O/c

TSL/MoEF&CC/TS-26/2025-02/606
November 25, 2025

The Deputy Director General of Forests (C)
Ministry of Environment, Forest & Climate Change,
Integrated Regional Office,
A/3, Chandrasekharpur,
Bhubaneswar-751023

Subject: Submission of half yearly EC compliance reports of 256 MW Power Plant of M/s. Tata Steel Limited, Meramandali for the period from April' 2025 to September' 2025.

Reference: EC vide letter No. J-13012/77/2011-IA-II(I); dated: 12.02.2015.

Dear Sir,

With reference to the captioned subject and cited reference, we are herewith submitting six monthly compliance reports for the conditions stipulated in the Environmental Clearance of 256 MW power plant M/s. Tata Steel Limited, Meramandali for the period from April' 2025 to September' 2025 along with monitoring reports for your kind perusal.

The soft copies of the aforesaid compliance report are also being sent through mail to roez.bsr-mef@nic.in for your kind information and necessary record please. Also copy of 256 MW power plant EC compliance is being uploaded on MoEF&CC web site on portal http://parivesh.nic.in.

Hope, the above are in line with the statutory requirements.

Thanking you

Yours faithfully,

For Tata Steel Limited

Anoop Srivastava

Anoop Srivastava
Chief Environment - TSM

GOVT. OF INDIA
29 NOV 2025
RECEIVED

Copy to:
1. The Zonal Officer, Central Pollution Control Board, Southern Conclave Block, 502, 5th & 6th Floors, 1582 Rajdanga Main Road, Kolkata – 700107.
2. The Member Secretary, SPCB, Parivesh Bhawan, A/118, Nilakantha Nagar, Unit-VIII, Odisha, Bhubaneswar-751012
3. The Regional Officer, State Pollution Control Board, Angul, Odisha.

SL.	STIPULATED CONDITIONS	COMPLIANCE STATUS
i	Vision document specifying prospective plan for the site shall be formulated and submitted to the RO of the Ministry within six months.	Vision, Mission and Environment Policy statements have been submitted to the Regional Office, MoEF&CC, BBSR along with the compliance report.
ii	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.	Solar power panels are being commissioned in a phase wise manner. 100 KW solar panel has been installed and commissioned. Photo of harnessing solar power is attached as **Annexure-I**.
iii	Sulphur and ash contents in the imported coal to be used in the project shall not exceed 0.3% and 6% respectively at any given time. In case of variation of coal quality at any point of time, fresh reference shall be made to the Ministry for suitable amendments to environment clearance condition wherever necessary.	**Not applicable**. • As presently gas-based power plant of capacity 165 MW has been commissioned. This plant does not consume coal hence, no ash is being generated. • Amendments in environment clearance has been made on 13th Aug 2021 for change of fuel from dual firing (Coal + Mixed gas) to 100 % mixed gas firing.
iv	A long-term study of radioactivity and heavy metals contents in coal to be used shall be carried out through a reputed institute and results thereof analyzed every two years and reported along with monitoring reports. Thereafter mechanism for an in-built continuous monitoring for radioactivity and heavy metals in coal and fly ash (including bottom ash) shall be put in place.	**Not applicable.** • As presently gas-based power plant of capacity 165 MW has been commissioned. This plant does not consume coal hence, no ash is being generated. • Hence, no need no monitor Radioactivity and heavy metals contents in coal and ash.
v	A stack of 220-meter height shall be provided with continuous online monitoring equipment for SO_x, NO_x, PM_{10} and $PM_{2.5.}$ Exit velocity of flue gases shall not be less than 22 m / sec. Mercury emissions from stack shall also be monitored on periodic basis.	• Continuous online monitoring systems have been installed at both the chimneys of required height 70 m and 40 m attached to 60 TPH & 125 TPH and 250 TPH gas fired boilers. • The Ministry's Notification vide S.O.3305 (E) dated 07.12.2015 is applicable for coal based thermal power plant, whereas the by-product gas-based power plant has been installed instead of coal fired boiler in the above EC project granted on 12.02.2015. • A continuous online monitoring system has been installed to measure PM, SO2 & NOx at both the stacks and real time data have

		been integrated with OSPCB RT-DAS server. • Manual monitoring is being carried out on a periodic basis. A sample monitoring report for monitoring Exit velocity data is attached as **Annexure-II**.
vi	High efficiency 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 spraying system in dusty areas such as in coal handling and ash handling points, transfer areas and other vulnerable dusty areas shall be provided.	**Not applicable.** • Presently gas-based power plant of capacity 165 MW has been commissioned. This plant does not consume coal and particulate matter emission is very less. Hence, no requirement of ESPs.
vii	Adequate dust extraction system such as cyclones / bag filters and water spraying system in dusty areas such as in coal handling and ash handling points, transfer areas and other vulnerable dusty areas shall be provided.	**Not applicable.** • EC was granted to install coal base thermal power plant; however, gas base power plant has installed. • Presently only gas fired boilers (60TPH, 125TPH & 250TPH capacities) have been commissioned. Hence, coal and ash handling and dust extraction system such as cyclones / bag filters and water spraying system not required.
viii	COC of at least 5.0 shall be adopted	• COC more than 5 is being maintained.
ix	Monitoring of surface water quantity and quality shall also be regularly conducted and records maintained. The monitoring data shall be submitted to the Ministry regularly. Further, monitoring points shall be located between the plant and drainage in the direction of the flow of ground water and records maintained. Monitoring for heavy metals in ground water shall also be undertaken and results/findings submitted along with half yearly monitoring report.	• Surface water and ground water quality monitoring data is being submitted as a part of geo-hydrology report compliance carried out by CSIR-IMMT, vide our letter No. TSL/MoEF&CC/BS-01/2025-03/560 dated.29/05/2025. • The six-monthly summarized data from Apr' 2025 to Sep'2025 has been enclosed as **Annexure - III**. • Water withdrawal agreement with Government of Odisha for withdrawal of 46 Cusec or 112542.47 m3/day is available. The annual average water potential in the Brahmani and Baitarani basin is 28.48 billion cubic meters (BCM) as per the report issues by Government of India, Ministry of Water Resources. Part of the same report is attached as **Annexure - III A**.
x	A well-designed rainwater harvesting system shall be put in place within six	Approximately 6.5 Lakhs m3 of rainwater is being harvested in different rainwater

	months, which shall comprise of rain water collection from the built up and open area in the plant premises and detailed records kept of the quantity of water harvested every year and its use.	harvesting structures inside the plant premises. Harvested rainwater is being reused in the manufacturing process and other applications. Photographic evidence of existing rainwater harvesting structure is attached as **Annexure-IV**.
xi	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.	• The natural drain/nallah present on the northern side of the project site is not being disturbed. • No effluent is being routed towards this nallah. • A separate concrete road and vehicle parking area outside plant boundary has been constructed on the land belongs to project, which is being used by public. • A hospital has been constructed near the main gate, which is available for local public. • A biodiversity park and garden has been developed outside project boundary for public use. The development of the park not only embodies this vision but also emphasizes the importance of ecological balance, contributing to the overall environmental well-being and sustainable growth of the locality.
xii	Hydrogeology of the area shall be reviewed annually from an institute / organization of repute to assess impact of surface water and ground regime (especially around ash dyke). In case any deterioration is observed, specific mitigation measures shall be undertaken and report / data of water quality monitored regularly and maintained shall be submitted to the Regional Office of the Ministry.	Quarterly ground water & surface water quality has been obtained from CSIR-IMMT and submitted as a part of six-monthly EC compliance report vide letter No. TSL/MoEF&CC/TS-26/2025-01/561 dated. 29.05.2025. The annual review report is attached as **Annexure-V**.
xiii	Waste water generated from the plant shall be treated before discharge to comply limits prescribed by the SPCB / CPCB.	• Wastewater generated from the plant is being treated in Effluent Treatment Plant. • Treated water is reused in slag granulation, greenery development and low-end application in Blast Furnace & Sinter Plant etc. • The water quality parameters are well within the limit as per the prescribed standard.

		• Water analysis report for the period from Apr' 2025 to Sep' 2025 is enclosed as **Annexure-III**.
xiv	Additional soil for leveling of the proposed site shall be generated within the site (to the extent possible) so that natural drainage system of the area is protected and improved.	No additional soil is required for leveling the site.
xv	Prior approval of the Ministry shall be obtained for Mine Void and abandoned stone quarry filling of fly ash based on the outcome of the pilot study for which permission was accorded to the existing units by the Ministry on 05.09.2013 subject to Hon'ble NGT's Order.	**Not applicable**. We request to withdraw this condition as this is not applicable. We have communicated vide letter No. TSBSL/MoEF&CC/BS-01/2020-01/57 dtd.27.08.2020.
xvi	Fly ash shall be collected in dry form and storage facility (silos) shall be provided. Unutilized fly ash shall be disposed off in the ash pond in the form of slurry. Mercury and other heavy metals (As, Cr, Pb etc) will be monitored in the bottom ash as also in the effluents emanating from the existing ash pond. No ash shall be disposed off in low lying areas.	**Not applicable**. Presently gas-based power plant of capacity 165 MW has been commissioned. This plant does not consume coal hence, no ash is being generated.
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 provided in consultation with the local panchayat.	**Not applicable**. Currently gas-based power plant of capacity 165 MW has been commissioned. This plant does not consume coal hence, no ash is being generated.
xviii	Ash pond shall be lined up with HDPE/LDPE lining or any other suitable material impermeable media such that no leachate takes place at any point of time. Adequate safety measures shall also be implemented to protect the ash dyke from getting breached.	**Not applicable**. Currently gas-based power plant of capacity 165 MW has been commissioned. This plant does not consume coal hence, no ash is being generated.
xix	Green belt consisting of three tire of plantation of native species around plant and at least 50 m width shall be raised. Wherever 50 m width is not feasible a 20 m width shall be raised and adequate justification shall be submitted to the	• Green belt development work is ensured through plantation along the plant, internal roads as well as all the vacant spaces inside the plant premises.

<table>
<tr><td></td><td>Ministry. Tree density shall not be less than 2500 trees per ha with survival rate not less than 80%. Only native species shall be planted and the green belt development shall be expedited.</td><td>• Additional Land acquisition contiguous to the existing plant is being done under expansion project to increase greenbelt.
• Glimpses of plantation along boundary wall is hereby attached as Annexure-VI.</td></tr>
<tr><td>xx</td><td>CSR schemes identified based on Public Hearing issues and need based assessment shall be implemented in consultation with the village panchayat and the District administration starting from the development of the project itself. As part of CSR, prior identification of local employable youth and eventual employment in the project after imparting relevant training shall be also undertaken. Company shall provide separate budget for community development activities and income generating program.</td><td>• Tata Steel's commitment to the National Apprentices Act, 1961, underscores its dedication to empowering local youth from surrounding villages through structured training aligned with regulatory norms.
• Training programmes are being conducted as a part of CSR initiatives under agriculture & sustainability initiatives and women empowerment. During the period from April' 2025 to Sep'2025, Rs. 335 Lakhs has been incurred to facilitate the education/ training/ skill development in the surrounding villages and communities.</td></tr>
<tr><td>xxi</td><td>As committed, a minimum amount of Rs. 40.00 crore shall be earmarked for CSR activities for next five years. For proper and 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 and final.</td><td>Tata Steel Limited has been incurred an expenditure Rs. 60.067 Crores during last three financial year {(i.e. from FY'23 to FY'26 (Till Sep'2025)} on CSR, which is beyond the stipulation of Rs.40 Crores. Detailed activities wise expenditure from FY'23 to FY'26 (As on Sep'25) is as below:
<table>
<tr><th>#</th><th>CSR Activity</th><th>Investment (Rs.Cr)</th></tr>
<tr><td>1</td><td>Health</td><td>6.013</td></tr>
<tr><td>2</td><td>Agriculture/livelihood</td><td>4.492</td></tr>
<tr><td>3</td><td>Environment</td><td>0.03</td></tr>
<tr><td>4</td><td>Empowerment</td><td>2.01</td></tr>
<tr><td>5</td><td>Drinking water supply</td><td>2.828</td></tr>
<tr><td>6</td><td>Ethnicity</td><td>0.24</td></tr>
<tr><td>7</td><td>Rural infrastructure development</td><td>16.75</td></tr>
<tr><td>8</td><td>Education</td><td>23.53</td></tr>
<tr><td>9</td><td>Sports</td><td>1.261</td></tr>
<tr><td>10</td><td>Skill development & miscellaneous</td><td>2.61</td></tr>
<tr><td>11</td><td>Gender & Community Enterprise</td><td>0.303</td></tr>
<tr><td colspan="2">Total</td><td>60.067</td></tr>
</table></td></tr>
</table>

xxii	For proper and 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 and final.	• As per the revised companies Act, 2013 and its amendment, CSR committee has been formed. Evaluation of each specific CSR intervention/activities is monitored & evaluated by the CSR Committee. • Evaluation of the Impact of Corporate Social Responsibility Projects has been carried out by XIMB, Bhubaneswar.
xxiii	An Environmental Cell comprising of at least one expert in environment 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 appropriate superiority 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.	• Environment Management Department has been established for implementation of stipulated environmental safeguards and control of pollution. • The head of the Environment department and other officers are having Environmental Science/Engineering qualification and adequate experience.

A	**General Conditions:**	
i	Space for FGD shall be provided for future installation as may be required.	**Not applicable**. Presently gas-based power plant of capacity 165 MW has been commissioned. This plant does not consume coal hence, generation of SO_2 is minimum. Hence, FGD is not required.
ii	The treated effluents conforming to the prescribed standards only shall be re-circulated and re-used within the plant. Arrangements shall be made that effluents and storm water do not get mixed.	Wastewater is treated in ETP. The treated effluent, conforming to the prescribed standards, are recycled and reused for slag granulation, dust suppression and green area development.
iii	A sewage treatment plant shall be provided (as applicable) and the treated sewage shall be used for raising greenbelt / plantation.	STP of 100 m^3 per day has been installed near Blast Furnace-I.
iv	Adequate safety measures shall be provided in the plant area to check/minimize spontaneous fire in coal yard especially during summer season. Copy of these measures with full details along with location on plant layout shall be submitted to the Ministry as well as to the Regional Office of the Ministry.	**Not applicable**. At present gas-based power plant of capacity 165 MW has been commissioned. This plant does not consume coal.
v	Storage facility for auxiliary liquid fuel such as LDO/HFO/LSHS shall be made in the plant area in consultation with the Department of Explosives, Nagpur. Sulphur content in the liquid fuel will not exceed 0.5%. Disaster Management Plan shall be prepared to meet any eventuality in case of an accident taking place due to storage of oil.	**Not applicable**. LDO/HFO/LSHS is not used for startup activities. Startup activities are being carried out by LPG or COG.
vi	First aid and sanitation arrangements shall be made for the drivers and other contract workers during construction phase.	Adequate First aid and sanitation arrangements were made during construction phase of the plant and similar facilities are being maintained during operational phase also for the workers and employees.
vii	Noise level emanating from turbines shall be so controlled such that the noise in the work zone shall be limited to 85 dB(A) from the source. For people working in the high noised areas, requisite PPEs like ear plugs/ear muffs etc. shall be provided. Workers engaged in noisy areas such as turbine area, air compressors etc. shall be periodically	• Various control methods have been adopted such as engineering control (Acoustic enclosures, sound barriers, silencers, vibration damper, aquatic liner etc.), management control (work rotation, noise mapping, equipment maintenance, quiet zones) and providing of adequate Personal

<table>
<tr><td></td><td>examined to maintain audiometric records and for treatment for any hearing loss including shifting to non-noisy/less noisy areas.</td><td>Protective Equipment at all sources of noise generation.
• Based on noise mapping, manned & unmanned area has been divided to minimize the noise impact.
• Audiometric test is a part of periodic medical examination of employees, which is being carried out once a year to comply with Factory Act.
• Year wise summary of audiometric test conducted is given below.
<table>
<tr><th>Year</th><th>No. of Audiometric test conducted</th></tr>
<tr><td>2022-23</td><td>43,964</td></tr>
<tr><td>2023-24</td><td>50,133</td></tr>
<tr><td>2024-25</td><td>48,016</td></tr>
<tr><td>2025-26 (Till Sep'2025)</td><td>25,849</td></tr>
</table></td></tr>
<tr><td>viii</td><td>Regular monitoring of ambient air ground level concentration of SO_2, NO_x, $PM_{2.5}$, PM_{10} and Hg shall be carried out in the impact zone and records maintained. If at any stage levels are found to exceed the prescribe limits, necessary control measures shall be provided immediately. The locations of the monitoring stations and frequency of monitoring shall be decided in consultation with SPCB. Periodic reports shall be submitted to the regional office of the Ministry. The data shall also be put on the website of the Company.</td><td>Ambient air quality is being monitored as per NAAQ Standard' 2009 and monitoring data has already been submitted.

Ambient air quality with respect to PM_{10} and $PM_{2.5}$ are dependent on several external factors like climatological conditions & anthropogenic activities. The following steps are being carried out in and around the plant premises to keep ambient air quality within the norms.
• Water sprinkling on NH and service road on regular interval.
• Wheel washing system has been installed at several identified locations to reduce the dust load on the roads due to vehicular movements.
• A metallic wind screen barrier been installed at Raw Material yard near the plant boundary to control fugitive dust emission.
• Fixed and Portable types of water sprinklers have been installed and being operated at material storage yard & along the roads inside the plant.
• Installed DE (Dust Extraction) & DFDS (Dry Fog Dust Suppression) including IVC (Industrial Vacuum Cleaning) at all Boilers</td></tr>
</table>

<table>
<tr><td></td><td></td><td>and Bag filter at ash silo. All internal roads have been concreted and paved, and periodic cleaning is being carried out by mechanical road sweepers.
• All internal roads have been concreted and paved, and periodic cleaning is being carried out by mechanical road sweepers.

This is to submit that ambient air quality is being monitored and reported for all the 12 nos. of parameters as per NAAQS, 2009 in which mercury (Hg) is not included, however stack emissions for mercury (Hg) is being monitored and reported which is always found to be within the prescribed standard. The Mercury emission monitoring report is given below:
<table><tr><th colspan="5">BFPP - Mercury (Hg) Emission (µg/Nm3)</th></tr><tr><td></td><td>Standard</td><td>Min.</td><td>Max.</td><td>Average</td></tr><tr><td>FY25</td><td rowspan="2">30</td><td>1.0</td><td>7.9</td><td>2.06</td></tr><tr><td>FY26 (Till Sep'25)</td><td>1.01</td><td>7.47</td><td>1.89</td></tr></table>
Five ambient air quality monitoring stations have been set up in nearby villages for measuring ground level concentrations of PM10, SO2 and NOx in consultation with SPCB. Odisha. EC compliance along with all report is being uploaded on the company's website at http://www.tatasteel.com.</td></tr>
<tr><td>Ix</td><td>Utilization of 100 % fly ash generated shall be made from 4th year of operation. Status of implementation shall be reported to the Regional Office of the Ministry from time to time.</td><td>Not applicable.
presently gas-based power plant of capacity 165 MW has been commissioned. This plant does not consume coal hence, no ash is being generated.</td></tr>
<tr><td>x</td><td>Provision shall be made for the housing of contractor workers (as applicable) within the site with all necessary infrastructure facilities such as fuel for cooking, mobile toilets, mobile STP, safe drinking water, medical health care, crèche etc.</td><td>Adequate arrangements of housing for construction workers were made during construction phase of the plant.</td></tr>
<tr><td>xi</td><td>The project proponent shall advertise in at least two local news papers widely circulated in the region around the project, one of which shall be in the vernacular language of the locality</td><td>• Advertisements were circulated in The Telegraph (English daily) dated 15.02.2015 and the Samaya (Oriya daily) dated 15.02.2015.</td></tr>
</table>

	concerned within seven days from the date of this clearance letter, informing that the project has been accorded environment clearance and copies of the clearance letters are available with the SPCB/Committee and may also be seen at website of the Ministry of Environment and Forests at http://envfor.nic.in	• A copy of the same was submitted to MoEF&CC vide our letter no. BSL/MoEF&CC/BS-02/2015-09 dated 21.02.2015.
xii	A copy of the clearance letter shall be sent by the proponent to concerned Panchayat, Zila Parishad / Municipal Corporation, Urban Local Body and the local NGO, if any, from whom suggestions/representations, if any, were received while processing the proposal. The clearance letter shall also be put on the web site of the Company by the Proponent.	Copy of the environment clearance was submitted to the concerned panchayat, Zila Parishad, District Industry Centre etc.
xiii	The proponent shall upload the status of compliance of the stipulated environment clearance conditions, including results of measured data on their website and shall update the same periodically. It shall simultaneously be sent to the Regional Office of the MoEF, the respective zonal office of CPCB and the SPCB. The criteria pollutant levels namely SPM, RSPM (PM_{10} and $PM_{2.5}$) SO_2, NO_x (ambient as well as stack emission) shall be displayed at a convenient location near the main gate of the Company in the public domain.	• Status of compliance of the stipulated environment clearance conditions are being uploaded on website and are being sent to the Ministry, CPCB and SPCB. Results of online air quality monitoring are displayed electronically near the main gate. • The last half yearly compliance report was submitted vide letter no. TSL/MoEF&CC/TS-26/2024-02/507 dated 25.11.2024.
xiv	The environment statement for each financial year ending 31st March in Firm-V as is mandated to be submitted by the project proponent to the concerned SPCB as prescribed under the Environment (Protection) Rules 1986, as amended subsequently, shall also be put on the website of the Company along with the status of compliance of environment clearance conditions and shall also be sent to the respective Regional Office of the Ministry by e-mail.	• The environment statement in Form-V for each financial year ending 31st March is submitted to the Regional Office of the Ministry, CPCB and SPCB. • Last environment statement was submitted vide letter no. TSL/SPCB/TS-03/2025-19/593 dated 26.09.2025.
xv	The project proponent shall submit six monthly reports on the status of the	• Six monthly reports on status of the implementation of the stipulated

	implementation of the stipulated environmental safeguards to the Ministry of environment and Forests, its Regional Office, CPCB and SPCB. The project proponent shall upload the status of compliance of the environmental clearance conditions on their website and update the same periodically and simultaneously send the same by e-mail to the Regional office of MoEF.	environmental safeguards are being submitted. • Status of compliance with the environmental clearance conditions is being uploaded on the Company's website at http://www.tatasteel.com.
xvi	Regional office of the MoEF will monitor the implementation of the stipulated conditions. A complete set of documents including Environment 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. Project proponent will upload the compliance status in their website and update the same from time to time at least six monthly basis. Criteria pollutants levels including NOx (from stack and ambient air) shall be displayed at the main gate of the power plant.	• All the required documents have been already submitted to the Regional Office and will be made available during inspection. • Compliance status is uploaded on the website and updated in every six months.
xvii	Separate funds shall be allocated for implementation of environmental protection measures along with item-wise break-up. These 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 should be reported to the Ministry.	• Adequate funds are being provided by the management for pollution control and to meet recurring costs. Environmental requirements are given top priority for fund allocation and approval of capital projects. • The funds earmarked for environment pollution control measures are not diverted for any other purpose.
xviii	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 project authorities and the dates of land development work and commissioning of plant.	The financial closure and final approval of the project was done on 23rd June 2009. The land development was started subsequently after grant of Consent to Establish (CTE) issued on 1st May 2015.
xix	Full cooperation shall be extended to the Scientists/Officers from the Ministry /	Full cooperation is extended to the Scientists/Officers from the Ministry / Regional

<table>
<tr><td></td><td>Regional Office / CPCB / SPCB who would be monitoring the compliance on environmental status.</td><td>Office / CPCB / SPCB who would be monitoring the compliance on environmental status.</td></tr>
<tr><td colspan="3">Name change in EC from M/s. Tata Steel BSL Limited to M/s. Tata Steel Limited</td></tr>
<tr><td>SL</td><td>ADDITIONAL CONDITION</td><td>COMPLIANCE STATUS</td></tr>
<tr><td>I</td><td>M/s Tata Steel BSL Ltd. (new incumbent) shall submit an application for amendment in EC for switching from 50% coal & 50% mix gases from Steel plant to 100% mix gases from steel plant for stipulation of adequate conditions on pollution control measures by the Ministry.</td><td>Amendment EC has been obtained for switching from 50% coal & 50% mix gases from Steel plant to 100% mix gases.</td></tr>
<tr><td>II</td><td>The revised emission standards and specific water consumption as per the Ministry's Notification vide S.O.33.5 dated 17.12.2015 and subsequent amendments shall be complied with. The progress of implementation of new emission standards as per the extended timelines given by CPCB vide Order dated 16.04.2018 shall be submitted as part of compliance report.</td><td>• The Ministry's Notification vide S.O.33.5 dated 17.12.2015 is applicable for coal based thermal power plant, whereas we have installed by product gas-based power plant in the above EC project granted on 12.02.2015.
• A continuous online monitoring system has been installed to measure PM, SO2 & NOx at both the above referred stacks and real time data have been integrated with OSPCB/CPCB server.
• Specific water consumption trend of last three years for 165 MW power plant is given below for reference.
<table>
<tr><td>Year</td><td>Fresh Water consumption (in m^3/MWh)</td></tr>
<tr><td>2023-24</td><td>2.62</td></tr>
<tr><td>2024-25</td><td>2.59</td></tr>
<tr><td>2025-26 (Till Sep'25)</td><td>2.36</td></tr>
</table></td></tr>
<tr><td>III</td><td>Details of quantity of water consumption, power generation and Specific water consumption shall be submitted as part of compliance report.</td><td>Water consumption, power generation and specific water consumption for the period from Apr'25 to Sep'25 are given below.

Power Generation: 1059540 MWh
Specific water consumption: 2.36 m3/MWh</td></tr>
<tr><td>IV</td><td>The status of case (CC case No.16/2014) filed before Hon'ble Sub Divisional Judicial Magistrate, Dhenkanal against Shri Neeraj Singhal,</td><td>Case is pending for Supply of Prosecution Report.</td></tr>
</table>

	M/s Bhushan Steel Ltd. shall also be communicated to the Ministry.	
Amendment Environment clearance of 256 MW power plant Letter no.: J-13012/77/2011-I-A. II (T) dated 13.08.2021		
SL	**ADDITIONAL CONDITION**	**COMPLIANCE STATUS**
7	PP shall submit Compliance report to Ministry Regional office within 6 months.	Certificate of compliance has already been communicated vide letter No.TSL/MoEF &CC/BS-26/2022-02/202 dtd. 13.05.2022.

LIST OF ENCLOSURES

Sl. No.	Enclosures	Details
1.	Annexure - I	Photos of Installed Solar Pannels
2.	Annexure - II	Manual Stack Monitoring Report Indicating Exit Velocity of Stack
3.	Annexure - III	Surface & Ground Water Monitoring Report
4.	Annexure - IIIA	Brahmani River Water Flow Quantification
5.	Annexure - IV	Photos of Rainwater Harvesting Structures
6.	Annexure - V	Geo-Hydrology Review Report by CSIR-IMMT
7.	Annexure - VI	Glimpses of Plantation

Annexure-I

(Solar power panel installed at TSM)

Mitra S.K.Private Limited

Mumbai Laboratory, Building No. D-5, Unit-230,
Bhumi World Associate, Bhiwandi, Thane, Maharashtra, India.
Tel. : 0252 2672352.
Email: mumbailab@mitrask.com
Web : www.mitrask.com

TC-8673

TEST REPORT

ULR: TC-867325000001675F

Name & Address of the Customer:
Tata Steel Ltd.
NH-55, Narendrapur, Meramandli,
Dhenkanal, Odisha-759129, India

Report No.	:C/2025/1675
Date	:31.05.25
Sample No.	:MSK/MUM/2025/1641
Date of receipt of sample	:26.05.25
Date(s) of performance	:26.05.25-31.05.25
Ref. No. & Date	:3000173605/A06
Discipline	:Chemical

We hereby certify that the following sample drawn by us from the customer has been analyzed with the following results:

1	Group	: Atmospheric Pollution
2	Description of sample *(As declared by customer)*	: Stack Emission
3	Sample Mark *(if any, given by the customer)*	: Stack Emission
4	Date of sampling	: 22.05.25 at 08.40 am to 09.12 am
5	Place of sampling	: Gas Fired Boiler (60+125 TPH)
6	Environmental conditions during sampling	: Cold Chain Maintained
7	Sampling Drawn By	: Mr. Chinmaya Biswal
8	Sampling Plan & Procedures used	: IS 11255 (Part-1, Part-2, Part-3, Part-7)
9	Location of performance of laboratory activities	: Laboratory Permanent Facility
10	Additions to, Deviation from the method (if any)	: No

ANALYSIS RESULT

A: GENERAL INFORMATION ABOUT STACK:		
1	Stack connected to	Gas Fired Boiler (60+125 TPH)
2	Emission due to	Burning Of BFG & COG
3	Material of construction of Stack	MS
4	Shape of Stack	Circular
5	Whether Stack is provided with permanent platform	Yes
6	Capacity	NA
B: PHYSICAL CHARACTERISTICS OF STACK:		
1	Height of Stack from ground level	70 m
2	Diameter of Stack at sampling point	6.1 m
3	Height of the sampling point from ground level	22 m
4	Area of Stack	29.20 m2
C: ANALYSIS/CHARACTERSTIC OF STACK:		
1	Fuel used : NA	2. Fuel consumption: NA

Reviewed By:

Signature :
Name : Mr. Mohammed Aamir
Designation : Jr. Executive Chemist

Authorized Signatory
For Mitra S.K. Private Limited

Signature :
Name : Ms. E. Elizabath Princy
Designation : Technical Manager

Mitra S.K.Private Limited

Mumbai Laboratory, Building No. D-5, Unit-230,
Bhumi World Associate, Bhiwandi, Thane, Maharashtra, India.
Tel. : 0252 2672352.
Email: mumbailab@mitrask.com
Web : www.mitrask.com

Report No. : C/2025/1675
Sample No. : MSK/MUM/2025/1641

ANALYSIS RESULT

ULR: TC-867325000001675F

D: RESULTS OF SAMPLING & ANALYSIS OF GASEOUS EMISSION:		Unit	RESULT	METHOD
1	Temperature	°C	88	IS 11255 (Part-3)
2	Barometric pressure	mm of Hg	752	IS 11255 (Part-3)
3	Velocity	m/sec	8.18	IS 11255 (Part-3)
4	Sulphur Dioxide as SO2	mg/Nm3	46	IS 11255 (Part-2)
5	Nitrogen dioxide as NO2	mg/Nm3	119	IS 11255 (Part-7)
6	Particulate Matter	mg/Nm³	9.4	IS 11255 (Part-1)
7	Moisture	%v/v	3.0	IS 11255 (Part-3)
8	Flow rate of the flue gas	Nm³/hr	680996	IS 11255 (Part-3)
E:	**POLLUTION:** - Details of pollution control devices attached with the stack: NA			

___ End ___

Reviewed By:

Signature :
Name : Mr. Mohammed Aamir
Designation : Jr. Executive Chemist

Authorized Signatory
For **Mitra S.K. Private Limited**

Signature :
Name : Ms. E. Elizabath Princy
Designation : Technical Manager

- *The results relate only to the item(s) tested.*
- *This Test Report shall not be reproduced except in full, without the permission of Mitra S.K. Private Limited.*
- *The reserved part of sample(s) shall be retained for 10 days & 30 days (Air) from the date of issue of the Test Report.*

Mitra S.K.Private Limited

Mumbai Laboratory, Building No. D-5, Unit-230,
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Tel. : 0252 2672352.
Email: mumbailab@mitrask.com
Web : www.mitrask.com

TEST REPORT

ULR: TC-867325000001676F

Name & Address of the Customer:
Tata Steel Ltd.
NH-55, Narendrapur, Meramandli,
Dhenkanal, Odisha-759129, India

Report No.	:C/2025/1676
Date	:31.05.25
Sample No.	:MSK/MUM/2025/1642
Date of receipt of sample	:26.05.25
Date(s) of performance	:26.05.25-31.05.25
Ref. No. & Date	:3000173605/A06
Discipline	:Chemical

We hereby certify that the following sample drawn by us from the customer has been analyzed with the following results:

1	Group	: Atmospheric Pollution
2	Description of sample *(As declared by customer)*	: Stack Emission
3	Sample Mark *(if any, given by the customer)*	: Stack Emission
4	Date of sampling	: 22.05.25 at 10.40 am to 11.11 am
5	Place of sampling	: Gas Fired Boiler (250 TPH)
6	Environmental conditions during sampling	: Cold Chain Maintained
7	Sampling Drawn By	: Mr. Chinmaya Biswal
8	Sampling Plan & Procedures used	: IS 11255 (Part-1, Part-2, Part-3, Part-7)
9	Location of performance of laboratory activities	: Laboratory Permanent Facility
10	Additions to, Deviation from the method (if any)	: No

ANALYSIS RESULT

A: GENERAL INFORMATION ABOUT STACK:		
1	Stack connected to	Gas Fired Boiler (250 TPH)
2	Emission due to	Burning Of BFG & COG
3	Material of construction of Stack	MS
4	Shape of Stack	Circular
5	Whether Stack is provided with permanent platform	Yes
6	Capacity	250 TPH
B: PHYSICAL CHARACTERISTICS OF STACK:		
1	Height of Stack from ground level	40 m
2	Diameter of Stack at sampling point	3.8 m
3	Height of the sampling point from ground level	25 m
4	Area of Stack	11.33 m2
C: ANALYSIS/CHARACTERSTIC OF STACK:		
1	Fuel used : BFG & COG	2. Fuel consumption: NA

Reviewed By:

Signature :
Name : Mr. Mohammed Aamir
Designation : Jr. Executive Chemist

Authorized Signatory
For **Mitra S.K. Private Limited**

Signature :
Name : Ms. E. Elizabath Princy
Designation : Technical Manager

Mitra S.K.Private Limited

Mumbai Laboratory, Building No. D-5, Unit-230,
Bhumi World Associate, Bhiwandi, Thane, Maharashtra, India.
Tel. : 0252 2672352.
Email: mumbailab@mitrask.com
Web : www.mitrask.com

Report No. : C/2025/1676
Sample No. : MSK/MUM/2025/1642

ANALYSIS RESULT

ULR: TC-867325000001676F

D: RESULTS OF SAMPLING & ANALYSIS OF GASEOUS EMISSION:		Unit	RESULT	METHOD
1	Temperature	^0C	137	IS 11255 (Part-3)
2	Barometric pressure	mm of Hg	753	IS 11255 (Part-3)
3	Velocity	m/sec	10.28	IS 11255 (Part-3)
4	Sulphur Dioxide as SO2	mg/Nm3	28	IS 11255 (Part-2)
5	Nitrogen dioxide as NO2	mg/Nm3	69	IS 11255 (Part-7)
6	Particulate Matter	mg/Nm³	10.1	IS 11255 (Part-1)
7	Moisture	%v/v	4.0	IS 11255 (Part-3)
8	Flow rate of the flue gas	Nm³/hr	289574	IS 11255 (Part-3)
E:	**POLLUTION:** - Details of pollution control devices attached with the stack: NA			

___ End ___

Reviewed By:

Signature :
Name : Mr. Mohammed Aamir
Designation : Jr. Executive Chemist

Authorized Signatory
For **Mitra S.K. Private Limited**

Signature :
Name : Ms. E. Elizabath Princy
Designation : Technical Manager

- *The results relate only to the item(s) tested.*
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Annexure-III

Summary of Surface Water Quality Analysis

(Period: From April 2025 to September 2025)

PARAMETER	UOM	Brahmani US			Brahmani DS			Kishinda US			Kishinda DS			Lingra US			Lingra DS		
		Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
pH Value	-	7.63	8.21	7.85	7.42	8.02	7.75	7.81	8.39	8.06	7.57	8.52	7.98	7.75	8.31	8.00	7.64	8.12	7.95
Temperature	Deg C	25	28.4	26.20	25.2	28	26.4	25.2	28.3	26.50	25	28.1	26.10	25.2	30	28.23	25.2	32	28.90
Total Suspended Solids	mg/l	2	11	70.3	1	76	28.33	5.6	18	11.27	12	33	19.67	2.1	14	8.20	2.1	11.5	6.27
Arsenic as As	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
BOD, 3days at 27°C	mg/l	2.6	2.9	2.75	2.6	2.9	2.75	2.6	2.9	2.75	2.6	2.9	2.75	2.6	2.9	2.75	2.6	2.9	2.75
Boron (as B)	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Cadmium (as Cd)	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Calcium (as Ca)	mg/l	8.8	13	10.90	9	9.4	9.20	33	34.56	33.78	26	33.8	29.90	36.2	38.7	37.45	37	41.5	39.25
Chlorides (as Cl)	mg/l	10	13.2	11.60	11.31	12	11.66	39	45.26	42.13	41	45.26	43.13	76	116.92	96.46	116.92	131	123.96
COD	mg/l	8.6	16	11.27	8.1	18	13.05	BDL	14.5	14.50	18.4	22.1	20.25	BDL	38	38.00	BDL	36	36.00
Copper (as Cu)	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Cyanide (as CN)	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Fluoride (as F^-)	mg/l	0.16	1.8	0.79	0.22	1.6	0.73	0.82	1.4	1.13	0.8	2	1.33	0.684	1.9	1.26	1.4	1.5	1.45
Hexavalent Chromium (as Cr^{+6})	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Iron (as Fe)	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Lead (as Pb)	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Manganese (as Mn)	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mercury (as Hg)	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Nickel (as Ni)	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

O&G	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Phenolic Compound	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Phosphate (as P)	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
RFC	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Selenium (as Se)	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
TKN	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Zinc (as Zn)	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

Note: BDL: Below Detectable Limit; DL: Detectable Limit, U/S: Upstream D/S: Downstream

Source: Monitoring/ Analysis report of S.K. Mitra Private Limited and Environment Laboratory of TSM.

BDL Values:

Arsenic (as As): 0.005mg/l, Boron (as B): 0.2mg/l, Cadmium (as Cd): 0.003mg/l, Copper (as Cu): 0.02mg/l, COD: 4.0mg/l, Cyanide (as CN^-): 0.02mg/l, Hexavalent Chromium (as Cr^{+6}): 0.03mg/l, Iron (as Fe): 0.05mg/l, Lead (as Pb): 0.005mg/l, Manganese (as Mn): 0.02mg/l, Mercury (as Hg): 0.02mg/l, Nickel (as Ni): 0.001mg/l, O&G (as Oil & Grease): 5.0mg/l, Phenolic compound (as C_6H_5OH): 0.1mg/l, Phosphate (as P): 0.001mg/l, RFC (as Residual Free Chlorine): 0.3mg/l, Selenium (as Se): 0.1mg/l, TKN (as Total Kjeldhal Nitrogen): 0.005mg/l, Zinc (as Zn): 0.3mg/l.

Summary of Treated Domestic Effluent Analysis

(Period: From April 2025 to September 2025)

Location	ETP-1 O/L			ETP-2 O/L			ETP-3 O/L			CRM ETP O/L		
Parameters	**Max**	**Min**	**Average**	**Max**	**Min**	**Average**	**Max**	**Min**	**Average**	**Max**	**Min**	**Average**
pH	7.08	8.22	7.38	6.71	7.51	6.98	7.08	8.05	7.712	6.98	8.36	7.7
TSS in mg/l	15	38	32	13	34	28	19	39	31.4	30	81	58
COD in mg/l	26	42	34	30	37	32	33	43	37.2	120	150	140
BOD in mg/l	4.7	6.5	5.4	4.7	6.1	5.2	4.4	9.6	6.32	16.9	23.1	20.52
O& G in mg/l	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
Fe in mg/l	0.46	0.58	0.52	0.46	0.58	0.524	0.46	0.58	0.504	1.49	1.96	1.764

Location	BOD-1 ETP O/L			BOD-2 ETP O/L		
Parameters	**Max**	**Min**	**Average**	**Max**	**Min**	**Average**
pH	6.62	7.07	6.82	6.59	7.05	6.794
TSS in mg/l	40	59	47	39	48	42.8
COD in mg/l	120	180	150	120	180	154
BOD in mg/l	18.8	25.7	22.3	18.4	25	22.625
O& G in mg/l	<4	<4	<4	<4	<4	<4
TCN in mg/l	0.13	0.18	0.14	<0.1	<0.1	<0.1
Phenol in mg/l	0.43	0.50	0.48	0.59	1.30	0.83
Ammoniacal Nitrogen in mg/l	29	113	57	14	24.5	19

Location	BF-1 Thickener O/L			BF-2 Thickener O/L			BOF Thickener O/L		
Parameters	**Max**	**Min**	**Average**	**Max**	**Min**	**Average**	**Max**	**Min**	**Average**
pH	6.95	7.42	7.216	6.9	7.14	7.02	8.77	9.78	9.14
TSS in mg/l	51	94	75.4	46	76	60.8	43	66	57.8
COD in mg/l	34	37	35	30	39	35	36	42	39.2
BOD in mg/l	4.6	5.6	5.075	4.9	5.2	5.025	5	5.7	5.25
O& G in mg/l	<4	<4	<4	<4	<4	<4	<4	<4	<4

Summary of ground water level monitoring report inside plant premises

(Period: From April 2025 to September 2025)

S.N.	Location with description	Sample Code	Depth of Monitoring Bore Well (m)	Longitude	Latitude	Ground Water Level (m)
1	Colony near STP	GW-1	50.29	20^0 47.956'	85^0 15.076'	2.42
2	RMHS Near Wagon Tippler	GW-2	91.44	20^0 49.045'	85^0 15.734'	2.54
3	Near Blast Furnace-2	GW-3	49.38	20^0 47.752'	85^0 15.993'	4.1
4	Near Railway bridge	GW-4	47.55	20^0 47.250'	85^0 15.613'	2.25

Ground Water Level Period: April 2025

S. No	Location	Sample Code	Longitude	Latitude	Water Level from GL (m) BGL
					April'25
1	Kharagprasad	GW-01	200 49.299'	850 18.923'	4.05
2	Charadagadia	GW-02	200 47.768'	850 17.083'	7.86
3	Sibpur	GW-03	200 46.941'	850 14.394'	7.29
4	Kochilamada	GW-04	200 47.541'	850 16.802'	5.95
5	Galapada	GW-05	200 48.142'	850 18.600'	6.23
6	Motonga	GW-06	200 48.143'	850 18.599'	5.72
7	Narendrapur	GW-08	200 49.483'	850 15.530'	5.20
8	Khaliberena	GW-09	200 46.946'	850 14.396'	4.78
9	Ganthigadia	GW-10	200 48.501'	850 15.118'	1.80

Ground Water Quality Analysis Report of surrounding villages

(Reporting period - July 2025)

S. No	LOCATIONS		Motanga	Galpada	Kharagprasad	Kochilamada	Charadagadia	Khaliberana	Ganthigadia	Narendrapur
1.	PARAMETER	UOM	VALUE	VALUE	VALUE	VALUE	VALUE	VALUE	VALUE	VALUE
2.	Colour	Hazen	3	2	2	3	3	2	2	3
3.	pH	-	7.34	6.95	7.02	6.85	7.34	7.14	7.18	6.83
4.	Odour	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
5.	Taste	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
6.	Turbidity	NTU	1.33	0.7	0.22	0.39	1.33	0.27	0.25	0.72
7.	Total Dissolved Solids (TDS)	mg/L	1754	986	1048	1820	1754	1045	966	1280
8.	Alkalinity as CaCO3	mg/L	820	303	492	371	820	383	488	440
9.	Total Hardness (as CaCO3)	mg/L	646	313	423	921	646	474	431	748
10.	Sulphide (as H_2S)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
11.	Sulphate (as SO4-2)	mg/L	186	278	170	273	186	166	114	60.4
12.	Chloride as Cl	mg/L	240	127	160	519	240	199	239	479
13.	Fluoride as F	mg/L	0.982	0.14	0.486	0.542	0.982	1.02	0.824	0.662
14.	Nitrate as NO3	mg/L	47.3	45.1	15.9	47.8	47.3	46.1	18.5	8.8
15.	Calcium as Ca	mg/L	202	83.2	111	212	202	124	108	188
16.	Ammonia (as NH3)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
17.	Magnesium as Mg	mg/L	56	34	42.8	86	56	40	39.1	67.5
18.	Iron (as Fe)	mg/L	0.103	0.092	0.103	0.108	0.103	0.099	0.099	0.103
19.	Aluminium (as Al)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
20.	Anionic Surface-Active Agents as (MBAS)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
21.	Barium (as Ba)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
22.	Boron (as B)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
23.	Copper (as Cu)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
24.	Free Residual Chlorine	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
25.	Manganese (as Mn)	mg/L	0.096	BDL	BDL	0.094	0.096	BDL	BDL	0.404

26.	Phenolic Compounds (as C_6H_5OH)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
27.	Selenium (as Se)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
28.	Silver (as Ag)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
29.	Zinc (as Zn)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
30.	Cadmium (as Cd)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
31.	Cyanide (as CN)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
32.	Lead (as Pb)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
33.	Mercury (as Hg)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
34.	Nickel (as Ni)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
35.	Total Arsenic (as As)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
36.	Molybdenum (as Mo)	µg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
37.	Mineral Oil	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
38.	Chloramines (as Cl2)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
39.	Total Chromium (as Cr)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
40.	Total Coliform	-	Not Detected	Detected	Detected	Detected	Not Detected	Detected	Detected	Detected
41.	E. coli	-	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected

Note: BDL: Below Detectable Limit; DL: Detectable Limit, UOM: Unit of Measurement

Source: Monitoring/ Analysis report of S.K. Mitra Private Limited and Environment Laboratory of TSM.

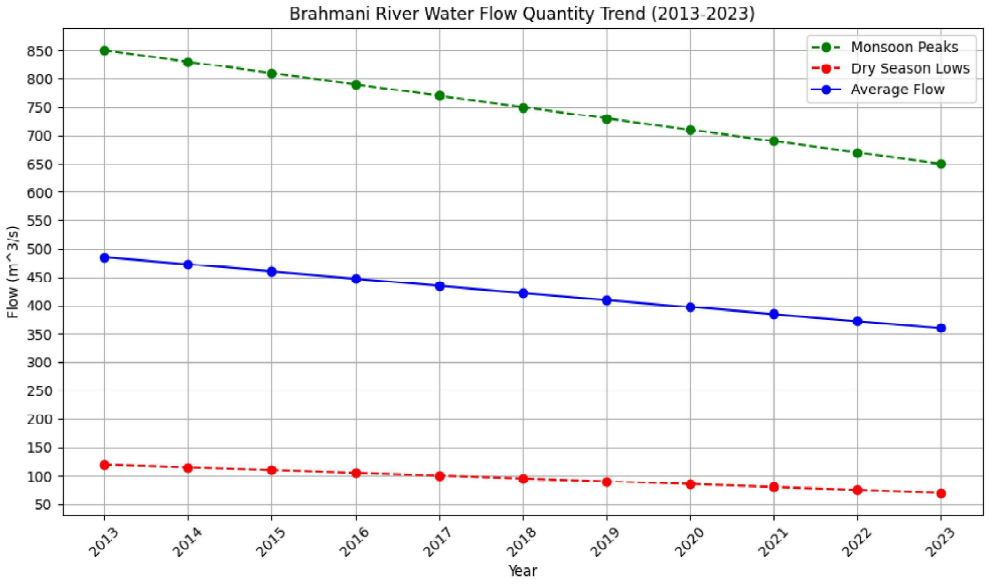
BDL Values:

Sulphide (as H_2S): 0.04mg/l, Ammonia (as NH_3): 0.1mg/l, Aluminium (as Al): 0.02mg/l, Anionic Surface-Active Agents as (MBAS): 0.025mg/l, Barium (as Ba): 0.1mg/l, Boron (as B): 0.2mg/l, Copper (as Cu): 0.03mg/l, Free Residual Chlorine: 0.1mg/l, Manganese (as Mn): 0.05mg/l, Phenolic Compounds (as C6H5OH): 0.001mg/l, Selenium (as Se): 0.01mg/l, Silver (as Ag): 0.1mg/l, Zinc (as Zn): 0.01mg/l, Cadmium (as Cd): 0.003mg/l, Cyanide (as CN): 0.012mg/l, Lead (as Pb): 0.01mg/l, Mercury (as Hg): 0.001mg/l, Nickel (as Ni): 0.01mg/l, Total Arsenic (as As): 0.005mg/l, Molybdenum (as Mo): 5.00mg/l, Mineral Oil: 0.01mg/l, Chloramines (as Cl_2): 1.0mg/l, Total Chromium (as Cr): 0.03mg/l.

---------- End of Report ----------

Brahmani River Water Flow Quantity Trend (2013-2023)

This report presents the water flow quantity trend of the Brahmani River over the last decade. The chart below illustrates the seasonal variations, including monsoon peaks, dry season lows, and average annual flow rates.



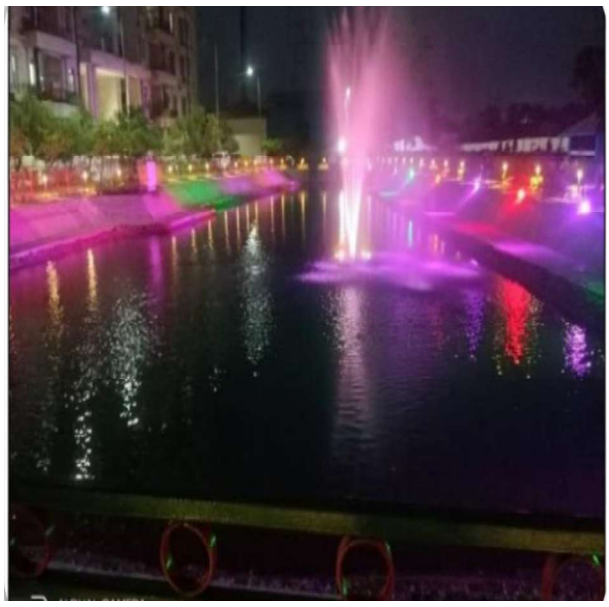
Key Insights

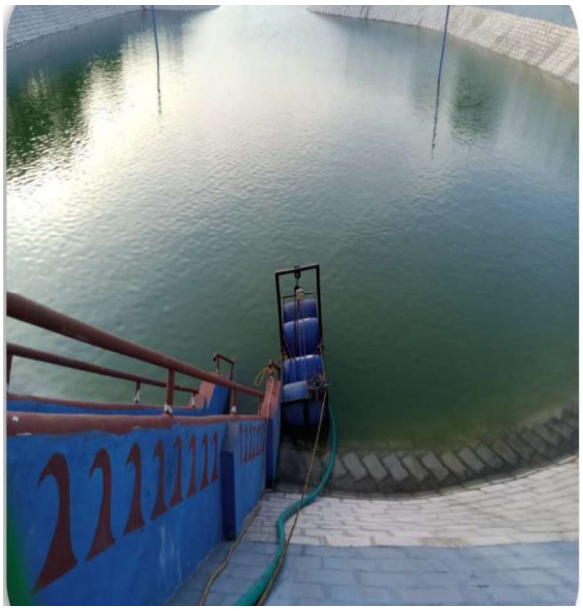
- Monsoon peak flows have declined from ~850 m^3/s in 2013 to ~650 m^3/s in 2023.
- Dry season lows have dropped from ~120 m^3/s to ~70 m^3/s.
- Average flow shows a consistent downward trend, indicating reduced water availability.

Data Sources

- Gowthaman T. et al. (2022), ARIMA Models for Water Quality Parameters of Brahmani River, International Journal of Environment and Climate Change.
- Padmini Behera et al. (2025), Streamflow Prediction using GEP, SVM, and MLR Models, NIT Rourkela.
- Abhijeet Das (2024), Evaluation of Surface Water Quality in Brahmani River Basin, Springer Journal.

Annexure-IV





(Rainwater Harvesting)

E&S/LT- 05/July/2025
Confidential

Report on

Geohydrology Study

[AUDIT PERIOD: APRIL 2024 to MARCH 2025]

Submitted to

TATA

Tata Steel Limited
At- Narendrapur, PO- Kusupanga, Via- Meramandali, Dhenkanal, Odisha 759121 (INDIA)

GEOHYDROLOGY STUDY of Tata Steel Plant Meramandali

NABL
ISO/IEC 17025
ACCREDITED LABORATORY
Certificate No: T- 8091

immt

CSIR-INSTITUTE OF MINERALS & MATERIALS TECHNOLOGY
(Council of Scientific & Industrial Research)
Bhubaneswar -751013

FOREWORD

It is the great pleasure for me to forward the final report (2024-25) on "Review of Geohydrology Study" in an around 10 Km radius of Tata Steel Limited, Meramandali. This report has been prepared by CSIR-Institute of Minerals & Materials Technology (IMMT), Bhubaneswar in accordance with the terms & condition of order awarded. The details of information incorporated in this report have been based on the periodic site visit, primary & secondary information collected. All efforts have been made to make the information as accurate as far as possible. The report will be immensely useful to all concerned for related studies and understanding on geohydrology study.

Director, CSIR-IMMT

ACKNOWLEDGEMENT

The team of the CSIR-IMMT is thankful to **Tata Steel Ltd,** Meramandali for providing necessary order & hospitality in executing of the sudy. We are aslo thankful to Central Ground water Board in assisting for weather data & other relevant information. Team members are also thankful to the Banarpal, Odopada and Hindol block Officers for providing necessary support and other facilities while conducting water sampling.

The team is grateful to Director, CSIR-Institute of Minerals and Materials Technology, Bhubaneswar for his keen interest, guidance and constant encouragement.

Dr. Arakshita Majhi
Sr.Principal Scientist
Project Leader

Team of Investigators

- Dr N. K. Dhal- Chief Scientist CSIR-IMMT (HOD Environment & Sustainable Depatment)
- Dr Manish Kumar- Scientist CSIR-IMMT
- Dr. R Boopathy- Scientist,
- Dr. Jasobanta Das- Sr. Technical Officer
- Mr. Murali Dhar Sahoo- Lab Chemist, and other staff members (Mr. G B Mallick, Mr.Suresh K Samal)

DISCLAIMER

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CONTENTS

1.1 **Introduction:**

M/s Tata Steel Limited, Meramandali is situated at Narendrapur Village of Kusupanga in Dhenkanal District of Odisha which is 2.2 km due south of NH-55 and nearly 6 km due south west of Brahmani river and bounded by the villages Narendrapur, Sivapur, Mitikapashi and Talabahal etc. It is bound by Latitudes 200 46’ 41" to 200 49’ 20" N and Longitudes 850 15’ 22” to 850 16’ 21”E. The installed Crude Steel and power generation capacity of the plant is 5.6 MTPA and 307 MW. Respectively. Apart from that, the plant has set up capacities to produce downstream products like HR Coils, Cold Rolled Coil etc. The steel plant is based on the Direct Reduced Iron (DRI) - Electric Arc Furnace (EAF), Blast Furnace – Ladle Refining Furnace (LRF) - Continuous Casting – Rolling Mill route with Captive Power Plant (CPP) based on waste heat recovery boiler (WHRB) from various processes, By-product waste Gas fired boiler and Coal Fired Boiler (CFBC & AFBC). The balance power requirement is met from the power plants of Tata Steel Limited TSM-CPP.

Study Context

This report provides a comprehensive review of the geohydrology study conducted by CSIR-Institute of Minerals & Materials Technology (IMMT), Bhubaneswar, for the area within a 10 km radius of Tata Steel Limited, Meramandali, Odisha. Commissioned by Tata Steel Limited, the study aimed to analyse the geohydrological conditions of the region and assess their implications for the company's operations and environmental stewardship. The information incorporated herein is based on periodic site visits and both primary and secondary data collection, ensuring accuracy for future studies and understanding of the geohydrology.

This report details the hydrological and hydrogeological study conducted in the vicinity of Tata Steel Limited. The primary purpose of this investigation is to assess the potential impact of the plant's operations on local surface and underground water bodies and to analyse long-term trends in water quality and levels.

The study area encompasses the region around the Tata Steel BSL Limited plant, which is situated downstream of the Rengali Dam . Key hydrological features include the Brahmani River, with a large catchment area of 39,033 sq. km, and the Rengali Dam, controlling a catchment area of 25,025 sq. km . Additionally, the Lingira and Kisinda rivers traverse the area, passing through the major industrial hubs.

Methodology Adopted: The study followed a structured methodology, consistent with the ongoing, two -year monitoring program (current year plus preceding one year).

- **Sampling Strategy:** Designated sampling locations, determined in collaboration with Tata Steel Limited, include both open wells for groundwater sampling and river sites for surface water sampling. For the Brahmani River, sampling was conducted downstream of the Rengali Dam. To specifically investigate the plant's impact, surface water samples from the Brahmani, Lingira and Kisinda rivers were collected at both upstream and downstream points relative to the Tata Steel Limited.
- **Temporal Phases:** Sample collection and water table measurements were performed across three distinct temporal phases: pre-monsoon (March), during monsoon (August), and post-monsoon (November).
- **Data Collection:** Water table levels were measured directly at the designated sites. Comprehensive water quality tests were conducted on the collected samples to facilitate the categorization of these water sources based on their characteristics.
- **Technical Team and Site Logistics:** The study was conducted by a technical team from CSIR-IMMT, including Dr. Arakshita Majhi (Sr. Principal Scientist), Dr. R Boopathy (Scientist), Mr. Jasobanta Das (Sr. Technical Officer), Mr. Murali Dhar Sahoo (Lab Chemist), and other staff members (Mr. G B Mallick, Suresh K Samal) . The team was supported by experts from Tata Steel Plant during site visits. Initial discussions were held at the plant office to finalize the scope, and relevant drawings and top sheets were acquired to facilitate the identification of sampling locations.

Limitation Acknowledgment: It is crucial to state that specific, granular, publicly available environmental monitoring data (including raw water quality parameters for sampling locations or detailed daily dam release figures) directly pertaining to the Tata Steel Limited site, the Lingira and Kisinda rivers, or the Rengali Dam for the 2022-2025 study period could not be retrieved during this study. Therefore, this report discusses expected behavior, general industry impacts, and Tata Steel's stated commitments, rather than presenting empirical findings based on site-specific data.

1.1 Scope of the Study:

1. Study on physiography, drainage pattern including drainage analysis, preparation of drainage map and climatology study.

2. Depict aquifer geometry of the area and aquifer characteristics.

3. Hydrogeological and Hydrological survey (10 km radius) of Tata Steel Limited, Dhenkanal.

4. Study on hydro-geology of the area:

   i. Interpretation of the prevailing hydro-geological condition of the area.
   ii. Well inventory, ground water flow along-with direction, measurement of
   i. ground water level
   iii. Collection of historical ground water level through secondary source.
   iv. Collection and analysis of seasonal (Monsoon, Winter and Summer) analysis of ground water quality trend including ground water level fluctuation.
   v. Preparation of map configuration of secondary system based on data collected from secondary source.
   vi. Collection and analysis of ground water sample.
   vii. Impact analysis of any change in surface/ ground water quality over the years.

1.2 Methodology of investigations.

The CSIR-IMMT study likely employed a rigorous methodology combining extensive primary and secondary data collection, followed by various analytical techniques to interpret the findings,.

Data Collection Methods

Primary Data Collection Methods (Field-Based and Direct Measurement):

1. **Periodic Site Visits and Field Surveys**: Crucial for direct observation of geological features, existing water sources, topography, land use, and potential pollution points, and for conducting reconnaissance and identifying sampling locations
2. **Groundwater Level Monitoring**: Involved establishing a network of observation wells (piezometers) to regularly measure water table fluctuations, providing real-time data on groundwater dynamics, hydraulic gradients, and flow directions,
3. **Water Quality Sampling and Analysis**: Representative water samples were collected from various sources (bore wells, open wells, surface water) to assess chemical,

physical, and biological quality, including parameters like pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), major ions, and heavy metals,

Secondary Data Collection Methods (Existing Records and Databases):

1. **Government and Institutional Databases**: Extensive use of data from the Central Ground Water Board (CGWB) for historical groundwater levels, quality, abstraction rates, and regional aquifer information. Data from State Pollution Control Boards (SPCBs) provided environmental monitoring data and compliance records. Meteorological data from the Indian Meteorological Department (IMD) was incorporated for recharge estimation, and national platforms like India-WRIS were utilized,
2. **Published Literature and Reports**: Review of scientific journals, conference papers, previous Environmental Impact Assessment (EIA) reports, and geohydrological studies relevant to the region or similar industrial areas,
3. **Cartographic and Remote Sensing Data**: Topographic maps from the Survey of India (SOI), geological maps from the Geological Survey of India (GSI), and satellite imagery/GIS data were used,

Analytical Techniques

The collected data was subjected to various analytical techniques to interpret findings and draw conclusions.

Laboratory Analysis of Water Samples:

1. **Physicochemical Analysis**: Measurement of parameters like pH, EC, TDS, and turbidity using standard laboratory methods,
2. **Major Ion Chemistry**: Analysis of cations (Calcium, Magnesium, Sodium, Potassium) and anions (Chloride, Sulfate, Bicarbonate, Carbonate, Nitrate, Fluoride) using techniques such as ion chromatography and atomic absorption spectrophotometry (AAS),
3. **Trace Element/Heavy Metal Analysis**: Detection of elements like Iron, Manganese, Chromium, Lead, Cadmium, Arsenic, Zinc, and Copper using advanced methods like Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) and ICP-Mass Spectrometry (ICP-MS),
4. **Microbiological Analysis**: Assessment of parameters like Total Coliforms and E. coli, if required, using standard microbiological techniques,

Hydrogeological and Spatial Analysis:

1. **Groundwater Flow Mapping**: Construction of water table contour maps using measured water levels and spatial interpolation in GIS software to determine flow directions and gradients,
2. **Statistical Analysis**: Application of descriptive statistics, correlation, regression, and multivariate methods to identify relationships and potential contamination sources,

Chapter II

Hydrometeorology & Ground Water Quality

The state Odisha is mostly influenced by monsoon rainfall. The state's economy is based on agriculture based and for that this monsoon based rainfall is highly responsible. The rainfall also occurs at a varied magnitude over the spread of the state. The coastal districts generally get a higher magnitude than that of interior districts. The state also has a good river network which is either controlled through a reservoir system or free flowing. The water which is either getting utilized for agriculture, industrial or any purpose are either received from nearby reservoir or tapped from nearest stream. In some cases, ground water is also getting utilized. The quantity and quality of available water near a locality influences the agriculture, industry and residential establishment of that place. The study reveals the quantitative and qualitative assessment of water resources of nearby locality of the nearby area of Tata Steel Plant. The descriptions are as follows:

RAINFALL

The study area is coming under sub-tropical climate with three distinct seasons i.e. summer, monsoon and winter. The southwest monsoon rain starts from mid of June and continues till mid of October. Like the coastal area it may not receive a huge rainfall but a moderate to high rainfall is seen in the area over the study area. The spread and distribution of rainfall over the state is depicted by an Isohyetal map given in **Figure 2.1 and average rainfall is given in Figure-2.2.**

The annual average rainfall within the project area of the district Dhenkanal is 1496.2 mm and average rainy days are about 70 in a year. The nearest IMD station is located at Odapada Block however another block nearest to study area is Banarpal and Hindol. So the rainfall statuses of both the blocks are considered. It is realized that the annual average rainfall values of Banarpal is 1249.7 mm, Odapada block are 816.0 mm and of Hindol is 2004 mm The month of July receives maximum rainfall in a year and least rainfall month is December.

The annual average rainfall within the project area of the district Dhenkanal is 1334 mm and average rainy days are about 66 in a year. The nearest IMD station is located at Odapada Block however another block nearest to study area is Banarpal and Hindol. So the rainfall statuses of both the blocks are considered. It is realized that the annual average rainfall values of Banarpal

is 1157.6mm, Odapada block are 1200.8 mm and of Hindol is 1700.1 mm. The month of July receives maximum rainfall in a year and least rainfall month is December.

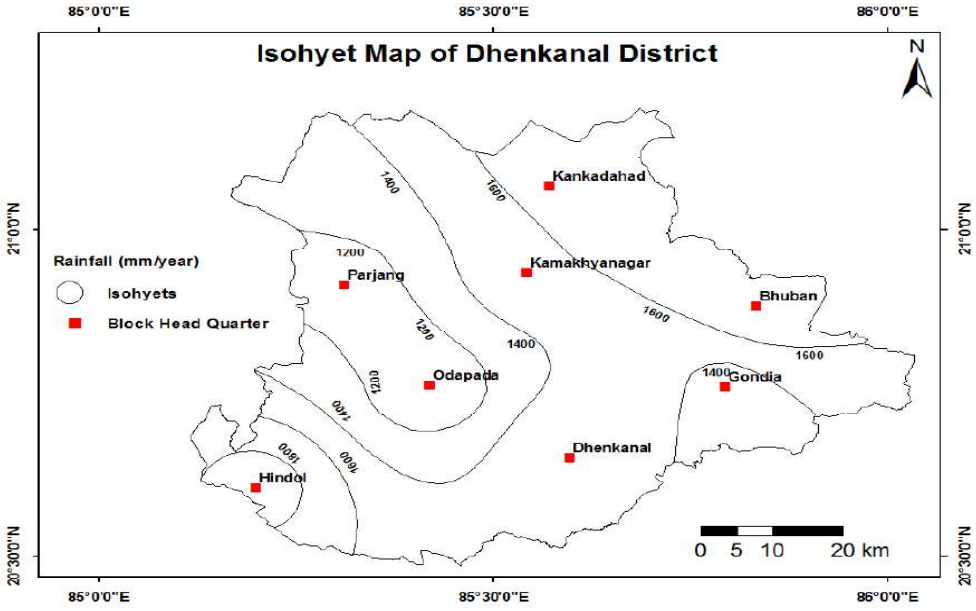


Figure 2.1. Isohyetal map of Dhenkanal District

Source: Ground water Report

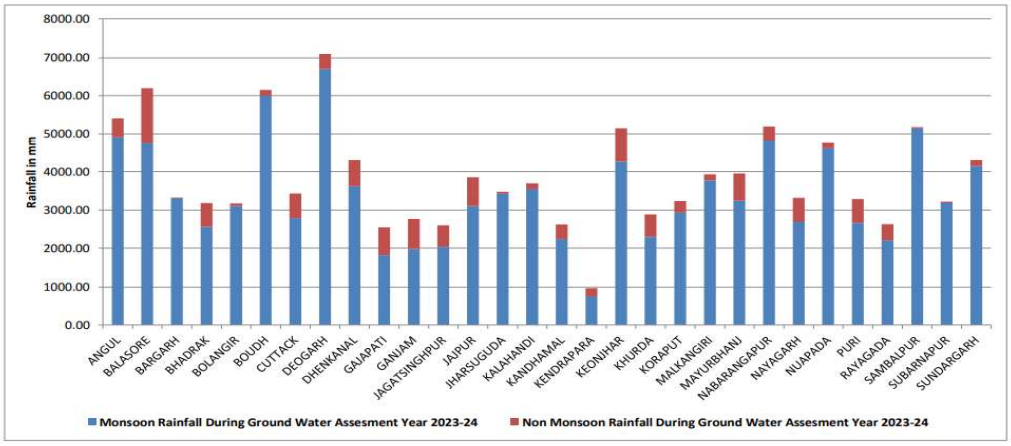


Fig.2.2 District wise Monsoon and Non-monsoon rainfall for Ground Water

Source: Dynamic Ground Water Resources of Odisha, 2024

The annual rainfall shows that (**Table No.2.1**), in the year 2005 maximum rainfall 2487.6 mm was received in Hindol Block whereas the lowest rainfall that is 552mm in 2017 in Odapada Block.

There is a sharp declination of the rainfall in Banarpal Block and most of the year it is below 1400mm. In the last 3 years, the annual rainfall is 1477.4 mm, 1421.7 mm and 1629.7 mm, which is good. A sharp fall in total rainfall quantity is seen in Odapada Block since 2013, whereas a good rainfall is being received in Hindol Block in most of the year. Although these blocks are situated close to each other, but the variation in rainfall will definitely put impact on local agricultural activity, stream flow, groundwater recharge, socio-economic aspects of these local area.

It was realized that the annual average rainfall values of Banarpal block are 1249.7 mm during the total year and 1053.3mm during monsoon rainfall. Whereas in Odapada 1200.8 and 1034.3mm and in Hindol 1700.1 and 1424.5 mm are the annual rainfall and monsoon rainfall respectively. The month of July receives maximum rainfall in a year and least rainfall monsoon month is February. In comparison among these 3 blocks Hindol receives higher rainfall annually and also in monsoon period. Both Odapada and Hindol have received a maximum rainfall of 1549.5mm 2487.6 mm in 2005.

Table-2.1 Annual rainfall (mm) of 3 blocks of buffer zone

Year	**Banarpal**			**Odapada**			**Hindol**		
	Monsoon	Non-Monsoon	Total	Monsoon	Non-Monsoon	Total	Monsoon	Non-Monsoon	Total
2005	1051.3	73.0	1124.3	1438.0	111.5	1549.5	2322.4	165.2	2487.6
2006	1059.2	103.0	1162.2	1394.0	130.0	1524.0	1379.0	322.8	1701.8
2007	1061.2	201.0	1262.2	1188.0	50.0	1238.0	1266.2	191.0	1457.2
2008	1081.5	132.7	1214.2	1256.5	193.0	1449.5	1162.0	180.2	1342.2
2009	1146.0	42.7	1188.7	1222.5	84.0	1306.5	1868.0	139.0	2007.0
2010	796.9	178.0	974.9	1151.0	205.9	1356.9	1305.0	298.0	1603.0
2011	1114.6	138.2	1252.8	1100.5	174.0	1274.5	1617.0	283.0	1900.0
2012	1124.1	173.0	1297.1	1298.5	234.5	1533.0	1406.3	228.0	1634.3
2013	1258.7	77.8	1336.5	1298.5	50.5	1349.0	2228.0	213.0	2441.0
2014	1270.5	141.2	1411.7	1020.0	230.0	1250.0	1098.5	222.0	1320.5
2015	868.0	35.6	903.6	691.0	207.0	898.0	962.0	184.0	1146.0
2016	937.0	150.0	1087.0	1030.7	135.0	1165.7	1009.0	127.2	1136.2
2017	722.2	104.0	826.2	482.0	70.0	552.0	1347.5	210.8	1558.3

Year	Banarpal			Odapada			Hindol		
	Monsoon	Non-Monsoon	Total	Monsoon	Non-Monsoon	Total	Monsoon	Non-Monsoon	Total
2018	1145.6	253.8	1399.4	1198.0	105.0	1303.0	1319.6	222.1	1541.7
2019	841.8	323.6	1165.4	735.0	287.6	1022.6	1427.2	352.9	1780.1
2020	1207.8	685.6	1893.4	797.0	401.0	1198.0	1257.3	637.6	1894.9
2021	999.6	354.8	1354.4	681.1	165.0	846.1	1524.4	478.9	2003.3
2022	1084.6	209.4	1294.0	835.0	203.0	1038	1390.1	327.9	1718.0
2023	1327.2	268.8	1596.0	835.0	127.0	962.0	1175.3	453.6	1628.9
Avg	1058.1	191.9	1249.7	1034.3	166.52	1200.8	1424.5	275.6	1700.1
Std.Dev	164.4	144.8	234.2	267.4	85.0	254.5	355.9	127.5	359.8
Max	1327.2	685.6	1893.4	1438.0	401.0	1549.5	2322.4	637.6	2487.6
Min	722.2	35.6	826.2	482.0	50.0	552.0	962.0	127.2	1136.2
Cv	0.15	0.75	0.19	0.25	0.51	0.21	0.25	0.46	0.21

The time series of annual rainfall shows that (Table.2.1), in the year 2005 maximum rainfall 2487.6 mm was received whereas year 2017 receives the lowest that is 552 mm. There is a sharp declination of the rainfall during 2014 to 2017 (Fig. 2.2A). After 2010 only in the year 2015 and 2017 a low rainfall value is received but in next year 2018 a good rainfall is received amounting to 1399.4 mm. In the year 2023 also good rainfall is received i.e. 1596.0 mm.

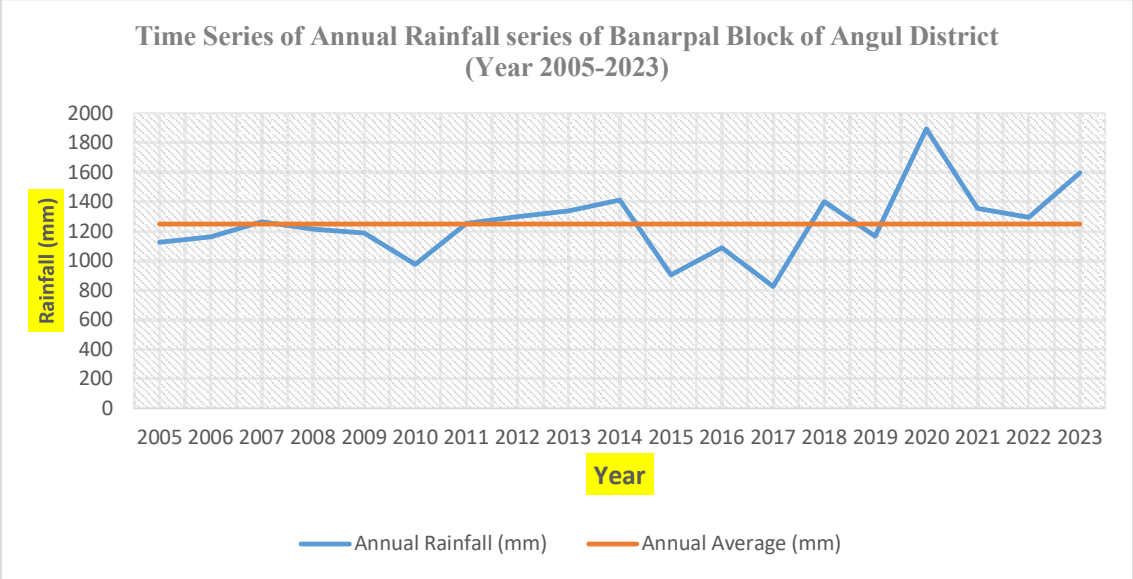


Fig.2.2 A Time Series of Rainfall (Banarpal Block)

Similarly, in Odapada maximum rainfall 2441 mm was received in the year 2013 whereas receives the lowest that is 1136.2 mm. There is a sharp declination of the rainfall during 2013 to 2016 (Fig. 2.2 B). After 2008, only in the year 2015 and 2017 a low rainfall value is received but in next year 2018 a good rainfall is received amounting to 1701.1 mm.

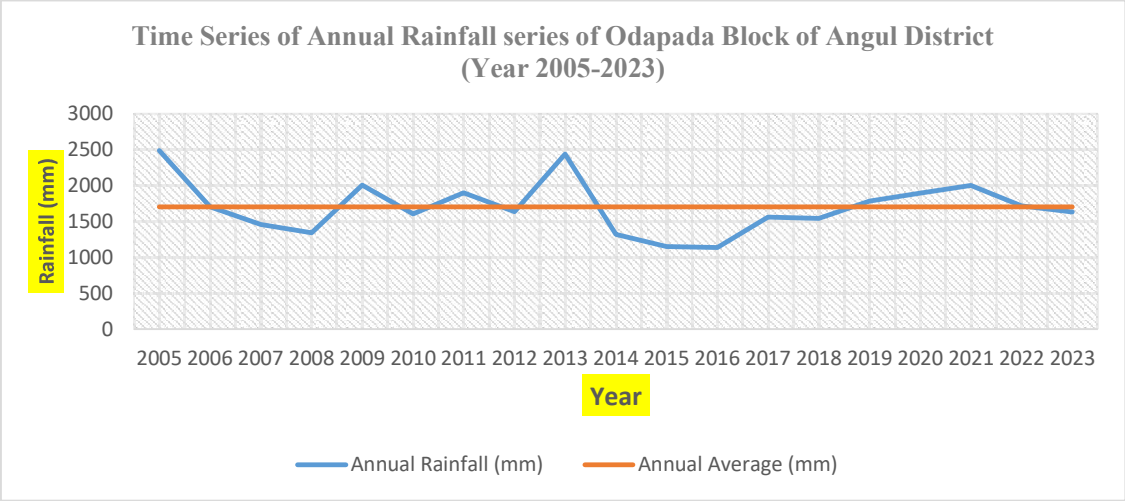


Fig.2.2 B. Time Series of Rainfall (Odapada Block)

Similarly, in Hindol block maximum rainfall 2441 mm was received in the year 2013, whereas year 2016 receives the lowest that is 1136.2 mm. There is a sharp declination of the rainfall during 2013 to 2016 (Fig. 2.2C). After 2008 only in the year 2014, 2015 and 2016 a low rainfall value is received but in next year 2018 a good rainfall is received amounting to 1541.7 mm.

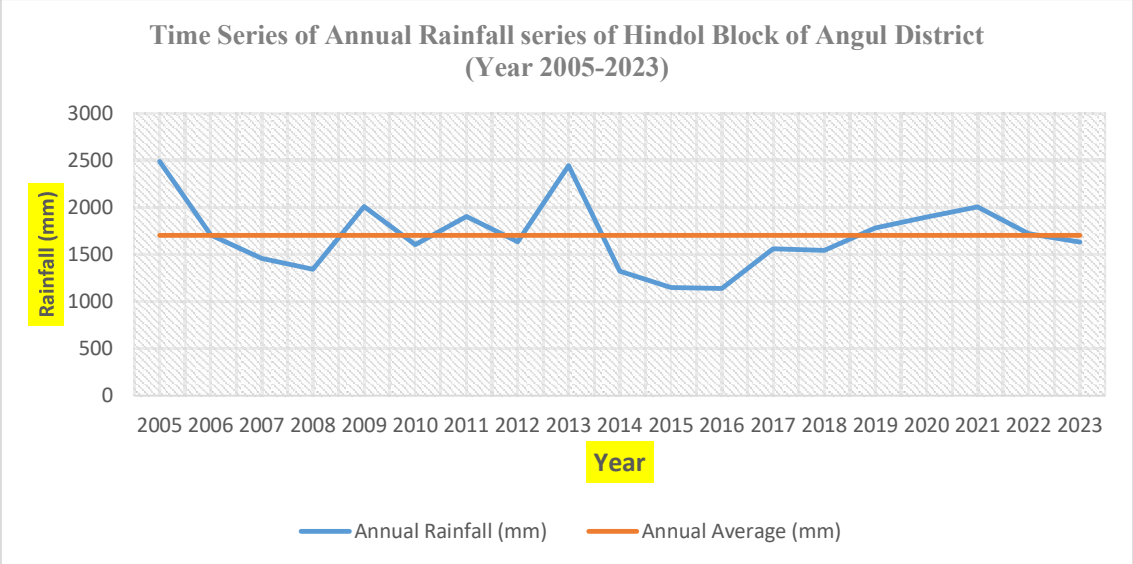


Fig.2.2 C Time Series of Rainfall (Hindol Block)

It is seen that in all the 3 blocks rainfall show a plunging down since 2013 and recovered during

2019 onwards. Although the month wise rainfalls show no big drastic change but overall it is reduced during 2014-17. Hindol block receives overall a high rainfall in comparison to other blocks.

It is tested for all standard statistical parameters like mean, standard deviation, coefficient of variation. Possible trend at 1%, 5% and 10% significance level is also tested. The results are shown in the Table 2.3.

Table-2.3. Existence of Trend using Kendall Rank Test

Rainfall	Z-statistics	Existence of Trend at Significance Level		
		1%	2%	3%
Annual	0.03499	No Trend	No Trend	No Trend
Monsoon	-0.10496	No Trend	No Trend	No Trend
Non-Monsoon	1.57433	No Trend	No Trend	No Trend

Further the rainfall of Banarpal block is checked for any deviations from the mean for total rainfall, monsoon and non-monsoon rainfalls (Table 2.3A). It is visualized that the deviation is maximum during 2020 and 2017 is negative side The rainfall is normal in all season. Out of the 19 years' data in 50% of the cases the rainfall remains below normal.

Table 2.3 A. Rainfall deviations for Banarapal block

Year	Deviation from mean (mm)		
	Annual	Monsoon	Non-Monsoon
2005	125.4	6.8	118.9
2006	87.5	-1.1	88.9
2007	-12.5	-3.1	-9.1
2008	35.5	-23.4	59.2
2009	61	-87.9	149.2
2010	274.8	261.2	13.9
2011	-3.1	-56.5	53.7
2012	-47.4	-66	18.9
2013	-86.8	-200.6	114.1
2014	-162	-212.4	50.7

2015	346.1	190.1	156.3
2016	162.7	121.1	41.9
2017	423.5	335.9	87.9
2018	-149.7	-87.5	-61.9
2019	84.3	216.3	-131.7
2020	-643.7	-149.7	-493.7
2021	-104.7	58.5	-162.9
2022	-44.3	-26.5	-17.5
2023	-346.3	-269.1	-76.9

In Odapada block the deviation is more prominent in the year 2005 and 2017. Monsoon rainfall shows negative deviation during 2014 to 2018 whereas negative deviation is seen in Non-monsoon rainfall from 2005 to 2014 (Table 2.3B).

Table 2.3 B. Rainfall deviations for Odapada block

Year	Deviation from mean (mm)		
	Annual	Monsoon	Non-Monsoon
2005	-348.7	-403.7	55.02
2006	-323.2	-359.7	36.52
2007	-37.2	-153.7	116.52
2008	-248.7	-222.2	-26.48
2009	-105.7	-188.2	82.52
2010	-156.1	-116.7	-39.38
2011	-73.7	-66.2	-7.48
2012	-332.2	-264.2	-67.98
2013	-148.2	-264.2	116.02
2014	-49.2	14.3	-63.48
2015	302.8	343.3	-40.48
2016	35.1	3.6	31.52
2017	648.8	552.3	96.52
2018	-102.2	-163.7	61.52
2019	178.2	299.3	-121.08
2020	2.8	237.3	-234.48

2021	354.7	353.2	1.52
2022	162.8	199.3	-36.48
2023	238.8	199.3	39.52

In Hindol block the deviation is more prominent in the year 2013 and 2016. Monsoon rainfall shows negative deviation during 2009 to 2011 whereas negative deviation is seen in Non-monsoon rainfall from 2020 to 2023 and in rest of the years the deviations are scattered (Table 2.3C).

Table 2.3 C. Rainfall deviations for Hindol block

Year	Deviation from mean (mm)		
	Annual	Monsoon	Non-Monsoon
2005	-787.5	-897.9	110.4
2006	-1.7	45.5	-47.2
2007	242.9	158.3	84.6
2008	357.9	262.5	95.4
2009	-306.9	-443.5	136.6
2010	97.1	119.5	-22.4
2011	-199.9	-192.5	-7.4
2012	65.8	18.2	47.6
2013	-740.9	-803.5	62.6
2014	379.6	326	53.6
2015	554.1	462.5	91.6
2016	563.9	415.5	148.4
2017	141.8	77	64.8
2018	158.4	104.9	53.5
2019	-80	-2.7	-77.3
2020	-194.8	167.2	-362
2021	-303.2	-99.9	-203.3
2022	-17.9	34.4	-52.3
2023	71.2	249.2	-178

Temperature:

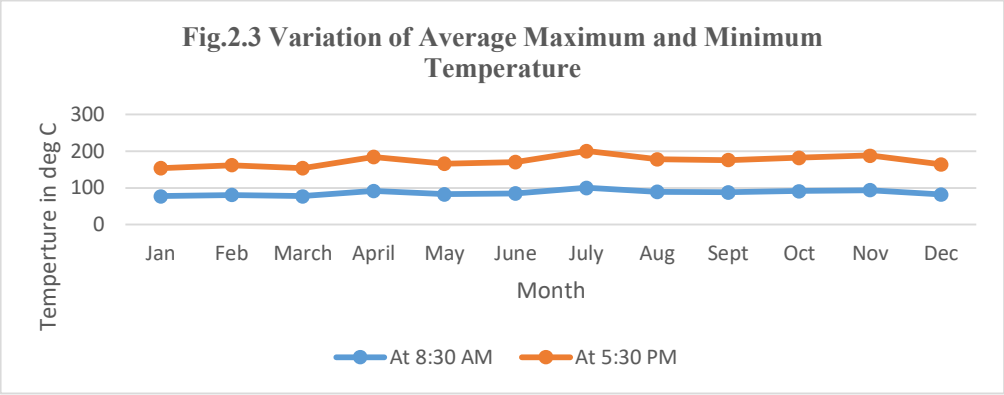
The nearest IMD observatory located at Angul has been taken for the study (2024). The summer commences from March during which temperature begins to rise rapidly. The month of April is the hottest month with the mean daily maximum temperature at 43.0^{0}C and the minimum during the month of December 12^{0}C (Table 2.4). From the month wise time series plot (Fig. 2.3) temperature rises from November and decreases from June.

The mean daily maximum temperature at 43^{0}C and the mean daily minimum temperature at 12^{0}C recorded at the site of Tata Steel, Meramandali complex.

Table 2.4 Variation of Average Maximum and Minimum Temp in ^{0}C

Month	Maximum	Minimum
January	30	15
February	36	17
March	37	17
April	43	22
May	41	23
June	40	24
July	38	26
August	35	25
September	37	26
October	36	24
November	33	16
December	32	12
Average	36.5	20.6

The variations of average maximum and minimum are represented vide Fig. no. 2.3.



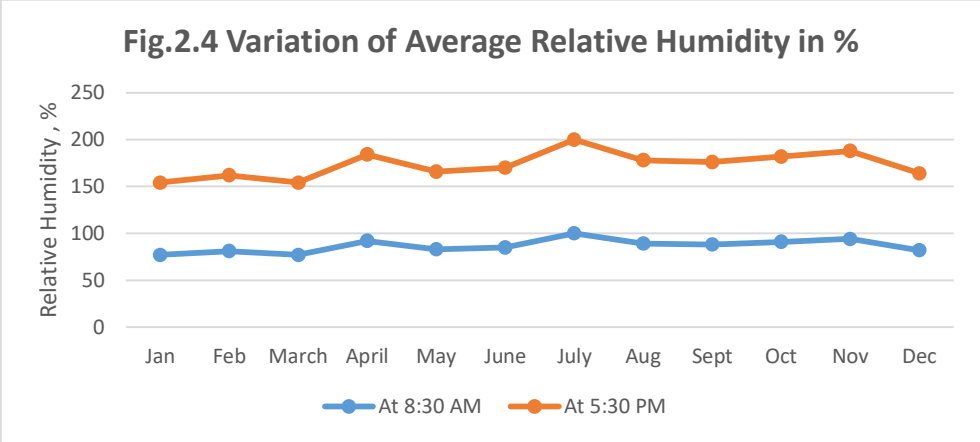
2.3 Humidity.

The relative humidity data collected from IMD Angul station is analysed (Table 2.5), on an average, varies from 63 to nearly 100% during the year (2024) and during monsoon it is much more where as in winter it is less. During post-monsoon period the humidity during morning and evening remain almost same (Fig. 2.4).

Table 2.5 Relative Humidity in %

Month	At 8.30 A.M	At 17.30 P.M
January	77	77
February	81	81
March	77	77
April	92	92
May	83	83
June	85	85
July	100	100
August	89	89
September	88	88
October	91	91
November	94	94
December	82	82
Average	86.5	86.5

The mean relative humidity varies from 63 to 94% recorded at the site of Tata Steel complex.



The mean monthly potential evapo-transpiration varies from 60 mm during January to 318 mm during May

2.4 Results and Discussions:

2.4.1 Drainage

In the study area drainage is controlled mainly by Brahmani river (besides other small nallahs are tributaries of this) as it passes through north eastern part of the area. It flows through the heart of Odisha between the Baitarani basin on the left and Mahanadi basin on the right till it mingles in the deltaic plain, finally out falling into the Bay of Bengal at Dhamara mouth. The drainage pattern is dendritic in entire area. Brahmani flows in the direction of NE. Nandira Jhore flowing in extreme northern part of buffer zone coming from west direction joins Brahmani River near village Kamalanga. Lingara or Nigra Nadi flowing in south eastern part of buffer zone having flow direction from SW to NE and joins Brahmani river near Surbhi village. Many other small and big nalas from west and south direction join Brahmani River and form the catchment of the river basin. The streams are highly meandering which may be due to prolonged weathering.

River Brahmani itself form meander in the north eastern part of the area. The drainage pattern is mostly dendritic. Many small water tanks are available in the area, which is a traditional source of water storage. Kisinda Jhore is the longest stream in buffer zone. The drainage system around the study area is shown in **Figure 2.5**.

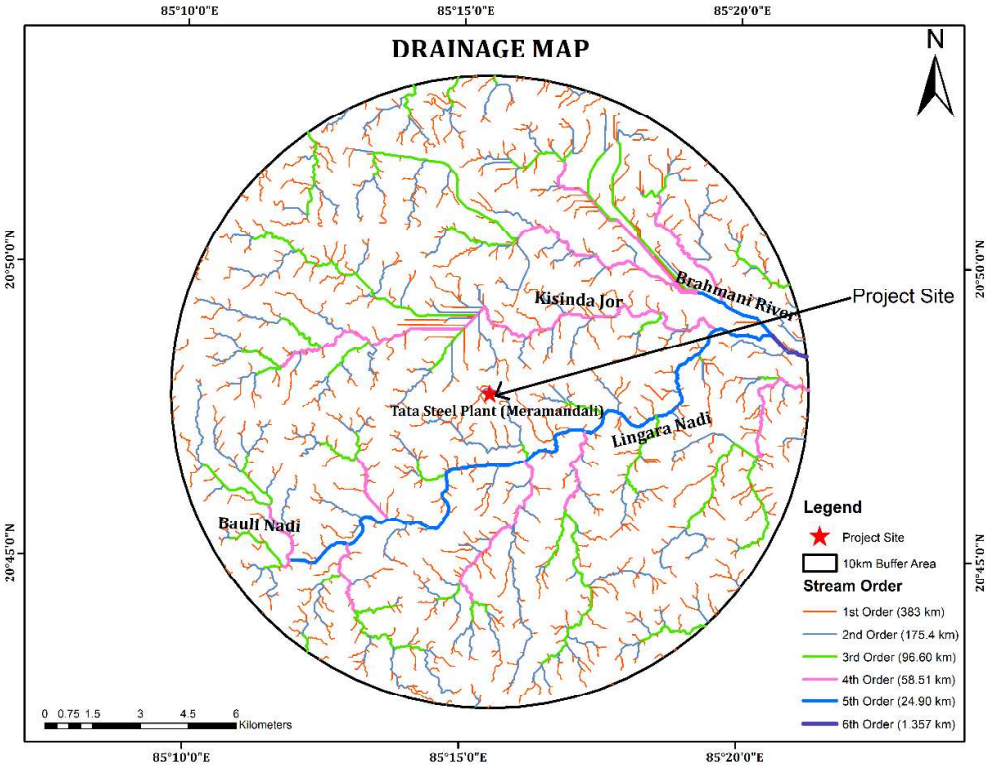


Figure 2.5 Map showing drainage system around the study Area.

The Digital Elevation Model (DEM) of Tata Steel Meramandali area is developed. The river networks are also delineated from the developed DEM for the above said area. The latitude and longitudes of different sampling locations is given in Table 2.6 and also was put over this GIS map and spreads of these locations are visualized **(Fig. 2.6).**

Table 2.6. Location of sample collection (March 2024)

#	Station Name	Location ID	Latitude	Longitude	Elevation(mt)	Water table (WT) (in mt)		
						BGL	AGL	Net WT
1	Kharagprasad	GW1	20.8215	85.3154	52.12	3.89	0.31	3.58
2	Charadagadia	GW2	20.7961	85.18	82.18	7.0	0.50	6.50
3	Motonga	GW3	20.8018	85.3109	48.16	3.74	0.36	3.38
4	Ganthigadia	GW4	20.8042	85.2443	77.17	1.67	0.53	1.14
5	Narendrapur	GW5	20.8246	85.2588	51.12	8.89	0.31	8.58
6	Sarapa	GW6	20.8202	85.2713	72.13	1.29	0.51	0.78
7	Galpada	GW7	20.7710	85.2950		4.29	0.41	3.88
8	Kochilamara	GW8	20.7923	85.2799	65.19	5.69	0.21	5.48
9	Khaliberena	GW9	20.7820	85.2396	65.23	4.43	0.17	4.26
10	Sivapur	GW10	20.8045	85.2718	62.16	6.8	0.0	6.8
	Surface Water Location							
11	Lingara U/S	SW1	20.7764	85.2621	64.23	-	-	-
12	Lingara D/S	SW2	20.7913	85.3099	42.19	-	-	-
13	Kesinda U/S	SW3	20.8159	85.2552	67.14	-	-	-
14	Kesinda D/S	SW4	20.815	85.255	50.13	-	-	-

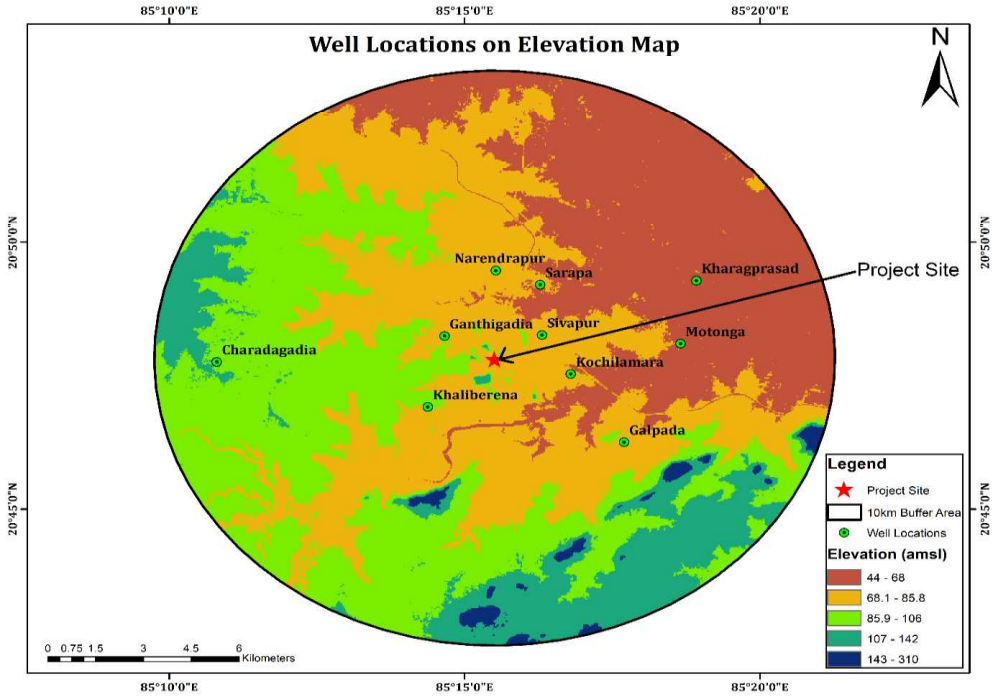


Fig. 2.6 River Network and Well Locations

Streams are marked into different orders from 1st order to 6th order. The stream lengths of different orders are shown in the Table below. A total of 119 streams with its corresponding lengths (Table 2.7) are located from the site of buffer zone. From the distribution it seems the river networks are well distributed over the study area and the adjoining parts.

The 10 Km buffer of the study area is covered by the Hindol and Oda Pada blocks, which are in the southern mountainous regions of the Dhenkanal district in Odisha. The elevation of the study area ranges between 32m to 223m (Figure 2.2). The hill slopes are covered with moderate to dense forests. The topography is sloping in the East direction. The Brahmani is the major river in the study area. The drainage pattern is dentritic in nature.

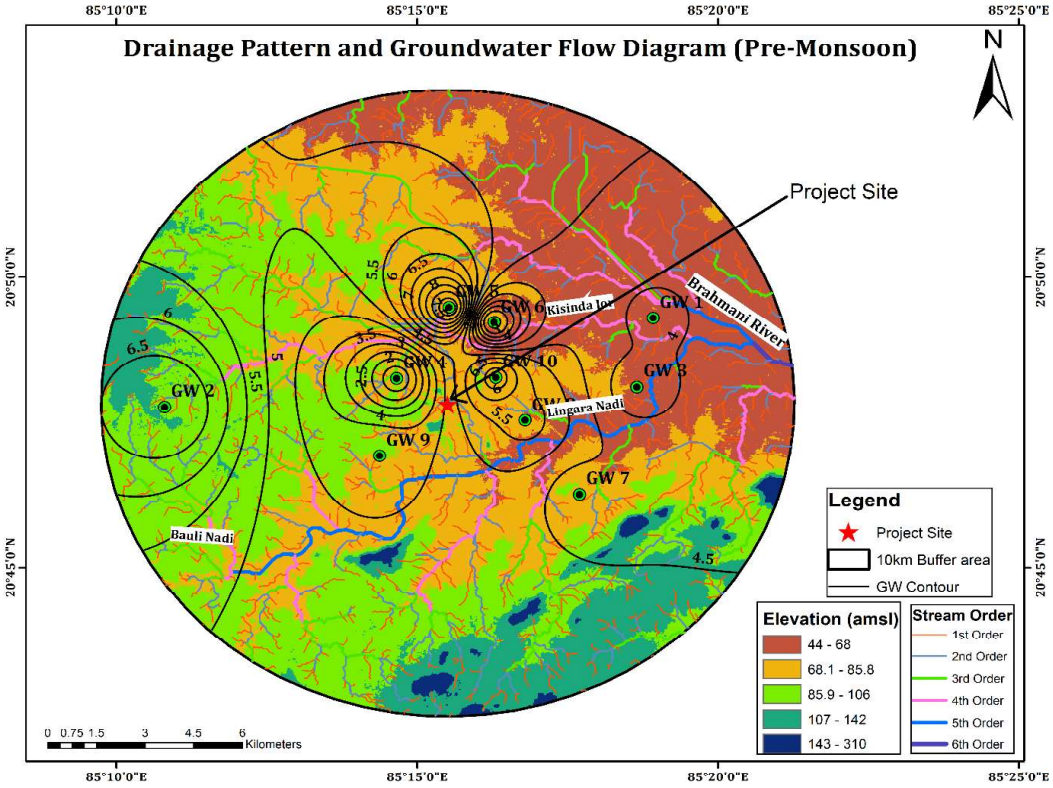


Figure 2.7 (1) Map showing water elevation level around the study Area (March'24)

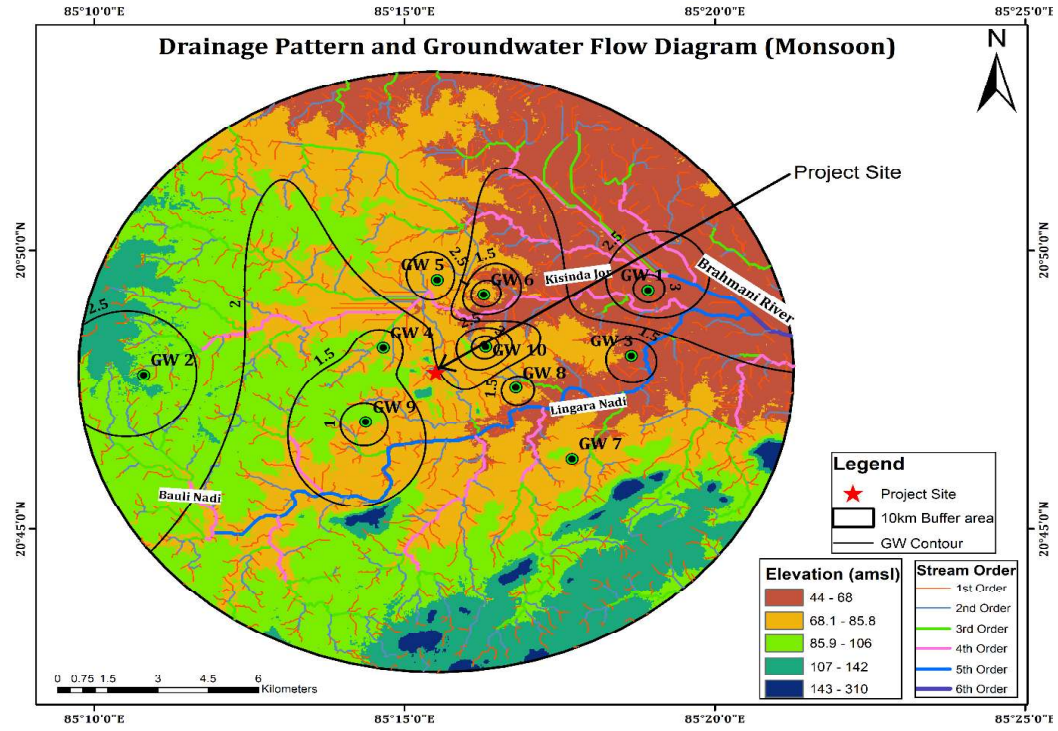


Figure 2.7 (2) Map showing water elevation level around the study Area (Aug'24)

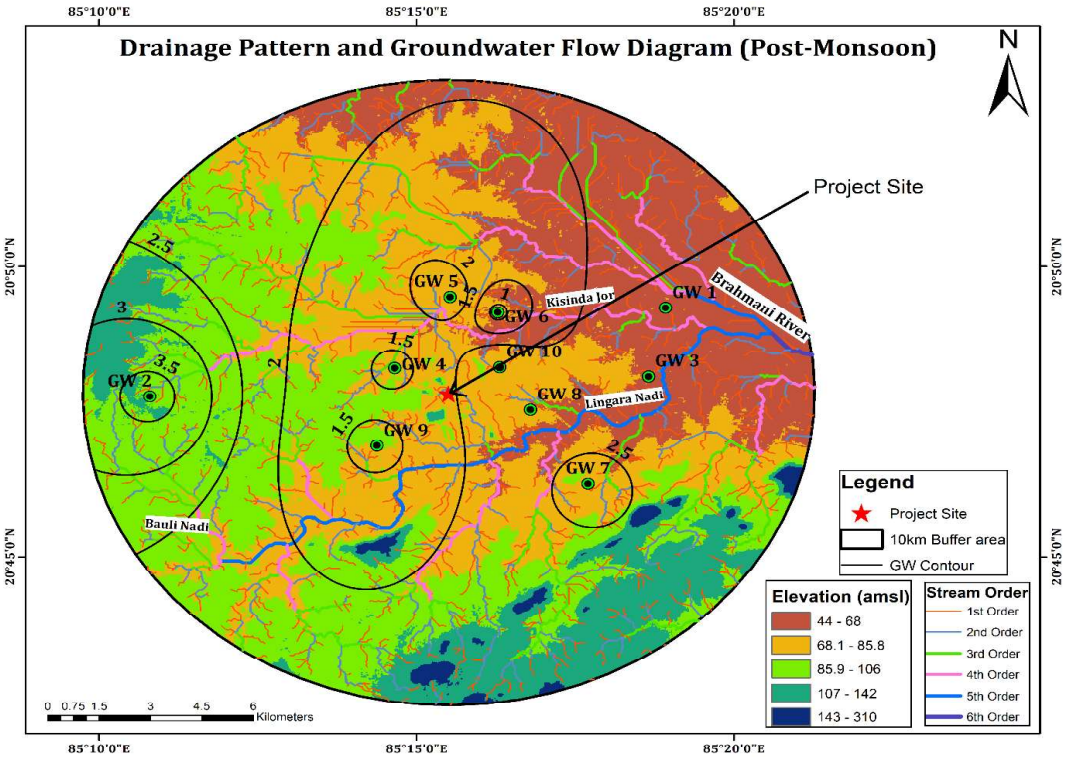


Figure 2.7 (2) Map showing water elevation level around the study Area (Nov'24

Table 2.7 Showing number of streams and its length in mt.					
Sl. No.	River Length(m)	Sl. No.	River Length(m)	Sl. No.	River Length(m)
1	49.79	41	17.2	81	412.1
2	1986.8	42	18481.4	82	296.3
3	1011.2	43	1232.5	83	424.3
4	1570	44	722.6	84	471.2
5	866.5	45	853.5	85	579.3
6	776.2	46	413	86	1098.7
7	1083	47	1969.1	87	4328.8
8	844	48	1648.4	88	384.6
9	2012.2	49	1207.7	89	410.4
10	805.5	50	1468	90	1476.7
11	602.6	51	1495.5	91	1299.2
12	720.8	52	695.3	92	1059.3
13	566	53	4488.8	93	460.4
14	530	54	4545.3	94	337.2
15	1723	55	577.1	95	421.5
16	485.9	56	1081.6	96	370.6
17	1934.9	57	497.1	97	278.1
18	4164.4	58	22.2	98	404.4
19	432.2	59	433.9	99	458
20	1577.4	60	4324.7	100	2323.4
21	901.14	61	9851.9	101	652.6
22	466.3	62	835.1	102	876.2
23	974.7	63	361.2	103	777.7
24	5682.6	64	196.8	104	1196.6
25	558.9	65	198.5	105	551.3
26	431.6	66	484.6	106	725.9
27	512.9	67	1270.4	107	1125.4
28	1134.6	68	903.5	108	760.9
29	2180.6	69	8845	109	514.5
30	8776.3	70	3806.2	110	959
31	957.3	71	893.2	111	7545.9
32	366.2	72	2646	112	802.6
33	2441.8	73	605.6	113	1633.1
34	378.3	74	7145	114	425.3
35	515.2	75	707.4	115	1491.9
36	578.2	76	165.8	116	341
37	27	77	273.33	117	3387
38	391.2	78	458.9	118	718
39	619.5	79	4282	119	450
40	550.9	80	712.4	120	

Impact of rainfall and infiltration basing on the geological strata leads to groundwater storage, which can be well marked through Water Tables at open wells. Accordingly, the water levels

were collected on March, August and November 2024 kept for comparison in subsequent period of time.

Table 2.8. Ground Water Table of different season (mt)

Sl No	Location ID	Elevation (mt)	Pre-monsoon (March'24)			Monsoon (Aug'24)			March'24 Post Monsoon (Nov'24)		
			BGL	AGL	Net WT	BGL	AGL	Net WT	BGL	AGL	Net WT
1	GW1	52.12	3.89	0.31	3.58	3.12	0.31	2.81	2.38	0.31	2.07
2	GW2	82.18	7.0	0.50	6.50	2.80	0.50	2.30	3.60	0.50	3.10
3	GW3	48.16	3.74	0.36	3.38	1.28	0.36	1.28	2.19	0.36	1.83
4	GW4	77.17	1.67	0.53	1.14	1.37	0.53	0.84	1.40	0.53	0.87
5	GW5	51.12	8.89	0.31	8.58	2.99	0.31	2.68	2.25	0.31	1.94
6	GW6	72.13	1.29	0.51	0.78	0.63	0.51	0.12	0.91	0.51	0.40
7	GW7	-	4.29	0.41	3.88	1.89	0.41	1.48	2.69	0.41	2.28
8	GW8	65.19	5.69	0.21	5.48	1.34	0.21	1.13	2.26	0.21	2.05
9	GW9	65.23	4.43	0.17	4.26	0.83	0.17	0.66	1.38	0.17	1.21
10	GW10	62.16	6.8	0.0	6.8	3.3	0.0	3.3	2.51	0.0	2.51

As per Table 2.8, which shows the variation of WT during pre-monsoon, monsoon and post monsoon season.

Pre-monsoon: It is seen that, out of the 10 wells the water table maximum varied from 8.58 m at Narendrapur to 1.14 m at Ganthigadia. While looking through Fig.2.7A, the slope of Water Table is visible from Narendrapur to Sarapa. There is a sharp declination of WT between Motonga to Ganthigadia and Narendrapur to Sivapur.

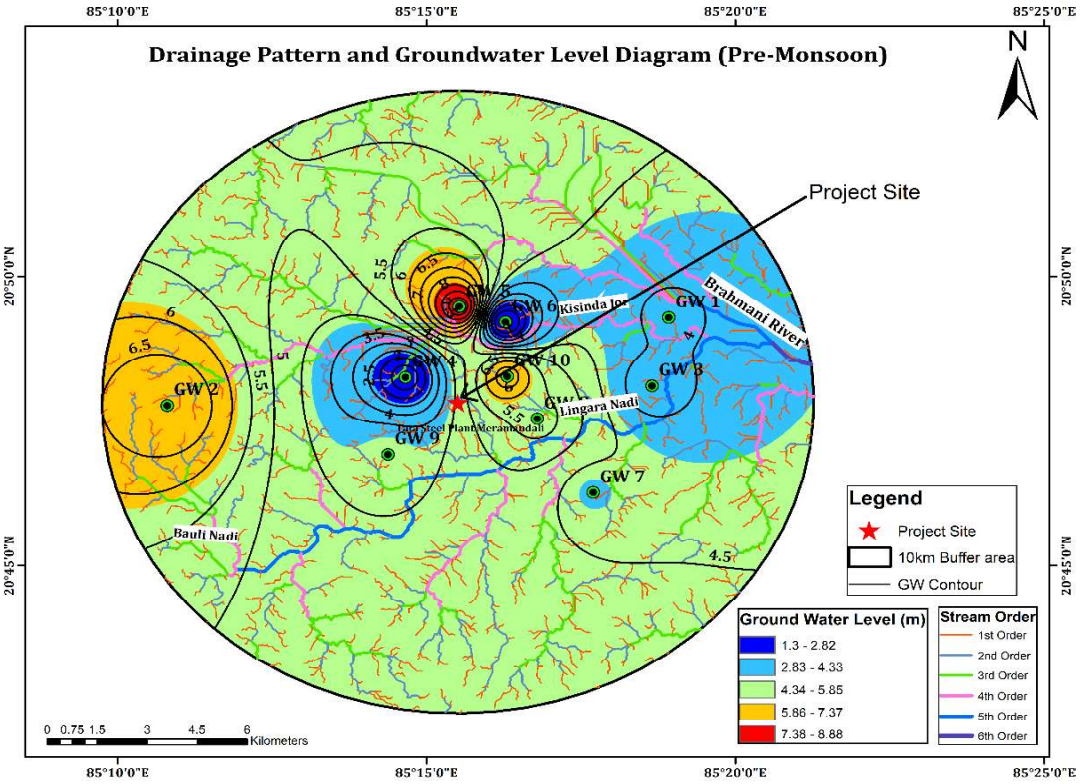


Figure 2.6 (1) Map showing ground water level around the study Area (March'24)

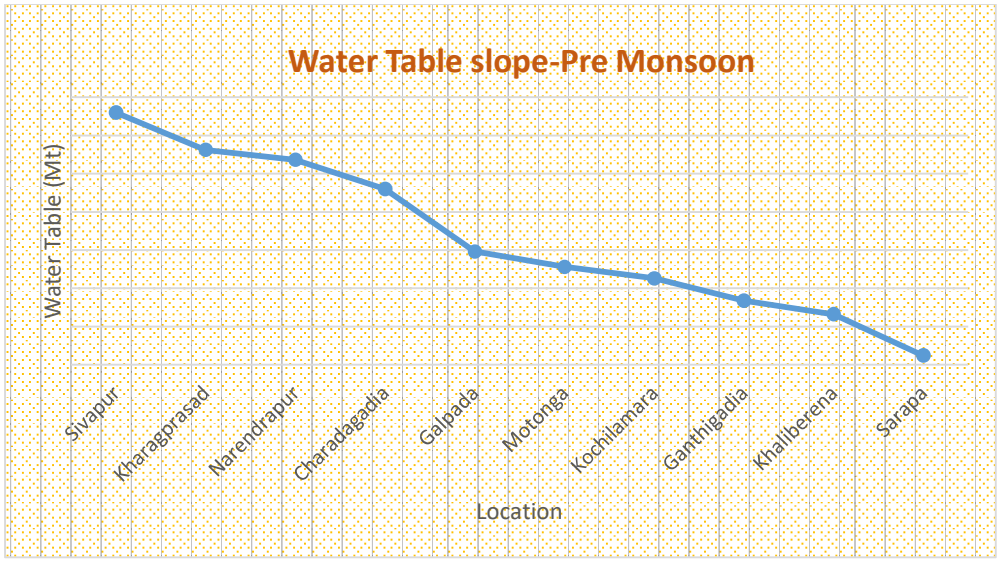


Fig. 2.6 A. Water Table slope (Pre-Monsoon)

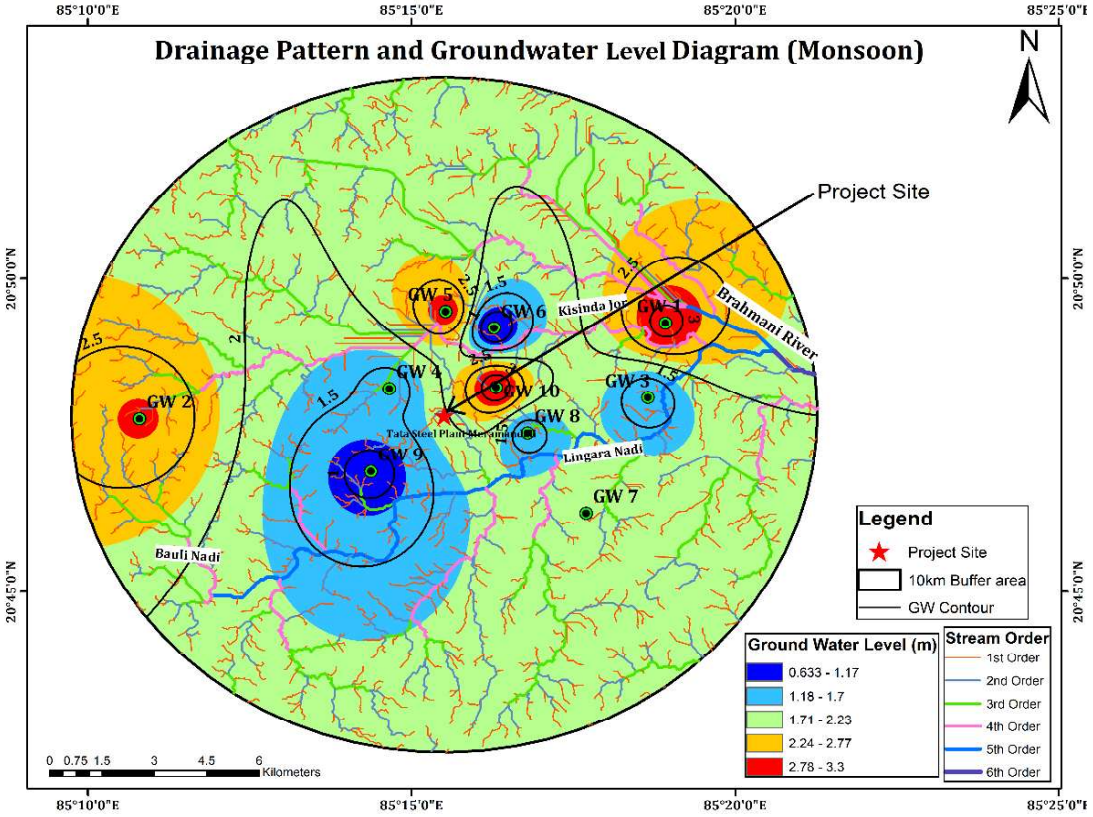


Figure 2.6 (2) Map showing ground water level around the study Area (Aug'24).

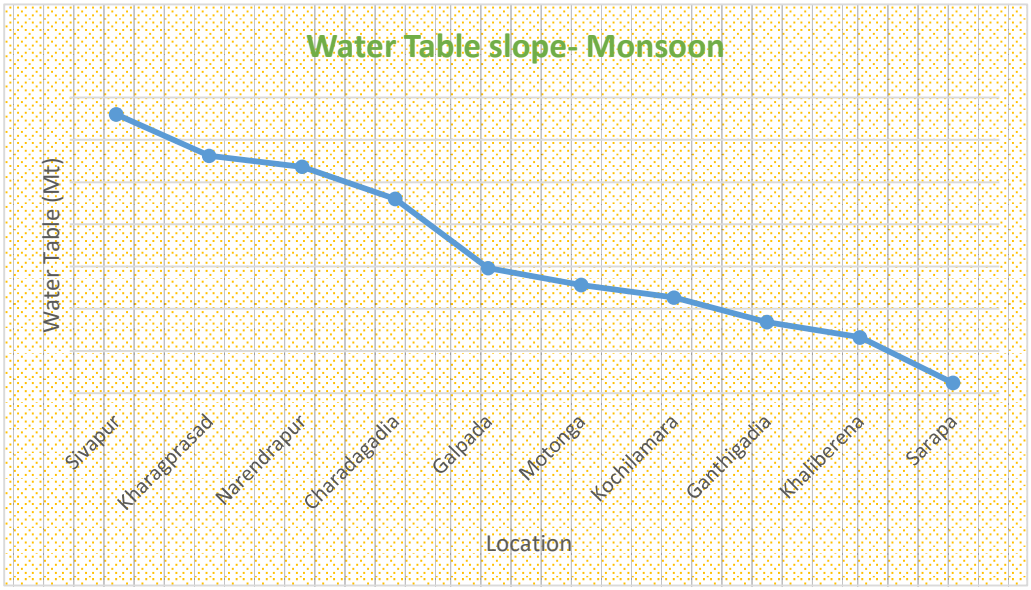


Fig. 2.6 B. Water Table slope (Monsoon)

Monsoon : As per Table 2.8, the net water table varied from maximum 3.3 m at Sivapur to 0.12 m at Sarapa. The water table slope (Fig.2.6B) shows the comparative variation of water table for 10 locations of wells and the slope of water table. The Galpada, Motonga, Kochilmara sites show a very little variation in WT whereas the slope declines from Charadagadia to Galpada and continues sharply to other sites.

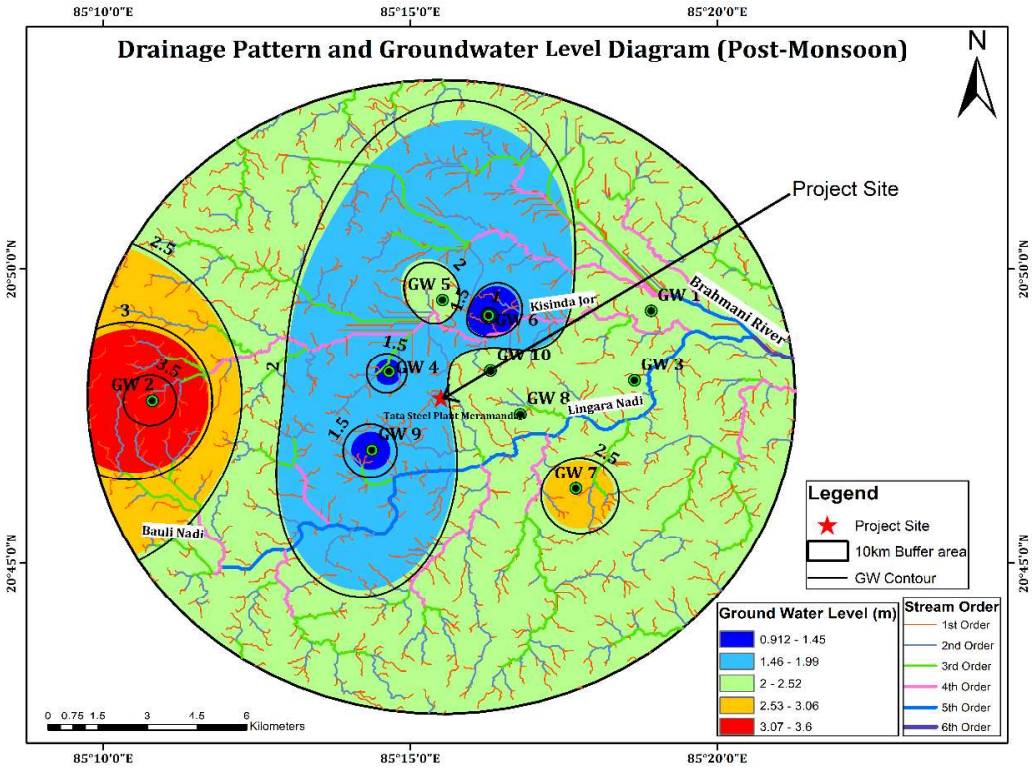


Figure 2.6 (3) Map showing water level around the study Area (Nov'24)

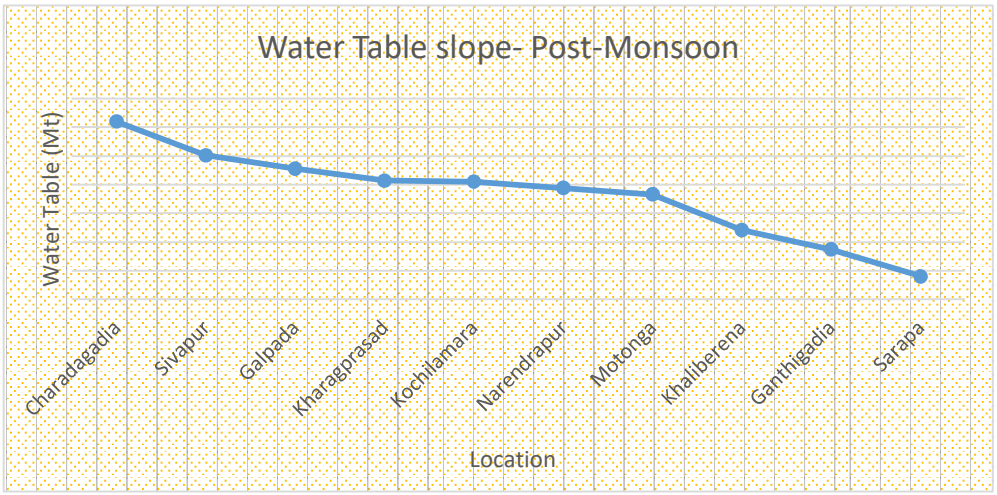


Fig. 2.7C. Water Table slope (Post-Monsoon)

During post-monsoon period when the survey was made on 14.11.2024, it was seen that (Fig.2.7C), the Charadagadia has a deepest depth of water table i.e at 3.10 m, followed by Kharagprasad at 2.07 m, whereas Sarapa has the lowest depth of 0.40m. The water table slope shown in Fig.3C explain that the Sarapa site has the lowest WT depth whereas the Charadagadia has the highest depth**.** Thus a comparative study of these wells is made (Fig.2.7D) and it was found that there is a wide variation of water table in Narendrapur during, post and pre monsoon. However, the variation between post and pre-monsoon is much wider. During monsoon, there was a rising WT between Narendrapur, Charadagadia and Sivapur, but that slope just reverses during post and finally during pre-monsoon the slope is much wider. The sites of Sarapa and Ganthigadia show very less variation in WT.

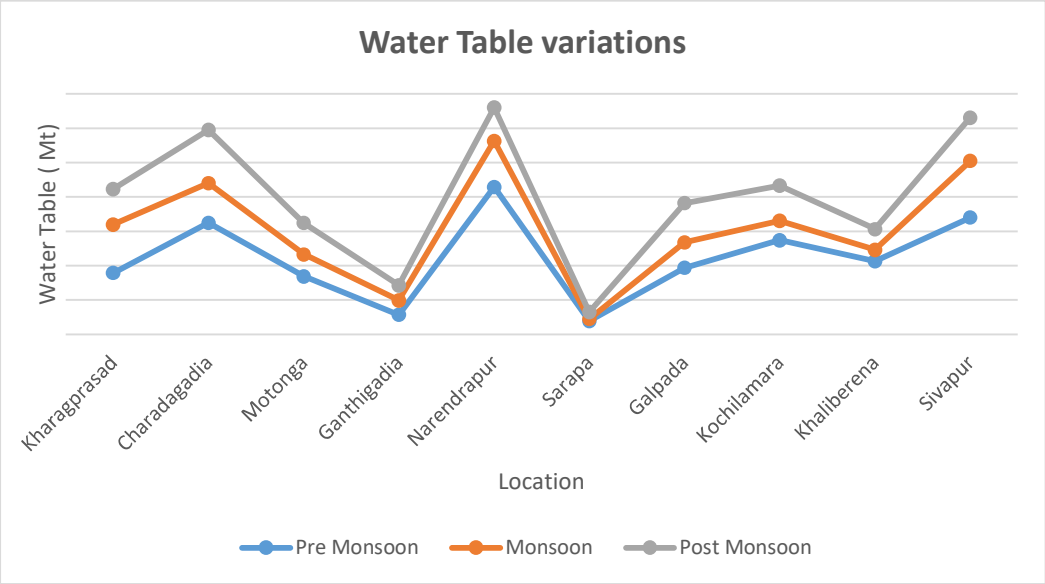


Fig 2.7 D Water Table at Wells at different phases (Year 2024)

Analysis of different chemical constituents present in water (both ground and surface water) is made as per the sample taken at different period of time (Table 2.10A). Generally, the water meets the requirement of drinking water specification as per IS 10500:2012. Other properties like conductivity, hardness, alkalinity, chloride, fluoride, nitrate and chromium shows within permissible limit for all the wells. The fluoride content is higher (but within permissible limit) for sites GW3 and GW4.

Table 2.10 A. Physico-chemical constituent of Ground water (March 2024)

#	Parameters	Unit	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8	GW9	GW10	Norms
1	Turbidity,	NTU	3.45	1.70	1.66	4.71	7.75	13.28	1.19	0.75	1.10	2.70	5.0
2	pH Value	-	6.76	7.11	7.29	7.54	7.52	6.80	7.05	7.16	7.57	7.59	6.5-8.5
3	TDS	mg/L	277.0	1268.0	676.0	591.0	565.0	1390	186.0	503	484.0	493.0	2000
4	Total Hardness	mg/L	160.0	608.0	632.0	436.0	324.0	580.0	104.0	316.0	372.0	332.0	600
5	Calcium	mg/L	40.08	35.27	89.78	83.37	16.03	136.27	32.06	52.91	83.37	80.16	200
6	Magnesium	mg/L	14.58	126.62	99.14	55.40	69.01	58.32	5.83	44.71	39.85	32.08	100
7	Total Alkalinity	mg/L	140.0	484.0	320.0	413.0	376.0	216.0	96.0	392.0	364.0	304.0	600
8	Chloride	mg/L	29.0	240.0	118.0	47.0	45.0	425.0	15.00	50.0	40.0	57.0	1000
9	Sulfate	mg/L	30.67	125.4	129.9	82.02	62.25	157.4	13.61	57.25	47.26	63.39	400
10	Fluoride	mg/L	0.12	0.98	1.0	1.10	0.94	0.39	0.19	1.10	0.55	0.46	1.5
11	Iron	mg/L	0.228	0.125	0.153	0.301	0.172	0.471	0.989	0.238	0.339	0.157	0.30
12	Copper	mg/L	0.012	0.007	0.005	0.013	0.008	0.021	0.032	0.011	0.018	0.014	1.5
13	Manganese	mg/L	0.025	0.032	0.060	0.028	0.354	1.004	0.077	0.027	0.027	0.086	0.3
14	Zinc	mg/L	0.057	0.079	0.064	0.108	0.064	0.147	0.227	0.073	0.089	0.084	15
15	Lead	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
16	Cadmium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003
17	Chromium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.05
18	Nickel	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.02
19	Color	Hazen	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	15
20	Odour	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
21	EC	µs/cm	450	1772	1275	1015	964	1663	248	869	845	669	-
22	TSS	mg/L	3.0	6.0	2.0	6.0	8.0	26.0	2.0	2.0	12.0	4.0	
23	Nitrite	mg/L	0.048	0.556	0.039	0.181	0.089	0.121	0.024	0.115	0.045	0.026	-
24	Nitrate	mg/L	12.3	182.0	12.1	17.2	10.63	28.2	3.12	49.6	3.58	3.76	45
25	Sodium	mg/L	9.84	167.48	69.8	30.47	75.36	108.29	7.72	89.2	36.57	19.62	-
26	Potassium	mg/L	10.33	5.61	1.33	0.33	3.39	0.93	0.44	0.55	0.67	16.89	-
27	Chlorine	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	1.0
28	Arsenic	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
29	TC	MPN	348/100ml	221/100ml	17/100ml	542/100ml	542/100ml	2/100ml	141/100ml	542/100ml	542/100ml	542/100ml	-
30	FC	MPN	10/100ml	4/100ml	2/100ml	39/100ml	120/100ml	2/100ml	2/100ml	14/100ml	2/100ml	14/100ml	-

Table 2.10 B. Physico-chemical constituent of Surface Water (March 2024)

#	Characteristics	Unit	SW1	SW2	SW3	SW4
1.	pH	@25^{0}C	8.38	7.77	7.98	7.97
2.	Colour	Hazen	1.6	1.4	<5	<5
3.	EC	µs/cm	431	708	950	995
4.	TDS	mg/l	248	596.0	608.0	508.0
5.	DO	mg/l	8.6	6.0	9.0	9.5
6.	BOD (3) days at 27˚C	mg/l	1.8	2.6	4.5	3.1
7.	Chloride	mg/l	37.0	82.0	91.0	143.0
8.	Fluoride as F	mg/l	0.63	1.60	3.20	1.80
9.	Sulphates	mg/l	11.38	65.43	186.76	140.18
10.	Nitrate	mg/l	2.54	10.8	3.62	9.10
11.	Hexavalent Chromium as Cr +6	mg/l	0.016	0.022	0.009	0.008
12.	Cyanide as CN	mg/l	<0.03	<0.03	<0.03	<0.03
13.	Copper as Cu	mg/l	0.016	0.007	0.013	0.006
14.	Iron as Fe	mg/l	0.160	0.175	0.138	0.252
15.	Cadmium as Cd	mg/l	<0.001	<0.001	<0.001	<0.001
16.	Selenium as Se	mg/l	<0.001	<0.001	<0.001	<0.001
17.	Arsenic as As	mg/l	<0.001	<0.001	<0.001	<0.001
18.	Lead as Pb	mg/l	<0.001	<0.001	<0.001	<0.001
19.	Zinc as Zn	mg/l	0.035	0.079	0.108	0.036
20.	Sodium Absorption Ratio	-	7.51	10.79	6.57	9.72
21.	Total Coliform	MPN	348/100ml	221/100ml	172/100ml	542/100ml
22.	Faecal Coliform	MPN	14/100ml	7/100ml	33/100ml	9/100ml
23.	Manganese as Mn	mg/l	0.028	0.032	0.028	0.025
24.	Sodium as Na	mg/l	37.08	74.25	49.99	66.18
25.	Potassium as K	mg/l	2.84	11.52	3.47	7.97
26.	Nickel as Ni	mg/l	0.001	0.008	0.004	0.007
27.	COD	mg/l	24.0	22.0	20.0	16.0
28.	Free Ammonia	mg/l	<0.01	<0.01	<0.01	<0.01
29.	Boron as B	mg/l	0.004	0.001	0.006	0.004

All the parameters are within the safer limit for the surface water sample collected during Pre –monsoon, the PH value which is towards more alkalinity (Table 2.10B). All parameters tested for open well sites remain within safer limit for the open well samples collected during monsoon season (Table 2.11A).

Table 2.11 A. Physico-chemical constituent of Ground water (August 2024)

#	Parameters	Unit	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8	GW9	GW10	Norms
1	Turbidity,	NTU	0.56	0.78	0.73	2.43	4.08	0.49	0.59	0.43	1.17	2.03	5.0
2	pH Value	-	6.46	6.96	6.97	7.60	7.22	7.48	6.88	7.21	7.22	7.42	6.5-8.5
3	TDS	mg/L	258.0	1241.0	697.0	473.0	535.0	505.0	252.0	643.0	267.0	240.0	2000
4	Total Hardness	mg/L	168.0	604.0	418.0	324.0	318.0	390.0	166.0	420.0	176.0	154.0	600
5	Calcium	mg/L	46.49	36.07	84.17	36.87	11.22	79.36	54.51	76.15	14.43	52.10	200
6	Magnesium	mg/L	12.64	124.9	50.54	56.38	70.47	46.66	7.29	55.89	34.02	5.83	100
7	Total Alkalinity	mg/L	140.0	456.0	326.0	240.0	264.0	304.0	158.0	362.0	200.0	126.0	600
8	Chloride	mg/L	30.0	180.0	70.0	40.0	48.0	42.0	22.0	58.0	18.0	24.0	1000
9	Sulfate	mg/L	29.19	138.13	139.13	115.7	79.51	92.59	21.26	102.15	35.98	33.46	400
10	Fluoride	mg/L	0.21	0.72	0.80	0.95	0.68	0.55	0.22	0.81	0.59	0.64	1.5
11	Iron	mg/L	0.065	0.168	0.068	0.090	0.027	0.204	0.394	0.169	0.053	0.113	0.30
12	Copper	mg/L	0.031	0.031	0.026	0.029	0.027	0.024	0.025	0.028	0.049	0.039	1.5
13	Manganese	mg/L	0.019	0.009	0.014	0.018	0.008	0.018	0.048	0.034	0.013	0.019	0.3
14	Zinc	mg/L	0.199	0.107	0.197	0.117	0.086	0.098	0.096	0.078	0.128	0.277	15
15	Lead	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
16	Cadmium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003
17	Chromium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	0.153	<0.001	0.206	<0.001	<0.001	0.05
18	Nickel	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.02
19	Color	Hazen	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	15
20	Odour	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
21	EC	µs/cm	432	1804	1094	773	842	790	389	1052	481	415	-
22	TSS	mg/L	3.0	7.0	5.0	8.0	10.0	6.0	3.0	2.0	5.0	8.0	
23	Nitrite	mg/L	0.217	0.618	0.102	0.247	0.267	0.079	0.031	0.341	0.037	0.148	-
24	Nitrate	mg/L	20.9	162.0	25.6	40.5	51.9	4.39	2.65	68.0	5.65	25.30	45
25	Sodium	mg/L	14.59	167.95	77.71	29.15	55.50	20.54	15.09	78.67	15.12	16.38	-
26	Potassium	mg/L	14.57	5.55	2.99	18.66	6.39	1.63	0.70	2.14	3.43	13.85	-
27	Chlorine	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	1.0
28	Arsenic	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
29	TC	MPN	>542/100ml	>542/100ml	221/100ml	>542/100ml	348/100ml	542/100ml	>542/100ml	>542/100ml	>542/100ml	>542/100ml	-
30	FC	MPN	17/100ml	>542/100ml	79/100ml	21/100ml	11/100ml	<2/100ml	5/100ml	7/100ml	348/100ml	32/100ml	-

Table 2.11 B. Physico-chemical constituent of Surface Water (August 2024)

#	Characteristics	Unit	SW1	SW2	SW3	SW4
1.	pH	@25^{0}C	7.45	7.43	7.66	7.69
2.	Colour	Hazen	<5	<5	<5	<5
3.	EC	µs/cm	270	272	447	481
4.	TDS	mg/l	145.0	151.0	232	263
5.	DO	mg/l	5.4	5.8	6.2	5.8
6.	BOD (3) days at 27˚C	mg/l	1.6	2.0	5.2	1.6
7.	Chloride	mg/l	16.0	14.0	26.0	26.0
8.	Fluoride as F	mg/l	0.41	0.41	3.1	2.6
9.	Sulphates	mg/l	5.11	21.44	23.1	40.2
10.	Nitrate	mg/l	2.72	2.48	5.55	3.92
11.	Hexavalent Chromium as Cr +6	mg/l	0.012	0.014	0.016	0.024
12.	Cyanide as CN	mg/l	<0.03	<0.03	<0.03	<0.03
13.	Copper as Cu	mg/l	0.020	0.019	0.019	0.026
14.	Iron as Fe	mg/l	0.369	0.702	0.128	0.149
15.	Cadmium as Cd	mg/l	<0.001	<0.001	<0.003	<0.003
16.	Selenium as Se	mg/l	<0.001	<0.001	<0.001	<0.001
17.	Arsenic as As	mg/l	<0.001	<0.001	<0.001	<0.001
18.	Lead as Pb	mg/l	<0.001	<0.001	<0.001	<0.001
19.	Zinc as Zn	mg/l	0.063	0.081	0.129	0.053
20.	Sodium Absorption Ratio	-	3.88	3.56	4.95	6.45
21.	Total Coliform	MPN	542/100ml	>542/100ml	345/100ml	>542/100ml
22.	Fecal Coliform	MPN	348/100ml	120/100ml	109/100ml	278/100ml
23.	Manganese as Mn	mg/l	0.083	0.064	0.039	0.045
24.	Sodium as Na	mg/l	15.12	14.69	23.67	31.24
25.	Potassium as K	mg/l	3.43	3.37	3.66	3.69
26.	Nickel as Ni	mg/l	<0.001	<0.001	<0.001	<0.001
27.	COD	mg/l	12.0	16.0	24.0	28.0
28.	Free Ammonia	mg/l	<0.01	<0.01	<0.01	<0.01
29.	Boron as B	mg/l	<0.01	<0.01	<0.01	<0.01

All parameters tested for the surface water samples collected during monsoon season (Table 2.11B), are within permissible limit. During post-monsoon period (Table-2.12A) the GW1 and GW9 shows fluoride content is higher while other parameters remain within safer limit.

Table 2.12 A. Physico-chemical constituent of Ground water (November 2024)

#	Parameters	Unit	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8	GW9	GW10	Norms
1	Turbidity,	NTU	1.21	2.28	1.15	1.64	0.67	9.23	0.42	0.46	0.41	1.39	5.0
2	pH Value	-	6.88	7.25	7.56	7.43	7.41	7.83	7.09	7.49	7.61	7.61	6.5-8.5
3	TDS	mg/L	303.0	1392.0	810.0	841.0	539.0	461.0	283.0	738.0	484.0	366.0	2000
4	Total Hardness	mg/L	166.0	686.0	422.0	572.0	322.0	284.0	138.0	376.0	296.0	230.0	600
5	Calcium	mg/L	35.27	75.35	92.18	63.33	55.31	78.56	36.07	46.49	56.91	55.31	200
6	Magnesium	mg/L	18.95	121.01	46.66	100.60	44.71	21.38	11.66	63.18	37.42	22.36	100
7	Total Alkalinity	mg/L	124.0	504.0	364.0	470.0	286.0	212.0	142.0	454.0	342.0	196.0	600
8	Chloride	mg/L	21.0	181.0	80.0	64.0	44.0	65.0	14.0	63.0	18.0	33.0	1000
9	Sulfate	mg/L	36.73	147.19	137.12	119.26	46.80	52.08	19.40	83.03	49.82	37.24	400
10	Fluoride	mg/L	0.18	1.10	1.00	1.00	0.82	0.54	0.28	1.00	0.71	0.59	1.5
11	Iron	mg/L	0.270	0.181	0.112	0.137	0.245	0.152	0.216	0.216	0.176	0.162	0.30
12	Copper	mg/L	0.103	0.070	0.090	0.074	0.114	0.112	0.110	0.1034	0.076	0.096	1.5
13	Manganese	mg/L	0.017	0.016	0.002	<0.005	<0.005	<0.005	<0.005	<0.005	0.002	0.044	0.3
14	Zinc	mg/L	0.097	0.186	0.115	0.139	0.059	0.177	0.051	0.052	0.095	0.016	15
15	Lead	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.001
16	Cadmium	mg/L	0.090	0.081	<0.003	0.064	0.003	0.064	<0.003	0.083	0.067	0.059	0.003
17	Chromium	mg/L	0.275	0.076	0.091	0.076	0.382	0.122	0.031	0.153	0.107	0.183	0.05
18	Nickel	mg/L	0.089	0.077	0.098	0.035	0.074	0.068	0.012	0.083	0.080	0.104	0.02
19	Color	Hazen	<5	<5	< 5	<5	< 5	<5	<5	<5	<5	<5	15
20	Odour	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
21	EC	µs/cm	413	1973	1156	1185	821	688	350	1181	716	561	-
22	TSS	mg/L	3.7	4.8	2.6	4.1	2.4	14.2	1.5	1.9	2.9	2.8	
23	Nitrite	mg/L	0.127	0.527	0.085	0.215	0.218	0.122	0.075	0.264	0.081	0.049	-
24	Nitrate	mg/L	19.2	184	16.7	34.3	39.6	13.1	12.8	61.0	14.3	6.12	45
25	Sodium	mg/L	14.85	159.6	77.02	34.18	50.54	27.83	10.80	95.32	33.08	13.8	-
26	Potassium	mg/L	12.27	4.84	1.22	3.01	5.89	2.13	0.46	1.53	1.11	16.58	-
27	Chlorine	mg/L	<0.01	,0.01	<0.1	<0.1	<0.1	<0.01	<0.1	<0.01	<0.01	<0.01	1.0
28	Arsenic	mg/L	<0.001	<0.001	<0.010	<0.001	<0.010	<0.001	<0.010	<0.001	<0.001	<0.001	<0.001
29	TC	MPN	>542/100ml	278/100ml	33/100ml	>542/100ml	348/100ml	11/100ml	348/100ml	542/100ml	221/100ml	542/100ml	-
30	FC	MPN	33/100ml	120/100ml	2/100ml	79/100ml	39/100ml	2/100ml	11/100ml	14/100ml	17/100ml	21/100ml	-

Table 2.12 B. Physico-chemical constituent of Surface Water (November 2024)

#	Characteristics	Unit	SW1	SW2	SW3	SW4
1.	pH	@25^{0}C	8.36	7.91	8.33	8.03
2.	Colour	Hazen	20	25	15	20
3.	EC	µs/cm	499	598	711	1004
4.	TDS	mg/l	309.0	360.0	448.0	692.0
5.	DO	mg/l	9.9	8.6	9.0	8.8
6.	BOD (3) days at 27˚C	mg/l	6.9	3.0	5.4	3.4
7.	Chloride	mg/l	25.0	41.0	35.0	126.0
8.	Fluoride as F	mg/l	0.70	1.50	5.2	3.5
9.	Sulphates	mg/l	10.54	27.42	41.01	111.96
10.	Nitrate	mg/l	6.28	17.0	10.2	17.7
11.	Hexavalent Chromium as Cr +6	mg/l	<0.01	<0.01	<0.01	<0.01
12.	Cyanide as CN	mg/l	<0.03	<0.03	<0.03	<0.03
13.	Copper as Cu	mg/l	0.065	0.147	0.074	0.107
14.	Iron as Fe	mg/l	0.078	0.412	0.078	0.211
15.	Cadmium as Cd	mg/l	0.060	0.093	0.048	0.083
16.	Selenium as Se	mg/l	<0.01	<0.01	<0.01	<0.01
17.	Arsenic as As	mg/l	0.005	0.007	0.008	0.011
18.	Lead as Pb	mg/l	<0.01	<0.01	<0.01	<0.01
19.	Zinc as Zn	mg/l	0.005	0.032	0.108	0.010
20.	Sodium Absorption Ratio	-	7.05	7.40	10.28	10.81
21.	Total Coliform	MPN	542	348	348	>542
22.	Fecal Coliform	MPN	32	120	33	120
23.	Manganese as Mn	mg/l	<0.005	<0.005	0.017	<0.01
24.	Sodium as Na	mg/l	37.31	39.95	62.36	72.05
25.	Potassium as K	mg/l	1.94	4.52	2.11	5.89
26.	Nickel as Ni	mg/l	0.065	0.056	0.074	0.098
27.	COD	mg/l	24.0	28.0	40.0	36.0
28.	Free Ammonia	mg/l	<0.01	<0.01	<0.01	<0.01
29.	Boron as B	mg/l	0.014	0.019	0.012	0.018

During post-monsoon period for surface water (Table-2.12B) the fluoride content is much higher in 2 locations except SW1 and SW 2 while other parameters remain within safer limit.

Table-2.13 Review of ground water level

Water Level					2022		2023		2024		Standard Deviation	Remarks
Sl No	Station Name	Location ID	Latitude	Longitude	Rain Fall (mm)	Water Level (Mt)	Rain Fall (mm)	Water Level (Mt)	Rain Fall (mm)	Water Level (Mt)		
1	Kharagprasad	GW1	20.8215	85.3154	1038	7.12	962	7.27	1050	7.81	0.29	Negligible Change
2	Charadagadia	GW2	20.7961	85.1800		7.12		7.27		7.81	0.29	Negligible Change
3	Motonga	GW3	20.8018	85.3109		7.12		7.27		7.81	0.29	Negligible Change
4	Narendrapur	GW5	20.8246	85.2588		7.12		7.27		7.81	0.29	Negligible Change
5	Kochilamara	GW8	20.7923	85.2799		7.12		7.27		7.81	0.29	Negligible Change
6	Sivapur	GW10	20.8045	85.2718		7.12		7.27		7.81	0.29	Negligible Change
7	Ganthigadia	GW4	20.8042	85.2443	1718	9.06	1628	9.71	1716	9.5	0.27	Negligible Change
8	Sarapa	GW6	20.8202	85.2713		9.06		9.71		9.5	0.27	Negligible Change
9	Galpada	GW7	20.7710	85.2950		9.06		9.71		9.5	0.27	Negligible Change
10	Khaliberena	GW9	20.7820	85.2396		9.06		9.71		9.5	0.27	Negligible Change
11	**Standard Deviation**					**0.95**		**1.19**		**0.83**	-	

Note : Sl 1 to 6 – Odapada Block , Sl No 7 to 10- Hindol Block

Source- CGWB report

Review of Ground Water Level:

The seasonal fluctuation of water table has been depicted in above table-2.13. A study of the above table reveals that in the study area (Hindol and Odapada block) of the water table is in the range of 7 m to 9 m. There is not much fluctuation in water level in the last three years, which is again confirmed from the standard deviation. Considering the minor magnitude of rise and fall of water level over a period of 03 years both the rise and fall values can be ignored in both the cases. From the long-term trend data there is no significant variation in ground water level in the study area.

Water samples were collected in pre-monsoon, monsoon and post monsoon season and analysed for various physico chemical parameters. Table- 2.10 A, 2.11 A & 2.12 A depicts the water quality data. It reveals that pH, fluoride of all ground water (GW1-GW10) for all season lies within specification of IS 10500:2012. The key parameters are also within the limit.
The groundwater level contours (**Figures 2.8**) indicates that the groundwater flow direction is from South-West to North-East.

CONCLUSION:

1) No trend in rainfall is found and the negative deviation of rainfall continues with an interval of 2 to 3 years.
2) Within the test period of year 2024 only in 5 years' rainfall has recorded below 1000 mm i.e. in year 2010 (974.9 mm), 2015(903.6 mm), 2017 (826.2 mm), 2015 (903.6 mm).
3) The WT is available at higher depths at Sivapur, Kharagprasad and Narendrapur, but there is a sharp declination in Water Table in Khaliberena and Sarapa during two observational dates of March and August 2024. The Motonga and Kochilmara show very less deviation in Water table during these two observational dates.
4) The physico-chemical properties like pH, Conductivity, Total Hardness, Total Alkalinity, Chloride, Nitrate are within acceptable limit during both the observational dates however Fluoride values are a bit alarming. Particularly the Fluoride value is increasing for the surface & ground water during post-monsoon period, may be due to presence of crystalline host rocks like hornblende biotite gneiss, granitic gneiss, and biotite gneiss, which contribute abundant fluoride-bearing minerals like apatite, micas, and hornblende

supplementary minerals fluoride bearing rocks and lack of enough water in the stream for pollution abatement.

5) No such alarming effect was found in the presence of heavy metals.
6) All the heavy metals concentration in the ground water are well within the standards prescribed in BIS-10500.

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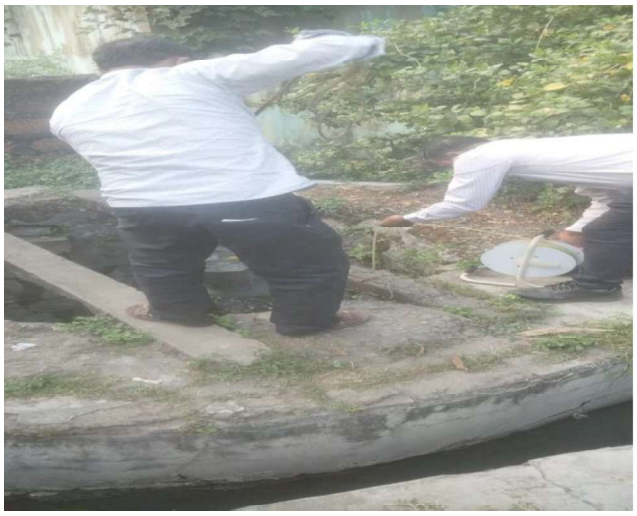
Annexure

Few Photographs taken during sampling



Annexure-VI

(Three Tier Plantation Photos)