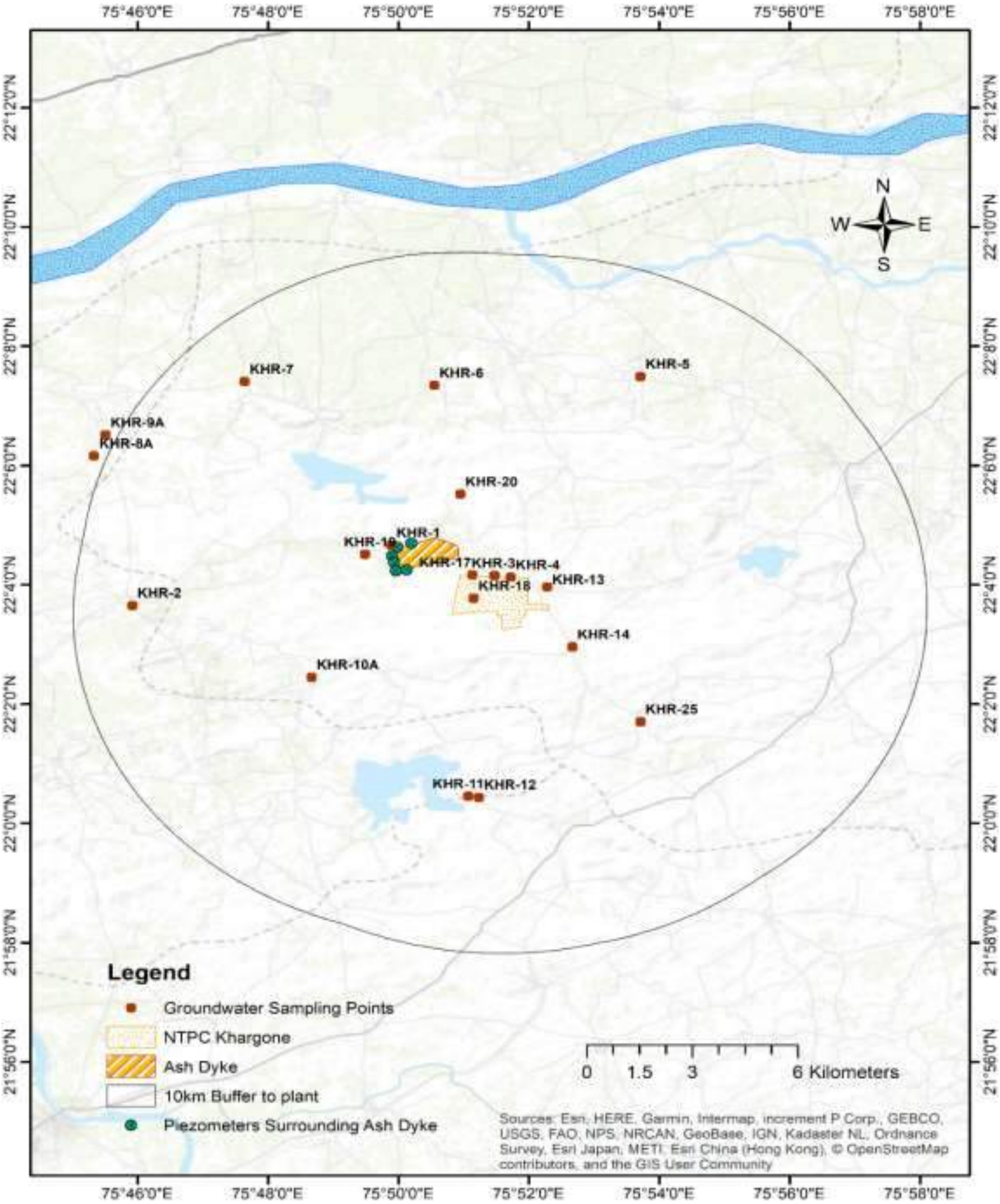


Figure 17. Groundwater sampling points during the pre-monsoon 2023 season.

The mean value of in-situ parameters for the pre-monsoon period is listed in Table 26. The DO concentrations ranged from 1.1 mg/L to 5.9 mg/L, with a mean value of 3.2 mg/L. TDS concentrations range from 230 mg/L to 730 mg/L in the pre-monsoon period, with an average value of 466.6 mg/L. The EC concentration ranged from 470 µs/cm to 1460 µs/cm, with an average value of 940 µs/cm. The pH value ranged between 5.7-8, with an average value of 7 in the pre-monsoon period. The temperature of groundwater in pre-monsoon ranged from 28.6°C to 32.8°C with an average value of 30.5°C. The Hardness ranged from 57.6 mg/L to 789.9 mg/L in the pre-monsoon period, with an average of 511.3 mg/L.

Table 26. Measured values of physical parameters (DO, TDS, EC, pH, Hardness and Temperature) in the groundwater samples during the pre-monsoon 2023 season from In-situ analysis.

S.No.	Code	DO (mg/L)	TDS (mg/L)	EC (µS/cm)	pH	Temp (°C)	Hardness
1	KHR-1	3.35	630	1260	6.74	31.3	**657**
2	KHR-2	1.5	540	1090	**5.65**	31.7	433
3	KHR-3	2.84	480	980	6.98	30.7	511
4	KHR-4	5.88	320	650	7.16	28.9	395
5	KHR-5	1.14	300	610	8.03	31	58
6	KHR-6	2.85	520	1030	6.74	29.1	**635**
7	KHR-7	1.6	410	820	6.91	29.8	569
8	KHR-8A	2.59	230	470	6.9	32.1	245
9	KHR-9A	4.29	410	840	6.97	31.3	325
10	KHR-10A	1.46	260	530	7.37	32.8	272
11	KHR-11	3.36	355	650	7.23	32.3	303
12	KHR-12	3.51	380	700	6.83	29.3	204
13	KHR-13	1.41	440	880	6.91	32.4	**606**
14	KHR-14	4.25	450	920	6.68	29.9	433
15	KHR-15	3.8	440	900	6.98	31.8	542
16	KHR-17	4.79	480	970	7.05	29.8	**698**
17	KHR-18	5.58	690	1390	7.16	29	**778**
18	KHR-19	1.94	570	1140	6.98	30	246
19	KHR-20	2.8	390	800	6.78	31.8	**623**
20	KHR-25	2.19	600	1210	6.65	30.1	**790**
21	KHR-Pz1	4.72	407	920	6.98	28.7	**747**
22	KHR-Pz2	3.03	620	1250	7.11	29.7	**627**
23	KHR-Pz3	3.16	730	1460	7.11	29	521
24	KHR-Pz4	4.36	430	870	7.7	28.6	**723**
25	KHR-Pz5	2.88	480	960	6.64	30.4	**691**
26	KHR-Pz6	3.82	570	1140	6.78	31.4	**663**
BIS Limits (IS:10500-2012)	**AL**	**NS**	**500**	**NS**	**6.5-8.5**	**NS**	**200**
	PL		**2000**		**NR**		**600**

Notations: NS-Not specified; NR-No relaxation; ND- Not Detected; AL-Acceptable Limit; PL-Permissible Limit; BDL: Below detection limit

Concentrations of major ions and other elements measured in groundwater samples and their comparison with BIS limits for the pre-monsoon season are shown in Table 27. The concentration of F- ranged from 0.3 mg/L to 3.3 mg/L, with an average value of 0.6 mg/L. Only one sample collected from inside the primary school in the village of Baddgaon showed an elevated level of fluoride. This might be due to the presence of traces of substances or minerals that include fluoride. These substances may be released into the groundwater when they are burned (coal) or dissolved (rock). The concentration of Cl- ranged from 16.4 mg/L to 125.4 mg/L, with an average value of 59.8 mg/L. NO_3- levels ranged from BDL mg/L to 139.7 mg/L, with an average of 36.1 mg/L. Out of 26 samples, approximately 34% of the samples have increased nitrate levels. This could be a result of heavy usage of nitrogenous fertilisers by local farmers, which leak into the groundwater table. SO_4^{2}- levels ranged from 19.6 mg/L to 996.8 mg/L, with an average of 312.7 mg/L. About 31% of the samples showed elevated levels of SO_4^{2}-. This could be a result of SO_4^{2}- spontaneously entering groundwater as a result of mineral disintegration from geological formations. Also, anthropogenic activities, such as the use of sulphate-based fertilisers or animal waste, can add sulphate to the soil, which eventually reaches the groundwater table through leaching or runoff might be the possible reasons for elevated SO_4^{2}- concentration in the study area. In the pre-monsoon season, the Ca2+ concentration ranged from 13.6 mg/L to 241 mg/L, averaging 151.6 mg/L. Likewise, K+ concentration ranged from 0.33 mg/L to 13.06 mg/L, with a mean value of 2.25 mg/L. The Mg concentration ranged from 3.42 mg/L to 72.21 mg/L, with an average value of 32.25 mg/L. Na values varied between 1.46-149.2 mg/L with a mean value of 84.4 mg/L in the pre-monsoon season. The concentration of HCO_3- varied between 91-546 mg/L with a mean value of 309.5 mg/L.

The mean concentration of heavy metals in the collected groundwater samples and their comparison with BIS limits are listed in Table 28. The concentration of arsenic (As) ranged from 0.005 ppm to 0.010 ppm, with a mean value of 0.006 ppm. Mercury (Hg) was not detected in any groundwater sample in the current pre-monsoon 2023 season. Pb levels ranged from 0.001 to 0.008 ppm, averaging 0.002 ppm. The rest of the elements, such as Cd (BDL-0.001), Cr (0.006-0.015), Cu (0.029-0.116), Zn (0.07-

1.002), Se (BDL-0.015), and Fe (0.007-4.97) varied with average values of 0.001, 0.008, 0.04, 0.23, 0.003, and 0.47 ppm, respectively. About 29% of the groundwater samples showed an elevated concentration of Fe in the present study area. This may be due to localized corrosion in the casing pipes of hand pumps. Moreover, natural geological processes may also be attributed to the release of iron into groundwater from iron-bearing minerals and rocks in the study area.

Table 27. Mean concentration (in mg/L) of major ions in Groundwater samples and their comparison with BIS limits during pre-monsoon 2023 season.

Sr. No.	Code	F^-	Cl^-	Br^-	NO_3^-	PO_4^-	SO_4^{2-}	Ca	K	Mg	Na	CO_3^-	HCO_3^-
1	KHR-1	0.3	71.1	ND	5.4	ND	**803**	185	1	47.3	36.1	ND	245
2	KHR-2	0.5	85.1	ND	41.4	ND	57.6	133.5	13.1	24.3	125.0	ND	91
3	KHR-3	0.6	72.6	ND	13.2	ND	**414.1**	142.8	0.5	37.5	86.2	ND	170
4	KHR-4	0.5	50.1	ND	34.4	ND	219.8	111	0.7	28.6	34.8	ND	254
5	KHR-5	**3.3**	48.8	ND	12.4	ND	98.9	17.4	0.9	3.4	135.7	ND	312
6	KHR-6	0.5	72.7	ND	**111.8**	ND	131.8	164.8	7.7	54.2	88.7	ND	546
7	KHR-7	0.4	42.3	ND	**63.0**	ND	68.3	168.8	1.4	35.7	41.8	ND	390
8	KHR-8A	0.5	18.6	ND	22.5	ND	19.6	69.2	0.3	17.6	74.4	ND	267
9	KHR-9A	0.4	71.7	ND	**65.4**	ND	53.5	70	0.9	36.5	91.5	ND	379
10	KHR-10A	0.5	38.9	ND	32.2	ND	67.6	98.7	0.7	6.3	123.5	ND	395
11	KHR-11	0.6	24.3	ND	**63.0**	ND	60.8	76.8	3	27	1.5	ND	410
12	KHR-12	0.7	16.4	ND	**62.7**	ND	48.6	13.6	1.1	41.2	45.5	ND	405
13	KHR-13	0.5	30.6	ND	12.4	ND	135.8	209.2	1.3	20.2	131.8	ND	315
14	KHR-14	0.9	62.3	ND	**139.7**	ND	47.2	115	0.7	35.3	39.9	ND	290
15	KHR-15	0.6	58.7	ND	**58.2**	ND	284.7	189	0.8	17.1	120.3	ND	265
16	KHR-17	0.6	100.4	ND	7.7	ND	**429.5**	212.5	2.2	40.7	104.0	ND	220
17	KHR-18	0.6	39.7	ND	15.8	ND	**921.1**	192.6	0.3	72.2	67.8	ND	324
18	KHR-19	0.5	78.6	ND	6.2	ND	**787.3**	75.4	3.1	14	149.2	ND	345
19	KHR-20	0.4	43.6	ND	**45.7**	ND	117.9	195.8	0.6	32.5	68.9	ND	416
20	KHR-25	0.3	43.9	ND	**75.2**	ND	56.6	225.6	5	55	134.1	ND	110
21	KHRPz-1	0.4	125.4	ND	27.6	ND	116.7	241	1.6	35.4	60.8	ND	415
22	KHRPz-2	0.3	72.5	ND	1.4	ND	**996.8**	202	0.9	29.7	80.0	ND	286
23	KHRPz-3	0.3	68.0	ND	4.8	ND	**983.7**	190.1	1.1	11.2	126.1	ND	315
24	KHRPz-4	0.8	86.3	ND	ND	ND	**585.5**	222	7.3	41	87.2	ND	264
25	KHRPz-5	0.5	46.1	ND	ND	ND	187.2	235.7	1.8	24.7	101.2	ND	324
26	KHRPz-6	0.4	86.1	ND	16.4	ND	**436.2**	183.4	0.6	49.8	38.5	ND	295
BIS limits (IS:10500-2012)	**AL**	**1**	**250**	**NS**	**45**	**NS**	**200**	**75**	**NS**	**30**	**NS**	**NS**	**NS**
	PL	**1.5**	**1000**		**NR**		**400**	**200**		**100**			

Notations: NS-Not specified; NR-No relaxation; ND- Not Detected; AL-Acceptable Limit; PL-Permissible Limit; BDL: Below detection limit

About 46% of groundwater samples show hard water quality. This might be due to the presence of excess Ca and Mg concentration in the groundwater samples. Only one sample collected from the village of Bhatyaan Khurd has the lowest pH value. This might be due to any mineral dissolution or leaching of surface water. Overall, the groundwater quality in the pre-monsoon season is suitable for domestic use, indicating that it meets the standards and requirements necessary to provide safe and clean water for households.

Table 28. Mean concentration (in ppm) of heavy metals in the groundwater samples and their comparison with BIS limits during the pre-monsoon 2023 season.

S. No.	Code	As	Hg	Pb	Cd	Cr	Cu	Zn	Se	Fe
1	KHR-1	0.008	ND	0.002	0.001	0.01	0.04	0.97	ND	**0.39**
2	KHR-2	0.005	ND	0.002	0.001	0.01	0.04	0.98	ND	**1.35**
3	KHR-3	0.007	ND	0.002	0.001	0.01	0.03	0.16	ND	0.08
4	KHR-4	0.005	ND	0.002	0.001	0.01	0.03	0.07	ND	0.13
5	KHR-5	0.010	ND	0.002	BDL	0.01	0.04	0.15	ND	**0.52**
6	KHR-6	0.005	ND	0.002	BDL	0.01	0.05	0.13	ND	**0.36**
7	KHR-7	0.006	ND	0.001	0.001	0.01	0.03	0.14	ND	0.27
8	KHR-8A	0.008	ND	0.002	0.001	0.01	0.04	0.21	0.01	0.23
9	KHR-9A	0.009	ND	0.002	0.001	0.01	0.04	0.15	0.01	0.13
10	KHR-10A	0.008	ND	0.002	0.001	0.01	0.04	0.23	**0.02**	**0.38**
11	KHR -11	0.006	ND	0.002	0.001	0.01	0.04	0.08	ND	0.15
12	KHR -12	0.006	ND	0.002	BDL	0.01	0.03	0.09	ND	0.18
13	KHR -13	0.006	ND	0.002	0.001	0.01	0.04	0.13	0.01	0.09
14	KHR -14	0.006	ND	0.002	0.001	0.01	0.07	0.48	ND	0.21
15	KHR -15	0.005	ND	0.002	0.001	0.01	0.03	0.13	0.01	0.17
16	KHR-17	0.006	ND	0.002	BDL	0.01	0.03	0.08	ND	0.17
17	KHR-18	0.006	ND	0.002	0.001	0.01	0.03	0.07	ND	0.20
18	KHR-19	0.006	ND	0.002	0.001	0.01	0.03	0.08	ND	0.12
19	KHR-20	0.006	ND	0.002	0.001	0.01	0.03	0.11	ND	0.10
20	KHR-25	0.007	ND	0.005	0.001	0.01	0.06	1.00	ND	**4.97**
21	KHR PZ-1	0.006	ND	0.003	0.001	0.01	0.03	0.09	ND	0.13
22	KHR PZ-2	0.006	ND	0.002	0.001	0.01	0.04	0.07	ND	0.13
23	KHR PZ-3	0.006	ND	0.002	0.001	0.01	0.03	0.11	ND	0.17
24	KHR PZ-4	0.007	ND	0.005	0.001	0.02	0.03	0.13	ND	**0.33**
25	KHR PZ-5	0.007	ND	0.008	0.001	0.01	0.12	0.10	ND	**0.98**
26	KHR PZ-6	0.006	ND	0.002	0.001	0.01	0.03	0.09	ND	0.20
BIS (IS:10500-2012)	**AL**	**0.01**	**0.001**	**0.01**	**0.003**	**0.05**	**0.05**	**5**	**0.01**	**0.3**
	PL	**0.05**	**NR**	**NR**	**NR**	**NR**	**1.5**	**15**	**NR**	**NR**

Notations: NS-Not specified; NR-No relaxation; ND- Not Detected; AL-Acceptable Limit; PL-Permissible Limit; BDL: Below detection limit

7.2 Groundwater Quality for Post-monsoon 2023 Season

The groundwater sampling for the post-monsoon 2023 season was undertaken during October 9 – 13, 2023. Salient details such as sample code, station name, location, and type of analysis for which groundwater samples were collected are given in Table 29.

Table 29. Location of collected groundwater samples in the study area during the post-monsoon 2023 season for In-situ/Ex-situ analyses.

S.No.	Code	Latitude	Longitude	Station Name	Type of Analysis	Type of Site
1	KHR-1	22.07775	75.83155	Vill. Dalchi	In-situ and Ex-situ	Hand pump
2	KHR-2	22.0609	75.7653	Vill. Bhatyaan Khurd	In-situ and Ex-situ	Hand pump
3	KHR-3	22.06926	75.85789	Near NTPC opp Bhilal Baba Temple, Gate No. 1	In-situ and Ex-situ	Hand pump
4	KHR-4	22.0688	75.86202	Between NTPC & Township	In-situ and Ex-situ	Hand pump
5	KHR-5	22.12494	75.8952	Inside Primary School, Vill Baddgaon	In-situ and Ex-situ	Hand pump
6	KHR-6	22.12242	75.84251	Opp. Madhya Pradesh Gramin Bank, Vill Kanapur	In-situ and Ex-situ	Hand pump
7	KHR-7	22.1235	75.794	In House of sh. Daya Ram, Vill Londhi (Jhirbar)	In-situ and Ex-situ	Hand pump
8	KHR-8A	22.10271	75.75548	Karan Gangle Handpump, Pipalgone village.	In-situ and Ex-situ	Hand pump
9	KHR-9A	22.10857	75.75845	Lokesh Rathore Tubewell, Pipalgaon	In-situ and Ex-situ	Tube well
10	KHR-10A	22.04086	75.81116	Near Roop Singh house, Bhopada	In-situ and Ex-situ	Hand pump
11	KHR-11	22.00759	75.85122	Near KHR 12, Hanuman Temple, Padaliya village	In-situ and Ex-situ	Hand pump
12	KHR-12	22.00728	75.85394	Padaliya village	In-situ and Ex-situ	Hand pump
13	KHR-13	22.06608	75.87139	Adjoining of NTPC Community Centre	In-situ and Ex-situ	Hand pump
14	KHR-14	22.0493	75.87783	Opp Gram Panchayat office. Vill Kheri Bujurg	In-situ and Ex-situ	Hand pump
15	KHR-15	22.06923	75.85798	Near Bhilal Baba Temple, Near NTPC Gate No. 1	In-situ and Ex-situ	Hand pump
16	KHR-17	22.06947	75.85227	Below Tower Line, North side of Power station,	In-situ and Ex-situ	Seepage
17	KHR-18	22.06295	75.85256	Well inside power station	In-situ and Ex-situ	Open well
18	KHR-19	22.07518	75.82482	Near Baba Ramdev Mandir, Dalchi	In-situ and Ex-situ	Hand pump
19	KHR-20	22.09205	75.84918	Below Tower Line, North side of Power station,	In-situ and Ex-situ	Hand pump
20	KHR-25	22.02839	75.89527	Rewa Gurjar Dharamshala, Umaria	In-situ and Ex-situ	Hand pump
21	KHR-Pz1	22.07826	75.8367	Piezometer 1, Ash Dyke	In-situ and Ex-situ	Piezometer
22	KHR-Pz2	22.07721	75.83306	Piezometer 1, Ash Dyke	In-situ and Ex-situ	Piezometer
23	KHR-Pz3	22.07476	75.83177	Piezometer 1, Ash Dyke	In-situ and Ex-situ	Piezometer
24	KHR-Pz4	22.07289	75.83233	Piezometer 1, Ash Dyke	In-situ and Ex-situ	Piezometer
25	KHR-Pz5	22.07055	75.83277	Piezometer 1, Ash Dyke	In-situ and Ex-situ	Piezometer
26	KHR-Pz6	22.07089	75.83548	Piezometer 1, Ash Dyke	In-situ and Ex-situ	Piezometer

The mean value of in-situ parameters for the post-monsoon period is listed in Table 30. The DO concentrations ranged from 1.35 mg/L to 6.58 mg/L, with a mean value of 2.9 mg/L. TDS concentrations range from 225 mg/L to 1060 mg/L in the post-monsoon period, with an average value of 452.7 mg/L. The EC concentration ranged from 460 µs/cm to 2140 µs/cm, with an average value of 913.8 µs/cm. The pH value ranged between 6.85 -7.98, with an average value of 7.2 in the post-monsoon period. The temperature of groundwater in post-monsoon ranged from 27.7°C to 32.9°C with an average value of 30.3°C. The Hardness ranged from 29 mg/L to 870 mg/L in the pre-monsoon period, with an average of 390 mg/L.

Table 30. Measured values of physical parameters (DO, TDS, EC, pH, Hardness and Temperature) in the groundwater samples during the post-monsoon 2023 season from In-situ analysis.

S.No.	Code	DO (mg/L)	TDS (mg/L)	EC (µS/cm)	pH	Temp (°C)	Hardness
1	KHR-1	2.9	590	1160	6.9	29.1	625
2	KHR-2	1.9	470	950	7.1	29.3	549
3	KHR-3	3.6	460	940	7.34	30.3	245
4	KHR-4	6.58	490	1000	7.63	27.7	406
5	KHR-5	1.9	280	570	7.98	29.4	29
6	KHR-6	2.2	550	1130	7.1	28.4	457
7	KHR-7	1.9	420	850	6.9	31.3	397
8	KHR-8A	2.7	225	460	7.1	30.4	120
9	KHR-9A	3.9	410	820	7.04	32.9	375
10	KHR-10A	1.7	275	550	7.3	30.2	234
11	KHR-11	2.18	350	720	7.6	32.3	155
12	KHR-12	2.96	360	750	7.02	30.1	330
13	KHR-13	1.9	550	1100	7.24	30.7	620
14	KHR-14	2.82	590	1190	6.9	32.1	435
15	KHR-15	4.1	410	850	7.1	29.4	491
16	KHR-17	4.97	470	960	7.3	29.3	297
17	KHR-18	4.23	270	550	7.34	31.8	736
18	KHR-19	2.3	540	1020	7.21	28.21	253
19	KHR-20	3.1	430	870	6.9	32.1	365
20	KHR-25	1.35	510	1020	7.18	30.9	331
21	KHR-Pz1	3.6	400	810	7.52	29.1	332
22	KHR-Pz2	2.3	1060	2140	7.08	29.2	793
23	KHR-Pz3	2.6	270	550	7.42	29.9	230
24	KHR-Pz4	1.6	770	1550	7.28	30.1	871
25	KHR-Pz5	2.7	350	700	6.85	30.8	341
26	KHR-Pz6	3.7	270	550	7.34	31.8	135
BIS Limits (IS:10500-2012)	**AL**	**NS**	**500**	**NS**	**6.5-8.5**	**NS**	**200**
	PL		**2000**		**NR**		**600**

Notations: NS-Not specified; NR-No relaxation; ND- Not Detected; AL-Acceptable Limit; PL-Permissible Limit; BDL: Below detection limit

Concentrations of major ions and other elements measured in groundwater samples and their comparison with BIS limits during the post-monsoon 2023 season are listed in Table 31. The concentration of F^- ranged from BDL to 7.6 mg/L, with an average value of 0.9 mg/L. The concentration of Cl^- ranged from 50 mg/L to 439.9 mg/L, with an average value of 147.8 mg/L. NO_3^- levels ranged from BDL mg/L to 206 mg/L, with an average of 60.9 mg/L. SO_4^{2-} levels ranged from BDL to 284.7 mg/L, with an average of 82.9 mg/L. In the post -monsoon season, the Ca^{2+} concentration ranged from 8.4 mg/L to 215.8 mg/L, averaging 104.2 mg/L. Likewise, K^{+} concentration ranged from 0.02 mg/L to 26.85 mg/L, with a mean value of 1.9 mg/L. The Mg concentration ranged from 1.95 mg/L to 80.55 mg/L, with an average value of 31.6 mg/L. Na values varied between 49.35-300.15 mg/L with a mean value of 141.4 mg/L in the post-monsoon season. The concentration of HCO_3^- varied between 110-455 mg/L with a mean value of 286.2 mg/L.

The mean concentration of heavy metals in the collected groundwater samples and their comparison with BIS limits 10500:2012 during the post-monsoon 2023 season is listed in Table 32. The concentration of arsenic (As) ranged from BDL to 0.004 ppm with a mean value of 0.001 ppm. The concentration of Mercury (Hg) ranged from BDL to 0.012 ppm with a mean value of 0.001 ppm. Pb level ranged from BDL to 0.024 ppm with an average of 0.004 ppm. The rest of the elements, such as Cd (BDL-0.007), Cr (BDL-0.151), Cu (BDL-0.037), Zn (BDL- 0.707), Se (BDL-0.011), and Fe (BDL-0.837) varied with average values of 0.002, 0.024, 0.008, 0.113, 0.001, and 0.255 ppm, respectively.

Table 31. Mean concentration (in mg/L) of major ions in Groundwater samples and their comparison with BIS limits of IS 10500:2012 during post-monsoon 2023 season.

Sr. No.	Code	F^-	Cl^-	Br^-	NO_3^-	PO_4^-	SO_4^{2-}	Ca	K	Mg	Na	CO_3^-	HCO_3^-
1	KHR-1	0.3	140	ND	20.5	ND	199.3	158	1.2	55.95	49.4	ND	210
2	KHR-2	0.7	210	ND	62.1	ND	42.1	147	0.9	44.1	93.3	ND	110
3	KHR-3	0.7	100	ND	22.6	ND	142	70.35	26.85	16.95	237.3	ND	165
4	KHR-4	BDL	120	ND	BDL	ND	BDL	99.45	1.05	38.25	85.1	ND	250
5	KHR-5	**7.6**	150	ND	10	ND	27	8.4	1.5	1.95	270.3	ND	295
6	KHR-6	0.4	150	ND	86.5	ND	30.9	97.05	9.3	52.05	120.8	ND	455
7	KHR-7	0.6	80	ND	79.3	ND	14.2	101.4	1.5	34.95	64.7	ND	350
8	KHR-8A	0.7	50	ND	16.5	ND	5.7	43.65	0.9	2.7	141.3	ND	265
9	KHR-9A	0.3	90	ND	135.4	ND	17	94.65	1.05	33.6	104.7	ND	310
10	KHR-10A	0.7	120	ND	94.4	ND	47.1	71.1	0.9	13.65	218.4	ND	410
11	KHR-11	0.6	100	ND	48.4	ND	7.9	53.55	0.09	5.1	284.6	ND	390
12	KHR-12	0.4	70	ND	118.9	ND	42.4	77.4	1.8	33.15	73.2	ND	375
13	KHR-13	0.6	180	ND	187.5	ND	75.2	190.1	2.55	35.4	171	ND	290
14	KHR-14	0.5	180	ND	200.6	ND	58.5	105.6	0.06	41.55	72.8	ND	275
15	KHR-15	0.4	65	ND	45	ND	284.7	145	0.2	31.2	96.4	ND	245
16	KHR-17	0.6	140	ND	26.5	ND	65.4	91.8	0.03	16.5	54.6	ND	245

17	KHR-18	**1.6**	160	ND	54	ND	197.7	180.7	0.03	69.15	97.8	ND	310
18	KHR-19	0.5	100	ND	14.6	ND	184.6	82.4	0.11	11.4	300.2	ND	290
19	KHR-20	0.3	140	ND	101.8	ND	184.6	96.3	0.03	30.3	100.4	ND	390
20	KHR-25	0.8	140	ND	100.2	ND	59	88.95	0.12	26.4	287	ND	150
21	KHRPz-1	0.4	360	ND	25.7	ND	41.5	92.55	0.08	24.45	98.4	ND	310
22	KHRPz-2	0.3	120	ND	12.2	ND	31.1	196.1	0.04	73.65	115.7	ND	310
23	KHRPz-3	0.5	440	ND	16.1	ND	188	71.4	0.06	12.45	77.1	ND	290
24	KHRPz-4	**2.9**	160	ND	15.4	ND	12.4	215.8	0.13	80.55	210.8	ND	245
25	KHRPz-5	0.7	120	ND	72	ND	163.9	87.9	0.06	29.55	71.4	ND	265
26	KHRPz-6	0.6	160	ND	16	ND	34	42.3	0.02	7.05	180.5	ND	240
BIS limits	**AL**	**1**	**250**	**NS**	**45**	**NS**	**200**	**75**	**NS**	**30**	**NS**	**NS**	**NS**
(IS:10500-2012)	**PL**	**1.5**	**1000**		**NR**		**400**	**200**		**100**			

Notations: NS-Not specified; NR-No relaxation; ND- Not Detected; AL-Acceptable Limit; PL-Permissible Limit; BDL: Below detection limit

Table 32. Mean concentration (in ppm) of heavy metals in the groundwater samples and their comparison with BIS limits 10500:2012 during post-monsoon 2023 season

S.No.	Code	As	Hg	Pb	Cd	Cr	Cu	Zn	Se	Fe
1	KHR-1	0.002	0.004	0.003	0.003	0.02	0.005	0.46	BDL	0.18
2	KHR-2	0.001	0.001	0.002	0.004	0.02	0.006	0.06	0.002	0.15
3	KHR-3	0.001	BDL	0.003	0.002	0.02	0.010	0.71	0.002	0.43
4	KHR-4	0.001	BDL	0.003	0.002	0.02	0.004	0.06	BDL	0.25
5	KHR-5	0.004	BDL	0.003	0.002	0.02	0.003	0.02	BDL	0.45
6	KHR-6	0.001	0.012	BDL	0.007	0.15	0.015	BDL	0.001	0.53
7	KHR-7	0.001	BDL	0.005	0.002	0.02	0.013	0.02	BDL	0.26
8	KHR-8A	0.001	BDL	0.002	0.001	0.02	0.004	0.06	0.011	0.34
9	KHR-9A	0.001	BDL	0.004	0.002	0.02	0.009	0.01	BDL	0.20
10	KHR-10A	0.001	BDL	0.003	0.002	0.02	0.004	0.55	0.005	0.29
11	KHR -11	0.001	BDL	0.003	0.002	0.02	0.005	BDL	BDL	0.17
12	KHR -12	0.001	BDL	0.003	0.002	0.02	0.008	0.01	BDL	0.21
13	KHR -13	0.002	BDL	0.003	0.002	0.02	0.007	BDL	BDL	0.19
14	KHR -14	0.001	BDL	0.002	0.002	0.02	0.037	0.43	BDL	0.25
15	KHR -15	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
16	KHR-17	0.001	BDL	0.002	0.002	0.02	0.002	BDL	BDL	0.21
17	KHR-18	0.001	BDL	0.003	0.003	0.02	0.005	BDL	BDL	0.21
18	KHR-19	0.001	0.002	0.002	0.002	0.02	0.005	BDL	BDL	0.20
19	KHR-20	0.001	BDL	0.002	0.001	0.02	0.004	0.04	BDL	0.26
20	KHR-25	0.001	BDL	0.003	0.002	0.02	0.007	0.45	BDL	0.84
21	KHR PZ-1	0.001	BDL	0.024	0.002	0.02	0.011	0.05	0.001	0.18
22	KHR PZ-2	0.001	BDL	0.002	0.001	0.02	0.004	0.01	BDL	0.16
23	KHR PZ-3	0.001	BDL	0.010	0.002	0.02	0.009	BDL	BDL	0.15
24	KHR PZ-4	0.001	BDL	0.009	0.001	0.02	0.005	BDL	0.002	0.23
25	KHR PZ-5	0.001	BDL	0.003	0.001	0.02	0.014	BDL	BDL	0.16
26	KHR PZ-6	0.001	BDL	0.008	0.001	0.02	0.007	BDL	0.009	0.14
BIS	**AL**	**0.01**	**0.001**	**0.01**	**0.003**	**0.05**	**0.05**	**5**	**0.01**	**0.3**
(IS:10500-2012)	**PL**	**0.05**	**NR**	**NR**	**NR**	**NR**	**1.5**	**15**	**NR**	**NR**

Notations: NS-Not specified; NR-No relaxation; ND- Not Detected; AL-Acceptable Limit; PL-Permissible Limit; BDL: Below detection limit

7.3 Groundwater Quality for Pre-monsoon 2024 Season

The groundwater sampling for the pre-monsoon season was undertaken May 5 – 9, 2024. The mean value of in-situ parameters for the pre-monsoon period is listed in Table 33. The DO concentrations ranged from 1.80 mg/L to 7.01 mg/L, with a mean value of 4.15 mg/L. TDS concentrations range from 280mg/L to 950mg/L in the pre-monsoon period, with an average value of 531.82mg/L. The EC concentration ranged from 0.58 ms/cm to 1.91 ms/cm, with an average value of 1.07 ms/cm. The pH value ranged between 7.07 to 8.32, with an average value of 7.46 in the pre-monsoon period. The temperature of groundwater in pre-monsoon ranged from 28.30 to 34.80°C with an average value of 30.60 °C. The Hardness ranged from 64 mg/L to 788 mg/L in the pre-monsoon period, with an average of 483.09 mg/L. Concentrations of major ions and other elements measured in groundwater samples and their comparison with BIS limits for the pre-monsoon season are shown in Table 34. The concentration of F- ranged from 0.000mg/L to 0.887mg/L, with an average value of 0.276 mg/L. The concentration of Cl- ranged from 16.59mg/L to 113.70mg/L, with an average value of 53.16 mg/L. NO_3^- levels ranged from 1.55mg/L to 85.64 mg/L, with an average of 25.13mg/L. Out of 23 samples, approximately 9.96% of the samples have increased nitrate levels. This could be a result of heavy usage of nitrogenous fertilisers by local farmers, which leak into the groundwater table. SO_4^{2-} levels ranged from 12.35mg/L to 811.67mg/L, with an average of 165.93mg/L. About 9.96% of the samples showed elevated levels of SO_4^{2-}. This could be a result of SO_4^{2-} spontaneously entering groundwater as a result of mineral disintegration from geological formations. Also, anthropogenic activities, such as the use of sulphate-based fertilisers or animal waste, can add sulphate to the soil, which eventually reaches the groundwater table through leaching or runoff might be the possible reasons for elevated SO_4^{2-} concentration in the study area. In the pre-monsoon season, the Ca^{2+} concentration ranged from 0.00 mg/L to 196.65mg/L, averaging 87.72mg/L. Likewise, K^+ concentration ranged from 0.30mg/L to 10.80mg/L, with a mean value of 1.81 mg/L. The Mg concentration ranged from 3.45mg/L to 66.00 mg/L, with an average value of 32.56 mg/L. Na values varied between 12.45 to 68.70 mg/L with a mean value of 27.44 mg/L in the pre-monsoon season. The concentration of HCO^{3-} varied between 98 to 528 mg/L with a mean value of 315 mg/L. The mean concentration of heavy metals in the collected groundwater samples and their comparison with BIS limits are listed in Table 35. The concentration of arsenic (As) ranged from 0.000 ppm to 0.003 ppm, with a mean value of 0.001ppm. Mercury (Hg) was not detected in any groundwater sample in the current pre-monsoon 2024 season. Pb levels ranged from 0.002 to 0.003 ppm, averaging 0.002ppm. The rest of the elements, such as Cd (BDL-0.001), Cr (0.0007-0.0015), Cu (0.018-0.04), Zn (0.000-0.241), Se (BDL-0.014), and Fe (0.067-0.769) varied with average values of 0.001, 0.001, 0.031, 0.030, 0.002, and 0.122ppm, respectively. Overall, the groundwater quality in the pre-monsoon season is suitable for domestic use, indicating that it meets the standards and requirements necessary to provide safe and clean water for households.

Table 33. Measured values of physical parameters (DO, TDS, EC, pH, Hardness and Temperature) in the groundwater samples during the pre-monsoon. May 2024 season from In-situ analysis

S.No.	Code	DO (mg/L)	TDS (mg/L)	EC (mS/cm)	pH	Temp (°C)	Hardness
1	KHR-1	2.44	850	1.71	7.30	28.7	**644**
2	KHR-2	2.44	420	0.84	7.71	29.0	424
3	KHR-3	1.80	310	0.63	8.32	30.8	502
4	KHR-4	6.75	450	0.90	7.49	29.5	385
5	KHR-5	1.80	310	0.63	7.32	30.8	64
6	KHR-6	3.78	530	1.07	7.22	30.8	**624**
7	KHR-7	2.15	510	1.03	7.16	29.6	554
8	KHR-8	2.52	350	0.71	7.46	29.9	236
9	KHR-9	5.77	450	0.90	7.41	30.0	312
10	KHR-10	3.10	310	0.64	7.63	32.1	286
11	KHR-11	4.22	280	0.58	7.89	32.4	310
12	KHR-12	4.08	370	0.74	7.46	29.1	212
13	KHR-13	4.44	730	1.46	7.43	34.8	**616**
14	KHR-14	3.04	450	0.91	7.32	29.5	418
15	KHR-17	5.37	530	1.07	7.56	30.5	**718**
16	KHR-18	5.83	450	0.91	7.32	29.7	**788**
17	KHR-19	2.50	880	1.76	7.20	28.3	236
18	KHR-20	2.45	420	0.84	7.38	29.7	**646**
19	KHR-Pz1	4.65	880	1.77	7.07	31.1	**756**
20	KHR-Pz2	4.50	950	1.91	7.40	32.1	**647**
21	KHR-Pz3	6.27	590	1.19	7.61	31.0	518
22	KHR-Pz4	6.75	890	1.78	7.52	31.3	**720**
23	KHR-Pz6	7.01	640	1.29	7.29	31.1	**656**
BIS Limits	**AL**	**NS**	**500**	**NS**	**6.5-8.5**	**NS**	**200**
	PL		**2000**		**NR**		**600**

(IS:10500-2012)	

Notations: NS-Not specified; NR-No relaxation; ND- Not Detected; AL-Acceptable Limit; PL- Permissible Limit; BDL: Below detection limit

Table 34. Mean concentration (in mg/L) of major ions in Groundwater samples and their comparison with BIS limits during pre-monsoon May 2024 season

Sr. No.	Code	F^-	Cl^-	Br^-	NO_3^-	PO_4^-	SO_4^{2-}	Ca	K	Mg	Na	CO_3^-	HCO_3^-
1	KHR-1	0.00	42.92	ND	2.87	ND	121.70	**221.25**	1.05	51.75	39.15	ND	258
2	KHR-2	0.35	82.99	ND	14.70	ND	47.26	60.90	2.70	10.95	51.15	ND	98
3	KHR-3	0.25	61.13	ND	1.55	ND	**408.06**	126.45	0.75	48.15	26.25	ND	180
4	KHR-4	0.53	43.16	ND	18.83	ND	73.07	98.70	1.05	40.95	14.70	ND	244
5	KHR-5	0.89	58.99	ND	31.35	ND	135.74	21.60	0.60	9.00	47.25	ND	290
6	KHR-6	0.22	29.26	ND	42.10	ND	36.70	47.55	1.95	24.30	17.25	ND	528
7	KHR-7	0.00	71.35	ND	**82.73**	ND	40.95	105.90	1.20	40.80	13.20	ND	376
8	KHR-8	0.19	31.57	ND	9.65	ND	27.81	41.85	0.30	25.65	22.50	ND	276
9	KHR-9	0.35	76.78	ND	**72.62**	ND	62.51	84.30	0.45	32.10	28.05	ND	386
10	KHR-10	0.00	31.01	ND	33.77	ND	20.50	47.25	0.30	6.00	33.45	ND	410
11	KHR-11	0.48	34.73	ND	20.14	ND	30.96	31.05	0.60	3.45	39.45	ND	408
12	KHR-12	0.40	16.59	ND	**58.76**	ND	30.33	86.40	0.75	39.90	13.50	ND	412
13	KHR-13	0.00	26.86	ND	4.73	ND	**400.84**	136.35	0.90	17.70	68.70	ND	328
14	KHR-14	0.00	61.93	ND	**85.64**	ND	36.53	118.05	1.95	29.70	18.30	ND	288
15	KHR-17	0.52	102.02	ND	7.53	ND	366.06	108.15	1.05	40.05	25.80	ND	256
16	KHR-18	0.53	37.45	ND	2.71	ND	171.11	102.00	0.60	44.85	14.25	ND	240
17	KHR-19	0.00	66.22	ND	7.51	ND	224.49	155.70	10.80	38.25	41.85	ND	320
18	KHR-20	0.37	55.70	ND	32.18	ND	137.00	93.90	7.80	28.35	19.80	ND	344
19	KHR-Pz1	0.42	113.70	ND	1.87	ND	12.35	0.00	1.80	46.35	33.30	ND	412
20	KHR-Pz2	0.15	43.05	ND	4.19	ND	**811.67**	0.00	0.75	55.35	20.25	ND	118
21	KHR-Pz3	0.00	39.82	ND	5.01	ND	304.49	116.10	0.90	15.00	14.85	ND	422
22	KHR-Pz4	0.45	44.29	ND	4.33	ND	219.50	196.65	1.80	66.00	27.30	ND	276
23	KHR-Pz6	0.00	41.02	ND	10.95	ND	52.54	151.05	0.90	53.55	12.45	ND	318
BIS limits (IS:10500-2012)	**AL**	**1**	**250**	**NS**	**45**	**NS**	**200**	**75**	**NS**	**30**	**NS**	**NS**	**NS**
	PL	**1.5**	**1000**		**NR**		**400**	**200**		**100**			

Notations: NS-Not specified; NR-No relaxation; ND- Not Detected; AL-Acceptable Limit; PL- Permissible Limit; BDL: Below detection limit

Table 35. Mean concentration (in ppm) of heavy metals in the groundwater samples and their comparison with BIS limits during the pre-monsoon May 2024 season.

S. No.	Code	As	Hg	Pb	Cd	Cr	Cu	Zn	Se	Fe
1	KHR-1	0.001	0.0000	0.002	0.001	0.001	0.02	0.002	0.00	0.06
2	KHR-2	0.003	0.0000	0.002	0.001	0.001	0.02	0.001	0.00	0.07
3	KHR-3	0.001	0.0000	0.002	0.001	0.001	0.02	0.001	0.00	0.07
4	KHR-4	0.002	0.0000	0.002	0.001	0.001	0.02	0.001	0.00	0.07
5	KHR-5	0.003	0.0000	0.002	0.000	0.001	0.02	0.004	0.00	0.10
6	KHR-6	0.002	0.0000	0.002	0.000	0.001	0.02	0.001	0.00	0.08
7	KHR-7	0.000	0.0000	0.002	0.001	0.001	0.02	0.001	0.00	0.09
8	KHR-8	0.001	0.0000	0.002	0.001	0.001	0.03	0.001	**0.01**	0.07
9	KHR-9	0.001	0.0000	0.002	0.001	0.001	0.03	0.001	**0.01**	0.09
10	KHR-10	0.000	0.0000	0.002	0.001	0.001	0.04	0.001	**0.01**	0.08
11	KHR-11	0.001	0.0000	0.002	0.001	0.001	0.04	0.001	0.00	0.08
12	KHR-12	0.001	0.0000	0.002	0.001	0.001	0.04	0.001	0.00	0.08
13	KHR-13	0.001	0.0000	0.002	0.001	0.001	0.05	0.001	0.00	0.09
14	KHR-14	0.000	0.0000	0.002	0.001	0.001	0.04	0.001	0.00	**0.77**
15	KHR-17	0.001	0.0000	0.002	0.001	0.001	0.05	0.001	0.00	0.10
16	KHR-18	0.001	0.0000	0.002	0.001	0.001	0.02	0.001	0.00	0.10
17	KHR-19	0.001	0.0000	0.002	0.001	0.001	0.02	0.001	0.00	0.11
18	KHR-20	0.001	0.0000	0.002	0.001	0.001	0.04	0.001	0.00	0.14
19	KHR-Pz1	0.001	0.0000	0.003	0.001	0.001	0.02	0.000	0.00	0.07
20	KHR-Pz2	0.001	0.0000	0.002	0.001	0.001	0.02	0.137	0.00	0.07
21	KHR-Pz3	0.001	0.0000	0.002	0.001	0.001	0.02	0.241	0.00	0.20
22	KHR-Pz4	0.000	0.0000	0.003	0.001	0.001	0.02	0.118	0.00	0.08
23	KHR-Pz6	0.001	0.0000	0.020	0.001	0.001	0.02	0.154	0.00	0.07
BIS (IS:10500-2012)	**AL**	**0.01**	**0.001**	**0.01**	**0.003**	**0.05**	**0.05**	**5**	**0.01**	**0.3**
	PL	**0.05**	**NR**	**NR**	**NR**	**NR**	**1.5**	**15**	**NR**	**NR**

Notations: NS-Not specified; NR-No relaxation; ND- Not Detected; AL-Acceptable Limit; PL- Permissible Limit; BDL: Below detection limit

7.4 Groundwater Quality for Post-monsoon 2024 Season

The groundwater sampling for the post-monsoon season was undertaken during September 25 – 29, 2024. The mean value of in-situ parameters for the post-monsoon period of 2024 is listed in Table 36. The DO level ranged from 1.94 mg/L to 6.72 mg/L, with a mean value of 3.86 mg/L. TDS concentration ranged from 80mg/L to 990mg/L in the post-monsoon period, with an average value of 497.14mg/L. The EC level ranged from 0.16 ms/cm to 2.0 ms/cm, with an average value of 1.01 ms/cm. The pH value ranged between 6.96 to 8.43, with an average of 7.50 in the post-monsoon period. The temperature of groundwater in post-monsoon ranged from 28.60 to 36.80°C with an average value of 30.17 °C. The Hardness ranged from 78 mg/L to 776 mg/L in the post-monsoon period, with an average of 496.62 mg/L.

Concentrations of major ions and other elements measured in groundwater samples and their comparison with BIS limits during the post-monsoon 2024 season are listed in Table 37. The concentration of F- ranged from 0.20 to 6.40 mg/L, with an average value of 0.80 mg/L. The concentration of Cl- ranged from 55 mg/L to 430 mg/L, with an average value of 143.13 mg/L. NO_{3-} levels ranged from 11.20 mg/L to 188.60 mg/L, with an average of 61.86 mg/L. SO_4^{2-} levels ranged from 4.58 to 296.19 mg/L, with an average of 82.95 mg/L. In the post -monsoon season, the Ca^{2+} concentration ranged from 0.58 mg/L to 257.97 mg/L, averaging 99.71 mg/L. Similarly, K^+ concentration ranged from BDL mg/L to 24.91 mg/L, with a mean value of 2.40 mg/L. The Mg concentration ranged from 0.25 mg/L to 55.79 mg/L, with an average value of 22.64 mg/L. Na value varied between 9.94-189.02 mg/L with a mean value of 58.96 mg/L in the post-monsoon season. The concentration of HCO_{3-} varied between 108-446 mg/L with a mean value of 288.46 mg/L.

The mean concentration of heavy metals in the collected groundwater samples and their comparison with BIS limits 10500:2012 during the post-monsoon 2024 season is listed in Table 37. The concentration of arsenic (As) ranged from BDL to 0.002 ppm with a mean value of negligible. The concentration of Cr ranged from BDL to 0.009 ppm with a mean value of 0.006 ppm. The concentration of Fe ranged from BDL to 0.017 ppm with a mean value of 0.001 ppm. The rest of the elements, such as Zn (BDL -0.835), Se (BDL- 0.027), Cd (BDL- 0.001), Hg (BDL), and Pb (BDL), varied with average values of 0.130, 0.006, and also Cd, Hg and Pb negligible average concentrations, respectively.

Table 36 Measured values of physical parameters (DO, TDS, EC, pH, Hardness, and Temperature) in the groundwater samples during the post-monsoon September 2024 season from In-situ analysis

S.No.	Code	DO (mg/L)	TDS (mg/L)	EC (mS/cm)	pH	Temp (°C)	Hardness
1	**KHR-1**	2.53	890	1.79	7.30	29.30	**688**
2	**KHR-2**	2.81	710	1.44	7.61	28.70	424
3	**KHR-3**	2.50	500	1.01	7.83	30.20	516
4	**KHR-5**	1.94	300	0.62	8.43	29.10	78
5	**KHR-6**	4.60	570	1.14	7.21	30.60	**644**
6	**KHR-7**	2.15	430	0.87	7.18	29.20	564
7	**KHR-8A**	3.39	250	0.51	7.72	32.80	242
8	**KHR-9A**	3.90	400	0.82	7.69	36.80	318
9	**KHR-10A**	2.05	310	0.63	7.63	30.10	296
10	**KHR-11**	4.81	400	0.81	7.30	28.80	328
11	**KHR-12**	2.87	370	0.87	7.63	30.70	224
12	**KHR-13**	4.15	370	0.75	7.30	30.90	**612**
13	**KHR-14**	2.86	560	1.13	6.98	28.60	409
14	**KHR-17**	5.41	440	0.98	7.44	30.50	**728**
15	**KHR-18**	5.32	450	0.91	7.42	30.00	**776**
16	**KHR-19**	2.53	870	1.79	7.32	28.90	248
17	**KHR-20**	2.60	690	1.30	6.96	30.30	**658**
18	**KHR-Pz1**	6.72	740	1.45	7.78	29.10	**768**
19	**KHR-Pz2**	4.45	990	2.00	7.47	30.00	**658**
20	**KHR-Pz3**	6.30	360	0.72	7.76	29.70	532
21	**KHR-Pz4**	5.55	80	0.16	7.35	28.90	**738**
22	**KHR-Pz6**	4.19	650	1.32	7.58	29.6	**668**
BIS Limits (IS:10500-2012)	**AL**	**NS**	**500**	**NS**	**6.5-8.5**	**NS**	**200**
	PL		**2000**		**NR**		**600**

Notations: NS-Not specified; NR-No relaxation; ND- Not Detected; AL-Acceptable Limit; PL- Permissible Limit; BDL: Below detection limit

Table 37 Mean concentration (in mg/L) of major ions in Groundwater samples and their comparison with BIS limits during post-monsoon September 2024 season

Sr. No.	Code	F^-	Cl^-	Br^-	NO_3^-	PO_4^-	SO_4^{2-}	Ca	K	Mg	Na	CO_3^-	HCO_3^-
1	KHR-1	0.20	130.00	ND	18.40	ND	188.30	83.20	1.19	257.97	45.24	ND	198
2	KHR-2	0.60	220.00	ND	41.20	ND	49.20	189.02	24.91	99.35	12.96	ND	108
3	KHR-3	0.80	110.00	ND	18.20	ND	156.20	96.21	13.02	**101.76**	22.42	ND	155
4	KHR-4	**6.40**	140.00	ND	11.20	ND	24.23	49.29	0.66	0.58	0.25	ND	265
5	KHR-5	0.30	130.00	ND	**78.98**	ND	28.27	62.84	6.27	**111.90**	46.04	ND	446
6	KHR-6	0.40	70.00	ND	**89.40**	ND	15.28	31.81	0.55	**110.92**	32.20	ND	348
7	KHR-7	0.60	60.00	ND	18.20	ND	4.58	23.51	1.31	30.61	5.61	ND	236
8	KHR-8	0.20	80.00	ND	**123.20**	ND	16.26	43.15	0.80	**113.73**	32.24	ND	296
9	KHR-9	0.60	130.00	ND	**83.50**	ND	56.18	45.49	ND	28.31	6.28	ND	390
10	KHR-10	0.50	110.00	ND	42.10	ND	8.10	29.65	1.22	82.93	25.93	ND	410
11	KHR-11	0.30	70.00	ND	**108.00**	ND	44.29	62.23	1.19	14.28	2.87	ND	384
12	KHR-12	0.50	170.00	ND	**178.50**	ND	78.38	53.52	1.38	83.27	11.46	ND	310
13	KHR-13	0.40	170.00	ND	**188.60**	ND	62.36	25.89	0.38	**157.15**	30.54	ND	266
14	KHR-14	0.30	55.00	ND	**46.00**	ND	296.19	86.40	0.30	**115.20**	38.55	ND	255
15	KHR-17	0.50	150.00	ND	36.20	ND	66.30	15.79	1.53	47.96	12.08	ND	258
16	KHR-18	**1.80**	140.00	ND	44.60	ND	186.20	26.21	0.33	**113.60**	36.45	ND	320
17	KHR-19	0.40	110.00	ND	12.80	ND	172.20	131.92	ND	**138.06**	16.50	ND	294
18	KHR-20	0.20	130.00	ND	**98.20**	ND	174.20	41.59	0.51	**151.12**	32.20	ND	366
19	KHR-Pz1	0.40	120.00	ND	**101.20**	ND	60.28	96.29	0.52	57.46	11.30	ND	166
20	KHR-Pz2	0.20	340.00	ND	24.30	ND	38.26	32.86	0.53	**106.99**	20.53	ND	296
21	KHR-Pz3	0.20	110.00	ND	14.12	ND	32.11	32.86	0.53	**106.99**	20.53	ND	318
22	KHR-Pz4	0.30	430.00	ND	15.23	ND	178.11	35.85	0.00	66.48	55.79	ND	328
23	KHR-Pz6	**2.70**	120.00	ND	14.23	ND	18.28	9.94	0.51	**157.62**	10.86	ND	266
BIS limits (IS:10500-2012)	**AL**	**1**	**250**	**NS**	**45**	**NS**	**200**	**75**	**NS**	**30**	**NS**	**NS**	**NS**
	PL	**1.5**	**1000**		**NR**		**400**	**200**		**100**			

Notations: NS-Not specified; NR-No relaxation; ND- Not Detected; AL-Acceptable Limit; PL- Permissible Limit; BDL: Below detection limit

Table 38 Mean concentration (in ppm) of heavy metals in the groundwater samples and their comparison with BIS limits during the post-monsoon September 2024 season

S. No.	Code	Cr	Fe	Cu	Zn	As	Se	Cd	Hg	Pb
1	KHR-1	0.006	BDL	BDL	0.046	BDL	BDL	BDL	BDL	BDL
2	KHR-2	0.007	BDL	BDL	0.835	BDL	0.007	BDL	BDL	BDL
3	KHR-3	0.006	BDL	BDL	0.296	BDL	0.026	0.001	BDL	BDL
4	KHR-4	0.005	BDL	BDL	0.235	BDL	0.019	BDL	BDL	BDL
5	KHR-5	BDL	BDL	BDL	BDL	BDL	0.025	0.001	BDL	BDL
6	KHR-6	0.005	BDL	BDL	0.219	BDL	0.001	BDL	BDL	BDL
7	KHR-7	0.006	BDL	0.002	0.048	BDL	0.003	BDL	BDL	BDL
8	KHR-8A	0.007	BDL	BDL	0.005	BDL	BDL	BDL	BDL	BDL
9	KHR-9A	0.007	BDL	BDL	0.019	BDL	0.005	BDL	BDL	BDL
10	KHR-10A	0.008	BDL	BDL	BDL	0.001	BDL	BDL	BDL	BDL
11	KHR-11	0.008	BDL	BDL	0.159	0.001	0.002	BDL	BDL	BDL
12	KHR-12	0.007	BDL	BDL	0.010	BDL	BDL	BDL	BDL	BDL
13	KHR-13	0.005	0.006	BDL	0.068	0.001	0.003	BDL	BDL	BDL

14	KHR-14	0.008	BDL	BDL	0.530	0.001	0.006	BDL	BDL	BDL
15	KHR-17	0.008	BDL	0.013	0.018	BDL	BDL	BDL	BDL	BDL
16	KHR-18	0.006	0.008	BDL	0.016	0.002	BDL	BDL	BDL	BDL
17	KHR-19	0.008	0.017	BDL	0.060	BDL	0.008	BDL	BDL	BDL
18	KHR-20	0.009	BDL	BDL	0.051	BDL	0.008	BDL	BDL	BDL
19	KHR-25	0.009	BDL	BDL	0.102	BDL	BDL	BDL	BDL	BDL
20	KHR-PZ1	0.009	BDL	BDL	0.019	BDL	0.001	BDL	BDL	BDL
21	KHR-PZ2	BDL	BDL	BDL	0.032	BDL	BDL	BDL	BDL	BDL
22	KHR-PZ3	0.009	BDL	BDL	0.141	BDL	BDL	BDL	BDL	BDL
23	KHR-PZ4	0.006	BDL	BDL	0.037	BDL	BDL	BDL	BDL	BDL
BIS (IS:10500-2012)	**AL**	**0.01**	**0.001**	**0.01**	**0.003**	**0.05**	**0.05**	**5**	**0.01**	**0.3**
	PL	**0.05**	**NR**	**NR**	**NR**	**NR**	**1.5**	**15**	**NR**	**NR**

Notations: NS-Not specified; NR-No relaxation; ND- Not Detected; AL-Acceptable Limit; PL- Permissible Limit; BDL: Below detection limit

8 Estimated Contribution of Rainwater harvesting done at NTPC plant to the groundwater recharge

The comprehensive assessment of rainwater harvesting potential across different areas, as outlined in the report from the National Institute of Hydrology (NIH) in 2018, revealed an intricate understanding of the catchment type, climatic conditions, and surface characteristics. The calculated potential for rainwater harvesting from the main plant area, township, and green belt regions amounts to 0.844 million cubic meters (MCM) for enrichment of water resources of nearby plant areas.

As a contribution to this, an initiative has been undertaken at the NTPC plant at Khargone, specifically addressing the impact on groundwater recharge. NTPC has implemented a rainwater harvesting system consisting of 44 recharge pits strategically installed within the main plant premises. These recharge pits are designed to capture rainwater from various sources, including rooftop surfaces, open areas, and stormwater runoff. The rainwater collected from these sources is directed into the recharge pits, facilitating water infiltration into the underlying groundwater resource. This process contributes to the recharge of subsurface unconfined aquifers, enhancing the overall groundwater levels in the region. The collective recharge capacity of these 44 pits is specified as 0.36 million cubic meters (MCM). However, the successful implementation of the rainwater harvesting system at the NTPC plant in Khargone, coupled with the insights gained from the comprehensive assessment by NIH Roorkee in 2018, paves the way for further impactful contributions to water resource enrichment. The calculated potential of 0.844 million cubic meters (MCM) highlights the substantial capacity for rainwater harvesting across the main plant area, township, and green belt regions. Indeed, there is a scope for expanding and improving the existing rainwater harvesting structures and methodologies. This could involve identifying additional strategic locations for recharge pits, optimizing capture mechanisms, and implementing advanced technologies for efficient rainwater utilisation. Furthermore, ongoing monitoring and periodic reassessments of rainwater harvesting potential will enable adaptive strategies, ensuring continuous improvement and resilience in addressing local water needs.

8.1 *Monitoring of groundwater level and quality for observation points inside and adjacent to the plant*

A subset of data on groundwater level observation and groundwater quality observed inside the plant and adjacent to the plant area is present in this section specifically to understand the influence of the rainwater harvesting scheme implemented in the plant. Two observation wells (KHR-13, KHR-15A, KHR-18 and 6 piezometers) were monitored for groundwater level, and seven observation points (KHR-1, KHR-3, KHR-4, KHR-13, KHR-17, KHR-18, KHR-19 and 6 piezometers) were monitored to assess water quality parameters. A detailed analysis of groundwater level and quality in an area of a 10-km radius from the plant is presented in sections 5 and 7. A subset of the data for identified points inside and adjacent to the plant is presented in this section again. The salient information about groundwater table observation points is given in Table 39. The observed groundwater levels below ground level at observation points mentioned in Table 39 are given in Table 40.

Table 39. Salient details of observation wells for groundwater level monitoring inside and adjacent to the plant

S.No.	Site Code	Latitude (˚E)	Longitude (˚N)	Location and source	Ground Elevation (m amsl)
1	KHR-13	22.06608	75.87139	Adjoining of NTPC Community Centre Near New Hanumaan Temple, open well	263
2	KHR-15A	22.07092	75.85599	Near Bhilal Baba Temple, opp cooling tower, Near NTPC Gate no. 1, below mango tree, open well	247
3	KHR-16A	22.07912	75.80412	Adjacent to Gangour thermal power station road	238
4	KHR-18	22.06295	75.85256	Well inside power station, open well	249
5	KHR-Pz1	22.07826	75.8367	Piezometer 1, Ash Dyke	241

6	KHR-Pz2	22.07721	75.83306	Piezometer 2, Ash Dyke	239
7	KHR-Pz3	22.07476	75.83177	Piezometer 3, Ash Dyke	234
8	KHR-Pz4	22.07289	75.83233	Piezometer 4, Ash Dyke	230
9	KHR-Pz5	22.07055	75.83277	Piezometer 5, Ash Dyke	236
10	KHR-Pz6	22.07089	75.83548	Piezometer 6, Ash Dyke	238

Table 40. Measured groundwater level at identified locations inside and adjacent to the plant

S.No.	Site Code	Depth to the water table (m)			
		Pre-monsoon		Post-monsoon	
		2023	2024	2023	2024
1	KHR-13	7.9	NA	NA	1.15
2	KHR-15A	1.55	1.5	1.78	1.72
3	KHR-16A	12.4	7.12	NA	3.91
4	KHR-18	4.56	4.3	4.1	4.0
5	KHR-Pz1	2.7	1.5	2.1	1.82
6	KHR-Pz2	12.33	9.8	9.27	9.20
7	KHR-Pz3	3.3	3.14	2.42	2.32
8	KHR-Pz4	3.5	4.32	1.2	1.35
9	KHR-Pz5	9.4	NA	7.1	NA
10	KHR-Pz6	9.5	1.02	5.5	5.60

NA=Not available

The salient information about groundwater quality observation points inside and adjacent to the plant is given in Table 41. Measured values of physical parameters (DO, TDS, EC, pH, Hardness and Temperature) in the groundwater samples inside and adjacent to the plant are given in Table 42.

Table 41. Salient information of the groundwater quality observation points inside and adjacent to the plant.

S.No.	Code	Latitude	Longitude	Station Name	Type of Analysis	Type of Site
1	KHR-1	22.07775	75.83155	Vill. Dalchi	In-situ and Ex-situ	Hand pump
2	KHR-3	22.06926	75.85789	Near NTPC opp Bhilal Baba Temple, Gate No. 1	In-situ and Ex-situ	Hand pump
3	KHR-4	22.0688	75.86202	Between NTPC & Township	In-situ and Ex-situ	Hand pump
4	KHR-13	22.06608	75.87139	Adjoining of NTPC Community Centre	In-situ and Ex-situ	Hand pump
5	KHR-14	22.0493	75.87783	Opp Gram Panchayat office. Vill Kheri Bujurg	In-situ and Ex-situ	Hand pump
6	KHR-15	22.06923	75.85798	Near Bhilal Baba Temple, Near NTPC Gate No. 1	In-situ and Ex-situ	Hand pump
7	KHR-17	22.06947	75.85227	Below Tower Line, North side of Power station,	In-situ and Ex-situ	Seepage
8	KHR-18	22.06295	75.85256	Well inside power station	In-situ and Ex-situ	Open well

9	KHR-19	22.07518	75.82482	Near Baba Ramdev Mandir, Dalchi	In-situ and Ex-situ	Hand pump
10	KHR-Pz1	22.07826	75.8367	Piezometer 1, Ash Dyke	In-situ and Ex-situ	Piezometer
11	KHR-Pz2	22.07721	75.83306	Piezometer 1, Ash Dyke	In-situ and Ex-situ	Piezometer
12	KHR-Pz3	22.07476	75.83177	Piezometer 1, Ash Dyke	In-situ and Ex-situ	Piezometer
13	KHR-Pz4	22.07289	75.83233	Piezometer 1, Ash Dyke	In-situ and Ex-situ	Piezometer
14	KHR-Pz5	22.07055	75.83277	Piezometer 1, Ash Dyke	In-situ and Ex-situ	Piezometer
15	KHR-Pz6	22.07089	75.83548	Piezometer 1, Ash Dyke	In-situ and Ex-situ	Piezometer

Table 42. Measured values of physical parameters (DO, TDS, EC, pH, Hardness and Temperature) in the groundwater samples inside and adjacent to the plant

S.No.	Code	Season	DO (mg/L)	TDS (mg/L)	EC (µS/cm)	pH	Temp (°C)	Hardness
1	KHR-1	Pre-monsoon 2023	3.35	630	1260	6.74	31.3	**657**
		Post-monsoon 2023	2.9	590	1160	6.9	29.1	625
		Pre-monsoon 2024	2.44	850	1.71	7.30	28.7	**644**
		Post-monsoon 2024	2.53	890	1.79	7.30	29.30	688
2	KHR-3	Pre-monsoon 2023	2.84	480	980	6.98	30.7	511
		Post-monsoon 2023	3.6	460	940	7.34	30.3	245
		Pre-monsoon 2024	1.80	310	0.63	8.32	30.8	502
		Post-monsoon 2024	2.50	500	1.01	7.83	30.20	516
3	KHR-4	Pre-monsoon 2023	5.88	320	650	7.16	28.9	395
		Post-monsoon 2023	6.58	490	1000	7.63	27.7	406
		Pre-monsoon 2024	1.80	310	0.63	8.32	30.8	502
		Post-monsoon 2024	NA	NA	NA	NA	NA	NA
4	KHR-13	Pre-monsoon 2023	1.41	440	880	6.91	32.4	**606**
		Post-monsoon 2023	1.9	550	1100	7.24	30.7	620
		Pre-monsoon 2024	4.44	730	1.46	7.43	34.8	**616**
		Post-monsoon 2024	4.15	370	0.75	7.30	30.90	612
5	KHR-14	Pre-monsoon 2023	4.25	450	920	6.68	29.9	433
		Post-monsoon 2023	2.82	590	1190	6.9	32.1	435
		Pre-monsoon 2024	3.04	450	0.91	7.32	29.5	418
		Post-monsoon 2024	2.86	560	1.13	6.98	28.60	409
6	KHR-15	Pre-monsoon 2023	3.8	440	900	6.98	31.8	542
		Post-monsoon 2023	4.1	410	850	7.1	29.4	491
		Pre-monsoon 2024	NA	NA	NA	NA	NA	NA
		Post-monsoon 2024	NA	NA	NA	NA	NA	NA
7	KHR-17	Pre-monsoon 2023	4.79	480	970	7.05	29.8	**698**
		Post-monsoon 2023	4.97	470	960	7.3	29.3	297
		Pre-monsoon 2024	5.37	530	1.07	7.56	30.5	**718**
		Post-monsoon 2024	5.41	440	0.98	7.44	30.50	728
8	KHR-18	Pre-monsoon 2023	5.58	690	1390	7.16	29	**778**
		Post-monsoon 2023	4.23	270	550	7.34	31.8	736
		Pre-monsoon 2024	5.83	450	0.91	7.32	29.7	**788**
		Post-monsoon 2024	5.32	450	0.91	7.42	30.00	776
9	KHR-19	Pre-monsoon 2023	1.94	570	1140	6.98	30	246
		Post-monsoon 2023	2.3	540	1020	7.21	28.21	253
		Pre-monsoon 2024	2.50	880	1.76	7.20	28.3	236
		Post-monsoon 2024	2.53	870	1.79	7.32	28.90	248

10	KHR-Pz1	Pre-monsoon 2023	4.72	407	920	6.98	28.7	**747**
		Post-monsoon 2023	3.6	400	810	7.52	29.1	332
		Pre-monsoon 2024	4.65	880	1.77	7.07	31.1	**756**
		Post-monsoon 2024	6.72	740	1.45	7.78	29.10	768
11	KHR-Pz2	Pre-monsoon 2023	3.03	620	1250	7.11	29.7	**627**
		Post-monsoon 2023	2.3	1060	2140	7.08	29.2	793
		Pre-monsoon 2024	4.50	950	1.91	7.40	32.1	**647**
		Post-monsoon 2024	4.45	990	2.00	7.47	30.00	658
12	KHR-Pz3	Pre-monsoon 2023	3.16	730	1460	7.11	29	521
		Post-monsoon 2023	2.6	270	550	7.42	29.9	230
		Pre-monsoon 2024	6.27	590	1.19	7.61	31.0	518
		Post-monsoon 2024	6.30	360	0.72	7.76	29.70	532
13	KHR-Pz4	Pre-monsoon 2023	4.36	430	870	7.7	28.6	**723**
		Post-monsoon 2023	1.6	770	1550	7.28	30.1	871
		Pre-monsoon 2024	6.75	890	1.78	7.52	31.3	**720**
		Post-monsoon 2024	5.55	80	0.16	7.35	28.90	**738**
14	KHR-Pz5	Pre-monsoon 2023	2.88	480	960	6.64	30.4	**691**
		Post-monsoon 2023	2.7	350	700	6.85	30.8	341
		Pre-monsoon 2024	NA	NA	NA	NA	NA	NA
		Post-monsoon 2024	NA	NA	NA	NA	NA	NA
15	KHR-Pz6	Pre-monsoon 2023	3.82	570	1140	6.78	31.4	**663**
		Post-monsoon 2023	3.7	270	550	7.34	31.8	135
		Pre-monsoon 2024	7.01	640	1.29	7.29	31.1	**656**
		Post-monsoon 2024	4.19	650	1.32	7.58	29.6	**668**
BIS Limits (IS:10500-2012)	**AL**		NS	**500**	NS	**6.5-8.5**	NS	**200**
	PL			**2000**		**NR**		**600**

Notations: NS-Not specified; NR-No relaxation; ND- Not Detected; AL-Acceptable Limit; PL-Permissible Limit; BDL: Below detection limit, NA: Not Available.

The groundwater samples collected from inside and adjacent to the plant were further assessed for major ions, and heavy metals. The mean concentration of major ions in groundwater samples and their comparison with BIS limits is listed in Table 43. The mean concentration of heavy metals in groundwater samples and their comparison with BIS limits is listed in Table 44.

Table 43. Mean concentration (mg/l) of major ions in groundwater samples inside and adjacent to the plant and their comparison with BIS limits

Code	**Season**	**F^-**	**Cl^-**	**Br^-**	**NO_3^-**	**PO_4^-**	**SO_4^{2-}**	**Ca**	**K**	**Mg**	**Na**	**CO_3^-**	**HCO_3^-**
KHR-1	S1	0.3	71.1	BDL	5.4	BDL	**803**	185	1	47.3	36.1	BDL	245
	S2	0.3	140	BDL	20.5	BDL	199.3	158	1.2	55.95	49.4	BDL	210
	S3	0.00	42.92	BDL	2.87	BDL	121.70	**221.25**	1.05	51.75	39.15	BDL	258
	S4	0.20	130.00	BDL	18.40	BDL	188.30	83.20	1.19	257.97	45.24	BDL	198

KHR-3	S1	0.6	72.6	BDL	13.2	BDL	**414.1**	142.8	0.5	37.5	86.2	BDL	170
	S2	0.7	100	BDL	22.6	BDL	142	70.35	26.85	16.95	237.3	BDL	165
	S3	0.25	61.13	BDL	1.55	BDL	**408.06**	126.45	0.75	48.15	26.25	BDL	180
	S4	0.80	110.00	BDL	18.20	BDL	156.20	96.21	13.02	101.76	22.42	BDL	155
KHR-4	S1	0.5	50.1	BDL	34.4	BDL	219.8	111	0.7	28.6	34.8	BDL	254
	S2	BDL	120	BDL	BDL	BDL	BDL	99.45	1.05	38.25	85.1	BDL	250
	S3	0.53	43.16	BDL	18.83	BDL	73.07	98.70	1.05	40.95	14.70	BDL	244
	S4	**6.40**	140.00	BDL	11.20	BDL	24.23	49.29	0.66	0.58	0.25	BDL	265
KHR-13	S1	0.5	30.6	BDL	12.4	BDL	135.8	209.2	1.3	20.2	131.8	BDL	315
	S2	0.6	180	BDL	187.5	BDL	75.2	190.1	2.55	35.4	171	BDL	290
	S3	0.00	26.86	BDL	4.73	BDL	**400.84**	136.35	0.90	17.70	68.70	BDL	328
	S4	0.40	170.00	BDL	188.60	BDL	62.36	25.89	0.38	157.15	30.54	BDL	266
KHR-14		0.9	62.3	BDL	**139.7**	BDL	47.2	115	0.7	35.3	39.9	BDL	290
	S2	0.5	180	BDL	200.6	BDL	58.5	105.6	0.06	41.55	72.8	BDL	275
	S3	0.00	61.93	BDL	**85.64**	BDL	36.53	118.05	1.95	29.70	18.30	BDL	288
	S4	0.30	55.00	BDL	46.00	BDL	296.19	86.40	0.30	115.20	38.55	BDL	255
KHR-15	S1	0.6	58.7	BDL	**58.2**	BDL	284.7	189	0.8	17.1	120.3	BDL	265
	S2	0.4	65	BDL	45	BDL	284.7	145	0.2	31.2	96.4	BDL	245
	S3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	S4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
KHR-17	S1	0.6	100.4	BDL	7.7	BDL	**429.5**	212.5	2.2	40.7	104.0	BDL	220
	S2	**1.6**	160	BDL	54	BDL	197.7	180.7	0.03	69.15	97.8	BDL	310
	S3	0.00	66.22	BDL	7.51	BDL	224.49	155.70	10.80	38.25	41.85	BDL	320
	S4	0.50	150.00	BDL	36.20	0.00	66.30	15.79	1.53	47.96	12.08	BDL	258
KHR-18	S1	0.6	39.7	BDL	15.8	BDL	**921.1**	192.6	0.3	72.2	67.8	BDL	324
	S2	**1.6**	160	BDL	54	BDL	197.7	180.7	0.03	69.15	97.8	BDL	310
	S3	0.53	37.45	BDL	2.71	BDL	171.11	102.00	0.60	44.85	14.25	BDL	240
	S4	**1.80**	140.00	BDL	44.60	BDL	186.20	26.21	0.33	113.60	36.45	BDL	320
KHR-19	S1	0.5	78.6	BDL	6.2	BDL	**787.3**	75.4	3.1	14	149.2	BDL	345
	S2	0.5	100	BDL	14.6	BDL	184.6	82.4	0.11	11.4	300.2	BDL	290
	S3	0.00	66.22	BDL	7.51	BDL	224.49	155.70	10.80	38.25	41.85	BDL	320
	S4	0.40	110.00	BDL	12.80	BDL	172.20	131.92	BDL	138.06	16.50	BDL	294
KHRPz-1	S1	0.4	125.4	BDL	27.6	BDL	116.7	241	1.6	35.4	60.8	BDL	415
	S2	0.4	360	BDL	25.7	BDL	41.5	92.55	0.08	24.45	98.4	BDL	310
	S3	0.42	113.70	BDL	1.87	BDL	12.35	0.00	1.80	46.35	33.30	BDL	412
	S4	0.40	120.00	BDL	101.20	BDL	60.28	96.29	0.52	57.46	11.30	BDL	166
KHRPz-2	S1	0.3	72.5	BDL	1.4	BDL	**996.8**	202	0.9	29.7	80.0	BDL	286
	S2	0.3	120	BDL	12.2	BDL	31.1	196.1	0.04	73.65	115.7	BDL	310
	S3	0.15	43.05	BDL	4.19	BDL	**811.67**	0.00	0.75	55.35	20.25	BDL	118
	S4	0.20	340.00	BDL	24.30	BDL	38.26	32.86	0.53	106.99	20.53	BDL	296
KHRPz-3	S1	0.3	68.0	BDL	4.8	BDL	**983.7**	190.1	1.1	11.2	126.1	BDL	315
	S2	0.5	440	BDL	16.1	BDL	188	71.4	0.06	12.45	77.1	BDL	290
	S3	0.00	39.82	BDL	5.01	BDL	304.49	116.10	0.90	15.00	14.85	BDL	422
	S4	0.20	110.00	BDL	14.12	BDL	32.11	32.86	0.53	106.99	20.53	BDL	318
KHRPz-4	S1	0.8	86.3	BDL	BDL	BDL	**585.5**	222	7.3	41	87.2	BDL	264
	S2	**2.9**	160	BDL	15.4	BDL	12.4	215.8	0.13	80.55	210.8	BDL	245
	S3	0.45	44.29	BDL	4.33	BDL	219.50	196.65	1.80	66.00	27.30	BDL	276
	S4	0.30	430.00	0.00	15.23	BDL	178.11	35.85	BDL	66.48	55.79	BDL	328
KHRPz-5	S1	0.5	46.1	BDL	BDL	BDL	187.2	235.7	1.8	24.7	101.2	BDL	324

	S2	0.7	120	BDL	72	BDL	163.9	87.9	0.06	29.55	71.4	BDL	265
	S3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	S4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
KHRPz-6	S1	0.4	86.1	BDL	16.4	BDL	**436.2**	183.4	0.6	49.8	38.5	BDL	295
	S2	0.6	160	BDL	16	BDL	34	42.3	0.02	7.05	180.5	BDL	240
	S3	0.00	41.02	BDL	10.95	BDL	52.54	151.05	0.90	53.55	12.45	BDL	318
	S4	**2.70**	120.00	BDL	14.23	BDL	18.28	9.94	0.51	157.62	10.86	BDL	266
BIS limits (IS:10500-2012)	**AL**	**1**	**250**	**NS**	**45**	**NS**	**200**	**75**	**NS**	**30**	**NS**	**NS**	**NS**
	PL	**1.5**	**1000**		**NR**		**400**	**200**		**100**			

Notations: S1: Pre-monsoon2023; S2: Post-monsoon 2023; S3: Pre-monsoon 2024; S4: Post-monsoon 2024, *NS-Not specified; NR-No relaxation; NA- Not Available; AL-Acceptable Limit; PL- Permissible Limit; BDL: Below detection limit*

Table 44. Mean concentration (in ppm) of heavy metals in groundwater samples inside and adjacent to the plant and their comparison with BIS limits

Code	Season	As	Hg	Pb	Cd	Cr	Cu	Zn	Se	Fe
KHR-1	S1	0.008	BDL	0.002	0.001	0.01	0.04	0.97	BDL	**0.39**
	S2	0.002	0.004	0.003	0.003	0.02	0.005	0.46	BDL	0.18
	S3	0.001	0.0000	0.002	0.001	0.001	0.02	0.002	0.00	0.06
	S4	*BDL*	*BDL*	*BDL*	*BDL*	0.006	*BDL*	0.046	*BDL*	*BDL*
KHR-3	S1	0.007	BDL	0.002	0.001	0.01	0.03	0.16	BDL	0.08
	S2	0.001	BDL	0.003	0.002	0.02	0.010	0.71	0.002	0.43
	S3	0.001	0.0000	0.002	0.001	0.001	0.02	0.001	0.00	0.07
	S4	*BDL*	*BDL*	*BDL*	0.001	0.006	*BDL*	0.296	0.026	*BDL*
KHR-4	S1	0.005	BDL	0.002	0.001	0.01	0.03	0.07	BDL	0.13
	S2	0.001	BDL	0.003	0.002	0.02	0.004	0.06	BDL	0.25
	S3	0.002	0.0000	0.002	0.001	0.001	0.02	0.001	0.00	0.07
	S4	*BDL*	*BDL*	*BDL*	*BDL*	0.005	*BDL*	0.235	0.019	*BDL*
KHR -13	S1	0.006	BDL	0.002	0.001	0.01	0.04	0.13	0.01	0.09
	S2	0.002	BDL	0.003	0.002	0.02	0.007	BDL	BDL	0.19
	S3	0.001	0.0000	0.002	0.001	0.001	0.05	0.001	0.00	0.09
	S4	0.001	*BDL*	*BDL*	*BDL*	0.005	*BDL*	0.068	0.003	0.006
KHR -14	S1	0.006	BDL	0.002	0.001	0.01	0.07	0.48	BDL	0.21
	S2	0.001	BDL	0.002	0.002	0.02	0.037	0.43	BDL	0.25
	S3	0.000	0.0000	0.002	0.001	0.001	0.04	0.001	0.00	**0.77**
	S4	0.001	*BDL*	*BDL*	*BDL*	0.008	*BDL*	0.530	0.006	BDL
KHR -15	S1	0.005	BDL	0.002	0.001	0.01	0.03	0.13	0.01	0.17
	S2	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
	S3	NA	NA	NA	NA	NA	NA	NA	NA	NA
	S4	NA	NA	NA	NA	NA	NA	NA	NA	NA
KHR-17	S1	0.006	BDL	0.002	BDL	0.01	0.03	0.08	BDL	0.17
	S2	0.001	BDL	0.002	0.002	0.02	0.002	BDL	BDL	0.21
	S3	0.001	0.0000	0.002	0.001	0.001	0.05	0.001	0.00	0.10
	S4	*BDL*	*BDL*	*BDL*	*BDL*	0.008	0.013	0.018	*BDL*	*BDL*
KHR-18	S1	0.006	BDL	0.002	0.001	0.01	0.03	0.07	BDL	0.20
	S2	0.001	BDL	0.003	0.003	0.02	0.005	BDL	BDL	0.21
	S3	0.001	0.0000	0.002	0.001	0.001	0.02	0.001	0.00	0.10
	S4	0.002	*BDL*	*BDL*	*BDL*	0.006	*BDL*	0.016	*BDL*	0.008
KHR-19	S1	0.006	BDL	0.002	0.001	0.01	0.03	0.08	BDL	0.12
	S2	0.001	0.002	0.002	0.002	0.02	0.005	BDL	BDL	0.20
	S3	0.001	0.0000	0.002	0.001	0.001	0.02	0.001	0.00	0.11
	S4	*BDL*	*BDL*	*BDL*	*BDL*	0.008	*BDL*	0.060	0.008	0.017
KHR PZ-1	S1	0.006	BDL	0.003	0.001	0.01	0.03	0.09	BDL	0.13
	S2	0.001	BDL	0.024	0.002	0.02	0.011	0.05	0.001	0.18
	S3	0.001	0.0000	0.003	0.001	0.001	0.02	0.000	0.00	0.07
	S4	*BDL*	*BDL*	*BDL*	*BDL*	0.009	*BDL*	0.019	0.001	*BDL*
KHR PZ-2	S1	0.006	BDL	0.002	0.001	0.01	0.04	0.07	BDL	0.13

	S2	0.001	BDL	0.002	0.001	0.02	0.004	0.01	BDL	0.16
	S3	0.001	0.0000	0.002	0.001	0.001	0.02	0.137	0.00	0.07
	S4	*BDL*	*BDL*	*BDL*	*BDL*	*BDL*	*BDL*	0.032	*BDL*	*BDL*
KHR PZ-3	S1	0.006	BDL	0.002	0.001	0.01	0.03	0.11	BDL	0.17
	S2	0.001	BDL	0.010	0.002	0.02	0.009	BDL	BDL	0.15
	S3	0.001	0.0000	0.002	0.001	0.001	0.02	0.241	0.00	0.20
	S4	*BDL*	*BDL*	*BDL*	*BDL*	0.009	*BDL*	0.141	*BDL*	*BDL*
KHR PZ-4	S1	0.007	BDL	0.005	0.001	0.02	0.03	0.13	BDL	**0.33**
	S2	0.001	BDL	0.009	0.001	0.02	0.005	BDL	0.002	0.23
	S3	0.000	0.000	0.003	0.001	0.001	0.02	0.118	0.00	0.08
	S4	*BDL*	*BDL*	*BDL*	*BDL*	0.006	*BDL*	0.037	*BDL*	*BDL*
KHR PZ-5	S1	0.007	BDL	0.008	0.001	0.01	0.12	0.10	BDL	**0.98**
	S2	0.001	BDL	0.003	0.001	0.02	0.014	BDL	BDL	0.16
	S3	NA	NA	NA	NA	NA	NA	NA	NA	NA
	S4	NA	NA	NA	NA	NA	NA	NA	NA	NA
KHR PZ-6	S1	0.006	BDL	0.002	0.001	0.01	0.03	0.09	BDL	0.20
	S2	0.001	BDL	0.008	0.001	0.02	0.007	BDL	0.009	0.14
	S3	0.001	0.0000	0.020	0.001	0.001	0.02	0.154	0.00	0.07
	S4	*BDL*	*BDL*	*BDL*	*BDL*	0.007	*BDL*	0.188	0.027	*BDL*
BIS (IS:10500-2012)	**AL**	**0.01**	**0.001**	**0.01**	**0.003**	**0.05**	**0.05**	**5**	**0.01**	**0.3**
	PL	**0.05**	**NR**	**NR**	**NR**	**NR**	**1.5**	**15**	**NR**	**NR**

Notations: S1: Pre-monsoon2023; S2: Post-monsoon 2023; S3: Pre-monsoon 2024; S4: Post-monsoon 2024, *NS-Not specified; NR-No relaxation; AL-Acceptable Limit; PL- Permissible Limit; BDL: Below detection limit, NA: Not Available.*

9 ANALYSIS OF SOIL CHEMICAL PROPERTIES

Typically, the elements found in natural soil are represented by soil chemistry. However, many natural and anthropogenic processes alter the natural soil chemistry, including leaching of chemical elements by flood irrigation, chemical reactions, different patterns of land use, intense fertiliser usage, and biological processes. Depending on how the soil will be used in the future, these changes may be deemed to have either beneficial or adverse effects. In order to monitor the environment and determine potential effects on the local ecology, it is crucial to examine the soil components close to thermal power stations. Various heavy metals (mercury, lead, cadmium, and arsenic), and other ions (nitrate) are among the many pollutants that thermal power stations frequently emit into the atmosphere. These emissions have the potential to pollute the soil when they settle onto it. These metals can build up in the soil over time and get into plants and animals, which then get into the food chain. Also, soil-borne pollutants have the potential to seep into groundwater and contaminate sources of drinking water. The possible migration of contaminants from the soil to groundwater can be better understood with the soil element analysis. Monitoring changes in soil quality over time is possible with routine soil element analyses. This ongoing observation provides the detailed characterisation which can be used to implement pollution control strategies. As per the scope of the present study, 36 soil samples were collected from 12 locations, and three samples from each location, i.e., from the surface, 30 cm and 60 cm depth from the surface were collected using an auger. The samples were appropriately tagged and placed in polythene bags for analysis in the laboratory. The samples were brought to IIT Roorkee Laboratory for further chemistry-based analysis.

9.1 Soil Chemical Properties during pre-monsoon 2023 season

The geographical location of soil sampling locations in the study area is shown in Figure 18. Table 45 presents the details of the sampling locations. The results of laboratory analysis for physical parameters and major ions (F^-, Cl^-, HCO_3^-, SO_4^{2-}, NO_3, PO_4^{3-}, Ca^{2+}, Mg^{2+}, Na^+, K^+, and Fe^{2+}) are listed in Table 46.

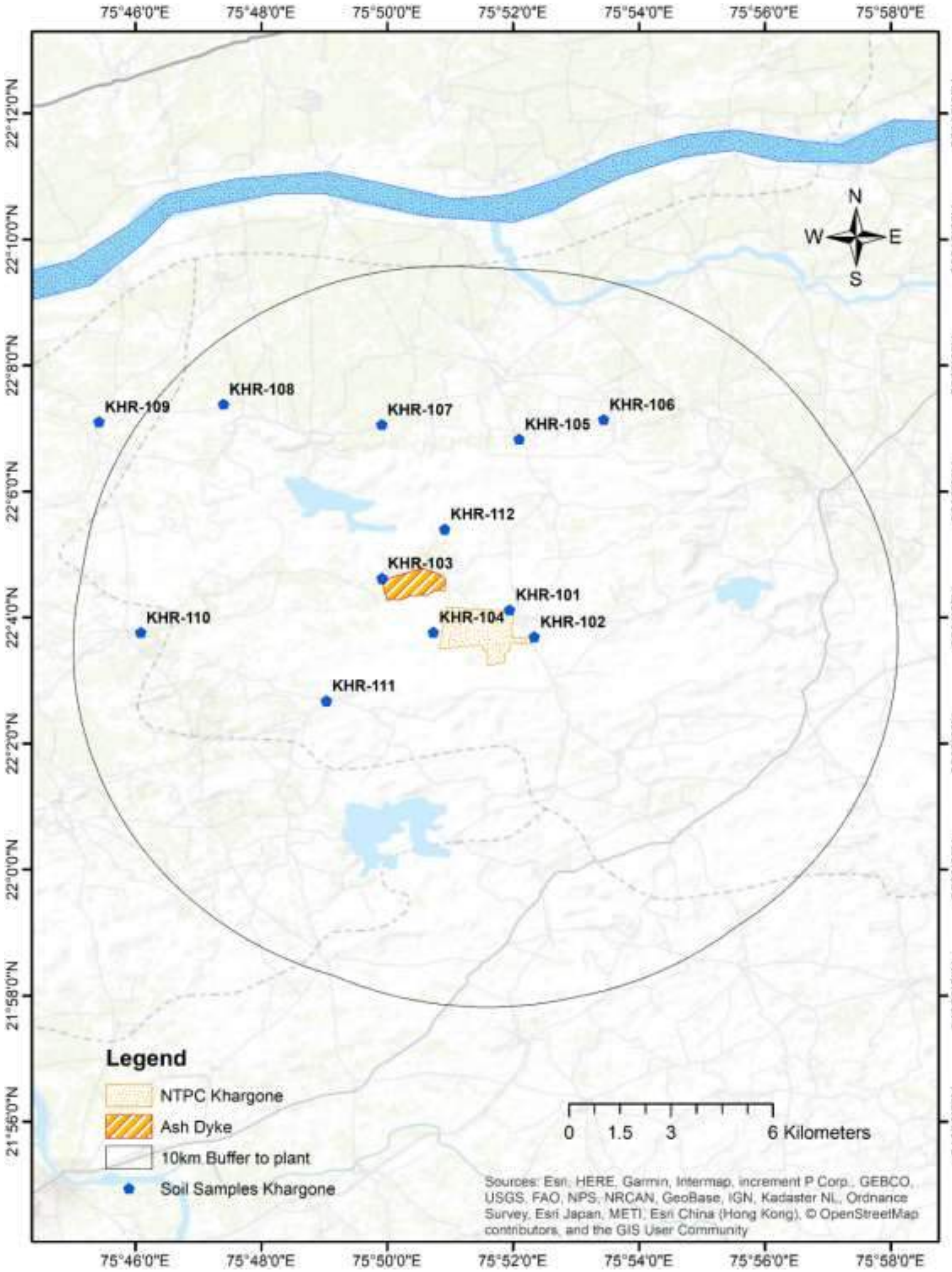


Figure 18. Soil sampling points within the 10 km buffer zone of power station site in the study area

Table 45. Details of soils samples and their location name with geo-coordinates in the study area

S.No.	Site Code	Location name	Latitude	Longitude
1	KHR-101	NTPC Plantation Land near Shelda Village	22.068686	75.865808
2	KHR-102	NTPC Power station to Kheri road along NTPC Railway line	22.061526	75.87233
3	KHR-103	Near NTPC Boundary inside Dalchi along Power station AshDyke - Dalchi road	22.077065	75.832013
4	KHR-104	Power station to Bhopada side single Chimney side	22.062734	75.845571
5	KHR-105	Opp side of Kottara Pond, Power station to Kattora Village	22.113848	75.868283
6	KHR-106	Near Badgaon Village, Near Papu Dhaba	22.119023	75.890667
7	KHR-107	Kanhapur- Pipalgaon Road, Along Road site outside Kanhapur	22.117732	75.83194
8	KHR-108	Pipalgaon Londi road, Londi along road side Near Hand Pump	22.123119	75.790038
9	KHR-109	Opp Sant Siya ram Auto Parts & Garrage	22.118459	75.757034
10	KHR-110	Village Bhatiyan On Power station road Near Overhead water tank opp side	22.062688	75.768112
11	KHR-111	Village Bhopada Shalda Road	22.044646	75.817312
12	KHR-112	Vill Jamnia	22.090059	75.848602

The pH range for most soils varies between 3.5 and 10. The natural pH of soils normally ranges from 5 to 7 in areas with more rainfall and from 6.5 to 9 in dry regions. According to their pH value, soils can be categorized as neutral (pH range: 6.5 to 7.5), alkaline (pH over 7.5), or acidic (pH less than 6.5). Strongly acidic soils have a pH of less than 5.5. The pH range of the soil samples analysed in this study ranged from 6.05 to 7.5, with an average value of 6.8 when all sample depths were taken into account. The soil is frequently found to be neutral (34 out of 36 samples) within the pH range of 6.5 to 7.5. Only two samples showed acidic nature at 0 cm depth and 30 cm depth, respectively.

Soil electrical conductivity (EC), also known as the electrical conductivity of soil, is a measure of the soil's ability to conduct an electric current. It provides useful information about the physical and chemical qualities of the soil, as well as its moisture content and salinity. Soil EC monitoring is useful in a variety of sectors, including agriculture, environmental research, and geology. The value of EC for soil in the study area during the pre-monsoon period (April 2023) ranged from 150 μS/cm to 460 μS/cm with an average value of 262.9 μS/cm. Considering all the samples at various depths. Furthermore, no specific trend of depth-wise increase or decrease in EC values has been detected in the majority of soil samples. Moreover, the mean concentration of essential ions in soil samples at various depths (at the surface, at 30 cm depth, and at 60 cm depth) during the pre-monsoon 2023 season (April 2023) is listed in Table 46.

Table 46. Mean concentration of major ions in soil samples during the pre-monsoon 2023 season (April 2023) (ions in mg/g, EC in µs/cm, pH in standard unit)

S.No.	Site Code	pH	EC	CO_3^-	HCO_3^-	Cl^-	SO_4^{2-}	NO_3^-	PO_4^-	F^-	Na^+	K^+	Ca^{2+}	Mg^{2+}	Br^-
1	KHR 101(0)	6.9	230	ND	0.28	0.06	0.38	0.06	ND	0.001	ND	0.0004	0.02	0.006	ND
2	KHR 101(30)	6.7	240	ND	0.41	0.06	0.37	0.02	ND	0.001	0.015	0.0003	0.01	0.004	ND
3	KHR 101(60)	6.9	240	ND	0.36	0.05	0.22	0.02	ND	0.003	0.001	0.0012	0.02	0.007	0.001
4	KHR 102 (0)	6.8	170	ND	0.34	0.03	0.11	0.00	ND	0.005	ND	0.0009	0.02	0.007	ND
5	KHR 102 (30)	6.8	200	ND	0.49	0.02	0.16	0.01	ND	0.005	ND	0.0010	0.02	0.007	ND
6	KHR 102(60)	6.9	210	ND	0.34	0.02	0.15	0.02	ND	0.005	ND	0.0013	0.05	0.009	0.001
7	KHR 103 (0)	6.7	150	ND	0.66	0.03	0.22	0.04	ND	0.001	0.000	0.0009	0.01	0.004	ND
8	KHR 103 (30)	6.6	150	ND	0.73	0.03	0.25	0.03	ND	0.001	0.005	0.0009	0.01	0.004	ND
9	KHR 103 (60)	6.8	190	ND	0.92	0.04	0.25	0.04	ND	0.001	ND	0.0012	0.01	0.004	ND
10	KHR 104(0)	6.5	410	ND	0.31	0.05	0.28	0.21	ND	0.005	ND	0.0007	0.02	0.006	0.001
11	KHR 104(30)	6.8	280	ND	0.25	0.03	0.14	0.06	ND	0.005	0.006	0.0004	0.02	0.007	0.001
12	KHR 104(60)	6.9	260	ND	0.47	0.03	0.11	0.04	ND	0.007	0.001	0.0005	0.02	0.009	0.001
13	KHR 105 (0)	7.5	360	ND	0.14	0.07	0.30	0.28	ND	0.004	0.001	0.0004	0.02	0.005	0.003
14	KHR 105 (30)	7.3	230	ND	0.34	0.02	0.11	0.02	ND	0.004	0.001	0.0004	0.06	0.006	0.001
15	KHR 105 (60)	7.5	180	ND	0.37	0.02	0.14	0.01	ND	0.005	0.001	0.0002	0.07	0.006	ND
16	KHR 106 (0)	6.1	360	ND	0.50	0.06	0.15	0.44	0.02	0.002	0.001	0.0006	0.02	0.010	ND
17	KHR 106 (30)	6.6	220	ND	0.26	0.06	0.08	0.05	ND	0.004	ND	0.0005	0.01	0.009	ND
18	KHR 106 (60)	6.5	190	ND	0.30	0.11	0.07	0.14	0.11	0.005	ND	0.0004	0.02	0.009	ND
19	KHR 107 (0)	6.9	350	ND	0.67	0.02	0.04	0.16	0.01	ND	0.004	0.0007	0.02	0.006	ND
20	KHR 107 (30)	6.8	310	ND	0.45	0.03	0.06	0.10	ND	ND	0.001	0.0006	0.04	0.006	ND
21	KHR 107 (60)	6.8	305	ND	0.51	0.02	0.09	0.13	0.01	ND	0.038	0.0003	0.04	0.008	ND
22	KHR 108(0)	6.4	310	ND	0.70	0.15	0.09	0.01	ND	ND	0.001	0.0005	0.02	0.006	ND
23	KHR 108(30)	6.3	190	ND	0.37	0.13	0.04	0.08	0.01	ND	0.006	0.0003	0.01	0.004	ND
24	KHR 108(60)	6.7	210	ND	0.40	0.14	0.12	0.08	ND	ND	0.002	0.0006	0.04	0.005	ND
25	KHR 109 (0)	6.5	330	ND	0.59	0.10	0.16	0.09	0.01	0.004	ND	0.0012	0.03	0.008	0.001
26	KHR 109 (30)	6.9	360	ND	0.73	0.09	0.20	0.03	0.01	0.005	0.001	0.0022	0.04	0.012	0.001
27	KHR 109 (60)	7.2	320	ND	0.51	0.10	0.11	0.09	0.01	0.008	0.001	0.0012	0.03	0.007	0.001
28	KHR 110 (0)	6.6	460	ND	0.47	0.12	0.33	0.21	ND	0.003	0.005	0.0030	0.02	0.005	ND
29	KHR 110 (30)	6.6	300	ND	0.23	0.05	0.13	0.08	ND	0.002	ND	0.0038	0.02	0.007	ND
30	KHR 110 (60)	6.6	230	ND	0.30	0.04	0.12	0.05	ND	0.004	0.001	0.0025	0.02	0.006	ND
31	KHR 111 (0)	6.8	210	ND	0.58	0.07	0.16	0.03	ND	0.003	0.001	0.0029	0.02	0.009	ND
32	KHR 111 (30)	6.8	150	ND	0.30	0.07	0.16	0.01	ND	0.004	0.003	0.0018	0.04	0.011	ND
33	KHR 111 (60)	6.7	200	ND	0.35	0.06	0.13	0.04	ND	0.004	0.002	0.0039	0.03	0.015	ND
34	KHR112 (0)	6.9	340	ND	0.63	0.15	0.01	0.09	ND	ND	ND	0.0009	0.01	0.006	ND
35	KHR112 (30)	6.8	310	ND	0.14	0.10	0.07	0.01	0.01	0.009	0.002	0.0008	0.03	0.008	ND
36	KHR112 (60)	6.9	310	ND	0.63	0.19	0.08	0.08	ND	ND	0.003	0.0008	0.03	0.007	ND

Notations: NS-Not specified; NR-No relaxation; ND- Not Detected; AL-Acceptable Limit; PL-Permissible Limit; BDL: Below detection limit

Heavy metals (HMs) are naturally occurring minerals found in soil; however, human activities can contribute considerably to high amounts of these metals in the soil. Moreover, heavy metals can enter the soil through the use of certain fertilizers, insecticides, and animal dung. Also, they are released into the soil by the degradation of rocks and minerals in the Earth's crust. However, the presence of these metals is influenced by soil composition, local geology, and geological processes. Heavy metal pollution in the soil can harm ecosystems, human health, and agricultural output. Therefore, various HMs have been analyzed in the soil samples collected from the power station area. The mean concentration of heavy metals in the soil samples at various depths during the pre-monsoon season of April (2023) is listed in Table 47.

Table 47. Mean concentration of heavy metals in the soil samples during the pre-monsoon 2023 season (April 2023).

Sr. No.	Site Code	Cr (mg/g)	Fe (mg/g)	Cu (mg/g)	Zn (mg/g)	As (mg/g)	Se (mg/g)	Cd (mg/g)	Hg (mg/g)	Pb (mg/g)
1	KHR 101 (0)	0.002	2.7	0.007	0.005	ND	ND	ND	ND	ND
2	KHR 101 (30)	0.001	1.6	0.004	0.003	ND	ND	ND	ND	ND
3	KHR 101 (60)	0.002	3.1	0.008	0.004	ND	ND	ND	ND	ND
4	KHR 102 (0)	0.003	2.5	0.008	0.005	ND	ND	ND	ND	ND
5	KHR 102 (30)	0.003	2.4	0.008	0.006	ND	ND	ND	ND	ND
6	KHR 102 (60)	0.003	2.4	0.008	0.004	ND	ND	ND	ND	ND
7	KHR 103 (0)	0.002	3.6	0.011	0.006	ND	ND	ND	ND	ND
8	KHR 103 (30)	0.002	3.7	0.011	0.006	ND	ND	ND	ND	ND
9	KHR 103 (60)	0.002	3.9	0.012	0.005	ND	ND	ND	ND	ND
10	KHR 104 (0)	0.002	2.1	0.006	0.005	ND	ND	ND	ND	ND
11	KHR 104 (30)	0.002	2.2	0.006	0.005	ND	ND	ND	ND	ND
12	KHR 104 (60)	0.002	2.6	0.007	0.004	ND	ND	ND	ND	ND
13	KHR 105 (0)	0.001	1.2	0.002	0.003	ND	ND	ND	ND	ND
14	KHR 105 (30)	0.001	1.4	0.002	0.003	ND	ND	ND	ND	ND
15	KHR 105 (60)	0.001	1.2	0.002	0.002	ND	ND	ND	ND	ND
16	KHR 106 (0)	0.001	2.0	0.003	0.005	ND	ND	ND	ND	ND
17	KHR 106 (30)	0.001	2.5	0.003	0.003	ND	ND	ND	ND	ND
18	KHR 106 (60)	0.001	2.4	0.005	0.002	ND	ND	ND	ND	ND
19	KHR 107 (0)	0.002	1.5	0.003	0.003	ND	ND	ND	ND	ND
20	KHR 107 (30)	0.002	1.4	0.003	0.006	ND	ND	ND	ND	ND
21	KHR 107 (60)	0.001	1.5	0.003	0.003	ND	ND	ND	ND	ND
22	KHR 108 (0)	0.002	2.0	0.005	0.004	ND	ND	ND	ND	ND
23	KHR 108 (30)	0.001	1.6	0.004	0.003	ND	ND	ND	ND	ND
24	KHR 108 (60)	0.001	1.5	0.005	0.005	ND	ND	ND	ND	ND
25	KHR 109 (0)	0.002	2.2	0.006	0.003	ND	ND	ND	ND	ND
26	KHR 109 (30)	0.003	3.0	0.008	0.005	ND	ND	ND	ND	ND
27	KHR 109 (60)	0.002	1.8	0.005	0.003	ND	ND	ND	ND	ND
28	KHR 110 (0)	0.001	1.5	0.005	0.003	ND	ND	ND	ND	ND
29	KHR 110 (30)	0.001	2.2	0.008	0.005	ND	ND	ND	ND	ND
30	KHR 110 (60)	0.001	1.9	0.006	0.004	ND	ND	ND	ND	ND
31	KHR 111 (0)	0.002	3.9	0.012	0.007	ND	ND	ND	ND	ND
32	KHR 111 (30)	0.006	5.5	0.016	0.010	ND	ND	ND	ND	ND

33	KHR 111 (60)	0.003	5.9	0.020	0.010	ND	ND	ND	ND	ND
34	KHR 112 (0)	0.001	1.8	0.008	0.002	ND	ND	ND	ND	ND
35	KHR 112 (30)	0.004	4.0	0.012	0.009	ND	ND	ND	ND	ND
36	KHR 112 (60)	0.003	2.8	0.014	0.006	ND	ND	ND	ND	ND

Notations: NS-Not specified; NR-No relaxation; ND- Not Detected; AL-Acceptable Limit; PL-Permissible Limit; BDL: Below detection limit.

*9.2 **Soil Chemical Properties during the post-monsoon 2023 season***

The soil sampling at the desired depth for the post-monsoon 2023 season was undertaken during October 9 – 13, 2023. The results of laboratory analysis for physico-chemical parameters and major ions (F^-, Cl^-, HCO_3^-, SO_4^{2-}, NO_3, PO_4^{3-}, Ca^{2+}, Mg^{2+}, Na^+, K^+, and Fe^{2+}) are listed in Table 48. The pH range of the soil samples analyzed in the post monsoon study ranged from 6.08 to 7.5, with an average value of 6.88 when all sample depths were considered. The nature of the soil does not shown variation during post monsoon period as compared to pre monsoon season. The value of EC for soil in the study area during the post-monsoon period ranged from 180 μS/cm to 390 μS/cm with an average value of 262.22 μS/cm. Considering all the samples at various depths. Furthermore, no specific trend of depth-wise increase or decrease in EC values has been detected in the majority of soil samples, similar to the pre-monsoon period. The mean concentration of heavy metals in the soil samples at various depths during the post-monsoon 2023 season is listed in Table 49.

Table 48. Mean concentration of major ions in soil samples during the post-monsoon season of 2023 (ions in mg/g, EC in µs/cm, pH in standard unit)

S.No.	Site Code	pH	EC	CO_3^-	HCO_3^-	Cl^-	SO_4^{2-}	NO_3^-	PO_4^-	F^-	Na^+	K^+	Ca^{2+}	Mg^{2+}	Br^-
1	KHR 101(0)	6.75	280	ND	0.26	0.10	0.31	0.06	ND	0.01	0.0010	0.0002	0.002	0.0004	ND
2	KHR 101(30)	6.43	180	ND	0.39	0.10	0.29	0.12	ND	BDL	0.0003	0.0001	0.001	0.0001	ND
3	KHR 101(60)	6.24	270	ND	0.33	0.08	0.16	0.11	ND	BDL	0.0010	0.0001	0.002	0.0005	ND
4	KHR 102 (0)	6.35	180	ND	0.28	0.10	0.19	0.08	ND	0.01	0.0009	0.0002	0.001	0.0003	ND
5	KHR 102 (30)	6.50	270	ND	0.45	0.08	0.11	0.07	ND	0.01	0.0009	0.0002	0.002	0.0004	ND
6	KHR 102(60)	6.55	240	ND	0.32	0.10	0.17	0.10	ND	0.01	0.0010	0.0002	0.002	0.0004	ND
7	KHR 103 (0)	6.57	280	ND	0.59	0.04	0.24	0.10	ND	BDL	0.0011	0.0002	0.002	0.0005	ND
8	KHR 103 (30)	6.67	260	ND	0.66	0.16	0.26	0.17	ND	BDL	0.0011	0.0002	0.002	0.0005	ND
9	KHR 103 (60)	6.68	270	ND	0.46	0.10	0.24	0.08	ND	BDL	0.0011	0.0002	0.002	0.0005	ND
10	KHR 104(0)	6.64	330	ND	0.28	0.18	0.18	0.50	ND	0.01	0.0008	0.0003	0.003	0.0005	ND
11	KHR 104(30)	6.08	290	ND	0.29	0.18	0.14	0.15	ND	0.01	0.0012	0.0003	0.002	0.0006	ND
12	KHR 104(60)	7.07	250	ND	0.34	0.08	0.17	0.02	ND	0.01	0.0014	0.0001	0.001	0.0004	ND
13	KHR 105 (0)	6.92	390	ND	0.24	0.20	0.18	0.04	ND	BDL	0.0008	0.0002	0.003	0.0004	ND
14	KHR 105 (30)	7.06	180	ND	0.29	0.14	0.19	0.07	ND	BDL	0.0006	0.0001	0.001	0.0002	ND
15	KHR 105 (60)	7.00	240	ND	0.32	0.16	0.18	0.08	ND	0.01	0.0008	0.0002	0.002	0.0003	ND
16	KHR 106 (0)	6.90	300	ND	0.49	0.12	0.05	1.43	ND	BDL	0.0008	0.0002	0.002	0.0005	ND
17	KHR 106 (30)	7.50	180	ND	0.28	0.14	0.04	0.15	ND	BDL	0.0008	0.0001	0.001	0.0003	ND
18	KHR 106 (60)	7.03	190	ND	0.62	0.12	0.05	0.09	ND	BDL	0.0008	0.0001	0.001	0.0003	ND
19	KHR 107 (0)	6.92	360	ND	0.46	0.26	0.06	0.11	ND	BDL	0.0013	0.0002	0.003	0.0008	ND
20	KHR 107 (30)	7.05	280	ND	0.29	0.14	0.40	0.10	ND	BDL	0.0014	0.0002	0.002	0.0007	ND
21	KHR 107 (60)	7.08	250	ND	0.41	0.16	0.07	0.12	ND	BDL	0.0011	0.0001	0.002	0.0005	ND
22	KHR 108(0)	7.07	300	ND	0.49	0.24	0.06	0.10	ND	BDL	0.0012	0.0003	0.002	0.0006	ND
23	KHR 108(30)	7.27	260	ND	0.65	0.16	0.05	0.02	ND	BDL	0.0014	0.0001	0.002	0.0005	ND
24	KHR 108(60)	7.24	220	ND	0.37	0.12	0.08	0.19	ND	BDL	0.0011	0.0001	0.002	0.0004	ND
25	KHR 109 (0)	7.19	240	ND	0.39	0.24	0.11	0.14	ND	0.01	0.0018	0.0002	0.002	0.0004	ND
26	KHR 109 (30)	7.12	290	ND	0.46	0.12	0.15	0.10	ND	0.01	0.0024	0.0002	0.002	0.0005	ND
27	KHR 109 (60)	7.22	270	ND	0.49	0.12	0.14	0.10	ND	0.01	0.0031	0.0001	0.001	0.0003	ND
28	KHR 110 (0)	6.96	350	ND	0.26	0.26	0.18	0.41	ND	BDL	0.0008	0.0008	0.003	0.0006	ND
29	KHR 110 (30)	7.04	250	ND	0.64	0.22	0.19	0.04	ND	0.01	0.0010	0.0005	0.002	0.0005	ND
30	KHR 110 (60)	7.08	230	ND	0.87	0.16	0.17	0.12	ND	BDL	0.0008	0.0003	0.002	0.0005	ND
31	KHR 111 (0)	7.12	240	ND	0.49	0.16	0.22	0.12	ND	BDL	0.0011	0.0002	0.002	0.0006	ND
32	KHR 111 (30)	7.16	220	ND	0.29	0.10	0.29	0.02	ND	BDL	0.0010	0.0001	0.001	0.0004	ND
33	KHR 111 (60)	7.16	250	ND	0.27	0.16	0.24	0.04	ND	BDL	0.0011	0.0001	0.002	0.0006	ND
34	KHR112 (0)	6.70	290	ND	0.62	0.10	0.17	0.70	ND	BDL	0.0012	0.0002	0.002	0.0006	ND
35	KHR112 (30)	6.70	260	ND	0.36	0.14	0.20	0.08	ND	BDL	0.0011	0.0001	0.002	0.0005	ND
36	KHR112 (60)	6.80	300	ND	0.58	0.12	0.19	0.07	ND	BDL	0.0011	0.0001	0.002	0.0006	ND

Notations: NS-Not specified; NR-No relaxation; ND- Not Detected; AL-Acceptable Limit; PL-Permissible Limit; BDL: Below detection limit

Table 49. Mean concentration of heavy metals in the soil samples during post-monsoon 2023 season.

Sr. No.	Site Code	Cr (mg/g)	Fe (mg/g)	Cu (mg/g)	Zn (mg/g)	As (mg/g)	Se (mg/g)	Cd (mg/g)	Hg (mg/g)	Pb (mg/g)
1	KHR 101 (0)	0.003	0.007	0.003	0.001	ND	ND	ND	ND	ND
2	KHR 101 (30)	0.002	0.009	0.001	ND	ND	ND	ND	ND	ND
3	KHR 101 (60)	0.003	0.012	0.003	ND	ND	ND	ND	ND	ND
4	KHR 102 (0)	0.003	0.009	0.003	0.001	ND	ND	ND	ND	ND
5	KHR 102 (30)	0.003	0.010	0.003	ND	ND	ND	ND	ND	ND
6	KHR 102 (60)	0.003	0.010	0.003	ND	ND	ND	ND	ND	ND
7	KHR 103 (0)	0.005	0.014	0.004	0.001	ND	ND	ND	ND	ND
8	KHR 103 (30)	0.003	0.009	0.003	0.001	ND	ND	ND	ND	ND
9	KHR 103 (60)	0.002	0.008	0.003	ND	ND	ND	ND	ND	ND
10	KHR 104 (0)	0.003	0.011	0.005	0.001	ND	ND	ND	ND	ND
11	KHR 104 (30)	0.004	0.011	0.003	0.001	ND	ND	ND	ND	ND
12	KHR 104 (60)	0.005	0.012	0.003	0.001	ND	ND	ND	ND	ND
13	KHR 105 (0)	0.003	0.010	0.002	0.001	ND	ND	ND	ND	ND
14	KHR 105 (30)	0.003	0.009	0.001	ND	ND	ND	ND	ND	ND
15	KHR 105 (60)	0.003	0.008	0.002	0.002	ND	ND	ND	ND	ND
16	KHR 106 (0)	0.003	0.010	0.002	0.001	ND	ND	ND	ND	ND
17	KHR 106 (30)	0.005	0.011	0.002	ND	ND	ND	ND	ND	ND
18	KHR 106 (60)	0.003	0.007	0.002	ND	ND	ND	ND	ND	ND
19	KHR 107 (0)	0.003	0.010	0.004	0.002	ND	ND	ND	ND	ND
20	KHR 107 (30)	0.003	0.012	0.003	0.003	ND	ND	ND	ND	ND
21	KHR 107 (60)	0.004	0.011	0.002	0.003	ND	ND	ND	ND	ND
22	KHR 108 (0)	0.006	0.008	0.004	0.002	ND	ND	ND	ND	ND
23	KHR 108 (30)	0.003	0.009	0.003	0.002	ND	ND	ND	ND	ND
24	KHR 108 (60)	0.003	0.010	0.002	0.002	ND	ND	ND	ND	ND
25	KHR 109 (0)	0.003	0.010	0.003	0.001	ND	ND	ND	ND	ND
26	KHR 109 (30)	0.003	0.011	0.003	0.002	ND	ND	ND	ND	ND
27	KHR 109 (60)	0.003	0.010	0.002	0.002	ND	ND	ND	ND	ND
28	KHR 110 (0)	0.003	0.010	0.005	0.002	ND	ND	ND	ND	ND
29	KHR 110 (30)	0.004	0.014	0.005	0.003	ND	ND	ND	ND	ND
30	KHR 110 (60)	0.003	0.009	0.003	0.002	ND	ND	ND	ND	ND
31	KHR 111 (0)	0.002	0.009	0.003	0.002	ND	ND	ND	ND	ND
32	KHR 111 (30)	0.003	0.007	0.002	0.002	ND	ND	ND	ND	ND
33	KHR 111 (60)	0.002	0.007	0.003	0.002	ND	ND	ND	ND	ND
34	KHR 112 (0)	0.003	0.013	0.003	0.004	ND	ND	ND	ND	ND
35	KHR 112 (30)	0.003	0.008	0.002	0.002	ND	ND	ND	ND	ND
36	KHR 112 (60)	0.003	0.007	0.002	0.002	ND	ND	ND	ND	ND

Notations: NS-Not specified; NR-No relaxation; ND- Not Detected; AL-Acceptable Limit; PL-Permissible Limit; BDL: Below detection limit.

9.3 *Soil Chemical Properties during pre-monsoon 2024 Season*

The results of laboratory analysis for physical parameters and major ions (F^-, Cl^-, HCO3-, SO42-, NO3, PO43-, Ca2+, Mg2+, Na+, K+, and Fe2+) are listed in Table 50. The natural pH of soils normally ranges from 5 to 7 in areas with more rainfall and from 6.5 to 9 in dry regions. According to their pH value, soils can be categorized as neutral (pH range: 6.5 to 7.5), alkaline (pH over 7.5), or acidic (pH less than 6.5). Strongly acidic soils have a pH of less than 5.5. The pH range of the soil samples analyzed in this study ranged from 6.33 to 7.49, with an average value of 6.61 when all sample depths were considered. The soil is frequently found to be neutral (26 out of 36 samples) within the pH range of 6.5 to 7.5. 10 samples showed acidic nature at 0 cm depth and 60 cm depth, respectively.

Soil electrical conductivity (EC), also known as the electrical conductivity of soil, is a measure of the soil's ability to conduct an electric current. It provides useful information about the physical and chemical qualities of the soil, as well as its moisture content and salinity. Soil EC monitoring is useful in a variety of sectors, including agriculture, environmental research, and geology. The value of EC for soil in the study area during the pre-monsoon period (May 2024) ranged from 160μS/cm to 360 μS/cm with an average value of 257μS/cm. Considering all the samples at various depths. Furthermore, no specific trend of depth-wise increase or decrease in EC values has been detected in the majority of soil samples. Moreover, the mean concentration of essential ions in soil samples at various depths (at the surface, at 30 cm depth, and at 60 cm depth) during the pre-monsoon 2024 season (May 2024) is listed in Table 50.

Heavy metals (HMs) are naturally occurring minerals found in soil; however, human activities can contribute considerably to high amounts of these metals in the soil. Moreover, heavy metals can enter the soil through the use of certain fertilizers, insecticides, and animal dung. Also, they are released into the soil by the degradation of rocks and minerals in the Earth's crust. However, the presence of these metals is influenced by soil composition, local geology, and geological processes. Heavy metal pollution in the soil can harm ecosystems, human health, and agricultural output. Therefore, various HMs have been analyzed in the soil samples collected from the power station area. The mean concentration of heavy metals in the soil samples at various depths during the pre-monsoon season of April (2024) is listed in Table 51.

Table 50. Mean concentration of major ions in soil samples during the pre-monsoon season May 2024 (ions in mg/g, EC in µs/cm, pH in standard unit)

S.No.	Site Code	pH	EC	CO_3^-	HCO_3^-	Cl^-	SO_4^{2-}	NO_3^-	F^-	Na^+	K^+	Ca^{2+}	Mg^{2+}	Br^-
1	KHR 101(0)	6.78	220	ND	0.27	0.430	0.479	0.318	0.020	0.56	0.16	1.03	0.26	ND
2	KHR 101(30)	6.61	230	ND	0.31	0.492	0.646	0.243	0.019	0.69	0.23	1.05	0.48	ND
3	KHR 101(60)	6.61	230	ND	0.35	0.379	0.446	0.154	0.014	0.42	0.08	0.35	0.21	ND
4	KHR 102 (0)	6.66	200	ND	0.32	0.388	0.586	0.153	0.020	0.48	0.16	0.78	0.28	ND
5	KHR 102 (30)	6.51	210	ND	0.39	0.413	0.594	0.281	0.000	0.49	0.14	0.67	0.20	ND
6	KHR 102(60)	6.68	200	ND	0.36	0.365	0.675	0.411	0.008	0.48	0.15	0.71	0.23	ND
7	KHR 103 (0)	6.49	160	ND	0.58	0.377	1.582	0.433	0.021	0.93	0.16	1.00	0.28	ND
8	KHR 103 (30)	6.58	160	ND	0.53	0.451	1.788	0.125	0.000	0.84	0.12	0.75	0.21	ND
9	KHR 103 (60)	6.44	170	ND	0.59	0.551	2.658	0.129	0.010	0.73	0.16	0.86	0.25	ND
10	KHR 104(0)	6.38	260	ND	0.31	0.632	1.004	0.116	0.016	0.88	0.45	2.64	0.55	ND
11	KHR 104(30)	6.37	250	ND	0.29	0.396	0.504	0.171	0.018	0.74	0.18	1.40	0.37	ND
12	KHR 104(60)	6.33	270	ND	0.31	0.517	0.556	0.288	0.021	0.49	0.19	1.19	0.27	ND
13	KHR 105 (0)	7.48	260	ND	0.24	0.436	0.535	0.558	0.019	0.72	0.21	1.15	0.24	ND
14	KHR 105 (30)	7.44	240	ND	0.32	0.612	0.67	0.238	0.081	0.52	0.16	0.72	0.17	ND
15	KHR 105 (60)	7.49	230	ND	0.34	0.488	0.552	0.07	0.017	0.50	0.19	0.90	0.21	ND
16	KHR 106 (0)	6.36	320	ND	0.47	0.405	0.733	0.121	0.018	0.68	0.28	1.07	0.23	ND
17	KHR 106 (30)	6.34	280	ND	0.45	0.382	0.739	0.130	0.018	0.71	0.25	1.26	0.28	ND
18	KHR 106 (60)	6.37	200	ND	0.41	0.419	0.834	0.116	0.019	0.41	0.19	0.89	0.23	ND
19	KHR 107 (0)	6.53	320	ND	0.51	5.877	16.06	5.099	0.295	0.97	0.37	2.62	0.41	ND
20	KHR 107 (30)	6.49	300	ND	0.49	5.544	12.81	1.742	0.356	0.58	0.21	1.72	0.27	ND
21	KHR 107 (60)	6.51	300	ND	0.51	6.973	15.94	2.079	0.400	0.51	0.21	1.67	0.26	ND
22	KHR 108(0)	6.44	300	ND	0.69	8.884	10.86	4.375	0.273	0.99	0.28	1.30	0.30	ND
23	KHR 108(30)	6.48	280	ND	0.63	6.853	15.85	9.891	0.453	0.77	0.19	1.18	0.30	ND
24	KHR 108(60)	6.47	280	ND	0.41	6.736	9.601	2.290	0.266	0.55	0.16	0.85	0.20	ND
25	KHR 109 (0)	6.58	310	ND	0.48	7.654	9.621	1.414	0.311	0.68	0.21	1.06	0.28	ND
26	KHR 109 (30)	6.51	340	ND	0.51	6.759	9.913	4.706	0.165	0.62	0.19	1.05	0.30	ND
27	KHR 109 (60)	6.53	300	ND	0.50	5.653	7.558	3.559	0.000	0.48	0.16	1.04	0.30	ND
28	KHR 110 (0)	6.61	360	ND	0.44	8.011	9.433	0.894	0.000	0.89	0.71	1.49	0.32	ND
29	KHR 110 (30)	6.63	280	ND	0.31	6.373	7.10	0.000	0.000	0.64	0.63	1.39	0.30	ND
30	KHR 110 (60)	6.68	250	ND	0.30	6.012	6.38	0.000	0.000	0.57	0.69	1.58	0.33	ND
31	KHR 111 (0)	6.56	200	ND	0.49	9.502	13.97	5.109	0.335	1.75	0.46	2.12	0.61	ND
32	KHR 111 (30)	6.58	180	ND	0.38	15.634	16.48	11.452	0.427	1.48	0.47	1.97	0.57	ND
33	KHR 111 (60)	6.59	190	ND	0.32	10.289	14.23	5.775	0.374	1.20	0.42	2.18	0.62	ND
34	KHR112 (0)	6.64	320	ND	0.52	19.129	41.36	1.775	0.454	1.87	0.27	1.94	0.60	ND
35	KHR112 (30)	6.68	300	ND	0.44	10.129	22.44	1.033	0.234	1.06	0.16	1.13	0.33	ND
36	KHR112 (60)	6.66	300	ND	0.43	10.473	31.33	1.224	0.274	1.11	0.23	1.50	0.42	ND

Notations: NS-Not specified; NR-No relaxation; ND- Not Detected; AL-Acceptable Limit; PL- Permissible Limit; BDL: Below detection limit

Table 51. Mean concentration of heavy metals in the soil samples during the pre-monsoon seasons of 2024.

Sr. No.	Site Code	Cr (mg/g)	Fe (mg/g)	Cu (mg/g)	Zn (mg/g)	As (mg/g)	Se (mg/g)	Cd (mg/g)	Hg (mg/g)	Pb (mg/g)
1	KHR 101 (0)	0.002	0.012	0.003	0.008	0.00	0.00	0.00	0.00	0.00
2	KHR 101 (30)	0.002	0.010	0.003	0.006	0.00	0.00	0.00	0.00	0.00
3	KHR 101 (60)	0.002	0.010	0.002	0.006	0.00	0.00	0.00	0.00	0.00
4	KHR 102 (0)	0.002	0.012	0.005	0.007	0.00	0.00	0.00	0.00	0.00
5	KHR 102 (30)	0.003	0.013	0.005	0.009	0.00	0.00	0.00	0.00	0.00
6	KHR 102 (60)	0.003	0.012	0.007	0.008	0.00	0.00	0.00	0.00	0.00
7	KHR 103 (0)	0.002	0.013	0.007	0.009	0.00	0.00	0.00	0.00	0.00
8	KHR 103 (30)	0.002	0.012	0.004	0.008	0.00	0.00	0.00	0.00	0.00
9	KHR 103 (60)	0.002	0.011	0.005	0.010	0.00	0.00	0.00	0.00	0.00
10	KHR 104 (0)	0.002	0.012	0.015	0.009	0.00	0.00	0.00	0.00	0.00
11	KHR 104 (30)	0.003	0.012	0.011	0.009	0.00	0.00	0.00	0.00	0.00
12	KHR 104 (60)	0.003	0.013	0.008	0.008	0.00	0.00	0.00	0.00	0.00
13	KHR 105 (0)	0.003	0.012	0.006	0.008	0.00	0.00	0.00	0.00	0.00
14	KHR 105 (30)	0.003	0.012	0.009	0.009	0.00	0.00	0.00	0.00	0.00
15	KHR 105 (60)	0.002	0.012	0.008	0.008	0.00	0.00	0.00	0.00	0.00
16	KHR 106 (0)	0.003	0.015	0.008	0.009	0.00	0.00	0.00	0.00	0.00
17	KHR 106 (30)	0.002	0.012	0.006	0.007	0.00	0.00	0.00	0.00	0.00
18	KHR 106 (60)	0.003	0.015	0.006	0.009	0.00	0.00	0.00	0.00	0.00
19	KHR 107 (0)	0.003	0.021	0.015	0.013	0.00	0.00	0.00	0.00	0.00
20	KHR 107 (30)	0.003	0.020	0.011	0.010	0.00	0.00	0.00	0.00	0.00
21	KHR 107 (60)	0.003	0.018	0.010	0.010	0.00	0.00	0.00	0.00	0.00
22	KHR 108 (0)	0.003	0.017	0.010	0.010	0.00	0.00	0.00	0.00	0.00
23	KHR 108 (30)	0.003	0.020	0.011	0.010	0.00	0.00	0.00	0.00	0.00
24	KHR 108 (60)	0.003	0.020	0.010	0.011	0.00	0.00	0.00	0.00	0.00
25	KHR 109 (0)	0.003	0.020	0.008	0.010	0.00	0.00	0.00	0.00	0.00
26	KHR 109 (30)	0.003	0.019	0.010	0.010	0.00	0.00	0.00	0.00	0.00
27	KHR 109 (60)	0.002	0.015	0.009	0.007	0.00	0.00	0.00	0.00	0.00
28	KHR 110 (0)	0.002	0.021	0.007	0.007	0.00	0.00	0.00	0.00	0.00
29	KHR 110 (30)	0.003	0.018	0.007	0.008	0.00	0.00	0.00	0.00	0.00
30	KHR 110 (60)	0.002	0.014	0.008	0.007	0.00	0.00	0.00	0.00	0.00
31	KHR 111 (0)	0.003	0.021	0.014	0.011	0.00	0.00	0.00	0.00	0.00
32	KHR 111 (30)	0.002	0.016	0.015	0.010	0.00	0.00	0.00	0.00	0.00
33	KHR 111 (60)	0.003	0.018	0.012	0.010	0.00	0.00	0.00	0.00	0.00
34	KHR 112 (0)	0.003	0.021	0.012	0.011	0.00	0.00	0.00	0.00	0.00
35	KHR 112 (30)	0.003	0.016	0.011	0.008	0.00	0.00	0.00	0.00	0.00
36	KHR 112 (60)	0.006	0.045	0.010	0.022	0.00	0.00	0.00	0.00	0.00

Notations: NS-Not specified; NR-No relaxation; ND- Not Detected; AL-Acceptable Limit; PL- Permissible Limit; BDL: Below detection limit.

9.4 Soil Chemical Properties during post-monsoon 2024 Season

The soil sampling at the desired depth for the post-monsoon 2024 season was undertaken during September 25 – 29, 2024. The results of laboratory analysis for physico-chemical parameters and major ions (F^-, Cl^-, HCO_3^-, SO_4^{2-}, NO_3, PO_4^{3-}, Ca^{2+}, Mg^{2+}, Na^+, K^+, and Fe^{2+}) are listed in Table 52. The pH range of the soil samples analyzed in the post monsoon study ranged from 6.18 to 7.5, with an average value of 6.84 when all sample depths were considered. The nature of the soil does not shown variation during post monsoon period as compared to pre monsoon season. The value of EC for soil in the study area during the post-monsoon period ranged from 190 µS/cm to 380 µS/cm with an average value of 267.5 µS/cm. It is to be noted that no specific trend of depth-wise increase or decrease in EC values has been detected in the majority of soil samples, similar to the pre-monsoon period. The mean concentration of heavy metals in the soil samples at various depths during the post-monsoon 2024 season is listed in Table 53.

Table 52 Mean concentration of major ions in soil samples during the post-monsoon season of 2024 (ions in mg/g, EC in µs/cm, pH in standard unit)

S.No.	Site Code	pH	EC	CO_3^-	HCO_3^-	Cl^-	SO_4^{2-}	NO_3^-	PO_4^-	F^-	Na^+	K^+	Ca^{2+}	Mg^{2+}	Br^-
1	KHR 101(0)	6.64	270	ND	0.25	0.1	0.21	0.16	ND	0.01	0.001	0.0002	0.001	0.0002	ND
2	KHR 101(30)	6.52	280	ND	0.29	0.1	0.22	0.14	ND	0.001	0.003	0.0001	0.001	0.0001	ND
3	KHR 101(60)	6.32	280	ND	0.23	0.06	0.26	0.14	ND	BDL	0.001	0.0002	0.002	0.0004	ND
4	KHR 102 (0)	6.42	190	ND	0.38	0.1	0.22	0.06	ND	0.01	0.0009	0.0001	0.002	0.0003	ND
5	KHR 102 (30)	6.42	260	ND	0.35	0.07	0.18	0.04	ND	0.01	0.0009	0.0002	0.001	0.0002	ND
6	KHR 102(60)	6.42	250	ND	0.32	0.1	0.16	0.04	ND	0.01	0.0011	0.0001	0.002	0.0002	ND
7	KHR 103 (0)	6.32	270	ND	0.56	0.05	0.24	0.12	ND	BDL	0.001	0.0002	0.001	0.0003	ND
8	KHR 103 (30)	6.56	250	ND	0.66	0.18	0.24	0.14	ND	0.01	0.001	0.0001	0.002	0.0002	ND
9	KHR 103 (60)	6.56	260	ND	0.56	0.1	0.26	0.12	ND	BDL	0.001	0.0002	0.001	0.0002	ND
10	KHR 104(0)	6.44	320	ND	0.38	0.16	0.17	0.24	ND	0.01	0.0008	0.0002	0.002	0.0003	ND
11	KHR 104(30)	6.18	280	ND	0.39	0.17	0.16	0.25	ND	0.01	0.0011	0.0001	0.002	0.0002	ND
12	KHR 104(60)	7.11	240	ND	0.35	0.09	0.18	0.26	ND	0.01	0.0012	0.0001	0.001	0.0002	ND
13	KHR 105 (0)	6.92	380	ND	0.22	0.1	0.19	0.06	ND	BDL	0.0006	0.0001	0.002	0.0003	ND
14	KHR 105 (30)	7.01	280	ND	0.28	0.11	0.18	0.07	ND	0.001	0.0006	0.0001	0.001	0.0002	ND
15	KHR 105 (60)	7.02	250	ND	0.22	0.12	0.16	0.06	ND	0.01	0.0008	0.0002	0.002	0.0003	ND
16	KHR 106 (0)	6.9	210	ND	0.39	0.14	0.04	0.13	ND	BDL	0.0006	0.0001	0.002	0.0004	ND
17	KHR 106 (30)	7.5	190	ND	0.28	0.12	0.06	0.15	ND	BDL	0.0006	0.0001	0.001	0.0003	ND
18	KHR 106 (60)	7.03	190	ND	0.32	0.16	0.05	0.19	ND	BDL	0.0008	0.0001	0.001	0.0002	ND
19	KHR 107 (0)	6.91	310	ND	0.36	0.14	0.06	0.11	ND	0.001	0.0012	0.0001	0.002	0.0006	ND
20	KHR 107 (30)	7.02	290	ND	0.39	0.14	0.04	0.12	ND	BDL	0.0013	0.0002	0.002	0.0007	ND
21	KHR 107 (60)	7.04	280	ND	0.31	0.15	0.06	0.12	ND	BDL	0.0012	0.0001	0.002	0.0005	ND
22	KHR 108(0)	7.02	280	ND	0.59	0.14	0.04	0.14	ND	BDL	0.0011	0.0002	0.001	0.0004	ND
23	KHR 108(30)	7.24	270	ND	0.55	0.16	0.05	0.12	ND	BDL	0.0013	0.0001	0.002	0.0006	ND
24	KHR 108(60)	7.27	280	ND	0.47	0.12	0.06	0.16	ND	BDL	0.0011	0.0001	0.001	0.0004	ND
25	KHR 109 (0)	7.01	250	ND	0.49	0.24	0.14	0.14	ND	0.01	0.0018	0.0002	0.001	0.0004	ND
26	KHR 109 (30)	7.1	280	ND	0.46	0.12	0.16	0.16	ND	0.01	0.0022	0.0001	0.002	0.0004	ND
27	KHR 109 (60)	7.02	260	ND	0.49	0.12	0.12	0.14	ND	0.01	0.0022	0.0001	0.001	0.0003	ND
28	KHR 110 (0)	6.98	350	ND	0.26	0.24	0.12	0.11	ND	BDL	0.0008	0.0004	0.002	0.0004	ND
29	KHR 110 (30)	7.02	250	ND	0.34	0.22	0.14	0.14	ND	0.01	0.0006	0.0004	0.002	0.0003	ND
30	KHR 110 (60)	7.01	230	ND	0.47	0.26	0.11	0.12	ND	BDL	0.0008	0.0003	0.002	0.0004	ND

31	KHR 111 (0)	7.11	250	ND	0.39	0.12	0.24	0.02	ND	BDL	0.0012	0.0002	0.001	0.0004	ND
32	KHR 111 (30)	7.12	240	ND	0.39	0.14	0.26	0.02	ND	BDL	0.0012	0.0001	0.001	0.0004	ND
33	KHR 111 (60)	7.12	250	ND	0.37	0.12	0.24	0.04	ND	BDL	0.0012	0.0001	0.002	0.0005	ND
34	KHR112 (0)	6.65	280	ND	0.52	0.1	0.17	0.07	ND	BDL	0.0012	0.0001	0.001	0.0005	ND
35	KHR112 (30)	6.68	270	ND	0.46	0.12	0.19	0.08	ND	BDL	0.0012	0.0001	0.002	0.0004	ND
36	KHR112 (60)	6.67	360	ND	0.57	0.1	0.16	0.07	ND	BDL	0.0011	0.0001	0.002	0.0004	ND

Table 53 Mean concentration of heavy metals in the soil samples during post-monsoon 2024 season

Sr. No.	Site Code	Cr (mg/g)	Fe (mg/g)	Cu (mg/g)	Zn (mg/g)	As (mg/g)	Se (mg/g)	Cd (mg/g)	Hg (mg/g)	Pb (mg/g)
1	KHR 101 (0)	0.006	ND	ND	ND	ND	ND	ND	ND	ND
2	KHR 101 (30)	0.007	ND	ND	ND	ND	ND	ND	ND	ND
3	KHR 101 (60)	0.005	ND	ND	ND	ND	ND	ND	ND	ND
4	KHR 102 (0)	0.009	ND	ND	0.001	ND	ND	ND	ND	ND
5	KHR 102 (30)	0.004	ND	ND	ND	ND	ND	ND	ND	ND
6	KHR 102 (60)	0.005	ND	ND	ND	ND	ND	ND	ND	ND
7	KHR 103 (0)	0.008	ND	ND	ND	ND	ND	ND	ND	ND
8	KHR 103 (30)	0.011	0.012	ND	ND	ND	ND	ND	ND	ND
9	KHR 103 (60)	0.010	0.014	ND	ND	ND	ND	ND	ND	ND
10	KHR 104 (0)	0.006	ND	ND	ND	ND	ND	ND	ND	ND
11	KHR 104 (30)	0.005	ND	ND	ND	ND	ND	ND	ND	ND
12	KHR 104 (60)	0.008	0.007	ND	ND	ND	ND	ND	ND	ND
13	KHR 105 (0)	0.016	0.013	ND	ND	ND	ND	ND	ND	ND
14	KHR 105 (30)	0.004	ND	ND	ND	ND	ND	ND	ND	ND
15	KHR 105 (60)	0.026	ND	0.006	0.007	ND	ND	ND	ND	ND
16	KHR 106 (0)	0.009	ND	ND	0.002	ND	ND	ND	ND	ND
17	KHR 106 (30)	0.006	ND	ND	ND	ND	ND	ND	ND	ND
18	KHR 106 (60)	0.023	ND	0.042	0.093	ND	ND	ND	ND	ND
19	KHR 107 (0)	0.009	ND	ND	ND	ND	ND	ND	ND	ND
20	KHR 107 (30)	0.007	ND	ND	ND	ND	ND	ND	ND	ND
21	KHR 107 (60)	0.005	0.015	0.009	0.021	ND	ND	ND	ND	ND
22	KHR 108 (0)	0.007	ND	ND	ND	ND	ND	ND	ND	ND
23	KHR 108 (30)	0.002	ND	ND	ND	ND	ND	ND	ND	ND
24	KHR 108 (60)	0.003	0.015	ND	ND	ND	ND	ND	ND	ND
25	KHR 109 (0)	0.013	0.004	ND	0.004	ND	ND	ND	ND	ND
26	KHR 109 (30)	0.003	ND	ND	ND	ND	ND	ND	ND	ND
27	KHR 109 (60)	0.003	0.009	ND	ND	ND	ND	ND	ND	ND
28	KHR 110 (0)	0.011	0.004	ND	ND	ND	ND	ND	ND	ND
29	KHR 110 (30)	0.005	ND	ND	ND	ND	ND	ND	ND	ND
30	KHR 110 (60)	0.002	0.013	ND	ND	ND	ND	ND	ND	ND
31	KHR 111 (0)	0.006	ND	ND	ND	ND	ND	ND	ND	ND
32	KHR 111 (30)	0.004	ND	ND	ND	ND	ND	ND	ND	ND
33	KHR 111 (60)	0.013	ND	ND	ND	ND	ND	ND	ND	ND
34	KHR 112 (0)	0.007	ND	ND	ND	ND	ND	ND	ND	ND
35	KHR 112 (30)	0.007	ND	ND	ND	ND	ND	ND	ND	ND
36	KHR 112 (60)	0.003	ND	ND	ND	ND	ND	ND	ND	ND

Notations: NS-Not specified; NR-No relaxation; ND- Not Detected; AL-Acceptable Limit; PL-Permissible Limit; BDL: Below detection limit.

10 ISOTOPE DATA ANALYSIS

Isotopes can play a significant role in studying the origin, age, occurrence, and distribution of groundwater in a region, recharge mechanism, determination of groundwater flow direction and velocity, interconnections and interaction between aquifers, and identification of recharge areas and sources. Isotopes can also be applied to study surface water and groundwater interaction, among others.

In the present study, groundwater and surface water samples were collected from different sources such as hand pumps, tube wells, and open wells for isotopic characterisation of the waters of the study area. Water samples were collected from different sources for analysis of stable isotopes. For the analysis of δ^2H, $\delta^{18}O$, a 20 ml sample was collected in pre-cleaned Polypropylene bottles (Tarsons make). The bottles were rinsed and filled with water samples, and tightly capped (to prevent evaporation and exchange with air). On-site measurements like sample temperature, pH, and conductivity, along with all other relevant site information, were also recorded.

The stable isotope ratio is the molar ratio of heavy to light isotopes and is known as the abundance ratio. It is denoted by δ(x) and given by

$$\delta(x) = \left\{\frac{R_{SAMPLE}}{R_{STANDARD}} - 1\right\} * 1000\ (in\ permil\ /\ ‰)$$

where δ(x) is the delta value of the sample for element' x' in permil (‰), and R is the molar ratio of the heavy-to-light isotope in the sample. Different isotope standards can determine the isotopic compositions, the most common being VSMOW (Vienna Standard Mean Ocean Water). Water isotope ratios vary with the season, and groundwater isotope values differ from GMWL and LMWL due to (i) natural intermittent processes such as evaporation, infiltration, and percolation and (ii) anthropogenic-driven processes. A small fraction of rain percolates through the soil to become groundwater; however, significant modifications in signatures are observed in meteoric water, particularly in arid and semi-arid regions.

*10.1 **Isotope Analysis for Pre-monsoon Season***

For the study, 16 representative groundwater samples were collected from semi-arid regions in the Khargone district of Madhya Pradesh during the pre-monsoon season. Six groundwater samples were collected from the piezometer, seven from the handpump, two from the tube well, and one from the open well. The ratios of heavy stable isotopes were measured using Dual Inlet Isotope Ratio Mass Spectrometer-DI IRMS. The results of $\delta^{18}O$ varied from -0.69 to -4.84 ‰ with an average value of -2.61 ‰, whereas $\delta\,^{2}H$ varied from -9.11 to - 37.07 ‰ with an average value of -19.43 ‰. The characteristic isotope lines of groundwater samples are very closely related to the LMWL (as shown in Table 54), indicating that meteoric water is the primary source of recharge in groundwater. The slight variation in the slope of GMWL (8) and LMWL (7.68) may be due to differences in the source of moisture and climatic and geographic conditions. The overall slope of the groundwater sample (5.74) is less steep than the LMWL (7.68), indicating the occurrence of evaporation before water infiltration in the vadose zone. The individual trends of piezometer samples (06), handpump (07), tube wells (02), and the open well (01) are showing the similar patterns. Figure 19 represents isotopic characterization for groundwater samples based on plots between $\delta^{2}H$ and $\delta^{18}O$.

Table 54 Characteristic isotope lines of GMWL, LMWL, and groundwater samples for Pre-monsoon 2023

S. No.	Component type	Regression equation
1	Global meteoric water line (Craig, 1961)	$\delta^2H = 8\delta^{18}O + 10$
2	Local meteoric water line (Deshpande et al., 2013)	$\delta^2H = \mathbf{7.68}\delta^{18}O + 5.77$
3	Groundwater representative samples	$\delta^2H = \mathbf{5.74}\delta^{18}O - 4.54$

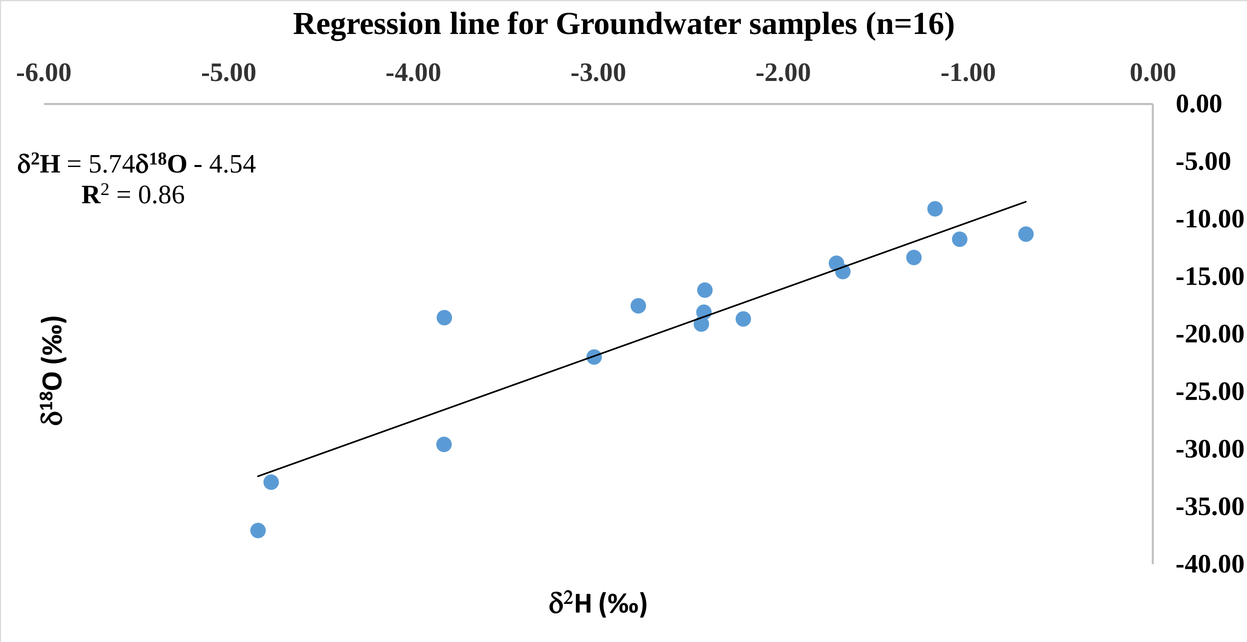


Figure 19. Isotopic characterization for Groundwater samples collected from piezometers (06), handpump (07), tube-wells (02), and the open well (01) for Pre-monsoon 2023.

10.2 *Isotope Analysis for Post-monsoon Season*

The δ ^{8}O varied from -0.64 to -9.02 ‰ with an average value of -3.62 ‰, whereas δ^{2}H varied from -9.04 to – 48.71 ‰ with an average value of -21.93 ‰. The characteristic isotope lines of groundwater samples are very closely related to the LMWL (as shown in Table 55 Characteristic isotope lines of GMWL, LMWL, and groundwater samples for post-monsoon 2023 season.). The overall slope of the post-monsoon groundwater samples (5.09) is less steep than the LMWL (7.68) and pre-monsoon groundwater samples (5.74), indicating meteoric water to be the primary source of groundwater recharge. The individual trends of piezometer samples (06), handpump (07), tubewells (02), and the open well (01) show similar patterns as in the case of the pre-monsoon season. The variation in intercept is due to differences in the source of moisture and climatic conditions. The contribution from each factor cannot be equal and it can be negligible in some places. Some rapid changes are likely linked to poor well integrity and anulus flow, highlighting the risk to groundwater sources from surface water intrusion. Moreover, the suggested predominance of evaporation in both pre- and post-season due to semi-arid conditions was also observed.

Figure 20 shows Isotopic characterization for Groundwater samples collected from piezometers (06), handpump (07), tube-wells (02), and the open well (01) in the post-monsoon season.

Table 55 Characteristic isotope lines of GMWL, LMWL, and groundwater samples for post-monsoon 2023 season.

S. No.	Component type	Regression equation
1	Global meteoric water line (Craig, 1961)	$\delta^2H = 8\delta^{18}O + 10$
2	Local meteoric water line (Deshpande et al., 2013)	$\delta^2H = \mathbf{7.68}\delta^{18}O + 5.77$
3	Groundwater representative samples	$\delta^2H = \mathbf{5.09}\delta^{18}O - 0.05$

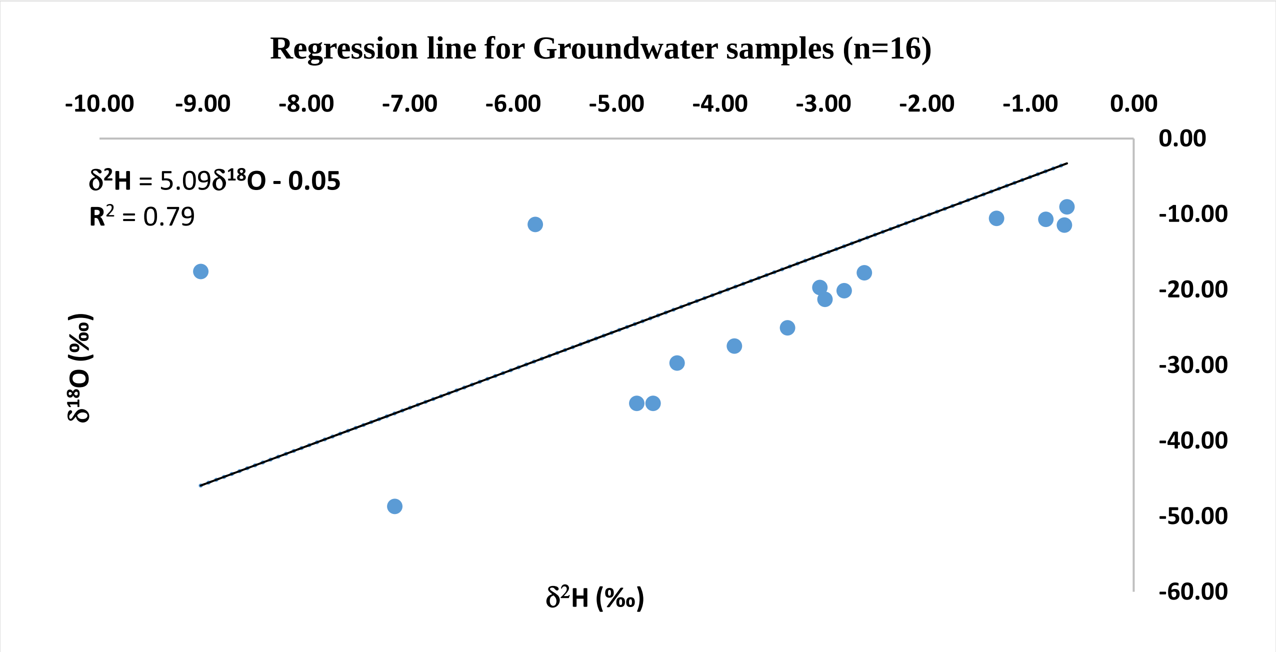


Figure 20. Isotopic characterization for Groundwater samples collected from piezometers (06), handpump (07), tube-wells (02), and the open well (01) for Post-monsoon 2023.

11 SUMMARY AND CONCLUSION

Site visits to NTPC Khargone power station, located near villages Selda, Balabad and Dalchi in Barwah tehsil of Khargone district of Madhya Pradesh, and the surrounding 10 km area were undertaken for pre-monsoon season during April 25 – 30, 2023, for post-monsoon season during October 9 – 13, 2023 and for pre-monsoon season during May 5 – 9, 2024 and post-monsoon September 25 – 29, 2024 by the survey team of IIT Roorkee. During these site visits, groundwater and surface water samples were collected from different sources such as hand pumps, tube wells, open wells, ponds, reservoirs, rivers, ash dyke and piezometers etc. Groundwater table depth was also measured in existing open wells and piezometers to prepare groundwater table and flow direction maps. Soil samples at the surface, 30 cm, and 60 cm from the ground were also collected and brought to IIT Roorkee for the analysis of soil chemical properties, like EC, pH, major ions (Na, K, Ca, Mg, Fe, CO_3, HCO_3, Cl, SO_4, NO_3, F-, and PO_4), and Heavy metals (Cd, Zn, Hg, As, Cr, Pb etc.). Collected surface and groundwater samples were analysed to measure water quality parameters like pH, EC, DO, BOD, COD, major cations (Na, K, Ca, Mg, and Fe etc.), major anions (CO3, HCO3, Cl, SO4, NO3, F-, and PO4 etc.) and Heavy metals (Cd, Zn, Hg, As, Cr, Pb etc.). Some water quality parameters were determined using in-situ probes, and major cations, anions and heavy metals were determined using laboratory facilities available at IIT Roorkee. The following conclusions are made based on the analysis of 1st & 2nd year of sampling (pre and post-monsoon 2023-2024 data).

Analysis of groundwater table observation reveals that, in general, the groundwater is flowing in two distinct patterns. The groundwater in the area to the north of the power station flows northwards towards Narmada River, and the groundwater in the area to the southern side of the power station flows towards the south and southwest direction.

1. The groundwater table contour map of the area is found mostly in line with its surface drainage pattern and didn't change much during the pre and post monsoon seasons 2023-2024.
2. The water quality of most of the surface water samples was found to be well within the prescribed limits of BIS standards during the pre and post-monsoon

2023-2024 season. The concentration of a few elements such as fluoride, sulphate and some heavy metals such as Fe, Se, and As was found to be slightly higher than the prescribed BIS limits of drinking water in ash dyke samples. Also, the pH values were slightly high in surface water samples collected from the ash dyke area. The surface water quality in the post-monsoon 2024 season was generally within BIS limits, with pH (mean: 8.0), TDS (336.36 mg/L), and DO (6.94 mg/L) indicating good quality, though elevated BOD (13.83 mg/L) and COD (52.83 mg/L) suggest organic pollution. Heavy metals were minimal, and major ions like fluoride and chloride were mostly compliant.

3. The water quality of most of the groundwater samples was found to be well within the prescribed limits of BIS standards during the pre and post-monsoon 2023-2024 season. The concentration of a few elements such as fluoride, nitrate, sulphate, and some heavy metals such as Fe, and Se was found to be slightly higher than the prescribed BIS limits of drinking water in a few groundwater samples during pre-monsoon 2023 season. The groundwater quality during the post-monsoon 2024 season showed moderate levels of key parameters like DO (3.86 mg/L), TDS (497.14 mg/L), and pH (7.50), with most values within BIS limits. Elevated concentrations of fluoride, nitrate, and hardness were noted in some areas, requiring attention. Heavy metals were mostly within safe limits, with negligible levels of arsenic, chromium, and iron. Overall, the groundwater quality in the pre and post monsoon season is suitable for domestic use, indicating that it meets the standards and requirements necessary to provide safe and clean water for households.
4. The pH range of the soil samples analyzed in this study ranged from 6.05 to 7.5, with an average value of 6.8 when all sample depths were considered. The soil is frequently found to be neutral (34 out of 36 samples) within the pH range of 6.5 to 7.5. Only two samples showed acidic nature at 0 cm depth and 30 cm depth, respectively. Other soil chemical properties were found well within the prescribed limits. The nature of the soil remains consistent during the post-monsoon period compared to the pre-monsoon season of 2023-2024.

Considering all the samples across various depths, no specific trend of increase or decrease with depth is observed.

5. The overall slope of the post-monsoon groundwater samples (5.09) is less steep than the LMWL (7.68) and pre-monsoon groundwater samples (5.74), indicating meteoric water to be the primary source of groundwater recharge. The individual trends of piezometer samples (06), handpump (07), tubewells (02), and the open well (01) are showing the similar patterns as in case both pre-monsoon season and post-monsoon season.

Reference:

1. Kritzberg, E. S., Ekström, S. M. (2012). Increasing iron concentrations in surface waters–a factor behind brownification. Biogeosciences, 9(4), 1465-1478.
2. Mukate, S., Panaskar, D., Wagh, V., Muley, A., Jangam, C., Pawar, R. (2018). Impact of anthropogenic inputs on water quality in Chincholi industrial area of Solapur, Maharashtra, India. Groundwater for Sustainable Development, 7, 359-371.
3. CGWB (2013). Ground water information Solapur district Maharashtra. Central Groundwater Board. http://cgwb.gov.in/District_Profile/Maharashtra/Solapur.pdf
4. Kulkarni, U. D., Sangpal, R. R., Nandurkar, Y. M. (2011). Geochemical Impact of the Surface Runoff on the Drinking Water Quality of the Yeshwantsagar Reservoir in Ujjani DAM, Solapur District (India). In Advances in Geosciences: Volume 23: Hydrological Science (HS) (pp. 171-183). https://doi.org/10.1142/9789814355339_0014
5. Deshpande, R. D., Maurya, A. S., Angasaria, R. C., Dave, M., Shukla, A. D., Bhandari, N., & Gupta, S. K. (2013). Isotopic studies of megacryometeors in western India. *Current Science*, 728-737.
6. Craig, H. (1961). Isotopic variations in meteoric waters. *Science*, *133*(3465), 1702-1703.

Appendix-A: Photographs of Sampling Sites

Sl. No.	Site Details	Location Details	Location Photograph
Ground Water Sites			
1.	Site Code: KHR1 Latitude: 22.077748 Longitude: 75.831549	In House of Sh. Rai Singh S/O Sh. Jai Sing. On Road of Pipalgaon to NTPC Power station, Near Electric Triangle pole of HT Line, Vill Dalchi	
2.	Site Code: KHR2 Lat: 22.060904 Long: 75.765297	Anganwadi & School Compound Near Hanuman Mandir, Vill Bhatyaan Khurd Remarks: Nearby well depth was also taken	
3.	Site Code: KHR3 Lat: 22.069258 Long: 75.857885	Near NTPC opp Bhilal Baba Temple, Gate No. 1,opp Cooling Towers, Below Bargad Tree	

4.	Site Code: KHR4 Lat: 22.068803 Long: 75.862023	Between NTPC & Town ship, opposite to Boundary Pillar S.N. 230-240	
5.	Ste Code: KHR5 Lat: 22.124938 Long: 75.895198	Inside Primary School, Vill Baddgaon Remarks: Nearby well depth also measured	
6.	Site Code: KHR5A Lat: 22.12407 Long: 75.89518	Adjacent to main road, Vill Badgaon	

7.	Site Code: KHR6 Lat: 22.122422 Long: 75.842507	opp Madhya Pradesh Gramin Bank, opp Health Centre. Vill Kanapur Remarks: Indiamarka Handpump	
8.	Site Code: KHR6A Lat: 22.12545 Long: 75.84165	Well in the field, Vill Kanapur	
9.	Site Code: KHR7 Lat: 22.123495 Long: 75.794	In House of sh. Daya Ram, Vill Londhi (Jhirbar)	

10.	Site Code: KHR7A Lat: 22.12314 Long: 75.7963	Londhi village Remarks: Motor was running at time of measurement	
11.	Site Code: KHR7B Lat: 22.12126 Long: 75.79317	Londhi village	
12.	Site Code: KHR8A Lat: 22.10271 Long: 75.75548	Karan Gangle Handpump, Pipalgone village. Remarks: Nearby well depth also measured	

13.	Site Code: KHR9A Lat: 22.10857 Long: 75.75845	Lokesh Rathore Tubewell, Pipalgaon	
14.	Site Code: KHR10 Lat: 22.04166 Long: 75.81254	Near Anganwadi Kendra, Bhopada	
15.	Site Code: KHR10A Lat: 22.04086 Long: 75.81116	Near Roop Singh house, Bhopada Remarks: Indiamarka handpump	

16.	Site Code: KHR11 Lat: 22.007591 Long: 75.851219	Near KHR 12, Hanuman Temple, Padaliya village	
17.	Site Code: KHR12 Lat: 22.007275 Long:75.853942	Padaliya village Remarks: Gawali samaj Dharamshala	
18.	Site Code: KHR13 Lat: 22.066083 Long: 75.871388	Adjoining of NTPC Community Centre Near New Hanumaan Temple Remarks: Measurement of nearby well also done	

19.	Site Code: KHR14 Lat: 22.049303 Long: 75.877826	Opp Gram Panchayat office. Vill Kheri Bujurg	
20.	Site Code: KHR15 Lat: 22.069233 Long: 75.857978	Near Bhilal Baba Temple, opposite cooling tower, Near NTPC Gate No. 1	
21.	Site Code: KHR15A Lat: 22.07092 Long: 75.85599	Near KHR 15 and KHR 3, Below Mango tree	

22.	Site Code: KHR16A Lat: 22.07912 Long: 75.80412	Adjacent to Gangour thermal power station road	
23.	Site Code: KHR17 Lat: 22.069467 Long: 75.852274	Below Tower Line, North side of Power station, Side of NTPC Road Remarks: Seepage water from below power station	
24.	Site Code: KHR18 Lat: 22.062953 Long: 75.852559	Well inside power station	

25.	Site Code: KHR19 Lat: 22.075184 Long: 75.824819	opp Community Centre Near Primary School, Near Baba Ramdev Mandir, Dalchi	
26.	Site Code: KHR20 Lat: 22.092052 Long: 75.849177	Below Tower Line, North side of Power station, Side of NTPC Road	
27.	Site Code: KHR20A Lat: 22.0833 Long:75.8515	Maal Singh Jhapdiya Well, Jamniya village	

28.	Site Code: KHR21 Lat: 22.12321 Long:75.90812	Adjacent to pipalgone road	
29.	Site Code: KHR22 Lat: 22.11305 Long: 75.92877	Adjacent to Pipalgone road	
30.	Site Code: KHR23 Lat: 22.10902 Long: 75.93549	Adjacent to Pipalgone road	

31.	Site Code: KHR24 Lat: 22.04485 Long: 75.87855	Adjacent to Umaria road	
32.	Site Code: KHR25 Lat: 22.02839 Long: 75.89527	In front of Rewa Gurjar Dharamshala, Gram panchayat office, Umaria Remarks: Nearby handpump measurement was also done	
33.	Site Code: KHR26 Lat: 21.99242 Long: 75.86363	In the field adjacent to Padaliya road	

34.	Site Code: KHR-27 Lat: 22.021429 Long: 75.879967	Adjacent to road nimori	
35.	Site Code: KHR-28 Lat: 21.97891 Long: 75.86348	Adjacent to Padaliya road, open well	
36.	Site Code: KHR-29 Lat: 21.978471 Long: 75.862909	Adjacent to Khargone Sanawad Road Near IOC Petrol Pump	

37.	Site Code: KHR-30 Lat: 22.04404 Long: 75.85192	Adjacent to Umerdad road	
38.	Site Code: KHR-31 Lat: 22.06500 Long: 75.88535	Adjacent to Gangour Thermal Plant Rd	
39.	Site Code: KHR-32 Lat: 22.10956 Long: 75.96084	Adjacent to Khargone - Sanawad Rd, Amarpura	

Surface Water Sites			
34.	Site Code: KHR51 Lat: 22.07047 Long: 75.858149	Pond Between NTPC Power station & Township	
35.	Site Code: KHR52 Lat: 22.12206 Long: 75.842803	Pond near Health Centre at Main Road, Vill Kanapur	
36.	Site Code: KHR53 Lat: 22.104185 Long: 75.812277	Jirbhar lake	

37.	Site Code: KHR54A Lat: 22.158804 Long: 75.76167	Narmada River Downstream	
38.	Site Code: KHR55 Lat: 22.006354 Long: 75.848828	Ambak Reservoir	
39.	Site Code: KHR56 Lat: 22.075493 Long: 75.927687	Lachhora Talab	

40.	Site Code: KHR57 Lat: 22.115246 Long: 75.866087	Kattora Pond, Shelda Power station-Kattora Road	
41.	Site Code: KHR58 Lat: 22.07323 Long: 75.833941	OFL Ash Dyke	
42.	Site Code: KHR59 Lat: 22.073978 Long: 75.839568	Lagoon 1 Ash Dyke Remarks: Dried up	

43.	Site Code: KHR60 Lat: 22.07661 Long: 75.8332	Lagoon 2 Ash Dyke	
44.	Site Code: KHR61 Lat: 22.06741 Long: 75.860638	Raw water reservoir inside power station	Photo not taken
45.	Site Code: KHR61A Lat: 22.063462 Long: 75.855098	Aerated water from raw water reservoir	
46.	Site Code: KHR62 Lat: 22.07441 Long: 75.850902	Nala flowing as groundwater drainage below tower line on road crossing near power station.	

47.	Site Code: KHR63 Lat: 22.1927 Long: 75.97763	Narmada River upstream, Toksar	
48.	Site Code: KHR64 Lat: 22.00772 Long: 75.90917	Ambak River, Khargone-Sanawad road	

Soil Sampling Sites			
49.	Site Code: KHR101 Lat: 22.068686 Long: 75.865808	NTPC Plantation Land near Shelda Village	
50.	Site Code: KHR102 Lat: 22.061526 Long: 75.87233	NTPC Power station to Kheri road along NTPC Railway line	
51.	Site Code: KHR103 Lat: 22.077065 Long: 75.832013	Near NTPC Boundary inside Dalchi along Power station AshDyke - Dalchi road	

52.	Site Code: KHR104 Lat: 22.062734 Long: 75.845571	Power station to Bhopada side single Chimney side	
53.	Site Code: KHR105 Lat: 22.113848 Long: 75.868283	opp side of Kottara Pond, Power station to Kattora Village	
54.	Site Code: KHR106 Lat: 22.119023 Long: 75.890667	Near Badgaon Village, Near Papu Dhaba	

55.	Site Code: KHR107 Lat: 22.117732 Long: 75.83194	Kanhapur-Pipalgaon Road ,Along Road site outside Kanhapur	
56.	Site Code: KHR108 Lat: 22.123119 Long: 75.790038	Pipalgaon Londi road, Londi along road side Near Hand Pump	
57.	Site Code: KHR109 Lat: 22.118459 Long: 75.757034	opp Sant Siya ram Auto Parts & Garrage	

58.	Site Code: KHR110 Lat: 22.062688 Long: 75.768112	Village Bhatiyan On Power station road Near Overhead water tank opp side	
59.	Site Code: KHR111 Lat: 22.044646 Long: 75.817312	Village Bhopada Shalda Road	
60.	Site Code: KHR112 Lat: 22.090059 Long: 75.848602	Vill Jamnia	

Piezometers around ash dyke			
61.	Site Code: KHR PZ1 Lat: 22.07826 Long: 75.8367	Piezometer 1, Ash Dyke	
62.	Site Code: KHR PZ2 Lat: 22.07721 Long: 75.83306	Piezometer 2, Ash Dyke	
63.	Site Code: KHR PZ3 Lat: 22.07476 Long: 75.83177	Piezometer 3, Ash Dyke	

64.	Site Code: KHR PZ4 Lat: 22.07289 Long: 75.83233	Piezometer 4, Ash Dyke	
65.	Site Code: KHR PZ5 Lat: 22.07055 Long: 75.83277	Piezometer 5, Ash Dyke	
66.	Site Code: KHR PZ6 Lat: 22.07089 Long: 75.83548	Piezometer 6, Ash Dyke	

DEPARTMENT OF HYDROLOGY
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE
ROORKEE (UTTARAKHAND), INDIA
Phone: +91 1332 285845
Email: manoj.jain@hy.iitr.ac.in

Annexure-4

एनटीपीसी NTPC

एनटीपीसी लिमिटेड
(भारत सरकार का उद्यम)
NTPC Limited
(A Govt. of India Enterprise)

Ref: KGN/EMG/Ann. Comm./Ash Dyke Certification

Date: 15.03.2025

To
The Member Secretary,
Central Pollution Control Board
Delhi
Email- **mscb.cpcb@nic.in**
power.cpcb@gov.in

Sub: Submission of Annual Certification of Ash Dyke for FY 2024-25

Ref: MoEF & CC Gazette Notification dated 31.12.2021 & its amendments

Dear Sir,

As per Clause-A (6), Ministry of Environment and Forest & Climate Change (MoEF&CC) Gazette Notification, annual certification of the ash pond or dyke shall be done by the thermal power plants as per guidelines issued by Central Pollution Control (CPCB) & Central Electricity Authority (CEA)

In compliance to the above, annual certification of ash dyke for the year 2024-25 has been conducted at NTPC-Khargone by an institute of repute, M/s Shri. G. S. Institute of Technology & Science (SGSITS), Indore.

Accordingly, Annual Certification Report of Ash Dyke as above is submitted herewith for your kind information and perusal please.

Thanking you,

Yours Sincerely,
for Brijabrata Mondal
(Ashish Kumar Agarwal)
Add. General Manager (Ash & Envt. Mgmt.)

Enclosure:
1. Annual Certification of Ash Dyke Report for FY 2024-25

Copy to (Email) :-
1. M.P. Pollution Control Board
   Email- **ms-mppcb@mp.gov.in & ropcb-indore@mp.gov.in**
2. Central Electricity Authority
   Email- **tcdcea@nic.in**
3. Ministry of Environment, Forest, and Climate Change
   Email- **rowz.bpl-mef@nic.in & moefcccoalash@gov.in**)

Phone : 0731-2544415 (O)
Email :director@sgsits.ac.in
EPABX : 0731 - 2582101,112
Website : www.sgsits.ac.in

SHRI G.S. INSTITUTE OF TECHNOLOGY & SCIENCE

(A Govt. Aided, UGC Autonomous Institute under 2(F) & 12(B), Established in 1952)
23, Sir M. Visvesvaraya Marg (Park Road), INDORE - 452 003 (M.P.) India
(Shri Govindram Seksaria Institute of Technology & Science, Indore M.P.)

Ref. :

Date : 13-03-2025

CE-AMD/CONS/C-1294/SMN -SKA/2025/1811

13 MAR 2025

To

AGM Civil (O & M)
NTPC Khargone Super Thermal Power Project
Village-Selda, Post-Khedi (Bujurg)
Distt.-Khargone (MP) – 451113

Sub. : Report for Annual Certification of Ash Ponds and Dykes as per MOEF & CC guideline at NTPC Khargone (M.P.).

Ref.: Your Email Dated: 24-01-2025 and 14-02-2025
Our letter No: CE-AMD/Consultancy/SMN-SKA/Quotation/2025/1526 dated 28-01-2025

Sir,

This has reference to your email/letter cited above; the report of the annual certification of ash ponds and dykes as per MOEF & CC and CPCB guidelines for NTPC Super Thermal Power Project, Khargone (M.P.) is attached herewith. With reference to the above, we are submitting herewith our observations, recommendations and checklist (Annexure 1).

The consultancy charges of above work are Rs. 88,205/- (Consultancy fee 74,750 + 18% service tax (GST) 13,455/-). You are requested to make the payment of an amount of Rs. 88,205/- in account section of our Institute as soon as possible.

Your comments regarding the services provided by the Institute and your suggestions (if any) regarding the improvement for the same will be helpful to us.

Thanking you,

Yours Sincerely,

N. Purohit

DIRECTOR

Encl.: Report and Annexure 1

Phone : 0731-2544415 (O)
Email :director@sgsits.ac.in
EPABX : 0731 - 2582101,112
Website : www.sgsits.ac.in

SHRI G.S. INSTITUTE OF TECHNOLOGY & SCIENCE

(A Govt. Aided, UGC Autonomous Institute under 2(F) & 12(B), Established in 1952)
23, Sir M. Visvesvaraya Marg (Park Road), INDORE - 452 003 (M.P.) India
(Shri Govindram Seksaria Institute of Technology & Science, Indore M.P.)

Ref. : CE-AMD/CONS/C-1294/SMN -SKA/2025/1811 Date: 13 MAR 2025

REPORT ON

Annual Certification of Ash Ponds and Dykes for NTPC Khargone

Name of the Client	:	Additional General Manager Civil (O & M) NTPC Khargone Super Thermal Power Project, Khargone (M.P.)
Name of the work	:	Annual certification of ash ponds and dykes as per MOEF & CC and CPCB guidelines for NTPC Super Thermal Power Project, Khargone (M.P.).
Reference	:	Your Email Dated: 24-01-2025 and 14-02-2025 Our letter No: CE-AMD/Consultancy/SMN-SKA/Quotation/2025/1526 dated 28-01-2025.

The client has requested to conduct an annual certification of ash ponds and dykes as per MOEF & CC and CPCB guidelines for NTPC Super Thermal Power Project, Khargone (M.P.).

The site was visited by our Experts:

Dr. S.M. Narulkar
Ph.D. in Water Resources Engineering
Professor, Water and Environmental Division
Department of Civil Engineering
Email: snarulkar@sgsits.ac.in, M. No 98260-83317

Dr. S.K. Ahirwar
Ph.D. in Geotechnical Engineering
Associate Professor, Geotechnical Division
Department of Civil Engineering
Email: sahirwar@sgsits.ac.in, M. No. 81698-45602

OBSERVATIONS:

The following observations were made during the visit held on 08-03-2025 at NTPC plant located at Khargone.

1. The ash pond has been checked for all the parameters as required by the guidelines provided by the CPGB, MoEF & CC as referred for period i.e. 1st April, 2024 to 31st March, 2025.
2. The dyke was maintained well by taking all the necessary O&M activities by the NTPC during the evaluation period.
3. The detailed observation checklist for annual certification is attached as an Annexure-1.

RECOMMENDATIONS:

Based on the field visit and records verification, the dykes are maintained well as per the O&M guidelines provided by the regulatory authority.

Report Prepared by: Dr. S. M. Narulkar and Dr. S.K. Ahirwar.

(Dr. S. M. Narulkar)
Professor, CE-AMD

(Dr. S.K. Ahirwar)
Associate Professor, CE-AMD

(Dr. S. M. Narulkar)
Professor & Head, CE-AMD

DIRECTOR

Phone : 0731-2544415 (O)
Email :director@sgsits.ac.in
EPABX : 0731 - 2582101,112
Website : www.sgsits.ac.in

SHRI G.S. INSTITUTE OF TECHNOLOGY & SCIENCE

(A Govt. Aided, UGC Autonomous Institute under 2(F) & 12(B), Established in 1952)
23, Sir M. Visvesvaraya Marg (Park Road), INDORE - 452 003 (M.P.) India
(Shri Govindram Seksaria Institute of Technology & Science, Indore M.P.)

Ref. : CE-AMD/CONS/C-1294/SMN-SKA/2025/1811 Date : 13 MAR 2025

Annexure-1

Sr. No.	Component	Observations/Remarks
1.	Name of Power Plant	Khargone Super Thermal Power Project (2 × 660 MW)
2.	Name of the company	NTPC Limited
3.	District	Khargone
4.	State	Madhya Pradesh
5.	Postal address for communication:	NTPC Limited, Khargone Super Thermal Power Project, Selda - Balabad, PO: Khedi - Bujurg, Teh. Bediya, Khargone - 451113
6.	E-mail:	hopkhargone@ntpc.co.in mvkulkarni@ntpc.co.in
7.	Power Plant installed capacity (MW):	1320 MW
8.	No. of units generated (MWh):	2 units
9.	Total area under power plant (ha): (including area under ash ponds)	Approx. 715 Ha
10.	Method of slurry discharge/ water consumption or conservation in disposal, ash water recycling	High concentrated slurry discharge Bottom ash slurry discharge Ash water recycling system operational
11.	TSS of decant Water (Going outside/for recirculation)	Within Limit
12.	Maintenance of Dyke. 1. Top Width 2. Top level of dyke 3. Adequate Spillway Capacity 4. Free board 5. Available volume 6. Earth covering and turfing 7. U/S slope protection 8. WBM Road 9. Rock Toe, toe drain, berm, rock, pitching 10. Dyke compaction 11. D/S erosion control	For lagoons & OFL 1. 6 m 2. RL 250 m 3. Available 4. Available 1.5 m 5. Lagoon-1 = 23 LCM Lagoon-2 = 15.9 LCM Lagoon-3 = 6.5 LCM 6. Available 7. Available 8. Available 9. Available 10. OK 11. OK
13.	Instrumentation a) Piezometer, b) surface settlement	Available

Phone : 0731-2544415 (O)
Email :director@sgsits.ac.in
EPABX : 0731 - 2582101,112
Website : www.sgsits.ac.in

SHRI G.S. INSTITUTE OF TECHNOLOGY & SCIENCE

(A Govt. Aided, UGC Autonomous Institute under 2(F) & 12(B), Established in 1952)
23, Sir M. Visvesvaraya Marg (Park Road), INDORE - 452 003 (M.P.) India
(Shri Govindram Seksaria Institute of Technology & Science, Indore M.P.)

Ref.: CE-AMD/CONS/C-1294/SMN-SKA/2025/1811 Date: 13 MAR 2025

14.	Wet Patches/softening on down Slope	None
15.	Gully Formation	None
16.	Rat holes/ animal burrows	None
17.	Growth of plants	None
18.	Toe drain and surface drainage system	Available
19.	Facilities for inspection and maintenance of the dyke	Available
20.	Flooding Lighting	Available
21.	Seepage or Leakage	None
22.	Monolith Joints –	Not applicable
23.	Foundation should be examined for damage or possible undermining of the downstream toe	Examined. No damage or undermining is observed.
24.	Slope Stability dyke: 1.Dyke Slope stability, as per IS 7894: Dyke structural stability to be examined as per construction drawings, quality control documents monitoring reports etc. 2. Dyke slopes should be examined for irregularities in alignment and variances from smooth uniform slopes, unusual changes from original crest alignment and elevation, evidence of movement at or beyond the toe, and surface cracks, which indicate movement.	Examined and found OK. Examined and found OK.
25.	Condition of Drainage Systems	OK
26.	Condition of Slope Protection	OK
27.	Environmental Pollution	Under Control
28.	Green belt	OK
29.	Any other information: Soft copy of the annual compliance report, and shape files of power plant and ash ponds may be e-mailed to:- moefcccoalash@gov.in	NTPC Khargone may send the documents stipulated to the authority mentioned.
30.	Signature of Authorized Signatory	

(Dr. S. M. Narulkar)
Professor, CE-AMD

(Dr. S.K. Ahirwar)
Associate Professor, CE-AMD

(Dr. S. M. Narulkar)
Professor & Head, CE-AMD

DIRECTOR

ANNEXURE-5

भारत सरकार
परमाणु ऊर्जा विभाग
विकिरण एवं आइसोटोप प्रौद्योगिकी बोर्ड

Government of India
Department of Atomic Energy
Board of Radiation & Isotope Technology

प्रमाणपत्र ट्रैकिंग आईडी/Certificate Tracking ID : 2501844
जारी करने की तिथि/Date of Issue : 26-Apr-2025
प्रमाणपत्र क्रमांक/Certificate Sr.No.: ULR-TC1170325000005131F

TC-11703

Radioanalytical Laboratory

RADIOACTIVITY TEST CERTIFICATE

Ref : BRIT/RAL/DOM/1787-1798/MISC/1392-1403/24-25

To :
M/S NTPC LIMITED (KHARGONE SUPER THERMAL POWER PROJECT)
PO.: SELDA, SO : BEDIYA, DISTT.KHARGONE,
MADHYA PRADESH - 451 114.

This is regarding the sample of "COAL, FLY ASH & BOTTOM ASH" sent for radioactivity analysis vide your letter Ref.no. NTPC/KGN/EMG/BRIT/2024-2025 dated 15.03.2025 as shown in italics:

Sr. No	SAMPLE DESCRIPTION	SAMPLE LOCATION	SAMPLING DATE
1	COAL	FEEDER, UNIT-2	04/03/2025
2	FLY ASH	UNIT-1	05.03.2025
3	BOTTOM ASH	UNIT-1	05.03.2025

DATE OF RECEIPT OF SAMPLE: 22.03.2025 **DATE OF COMPLETION OF TEST: 15.04.2025**

The samples were analysed for U-238, Ra-226 , Th-232 and K-40 radioactivity content by HPGe gamma spectrometry and the values obtained are as follows:

Sr. No	NAME OF THE PRODUCT	U-238 (Bq/Kg)	Ra-226 (Bq/Kg)	Th-232 (Bq/Kg)	K-40 (Bq/Kg)
1	COAL	43.7 ± 2.3	26.2 ± 4.1	78 ± 4.6	157 ± 10.8
2	FLY ASH	76.5 ± 2.5	73.3 ± 6.2	126 ± 4.2	301 ± 14.8
3	BOTTOM ASH	72.3 ± 2.8	68.7 ± 6.9	132 ± 8.4	320 ± 17.2

Opinion: The measurement values are below the clearance level for radionuclides of natural origin in bulk solid materials, as per AERB directive 01/2010 (table-3) dated 26/11/2010.

Note: (i) The report pertains to the given sample only. (ii) The sample will be retained in this laboratory for a period of 1 month from certificate date and thereafter it will be disposed off. (iii) This report shall not be reproduced except in full, without written approval of the laboratory. (iv) The sampling is not done by this laboratory.

Checked by:
GANPAT B NAKTI
Assistant

Authorized Signatory:
AJAY NANA THAMKE
OIC, RAL

**************** End of Report ******************

विआप्रौबो/ बीएआरसी परिसर, सेक्टर २०, वाशी, नवी मुंबई - ४०० ७०३ (महाराष्ट्र)
BRIT/ BARC Vashi Complex, Sector 20, Navi Mumbai - 400 703 (Maharashtra)
वेबसाइट/ Website: www.britatom.gov.in; दूरभाष/ 022 2788 7002/ 7006

Annexure-6

CSR Works by NTPC-Khargone STPS

FY: 2024-25 (April 2024 to September 2024)

Girl Empowerment mission Workshop 2024 by NTPC Khargone.

Organization of Mega Health checkup camp at Dalchi Village

Education- Stationery and School Bag Distribution to PAV Govt. Schools

Distribution of Sweet packets to PAV schools under CSR on Independence Day- 2024

Organization of District Level Kabaddi at NTPC Khargone Stadium in which more than 500 students participated.

Organization of District Level Kabaddi at NTPC Khargone Stadium in which more than 800 students participated.



Distribution of school kits to 14 GEM Girls in BBPS


Annexure-7

Indian Institute of Corporate Affairs

Partners in Knowledge. Governance. Transformation.

Social Impact Assessment

of

R&R & Community Development Projects for

NTPC Khargone

2022

Disclaimer

This report is based on the social impact assessment survey conducted for community development programme of NTPC Khargone. The information contained in the report is of general nature and will not be intended to address the circumstances of any particular individual or entity. Recommendations and Comments in our report are not intended, nor should they be interpreted to be a binding opinion. IICA does not undertake any responsibility arising in any way whatsoever, to any person other than NTPC Khargone in respect of the matters dealt with in this report, including any errors or omissions therein, arising through negligence or otherwise, howsoever caused.

ACKNOWLEDGEMENTS

The development be it social, economic or political, does not happen in isolation. The actual development is possible when all the efforts are converged and every one works together in order to release measurable social impact. Corporate Social Responsibility is a way to put additional efforts to provide impetus to the development of the country and its people. NTPC Khargone has been implementing CSR-CD activities in its peripheral villages and trying to improve the quality of life in the villages.

This report is an outcome of the social impact assessment survey undertaken by the Centre for Excellence in CSR and Corporate Citizenship, Indian Institute of Corporate Affairs. The study was undertaken with the cooperation and support of the officials of NTPC Khargone.

We would like to extend our sincere thanks to NTPC Khargone and its officials involved in the study. This could not be possible without their coordination and constant support. We are also thankful to the field co-ordinators and data enumerators for conducting the field survey. We also owe gratitude to the respondents of the survey, people of the villages and the village heads for their support and facilitation of the survey.

Evaluation Team

Mr. Mukesh Kumar
Head- Centre for Excellence in CSR & Corporate Citizenship
Email: mukesh.kumar@iica.in

Dr. Mona Jha
Senior Research Associate
Centre for Excellence in CSR & Corporate Citizenship
Email: mona.jha@iica.in

Ms. Diksha Yadav
Research Associate
Centre for Excellence in CSR & Corporate Citizenship
Email: diksha.yadav@iica.in

TABLE OF CONTENT

1. SOCIAL IMPACT EVALUATION OF R&R & COMMUNITY DEVELOPMENT PROJECTS NTPC KHARGONE 1
   - 1.1 NTPC & its approach to R&R & Community Development 1
   - 1.2 Type of land acquired by NTPC Khargone in Selda/Balabad and Dalchi 2
2. RESEARCH METHODOLOGY 3
   - 2.1 Research Method and Sampling 3
3. TARGET AREA PROFILE 5
   - 3.1 Educational status 6
   - 3.2 Employment status 10
   - 3.3 Economic condition 12
   - 3.4 Gender equality and women empowerment 14
   - 3.5 Health status 14
   - 3.6 Quality of life 17
4. KNOWLEDGE, ATTITUDE AND PRACTICES ANALYSIS (KAP) 21
   - 4.1 Language and habit of communication 21
   - 4.2 Cultural characteristics, traditions, values, beliefs 21
5. AGRICULTURE DEVELOPMENT 22
6. INFRASTRUCTURE AVAILABLE 23
   - 6.1 School infrastructure 23
   - 6.2 Availability of all-weather roads 24
   - 6.3 Quality of potable water 25
   - 6.4 Availability of community hall 26
7. OTHER 28
   - 7.1 Population covered under Aadhar 28
   - 7.2 Percentage of households covered with a bank account under PMJDY Target 28
   - 7.3 Percentage of eligible persons covered under PMSBY 28
   - 7.4 Percentage of eligible person covered under Atal Pension Yojana 29
8. KEY FINDINGS- SOCIAL IMPACT EVALUATION 30
   - 8.1 Impact of Interventions in Education 30
   - 8.2 Impact of Interventions in Health 33
   - 8.3 Impact of Intervention in Rural Infrastructure 36
   - 8.4 Impact of Interventions in Drinking water and Sanitation 38
   - 8.5 Interventions in Skill development 39
9. SOCIAL RETURN ON INVESTMENT 41
10. CONCLUSION AND RECOMMENDATIONS 53
11. ANNEXURES 58
    - 11.1 Annexure 1: Economic Status 58
    - 11.2 Annexure 2: Education & Vocational skill status 58
    - 11.3 Annexure 3: Health Issue in the community 59
    - 11.4 Annexure 4: Gender Equality & Women Empowerment 62
    - 11.5 Annexure 5: Quality of life 63
    - 11.6 Annexure 6 : Others 64
    - 11.7 Annexure 7: School Infrastructure Requirements 67
    - 11.8 Annexure 8: Anganwadi centres requirements 69
    - 11.9 Annexure 9: Health care requirements 69
    - 11.10 Annexure 10: SROI Calculations 70

LIST OF ACRONYMS

AWW KII	Anganwadi Worker Key Informant Interview
BPL	Below Poverty Line
CSR	Corporate Social Responsibility
CSR-CD	Corporate Social responsibility- Community Development
IMR	Infant Mortality Rate
KII	Key Informant Interview
MMR	Maternal Mortality Rate
NA	Data not available
NSO	National Statistical Organisation
PHC	Primary Health Centres
RGI	Registrar General of India
SHG	Self Help Group
KgSTPP	Khargone Super Thermal Power Plant
FGD	Focused Group Discussion
GEM	Girl Empowerment Mission
IICA	Indian Institute of Corporate Affairs
SROI	Social Return on Investment

LIST OF IMAGES

Image 1	:	Demographic profile of the survey area	5
Image 2	:	School buildings at Selda and Dalchi	30
Image 3	:	Classrooms at schools in Selda and Dalchi	31
Image 4	:	Girls' toilets at schools in Selda and Dalchi	31
Image 5	:	Installation of Smart TV at a high school in Selda for smart classes and EVOICE initiative by NTPC Khargone	31
Image 6	:	Scholarships, Coaching and Uniforms to school students in Selda and Dalchi	32
Image 7	:	FGD with Women's group at Anganwadi Centre in Selda and Dalchi	34
Image 8	:	Mobile Medical Unit Van of NTPC Khargone	35
Image 9	:	Gangour Ghat, Roads, and Community centre built by NTPC Khargone in PAVs	37

LIST OF FIGURES

Figure 1	: Core Values of NTPC	1
Figure 2	: Type of land acquired by NTPC Khargone	2
Figure 3	: Research Steps adopted in the study	3
Figure 4	: Social category of respondents	6
Figure 5	: Percentage of differently- abled people	6
Figure 6	: Literacy Rate	7
Figure 7	: Respondents' educational qualification	7
Figure 8	: Gender wise educational qualification	8
Figure 9	: Educational status (Social Category wise)	8
Figure 10	: Schools reporting incidence of dropout	9
Figure 11	: Percentage of children (6-14 years) attending the school-Rural	9
Figure 12	: Training and skills	10
Figure 13	: Occupation of Respondents	10
Figure 14	: Employment status of respondents in Dalchi	11
Figure 15	: Employment status of respondents in Selda/Balabad	11
Figure 16	: Migration (%)	12
Figure 17	: BPL Population (%)	13
Figure 18	: Monthly income range of the surveyed households in Dalchi and Selda/Balabad (INR)	13
Figure 19	: Total number of SHGs promoted	14
Figure 20	: Proportion of seats held by women in government decision-making bodies	14
Figure 21	: Institutional births in public facility	15
Figure 22	: Percentage of 1 year old children immunization status	16
Figure 23	: Prevalence of diseases across the study villages	16
Figure 24	: Presence of Anaemic women	17

Figure 25 : Households with access to piped drinking water 17

Figure 26 : Source of Water 18

Figure 27 : Percentage of households in the Villages with access to domestic electricity 18

Figure 28 : Domestic electricity connection (type) 19

Figure 29 : Households living in Pucca houses 19

Figure 30 : Population having Toilet facilities 20

Figure 31 : School Infrastructure at Dalchi 23

Figure 32 : School Infrastructure at Selda/Balabad 24

Figure 33 : Availability of all-weather roads in the neighbourhood (%) 25

Figure 34 : Quality of potable water 26

Figure 35 : Availability of community hall 26

Figure 36 : Percentage of population covered under Aadhar 28

Figure 37 : Percentage of households covered with a bank account under PMJDY against target 28

Figure 38 : Percentage of eligible persons covered under Pradhan Mantri Suraksha BimaYojana 29

Figure 39 : Percentage of eligible person covered under Atal Pension Yojana 29

Figure 40 : Perception and satisfaction level of the respondents towards the educational interventions 33

Figure 41 : Percentage of respondents benefitting from mobile medical unit 35

Figure 42 : Perception and satisfaction of the respondents towards the healthcare interventions 36

Figure 43 : Perception and satisfaction of the respondents towards the rural infrastructural interventions 38

Figure 44 : Perception and satisfaction of respondents towards the drinking water interventions 39

Figure 45 : Perception and satisfaction of respondents towards the interventions in Sanitation 39

Figure 46 : Perception and satisfaction of the respondents towards skill development interventions 40

Figure 47 : Steps in SROI Computation-IICA's Approach 41

Figure 48 : Budget allocated for different sectors (%) 43

LIST OF TABLES

Table 1	: List of Gram Panchayat	3
Table 2	: Stakeholder mapping to understand Project outcomes	4
Table 3	: Basic Demographics of selected villages/Gram Panchayat village	5
Table 4	: Infant Mortality Rate and Maternal Mortality Rate	15
Table 5	: Number of Infant and Maternal Deaths in the survey area	15
Table 6	: Key Stakeholders	44
Table 7	: List of excluded stakeholders	45
Table 8	: Impact Map for Educational Interventions	45
Table 9	: Impact Map for Healthcare Interventions	46
Table 10	: Impact Map for Vocational Training Projects	46
Table 11	: Impact Map of Water	47
Table 12	: Impact map for sanitation interventions	47
Table 13	: Impact Map for Infrastructure Development Projects	48
Table 14	: Impact Map for Sports Projects	48
Table 15	: Summary of SROI Valuation Filters	49
Table 16	: SROI of various thematic areas	49
Table 17	: Sensitivity Analysis for Education Intervention	50
Table 18	: Sensitivity Analysis for Healthcare	50
Table 19	: Sensitivity Analysis for Vocational Training Intervention	50
Table 20	: Sensitivity Analysis of interventions for Water	51
Table 21	: Sensitivity Analysis for Sanitation Intervention	51
Table 22	: Sensitivity Analysis for Rural Infrastructure Interventions	51
Table 23	: Sensitivity Analysis for sports Interventions	51

1. SOCIAL IMPACT EVALUATION OF R&R & COMMUNITY DEVELOPMENT PROJECTS NTPC KHARGONE

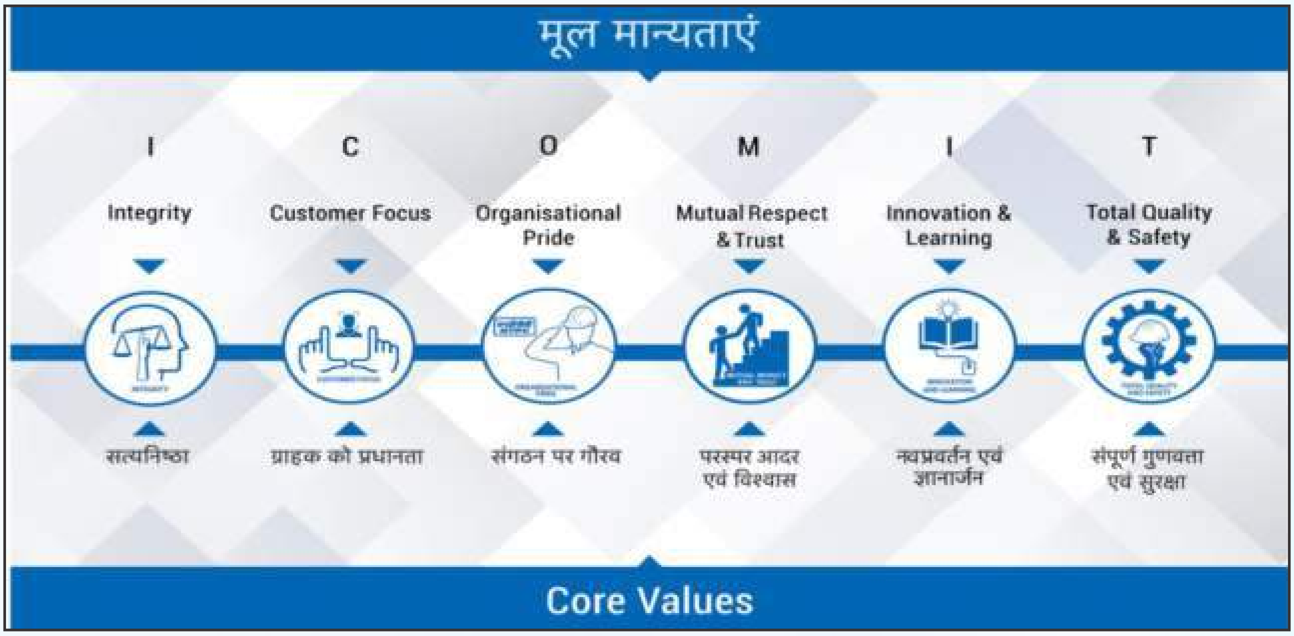
INTRODUCTION

1.1 NTPC & ITS APPROACH TO R&R & COMMUNITY DEVELOPMENT

NTPC is India's largest energy conglomerate with roots planted way back in 1975 to accelerate power development in India. Since then, it has established itself as the dominant power major with presence in the entire value chain of the power generation business. From fossil fuels it has forayed into generating electricity via hydro, nuclear and renewable energy sources. This foray will play a major role in lowering its carbon footprint by reducing greenhouse gas emissions. To strengthen its core business, the corporation has diversified into the fields of consultancy, power trading, training of power professionals, rural electrification, ash utilization and coal mining as well.

NTPC envisions to be the world's leading Power Company, energizing India's growth through providing reliable power and related solutions in an economical, efficient and environment friendly manner, driven by innovation and agility.

Figure 1 : Core Values of NTPC



(Source: NTPC)

NTPC's approach to Rehabilitation & Resettlement (R&R) is aligned well to its core business of setting up power projects and generating electricity. In accordance with its Rehabilitation and Resettlement Policy 2017[1]. NTPC focuses on implementing Community Development (CD) programmes in the affected/neighbouring villages around its operating stations. Initial Community Development (ICD) Policy is implemented in close cooperation with the concerned state Authority in the areas identified for settling up the Greenfield/ expansion projects. These CD activities are project specific aimed to address local social issues in PAFs and promote positive dialogue and confidence of all project stakeholders. After the completion of R&R Policy, the community development activities are being planned to be continued under Corporate Social Responsibility- Community Development (CSR-CD).

[1] https://www.ntpc.co.in/sites/default/files/r_r_policies/NTPC-R-R-Policy-2017.pdf

NTPC Khargone has completed the CD interventions in PAVs under R&R policy in its vicinity villages. Hence, the Social Impact Evaluation (SIE) of R&R activities and SROI for CSR-CD were commissioned to IICA.

NTPC endeavours to minimize the acquisition of prime agricultural land and avoid acquisition of homestead as per its policy in the first place. The Project Affected Families (PAFs) are subject to both compensation and R&R benefits in a transparent manner. NTPC follows a consultative approach in its design and implementation of R&R and Community Development (CD) programmes. NTPC also supports institutionalizing the process of its R&R and CD activities that are monitored and evaluated through research studies.

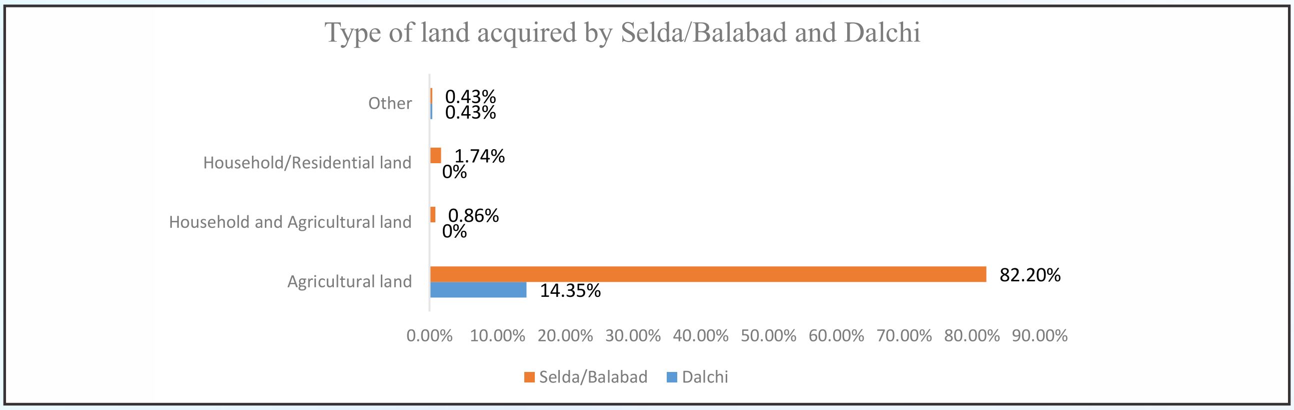
1.2 TYPE OF LAND ACQUIRED BY NTPC KHARGONE IN SELDA/BALABAD AND DALCHI

The construction of the NTPC Khargone plant affected two Gram Panchayat namely Selda/Balabad and Dalchi. A total of 357 persons were directly affected by NTPC Khargone's project, henceforth referred as the Project Affected Persons (PAPs).

Out of the 357 Project Affected Persons, only 244 could be contacted for interview. Rest of the PAPs had migrated to other locations and were untraceable. Also, their contact numbers were unavailable to the survey team. Out of the 244 PAPs spread across Selda and Dalchi, 230 people said that land was taken from them. Agricultural land was taken away from 222 people, followed by household land and agricultural land taken away from 2 people, and household/residential land was taken away from 4 people. Also, there were 2 people who said that some of their land was taken away but it was neither residential nor agricultural type of land.

The following figure represents the type of land acquired by NTPC Khargone from the PAPs who could be interviewed during IICA survey conducted in Selda/Balabad and Dalchi Gram Panchayat. As can be seen from the figure below, the majority of land that was acquired by NTPC Khargone happened to be agricultural land.

Figure 2: Type of land acquired by NTPC Khargone



Source: IICA Survey, 2022.

Furthermore, as mentioned in the Socio-Economic Study for KgSTPP, 2011and as per the NTPC R&R policy (June, 2010), the number of Homestead Oustees was nil. This meant that none of the PAPs lost any residential structure.

2. RESEARCH METHODOLOGY

Indian Institute of Corporate Affairs (IICA) has conducted the social impact evaluation study including the social return on investment in the Project Affected Villages (PAVs) around NTPC Khargone. IICA follows a systematic process for determining and addressing needs, or "gaps" between current conditions and desired conditions. The SIE component of the study would measure the social, educational, economic, and cultural impacts of R&R & CD activities of the projects of NTPC Khargone. A community level situation for impact has been assessed in the broad areas of Education, Vocational Training, Healthcare, Water and Sanitation, and Rural Infrastructure. The Impact assessment study was conducted in the following Gram Panchayat of Khargone district of Madhya Pradesh.

Table 1: List of Gram Panchayat

Village/ Gram Panchayat Name	Distance in kms from NTPC Khargone Plant
Selda/Balabad	2 Km (Approx.)
Dalchi	4.5 Km (Approx.)

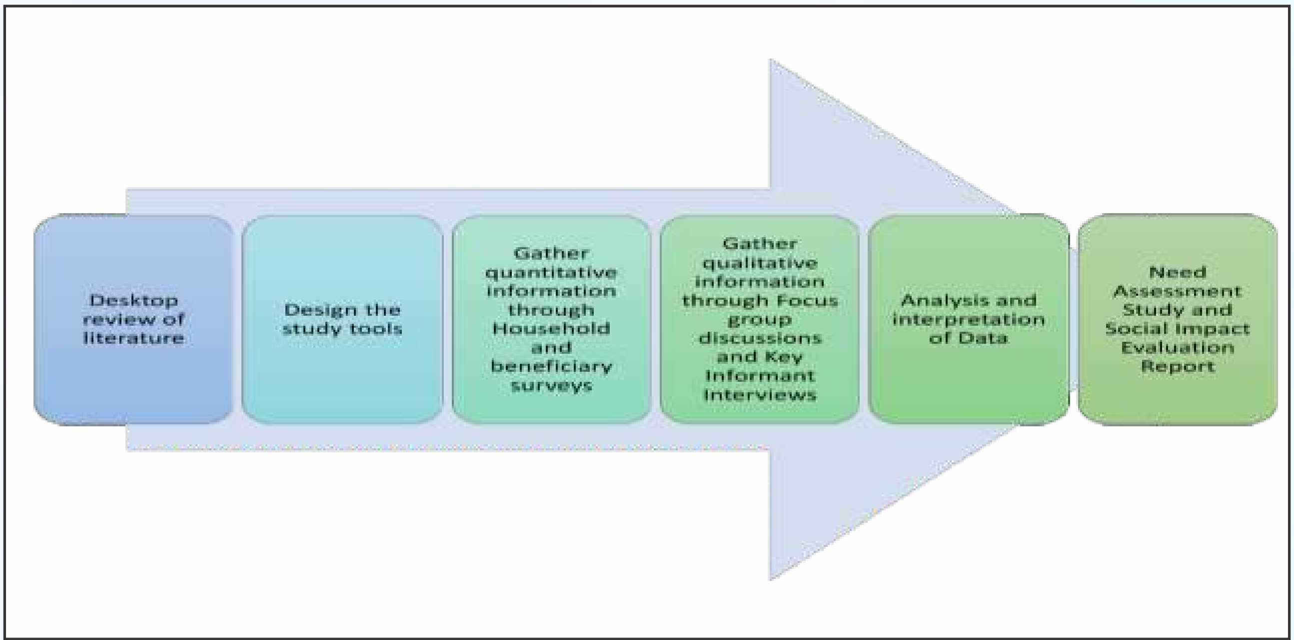
(Source: IICA Survey, 2022)

2.1 RESEARCH METHOD AND SAMPLING

The study employed both primary and secondary data. Primary data was collected through fieldwork in two-gram panchayats/villages named Selda/Balabad and Dalchi. These two gram panchayats comprise 13 hamlets. While Selda has 5 hamlets, Dalchi has 8 hamlets.

To conduct the SIE study, IICA adopted a six-step approach as explained in Figure 4

Figure 3: Research Steps adopted in the study



The first step was to collate Secondary data from different government sources (including websites, indices, and publications) and preparing a stakeholder map against the themes of the project. The second step was to prepare, pre-test and finalize the Research Tools for the field survey. The third step was to assemble a survey team and prepare them for the field survey in the two Gram Panchayats. As the fourth step, Focus Group Discussions (FGD) was held for the collection of qualitative information regarding the village. Fifth, data analysis of findings and preparation of the preliminary evaluation was done. The last step is the finalization of the report and reporting of conclusions and recommendations.

Table 2: Stakeholder mapping to understand Project outcomes

Education	Vocational Training	Health care	Water & Sanitation	Rural Development
Gram Panchayat	Gram Panchayat	Gram Panchayat	Gram Panchayat/ Village Water & Sanitation Committee	Gram Panchayat
NTPC Officials	NTPC Officials	NTPC Officials	NTPC Officials	NTPC Officials
Students	Farmers & Youth	Community members	Community members	Community members
Parents of children attending schools	Community Members	Local Doctors	Health and Sanitation Worker	Construction workers
School Officials (principal & teachers)	Skill Trainer	District Officer of Health (DoH)		Village Development Advisory Committee
School Management Committee	Family Members of trainees	AWW/ ASHA/ ANM		AWW/ Veterinary Doctor
Block Education Officer				
District Education Officer				
Village Development Advisory Committee				

To understand the impact of the interventions undertaken by NTPC Khargone, the primary data was collected through household surveys, focus group discussions and key informant interviews.

Overall, the total sample size happened to be 680 which include 648 Beneficiary survey and 32 Key Informant Interviews. Additionally, several villagers participated in the study through 13 FGDs.

The household survey covered questions regarding the significant domains such as education, vocational training, infrastructure, health, drinking water & sanitation. Additionally, the survey analyses the attitude, knowledge and behaviour of the locals/communities.

Secondary data was collected from the Census of India (2011), government reports and official records of various offices like Panchayati Raj Institution, Anganwadi Centres and Schools apart from the data received from the NTPC office. Data collected through quantitative questionnaires was analysed using Microsoft Excel and qualitative tools like FGD and KII were analysed through description and explanation.

A proportionate stratified sampling was undertaken to identify the size of the sample from each of the two gram panchayat. This was done to ensure that the size of the sample strata was proportional to the size of the population strata. Further, there were two categories of participants spread across the two-gram panchayat. One of the categories belonged to Project Affected Persons (PAPs) and the other included the Non-PAPs. While a simple random sampling technique was used to select non- PAP households from the hamlets under each of the main village/gram panchayat i.e. Selda and Dalchi, a purposive sampling technique was used to cover the PAPs for the impact evaluation study. The list of the PAPs was provided by NTPC Khargone. However, as some PAPs could not be traced due to the latter's migration; the non-PAPs households were selected at their place in order to meet the required sample size of the study.

3. TARGET AREA PROFILE

The current study of Social Impact Evaluation has been conducted in two Gram Panchayat namely Selda/Balabad and Dalchi in Khargone district of Madhya Pradesh.

History: The District of Khargone is in the Madhya Pradesh state in India's central region. Khargone was previously known as West Nimar. Functional offices i.e. police station, the collectorate office, telecom and other government organisations are located in the district headquarter i.e. in the town of Khargone. Cotton and chilly are grown on the banks of river Kunda. The people of Khargone speak Namadi as its primary language in west Nimar, Bareli and Palya.

Geography: The Khargone district spans 8,030 km2 (3,100 sq mi). The district is located between 74°25' and 76°14' east longitudes and latitudes between 21°22' and 22°35' north. The district is bordered by the districts of Dhar, Indore, and Dewas in the north; the state of Maharashtra's Jalgaon District in the south; the districts of Khandwa and Burhanpur in the east; and the districts of Barwani in the west.

Image 1: Demographic profile of the survey area

The village-wise demographic distribution of the population of the selected villages is given below

Table 3: Basic Demographics of selected villages/Gram Panchayat village

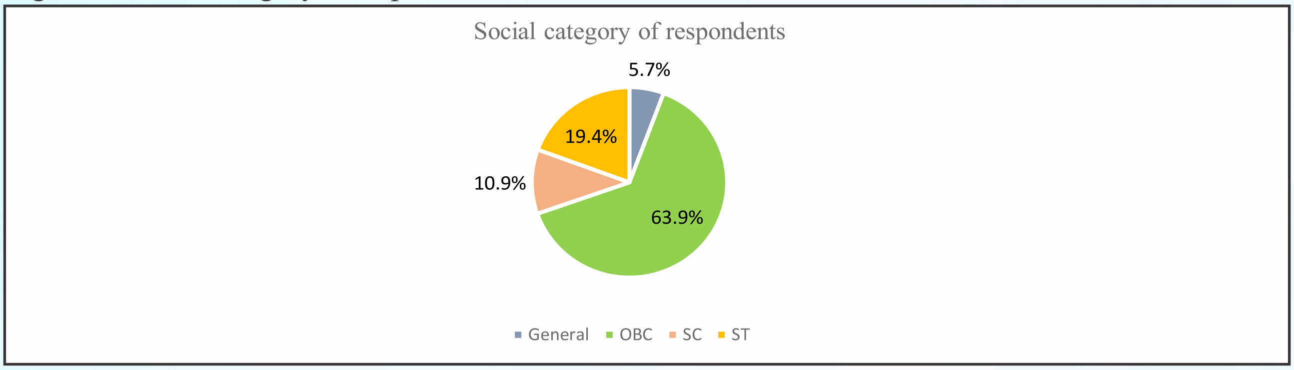
Indicator to measure keeping objective	India	Madhya Pradesh	Khargone	Selda/ Balabad	Dalchi
Total Population	1210854977	72626809	1873046	2569	1643
Male	623270258	37612306	953121	1338	890
Female	587584719	35014503	919925	1231	753
Sex Ratio	943	931	965.17	92.02	972.08
SC	201378372	11342320	209091	247	75
ST	104545716	15316784	730169	201	553
Number of infant (age of 0-6)	163819614	10809395	299990	228	283

(Source: Census of India, 2011 and data received from NTPC Khargone)

Social category of respondents

It is reported that 63.9 percent of the respondents belong to the OBC category. While 10.9 percent of the respondents also come from the schedule caste background, 19.4 percent of the respondents belong to the scheduled tribe category.

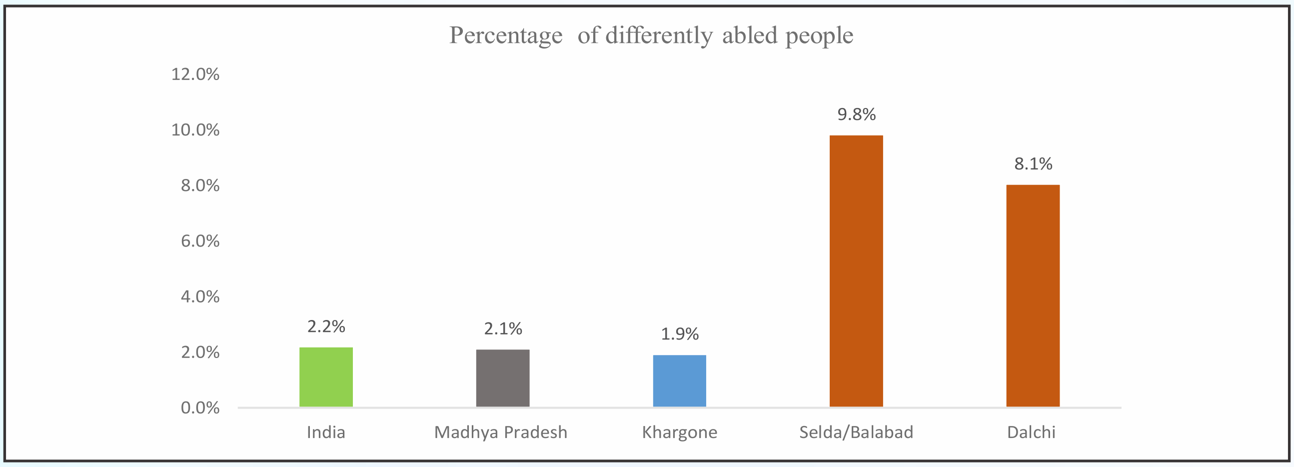
Figure 4: Social category of respondents



Percentage of differently- abled people

The percentage of differently- abled people at Selda/Balabad (9.8%) is higher when compared to the Dalchi gram panchayat (8.1%). It is also quite evident that the percentage of differently abled people at both the gram panchayat is higher than the national (2.2%), state (2.1%) and district (1.9 %) benchmark.

Figure 5: Percentage of differently- abled people



(Source: IICA Survey, 2022)

3.1 EDUCATIONAL STATUS

Literacy rate

The average literacy rate of India according to Census of India, 2011 was 72.98 % while it was pinned to 77.7 % in 2017-18 by National Sample Survey[2].

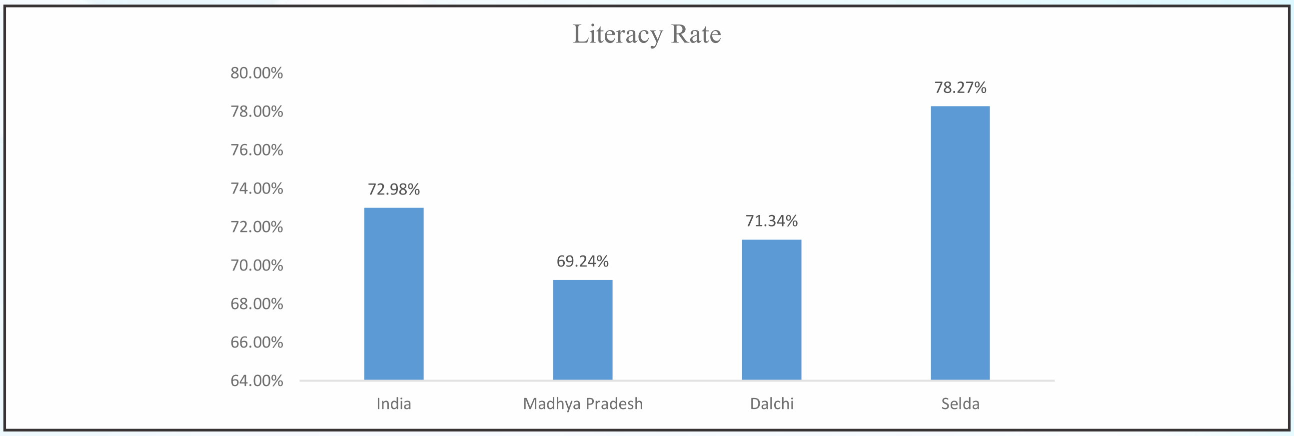
As mentioned in the Socio-Economic study for KgSTPP, 2011, the overall literacy rate in the PAVs was about 67.44%. Literacy is the ability to read and write only (and not educated). Following this definition of literacy, IICA Survey, 2022 found that 19.29% of the sample population were able to read and write only.

However, while mentioning the overall literacy of the sample population, IICA survey, 2022 has considered not only those who are able to read and write but also those who are educated further and have studied in school and college. Therefore, the overall literacy rate of the sample population in the PAVs (Selda/Balabad and Dalchi) was found to be 74. 69%.

[2] Census of India, 2011

A Gram Panchayat- wise analysis found that the level of literacy in Selda/Balabad is 78.27% while the literacy rate of Dalchi is 71.34% .The literacy rate of Dalchi (71.34%) is higher than the state benchmark (69.24%)but is slightly lower than the national bench mark (72.98%). The literacy rate of Selda/Balabad (78.27%) is higher than the state(69.24%) and national benchmark (72.98%). Therefore, it shows that the overall percentage of literate people(including educated) in the PAVs have improved from 67.44% (2011) to 74.69% (2022) after NTPC Khargone's interventions.

Figure 6: Literacy Rate



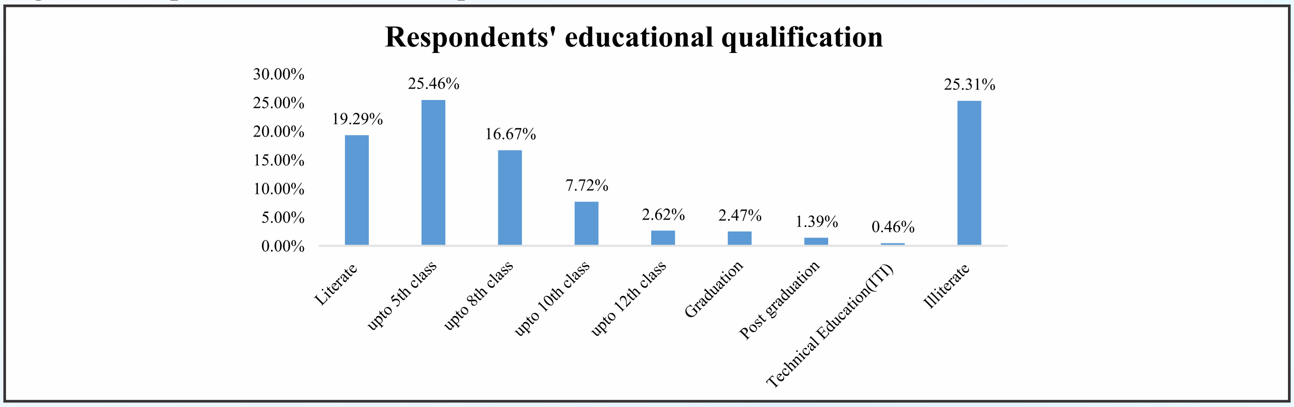
(Source: Census 2011 and IICA Survey, 2022)

Respondents' educational qualification

Figure below shows an analysis of the educational qualification of the surveyed respondents in Selda and Dalchi revealing that the maximum percentage of respondents had studied up to 5th class(25.46%), followed by respondents who are illiterate (25.31%), respondents who can read and write only (19.29%),respondents who had studied up to 8th class (16.67%), respondents who had studied up to 10h class (7.72%), respondents who had studied up to 12th class (2.62%), respondents who are Graduates (2.47%), and respondents who are post graduates (1.39%).

By technical education, it is meant the training received in ITI (as ITI is a technical course).
It was found that 0.46% of respondents had received technical education/ITI. As per the data received from NTPCKhargone,600 beneficiaries from Selda, Dalchi and Khedi Panchayat were provided skill development training and the local villagers are engaged for contractual jobs which are technical in nature.

Figure 7: Respondents' educational qualification



(Source: IICA Survey, 2022)

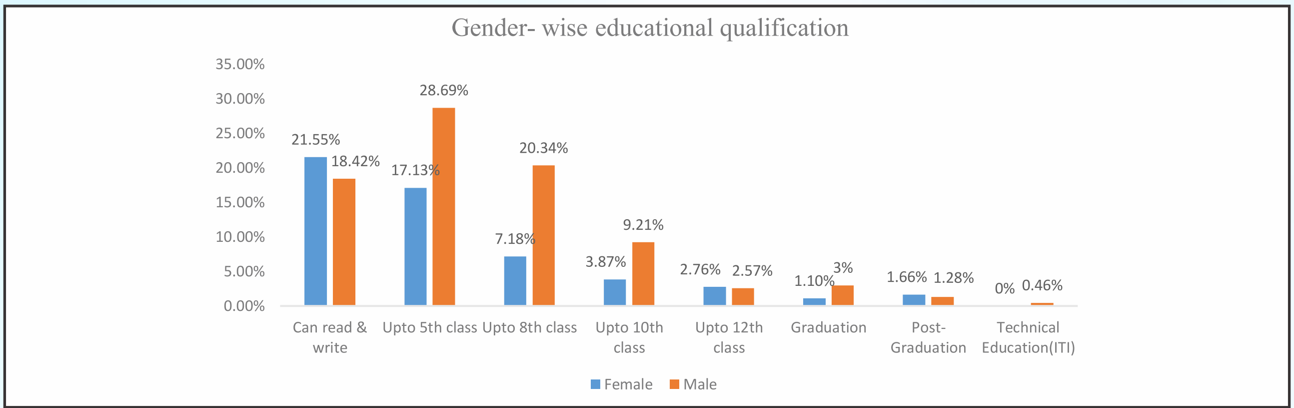
Gender-wise educational qualification (%)

Out of the total number of surveyed households (648) spread across Selda and Dalchi Gram Panchayat, in 27.9% of the households, the females participated in the interviews conducted by IICA while in 72.1% of the households, the males participated in the interviews. The educational qualifications of the female respondents were analyzed separately from the male respondents.

The survey also found that the women lag behind men in receiving school and college education. As can be seen, while 17.13% of the women respondents have studied till 5th class, 28.69% of the men respondents have studied till 5th class. Similarly, only 7.18% of women respondents have studied till 8th class as against 20.34% of the male respondents. Furthermore, only 3.87% of the female respondents could complete their matriculation in comparison to 9.21% male respondents. Also, at the higher educational level such as graduation, the women lagged behind men. Moreover, with respect to technical education like ITI, there were no women respondents.

Furthermore, as per the socio-economic study for KgSTPP conducted in 2011, the males were more educated than the females. This gap in education between men and women has more or less remained the same in 2022 as found during IICA survey.

Figure 8: Gender wise educational qualification

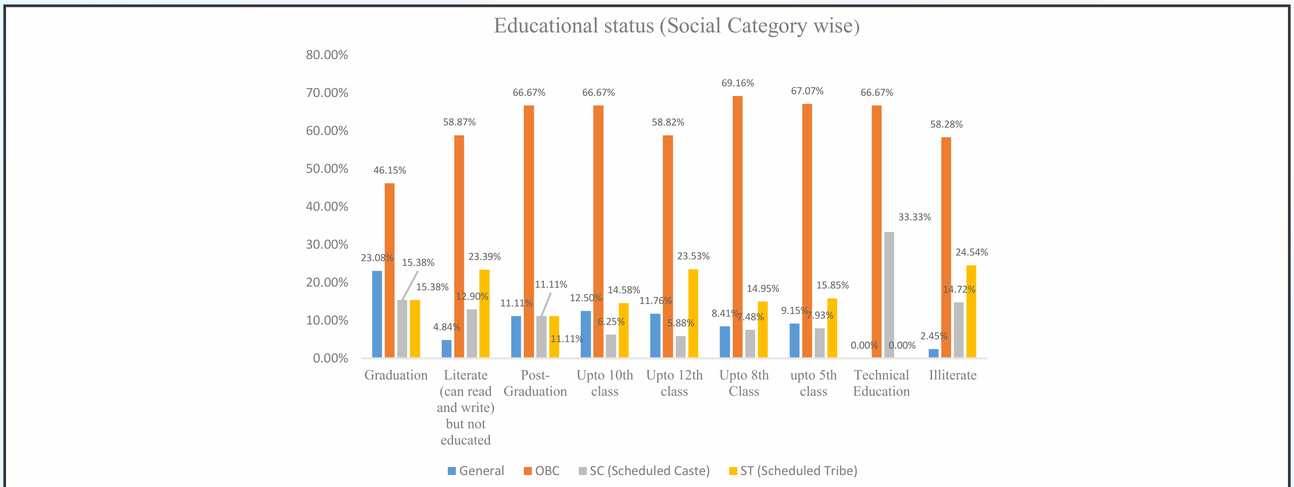


(Source: IICA Survey, 2022)

Educational status social category wise

As also discussed earlier (Figure 5), the maximum number of participants of the SIE study conducted by IICA belonged to the OBC category (63.9%), therefore, an analysis of the social category wise educational status of the respondents revealed that the maximum number of graduates, illiterates as well as those who received technical education were also from the OBC category.

Figure 9: Educational status (Social Category wise)

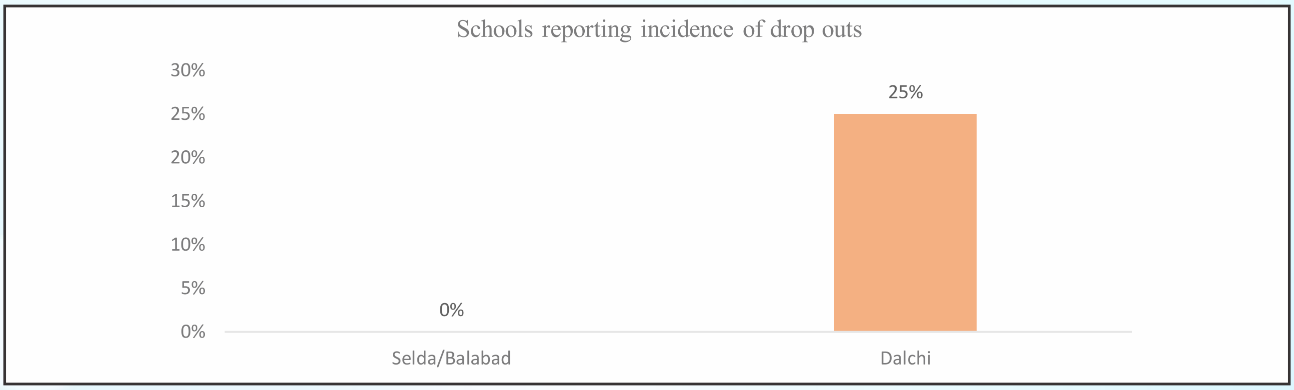


(Source: IICA Survey, 2022)

School dropout incidence

A total of nine schools were surveyed in Selda/Balabad and eight schools in Dalchi. The list of the schools to be surveyed was provided by NTPC Khargone. It was found that none of the schools in Selda/Balabad reported any incidence of school dropout, however, two schools at Dalchi reported that few students had to drop out due to migration. The following figure shows that 25% of the surveyed schools in Dalchi Gram Panchayat reported incidence of school dropout.

Figure 10: Schools reporting incidence of dropout



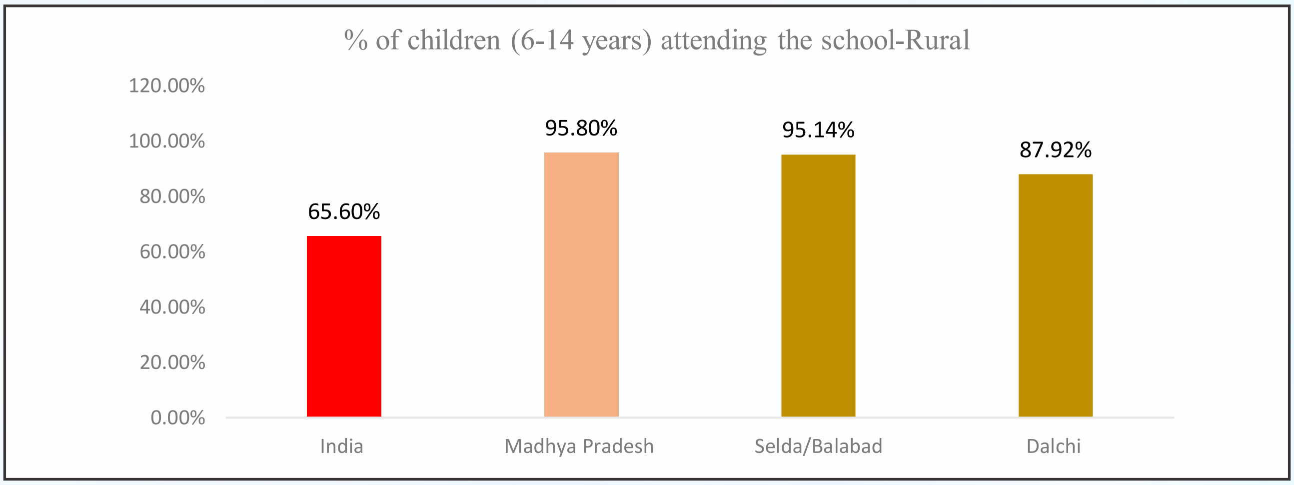
(Source: IICA Survey, 2022)

Percentage of children (6-14 years) attending the school-Rural

Any society's foundation is built on education. The quality of education being delivered is a key factor in how society develops. Therefore, by promoting the holistic development of children, schools play a significant role in shaping that country's future.

The IICA survey suggests that 65.6 % of children in India between the age group 6-14 years attend school. 95.8 % of children in Madhya Pradesh between the age group 6-14 years attend school. It is also evident from the figure below that the percentage of school going children between the age group (6-14 years) from the sampled households in the study gram panchayat Selda/Balabad (95.14%) and Dalchi (87.92%) are above the national benchmark (65.6%) but below the state benchmark (95.8%)

Figure 11: Percentage of children (6-14 years) attending the school-Rural



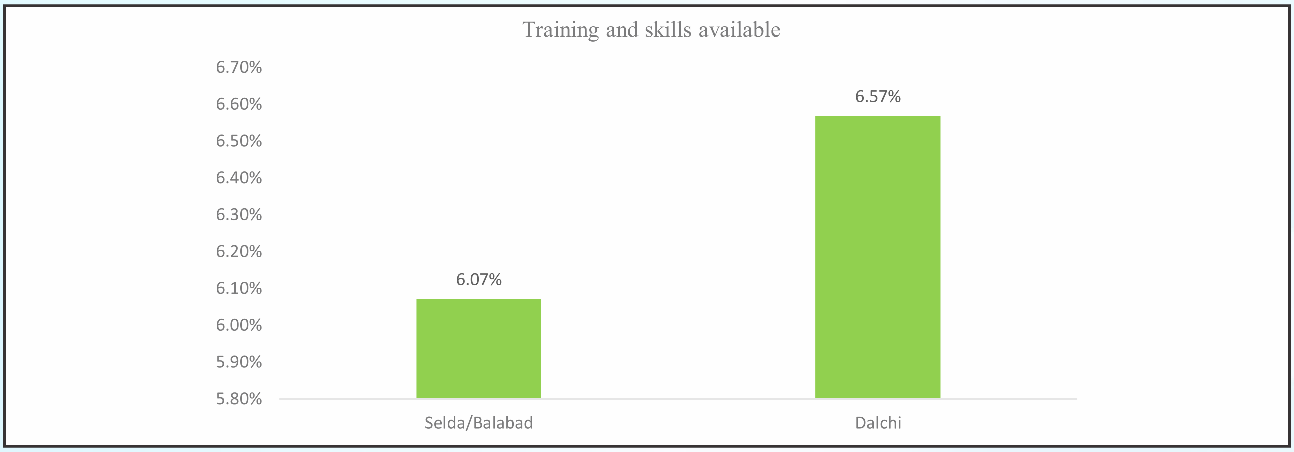
(Source: IICA Survey, 2022)

Training and skills available to people

In rural India, developing skills is crucial. Through limiting their access to well-paying jobs, a lack of proper education and training prevents people from having opportunities for self-advancement. Thus, this prevents them from having opportunities in their lives to develop a fulfilling and healthy lifestyle as well as from having an impact on the economic growth of the country.

The IICA survey shows that 6.07 % of the respondents from Selda/Balabad and 6.57 % of the respondents from Dalchi gram panchayat have undergone some form of skill development training, out of which a total of 3.54% of the respondents did receive the skill development training through NTPC Khargone. The names/types of the trainings as reported by people are Stitching, Pickle, Papad, Beauty Parlour, Electrical, AC repair, Rakhi, Computer, and agriculture.

Figure 12: Training and skills



(Source: IICA Survey, 2022)

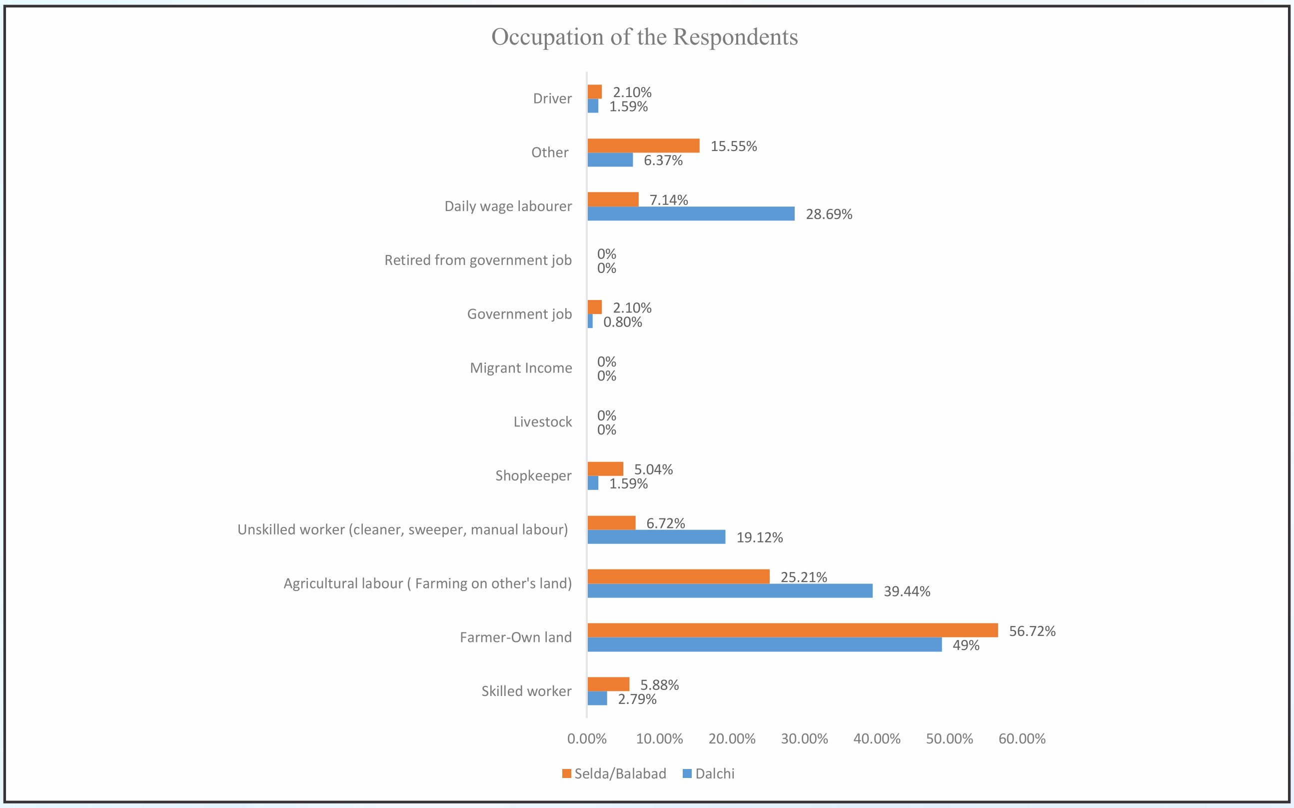
3.2 EMPLOYMENT STATUS

Employment is one of the critical issues in the rural communities. Employment and livelihood needs are major needs for the people in the rural areas.

Occupation of respondents

Figure below shows that there is a higher percentage of respondents from Selda/Balabad (5.3%) who are skilled workers as compared to Dalchi (2.2%). While the majority of the respondents in Selda/Balabad are engaged as farmers (51.5%) followed by agricultural labourers (22.9%), the majority of respondents in Dalchi are also engaged as farmers (37.8%) followed by agricultural labourers (30.5%). A small section of the respondents work in the dairy industry, coal factory, in a hospital as a doctor, and in a temple as a priest.1.2 % of the surveyed respondents are employed in NTPC as cooks, cleaners and other manual labour work.

Figure 13: Occupation of Respondents

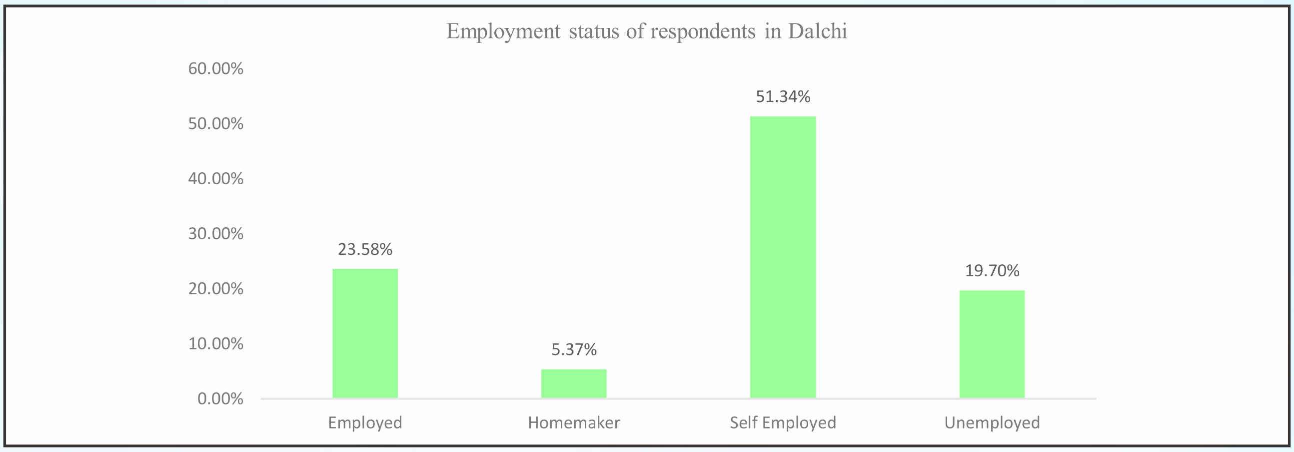


(Source: IICA Survey, 2022)

Employment status of the respondents

Figure below shows that 51.34 % of the respondents of Dalchi are self-employed. 23.58 % of the respondents are employed while 5.37 % and 19.70 % of the respondents remain as homemakers and unemployed respectively.

Figure 14: Employment status of respondents in Dalchi

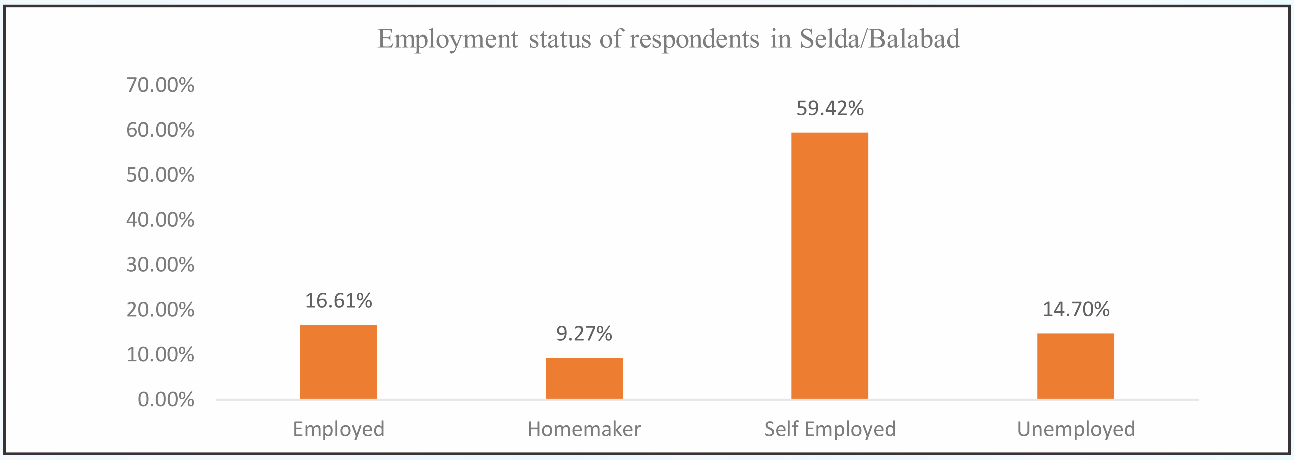


(Source: IICA Survey, 2022)

Employment status of Selda/Balabad

Figure below shows that 59.42 % of the respondents of Selda/Balabad are self-employed. 16.61% of the respondents are employed while 9.27 % and 14.70 %of the respondents remain as homemakers and unemployed respectively.

Figure 15: Employment status of respondents in Selda/Balabad



(Source: IICA Survey, 2022)

As per the socio-economic study for KgSTPP conducted in 2011, 52.6% population in the PAVs happened to be working and the remaining 47.84% was non-working population. The IICA survey, 2022 shows that overall 75.47% of the surveyed households spread across Selda/Balabad and Dalchi happened to be working (which includes 20.22% households as employed by others and 55.25% as self-employed). The total percentage of the non-working population was found to be 24.53% (which includes 7.25% as homemakers and 17.28% as unemployed). Therefore, it can be concluded that the percentage of working population in the PAVs have improved significantly in the past ten years i.e. from 2011(52.6%) to 2022 (75.47%) after NTPC Khargone's interventions.

Furthermore, the socio-economic study for KgSTPP in 2011 reveals that out of the total workers, 56.85% were cultivators, 37.49% happened to be agricultural labours, 0.33% were household workers and 2.32% other workers. The IICA survey, 2022 found that out of the total number of employed respondents in both Selda and Dalchi, overall 4.29% were skilled workers, 52.76% were farmers or cultivators, 32.51% were agricultural labour, 13.08% were unskilled workers, 1.82% were daily wage labourers and 10.83% were engaged as other workers. The occupational pattern has also been analysed separately for Selda/Balabad and Dalchi (Figure 13).

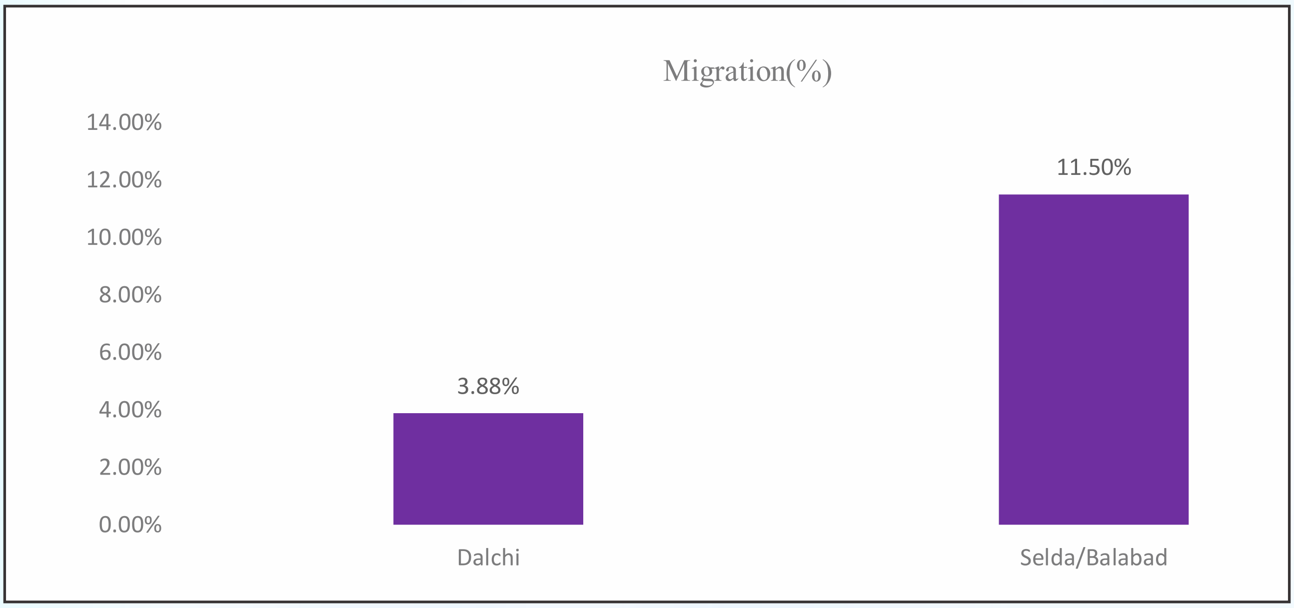
Therefore, it can be concluded that the percentage of farmers or cultivators have decreased in 2022 (52.76%) when compared with the baseline data in 2011 (56.85%). Similarly, the percentage of agricultural labour have also decreased in 2022 (32.51%) in comparison to the baseline data in 2011 (37.49%).

Migration

The search for better career opportunities and the lack of employment opportunities in the area are the primary reasons that have pushed people to other areas in search of employment.

Figure below suggests that Migration was observed to be higher in Selda/ Balabad (11.50%) while it was lesser in Dalchi (3.88%). During interaction with the community, the respondents revealed that people usually migrate to Mumbai, Maharashtra, and Indore, Madhya Pradeshin search of wage employment. However, as informed by NTPC Khargone, better opportunities of livelihood in different cities attract the agricultural labourer for a limited time period i.e. around three months after which they return. NTPC Khargone further informed that as per the government record, Selda/Balabad and Dalchi did not have permanent migration.

Figure 16: Migration (%)



(Source: IICA Survey, 2022)

3.3 ECONOMIC CONDITION

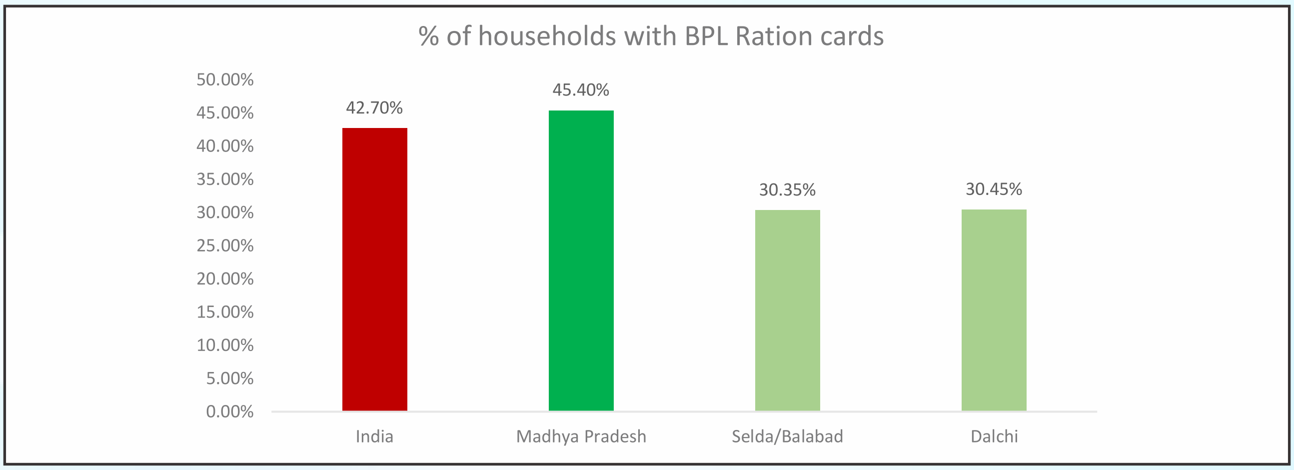
To understand the economic conditions of the respondents, the two most important indicators are population below BPL and per capita annual income.

BPL population

Out of the total population living in India, 42.7 % of them are living below the poverty line, and in Madhya Pradesh it is 45.4 %[3].Figure 18 highlights that the economic conditions of the people in the study area are relatively better when compared with the national (42.7%) and state benchmark (45.4%). On asking about the BPL cardholders, it was found that a slightly higher percentage of households below the poverty line were found in Dalchi (30.45%) than in Selda/Balabad (30.35%).

[3] Antyodaya Dashboard, 2019-20

Figure 17: BPL Population (%)



As informed by NTPC Khargone, a hefty compensation was provided to the Project Affected Persons (PAPs) much above the government rates. Further, in addition to the R& R grant, a lump sum amount was also given to the PAPs against non-availability of Jobs at NTPC Khargone.As per NTPC Khargone, post-land acquisition, 90 percent of the farmers could purchase a land which was double in size than they previously held.

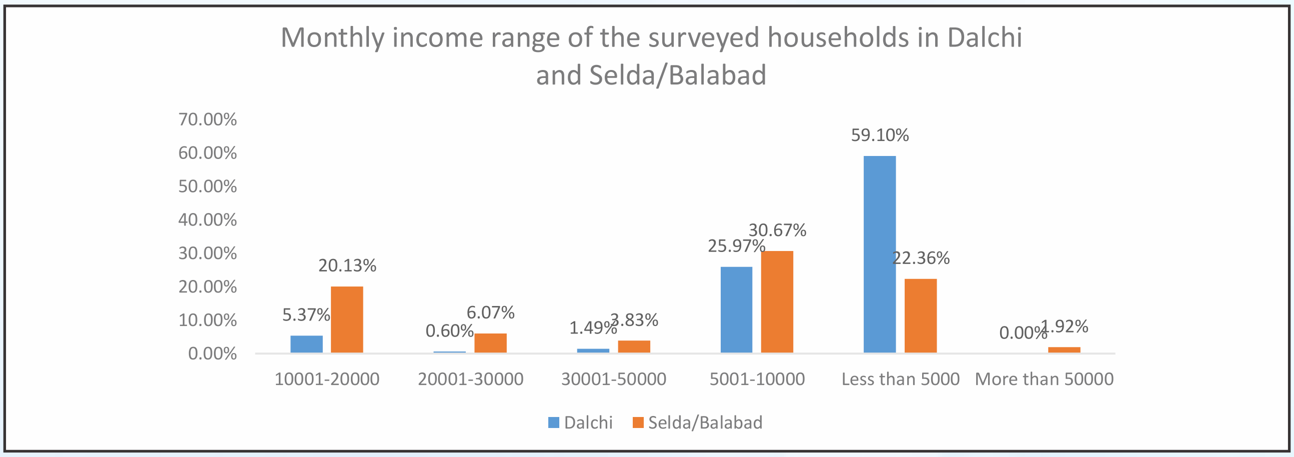
Monthly income range of respondents

As per the socio-economic study for KgSTPP in 2011, the annual household income varied between Rs. 20,000 and Rs. 5, 00,000 per family. Therefore, on comparing the baseline data for annual income range with the IICA survey, 2022, it was found that the maximum annual income has increased upto Rs 6,00,000and above (However, none of the surveyed households in Dalchi and only 1.92% of the surveyed households in Selda earned more than 50,000 per month or 6,00,000 Per annum).

Further, the minimum annual income as can also be observed from Figure 19 below, happened to be less than 60,000 per family. However, it is important to note here that the majority of the surveyed households in the study villages belong to this category of income (59.10% households in Dalchi and 22.36% households in Selda earn less than Rs 5000 per month or 60,000 per annum).Given the per capita income (NNI) of India being INR 94954[4], it can be said that the majority of the surveyed households in the study area have a monthly income range below the national benchmark.

Nevertheless, 25.97% households in Dalchi and 30.67% households in Selda earn a monthly income between Rs. 5000-Rs 10000, 5.37% households in Dalchi and 20.13% households in Selda earn a monthly income between Rs. 10000- Rs. 20000, followed by 0.6% households in Dalchi and 6.07% in Selda earning a monthly income between Rs. 20000 -Rs 30000. Moreover, 1.49% households in Dalchi and 3.83% households in Selda have a monthly income range between Rs. 30000-Rs. 50000.

Figure 18: Monthly income range of the surveyed households in Dalchi and Selda/Balabad (INR)



(Source: IICA Survey, 2022)

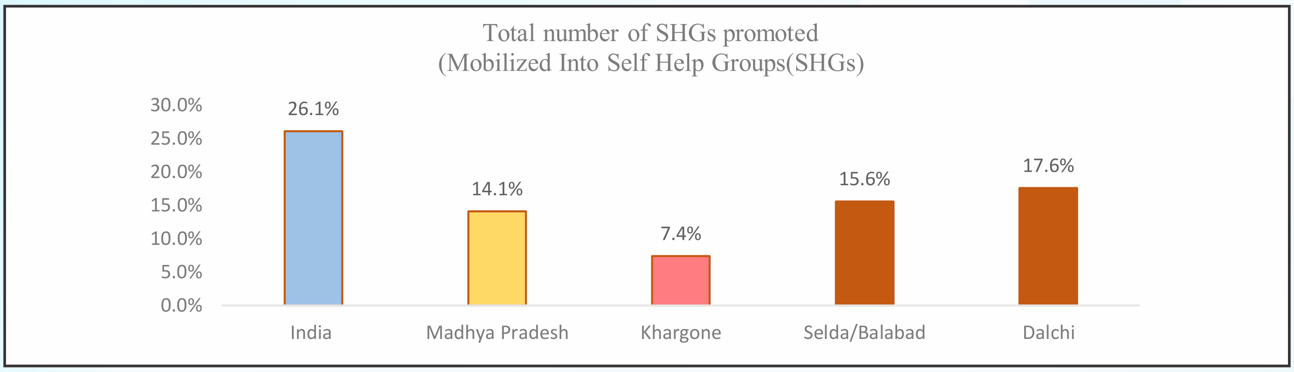
[4] https://www.rbi.org.in/scripts/PublicationsView.aspx?id=19735

3.4 GENDER EQUALITY AND WOMEN EMPOWERMENT

Total number of SHGs promoted (Mobilized into Self Help Groups (SHGs)

The figure below indicates the formation of SHGs is higher in the study gram panchayat villages when compared to the district (7.4%) and state bench mark(14.1%) however the former is still less than the national benchmark (26.1%). More women-centricinterventionsneed to be focused on the study gram panchayat to bring them to the national benchmark.

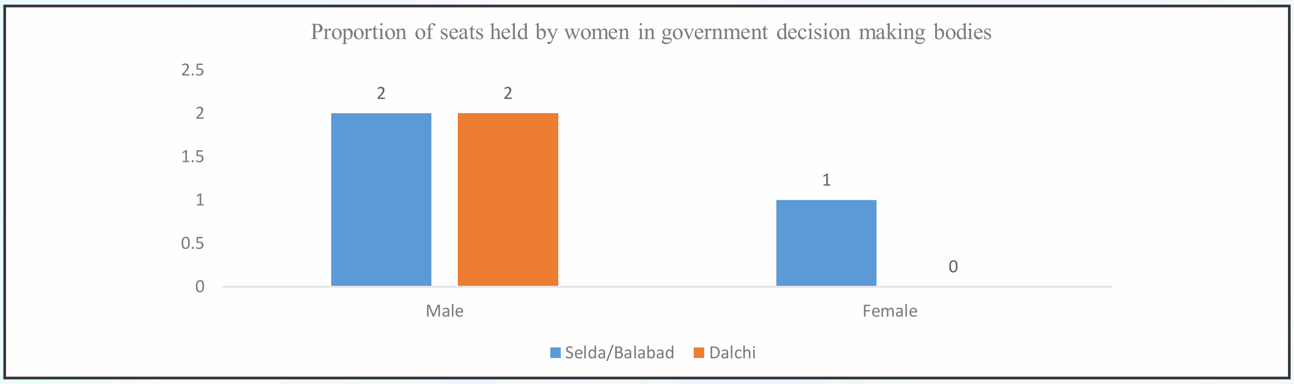
Figure 19: Total number of SHGs promoted



Proportion of seats held by women in government decision making bodies

According to Abraham Lincoln, a true democracy is a form of government that is run by, for, and by the people. For women's interests to be taken into account in governance, women must participate in decision-making. To create gender equal opportunities and gender sensitive policies, including women is crucial, especially in local governments. Women's needs and perspectives on social and political issues vary, so it is crucial to include them in governments in order to take into account all societal viewpoints when formulating policy and making decisions. As per IICA survey, key informant interviews were conducted with five Panchayat members. It is found that most of them are male candidates indicating low female participation in the area.

Figure 20: Proportion of seats held by women in government decision-making bodies



Source: IICA Survey, 2022)

3.5 HEALTH STATUS

Life expectancy

In 2013-2017, the life expectancy in Madhya Pradesh is 69 years. For men, it is 67.8 years and for females it is 70.4 years. In rural areas, it is 67.7 years.[5]

Maternal and infant mortality rates

The Infant Mortality Rate (IMR), which is widely accepted as a crude indicator of the overall health scenario of a country or a region, is defined as the infant deaths (less than one year) per thousand live births in a given time period and for a given region. Table 4shows the IMR and MMR of Madhya Pradesh and how it has improved over the period of time.

[5] https://pib.gov.in/PressReleasePage.aspx?PRID=1606209

Table 4: Infant Mortality Rate and Maternal Mortality Rate

	2015-17	2016-18	2019
IMR Madhya Pradesh	47[6]	48[7]	46[8]

	2015-17	2016-18	2017-19
MMR Madhya Pradesh[9]	188	173	163

In the study area, the data on the number of infant and maternal deaths in the gram panchayat villages over the period of one year was recorded from the register of Anganwadi workers. Maternal deaths and Infant deaths are given in table.

Table 5: Number of Infant and Maternal Deaths in the survey area

Gram Panchayat	**Maternal Deaths (in Numbers)**	**Infant Deaths (In Numbers)**
Selda / Balabad	0	3
Dalchi	0	0

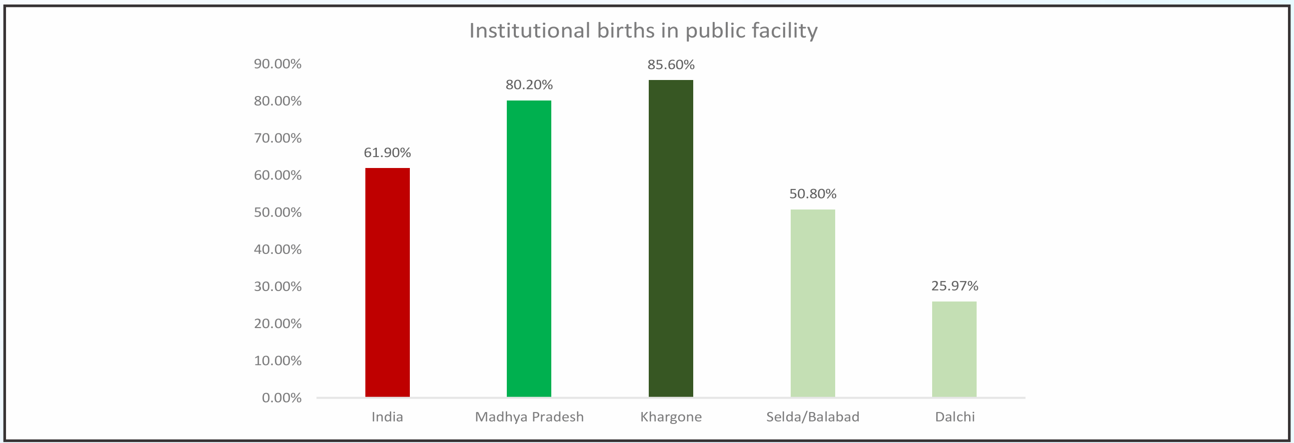
(Source: IICA Survey, 2022)

Institutional births in public facility (%)

Out of the total respondents of the study spread across Selda/Balabad and Dalchi, 5.71% of the respondents shared that their youngest child was born in private hospital, 37.96% shared that they opted for institutional birth in a public facility (government hospital), 28.4% respondents delivered their child at home. Out of those who delivered at home, 88.6% of the women were assisted by a health worker. The question did not apply to 13.89% of the respondents because their youngest child was too old for the purpose of the survey. Further, 14.04% of the respondents did not choose to answer the question.

With respect to institutional births in public facility i.e. government/district hospital, it was found that in Selda/Balabad, 50.80% of the surveyed households opted for institutional birth in public facility while in Dalchi, only 25.97% of the surveyed households opted for the same. As per the National Family Health Survey (NFHS-5) report 2019-2021, India's Institutional delivery in public health facilities is 61.9% while for Madhya Pradesh, it is 80.2%[10]. Further, the percentage of institutional delivery in Khargone district is 85.6% as per the NFHS-5 report for Madhya Pradesh[11]. Therefore, it can be concluded that both Selda/Balabad and Dalchi lag behind the National, State and District benchmark for institutional delivery in a public health facility.

Figure 21: Institutional births in public facility



(Source: IICA Survey, 2022)

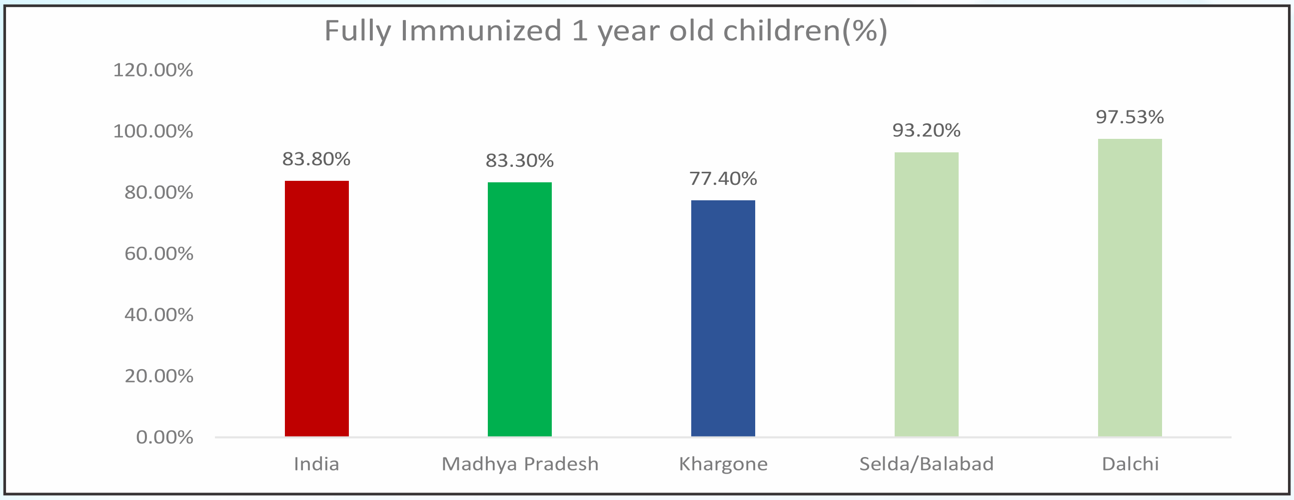
6 https://hmis.nhp.gov.in/#!/
7 https://hmis.nhp.gov.in/#!/
8 https://hmis.nhp.gov.in/#!/
9 https://censusindia.gov.in/nada/index.php/catalog/40525
10 https://main.mohfw.gov.in/sites/default/files/NFHS-5_Phase-II_0.pdf
11 http://rchiips.org/nfhs/NFHS-5Reports/Madhya_pradesh.pdf

Percentage of 1 year old children immunized

Millions of lives are saved annually as a result of vaccination, which is a success story in global health and development. In order to build protection against disease, vaccines work with one's body's natural defences to protect against diseases.

Figure below depicts the percentage of one-year-old children (12-23 months) who are immunized. It is seen that Dalchi gram panchayat has more immunized children (97.53%) when compared to Selda/Balabad gram panchayat (93.2%). It is also quite evident that the percentage of immunized one-year-old children is more in the study gram panchayat villages than in the district (77.4%)[12], state (83.3%)[13], and national level(83.8%)as per the NFHS-5 report.

Figure 22: Percentage of 1 year old children immunization status

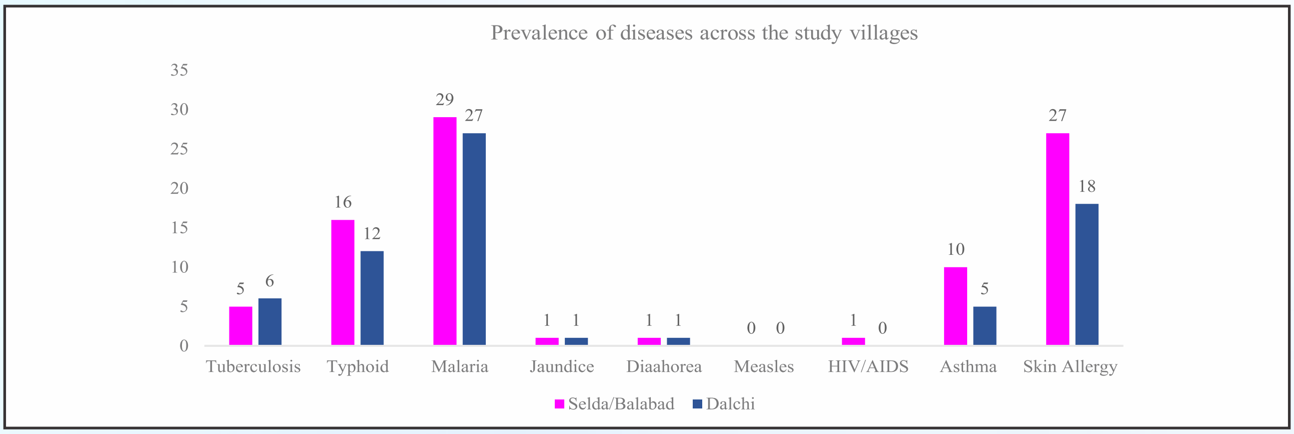


(Source: IICA Survey, 2022)

Prevalence of diseases

The figure below shows the prevalence of diseases across the study gram panchayat. The majority of the respondents (56) revealed that people suffer from malaria, while 28 respondents revealed that people suffer from Typhoid,15 respondents revealed that people suffer from Asthma and 11 respondents revealed that people suffer from Tuberculosis.

Figure 23: Prevalence of diseases across the study villages



(Source: IICA Survey, 2022)

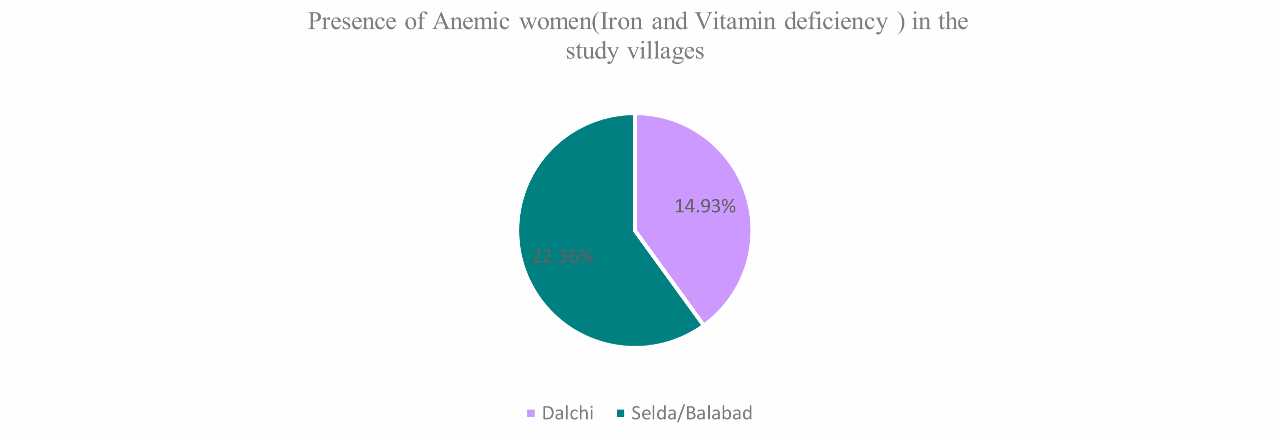
Incidence of anaemia cases

When there are not enough healthy red blood cells to deliver oxygen to ones' body organs, anaemia develops. As a result, a person experiences symptom of fatigue or weakness as well as a cold. Figure below depicts presence of anaemic women in the study gram panchayat villages. According to the Fifth National Family Health Survey (NFHS-5), At an all India level, 57% of all women aged between 15-49

[12] http://rchiips.org/nfhs/NFHS-5Reports/Madhya_pradesh.pdf
[13] https://main.mohfw.gov.in/sites/default/files/NFHS-5_Phase-II_0.pdf

years are found to be anaemic while in the rural areas of India, 58.5%women are found to be anaemic[14] It is reported that anaemic cases in Dalchi gram Panchayat is higher (14.93%) when compared to the anaemic cases in Selda/Balabad gram panchayat (22.36%).

Figure 24: Presence of Anaemic women



(Source: IICA Survey, 2022)

3.6 QUALITY OF LIFE

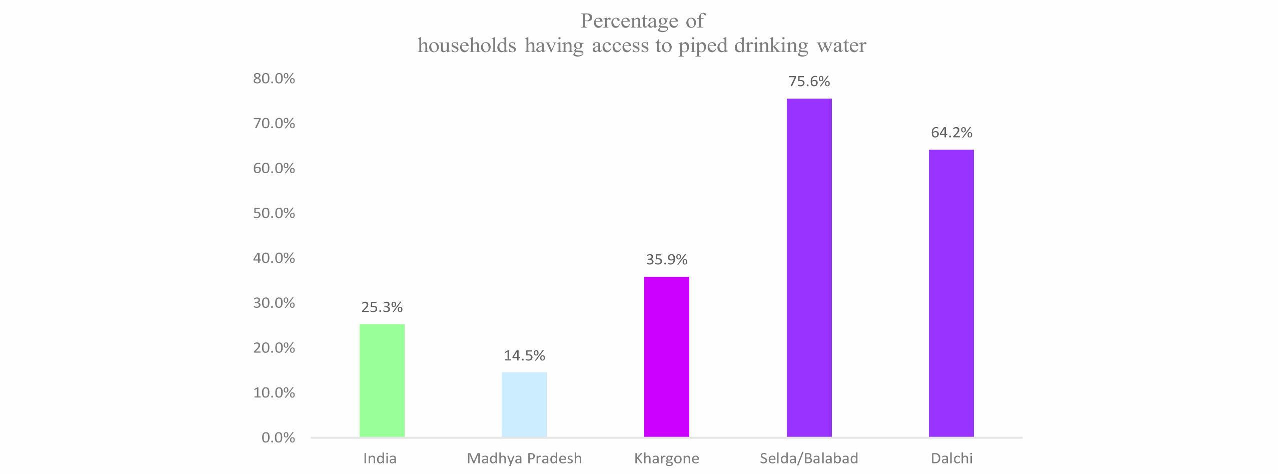
To assess the quality of life of the people in the study villages, indicators such as households having access to piped water, type of house, access to domestic electricity, and access to toilets are taken into consideration. These indicators are mapped against the national, state and district data from secondary sources like government databases and websites and village data as collected through household survey.

3.6.1 Households with piped drinking water

Around 25.3% households in India have piped drinking water connections. The percentage of households receiving piped drinking water directly at home is 14.5 % in the state of Madhya Pradesh[15].

The IICA survey found that the percentage of households covered with piped drinking water in Selda/Balabad (75.6%) and Dalchi (64.2%) are higher when compared to the district (35.9%), state (14.5%) and national bench mark (25.3%)

Figure 25: Households with access to piped drinking water



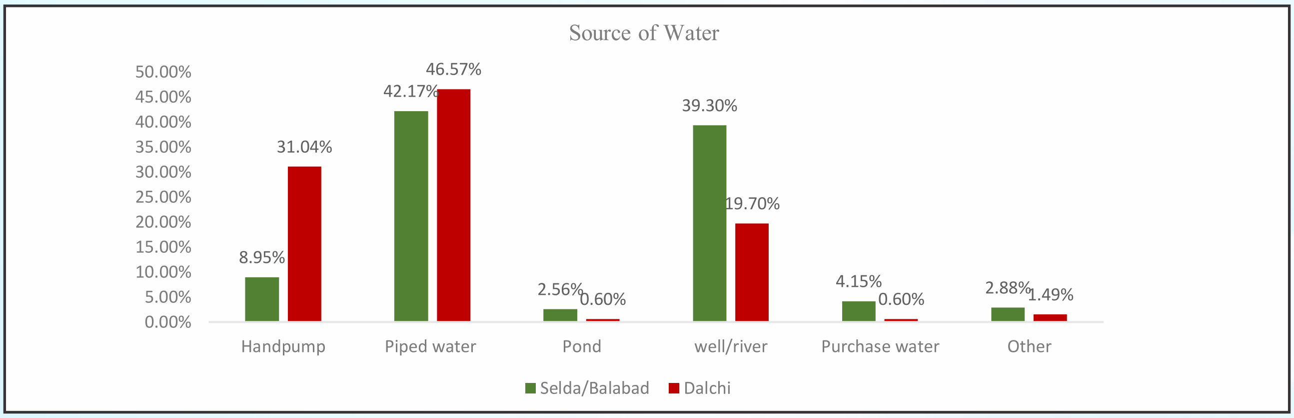
(Source: IICA survey, 2022)

Source of water

The major source of water for people in the area is piped water followed by hand pump, well/river in the study gram panchayat.

[14] https://main.mohfw.gov.in/sites/default/files/NFHS-5_Phase-II_0.pdf
[15] https://main.mohfw.gov.in/sites/default/files/NFHS-5_Phase-II_0.pdf

Figure 26:Source of Water



(Source: IICA survey, 2022)

Comparing the water supply facilities in Selda/Balabad and Dalchias per IICA Survey, 2022 with the baseline data in 2011 (as per the socio-economic study for KgSTPP), it was found that the water supply has significantly improved in the project affected villages. In 2011, the major source of water supply used to be wells and tube wells in the PAVs wherein people had to travel 350 m to fetch drinking water from the public tube wells. To make matter worse, only40% of the public tube wells/handpumps were functional and maintained. Also, the inadequate depth of few tube wells made them non-functional especially during summers.

In 2022, a significant percentage of households in Selda/Balabad (75.6%) and Dalchi (64.2%)have access to piped drinking water, as also mentioned in the findings above. It is especially a significant improvement when compared to the socio-economic study for KgSTPP, 2011. This is because none of the houses in the PAVs in 2011 had their source of drinking water within their house itself. Additionally, the source of water also includes handpump, well/river, pond and purchased water.

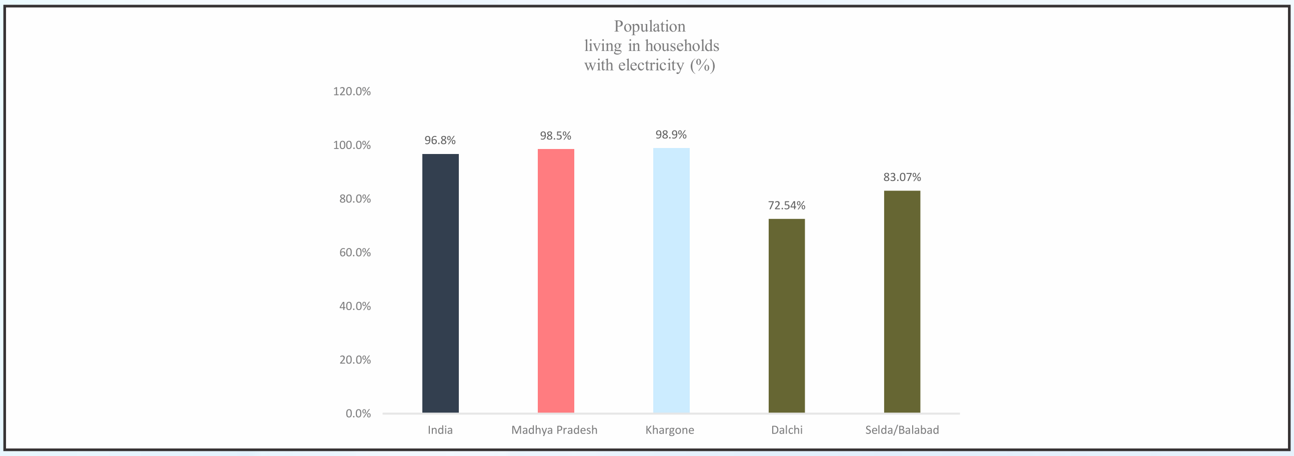
3.6.2 Households with access to domestic electricity

In terms of rural electrification in India (2018), about 88.2 %% of households had electricity for domestic use. The percentage of electrified households in Madhya Pradesh is 98.5 % (as per NFHS 5 2019-21)

The socio-economic study for KgSTPP, 2011 suggests that while most of the PAVs had electricity facility, there were some hamlets that did not. However, the study does not mention the name of these hamlets. At the same time, the study mentions that all the PAVs have domestic electricity connections.

The data from IICA survey suggests that overall 83.07% of the households in Selda/Balabadand 72.54% of the households in the Dalchi gram panchayat had access to electricity. It is quite evident that the households with electricity connections in both the gram panchayat are lower than the national (96.8%),state(98.5 %%) and district bench mark (98.9%).

Figure 27: Percentage of households in the Villages with access to domestic electricity

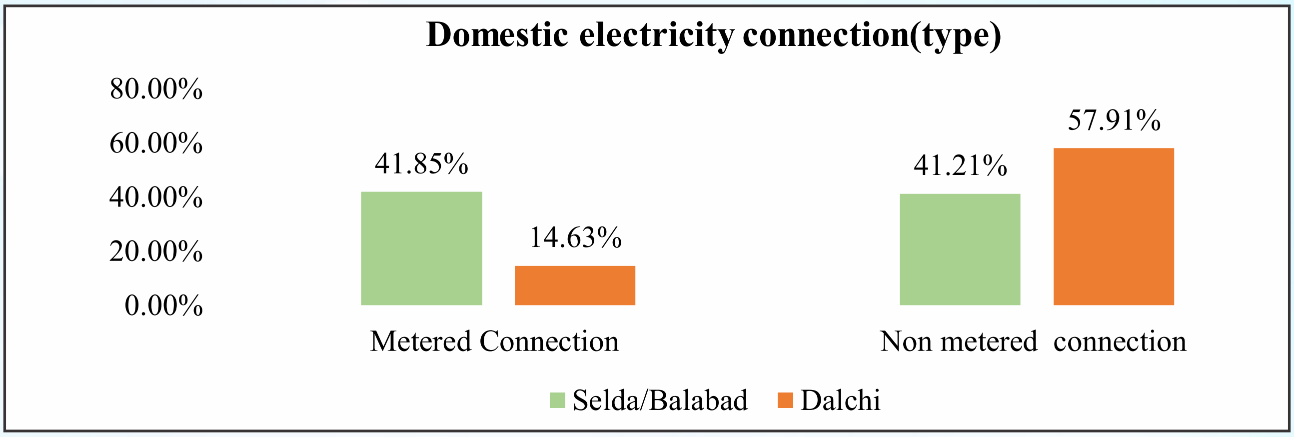


(Source: IICA Survey, 2022)

Electricity connection (type) in the households

Figure below depicts the type of electricity connections in the households.41.85% of the surveyed households in Selda/Balabad and 14.63% of the surveyed households in Dalchi had metered electricity connections. It is also noted that Dalchi gram panchayat has more non-metered connections than the Selda/Balabad gram panchayat

Figure 28: Domestic electricity connection (type)



(Source: IICA Survey, 2022)

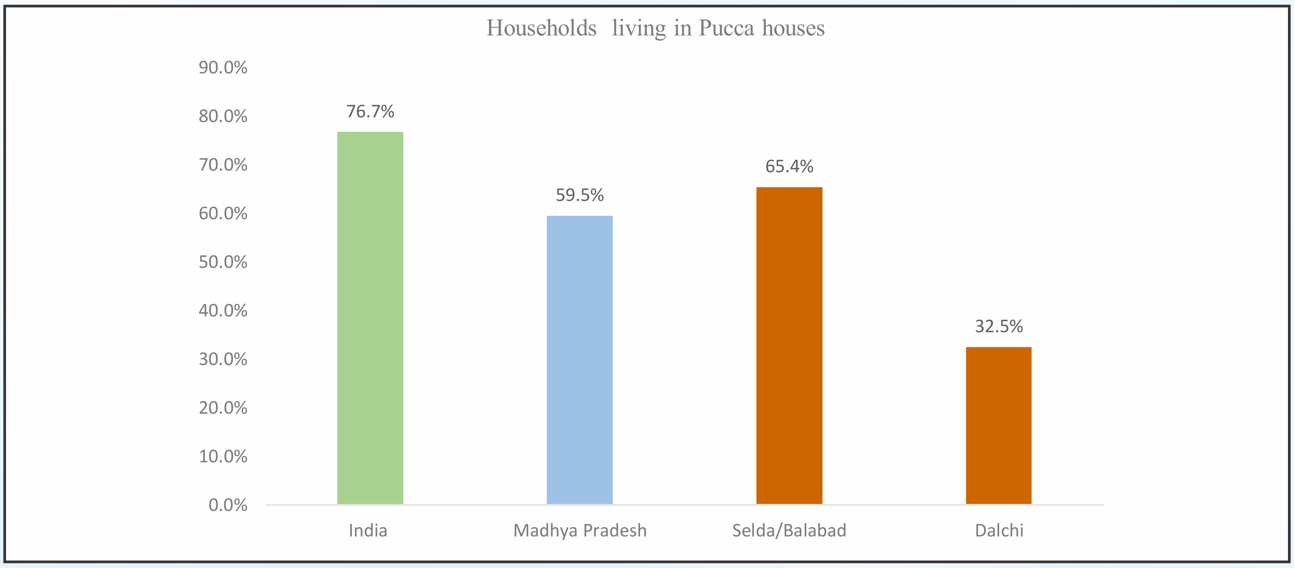
3.6.3 Population having pucca houses

Housing has a positive impact on the overall standard of living of rural people. In India, about 76.7 % households have the pucca structure, while in Madhya Pradesh 59.5 % of households have a pucca structure.

The socio-economic study for KgSTPP, 2011 found that the study area comprised only 17.06% houses having pucca structures. Rest of the houses (47.06%) had kutcha-pucca mixed structures while 35.88% houses had kutcha structures only. Compared to the baseline data, the IICA Survey, 2022 reveals that 65.5% respondents in Selda/Balabad and 32.5% respondents from Dalchi lived in Pucca houses. Therefore, it can be concluded that there has been significant improvement in the number of Pucca houses spread across Selda/Balabad and Dalchi.

Further, comparing the percentage of households having Pucca house structures with the National and State benchmark, while for Selda/Balabad, the percentage of households with pucca structure (65.5%) is higher than the state benchmark but lower than the National benchmark, for Dalchi, the percentage of households with Pucca structure (32.5%), is lower when compared to both the National and State benchmark.

Figure 29: Households living in Pucca houses



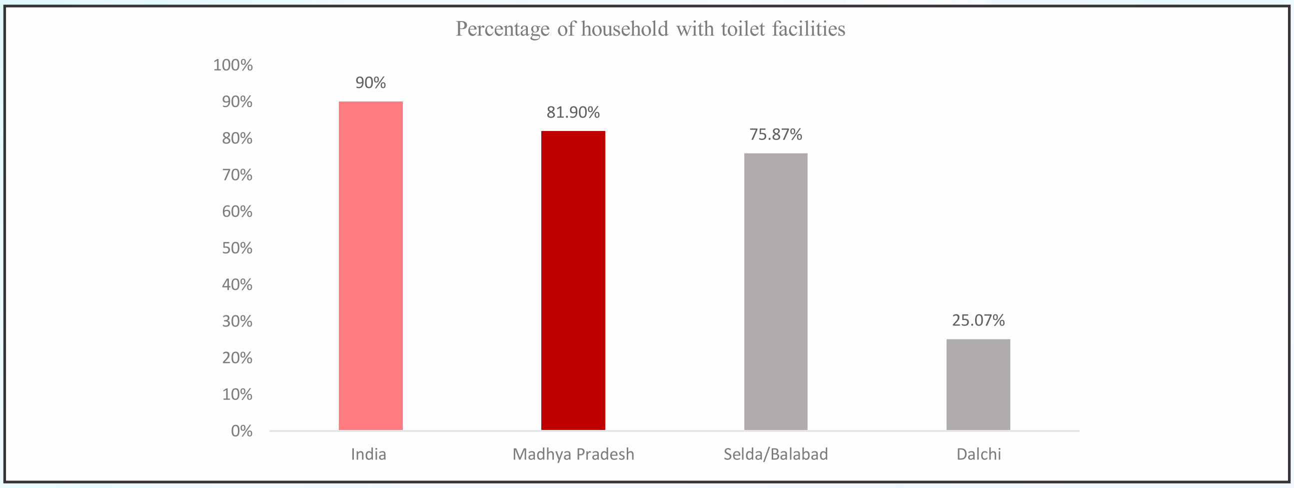
Source: IICA Survey, 2022)

3.6.4 Population having toilet facility within the household

Every member of the home benefits from having a toilet, especially the women and girls. Men and women both experience the difficulty of visiting an open defecation location and the risk of catching infections, although these issues are more prevalent among women. The health issues are more severe for expecting mothers.

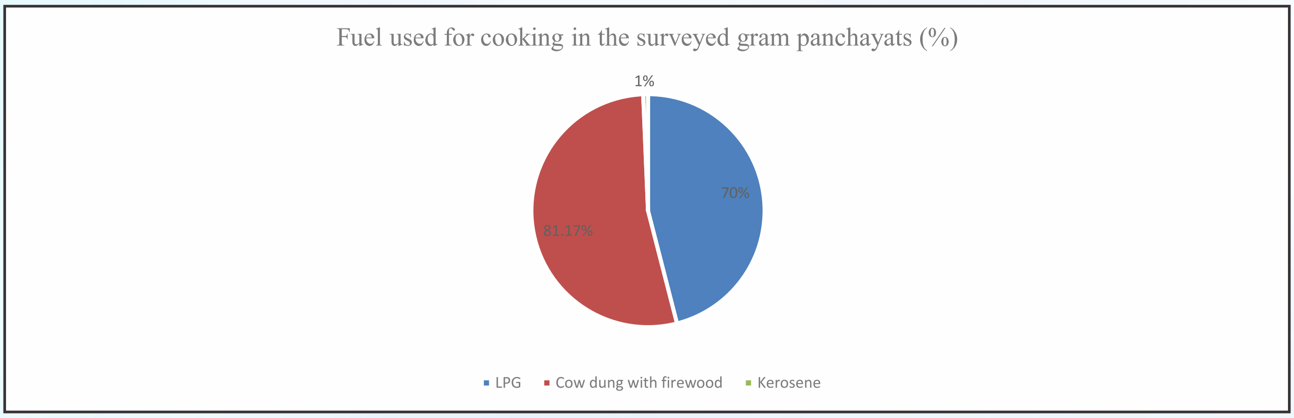
Figure 30 below depicts that the percentage of households with toilet facilities is low in both Selda/Balabad and Dalchi gram panchayats when compared to the national(90%) and state(81.9%) bench mark. Nevertheless, when compared with the baseline data, there has been a significant improvement in the percentage of households with toilet facility. As can be seen from the socio-economic study for KgSTPP, 2011, only 14.71% of the houses had separate and proper toilets. However, as per the IICA survey, 2022, 75.87 % of the surveyed households in Selda/Balabad and 25.07% of the surveyed households in Dalchi had toilet facilities. Furthermore, a significant difference between the percentage of households with toilet facilities in Dalchi and Selda/Balabad can be observed.

Figure 30: Population having Toilet facilities



(Source: IICA survey, 2022)

Fuel used for cooking in the study area/ surveyed gram panchayat



(Source: IICA survey, 2022)

As per the socio-economic study for KgSTPP, 2011, the majority of the PAPs in the study area used firewood as the main fuel for cooking. Additionally, the LPG, kerosene and electricity were also used as the supplementary cooking fuel.

The IICA Survey, 2022 shows that a majority of the surveyed households across Selda/Balabad and Dalchi Gram panchayat used Cow dung with firewood (81.17%) along with LPG (70%) as the main cooking fuel. Kerosene for cooking was used by only 1% of the surveyed households. Therefore, it can be said that while the LPG connections to the households have increased manifold in comparison to the 2011 baseline data, a majority of the households still rely on firewood as the main fuel for cooking.

4. KNOWLEDGE, ATTITUDE AND PRACTICES ANALYSIS (KAP)

4.1 LANGUAGE AND HABIT OF COMMUNICATION

The major language spoken by the locals in the region is Nimadi followed by Hindi. Nimadi speakers use Hindi mainly in education and for communication with outsiders. Nimadi is actually a form of the Malvi dialect of Rajasthani, but it has enough distinct characteristics of its own to be taken into account separately. A small portion of the population also speaks Adivasi, Banjara.

4.2 CULTURAL CHARACTERISTICS, TRADITIONS, VALUES, BELIEFS

Kanbai festival: The Kanbai Festival is celebrated by Nimadis people.

Navratri Festival: On this holiday, Durga, the goddess of might is worshipped.

Diwali: The Nimadi people celebrate Diwali with a tremendous deal of excitement. The celebration is marked for five days, with a great deal of excitement. On Dhanteras, a holiday honouring the goddess Dhanteras, people typically purchase new clothes, gold jewellery, metal utensils, and diyas for lighting up their homes.

Gangaur festival: The Gangaur festival is very significant for the Nimar citizens. Gauri, Lord Shiva's wife, is honoured during an annual festival that takes place in her honour. Visitors to the temple pay respect there. The Gangaur celebrations are a part of Rajasthani culture and tradition. Unmarried girls worship Gauri in order to make sure they find a nice and attractive spouse, while married women worship Gauri for blessing their spouse with long life. This event is among the major activities in the Nimad region.

5. AGRICULTURE DEVELOPMENT

Out of the total population surveyed, 63.9 per cent of respondents are engaged in agricultural activities.

Rainfall: The Khargone district in Madhya Pradesh has a hot summer and is generally dry, with the exception of the south-west monsoon season. There are four distinct seasons in a year. The hot season follows the cold season, which lasts from December to February. The south west monsoon season lasts from the middle of June to September. The post-monsoon or transitional period is formed by October and November.

835 mm of rain falls typically each year in the Khargone district. About 92.8% of the annual rainfall in the monsoon season is received at its highest during the June to September south-west monsoon period. Only 7.2% of the annual rainfall falls between the months of October and May. As a result, the only time surplus water is available for ground water recharge is during the south west monsoon season.

Agriculture: Since 63.9% population is engaged in agriculture in the study gram panchayat villages, they are engaged in rainfed- subsistence farming with traditional means. The people are either farming on their land or working as agricultural labourers in the villages. The major crops grown in the area are food grains, pulses, cash crops and oilseeds

Around 57.87% of the respondents spread across Selda/Balabad and Dalchi said that the major issue that they are facing is lack of water for irrigation for farming and are unable to access new techniques in farming.

Further, on an analysis of the baseline data (2011), as per the socio-economic study for KgSTPP, a significant part of the land in these PAVs were deprived of the irrigation facilities except during monsoon. Also, due to the unavailability of electricity, backwardness and poverty, very few tube wells were in use for the irrigation purpose. However, the IICA Survey, 2022 reveals that there has not been much improvement in the circumstances of people as more than half of the respondents of the study (57.87%)were unable to access the new farming techniques or have sufficient water for irrigation.

6. INFRASTRUCTURE AVAILABLE

Rural areas continue to face significant difficulties in providing dependable and efficient infrastructure. In order to better understand the need for school infrastructure, field research was done in each of the two gram panchayat villages. For the local population to meet their basic needs in these areas, infrastructure assets such as rural roads, tracks, bridges, irrigation schemes, water supplies, schools, health centres, and markets are required.

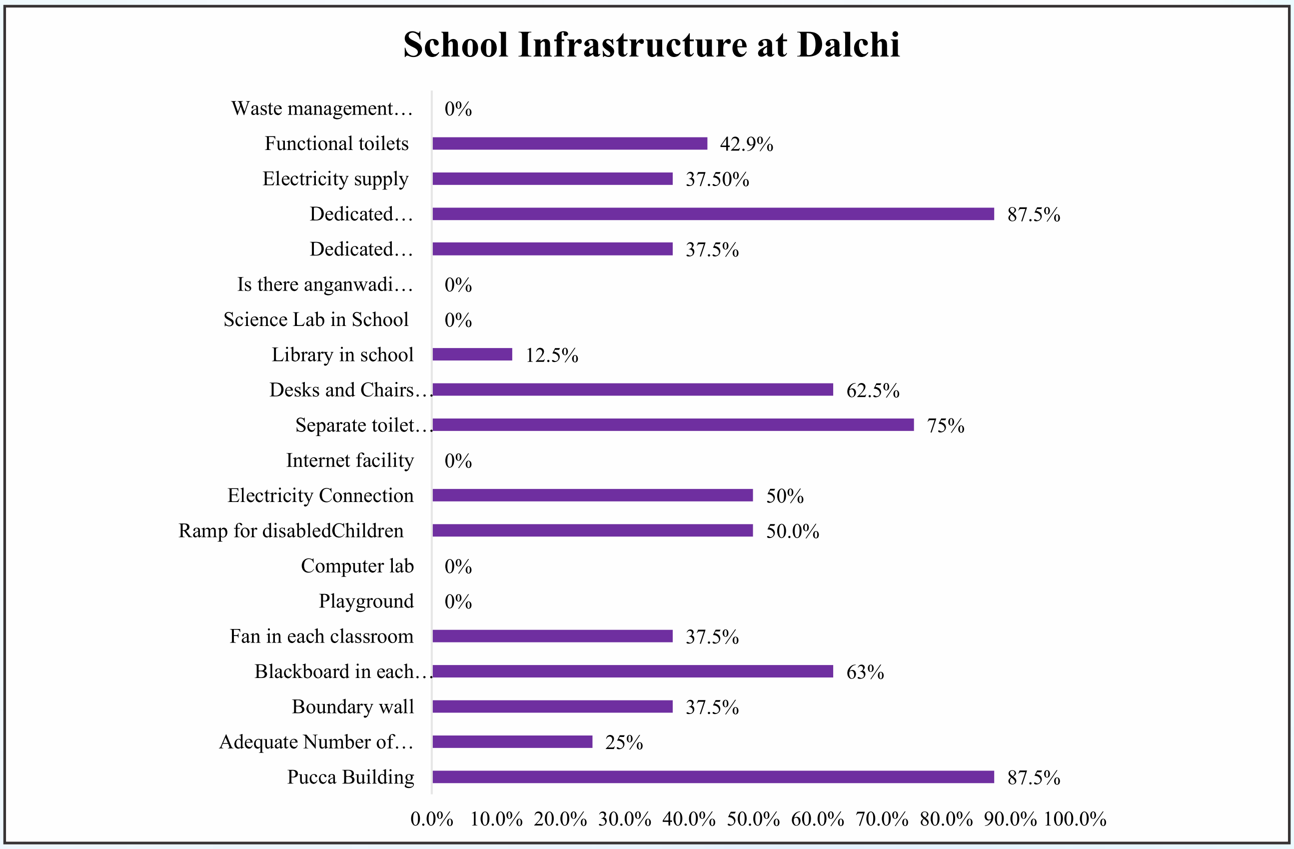
6.1 SCHOOL INFRASTRUCTURE

In survey villages of Khargone district, the public schooling system is functional, but the quality of education and school infrastructure still needs a lot of improvement as observed during the conversations with the respondents and key stakeholders in the area. To further understand the availability of basic facilities in schools, key informant interviews were conducted with school officials. The school infrastructure has been analysed separately for Dalchi and Selda gram panchayat.

Figure below shows that most of the surveyed schools in Dalchi have ramps for PWDs (50%) and 63% of the surveyed schools had an adequate number of blackboards.37.5%of the surveyed schools had an adequate number of fans and 75 %of the surveyed schools had a separate toilet for boys and girls. Additionally, important facilities like a library were found in 12.5% of the schools.

None of the surveyed schools in Dalchi had internet access, a computer lab, a science lab, and a playground.

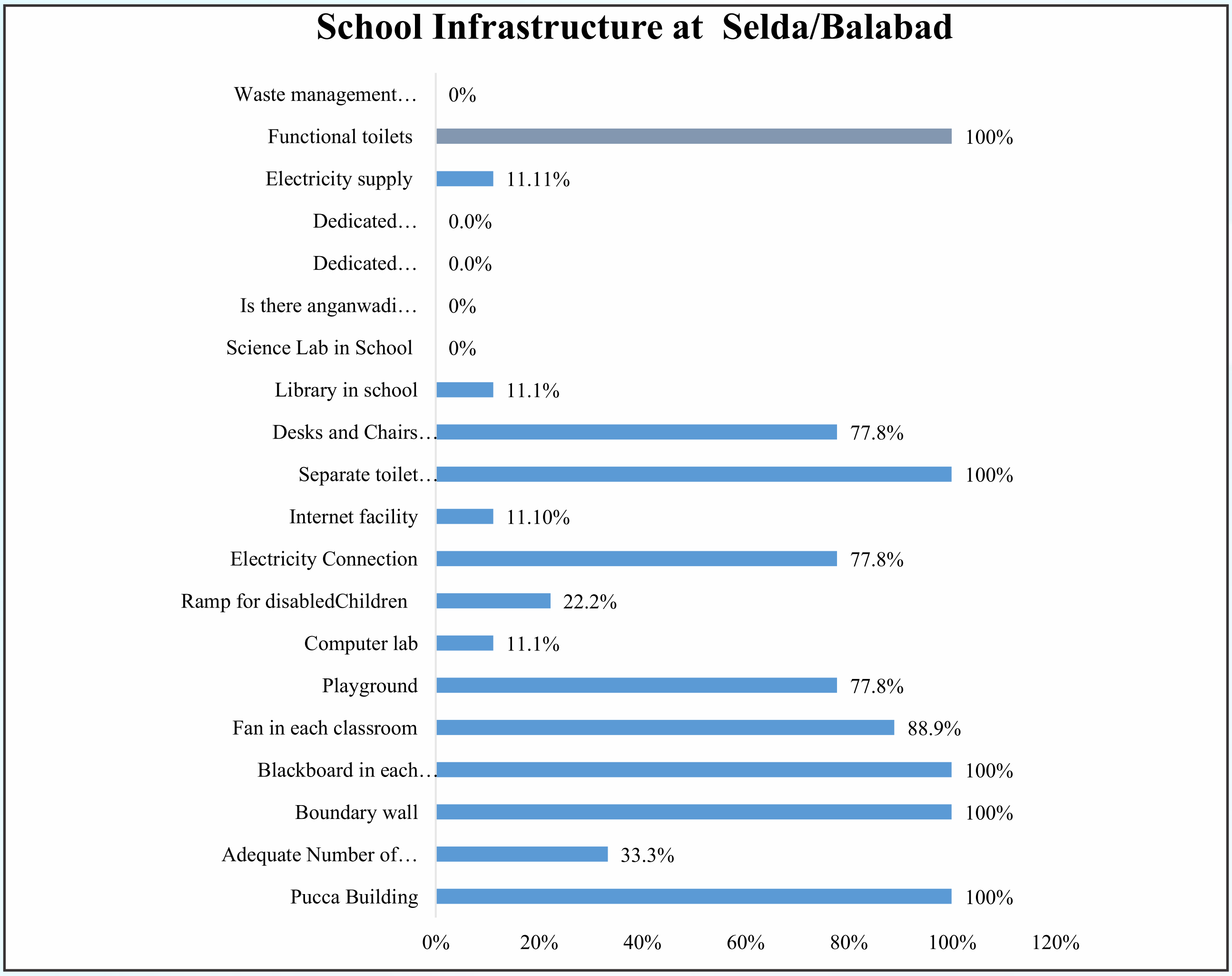
Figure 31: School Infrastructure at Dalchi



(Source: IICA Survey, 2022)

Figure below shows that some of the surveyed schools in Selda have ramp for PWDs (22.2%) All of the surveyed schools had an adequate number of blackboards and 77.8% of the surveyed schools had a playground.88.9% of the surveyed schools had an adequate number of fans and all of the surveyed schools had a separate toilet for boys and girls. Additionally, important facilities like a library, playground, computer lab, and internet facilities were found only in 11.1%, 77.8%, 11.1%, and 11.1 percent of the surveyed schools respectively. None of the surveyed schools had a science lab.

Figure 32: School Infrastructure at Selda/Balabad



(Source: IICA Survey, 2022)

IICA's communication with NTPC Khargone officials revealed that a learning level improvement programme was developed by them for the schools. Further, NTPC Khargone also constructed/ renovated the classrooms and the school buildings, in addition to providing the students with water facilities. Moreover, fans were provided by NTPC Khargone, L&T as well as the government. At the same time, the donors also want to contribute towards the development of a comfortable environment at school. Furthermore, as per NTPC Khargone, all the schools at Dalchi, Bedipura, Nurufaliya & Lalyachappad have separate toilets for girls and boys. While NTPC Khargone is concerned for the healthcare, sanitation facilities and hygiene level of the PAVs, they have not received any request from the people in the study area for the construction/renovation of toilets.

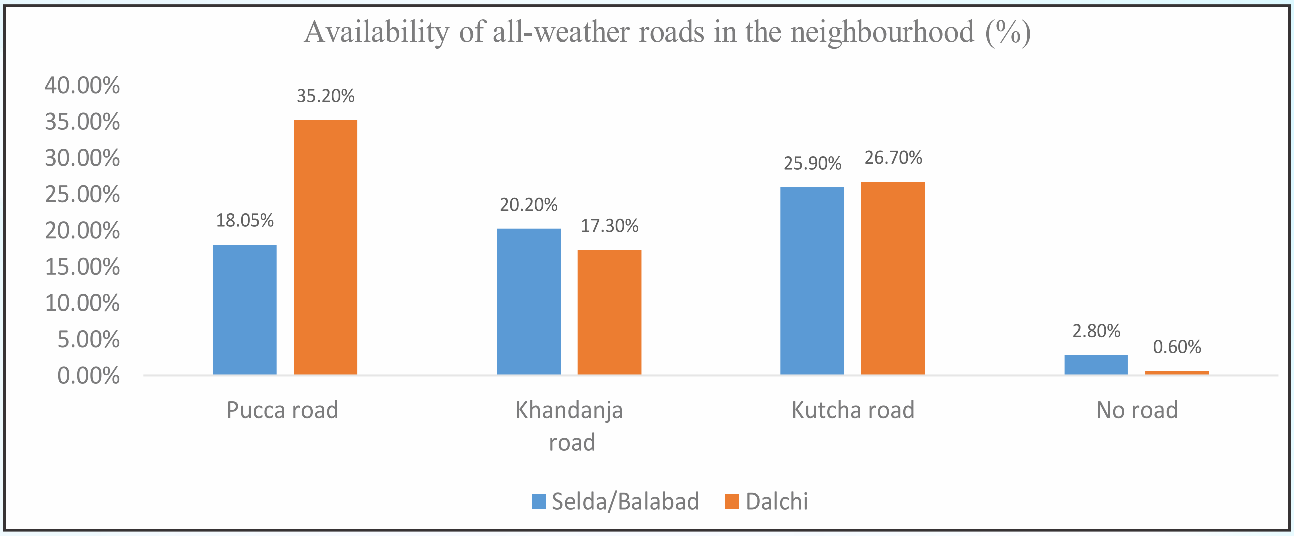
6.2 AVAILABILITY OF ALL-WEATHER ROADS

Rural living conditions are impacted by road connectivity in two ways. One benefit is that it gives local communities faster, more dependable access to goods, services, information, and social connections from the outside world. Two, connectivity makes it possible for communities to fully utilise the government services already in place that benefit rural areas. Additionally, because there is a relationship between rural connectivity and growth, employment, education, and healthcare, road connectivity projects have significant socio-economic effects on the lives of beneficiaries.

According to Mission Antyodaya dashboard (2019-20), the all-weather road coverage is 77 % in Madhya Pradesh and 74 % in Khargone. 35.2% of respondents in Dalchi gram panchayat villages confirmed the availability of pucca roads in their neighbourhood. Similarly,18.05% of the respondents in of Selda/Balabad gram panchayat villages confirmed the availability of pucca roads in their neighbourhood.

20.20% of the respondents in Selda/Balabad gram panchayat and 17.3 % of the respondents in Dalchi gram panchayat confirmed the presence of Kharanja road in their neighbourhood. Similarly,25.90 % of the respondents in Selda/Balabad gram panchayat and 26.70 % of the respondents in Dalchi gram panchayat confirmed the presence of Kutcha Road in their neighbourhood.

Figure 33: Availability of all-weather roads in the neighbourhood (%)



(Source: IICA Survey, 2022)

As per the socio-economic study for KgSTPP, 2011,while the PAVs were accessible through all-weather roads and the fair weather roads, a significant variation in accessibility to these roads was found amongst the different hamlets/tollas of the PAVs. The report mentions that some hamlets were connected to all-weather roads and few hamlets were connected to fair weather roads which were not in a good condition. The report also mentions that there were 2 concrete roads of 200 m length at Selda/Balabad and 60.6 m length at Dalchi, and that the people did not have any metalled road. Moreover, there were 20 Kutcha roads at Selda/Balabad (2500 m in length) and 10 Kutcha roads at Dalchi (909.1m length).

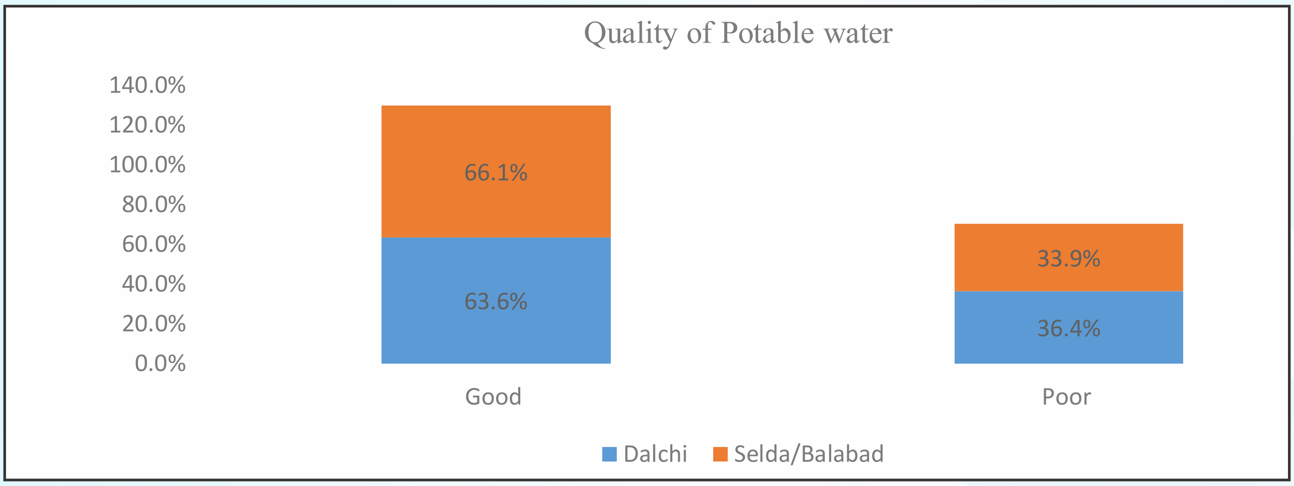
Therefore, when compared with the findings of IICA survey, 2022 (Figure 33), it can be said that while the percentage of people who have access to pucca/cemented/concrete roads have increased in the past 10 years, there is scope of much more improvement.

Furthermore, the communication with the NTPC Khargone officials revealed they have constructed 1 kilometre long Cement Concrete (CC) road in Dalchi, along with 2.5 Km road on deposit work through MP Rural Road Development Authority (MPRRDA), Gram Panchayat and other contractors. NTPC Khargone also informed that soon they would be awarding the contract for construction of 1 Kilometre road to Hariom construction. Additionally, the surveyed area was not well connected to Bediya prior to 2013. It was only after NTPC Khargone's intervention that accessibility of the people to Bedia improved.

6.3 QUALITY OF POTABLE WATER

Water needs to be pure and free of contaminants like disease, metals, and human and animal faces because it passes through our organs and cells. Drinking unclean or unfiltered water that might be contaminated can make one sick. Diarrhoea is among the most typical negative effects of ingesting contaminated water. If improperly addressed, this side effect alone has the potential to be fatal. Figure below depicts that 63.6% of the respondents revealed that water available for drinking in Dalchi gram panchayat village is of good quality. Similarly, 66.1% of the respondents revealed that water available for drinking in Selda/Balabad gram panchayat village is of good quality.

Figure 34: Quality of potable water(Source: IICA Survey, 2022)

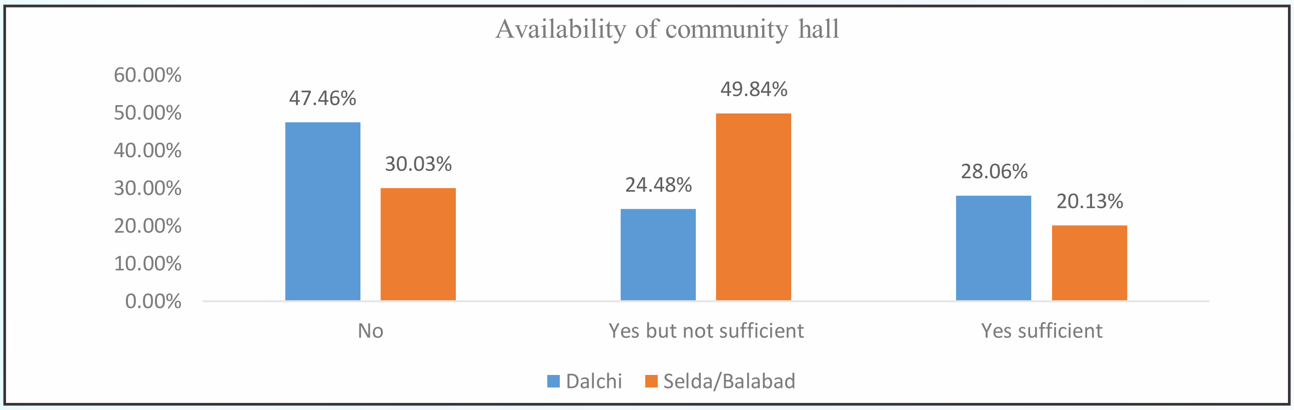


(Source: IICA Survey, 2022)

6.4 AVAILABILITY OF COMMUNITY HALL

Figure below explains the availability of community hall in the study villages. 30.03% respondents from Selda/Balabad gram panchayat and 47.46 % respondents from Dalchi gram panchayat denied any availability of a community hall in the locality. It is also reported that 20.13 %of respondents from Selda/Balabad gram panchayat and 28.06% from Dalchi gram panchayat were satisfied with the availability of community hall in their neighbourhood.

Figure 35: Availability of community hall



(Source: IICA Survey, 2022)

The communication with NTPC Khargone officials revealed that the community halls were constructed by them in both the Selda/Balabad and Dalchi Gram Panchayat. Additionally, NTPC Khargone renovated a community hall especially for the SC community in the study area. Apart from the community halls, NTPC Khargone made other infrastructural interventions like the construction and renovation of schools, classroom buildings, sanitation and drainage facilities as well as in providing healthcare to the people in the surveyed area. Thus, it can be said that the surveyed gram panchayat have developed compared to their situation in 2013.

Possession of assets

As per the Socio-economic study for KgSTPP, 2011, material assets such as bicycle, motorbike, four-wheeler happened to be the most common form of assets possessed by the PAPs. The total number of transport related material assets happened to be 164. When compared with the IICA Survey, 2022, it was found that out of the total number of surveyed households spread across Selda/Balabad and Dalchi, 35 households had four- wheeler, 64 households had bicycle, 396 households had Motorbike, and 3 households had tractor.

Furthermore, the communication related material assets including the telephone and mobile phone happened to be 163 as per the baseline data, 2011. When compared with the IICA Survey, 2022, it was found that out of the total households surveyed across Selda/Balabad and Dalchi, 549 households had a mobile phone. Moreover, the modern household related gadgets such as cooking gas, refrigerator and cooler, as well as entertainment related assets such as the TV, Radio etc. as found during the socio-economic study for KgSTPP in 2011 was very low due to the poor economic condition of the people. When compared with the IICA Survey, 2011, it was found that across all the surveyed households in Selda/Balabad and Dalchi, 439 respondents confirmed having access to cooking gas, 63 respondents had refrigerator in their household, cooler was found in 3 households, and 336 households had Television. Additionally, computer/laptop was possessed by 6 respondents, and gristmill or Atta Chakki by 2 respondents. However, there were 60 respondents who said that they did not have any of the above mentioned assets.

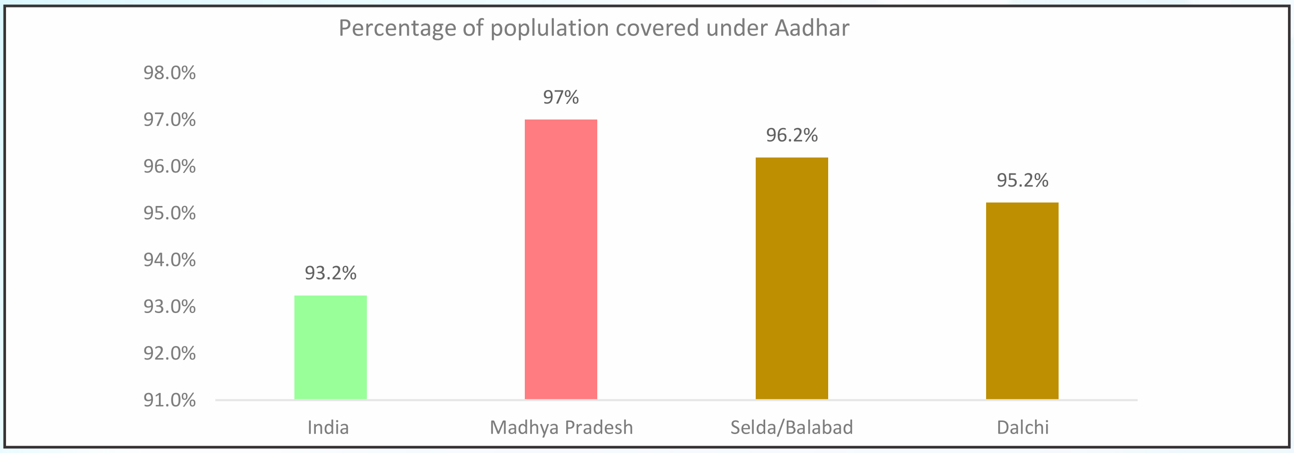
Based on the analysis above, it can therefore be concluded that as compared to 2011, the living conditions of the majority of the surveyed households in 2022 have improved significantly in context of the material assets possessed by them.

7. OTHER

7.1 POPULATION COVERED UNDER AADHAR

The graph below depicts the percentage of respondents covered under Aadhar. It is reported that most of the respondents in the study gram panchayat are covered under Aadhar scheme. The maximum percentage of households with all members covered under Aadhar are from Selda/Balabad (96.2%) which is higher than the National level (93.2%) but less than the state level (97%)

Figure 36: Percentage of population covered under Aadhar

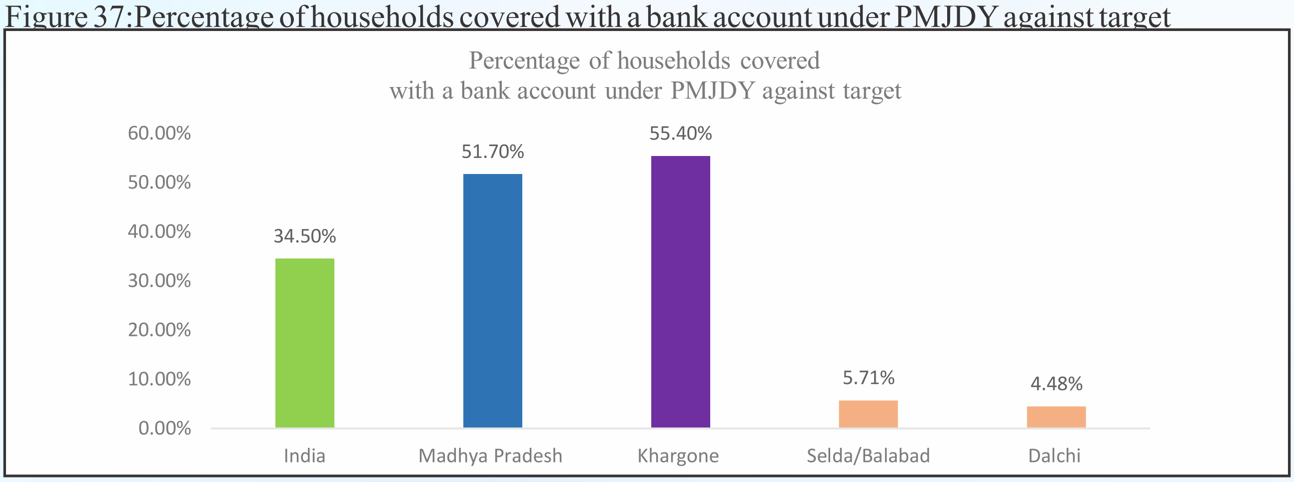


(Source: IICA Survey, 2022)

7.2 PERCENTAGE OF HOUSEHOLDS COVERED WITH A BANK ACCOUNT UNDER PMJDY TARGET

It is reported that the percentage of households covered with a bank account under PMJDY is low for Selda/Balabad gram panchayat village (5.71%) and Dalchi gram panchayat (4.48%).When compared to the district (55.40%), state(51.7%) and national bench mark (34.50%) , it seems that the benefits of banking system has still many more mile to cover in rural India.

Figure 37:Percentage of households covered with a bank account under PMJDY against target

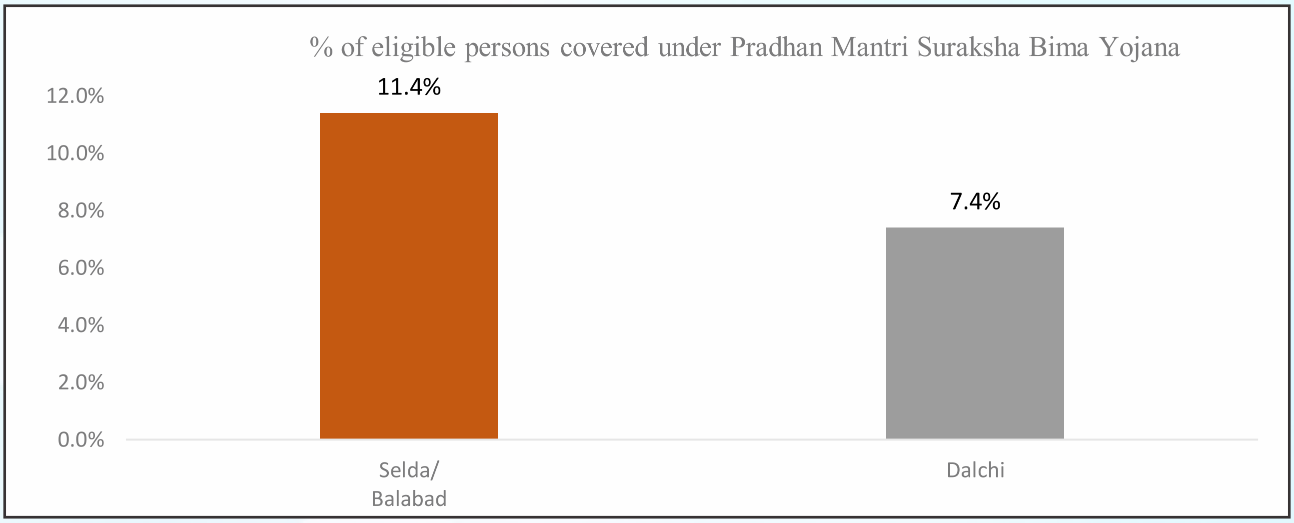


(Source: IICA Survey, 2022)

7.3 PERCENTAGE OF ELIGIBLE PERSONS COVERED UNDER PMSBY

The percentage of eligible persons covered under Pradhan Mantri Suraksha Bima Yojana is higher for Selda/Balabad gram Panchayat (11.4%) than in Dalchi gram panchayat (7.4%). Lack of information about the prevailing schemes might be the reason for such less coverage of respondents.

Figure 38: Percentage of eligible persons covered under Pradhan Mantri Suraksha Bima Yojana

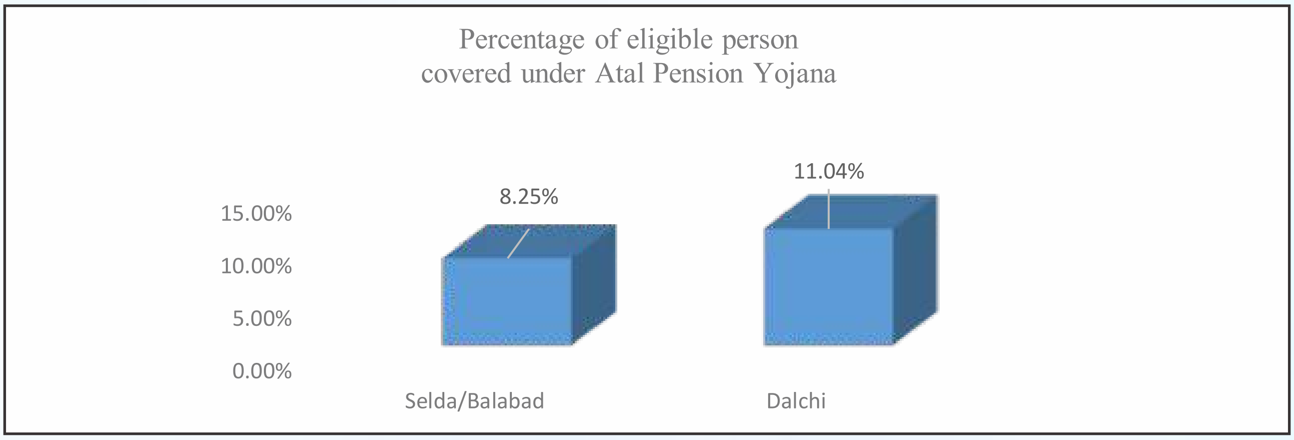


(Source: IICA Survey, 2022)

7.4 PERCENTAGE OF ELIGIBLE PERSON COVERED UNDER ATAL PENSION YOJANA

The percentage of eligible persons covered under Atal Pension Yojana is higher for Dalchi gram Panchayat (11.04%) than in Selda/Balabad gram panchayat (8.25%). Lack of information about the prevailing schemes might be the reason for such low coverage.

Figure 39: Percentage of eligible person covered under Atal Pension Yojana



(Source: IICA Survey, 2022)

8. KEY FINDINGS- SOCIAL IMPACT EVALUATION

8.1 IMPACT OF INTERVENTIONS IN EDUCATION

With an aim to promote education, NTPC Khargone undertook the following activities in the Project Affected Gram Panchayats namely Selda/Balabad and Dalchi.

- Construction of school building and boundary walls
- Distribution of uniforms, school bags, and stationary
- Renovation of classrooms
- Merit scholarships to students
- EVOICE- R& R department of NTPC Khargone in association with Evoice and BBPS provided coaching for 10th class students
- Girls merit award and Utkarsh scholarship to students
- 42 girls are enrolled for one-month residential Girl Empowerment Mission (GEM) workshop and 10 Girls out of these 42 were selected for BBPS which is an English medium school. Their financial, academic and medical expenditure have been adopted by NTPC Khargone.
- Elocution, Drawing, Sports Cultural and other activities are organized by NTPC Khargone.

A total of 17 schools including 10 primary schools, 5 secondary schools and 2 higher secondary schools were included in the study. All the schools were co-educational, Hindi medium and government schools. The teachers, principals, non-teaching staff, students and the villagers were interviewed to understand the impact of the educational interventions of NTPC Khargone in schools.

Image 2: School buildings at Selda and Dalchi

Source: IICA Survey, 2022

Image 3: Classrooms at schools in Selda and Dalchi

Source: IICA Survey, 2022

Image 4: Girls' toilets at schools in Selda and Dalchi

Source: IICA Survey, 2022

Image 5: Installation of Smart TV at a high school in Selda for smart classes and EVOICE initiative by NTPC Khargone

Source: IICA Survey, 2022

Image 6: Scholarships, Coaching and Uniforms to school students in Selda and Dalchi

Source: NTPC Khargone

Impact: Out of all the surveyed schools spread across Selda/Balabad and Dalchi, the IICA survey, 2022 found that there was one primary school at Dalchi which did not have a pucca building. The middle school at Dalchi comprises students belonging to 1stupto 8th standard. The middle school at Dalchi required an extra classroom. A new school was therefore approved by NTPC Khargone. However, till the time the NOC for the same is awaited, the classes for the middle school are conducted at the community hall constructed by NTPC Khargone. Further, all the surveyed schools had boundary walls except five schools at Dalchi. Moreover, there were three schools at Dalchi that did not have a blackboard. Also, all the schools had a functional fan except six schools, one at Selda and five at Dalchi. However, all the schools had provision of mid-day meals. All the schools had toilets except one at Dalchi, however, there was one school which did not have a separate toilet for girls. Moreover, all the surveyed schools except three schools at Dalchi and two schools at Selda had adequate number of desks, chairs and benches. Further, there were six schools, four at Dalchi and two at Selda that did not have an electricity supply. None of the schools had a safe waste disposal facility.

Overall, the teachers and principals of 12 out of 17 surveyed schools shared that NTPC Khargone made educational interventions which improved the school and education system. According to the respondents, NTPC Khargone renovated the school building, constructed the boundary wall, provided benches, almirahs, furniture, constructed toilet and contributed towards its maintenance, provided study kit for students, fans, water cooler and purifier. Moreover, school bags and uniform distribution was undertaken by NTPC Khargone in the project villages and merit scholarships (Utkarsh) was provided to the school students which created a positive impact on the lives of students. The survey team found the presence of Smart TVs in school installed by NTPC Khargone where classes through EVOICE platform were conducted for the students.

Relevance: The construction and renovation of the school infrastructure and provision of educational resources such as books and uniforms is highly relevant in the project affected villages. This is because it motivates the children to come to school as well as provides an opportunity and learning space for the educational development of the children. Further, the merit scholarship or NTPC Utkarsh is highly relevant as it encourages and motivates children and youth from the neighbourhood villages of NTPC Stations for higher studies. Since FY 2016-17, the Utkarsh scheme is aimed at benefitting about 7300 students every year from neighbourhood communities pursuing X, XII, ITI, B.E / B.Tech and MBBS studies.

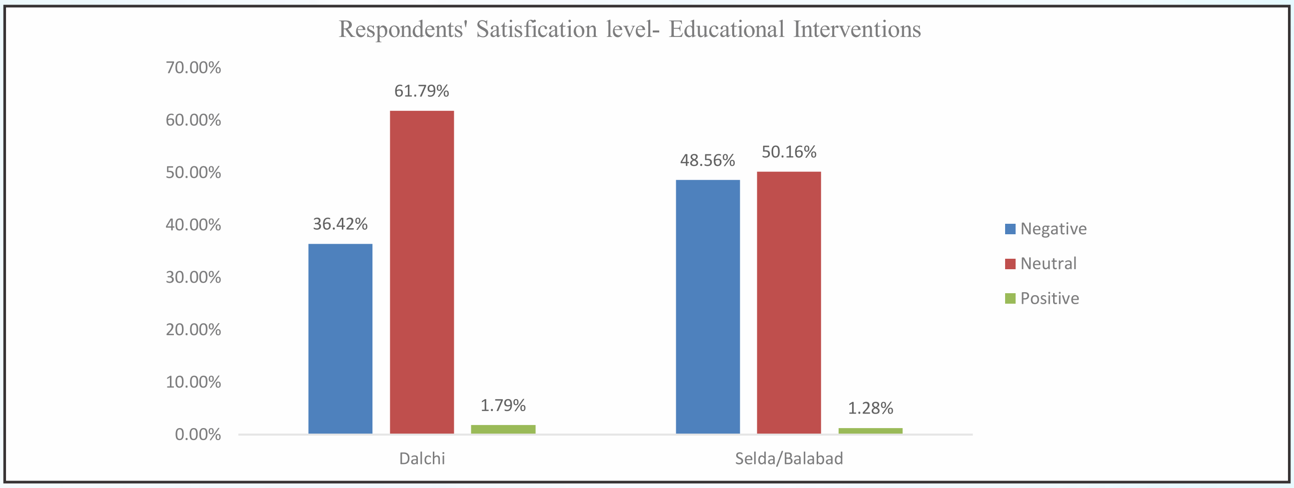
Effectiveness: The effectiveness of the community development programs/interventions relates to the 'level' by which the program activities produce the desired effect. 95% respondents from Dalchi and

92% respondents from Selda felt that no educational interventions were made by NTPC Khargone. However, 5% respondents from Dalchi and 6% respondents from Selda shared that NTPC Khargone made educational interventions such as the construction of boundary walls, repair of the school building, distribution of pencils, notebooks once in a year, provided books, furniture, and LCD TV. Around 2% respondents from Selda said that they did not have an idea about the educational contributions of NTPC Khargone for the community.

Sustainability: The sustainability of infrastructural assets created by NTPC Khargone requires maintenance. Therefore, for ensuring a long term sustainability of the infrastructure, NTPC Khargone may enter into an agreement with the beneficiaries regarding the maintenance of the assets, before the implementation of any project. With respect to other educational interventions like the provision of study material and uniforms, NTPC Khargone requires to provide financial support to the students since they come from lower socio- economic strata of the society.

The following figure represents the perception and satisfaction level of the respondents towards the educational interventions made by NTPC Khargone in Selda/Balabad and Dalchi along with their associated hamlets.

Figure 40: Perception and satisfaction level of the respondents towards the educational interventions



Source: IICA Survey, 2022

8.2 IMPACT OF INTERVENTIONS IN HEALTH

There were no medical facilities in the surveyed area in 2011 as per the Socio-Economic Study for KgSTPP. The baseline survey report mentions that there were no health sub-centres in the Project Affected Villages (PAVs). People from Selda/Balabad had to travel 10Km to reach the Primary Health Centre at Bedia. People from Dalchi had to travel 15km to reach the primary health centre at Pipalgone. Furthermore, even for accessing the health sub-centre, the people had to travel 17 to 27kms to reach Bedia or Sanawad. Also, for reaching the nearest diagnostic centre located at Bedia, the people had to travel 10-17Kms. The poor condition of the roads especially during rainy season further decreased the accessibility of the patients to receive medical services. As mentioned in the baseline report, the non-availability of the medical staff and doctors as well as the high cost of transportation to the health centre added to the woes of the people in the PAVs.

The Socio-Economic Study for KgSTPP, 2011 further mentions that the general health of the PAPs was poor due to malnutrition. The women and children suffered from poor health because of the reproductive cycle. Further, the hygiene related conditions of the PAVs was also poor as there were no garbage and/or waste water disposal system. Most of the houses except the pucca ones did not have toilet facilities and separate bathrooms.

Given the grave situation of health and hygiene in the PAVs in 2011, NTPC Khargone undertook the following activities with an aim to promote the healthcare situation in the Project Affected Gram Panchayats namely Selda/Balabad and Dalchi

- Construction of Anganwadi centres
- Mobile Medical Unit
- Maternal and Child Health Care: In FY 2022-23, 303 women were given nutritional supplements under this program by NTPC Khargone.
- Menstrual Hygiene talks for girls students
- Health awareness sessions
- Medical camps
- Child health and Family planning incentives

The AWWs, ANMs, ASHAs, doctors, adolescent girls, men and women were interviewed to understand the impact of NTPC Khargone's health interventions in Selda and Dalchi. The health facilities available at Selda/Balabad and Dalchi include Anganwadi Centres and Private Clinics. An NTPC hospital is also available to the people in the surveyed area. Moreover, the majority of the respondents (78.24%) said that they had to travel more than 5km for reaching the Primary Health Centre/District hospital. Therefore, to cater to the medical needs of the villagers, NTPC Khargone operates Mobile Medical Units in its Project Affected Villages. Therefore, the impact of health Interventions by NTPC Khargone have been mainly studied through Anganwadi centres and Mobile Medical Units.

Anganwadi Centre

All the health workers said that the condition of Anganwadi centre in the village was very bad although a majority of them appreciated the quality of nutrition supply. According to the health workers, all eligible children of the village were immunized and none of the mothers died at the time of child birth. However, there were three infant deaths in the past one year. The facilities provided to the Anganwadi Centres included nutrition and health education to the parents, immunization of children, early childhood care, pre-school education, pregnant women's health check-up and counselling, and screening/identification of high risk pregnancies, supply of Calcium, Iron and Deworming tablets. Mamta Divas or Village Health and Nutrition Days are also organized at the Anganwadis.

The health workers said that not much intervention has been done by NTPC Khargone for the welfare of women, adolescent girls and children. The health workers faced certain challenges such as the lack of proper building and sanitation at the Anganwadi Centre. The Anganwadi centres are in need of furniture, toys, water cooler, toilet, electricity and an almirah.

Image 7: FGD with Women's group at Anganwadi Centre in Selda and Dalchi

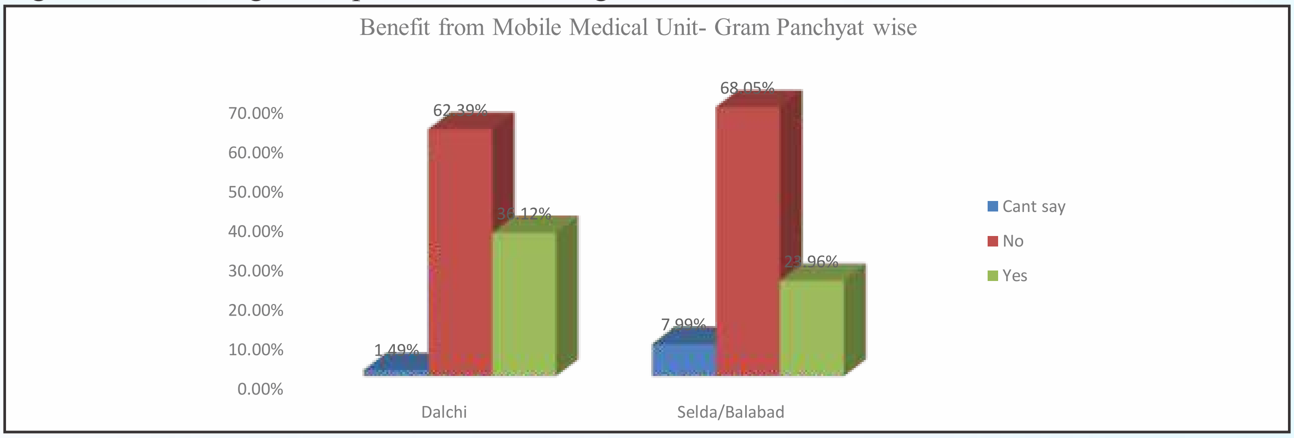
Source: IICA Survey, 2022

Mobile Medical Unit

Image 8: Mobile Medical Unit Van of NTPC Khargone

Source: IICA Survey, 2022

Figure 41: Percentage of respondents benefitting from mobile medical unit



Source: IICA Survey, 2022

As can be seen from the figure above, 36.12% respondents from Dalchi and 23.96% respondents from Selda/Balabad said that they have benefitted from the Mobile Medical Units by NTPC Khargone. The type of benefits as shared by the beneficiaries included basic check- ups, blood test and medicines.

Impact: The mobile medical units visit Selda and Dalchi twice a week and cater to the health needs of 46 villages. As per the data received from NTPC Khargone, on an average, 1400 people benefitted from MMU facility.The mobile medical units provide free consultation, medicines and pathological investigations at the doorstep of the beneficiaries. Several benefits are associated with mobile medical units such as preventing high cost healthcare expenditure of BPL groups, saving daily wages, travelling cost of patients staying in remotest locations, and primary healthcare service at the doorstep of vulnerable and marginalized communities. Also, when compared with the Socio-Economic Study/baseline data for KgSTPP, 2011, according to which there were no health facilities in Selda/Balabad and Dalchi and the people faced many challenges in accessing the medical facilities located at far off distance, the mobile medical units by NTPC Khargone is a boon. It is one of the most important and relevant interventions for improving the health of the people in the surveyed area.

Relevance: The concept of mobile medical units/vans is highly relevant in areas where medical infrastructure is sparse. They provide primary, preventive, curative health care services, thereby transforming the rural healthcare landscape by making primary care accessible in inaccessible areas.

Effectiveness: As the majority of respondents (65.2%) spread across Selda (68.05%) and Dalchi (62.39%) said that they did not benefit from the mobile medical unit provided by NTPC Khargone, it can be said that the health intervention has been ineffective in including a large number of villagers.

Sustainability: The mobile medical unit cannot be operated without the continued financial support from NTPC Khargone. However, in order to increase its acceptability and reach amongst villagers, it is important to increase the frequency of visits of the mobile medical units to the project affected villages.

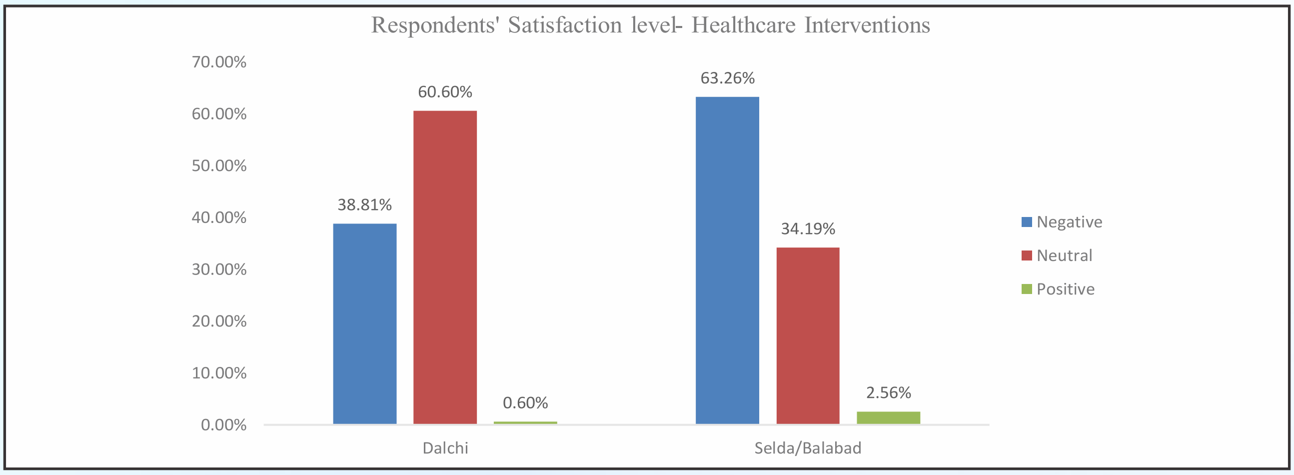
Furthermore, the Focus Group Discussions (FGDs) held in the surveyed gram panchayats Selda/Balabad and Dalchi revealed that despite the villagers having water pipes, the chemical pollutants in the water caused stomach pain, vomiting, diarrhea, acidity and even kidney stones. However, the communication with NTPC Khargone officials revealed that the district administration had instructed IIT Indore to investigate the presence of chemical pollutants in the water. It was found that no chemical or water from the plant contaminated the water and/or land of the area. Furthermore, the results were re-evaluated by IIT Madras which confirmed the findings of IIT Indore. Moreover, at the time of pregnancy, the women shared that they have to travel a large distance for delivery as there are no medical facilities available to them locally.

The women informed that they used clothes during periods and not sanitary pads. Also, the adolescent school going girls shared that they did not get proper guidance and menstrual hygiene trainings. Furthermore, a majority of the participants during FGDs shared that many people including women go for open defecation due to which there is a lot of filth around the 'mohalla'. The people have to go to the jungle or some other place which is 1Km away for defecation. According to them, there is no proper drainage system available. The waste/sewage flows over the roads. All this affects the health of the people very badly. The women during Focus Group Discussions complained that the mobile health vehicle did not visit them.

Moreover, the participants of the study perceived that their health was impacted as a result of air pollution caused due to NTPC plant operations. However, IICA's communication with NTPC Khargone revealed that no air pollution occurred due to the latter. This is due to the fact that NTPC Khargone is a Super Thermal Power Project that uses FGD technology. Hence, there has been no registered incidence of air pollution in the surveyed area. Furthermore, the common diseases as shared by the people included malaria, diarrhea, typhoid, skin diseases and eye problem.

The following figure represents the perception and satisfaction of the respondents towards the healthcare interventions made by NTPC Khargone in Selda/Balabad and Dalchi including their associated hamlets.

Figure 42: Perception and satisfaction of the respondents towards the healthcare interventions



Source: IICA Survey, 2022

8.3 IMPACT OF INTERVENTION IN RURAL INFRASTRUCTURE

The beneficiary household surveys including both the PAPs and Non-PAPs were used to understand the impact of rural infrastructural interventions by NTPC Khargone. Additionally, the PRI representatives such as the Village Sarpanch (Chief) and Sadasya (Members) of Selda/Balabad and Dalchi were interviewed to get their perspective on the infrastructural interventions of NTPC Khargone. The following infrastructures were assessed for their impact on the community:

- Community Centres
- Roads and Drains
- Gangour Ghat

Image 9: Gangour Ghat, Roads, and Community centre built by NTPC Khargone in PAVs

Source: NTPC Khargone

Impact: The community hall is used by the community people for holding their cultural and matrimonial functions. The constructed roads are used by all the villages for reaching hospitals, schools, markets and other community spaces. Further, 'Gangour' is the most important festival celebrated in Khargone district of Madhya Pradesh. The people in Selda and Dalchi celebrate the festival with great devotion and enthusiasm. Therefore, the renovation of Gangour Ghat has positively impacted the people in the survey area.

Relevance: The construction of community centre is relevant as the people using them mainly belong to the lower socio-economic strata, and therefore it helps them organize their family functions conveniently. Further, the construction of roads is relevant to the villagers as the enhanced connectivity helps the latter in reaching the different places with ease. The renovation and construction of Gangour ghat is highly relevant as it meets the religious and cultural needs of people in Selda and Dalchi.

Effectiveness: 24.23% respondents spread across Selda and Dalchi said that the community halls were available and adequate in meeting their needs, while 36.73% respondents said that the community hall were available but inadequate. Further, 39% respondents said that a community hall was not available in their community.

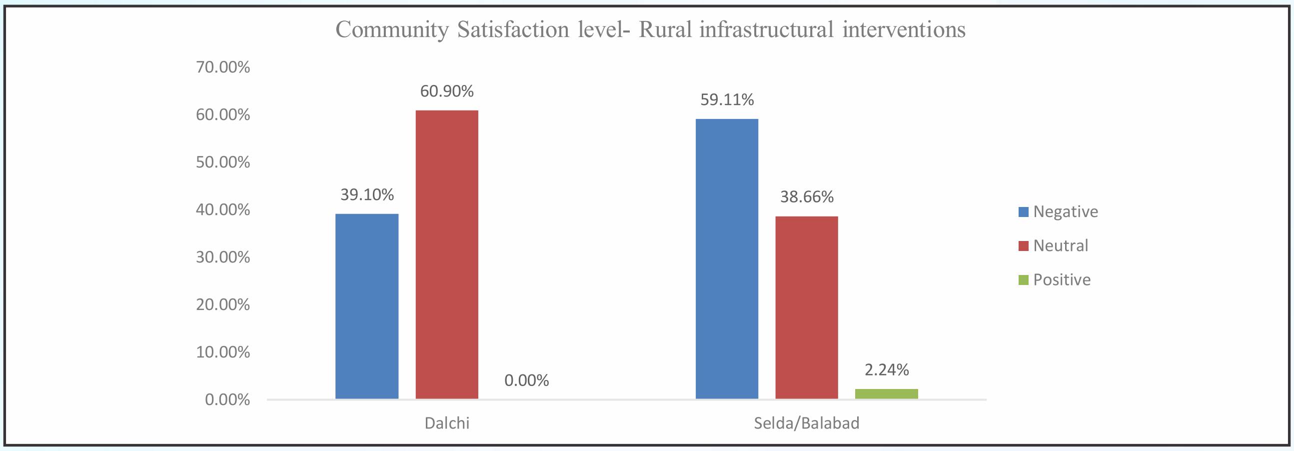
53.24% respondents spread across Selda/Balabad and Dalchi shared that an all- weather or pucca (concrete) road was available to them. Further, the surveyed gram panchayat also had kutcha and kharanja roads. A total of 52.62% respondents across Selda/Balabad and Dalchi shared that Kutcha road existed in their village. Coming to the drainage system in the surveyed area, only 12.04% respondents shared that a sewage pipe/drainage system existed while a larger majority of respondents (77.16%) said that the water from their bath and kitchen area was released in the open and on the roads. Around 10.19% respondents said that the dirty water from their houses released into the fields.

On the question of the infrastructural interventions made by NTPC Khargone,the villagers did not specifically mention Gangourghat built by NTPCKhargone, though they mentioned about pucca roads, drains and community centres. However, one of the Sarpanch(Village Chief) at Selda/Balabad appreciated for building/renovating the Gangour Ghat. Further more, the majority of the PRI representatives did not acknowledge the infrastructural interventions of NTPC Khargone and said that the latter did not make any contribution in the rural development of their Gram Panchayat. However, IICA's communication with the NTPC Khargone officials revealed that the Gram Panchayats send a “Tharv Prastav” duly signed by the representatives for infrastructures to NTPC Khargone. So far, NTPC Khargone had addressed 80% of the infrastructure as requested through the “Tharv Prastav”. These include roads construction and community hall amongst others.

Sustainability: Since the quality of the infrastructure like concrete roads, Gangourghat and community hall is good, they are expected to last long. However, proper maintenance of the community assets requires ownership and commitment of the community members and the financial support from NTPC Khargone.

The following figure represents the perception and satisfaction of the respondents towards the rural infrastructural interventions made by NTPC Khargone in Selda/Balabad and Dalchi including their associated hamlets.

Figure 43: Perception and satisfaction of the respondents towards the rural infrastructural interventions



Source: IICA Survey, 2022

8.4 IMPACT OF INTERVENTIONS IN DRINKING WATER AND SANITATION

The beneficiary household survey and FGDs including both the PAPs and Non-PAPs were used to understand the impact of drinking water and sanitation interventions by NTPC Khargone. The following infrastructures were assessed for their impact on the community:

- Repairing of Toilets under SVA
- Piped drinking water supply in the Project Affected Villages

Impact: The provision of safe and quality drinking water impacts the overall health of the survey area. Despite the availability of water pipes, the respondents complained about the lack of clean water as a result of which they fell sick due to water borne diseases. The improved sanitation environment due to the availability of functional toilets improves the overall quality of life of people. However, the survey found that a significant number of respondents practiced open defecation.

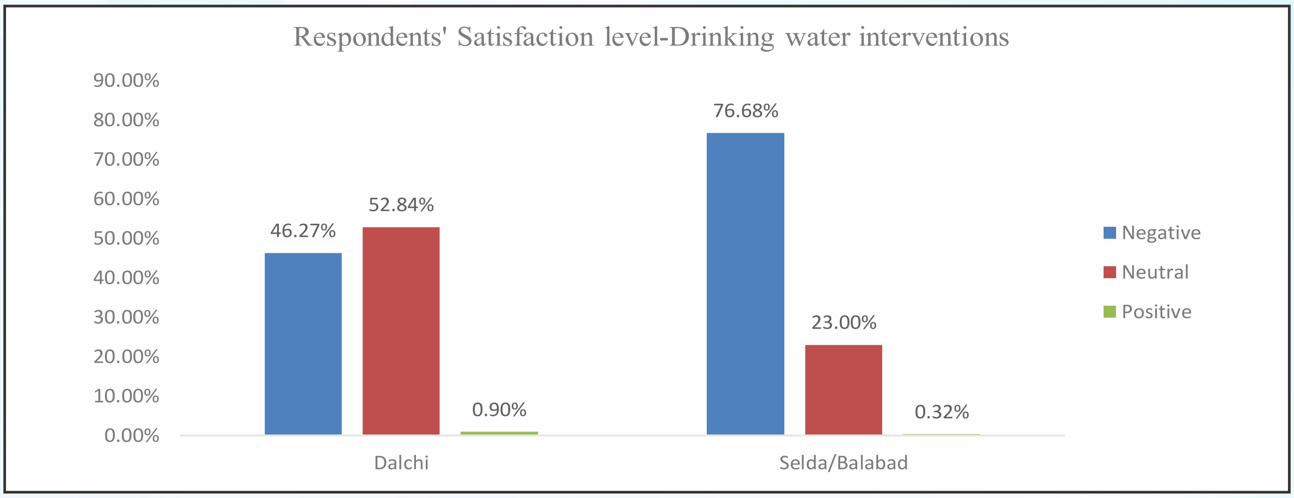
Relevance: Piped water supply to households is highly relevant as it enhances the quality of life and health of people. Functional toilets are basic necessity of any household and therefore are highly relevant for the people in the survey area.

Effectiveness: 69.75% respondents spread across Selda (75.72%) and Dalchi (64.18%) have piped water connection in their household. While 64.81% respondents have appreciated the quality of water supply, 35.19% respondents said that the quality of drinking water was poor. Coming to the availability of toilets, 25.07% respondents in Dalchi and 75.72% respondents in Selda/Balabad said that they had a functional toilet with water supply in their household. However, it is important to note that while the Govt. of MP has declared Khargone district to be open defecation free, the IICA Survey found that 74.93% respondents in Dalchi and 24.28% respondents in Selda still practice open defecation.

Sustainability: The individual household toilets have to be maintained by the family members who use the same. However, the maintenance of community toilets and the toilets constructed at schools will require community involvement and financial support from NTPC Khargone.

The following figure represents the perception and satisfaction of respondents towards the drinking water interventions made by NTPC Khargone in Selda/Balabad and Dalchi including their associated hamlets.

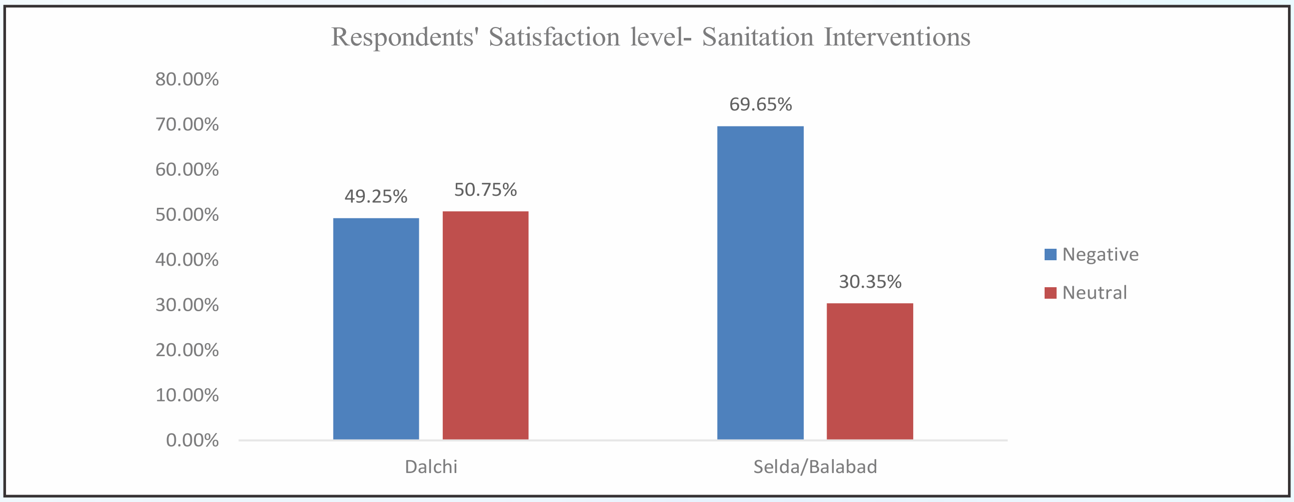
Figure 44: Perception and satisfaction of respondents towards the drinking water interventions



Source: IICA Survey, 2022

The following figure represents the perception and satisfaction of respondents towards the sanitation interventions made by NTPC Khargone in Selda/Balabad and Dalchi including their associated hamlets.

Figure 45: Perception and satisfaction of respondents towards the interventions in Sanitation



Source: IICA Survey, 2022

8.5 INTERVENTIONS IN SKILL DEVELOPMENT

The beneficiary household survey and FGDs including both the PAPs and Non-PAPs were used to understand the impact of skill development interventions by NTPC Khargone. Additionally, the PRI representatives such as the Village Sarpanch (Chief) and Sadasya (Members) of Selda/Balabad and Dalchi were interviewed to get their perspective on the skill development interventions of NTPC Khargone. NTPC Khargone provided the following opportunities to the people in the project affected villages.

- Dress Making training
- Empowering women through SHGs and providing capacity building training and helping them start their own enterprise on Masala powder and Pickles
- Other trainings

Impact: The skill development trainings facilitates in creating sustainable livelihood opportunities for the people in Project Affected Villages. NTPC Khargone provided training to the women in dress making (Stitching), Pickle and Papad making, and in beauty parlour. Additionally, it facilitated women in getting organized through SHGs. Further, it provided electrical and AC repair training to the youths. Rakhi training was also conducted in the survey villages. Computer training was organized for a few days in Selda and Dalchi. While the PRI representatives at Dalchi said that no skill development interventions were made by NTPC Khargone, the PRI representatives at Selda/Balabad shared that trainings were organized on stitching, electrical and agriculture. As per the data received from NTPC Khargone, more than 600 beneficiaries from Selda, Dalchi and Khedi Panchayat have undergone skill development training.

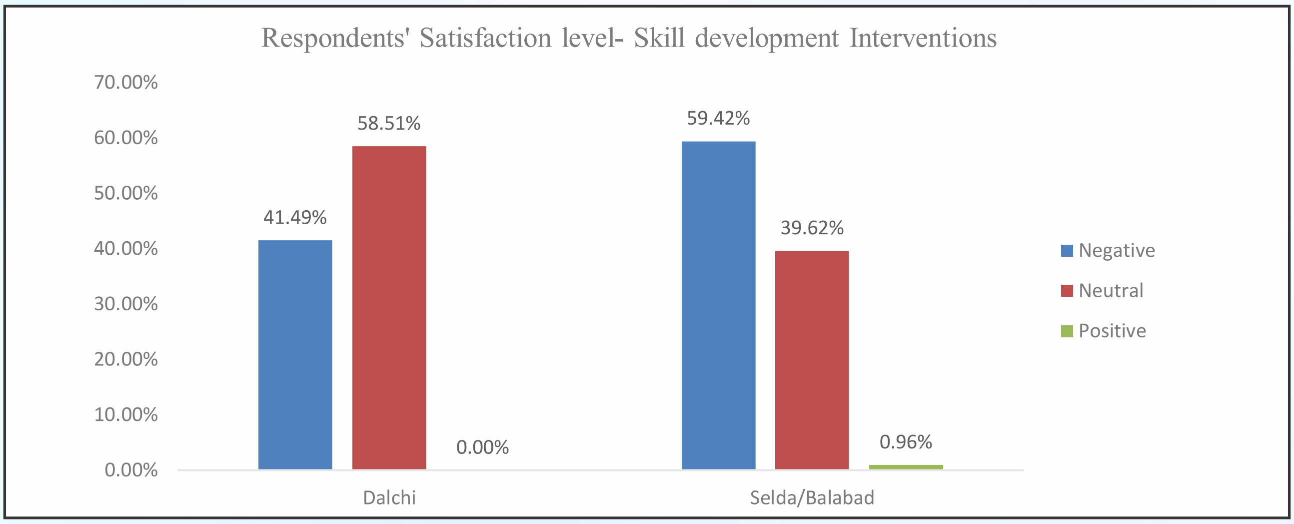
Relevance: 23.88%respondents in Dalchi and 21.33% respondents in Selda/Balabad said that the skill development training was beneficial for the youth of the village in getting employed or self-employed.

Effectiveness: Around 17.61% women in Dalchi and 15.02% women in Selda are associated to a Self-Help Group (SHG). Only 22.84% respondents spread across Selda (21.73%) and Dalchi (23.88%) said that they have received some form of skill development training.

Sustainability: The program is self-sustainable for women who have organized as SHGs and received training from NTPC Khargone. They can make and sell their products by running a shop within the NTPC Khargone Township. The profit can be saved in bank for buying raw materials and other items.

The following figure represents the perception and satisfaction of the respondents towards the skill development interventions made by NTPC Khargone in Selda/Balabad and Dalchi including their associated hamlets.

Figure 46: Perception and satisfaction of the respondents towards skill development interventions



Source: IICA Survey, 2022

9. SOCIAL RETURN ON INVESTMENT

Step 1: SROI process and methodology

The objective of the study is to measure SROI value of R&R and CSR-CD projects implemented by NTPC near its plant in Khargone. The study will help NTPC Khargone in strategic planning and will help to compare the social value generated for different projects. The projects were analysed based on secondary information provided by NTPC field office and primary data collected from the field visit conducted in 2022, and the scope of study was established. The SROI study was carried out by IICA for all the CSR-CD activities undertaken by NTPC Khargone for its two project affected Gram Panchayats namely Selda/Balabad and Dalchi. The IICA follows a 10-step strategy given in Figure 46.

Figure 47:Steps in SROI Computation-IICA's Approach

(Source: IICA)

1. **Understand and Plan:** The first step is the understanding the stages of the SROI study and planning the details of the SROI process. IICA accessed all the vital material and information on the nature and design of R&R projects, details of beneficiaries and implementing agencies and chalked out a plan to conduct the SROI analysis. A kick-off meeting was also done with the CSR team of NTPC| Khargone.

2. **Identification of Stakeholders:** After understanding and planning, the stakeholders involved in the projects were identified. The identification of the stakeholders is a key step in the calculation of the SROI. Much care and attention was given in the identification of stakeholders. Only those stakeholders were included who had materially benefitted from the projects or had been associated directly or indirectly with the project.

3. **Boundaries and Exclusions:** This step has two sub steps:

   a. Materiality analysis: The way of defining project 'materiality' to the SROI analysis is to evaluate whether a piece of information, if excluded, would significantly misrepresent the conclusions of CSR activities implemented by NTPC Khargone. In order to understand the biggest impact created, various factors were assessed such as Safety and wellness of school going children, sports interventions, toilet usage in the community, awareness of hygiene and sanitation among households, health care facilities, community support for hygiene and sanitation, provision and usefulness of skill development programs, provision of water, Usage of roads and its maintenance, usage of other infrastructure such as community centres etc. These criteria were used to assess the impact created under R&R interventions of NTPC Khargone.

b. **Inclusion and Exclusion criteria:** Based on the materiality analysis, the inclusion and exclusion criteria was applied to the CSR projects of NTPC Khargone and a short list of projects was developed. The concerned stakeholders of the selected projects were consulted for the SROI study.

4. **Impact mapping& financial proxies:** Once the R&R projects were shortlisted and stakeholders had been identified, the next step was to create an impact map. Project objectives, impact areas and nature of activities undertaken for projects were identified. Inputs, outputs, outcomes and impact were also outlined and a Theory of Change was formulated. The Theory of Change shows the inputs, outputs and outcomes as stated by different stakeholders. The nature of change that each stakeholder group undergoes was identified based on the theory of change to establish the relationship between inputs, outputs and outcomes for each project.

5. **Analyse Income & expenditure:** The materiality of the projects and the stakeholders is analysed by the amounts of expenditure incurred on the projects and the number of beneficiaries benefitted from the project.

6. **Projections:** From the expenditure data, it was ascertained whether the costs and benefits of the R&R projects may be projected over the future years. As advised by SROI experts, for the purpose of this study, projections of social values were taken for the next 5 years.

7. **Data collection:** Relevant data needed to calculate material change were identified and requested from NTPC Khargone. This involved developing outcomes, collecting relevant data, knowing duration of outcomes and weighing outcomes and then valuing them. Site visits of the villages under the CSR interventions of NTPC Khargone were also made to understand the impacts, determine proxy values and the perspective of various stakeholders for better estimation. This included one-on-one interactions, semi-structured interviews and focus group discussions with beneficiary and government officials.

8. **SROI plan:** The IICA team collected evidence on outcomes and monetized them, eliminating from consideration those aspects of change happening anyway or as a result of other factors. In cases where accurate data was not available, estimates were made by using proxies such as Government spending per person on Swachh Bharat Mission and fee of a school with good learning environment. By considering quantity of change and proxy values for each outcome, social value created was calculated and the value of deadweight and attribution was deducted from it.

9. **Calculating SROI:** In the last step, all project outcomes were added and various factors such as deadweight and attribution were subtracted and then the remaining value was divided by the total investment of NTPC Khargone on the projects. The contribution of the Government was also subtracted from NTPC Khargone investments to calculate the actual social value or SROI ratio. After the computation of the ratio, a sensitivity analysis was done to verify the results and their veracity. The aim of such an analysis is to test which assumptions have the greatest effect on the model. This allows us to report the amount of change necessary to make the ratio change from positive to negative or vice versa.

Once these calculations are done, the social value generated from the projects is calculated. The Social value is calculated by multiplying the financial value of outcomes with the total number of beneficiaries and then subtracting from it the deadweight, displacement, drop-off and attribution. The formula for the calculation of Social Value created is expressed as follows:

Social Value Created= Outcomes x Number of Beneficiaries-(minus)

(Deadweight+ Displacement+ Attribution+ Drop-off)

After calculating the Social Value created through the projects, the next step is to compute the SROI ratio. The SROI ratio is computed by dividing the total social value created by the total amount of expenditure on the CSR projects. The formulae for calculating the SROI is expressed as follows:

SROI= Social Value Created/ NTPC Khargone R&R budget

The formulae stated above gives the SROI ratio for each project/thematic area which is the unit of analysis. The SROI value can then be analysed and suggestions and recommendations can be drawn from the resultant SROI. The SROI ratio shows the value of the impact which has been generated through R&R projects.

10. **Report writing:** The reporting of the SROI value is done through standardized SROI reports which details the process and methods of calculation of the SROI. The reporting is done so that all the stakeholders can understand and verify the results.

Step 2: Scope of the study

The present study is the analysis of the Social Return on Investment of the R&R projects of NTPC Khargone. The R&R projects have been implemented in 2 gram panchayats named Selda and Dalchi in the vicinity of NTPC Khargone plant in Khargone District. The interventions have been categorized in seven thematic areas like Education, Healthcare, Water, Sanitation, sports, skill development Training and Infrastructure Development. The study analyses in detail the social return accrued because of R&R-CD projects. The study was done in consultation with the key stakeholders of the projects. The details of the projects and budgets incurred on them are given in the next section

Project Details and Budgets

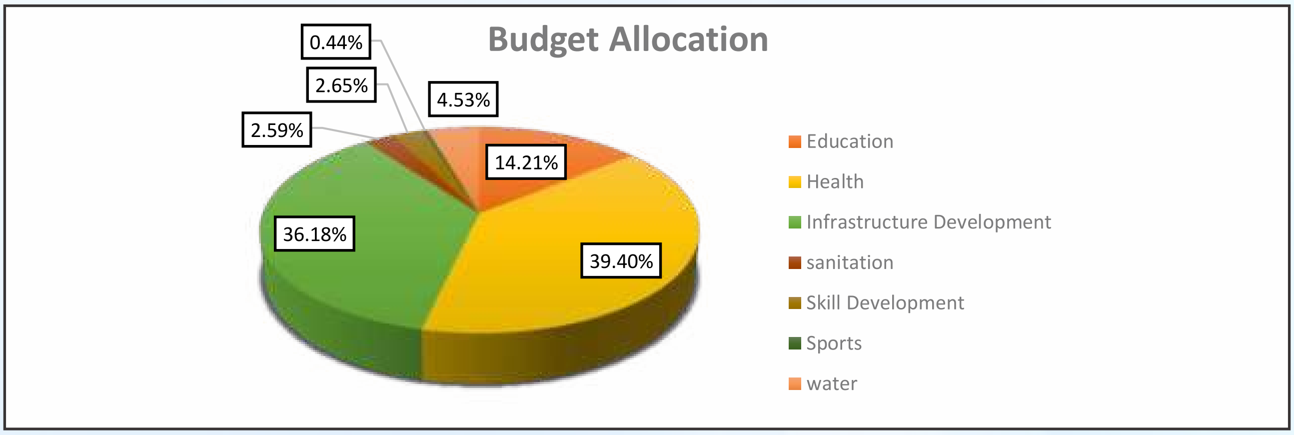
All the CSR activities implemented by NTPC Khargone are grouped together and classified under seven categories as listed below. These categories are in accordance with the R&R policy of NTPC:

1. Education
2. Healthcare
3. Sports
4. Skill development training
5. Water
6. Sanitation
7. Rural Infrastructure

Budget Allocation

Figure 47 shows that percentage of budget allocated to different thematic areas. Nearly 39% of the budget was allocated to the healthcare interventions, while 36% to infrastructure development. Interventions in education is another important area where allocation of budget is 14%. However, budget allocated for other important thematic areas like sanitation, water, sports and skill development is less than 10 per cent.

Figure 48 :Budget (in percentage)



Source: NTPC Khargone)

Step 3: Identifying stakeholders

The stakeholders are key to the SROI study. The consultation and engagement with all the stakeholders is needed to assess the impact of the study. Key stakeholders of these projects are identified and are given theme-wise in Table 6.

Table 6: Key Stakeholders

Thematic Areas	Key Stakeholders
Education	Students, Parents, School officials(teachers and principal), Gram Panchayat, BDO, NTPC officials
Healthcare	Community (Beneficiaries), Health officials, Gram Panchayat members and NTPC officials
Skill development Training	Trainees, Training Agency, Gram Panchayat members, NTPC officials
Water	Community (Beneficiaries), Gram Panchayat members, NTPC officials
Rural Infrastructure	Community (Beneficiaries), District Administration, Gram Panchayat members, NTPC officials
Sanitation	Community (Beneficiaries), District Administration, Gram Panchayat members, NTPC officials
Sports	Students, Parents, School officials(teachers and principal), NTPC officials

Step 4: Boundaries and Exclusions

It is important to assess and be clear about the boundaries and limitations of the study. At this stage, it is ensured that only those stakeholders and projects are considered for the study which are highly important and will impact the findings of the study, if left out.

Project stakeholders were consulted through focus group and one-to-one meetings in study area villages to understand the impact of the projects. Direct and indirect stakeholders comprehensively mentioned the change they have gone through in last few years due to NTPC Khargone's intervention in Health, Education, Water & Sanitation, Vocational training and Rural Infrastructure.

Consulting with various stakeholders through primary data collection exercise covered 680 households, 13 focus groups discussions in villages, and 32 interviews with key informants (Gram Panchayat Members, ANMs, Anganwadi workers, health officials and school officials) for monetizing outcomes. These were major primary stakeholders who were selected because they have undergone the material changes as per the objectives of the projects. Many outcomes emerged during the discussions but most relevant and significant outcomes which were experienced by most stakeholders were selected and monetized in the study.

In this stage, IICA determined the following:

- What is 'material' or important to include for decision-making purposes?
- Which stakeholders are we going to include and exclude?
- Which activities are we going to include and exclude?
- What data is available?

Materiality analysis: The way of defining project 'materiality' to the SROI analysis is to evaluate whether a piece of information, if excluded, would significantly misrepresent the conclusions of CSR activities implemented by NTPC Khargone. The materiality of the projects and the stakeholders is analysed by the amounts of expenditure incurred on the projects and the number of beneficiaries benefitted from the project. The excluded stakeholders of each thematic area are given in Table 7.

Table 7:List of excluded stakeholders

Focus Area	Excluded stakeholders	Reasons for exclusion
Rural Infrastructure	Construction Workers	List and contact details of construction workers who constructed roads and community structures not available
Sanitation	Construction workers	List and contact details of construction workers who repaired toilets not available
Water	District Water Board officials	Due to limited Scope of study
Skill development training	Trainers	List and contact details of trainers who trained the beneficiaries not available
Education	Construction workers	List and contact details of construction workers who constructed boundary walls and classrooms not available
Heath	Doctors and staff	List and contact details of medical personnel catering to maternal and child healthcare not available
	Construction workers	Due to limited Scope of study
Sports	School Officials	Due to limited Scope of study

Some stakeholders like local Government officials have been excluded due to limited scope of study. However, in certain cases, the real behind exclusion of stakeholder is non-availability of data.

Step 5: Impact Mapping and Financial Proxies

Impact mapping is one of the most important elements of a SROI study. A Theory of Change is made through logical framework analysis to determine the impact of the interventions. At this stage, the inputs, outputs and outcomes are linked to visualize the impacts of the interventions. The details regarding the outputs, outcomes and impacts have been arrived at by consulting and communicating with the stakeholders identified in the previous section.

Impact Map and Financial Proxies of Educational Interventions

The outcomes of Educational Interventions lead to outcomes like improvement in academic performance of children, improvement in confidence of children, confidence and better teaching learning experience because of renovation of school infrastructure. The outcomes from educational projects for the parents are that it leads to an increase in confidence in their children and it also leads to an increase in self-esteem of parents. Table 8 summarizes the inputs, outputs and outcomes of educational interventions.

Table 8:Impact Map for Educational Interventions

Stakeholder	Input	Output	Outcome	Financial Proxy
Students	Time & Energy	No. of beneficiaries of Classrooms and school building constructed in schools	Improved quality and ambience for learning	average annual tuition cost, average cost of quality education
Students	Time & Energy	No. of beneficiaries of GEM Scholarship	Increased self-reliance and exposure of girls students	Average cost of month attending a one summer school
Students	Time & Energy	No. of students receiving school kits, benches and uniforms	Holistic development of students	average cost of benches, uniform, kits and cost of quality education
NTPC	Financial & Monetary Resources	NTPC branding	Improved Brand Image	1% Cost of brand improving exercises

The monetization of educational outcomes will be done on indicators like the cost of quality education that increases the motivation to continue the school, and the cost of yearly commute as financial proxies for increased self-confidence and self-esteem. The improved quality of education led to the savings on part of children and their parents for a life-skills session and of engaging a private school tutor. Hence, the financial proxy for this outcome can be the cost of attending a private tuition. This cost will be calculated and multiplied with the total number of beneficiaries to arrive at the social value of this project.

Impact Map and Financial Proxies of Healthcare Interventions

The outcomes of healthcare interventions as reported by Community are improved physical health owing to check ups, blood tests, medicines and money saved on travelling to nearest medical facility. Provision of mobile medical unit, maternal and childcare and improved services in the district hospital improved the NTPC Khargone's reputation and brand value in the community. Table 9summarizes the inputs, outputs, outcomes and financial proxies of health interventions.

Table 9: Impact Map for Healthcare Interventions

Stakeholder	Input	Output	Outcome	Financial Proxy
Community members	Time & Energy	No. of beneficiaries who care and medical services at district hospital	Improved physical health of beneficiaries	average cost saved for medical consultation, medicine, travel expenses and time
Community members	Time & Energy	No. of beneficiaries who received doorstep medical facilities	Saved expenditure on travelling to nearest town	Average cost of travel to nearby district health facility
Community members	Time & Energy	No. of beneficiaries receiving women and childcare	Saved expenditure on maternal and childcare for 650 days	annual average cost for maternal and child care, savings in terms of travel, medicines and consultation
NTPC	Financial & Monetary Resources	NTPC Branding	Improved Brand Image	1% Cost of brand improving exercises

The financial proxies for the improved physical health of beneficiaries is taken equivalent to the average cost medical check-up per person and the average cost of travel to nearby district health facility. NTPC Khargone as a stakeholder also benefitted from the project, so the financial proxy for that outcome is the 1% cost of branding in the local newspaper.

Impact Map and Financial Proxies of Vocational Training projects

The skill development training led to employment of people and improvement in their livelihood conditions. The trainees reported to have improved self-esteem as a gainful employment because of the training. Table 10summarizes the inputs, outputs, outcomes and financial proxies of vocational training interventions.

Table 10:Impact Map for Vocational Training Projects

Stakeholder	Input	Output	Outcome	Financial Proxy
Youth and women Beneficiaries	Energy & Time	No. of beneficiaries participated in various vocational trainings	Improved skills level for employment/ Self employment	average cost of attending classes, improved average yearly income, cost of certificate provided, salary of the trainers
NTPC	Financial & Human Resource	Completion of vocational training programmes	Improved NTPC brand image	1% of Advertisement cost

The vocational training leads to employment of the trainees and increase in the income of the households. This leads to many social benefits for the family and the households. The training also gives employment to the trainers and the implementation agency gets income through its engagement with the project. Financial proxy for the placement and employment of trainees is the average salary that they will receive after employment

Impact Map and Financial Proxies of Water

NTPC Khargone as part of their intervention in water projects renovated and upgraded water pipelines and constructed water tanks. It led to an increase in the improved quality and quantity of potable water available to households and also saving time which was earlier spent in carrying water from far-off places. It also improved access to safe drinking water to people of Selda and Dalchi. Table 11 shows the inputs, outputs, outcomes and financial proxies of water interventions.

Table 11:Impact Map of Water

Stakeholder	Input	Output	Outcome	Financial Proxy
Community Members	Time & efforts	No. of beneficiaries of water pipeline renovation and upgradation, construction of water tanks etc.	Improved access to safe drinking water	Average cost incurred on renovating and upgradation of water pipeline, buying water from other sources
NTPC	Financial & Human Resources	Renovation and upgradation of water pipeline, construction of water tanks etc.	Improved NTPC Brand Image	01% Cost of brand improving exercises

The outcomes of the water interventions have been monetized by using the financial proxy of average cost incurred on renovating, upgradation of water pipeline and buying water from other sources.

Impact Map and Financial Proxies of Sanitation Interventions

The sanitation intervention improved the difficulties of the people in repairing the toilets in the villages. The major outcomes of these projects are improved quality of life and sanitation facilities in the villages. Table 12 shows the inputs, outputs, outcomes and financial proxies of the sanitation interventions.

Table 12: Impact map for sanitation interventions

Stakeholder	Input	Output	Outcome	Financial Proxy
Beneficiaries (Community)	Time & Energy	No. of beneficiaries of toilets repaired	Reduced expenditure on health since excess to toilets improved, improved quality of life due to sanitation facilities	Average financial Savings due to reduced expenditure on health and average cost of repairing a toilet.
NTPC	Financial & Monetary Resources	Improved sanitation facilities through individual toilets built by NTPC		

Increased access to improved sanitation facilities and quality of life, reduced expenditure on health due to improved sanitation conditions, employment generated for construction workers are the major outcomes for this project. Quantification of reduced expenditure on health, average cost of building an individual toilet, average earnings for constructing a toilet has been used as financial proxies to monetize the outcomes of this project.

Impact Map and Financial Proxies of Infrastructure Development Interventions

These interventions about the development of infrastructures lead to outcomes such as easy and improved access to community buildings, Gangour Ghats, bus stands, roads, drains etc. This leads to employment and improvement of other facilities to the people. Better community infrastructure leads to general welfare and well-being. Table 13 shows the input, output, outcomes and financial proxies of the rural development interventions.

Table 13: Impact Map for Infrastructure Development Projects

Stakeholder	Input	Output	Outcome	Financial Proxy
Community/ Villagers	Time and Efforts	No. of beneficiaries of road construction, Gangour Ghats, drains, bus stands etc.	Easy access to towns, reduced time and improved medical savings.	Average cost of vehicle maintenance and fuel saving and average travel costs.
Community/ Villagers	Time and Efforts	Number of community members who benefitted from creation of community centre	Improvement in access to recreational opportunities	Average cost of renting a public place/banquet hall
NTPC	Time, Human Resource & Monetary resources	Completion of Rural Infra Projects	Improved NTPC Brand Image	1% Cost of brand improving exercises

The outcomes of the rural infrastructure interventions have been monetized by using the financial proxies such as average cost saved in the maintenance of vehicle and fuel savings, average cost of renting a public place/ banquet hall and 1% cost of advertisement gained by NTPC.

Impact Map and Financial Proxies of sports Interventions

These sports interventions lead to outcomes such as participation in various sports events and competitions. This leads to better opportunities to excel in sports and enhanced sportsmanship spirit. Table 14 shows the input, output, outcomes and financial proxies of the sports interventions.

Table 14: Impact Map for Sports Projects

Stakeholder	Input	Output	Outcome	Financial Proxy
Students	Time and Efforts	No. of beneficiaries receiving a platform to excel in sports	Easy access to block level tournaments & savings of travel costs.	Average cost of attending block level tournament and average travel costs.
Students	Time and Efforts	Number of beneficiaries having enhanced sportsmanship spirts	Creation of opportunities and awareness through the athletic meet	Average cost of attending an athletic meet
NTPC	Time, Human Resource & Monetary resources	Organisation of various sports meet	Improved NTPC Brand Image	1% Cost of brand improving exercises

The outcomes of the sports interventions have been monetized by using the financial proxies such as average fuel savings, average cost of attending an athletic meet and 1% cost of advertisement gained by NTPC.

Step 6: Establishing Impact

After ascertaining the outcomes and monetizing them based on financial proxies, valuation filters are used to adjust the return on investment against any impact which is not the outcome of the interventions under study. To ascertain the actual social value of the impacts, valuation filters like deadweight, attribution, drop-off and displacement are calculated and deducted from the total value of the impacts. This presents the correct view of the social value created through interventions. Table 15 gives the summary of the valuation filters used in the SROI.

Table 15: Summary of SROI Valuation Filters

Thematic Area	Average Deadweight	Average Attribution	Average Drop-off	Average Displacement
Education	13%	13%	15%	0%
Healthcare	15%	13%	13%	0%
Skill development Training	15%	15%	10%	0%
Water	25%	15%	15%	0%
Sanitation	30%	20%	5%	0%
Rural Infrastructure	20%	20%	13%	0%
Sports	17%	7%	13%	0%

Step 7: The SROI Computation

The final stage in the process is the computation of the SROI ratio and analysis of the outcomes. The SROI ratio is calculated by multiplying the quantity of outputs with the value of the financial proxies. After this, the value of the deadweight, attribution, displacement and drop off are subtracted from it. This brings us the value of outcomes of the interventions. The next step is to calculate the net present value of outcomes which gives us the clear picture of the value generated. The formula for the calculation of net-present value is as follows:

Net Present Value= [Present value of benefits]- (minus) [Value of investments]

Once the net present value of the outcomes is calculated, the SROI ratio is calculated by dividing the net present value by the value of total inputs.

Net SROI ratio = Net Present Value of Outcomes/Value of inputs

Table 16 gives a theme-wise summary of the SROI of various interventions made by NTPC Khargone.

Table 16: SROI of various thematic areas

Thematic Area	Budget (in percentage)	SROI Value
Healthcare	39.4%	1.33
Skill development Training	2.65%	1.83
Water	5.53%	9.88
Education	14.21%	2.59
Sanitation	2.59%	1.72
Infrastructure Development	36.18%	1.49
Sports	0.44%	1.07
	Average SROI Value/ Mean Satisfaction Index	**1.98**

The average SROI is 1.98. This means that for every rupee spent by NTPC Khargone, benefits worth rupee 1.98 are generated for society.

Step 8: Sensitivity Analysis

The results presented in this SROI evaluation are based on variables according to available evidence including qualitative data on the experience of stakeholders. Despite rigorous data collection, analysis and calculation, the SROI ratio is still an estimate of true value to the community and is thus prone to error. The sensitivity analysis explores and tests these assumptions and variables to verify the results of the analysis. A theme-wise sensitivity analysis has been done to verify the results of the SROI. For each theme, the most important areas have been taken up for the study.

Educational Interventions

In these interventions, the deadweight, attribution and drop-off were tested along with values and number of beneficiaries.

Table 17: Sensitivity Analysis for Education Intervention

Tested Assumptions	Change in variable	Changed SROI
Deadweight	Assuming deadweight of 0% instead of 13%	2.89
Attribution	Assuming 0% attribution instead of 13%	2.89
Drop-off	Assuming 0% drop-off instead of 15%	3.14

The original calculated SROI value for the educational interventions is **2.59**. After changing the value of assumptions, it was found that the SROI values changed to a very limited extent. There were no huge fluctuations in the value of the SROI by changes in the assumptions. This proves that the initial assumptions and valuations are reasonable.

Healthcare Interventions

In healthcare interventions, the SROI value is **1.33.** To check the sensitivity of the value, the deadweight, attribution and drop-off will be tested along with values of other outcomes. After making modifications in rate of deadweight, attribution, and drop off. The change in SROI value is small compared to its base value. This proves that the initial assumptions and valuations are reasonable.

Table 18: Sensitivity Analysis for Healthcare

Tested Assumptions	Change in variable	Changed SROI
Deadweight	Assuming 0% deadweight instead of 15%	1.64
Attribution	Assuming 0% attribution instead of 13%	1.64
Drop-off	Assuming 0% drop-off instead of 13%	1.90

Skill development Training Interventions

In vocational training interventions, the SROI value is **1.83**. After making modifications in rate of deadweight, attribution, and drop off, the change in SROI value is small compared to its base value. This proves that the initial assumptions and valuations are reasonable.

Table 19: Sensitivity Analysis for Vocational Training Intervention

Tested Assumptions	Change in variable	Changed SROI
Deadweight	Assuming 0% deadweight instead of 15%	2.07
Attribution	Assuming 0% attribution instead of 15%	2.07
Drop-off	Assuming 0% drop-off instead of 10%	2.21

Interventions for Water Interventions

In interventions related to water, the SROI value is **9.88.** The change in SROI value is small compared to its base value. This proves that the initial assumptions and valuations are reasonable.

Table 20: Sensitivity Analysis of interventions for Water

Tested Assumptions	Change in variable	Changed SROI
Deadweight	Assuming 0% deadweight instead of 25%	14.09
Attribution	Assuming 0% attribution instead of 15%	11.00
Drop-off	Assuming 0% drop-off instead of 15%	12.02

Sanitation Interventions

In sanitation interventions, the SROI value is **1.72.** After making modifications in rate of deadweight, attribution, and drop off, the change in SROI value is small compared to its base value. This proves that the initial assumptions and valuations are reasonable.

Table 21: Sensitivity Analysis for Sanitation Intervention

Tested Assumptions	Change in variable	Changed SROI
Deadweight	Assuming 0% deadweight instead of 30%	2.71
Attribution	Assuming 0% attribution instead of 20%	2.15
Drop-off	Assuming 0% drop-off instead of 5%	2.00

Infrastructure Development Interventions

In rural infrastructure interventions, the SROI value is **1.49.** After making modifications in rate of deadweight, attribution, and drop off, the change in SROI value is small compared to its base value. This proves that the initial assumptions and valuations are reasonable.

Table 22: Sensitivity Analysis for Rural Infrastructure Interventions

Tested Assumptions	Change in variable	Changed SROI
Deadweight	Assuming 0% deadweight instead of 20%	1.86
Attribution	Assuming 0% attribution instead of 20%	1.86
Drop-off	Assuming 0% drop-off instead of 13%	1.81

Sports Interventions

In sports interventions, the SROI value is **1.07**. After making modifications in rate of deadweight, attribution, and drop off, the change in SROI value is small compared to its base value. This proves that the initial assumptions and valuations are reasonable.

Table 23: Sensitivity Analysis for sports Interventions

Tested Assumptions	Change in variable	Changed SROI
Deadweight	Assuming 0% deadweight instead of 17%	1.28
Attribution	Assuming 0% attribution instead of 7%	1.18
Drop-off	Assuming 0% drop-off instead of 13%	1.07

Thus, the sensitivity analysis explored how robust the SROI ratios are by adjusting variables in the calculation to establish how much change would reduce the ratio of return to 1:1. In conclusion, regardless of the extent to which the discounting factors or value propositions of major components are reinterpreted, the SROI of various thematic areas remains just acceptable.

Step 9: Analysis and Recommendations

The mean SROI value of the projects is 1.98. It shows a monetary value of the social impact (the benefit) of R&R-CD interventions of NTPC Khargone. It expresses material project outcomes as equivalent monetary values so that they can be compared with the cost of inputs. The social return of the projects were 1.98 times the amount of investments done by NTPC Khargone.

There were some limitations while conducting the SROI study. One of the major limitations of SROI is that it is difficult to compare results between organizations. Many organizations adopt different ways of analysis and reporting of the SROI study. There is also issues of focusing on certain aspects of the study which increase the SROI values and downplaying those areas which diminish the SROI score. This SROI study also had specific some limitation which are discussed below:

1. Lack of appropriate indicators to assess return on investment for specific projects.
2. High attribution overlap since most beneficiaries get these benefits from multiple sources like government and NTPC that contribute to returns;
3. Challenge to engage beneficiaries to discuss sensitive and often proprietary financial data; and
4. Lastly, the development outcomes and return on investment are not always applicable, especially in remote areas where implementation costs are high and development results are slow.

10. CONCLUSION AND RECOMMENDATIONS

CONCLUSION

A comprehensive impact analysis was done for the major CSR-CD projects of NTPC Khargone in the domain of education, health, rural infrastructure, drinking water, sanitation, and skill development. The impact, relevance, effectiveness and sustainability of each of the interventions were assessed. Furthermore, the Social Return on Investment (SROI) was calculated for each domain separately.

With respect to the educational interventions of NTPC Khargone, it was found that the latter has constructed school buildings, boundary walls, distributed uniforms, school bags, and stationary, renovated classrooms, provided merit scholarship to students, implemented Girl Empowerment Mission (GEM) workshop, installed SMART TVs in high school and organized EVOICE initiative amongst others. These educational initiatives by NTPC Khargone are highly relevant given the socio-economic condition of people in the project affected villages (PAVs). As a result of NTPC Khargone's interventions, the overall percentage of literate and educated people in the PAVs have improved from 67.44% (2011) to 74.69% (2022). However, the educational interventions of NTPC Khargone was perceived to be unsatisfactory by a majority of the respondents of the surveyed area.

The SROI for the educational interventions came out to be 2.59. This means that for every rupee spent by NTPC Khargone for the development of education, benefits worth rupee 2.59 are generated for the society.

With respect to the health interventions, it was found that NTPC Khargone undertook several initiatives with an aim to promote the healthcare situation in the Project Affected Gram Panchayats namely Selda/Balabad and Dalchi. These included mobile medical units, maternal and child health care, and health infrastructure development at district hospital Khargone amongst others. The health interventions of NTPC Khargone are highly relevant in the surveyed area when compared with the grave situation of health and hygiene in the PAVs in 2011. According to the Socio-Economic Study for KgSTPP, 2011, there were no medical facilities in the surveyed area and the general health and hygiene of the Project Affected Persons was poor. As the people faced many challenges in accessing the medical facilities located at far off distance, the mobile medical units by NTPC Khargone is a boon. However, these significant health interventions of NTPC Khargone was perceived to be unsatisfactory by a majority of the respondents of the surveyed area.

The SROI for the health interventions came out to be 1.33. This means that for every rupee spent by NTPC Khargone for the improvement of health of people in the surveyed area, benefits worth rupee 1.33 are generated for the society.

With respect to the infrastructural interventions, it was found that NTPC Khargone constructed the community centres, roads and drains, and Gangour Ghat amongst others. The rural infrastructures created by NTPC Khargone are highly relevant to the people in the surveyed area. It was found that the community centre was used by the community people for holding their cultural and social functions. The constructed roads are used by all the villagers for reaching hospitals, schools, markets and other community spaces. Gangour being the most important festival, the renovation of Gangour Ghat positively impacted the people in the survey area. When compared with the baseline data of 2011, IICA survey, 2022 found that the percentage of people who have access to concrete roads have increased in the past 10 years. However, there is scope of much more improvement as pucca or concrete roads was available to only 53 percent respondents. Despite the significant rural interventions of NTPC Khargone, a majority of the respondents of the surveyed area were found to be unsatisfied in the perception and satisfaction survey.

The SROI for the rural infrastructural interventions came out to be 1.49. This means that for every rupee spent by NTPC Khargone for the rural infrastructure development, benefits worth rupee 1.49 are generated for the society.

With respect to the drinking water interventions, it was found that NTPC Khargone renovated and upgraded the water pipeline, supplied water through tanker, and constructed water tank amongst others. The piped water supply to households is highly relevant as it enhances the quality of life and health of people. A majority of respondents spread across Selda and Dalchi have piped water connection in their households and also appreciated the quality of potable water. Compared to the baseline data, 2011, the water supply has improved significantly in the project affected villages.

The SROI for the water interventions came out to be 9.88. This means that for every rupee spent by NTPC Khargone for drinking water, benefits worth rupee 9.88 are generated for the society.

With respect to the interventions in sanitation, it was found that NTPC Khargone repaired the toilets for the people in the surveyed area. Functional toilets are basic necessity of any household and therefore are highly relevant for the people in the survey area. The IICA Survey, 2022 found that there has been a significant improvement in the percentage of households (76% respondents in Selda and 25% respondents in Dalchi) with functional toilets when compared with the baseline data, 2011 where only 14.71% of the households had separate and proper toilets. While it can be said that the level of hygiene and sanitation improved after NTPC Khargone's interventions, it may be noted that 75% respondents in Dalchi still practiced open defecation. Furthermore, it was found that a majority of respondents were unsatisfied with the sanitation interventions of NTPC Khargone.

The SROI for the interventions in sanitation came out to be 1.72. This means that for every rupee spent by NTPC Khargone for sanitation, benefits worth rupee 1.72 are generated for the society.

In order to enable people earn their livelihood, skill development training was provided to the youth and women in the surveyed gram panchayats by NTPC Khargone. The training included dress making (stitching), pickle and papad making, beauty parlour, electrical, rakhi making, computer, horticulture amongst others. These trainings are highly relevant in context of the socio-economic condition of the people in the PAVs. Furthermore, the IICA survey found that after NTPC Khargone's interventions, the percentage of working population in the PAVs have improved significantly in the past ten years i.e. from 2011(52.6%) to 2022 (75.47%). However, a majority of the respondents of the study were unsatisfied with the skill development interventions by NTPC Khargone.

The SROI for the skill development interventions came out to be 1.83. This means that for every rupee spent by NTPC Khargone for the development of skill of the youth and women in the surveyed area, benefits worth rupee 1.83 are generated for the society.

Based on the discussion above, it can therefore be concluded that as compared to 2011, there has been an improvement in the quality of life of the people in the surveyed area. This is proved by the fact that the overall SROI for all the CSR-CD projects undertaken by NTPC Khargone is 1.98. It means that for every rupee invested by NTPC Khargone for the development of the Project Affected Villages (PAVs), benefits worth rupee 1.98 are generated for the society.

RECOMMENDATIONS

The IICA recommendations may be incorporated in the future projects to ensure inclusivity, effectiveness, impact and sustainability of CSR-CD projects.

Strategic Recommendations

- **Ensure sustainability of project:** The long-term sustainability of interventions in CSR-CD is a complex and persistent challenge. First, before handing over any project to community, NTPC Khargone must ensure that it has got a buy in from the community and key stakeholders. In order to make the projects sustainable, it is important to integrate community and panchayat engagement, and converge with government schemes and programmes right from the beginning. Initially for two years, the project maintenance should be handled by NTPC Khargone. However, NTPC Khargone should safeguard by sensitizing communities about community resources ownership and community participation for sustainability of projects. For example: To ensure sustainability of the infrastructure in schools, NTPC Khargone must take a written consent from the school management committee (SMC)/ school administration regarding the responsibility to manage and timely repair the assets created by NTPC Khargone for sustainable long-term use.

- **Pilot-based project:** It shall be recommended that initially short-term projects should be executed in villages as pilot projects to assess the viability of a project. This will ensure the project impact and pros/cons along.

- **Branding of NTPC Khargone projects:** It is recommended that CSR project of NTPC Khargone should have clear branding so that the nearby community is aware of the social initiatives undertaken by NTPC Khargone.

- **Monitoring and evaluation of CSR projects:** A clear monitoring and evaluation framework along with the appropriate tracking system may be developed to make the projects more efficient and impactful.

- **Promotion of formation of Village Development Committee (VDC):** NTPC Khargone may promote the formation of Village Development Committee that will have men and women from the community who are responsible for taking care of the assets created by NTPC Khargone. It is recommended that the village level elected governing body collect some small payments for the usage of community projects. This helps to keep a check on the usage of resources as well as builds a corpus for future Operations & Maintenance.

- **Dovetailing with government schemes:** NTPC Khargone may ensure that its CSR-CD activities are aligned with central, state governments and district administration schemes and programmes. It can even support important welfare scheme such as old age pension, widow pension, and other social welfare benefits to see to it that the risks and vulnerability of the people belonging to very vulnerable segments of the society are addressed.

Thematic area wise recommendations

Education

- **Provision of bicycles to girl students:** The IICA survey, 2022 found that the women lagged behind men in receiving school and college education. Also, at the higher educational level such as graduation, the women lagged behind men. Moreover, with respect to technical education like ITI, there were no women respondents in the surveyed gram panchayats. The provision of bicycles to girl students have proven to empower and educate rural girls across India. Bicycles have proven to be wheels of change, and evidence[16] suggests they can successfully boost rural girls'enrolment in secondary school.

- **Provision of digital education:** The IICA survey, 2022 highlights that there are no computer labs and internet access in any of the school surveyed in Dalchi and only 11.1 per cent schools in Selda had computer labs and internet access. Thus, these are found to be an immediate requirement in the schools in the area. NTPC Khargone can provide digital infrastructure to schools in its operations area to positively impact the quality of education in the area.

[16] Muralidharan, Karthik and Nishith Prakash. 2017, "Cycling to School: Increasing Secondary School enrollment for girls in India" American Economic Journal: Applied Economics, 9 (3): 321-50

- **Improvement in enrolment in higher education institutes through scholarships:** The IICA survey, 2022 found that only 2.47% respondents were graduates and 1.39% respondents were post graduates. NTPC Khargone may provide scholarship to students to continue higher education in Khargone that may encourage them to continue education.

Healthcare

- **Creating awareness for institutional birth:** The IICA Survey, 2022 found that both Selda/Balabad (50.80%) and Dalchi (25.97%) lag behind the National (61.90%), State (80.20%) and District benchmark (85.60%) for institutional delivery in a public health facility. Thus, NTPC Khargone can organise awareness campaigns on the importance of institutional deliveries so that the villages in the study area achieve 100 per cent institutional deliveries.

- **Establishment of a telemedicine centre in each project gram panchayat/village:** Telemedicine refers to the use of information technologies and electronic communications to provide remote clinical services to patients. Nowadays, more health care providers are offering to 'see' patients by computer and smart phone. Telemedicine, which enables video or phone appointments between a patient and their health care practitioner, provides health benefits and is convenient. Telemedicine carts usually come equipped with computers, monitors, keyboards, cameras, and mobile medical devices, like digital scopes and wearable monitors. Hospitals are also increasingly using technology like interactive patient engagement systems to improve patient education and streamline workflows. The IICA survey, 2022 found that 85% of the households in the surveyed gram panchayats had a mobile phone. Therefore, NTPC Khargone may establish as well as run a telemedicine center within every project villages.

- **Building more awareness about NTPC Khargone's mobile medical units' initiative:** As per IICA Survey, 2022, a majority of the respondents in the surveyed area shared that they did not benefit from the MMUs. Therefore, the frequency of visit of the MMUs to the target beneficiaries may be increased. Additionally, the villagers may be made aware of the significance and visit schedule of the MMUs so that they can utilize the opportunity and benefit from the initiative.

Drinking Water and Sanitation

Water

- **Increase in the percentage of households with piped water supply:** As per IICA Survey, 2022, 76% households in Selda and 64% households in Dalchi had access to piped water supply which is much higher than the national, state and district benchmark. However, the survey found that the households which did not have piped water supply met their water needs through hand pumps and well/river. A very less percentage of respondents also required to purchase water for drinking purposes. Therefore, to increase the piped water supply, NTPC Khargone can dovetail the 'Jal Jeevan Mission- Har Ghar Jal Scheme' of Government of India by providing drinking water supply through pipelines and functional household tap connection to every rural household by 2024.

- **Installation of community taps with RO filtration Water plants system:** While 64.81% respondents have appreciated the quality of water supply, 35.19% respondents said that the quality of drinking water was poor. NTPC Khargone may therefore install RO water plant with co-pay model in PAVs.

Sanitation

- **Construction of community toilets:** The IICA Survey found that 74.93% respondents in Dalchi and 24.28% respondents in Selda still practice open defecation. This is because only 25.07% respondents in Dalchi and 75.72% respondents in Selda/Balabad said that they had a functional toilet with water supply in their household. Therefore, NTPC Khargone may construct community toilets so that the gram panchayats become open-defecation free.

- **Building awareness on usage of toilets:** Various studies highlight that the construction of toilets does not necessarily result in improved toilet usage. In order to reduce/end the incidence of open defecation, intensifying the Swachh Bharat Abhiyan, NTPC Khargone can support awareness-raising programmes in schools and other public places involving communities and local governments; raise awareness thorough mass-communication platforms with focus on excluded and marginalized social groups.

Skill development and livelihood

- **Empowering Self-help groups:** As found in IICA Survey, 2022, only around 17.61% women respondents in Dalchi and 15.02% women respondents in Selda are associated to a Self- Help Group (SHG). Women Self-Help Group (SHG) should be empowered through sensitization, exposure and trainings. NTPC Khargone can support SHGs with training in backward and forward linkages like marketing, branding and micro finance etc.

- **Vocational training:** The IICA Survey, 2022 found that only 22.84% respondents spread across Selda (21.73%) and Dalchi (23.88%) said that they have received some form of skill development training. People expressed their demand for attending vocational training courses. NTPC Khargone can identify skill training centres or Government run Industrial Training Institute (ITIs) in the Khargone district and can help the people in documentation and getting them enrolled in these centers. The fees can be co-funded by NTPC Khargone. NTPC Khargone in collaboration with PMKVY 3.0 scheme[17] can train the youths in order to help them secure better livelihood opportunities.

Rural infrastructure development

- **Construction of drains:** As per the IICA survey, 2022, only 12.04% respondents shared that a sewage pipe/drainage system existed while a larger majority of respondents (77.16%) said that the water from their bath and kitchen area was released in the open and on the roads. Around 10.19% respondents said that the dirty water from their houses released into the fields. Since drainage is an important public health issue, NTPC Khargone may undertake building of drainage system in the villages where it is not available.

- **Construction of roads:** As per the IICA Survey, 2022, 53% respondents have shared that pucca or concrete roads was available to them. As road connectivity projects have significant socio-economic effects on the lives of beneficiaries, NTPC Khargone may undertake road construction to positively impact the life of people in PAVs.

[17] https://www.pmkvyofficial.org/about-pmkvy

11. ANNEXURES

11.1 ANNEXURES 1: ECONOMIC STATUS

Indicator to measure keeping objective	Percentage of population living below national poverty line	% of population below BPL (% of households with BPL ration cards)	Per capita income (Average annual income)
Source of Information (Secondary survey, FGD,KII)	NITI Aayog SDG India Index 2.0	Antodaya 2019	MOSPI 2018-2019
India	21.92 (NITI Aayog SDG India Index 2019)	42.65 Antodaya 2019	Rs,1,26,,406 MOSPI 2018-19
Madhya Pradesh	31.65 (NITI Aayog SDG India Index 2.0)	45.42 Antodaya 2020	Rs 90998 MOSPI 2018-19
Khargone	Data not Available	Data not Available	Data not Available
Selda/Balabad	Data not Available	48.46%	Data not Available
Dalchi	Data not Available	51.54%	Data not Available

11.2 ANNEXURES 2: EDUCATION & VOCATIONAL SKILL STATUS

Indicator to measure keeping objective	% of children (6-14 years) attending the school-Rural	% of children (15-16 years) attending the school- Rural	% of girl child (15-16 years) attending the school- Rural	% of children drop out after grade 5 (Drop out rate upper primary 6-8)	Average annual drop out rate at secondary level (class 9-class 10)	% of population having higher education (Gross enrollment ratio in higher education 18-23 yrs)
Source of Information (Secondary survey, FGD,KII)	ASER Report (2018)	ASER Report (2018)	ASER Report (2018)	UDISE Report 2019_20	NITI Aayog 2020 (SDG Index-Quality Education)	AISHE 2020
India	65.6% ASER Report (2018)	86.9 ASER Report (2018)	86.6 ASER Report (2018)	2.6 UDISE Report 2019_20	17.97 NITI Aayog 2020 Dashboard	27.1% AISHE 2020
Madhya Pradesh	95.8 ASER Report(2018)	76.6 ASER Report (2018)	73.2 ASER Report (2018)	4.1 UDISE Report 2019_20	24.85 NITI Aayog 2020 (SDG Index-Quality Education)	24.2 AISHE 2020

Khargone	Data not Available	Data not Available	Data not Available	Data not Available	Data not Available	Data not Available
Selda/ Balabad	95.14%	Data not Available	Data not Available	Data not Available	Data not Available	Data not Available
Dalchi	87.92%	Data not Available	Data not Available	Data not Available	Data not Available	Data not Available

11.2.1 ANNEXURES 2: EDUCATION & VOCATIONAL SKILL STATUS

Indicator to measure keeping objective	Training and Skills available to people	% of youth (15-35 years) provided training/vocational for employment placement and/or self employment	Number of primary school/thousand population and average distance to nearest school	% of Children (15-18 years) attending the high school	% of girl child (15-18 years) attending the high school	Literacy rate of 7 plus year old (average literacy rate)
Source of Information (Secondary survey, FGD,KII)	Data not available	Data not available	MOSPI NSS 71ST Round	NITI Aayog 2015-16	NITI Aayog 2015-16	Census 2011
India	Data not available	Data not available	Less than 1 km	32.3% NITI Aayog 2015-16	32.67% NITI Aayog 2015-16	72.98 Census 2011
Madhya Pradesh	Data Not Available	Data Not Available	Data Not Available	Data Not Available	Data Not Available	69.24 Census 2011
Khargone	Data not Available	Data not Available	Data not Available	Data not Available	Data not Available	Data not Available
Selda/ Balabad	6.35%	Data not Available	Data not Available	80.41%	77.78%	Data not Available
Dalchi	6.57%	Data not Available	Data not Available	53.98%	52.38%	Data not Available

11.3 ANNEXURE 3: HEALTH ISSUE IN THE COMMUNITY

Indicator to measure keeping objective	Under-five mortality rate per 1000 live birth (Under five mortality rate)	Percentage of children age 9-11 months fully immunized (BCG, measles, and 3 doses each of polio and DPT) (%) (Percentage of children age 9-11 months fully immunized)	Number of physicians, nurses, midwives	No. of beds per thousand population (Number of Government Hospitals and Beds in Rural & Urban Areas)	Tuberculosis (Total patients registered for treatment) (Total case notification rate of tuberculosis)	Malaria

Source of Information (Secondary survey, FGD,KII)	NITI Aayog (2020 SDG Index-Good Health and Well-being)	NITI Aayog (2020 SDG Index-Good Health and Well-being)	NITI Aayog (2020 SDG Index-Good Health and Well-being)	NHP 2020	NITI Aayog (2020 SDG Index-Good Health and Well-being)	NA
India	36 (2020 SDG Index-	91 NITI Aayog (2020 SDG Index-G	36.84 NITI Aayog (2020 SDG Index	818396 (NHP,2020)	177 NITI Aayog (2020 SDG Index-Good Health and Well-being)	Data not available
Madhya Pradesh	56 NITI Aayog (2020 SDG Index-Good Health and Well-being)	89 NITI Aayog (2020 SDG Index-Good Health and Well-being)	32.84 NITI Aayog (2020 SDG Index-Good Health and Well-being)	31106 (NHP,2020)	226 (2020 SDG Index-Good Health and Well-being)	Data not Available
Khargone	Data not Available	Data not Available	Data not Available	Data not Available	Data not Available	Data not Available
Selda/ Balabad	Data not Available	Data not Available	Data not Available	Data not Available	Data not Available	Data not Available
Dalchi	Data not Available	Data not Available	Data not Available	Data not Available	Data not Available	Data not Available

11.3.1 ANNEXURES

Indicator to measure keeping objective	Water borne diseases/ Prevalence of diarrhoea (reported) in the last 2 weeks preceding the survey (%) (children under age 5 years)	HIV(HIV Incidence rate)	Prevalence of underweight children under 05 years of age (Children under 5 years who are underweight)	Under five mortality rate per 1000 live birth (village wise)	Infant mortality rate per thousand birth
Source of Information (Secondary survey, FGD,KII)	Data not Available	NITI Aayog (2020 SDG Index-Good Health and Well-being)	NFHS-5 2019-2021	NFHS-5 2019-2021	NFHS-5 2019-2021

India	Data not Available	0.05 NITI Aayog (2020 SDG Index-Good Health and Well-being)	32.1 NFHS -5 2019-2021	41.9 NFHS-5 2019-2021	35.2 NFHS-5 2019-2021
Madhya Pradesh	Data Not Available	0.04 NITI Aayog (2020 SDG Index-Good Health and Well-being)	33 NFHS -5 2019-2021	49.2 NFHS-5 2019-2021	41.3 NFHS-5 2019-2021
Khargone	Data Not Available	Data Not Available	44 NFHS -5 2019-2021	Data Not Available	Data Not Available
Selda/ Balabad	Data Not Available	Data Not Available	Data Not Available	Data Not Available	Data Not Available
Dalchi	Data Not Available	Data Not Available	Data Not Available	Data Not Available	Data Not Available

ANNEXURE 11.3.2

Indicator to measure keeping objective	% of children immunized (Percentage of fully immunized children in the age group 0-5 years)	% of 1 year old children immunization (Children age 12-23 months fully immunized, BCG, measles and 3 doses each of polio and DPT)	Maternal mortality rate per lakh (village wise) (maternal mortality ratio)	Cancer	Disability(% of Differently abled person)
Source of Information (Secondary survey, FGD,KII)	NITI Ayog SDG Dashboard 2019	NFHS-5	NITI Aayog SDG Dashboard 2020	NHP 2020	Census 2011
India	59.2 NITI Aayog SDG Dashboard 2019	83.8	113 NITI Aayog SDG Dashboard 2020	67741 NHP 2020	2.21 Census 2011
Madhya Pradesh	62.8 NITI Aayog SDG Dashboard 2019	83.3	173 NITI Aayog SDG Dashboard 2020	4,119 NHP 2020	2.13 Census 2011
Khargone	Data Not Available	77.4	Data Not Available	Data Not Available	Data Not Available
Selda/ Balabad	Data Not Available	93.2	Data Not Available	Data Not Available	Data Not Available
Dalchi	Data Not Available	97.5	Data Not Available	Data Not Available	Data Not Available

ANNEXURE 11.3.3

Indicator to measure keeping objective	Number of people benefitted from distribution of ads and appliances (No of physically challenged received implants appliances)	No of Differently abled people enrolled in school (inclusive education) Differently abled children (5-19 years) attending educational institutions(%)GOAL 4 SDG
Source of Information (Secondary survey,FGD,KII)	Antodaya dashboard 2020	NITI Aayog SDG Dashboard 2019
URL link	https://missionantyodaya.nic.in/preloginStateSocialWeakerWelfareReports2020.html	https://sdgindiaindex.niti.gov.in/#/ranking
India	2275862 Antodaya dashboard 2020	61.18 NITI Aayog SDG Dashboard 2019
Madhya Pradesh	149992 Antodaya dashboard 2020	63.99 NITI Aayog SDG Dashboard 2019
Khargone	4180 Antodaya dashboard 2020	Data Not Available
Selda/Balabad	Data Not Available	Data Not Available
Dalchi	Data Not Available	Data Not Available

11.4 ANNEXURE 4GENDER EQUALITY & WOMEN EMPOWERMENT

Indicator to measure keeping objective	Total number of SHGs promoted (Mobilized Into Self Help Groups (SHGs))Total number of SHGs promoted (Mobilized Into Self Help Groups (SHGs)	% of women in wage employment in the non- agricultural sector	% of seats held by women in government decision making bodies (Percentage of elected women over total seats in the state legislative assembly)
Source of Information (Secondary survey, FGD,KII)	Antyodaya Dashboard 2020 (Poverty Alleviation Programme)	Census of India 2011	NITI Aayog Dashboard 2020
India	26.1% Antyodaya Dashboard	28.2 Census 2011	8.46 NITI Aayog Dashboard 2020
Madhya Pradesh	14.1%Antyodaya Dashboard (Poverty Alleviation Programme)		9.13 NITI Aayog Dashboard 2020
Khargone	7.4% Antyodaya Dashboard (Poverty Alleviation Programme)	7.4% Antyodaya Dashboard (Poverty Alleviation Programme)	Data Not Available
Selda/Balabad	15.56%	Data Not Available	Data Not Available
Dalchi	17.61%	Data Not Available	Data Not Available

11.5 ANNEXURE 5 QUALITY OF LIFE

Indicator to measure keeping objective	Average out-of- pocket expenditure per delivery in a public health facility (Rs.)	Institutional births (%)	Institutional births in public facility (%)	"% of births attended by skilled health personnel Births assisted by a doctor /nurse /LHV/ANM/other health personnel (%) "	Child born at home but assisted by health care professionals . Home delivery conducted by skilled health personnel (out of total deliveries) (%)	Households with any usual member covered under a health insurance/ financing scheme (%)	Population living in households with electricity (%)
Source of Information (Secondary survey, FGD,KII)	NFHS-5 2019-2021	NFHS-5 2019-2021	NFHS-5 2019-2021	NFHS-5 2019-2021	NFHS-5 2019-2021	NFHS-5 2019-2021	NFHS-5 2019-2021
India	2,916 NFHS-5 2019-2021	88.6 NFHS-5 2019-2021	61.9 NFHS5 2019-2021	89.4 NFHS-5 2019-2021	3.2 NFHS-5 2019-2021	41 NFHS-5 2019-2021	96.8 NFHS-5 2019-2021
Madhya Pradesh	1,619 NFHS-5 2019-2021	90.7 NFHS-5 2019-2021	80.2 NFHS-5 2019-2021	89.3 NFHS-5 2019-2021	2.5 NFHS-5 2019-2021	38.1 NFHS-5 2019-2021	98.4 NFHS-5 2019-2021
Khargone	1,657 NFHS-5 2019-2021	92.8 NFHS-5 2019-2021	85.6 NFHS-5 2019-2021	88.2 NFHS-5 2019-2021	1.3 NFHS-5 2019-2021	43.7 NFHS-5 2019-2021	98.8 NFHS-5 2019-2021
Selda/ Balabad	Data Not Available	Data Not Available	71.38%	Data Not Available	12.72%	Data Not Available	41.59%
Dalchi	Data Not Available	Data Not Available	46.13%	Data Not Available	28.04%	Data Not Available	14.63%

ANNEXURE 11.5.1 QUALITY OF LIFE

Indicator to measure keeping objective	Percentage of household with toilet facilities	Population living in households that use an sanitation facility (%)	Distance of the nearest hospital Average radial distance (Km) covered by PHC-Rural	% of households provided with piped drinking water (Percentage of households covered with piped drinking water)	% of population with sustainable access to improved water an source (within their premises and near to their premises) types of facility that is handpump, tap water well etc(Households with an improved drinking-water source (%))	% of population with pucca house (Percentage distribution of households living in Pucca houses)	% of population having house/ shelter (owning a house)

Source of Information (Secondary survey, FGD,KII)	NSSO Survey | NFHS-5 2019-2021	NFHS-5 2019-2021	RHS 2018-19	Antodaya dashboard 2020	NFHS-5 2019-2021	MOSPI NSS 76th round	MOSPI NSS 76th round | NFHS-5 2019-2021
India	90% NSSO Survey	70.2 NFHS-5 2019-2021	6.18 RHS 2018-19	25.29 Antodaya dashboard 2020	95.9 NFHS-5 2019-2021	76.7 MOSPI NSS 76th round	96% MOSPI NSS 76th round
Madhya Pradesh	76 NFHS-5	65.1 NFHS-5 2019-2021	8.94 RHS 2018-19	14.5 Antodaya dashboard 2020	89 NFHS-5 2019-2021	59.5 MOSPI NSS 76th round	74 NFHS-5 2019-2021
Khargone	Data Not Available	73.8 NFHS-5 2019-2021	Data Not Available	35.9% Antodaya dashboard 2020	97 NFHS-5 2019-2021	Data Not Available	Data Not Available
Selda/ Balabad	75.87%	Data Not Available	Data Not Available	75.6% HH Survey	-	65.40%	Data Not Available
Dalchi	25.07%	Data Not Available	Data Not Available	64.20%	-	32.54%	Data Not Available

11.6 ANNEXURE 6 OTHERS

Indicator to measure keeping objective	Sex ratio of the total population (females per 1,000 males)	Sex ratio at birth for children born in the last five years (females per 1,000 males)	Women with 10 or more years of schooling (%)	Total Cultivable Area (in hectares)	Total irrigated land area (in hectare)	Total Unirrigated land area (in hectare)
Source of Information (Secondary survey, FGD,KII)	NFHS-5 2019-2021	NFHS-5 2019-2021	NFHS-5 2019-2021	Antyodaya Dashboard (Land Improvement and Minor Irrigation)	Antyodaya Dashboard 2020	Antyodaya Dashboard (Land Improvement and Minor Irrigation)
India	1020 NFHS 5 2019-2021	929 NFHS 5 2019-2021	41.0 NFHS 5 2019-2021	198100983.7 Antyodaya Dashboard 2020	75018663.7 Antyodaya Dashboard 2020	58663842.642 Antyodaya Dashboard 2020

Madhya Pradesh	970 NFHS 5 2019-2021	956 NFHS 5 2019-2021	29.3 NFHS 5 2019-2021	16939621.9 Antyodaya Dashboard 2020	7635483 Antyodaya Dashboard 2020	4867937.892 Antyodaya Dashboard 2020 (Land Improvement and Minor Irrigation
Khargone	936 NFHS 5 2019-2021	1043 NFHS 5 2019-2021	27,2 NFHS 5 2019-2021	400058.9 Antyodaya Dashboard 2020	186344.2 Antyodaya Dashboard 2020	123163.8 Antyodaya Dashboard 2020
Selda/ Balabad	Data Not Available	Data Not Available	Data Not Available	Data Not Available	Data Not Available	0%
Dalchi	Data Not Available	Data Not Available	Data Not Available	Data Not Available	Data Not Available	0.56%

ANNEXURE 11.6.1 OTHERS

Indicator measure to keeping objective	No of Children (0-6 age group) receiving ICDS services (% of children in ICDS CAS)	% of eligible persons covered under Pradhan Mantri Suraksha BimaYojana	% of eligible persons covered under Pradhan Mantri Jan Dhan Yojana (percentage of households covered with a bank account under PMJDY against target)	% of eligible persons covered under Atal Pension Yojana	% of eligible person covered under Pradhan Manri Jeevan Jyoti BimaYojana (Citizen enrolled under Pradhan Mantri Jeevan JyotiBima Yojana)	% of households provided food grains under PDS (% of Households receiving food grain from FPS)	% of eligible person enrolled under Aadhar (Percentage of poplulation covered under Aadhar)	% of any other government schemes like Ujjwala Yojna (Number of Ujjwala beneficiaries)
Source of Information (Secondary survey, FGD,KII)	Antyodaya Dashboard 2019-20	HH Survey	NITI Aayog SDG Dashboard 2020	HH Survey	Transforming India my gov Dashboard	Antyodaya Dashboard 2019	NITI Aayog SDG Dashboard	Antyodaya Dashboard 2019
India	43% Antyodaya Dashboard 2019-20	Data not Available	99.99 NITI Aayog SDG Dashboard 2020	Data not Available	123799999 Transforming India my gov Dashboard	34 Antyodaya Dashboard 2019	93.24 NITI Aayog SDG Dashboard	49725237 Antyodaya Dashboard 2019

Madhya Pradesh	45.7% Antyodaya Dashboard 2019-20	Data Not Available	100 NITI Aayog SDG Dashboard 2020	Data Not Available	Data Not Available	41.8 Antyodaya Dashboard 2019	97 NITI Aayog SDG Dashboard	5346017 Antyodaya Dashboard 2019
Khargone	Data Not Available	Data Not Available	51.7% Antyodaya Dashboard	Data Not Available	Data Not Available	Data Not Available	Data Not Available	Data Not Available
Selda/ Balabad	Data Not Available	11.43%	5.71%	8.25%	5.71%	95.88%	96.19%	Data Not Available
Dalchi	Data Not Available	4.78%	4.48%	11.04%	2.69%	92.16%	95.22%	Data Not Available

11.7 ANNEXURE 7: SCHOOL INFRASTRUCTURE REQUIREMENTS

Name of the main village/GP	Name of the hamlet under main Village	Government High School	Pucca Building	Adequate Number of classroom	Boundary Wall	Blackboard in each classroom	Fan in each classroom	Play ground	Computer lab
Selda	Selda/balabad	Government High School	Yes	No	Yes	Yes	Yes	Yes	No
Selda	Seldabalabad	Government High School	Yes	No	Yes	Yes	Yes	Yes	No
Selda	Balabad	Government High School	Yes	Yes	Yes	Yes	Yes	Yes	No
Selda	Seldabalabad	Government Primary School	Yes	Yes	Yes	Yes	Yes	Yes	No
Selda	Seldabalabad	Government Primary School	Yes	No	Yes	Yes	Yes	Yes	No
Selda	Seldabalabad	Government High School	Yes	No	Yes	Yes	Yes	Yes	No
Selda	Selda/balabad	Government High School	Yes	No	Yes	Yes	Yes	Yes	No
Selda	Selda/balabad	EGS lalyachapad	Yes	No	Yes	Yes	Yes	No	Yes
Selda	Lalyachapad	Government Middle School	Yes	Yes	Yes	Yes	No	No	No
Dalchi	Dalchi	Government primary school	Yes	No	Yes	No	Yes	No	No
Dalchi	Dalchi	Government Primary School	Yes	No	Yes	Yes	Yes	No	No
Dalchi	Bedipura	Government Primary School	Yes	No	Yes	No	No	No	No
Dalchi	Jamniya	Government Primary School	Yes	Yes	No	Yes	Yes	No	No
Dalchi	Nurufaliya	Government Primary School	Yes	No	No	Yes	No	No	No
Dalchi	Manjariymal	Government Primary School	No	No	No	No	No	No	No
Dalchi	Changdiyafaliya	UEGS changdiyafaliya	Yes	Yes	No	Yes	No	No	No
Dalchi	Changdiyafaliya	Changdiyafaliya	Yes	No	No	Yes	No	No	No

Annexure 11.7.1 School Infrastructure Requirements

Name of the main village/ GP	Name of the hamlet under main Village	Government High School	Ramp for Differently abled Children	Electricity Connection	Internet Facility	Separate Toilet for girls & boys	Desks & chair for all	Library in school	Science lab in School	Is the re anganwadi centre at	Dedicated drinking water supply
Selda	Selda/balabad	Government High School	No	Yes	No	Yes	Yes	No	No	No	No
Selda	Seldabalabad	Government High School	No	Yes	No	Yes	Yes	No	No	No	No
Selda	Balabad	Government High School	No	No	No	Yes	Yes	No	No	No	No
Selda	Selda/Balabad	Government Primary School	No	Yes	No	Yes	Yes	No	No	No	No
Selda	Selda/Balabad	Government Primary School	No	Yes	No	Yes	No	No	No	No	No
Selda	Selda/Balabad	Government High School	No	Yes	No	Yes	No	No	No	No	No
Selda	Selda/Balabad	Government High School	Yes	Yes	No	Yes	Yes	No	No	No	No
Selda	Selda/balabad	EGS lalyachapad	No	Yes	Yes	Yes	Yes	No	No	No	No
Selda	Lalyachapad	Government Middle School	Yes	No	No	Yes	Yes	Yes	No	No	No
Dalchi	Dalchi	Government Primary School	Yes	Yes	No	Yes	Yes	No	No	No	Yes
Dalchi	Dalchi	Government Primary School	Yes	Yes	No	Yes	Yes	No	No	No	Yes
Dalchi	Bedipura	Government Primary School	No	Yes	No	No	Yes	No	No	No	Yes
Dalchi	Jamniya	Government Primary School	No	Yes	No	Yes	Yes	Yes	No	No	No
Dalchi	Nurufaliya	Government Primary School	No	No	No	Yes	No	No	No	No	No
Dalchi	Manjariymal	Government Primary School	No	No	No	No	No	No	No	No	No
Dalchi	Changdiyafaliya	UEGS Changdiyafaliya	Yes	No	No	Yes	Yes	No	No	No	No
Dalchi	Changdiyafaliya	Changdiyafaliya	Yes	No	No	Yes	No	No	No	No	No

11.8 ANNEXURE 8: ANGANWADI CENTRES REQUIREMENTS

Name of the main village/ GP	Name of the hamlet under main Village	No of Anganwadi Centre	Overall Condition	Furniture	Toys and other	Water cooler	Toilet	Electricity
Selda	Davkarmohalla	2	Bad	Yes	Yes	Yes	Yes	Yes
Selda	Balawad	2	Very Bad	Yes	Yes	Yes	Yes	Yes
Selda	Balabad	2	Bad	Yes	Yes	Yes	Yes	Yes
Selda	Balabad/selda	2	Bad	Yes	Yes	Yes	Yes	Yes
Dalchi	Dalchi	1	Bad	Yes	Yes	Yes	Yes	Yes
Dalchi	Dalchi	1	Bad	Yes	Yes	Yes	Yes	Yes
Dalchi	Nurufaliya	1	Bad	Yes	Yes	Yes	Yes	Yes

11.9 ANNEXURE 9: HEALTH CARE REQUIREMENTS

Name of the main village/ GP	Name of the hamlet under main Village	Health facility availability CHC/ NTPC hospital/ PHC	Health Facility availability: health centre/ dispensary/ hospital/ private clinic	Bed facility availability at the centre	Electricity	Clean Water	Seperate Toilets for male and female	Computer Facility	Lady Doctor	Ambulance
Selda/Balabad	Davkarmohalla	No	Yes	No	No	No	No	No	No	No
SeldaBalabad	Selda		Yes	Yes	Yes	No	No	No	No	No
SeldaBalabad	SeldaBalawad	No	Yes	No	No	No	No	No	No	No
Dalchi	Dalchi	No	Yes	Yes	Yes	Yes	No	No	No	No

Health

Stage 1		Stage 2						Stage 4												
Source		**At what cost?**	**How much?**		**How long?**		**How valuable?**	**How much caused by the activity?**				**Still material?**								
Stakeholders		**Inputs**	Quantity (scale)	Amount of change per stakeholder (depth)	Duration of outcomes	Outcomes start	**Value in currency**	**Deadweight %**	**Displacement %**	**Attribution %**	**Drop off %**	**Impact calculation**	**Calculating Social Return**					
													Discount rate		**3.5%**			
Project name	Beneficiaries	Financial value (for the total population for the accounting period)	Number of people experiencing described outcome.	Financial Proxy	How long (in years) does the outcome last for?	Does the outcome start in Period of activity or in the Period after?	How important is the outcome to stakeholders (expressed in monetary terms)?	What will happen/what would have happened without the activity?	What activity would/did you displace?	Who else contributed to the change?	Does the outcome drop off in future years?	Number of people (quantity) times value, less deadweight, displacement and attribution	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Mobile Health Clinic	Community	7285000	1400	average cost saved for medical consultation, medicine, travel expenses and time	5	period of activity	500.00	10%	0%	0%	10%	6,30,000.00	6,30,000.00	5,67,000.00	5,10,300.00	4,59,270.00	4,13,343.00	0.00
Maternal and Child care	women and child	2231000	320	annual average cost for maternal and child care, savings in terms of travel, medicines and consultation	2	period of activity	5,000.00	10%	0%	10%	0%	12,96,000.00	12,96,000.00	12,96,000.00	0.00	0.00	0.00	0.00
	NTPC		1	1% cost of branding	5	period of activity	3,00,000.00	20%	0%	20%	20%	1,92,000.00	1,92,000.00	1,53,600.00	1,22,880.00	98,304.00	78,643.20	0.00
Health Infrastructure developed at district hospital khargone		27011000	4212	average cost of medical consultation and medicine at district hospital	5	period of activity	5,000.00	20%	0%	20%	20%	###########	1,34,78,400.00	1,07,82,720.00	86,26,176.00	69,00,940.80	55,20,752.64	0.00
								0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
								0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		3,65,27,000.00									**Total**	###########	1,55,96,400.00	1,27,99,320.00	92,59,356.00	74,58,514.80	60,12,738.84	0.00
											Present value of each year		1,55,96,400.00	1,23,66,492.75	86,43,707.90	67,27,153.02	52,39,754.53	0.00
											Total Present Value (PV)							4,85,73,508.21
											Net Present Value (PV minus the investment)							1,20,46,508.21
											Social Return (Value per amount invested)							**1.33**

Education

Stage 1		Stage 2						Stage 4										
Source		**At what cost?**	**How much?**		**How long?**		**How valuable?**	**How much caused by the activity?**				**Still material?**						
		Inputs	Quantity (scale)	Amount of change per stakeholder (depth)	Duration of outcomes	Outcomes start	**Value in currency**	**Deadweight %**	**Displacement %**	**Attribution %**	**Drop off %**	**Impact calculation**	**Calculating Social Return**					
													Discount rate		**3.5%**			
Project	Beneficiaries	Financial value (for the total population for the accounting period)	Number of people experiencing described outcome.	Financial Proxy	How long (in years) does the outcome last for?	Does the outcome start in Period of activity or in the Period after?	How important is the outcome to stakeholders (expressed in monetary terms)?	What will happen/what would have happened without the activity?	What activity would/did you displace?	Who else contributed to the change?	Does the outcome drop off in future years?	Number of people (quantity) times value, less deadweight, displacement and	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
construction of school buildings,additional classrooms, school boundary walls, playgrounds etc.	school students, parents	10703000	2153	average annual tution cost, average cost of quality education	5	period after	5,000.00	10%	0%	10%	10%	87,19,650.00	0.00	87,19,650.00	78,47,685.00	70,62,916.50	63,56,624.85	57,20,962.37
Girl Empowerment Mission 2022	school students, parents	1250000	42	average cost of of attending the one month summer school	2	period of activity	2,000.00	10%	0%	10%	10%	68,040.00	68,040.00	61,236.00	0.00	0.00	0.00	0.00
Distribution of School kit, benches and uniform to PAV's	school students, parents	1216000	635	average cost of benches, uniform, kits and cost of quality education	2	period of activity	1,000.00	10%	0%	10%	20%	5,14,350.00	5,14,350.00	4,11,480.00	0.00	0.00	0.00	0.00
	NTPC		1	1% cost of branding	5	period of activity	3,00,000.00	20%	0%	20%	20%	1,92,000.00	1,92,000.00	1,53,600.00	1,22,880.00	98,304.00	78,643.20	0.00
								0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
								0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		1,31,69,000.00									**Total**	94,94,040.00	7,74,390.00	93,45,966.00	79,70,565.00	71,61,220.50	64,35,268.05	57,20,962.37
											Present value of each year		7,74,390.00	90,29,918.84	74,40,607.72	64,59,010.59	56,07,964.33	48,16,896.80
											Total Present Value (PV)							3,41,28,788.27
											Net Present Value (PV minus the investment)							2,09,59,788.27
											Social Return (Value per amount invested)							**2.59**

Rural Infrastructure

Stage 1 – Source: Stakeholders – Project name	Beneficiaries	Stage 2 – At what cost?: Inputs	How much?: Quantity (scale)	Amount of change per stakeholder (depth)	How long?: Duration of outcome	Outcomes start	How valuable?: Value in currency	Stage 4 – How much caused by the activity?: Deadweight %	Displacement %	Attribution %	Drop off %	Still material?: Impact calculation	Calculating Social Return: Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
													Discount rate		3.5%			
Project name	Beneficiaries	Financial value (for the total population for the accounting period)	Number of people experiencing described outcome.	Financial Proxy	How long (in years) does the outcome	Does the outcome start in Period of activity or in the Period after?	How important is the outcome to stakeholders (expressed in monetary terms)?	What will happen/what would have happened without the activity?	What activity would/did you displace?	Who else contributed to the change?	Does the outcome drop off in future years?	Number of people (quantity) times value, less deadweight, displacement and attribution	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Community centre buildings	community	9213600	4212	average cost of renting a public place banquet hall	5	period of activity	1,000.00	20%	0%	20%	10%	26,95,680.00	26,95,680.00	24,26,112.00	21,83,500.80	19,65,150.72	17,68,635.65	0.00
construction of roads, drains,culverts, Gangour ghats, boundary walls, bus stand etc	community	24330000	15792	average cost of vehicle maintaience, fuel saving, time saved, travel amount saved etc	5	period of activity	1,000.00	20%	0%	20%	10%	1,01,06,880.00	1,01,06,880.00	90,96,192.00	81,86,572.80	73,67,915.52	66,31,123.97	0.00
	NTPC		1	1% of branding improved costs	5	period of activity	3,00,000.00	20%	0%	20%	20%	1,92,000.00	1,92,000.00	1,53,600.00	1,22,880.00	98,304.00	78,643.20	0.00
								0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
								0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		3,35,43,600.00									**Total**	1,29,94,560.00	1,29,94,560.00	1,16,75,904.00	1,04,92,953.60	94,31,370.24	84,78,402.82	0.00
											Present value of each year		1,29,94,560.00	1,12,81,066.67	97,95,284.46	85,06,555.59	73,88,438.24	0.00
											Total Present Value (PV)							4,99,65,904.96
											Net Present Value (PV minus the investment)							1,64,22,304.96
											Social Return (Value per amount invested)							**1.49**

Sanitation SROI

Stage 1		Stage 2						Stage 4										
Source		**At what cost?**	**How much?**		**How long?**		**How valuable?**	**How much caused by the activity?**				**Still material?**						
Stakeholders		**Inputs**	Quantity (scale)	Amount of change per stakeholder (depth)	Duration of outcomes	Outcomes start	**Value in currency**	**Deadweight %**	**Displacement %**	**Attribution %**	**Drop off %**	**Impact calculation**	**Calculating Social Return**					
													Discount rate		**3.5%**			
Project Name	Beneficiaries	Financial value (for the total population for the accounting period)	Number of people experiencing described outcome.	Financial Proxy	How long (in years) does the outcome last for?	Does the outcome start in Period of activity or in the Period after?	How important is the outcome to stakeholders (expressed in monetary terms)?	What will happen/what would have happened without the activity?	What activity would/did you displace?	Who else contributed to the change?	Does the outcome drop off in future years?	Number of people (quantity) times value, less deadweight, displacement and	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Repairing of Toilets	community	2400000	872	average cost of repairing toilets and money saved in terms of medical expenditures	5	period of activity	2,000.00	40%	0%	20%	10%	8,37,120.00	8,37,120.00	7,53,408.00	6,78,067.20	6,10,260.48	5,49,234.43	0.00
	NTPC		1	1% cost of branding	5	period of activity	3,00,000.00	20%	0%	20%	0%	1,92,000.00	1,92,000.00	1,92,000.00	1,92,000.00	1,92,000.00	1,92,000.00	0.00
								0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
								0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		24,00,000.00									**Total**	10,29,120.00	10,29,120.00	9,45,408.00	8,70,067.20	8,02,260.48	7,41,234.43	0.00
											Present value of each year		10,29,120.00	9,13,437.68	8,12,217.04	7,23,592.99	6,45,942.98	0.00
											Total Present Value (PV)							41,24,310.70
											Net Present Value (PV minus the investment)							17,24,310.70
											Social Return (Value per amount invested)							**1.72**

Skill Training SROI

Stage 1		Stage 2						Stage 4										
Source		At what cost?	How much?		How long?		How valuable?	How much caused by the activity?				Still material?						
Stakeholders		Inputs	Quantity (scale)	Amount of change per stakeholder (depth)	Duration of outcomes	Outcomes start	Value in currency	Deadweight %	Displacement %	Attribution %	Drop off %	Impact calculation	Calculating Social Return					
													Discount rate		3.5%			
Project Name	Beneficiaries	Financial value (for the total population for the accounting period)	Number of people experiencing described outcome.	Financial Proxy	How long (in years) does the outcome last for?	Does the outcome start in Period of activity or in the Period after?	How important is the outcome to stakeholders (expressed in monetary terms)?	What will happen/what would have happened without the activity?	What activity would/did you displace?	Who else contributed to the change?	Does the outcome drop off in future years?	Number of people (quantity) times value, less deadweight, displacement and attribution	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Dressmaking, computer,horticulture, beautician, driving, electrical, rakhi making etc.	community	2456417	600	average cost of attending classes, improved average yearly income, cost of certificate provided, salary of the trainers	5	period of activity	2,000.00	10%	0%	10%	10%	9,72,000.00	9,72,000.00	8,74,800.00	7,87,320.00	7,08,588.00	6,37,729.20	0.00
	NTPC		1	1% cost of branding	5	period of activity	3,00,000.00	20%	0%	20%	10%	1,92,000.00	1,92,000.00	1,72,800.00	1,55,520.00	1,39,968.00	1,25,971.20	0.00
								0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
								0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		24,56,417.00									**Total**	11,64,000.00	11,64,000.00	10,47,600.00	9,42,840.00	8,48,556.00	7,63,700.40	0.00
											Present value of each year		11,64,000.00	10,12,173.91	8,80,151.23	7,65,348.89	6,65,520.78	0.00
											Total Present Value (PV)							44,87,194.81
											Net Present Value (PV minus the investment)							20,30,777.81
											Social Return (Value per amount invested)							**1.83**

Sports SROI

Stage 1		Stage 2						Stage 4										
Source		At what cost?	How much?		How long?		How valuable?	How much caused by the activity?				Still material?						
Stakeholders		Inputs	Quantity (scale)	Amount of change per stakeholder (depth)	Duration of outcomes	Outcomes start	Value in currency	Deadweight %	Displacement %	Attribution %	Drop off %	Impact calculation	Calculating Social Return					
													Discount rate		3.5%			
Project Name	Beneficiaries	Financial value (for the total population for the accounting period)	Number of people experiencing described outcome.	Financial Proxy	How long (in years) does the outcome last for?	Does the outcome start in Period of activity or in the Period after?	How important is the outcome to stakeholders (expressed in monetary terms)?	What will happen/what would have happened without the activity?	What activity would/did you displace?	Who else contributed to the change?	Does the outcome drop off in future years?	Number of people (quantity) times value, less deadweight, displacement and	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Block level kabaddi Tournament	students	106000	535	average cost incurred for travel expenses	1	period of activity	300.00	10%	0%	0%	10%	1,44,450.00	1,44,450.00	0.00	0.00	0.00	0.00	0.00
District level Athletic Meet	students	300000	600	average cost incurred for travel expenses	1	period of activity	200.00	20%	0%	0%	10%	96,000.00	96,000.00	0.00	0.00	0.00	0.00	0.00
	NTPC		1	1% cost of branding	1	period of activity	3,00,000.00	20%	0%	20%	20%	1,92,000.00	1,92,000.00	0.00	0.00	0.00	0.00	0.00
								0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
								0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		4,06,000.00									Total	4,32,450.00	4,32,450.00	0.00	0.00	0.00	0.00	0.00
											Present value of each year		4,32,450.00	0.00	0.00	0.00	0.00	0.00
											Total Present Value (PV)							4,32,450.00
											Net Present Value (PV minus the investment)							26,450.00
											Social Return (Value per amount invested)							1.07

Water SROI

Stage 1		Stage 2						Stage 4										
Source		At what cost?	How much?		How long?			How much caused by the activity?				Still material?						
Stakeholders		Inputs	Quantity (scale)	Amount of change per stakeholder (depth)	Duration of outcomes	Outcomes start	Value in currency	Deadweight %	Displacement %	Attribution %	Drop off %	Impact calculation	Calculating Social Return					
													Discount rate		3.5%			
Project Name	Beneficiaries	Financial value (for the total population for the accounting period)	Number of people experiencing described outcome.	Financial Proxy	How long (in years) does the outcome last for?	Does the outcome start in Period of activity or in the Period after?	How important is the outcome to stakeholders (expressed in monetary terms)?	What will happen/what would have happened without the activity?	What activity would/did you displace?	Who else contributed to the change?	Does the outcome drop off in future years?	Number of people (quantity) times value, less deadweight, displacement and attribution	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Renovation and upgradation of pipeline, water supply through tanker, construction of water tank etc.	community	4202000	4212	average cost saved for water pipleine upgradation and access to safe drinking water	5	period of activity	4,000.00	30%	0%	10%	10%	1,06,14,240.00	1,06,14,240.00	95,52,816.00	85,97,534.40	77,37,780.96	69,64,002.86	0.00
	NTPC		1	0.1% cost of branding	5	period of activity	3,00,000.00	20%	0%	20%	20%	1,92,000.00	1,92,000.00	1,53,600.00	1,22,880.00	98,304.00	78,643.20	0.00
					1			0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					1			0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		42,02,000.00									Total	1,08,06,240.00	1,08,06,240.00	97,06,416.00	87,20,414.40	78,36,084.96	70,42,646.06	0.00
											Present value of each year		1,08,06,240.00	93,78,179.71	81,40,600.15	70,67,699.67	61,37,259.17	0.00
											Total Present Value (PV)							4,15,29,978.71
											Net Present Value (PV minus the investment)							3,73,27,978.71
											Social Return (Value per amount invested)							9.88

Overall SROI

Stage 1		Stage 2						Stage 4										
Sources		At what cost?	How much?		How long?		How valuable?	How much caused by the activity?				Still material?						
Stakeholders		Inputs	Quantity (scale)	Amount of change per stakeholder (depth)	Duration of outcomes	Outcomes start	Value in currency	Deadweight %	Displacement %	Attribution %	Drop off %	Impact calculation	Calculating Social Return					
													Discount rate		3.5%			
Project Name	Beneficiaries	Financial value (for the total population for the accounting period)	Number of people experiencing described outcome.	Financial proxy	How long (in years) does the outcome last for?	Does the outcome start in Period of activity or in the Period after?	How important is the outcome to stakeholders (expressed in monetary terms)?	What will happen/what would have happened without the activity?	What activity would/did you displace?	Who else contributed to the change?	Does the outcome drop off in future years?	Number of people (quantity) times value, less deadweight, displacement and attribution	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Community centre buildings	community	9213600	4212	average cost of renting a public place banquet hall	5	period of activity	1,000.00	20%	0%	20%	10%	26,95,680.00	26,95,680.00	24,26,112.00	21,83,500.80	19,65,150.72	17,68,635.65	0.00
construction of roads, drains,culverts, Gangour ghats, boundary walls, bus stand etc	community	24330000	15792	average cost of vehicle maintaience, fuel saving, time saved, travel amount saved etc	5	period of activity	1,000.00	20%	0%	20%	10%	1,01,06,880.00	1,01,06,880.00	90,96,192.00	81,86,572.80	73,67,915.52	66,31,123.97	0.00
construction of school buildings,additional classrooms, school boundary walls, playgrounds etc.	students and parents	10703000	2153	average annual tution cost, average cost of quality education	5	period after	5,000.00	10%	0%	10%	10%	87,19,650.00	0.00	87,19,650.00	78,47,685.00	70,62,916.50	63,56,624.85	57,20,962.37
Girl Empowement Mission 2022	students and parents	1250000	42	average cost of of attending the one month summer school	2	period of activity	2,000.00	10%	0%	10%	10%	68,040.00	68,040.00	61,236.00	0.00	0.00	0.00	0.00
Distribution of School kit, benches and uniform to PAV's	students and parents	1216000	635	average cost of benches, uniform, kits and cost of quality education	2	period of activity	1,000.00	10%	0%	10%	20%	5,14,350.00	5,14,350.00	4,11,480.00	0.00	0.00	0.00	0.00
Mobile Health Clinic	community	7285000	1400	average cost saved for medical consultation, medicine, travel expenses and time	5	period of activity	500.00	10%	0%	0%	10%	6,30,000.00	6,30,000.00	5,67,000.00	5,10,300.00	4,59,270.00	4,13,343.00	0.00
Maternal and Child care	women and child	2231000	320	annual average cost for maternal and child care, savings in terms of travel, medicines and consultation	2	period of activity	5,000.00	10%	0%	10%	0%	12,96,000.00	12,96,000.00	12,96,000.00	0.00	0.00	0.00	0.00
Health Infrastructure developed at district hospital khargone	community	27011000	4212	average cost of medical consultation and medicine at district hospital	5	period of activity	5,000.00	20%	0%	20%	20%	1,34,78,400.00	1,34,78,400.00	1,07,82,720.00	86,26,176.00	69,00,940.80	55,20,752.64	0.00
Block level kabaddi Tournament	students	106000	535	average cost incurred for travel expenses	1	period of activity	300.00	10%	0%	0%	10%	1,44,450.00	1,44,450.00	0.00	0.00	0.00	0.00	0.00
District level Athletic Meet	students	300000	600	average cost incurred for travel expenses	1	period of activity	200.00	20%	0%	0%	10%	96,000.00	96,000.00	0.00	0.00	0.00	0.00	0.00
Dressmaking, computer,horticulture, beautician, driving, electrical, rakhi making etc.	community	2456417	600	average cost of attending classes, improved average yearly income, cost of certificate provided, salary of the trainers	5	period of activity	2,000.00	10%	0%	10%	10%	9,72,000.00	9,72,000.00	8,74,800.00	7,87,320.00	7,08,588.00	6,37,729.20	0.00
Renovation and upgradation of pipeline, water supply through tanker, construction of water tank etc.	community	4202000	4212	average cost saved for water pipleine upgradation and access to safe drinking water	5	period of activity	4,000.00	30%	0%	10%	10%	1,06,14,240.00	1,06,14,240.00	95,52,816.00	85,97,534.40	77,37,780.96	69,64,002.86	0.00
Repairing of Toilets	community	2400000	872	average cost of repairing toilets and money saved in terms of medical expenditures	5	period of activity	2,000.00	40%	0%	20%	10%	8,37,120.00	8,37,120.00	7,53,408.00	6,78,067.20	6,10,260.48	5,49,234.43	0.00
	NTPC		7	average cost of branding gained	5	period of activity	3,00,000.00	20%	0%	20%	20%	13,44,000.00	13,44,000.00	10,75,200.00	8,60,160.00	6,88,128.00	5,50,502.40	0.00
								0%	0%	0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		9,27,04,017.00									**Total**	5,15,16,810.00	4,27,97,160.00	4,56,16,614.00	3,82,77,316.20	3,35,00,950.98	2,93,91,949.00	57,20,962.37
											Present value of each year		4,27,97,160.00	4,40,74,023.19	3,57,32,284.25	3,02,15,938.37	2,56,13,385.51	48,16,896.80
											Total Present Value (PV)							18,32,49,688.13
											Net Present Value (PV minus the investment)							9,05,45,671.13
											Social Return (Value per amount invested)							**1.98**

Indian Institute of Corporate Affairs

Partners in Knowledge. Governance. Transformation.

Sec. 5, IMT Manesar, Distt. Gurgaon (Haryana), Pin Code - 122052
Ph:- 0124-2640000, Email:- contactus@iica.in

Annexure-8

एनटीपीसी
NTPC

एनटीपीसी लिमिटेड
(भारत सरकार का उद्यम)
NTPC Limited
(A Govt. of India Enterprise)

Ref: KGN/EMG/MOEF/Ann. Return/ACR 2024-25

Date: 29.04.2025

To
Additional Principal Chief Conservator of Forests (C),
Ministry of Environment, Forest, and Climate Change,
Regional Office (WZ), Kendriya Paryavaran Bhawan,
E-5 Arera Colony, Link Road-3, Ravishankar Nagar,
Bhopal-462016, Madhya Pradesh
Email id- rowz.bpl-mef@nic.in
moefcc-coalash@gov.in

Sub: Submission of Annual Compliance Report for Ash Utilization for FY 2024-25

Ref: MOEF&CC, Notification S.O.-5481(E), dated 31.12.2021: Annual Compliance Report

Dear Sir,

With respect to the above-mentioned subject & reference, NTPC-Khargone Super Thermal Power Station is submitting herewith, **Annual Compliance Report** (ACR) of Ash Utilization in prescribed performa as **Annexure-1,** vide email for the period **01.04.2024 to 31.03.2025**.

Submitted for your kind information and perusal please.

Thanking you,

Yours Sincerely,

(Ashish Kumar Agarwal)
AGM (TS)

Enclosure:
1. Annexure-1: ACR of AU for FY 2024-25

Copy to (Email) :-
1. Member Secretory, CPCB, Delhi (mscb.cpcb@nic.in) (power.cpcb@gov.in)
2. Member Secretory, MPPCB, Bhopal (ms-mppcb@mp.gov.in)
3. Regional Officer, MPPCB, Indore (ropcb-indore@mp.gov.in)

Ash Compliance Report

(for the period 1st April'2024 to 31st March'2025)

(to be submitted on or before 31st May)

Ref.-MoEFCC Notification S.O. 5481(E), Dated-31.12.2021

S. No.	Details	Status
1	Name of Power Plant	Khargone Super Thermal Power Project
2	Name of the company	NTPC Ltd.
3	District	Khargone
4	State	Madhya Pradesh
5	Postal address for communication:	Village-Selda, PO-SPO NTPC-Selda,
6	E-mail:	emgkhargone@ntpc.co.in aukhargone@ntpc.co.in
7	Power Plant installed capacity (MW):	1320
8	Plant Load Factor (PLF %):	64.18
9	No. of units generated (MWh):	742119
10	Total area under power plant (ha): (including area under ash ponds)	554.42
11	Quantity of coal consumption during reporting period MTPA (Metric Tons Per Annum):	5200034
12	Average ash content in percentage (percent):	43.54
13	Quantity of current ash generation during reporting period MTPA (Metric Tons Per Annum):	2264186
	Fly ash MTPA (Metric Tons Per Annum):	1649771
	Bottom ash MTPA (Metric Tons Per Annum):	614415
14	Capacity of dry fly ash storage silo(s) (Metric Tons) :	HCSD SILOS: 1500 (500 x 3) FLY ASH SILOS: 4000 (1000 x 4) Total Capacity: 5500
15	Details of utilisation of current ash generated during reporting period-	
a	Total quantity of current ash utilised (MTPA) during reporting period:	2593261
b	Quantity of fly ash utilised (MTPA):	
i	*Fly ash based products (bricks or blocks or tiles or fibre cement sheets or pipes or boards or panels)*	157900
ii	*Cement manufacturing:*	1124626
iii	*Ready mix concrete:*	Nil
iv	*Ash and Geo-polymer based construction material:*	Nil
v	*Manufacturing of sintered or cold bonded ash aggregate:*	Nil
vi	*Construction of roads, road and fly over embankment:*	0
vii	*Construction of dams:*	Nil
viii	*Filling up of low lying area:*	Nil
ix	*Filling of mine voids:*	Nil
x	*Use in overburden dumps:*	Nil
xi	*Agriculture:*	Nil
xii	*Construction of shoreline protection structures in coastal districts;*	Nil
xiii	*Export of ash to other countries:*	Nil
xiv	*Others (please specify):*	Nil
c	Quantity of bottom ash utilised (MTPA):	Nil
i	*Fly ash based products (bricks or blocks or tiles or fibre cement sheets or pipes or boards or panels):*	Nil
ii	*Cement manufacturing:*	Nil
iii	*Ready mix concrete:*	Nil
iv	*Ash and Geo-polymer based construction material:*	Nil

Shail

v	*Manufacturing of sintered or cold bonded ash aggregate:*	Nil
vi	***Construction of roads, road and flyover embankment:***	1310736
vii	*Construction of dams:*	Nil
viii	*Filling up of low lying area:*	Nil
ix	*Filling of mine voids:*	Nil
x	*Use in overburden dumps:*	Nil
xi	*Agriculture:*	Nil
xii	*Construction of shoreline protection structures in coastal districts:*	Nil
xiii	*Export of ash to other countries:*	Nil
xiv	*Others (please specify):*	Nil
	Total quantity of current ash Unutilised (MTPA) during reporting period:	Nil
16	**Percentage utilisation of current ash generated during reporting period (per cent):**	114.53
17	**Details of disposal of ash in ash ponds**	
a	Total quantity of ash disposed in ash pond(s) (Metric Tons) as on 31st March (excluding reporting period):	835228
b	Quantity of ash disposed in ash pond(s) during reporting period (Metric Tons):	Nil
c	Total quantity of water consumption for slurry discharge into ash ponds during reporting period (m^3):	5297649
d	**Total number of ash ponds:**	1 Ash pond (with 03 Lagoons)
i	***Active:***	1
ii	*Exhausted (yet to be reclaimed):*	Nil
iii	*Reclaimed:*	Nil
e	**Total area under ash ponds (ha):**	132
18	**Individual ash pond details** ***Ash pond-1,2, etc (please provide below mentioned details separately, if number of ash ponds is more than one)***	
a	Status: Under construction or Active or Exhausted or Reclaimed	Active
b	Date of start of ash disposal in ash pond (DD/MM/YYYY or MMYYYY):	01/08/2019
c	Date of stoppage of ash disposal in ash pond after completing its capacity (DD/MM/YYYY or MM/YYYY): (Not applicable for active ash ponds)	NA
d	Area (hectares):	132
e	Dyke height (m):	Variable height 15-18 m
f	Volume (m^3):	5990000
g	**Quantity of ash disposed as on 31st March (Metric Tons):**	746184
h	**Available volume in percentage (percent) and quantity of ash can be further disposed (Metric Tons):**	87.75 % and 5243816 MT
i	Expected life of ash pond (number of years and months):	4.5 Years
j	Co-ordinates (Lat and Long): (please specify minimum 4 co-ordinates)	22°04'36.8"N 75°50'52.2"E 22°04'26.4"N 75°49'59.9"E 22°04'42.4"N 75°50'18.2"E 22°04'20.3"N 75°50'23.6"E
k	Type of lining carried in ash pond: HDPE lining or LDPE lining or clay lining or No lining	L1-HCSD: Fly ash lining L2-BA & L3-BA: Bentonite clay lining

Shaif.

l	Mode of disposal: Dry disposal or wet slurry (in case of wet slurry please specify whether HCSD or MCSD or LCSD)	**Wet and HSCD mode of disposal**
m	Ratio of ash: water in slurry mix	**HCSD-55:45 & BA-20:80**
n	Ash water recycling system (AWRS) installed and functioning: Yes or No	**Yes**
o	Quantity of wastewater from ash pond discharged into land or water body (m3):	**Nil**
p	Last date when the dyke stability study was conducted and name of the organisation who conducted the study:	**15.12.2021 by IIT-Hyderabad** **18.03.2024 by SGITS-Indore (Annual Certification)**
q	Last date when the audit was conducted and name of the organisation who conducted the audit:	**NA**
19	**Quantity of legacy ash utilised (MTPA):**	
i	*Fly ash based products (bricks or blocks or tiles or fibre cement sheets or pipes or boards or panels):*	**NA**
ii	*Cement manufacturing:*	**NA**
iii	*Ready mix concrete:*	**NA**
iv	*Ash and Geo-polymer based construction material:*	**NA**
v	*Manufacturing of sintered or cold bonded ash aggregate:*	**NA**
vi	*Construction of roads, road and flyover embankment:*	**NA**
vii	*Construction of dams:*	**NA**
viii	*Filling up of low lying area:*	**NA**
ix	*Filling of mine voids:*	**NA**
x	*Use in overburden dumps:*	**NA**
xi	*Agriculture:*	**NA**
xii	*Construction of shoreline protection structures in coastal districts;*	**NA**
xiii	*Export of ash to other countries:*	**NA**
xiv	*Others (please specify):*	**NA**

20	**Summary:**			
	Details	Quantity generated (MTPA)	Quantity utilised (MTPA) and (per cent)	Balance quantity (MTPA)
	Current ash during reporting period	**2264186**	**2593261 & 114.53%**	**0**
	Legacy ash	0	0	0
	Total	**2264186**	**2593261 & 114.53%**	**0**

21	**Any other information:** **Soft copy of the annual compliance report, and shape files of power plant and ash ponds may be e-mailed to:- moefcc- coalash@gov.in**	**Noted**
22	**Signature of Authorised Signatory**	ए.के. अग्रवाल अपर महाप्रबंधक (तकनीकी सेवाएं) एनटीपीसी लिमिटेड, खरगोन (म.प्र.)

एनटीपीसी NTPC

एनटीपीसी लिमिटेड (भारत सरकार का उद्यम)
NTPC Limited
(A Govt. of India Enterprise)

Ref: KGN/EMG/MPPCB/Ann. Returns

दिनांक-12/04/2025

प्रति,

श्रीमान सदस्य सचिव
मध्य प्रदेश प्रदूषण नियंत्रण बोर्ड
ई-5, अरेरा कॉलोनी, पर्यावरण परिसर,
भोपाल – 462016, मध्य प्रदेश
(Email- ms-mppcb@mp.gov.in)

विषय : वित्तीय वर्ष 2024-25 का पर्यावरणीय प्रतिवेदन (फार्म-V) प्रस्तुत करने हेतु।

महोदय,

एन. टी. पी. सी. लिमिटेड.- खरगोन सुपर थर्मल पावर प्रोजेक्ट द्वारा, वित्तीय वर्ष 2023-24 सम्बद्ध, वार्षिक पर्यावरणीय प्रतिवेदन, निर्धारित फार्म-V अनुसार आपके अनुमोदन हेतु प्रस्तुत है।

वार्षिक पर्यावरणीय प्रतिवेदन म प्र प्र नि बोर्ड के एक्स जी एन पोर्टल पर भी अपलोड कर दिया गया हैं।

सधन्यवाद,

(आशीष कुमार अग्रवाल)
अपर महाप्रबंधक (राख़ एवं पर्यावरण प्रबंधन)

संलग्न:
1. पर्यावरणीय प्रतिवेदन (फार्म-V), वित्तीय वर्ष 2024-25

प्रतिलिपि:
1. क्षेत्रीय अधिकारी, म. प्र. प्र. नि. बो., इंदौर, मध्य प्रदेश (Email-ropcb-indore@mp.gov.in)
2. सदस्य सचिव, के. प्र. नि. बो., दिल्ली (Email-mscb.cpcb@nic.in)
3. क्षेत्रीय कार्यालय, पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय, भोपाल, मध्य प्रदेश (Email-rowz.bpl-mef@nic.in)

Annual Environment Statement

FORM – V

(See rule 14)

Environmental Statement for the Financial year ending the 31st March 2025

PART – A

1	Name & address of the Owner/ Occupier of the Industry, operation or process.	Shri. Subhasis Bose (Executive Director) NTPC Ltd. Khargone Super Thermal Power Project Vill.-Selda, Teh.-Barwah, Dist.-Khargone, Madhya Pradesh, PIN-451114	
2	Industry category Primary (STC Code), Secondary (STC Code)	-	
3	Production Capacity- Units	1320 MW (2 x 660 MW)	
4	Year of establishment		Date of Commissioning
		Unit-I	29/9/2019
		Unit-II	24/3/2020
5	Date of last environmental statement	07-05-2024	

PART – B

Water & Raw material Consumption

1 Water Consumption m3/day process

	During the previous financial year 2023-24	During the current financial year 2024-25
Cat-I: Industrial Cooling	43532	48250
Cat-I: Boiler feed	850	620
Cat-I: Process-Ash Water	2080	2146
Cat.II: Domestic	1080	938
Cat-III: Process-water polluted,pollutants easily biodegradable	168	162

Water consumption per unit of products (m3/mwhr)

Name of Products	During the previous financial year 2023-24	During the current financial year 2024-25
Electricity	2.27	2.56

2 Raw Material Consumption

Name of Raw Materials	Name of Products	Consumption of Raw Material Per unit of output: During the previous financial year 2023-24	During the current financial year 2024-25
Coal (kg/kwh)	Electricity	0.61	0.70
Oil (ml/kwh)		0.28	0.34

PART – C

Pollution Generated

(Parameters as specified in the consent issued)

1	Pollutants	Quantity of pollutant discharged *	Concentration of Pollutants in discharges	Percentage of variation from prescribed standard with reasons
a	**Water** (Ann. Avg. of ETP treated effluents) (Kg/day)			
	pH (Limit: 5.5-9.0)	Not Quantifiable	7.34	Nil
	TSS (Limit: 100 mg/l max.)	Nil	9.9 mg/l	Nil
	BOD (Limit: 30 mg/l max.)	Nil	9.2 mg/l	Nil
	COD (Limit: 250 mg/l max.)	Nil	58 mg/l	Nil
	Oil&Grease (Limit: 10 mg/l max.)	Nil	4 mg/l	Nil
	TDS (Limit: 2100 mg/l max.)	Nil	890 mg/l	Nil
	Chlorides (Limit: 1000 mg/l max.)	Nil	174.6 mg/l	Nil
	*No water discharged outside plant premises. Treated water reused in ash handling, dust supression, processes etc.			
b.	**Air** (Ann. Avg. of stack emissions) (MT/Yr.)			
	PM (Limit: 30 mg/nm3 max.)	334.5	15.27 mg/nm3	Nil
	SO2 (Limit: 100 mg/nm3 max.)	15268.5	696.98 mg/nm3	Nil
	NOx (Limit: 100 mg/nm3 max.)	7597.0	346.79 mg/nm3	Nil
	Hg (Limit: 0.03 mg/nm3 max.)	0.219	0.01 mg/nm3	Nil

PART – D

[as specified under Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016]

1	Hazardous Wastes	Category	Total Quantity (In MT)	
			During the previous financial year 2023-24	During the current financial year 2024-25
a.	From Process			
	Used or Spent Oil	Sch.-I, Cat.-5.1	Nil	54.37 MT
	Wastes or residues containing oil	Sch.-I, Cat.-5.2	Nil	Nil
	Spent ion exchange resin containing toxic metals	Sch.-I, Cat.-35.2	Nil	1.98 MT
	Chemical Sludge from Water Treatemt	Sch.-I, Cat.-35.3	Nil	Nil
	Empty barrels/containers/liners contaminated with hazardous chemicals /wastes	Sch.-I, Cat.-33.1	12.14 MT	0.12 MT
	Toxic- Insulation Glass Wool Waste	Sch.-II, Cat.-C4	Nil	20.76 MT
b.	From Pollution Control Facilities		Nil	Nil

PART – E

Solid Wastes

1	Solid Wastes		Total Quantity (In MT)	
			During the previous financial year 2023-24	During the current financial year 2024-25
a.	From Process	Ash Generation	1765426	2264186
b	From pollution control facility		Nil	Nil
c	Quantity recycled or re-utilized	Ash Utilisation		
	Fly ash issue to Cement Plants		1075055	1133181
	Fly ash issue to Brick plants & Ash based product manufacterurs		39021	149028
	Fly ash issue to Others-Traders		0	0
	Pond ash to Road Projects		991140	1310736
	Pond ash in Ash dyke stabilisation		0	0
	Pond ash to Cement Plants		0	0
	Pond ash to Brick plants & Others		0	0
		Total	2105216	2592945

PART – F

Please specify the characteristics (in terms of concentration and quantum) of Hazardous as well as solid wastes and indicate disposal practice adopted for both these categories of wastes.

1	Hazardous Wastes	Composition	Quantum (Sanctioned) MT	Mode of disposal practice
	Used or Spent Oil (Sch.-I, Cat.-5.1)	-	70	Authorised Recycler with SPCB
	Wastes or residues containing oil (Sch.-I, Cat.-5.2)	-	10	Authorised Recycler with SPCB
	Chemical Sludge from Wastewater Treatment (Sch.-I, Cat.-35.3)	-	0.5	Through CTSDF
	Spent ion exchange resin containing toxic metals (Sch.-I, Cat.-35.2)	-	2	Authorised Recycler with SPCB/Through CTSDF
	Empty barrels/containers/ liners contaminated with hazardous chemicals /wastes (Sch.-I, Cat.-33.1)	-	20	Authorised Recycler with SPCB/Through CTSDF
	Toxic- Insulation Glass Wool Waste (Sch.-II, Class C4)	-	100	Through CTSDF

2	Solid Wastes	Composition (% by Mass)	Quantum of disposal (MT)	Mode of disposal
	Ash	(approx.)	2592945	Soild waste as ash generated being utilised by issuing to cement plants, bricks & ash based product manufacterurs etc. Balance quantities of un-utilised ash disposed at ash dyke through network of pipelines.
	Loss on Ignition	0.3		
	SiO2+Fe2O3+Al2O3	94.0		
	Magnesium oxide as MgO	0.5		
	Sulphur as SO3	0.5		
	Alkalies as Sodium Oxide Na2O	0.5		
	Chlorides	0.0		
	Others	4.2		

PART – G

Impact of pollution control measures on conservation of natural resources and consequently on the cost of production

Pollution control and environment management measures adopted has resulted in general improvement in the quality of environment in and around the industry. In turn the cost of production generally increases but improves the quality of environment in the way of betterment for people, flora and fauna, are incomparable.

	Pollution Control & Environmmet Management Measures	Cost Expenditure in 2024-25 (Rs. Lakhs)
1	Greenbelt development & Afforestation works	242.4
2	Environment monitoring works	4.9
3	Hydrogelogy review study	17.9
4	Environment awareness & Other Envt. Expenditures	3.9
5	Waste Management Expenditures	7.5
	Total	**276.6**

PART – H

Additional investment proposal for environmental protection including abatement of pollution

FGD: Flue Gas De-sulfurisation plants installed and available for both units for the control of SOx emissions from stacks at an expenditure of Rs.68286.9 Lakhs

PART – I

Miscellaneous

Any other particulates in respect of environment protection and abatement of pollution.

1 **Tree Plantation:**

1. Cummulative 5.07 Lakh trees planted under Greenbelt/Roadside/Carbon Sink plantation inside and around project.

2 **Ash Utilisation:**

1. Complied 100% Ash Utilisation in FY 2024-25 i.e. 114.5 %

(Ashish Kumar Agarwal)
AGM (Ash & Envt. Mgmt.)
Auth. Signatory

ए. के. अग्रवाल
अपर महाप्रबंधक (राख एवं पर्यावरण प्रबंधन)
एन टी पी सी लिमिटेड, खरगोन (म.प्र.)

ANNEXURE-10

Water withdrawal data at NTPC-Khargone STPS

Source- Narmada River
Period- Oct'24 to Mar'25' in FY: 2024-25

Water withdrawal data at NTPC Khargone STPP from Omkareshwar Dam on Narmada River				
Month	**Start date**	**Finish date**	**Days**	**Water Drawn, M3**
Oct-24	01-10-2024	31-10-2024	30	1906590
Nov-24	01-11-2024	30-11-2024	31	1724733
Dec-24	01-12-2024	31-12-2024	30	1847346
Jan-25	01-01-2025	31-01-2025	31	1831529
Feb-25	01-02-2025	28-02-2025	29	1401093
Mar-25	01-03-2025	31-03-2024	31	2064541
			Total Water Drawn, M3	**10775832**

Total Water Withdrawal from Oct'24 to Mar'25 = 10775832 m3