भारत कोकिंग कोल लिमिटेड
(एक मिनीरत्न कंपनी)
(कोल इण्डिया लिमिटेड की एक अनुषंगी कंपनी)
(भारत सरकार का उपक्रम)

बीसीसीएल BCCL
भारत कोकिंग कोल लिमिटेड
Bharat Coking Coal Limited

Bharat Coking Coal Limited
(A Miniratna Company)
(A Subsidiary of Coal India Limited)
(A Government of India Undertaking)

OFFICE OF THE GENERAL MANAGER, GOVINDPUR AREA
ENVIRONMENT DEPARTMENT

Ref: BCCL/AR.III/ENVT/2026-27/28 Date: 16.05.2026

Through Email: ro.ranchi-mef@gov.in

To
The Director
Ministry of Environment, Forest & Climate Change
2nd Floor, Headquarter- Jharkhand State Housing Board
Harmu Chowk, Ranchi
Jharkhand-834002

Subject: Six monthly compliance reports on implementation of Environmental measures for the period from October 2025 to March 2026 in respect of Cluster –III coal mining project, BCCL

Ref.: -EC file no. J-11015/100/2011-IA. II (M) (Proposal No. IA/JH/CMIN/513800/2024)
Date of EC grant: 03.03.2025

Dear Sir,

Kindly find enclosed herewith the enclosed six-monthly compliance report on implementation of Environmental measures for the period from **October 2025 to March 2026** in respect of Cluster –III coal mining project, BCCL having leasehold area 1420.61 ha.

This is for your kind information, please.

Encl: As above.

Yours faithfully

General Manager
Govindpur Area
(Cluster-III)
BCCL

महाप्रबंधक
General Manager
गोविन्दपुर क्षेत्र / Govindpur Area
भा.को.को.लि. / B.C.C.L.

CC to (through e-mail):
1. RD, CPCB, Kolkata
2. Regional Officer, JSPCB, Dhanbad
3. GM(Env), BCCL HQ

Six Monthly EC Compliance Report for Cluster-III Coal Mine BCCL, File no: J-11015/213/2010-IA.II(M)
Proposal No. IA/JH/CMIN/513800/2024, Date of EC grant: 03.03.2025

Sl no	EC Condition	EC Compliance Status
	1. A. Specific Conditions:	
1.1	The project proponent shall abide by all orders and judicial pronouncements, made from time to time by the Hon'ble High Court of Jharkhand in Writ Petition No. 4944 of 2011.	Writ Petition No. 4944 of 2011 has been disposed of by Hon'ble High Court of Jharkhand. Copy is enclosed herewith.
1.2	Project proponent shall ensure that diversion of water body, if any, in Cluster III Coal Mine Project shall be done with prior approval of State Government and prior amendment in EC will be sought from MoEF&CC for the same.	Agreed. Necessary prior approval shall be taken from State Government and MoEF&CC.
1.3	3756 Project Affected Families (PAF) will be affected due to the proposed project. The affected families should be rehabilitated as per R & R plan to be approved by the State Government. Compliance status in this regard shall be submitted to the concerned Regional Office of MoEF&CC along with the six-monthly compliance report.	The rehabilitation of Project-Affected Families (PAFs) is an ongoing process jointly conducted by BCCL and the Jharia Rehabilitation Development Authority (JRDA). The initiative has already begun, and 550 families have been relocated to date.
1.4	Rapid Loading System with Silo arrangement (RLS) within the lease area shall become operational by 30/06/2025 as committed. Coal from mine to the RLS shall be transported by covered dumpers. Road transportation of coal outside the lease area is not permitted beyond 30/06/2025.	Agreed. Shall be complied.
1.5	Four numbers of Continuous Ambient Air Quality monitoring system shall be set up to monitor common/criteria pollutants such as PM10, PM2.5, SO2, NOX within the lease area in consultation with concerned SPCB within six months from the date of EC amendment. The monitoring of other locations (at least three locations outside the lease area covering upwind and downwind directions at an angle of 120° each) shall be carried out manually.	Being complied. 4 nos. CAAQMS have been supplied and are under commissioning. (Photographs are enclosed herewith)
1.6	The budget proposed to address the issues raised during PH is Rs. 7.45 crores. Compliance status in this regard shall be submitted to the concerned Regional Office along with the six-monthly compliance report and also be uploaded on the web portal of the company.	Being complied. Details of expenditure incurred on issues raised during public hearing is enclosed herewith as **Annexure-I.**
1.7	PP shall implement the protective measures proposed in EMP in a time-bound manner. The budget earmarked is Rs 276.27 crores (Capital) (including R&R cost) and Rs 344.45 lakhs (recurring) and should be kept in separate accounts and audited annually. The implementation status along with the amount spent with documentary proof shall be submitted to the concerned Regional Office for the activities carried out during the previous year	Being complied. Details of expenditure incurred as per EIA/EMP is enclosed herewith as **Annexure-II.**
1.8	PP shall ensure that no OB dumping is done outside the mine lease area.	Being complied. OB dumping is being done within leasehold of Cluster-III.
1.9	PP shall emphasize for using and developing Renewable Energy for its consumption in its utilities/machinery/equipment instead of using electricity from Grid/generated from Thermal Power Plants. PP shall install solar power generation units. Compliance	Being complied. 88 KWP roof top solar power plant has been set up at CISF Camp, NAKC. Photographs are enclosed herewith. Further, 4 nos. EVs are being used for official usage.

	status in this regard shall be submitted to the concerned Regional Office along with the six-monthly compliance report and also be uploaded on the web portal of the company.	
1.10	PP shall minimize mine voids in the post mining phase so that maximum area postmining is under green belt or agriculture/ grazing land	Includes post mining condition. Shall be complied.
1.11	Project proponent shall prepare Watershed management plan through a reputed government agency. Project proponent shall submit the same along with the matrix containing action plan to comply with the recommendations of the study report with physical & financial outlay to the concerned Regional Office of the MoEF&CC within six months from the date of grant of EC amendment. Compliance to the action plan shall be monitored by the concerned Regional Office of the MoEF&CC.	Being complied. watershed management plan for cluster-III has been prepared by IIT (ISM), Dhanbad. Copy of the plan is enclosed herewith as **Annexure-III.**
1.12	Afforestation shall be done progressively covering an area of: 795.54 ha at the end of mining. This will include Reclaimed external OB dump (in ha): 36.68, internal dump (in ha): 690.17, Green belt (in ha): 68.69 (Safety Zone and existing). Local and fruit bearing species are being/ will be planted in consultation with state forest department. In addition to this, Agro forestry shall be encouraged in consultation with the land owners. Further, PP shall provide 50,000 plant saplings with 4 feet tall fruit bearing plants to farmers for plantation in barren and agriculture lands in the study area every year for 5 years with incentive to improve the green cover in and around the mine lease area.	Being complied. Plantation is being done regularly on available spaces. Copy of work order issued to DFO, Dhanbad for plantation in FY 25-26 is enclosed herewith as **Annexure-IV.** Total Plantation in FY 25-26 is 4.75 ha. Further, work order for carrying river bank plantation for 3.4 km length in FY 2026-27 has been awarded to DFO Dhanbad.
1.13	PP shall conduct Carbon Sequestration Study including carbon emissions from coal mining. Compliance status in this regard shall be submitted along with the six monthly compliance to the concerned Regional Office and also kept on the web portal of the company.	Being complied. IIT Kharagpur has submitted the final report for "Carbon Sequestration Study including carbon emissions from coal mining" . Copy of the report is enclosed herewith as **Annexure-V.**
1.14	The proposed project shall be operated on closed water circuit with a concept of 'Zero Liquid Discharge' (ZLD). 100% water will be recycled and no treated & untreated wastewater shall be discharged outside the boundaries of mine lease area	Being complied.
1.15	PP shall carry out a survey of the impact of blasting in the nearby area/villages by involving a reputed institute and take remedial measures as proposed by the respective institute. Further, provide compensation if any for any damage caused. PP must give crop compensation to the farmers in case there is decrease in the production due to the mining activities. Compliance status in this regard shall be submitted along with the six monthly compliance to the concerned Regional Office.	Being complied. Work order has been issued to BIT Sindri (copy of work order is enclosed herewith).
1.16	To control the production of dust at the source, the crusher shall be equipped with mist-type sprinklers. PP shall install fixed fog cannon (mist spayer) and fixed sprinkler all along the haul road/ CHP, and OB dump till Railway siding is completed. The sufficient number of fog cannons with 40 mts jet length shall be installed within	Being complied. 3 nos. trolley mounted fog cannon (100 mtr range), 1 no. Truck Mounted fog cannon system have been installed in cluster-III in addition to water sprinklers.

	6 months from the date of grant of EC amendment. It should be ensured that air pollution level confirm to the standards prescribed by the MOEFCC/CPCB. Also PP shall install Mist Cannon Dust Suppression Systems (80-100 mtrs.) at Coal Stock Yard to suppress the dust particles.	
1.17	PP shall make use of advanced computer simulation techniques for design and execution of blasting operation in the mine. PP shall make use of Electronic Delay Detonators for optimal blasting in coal and OB rock to minimize the environmental impacts of blasting such as ground vibration, fly rocks and excessive dust generation.	Being complied. Electronic detonators are being used for blasting to minimize impacts of blasting such as ground vibration, fly rocks and excessive dust generation.
1.18	PP shall create a "Public Grievance Redressal and Monitoring System" for resolving any issues related to the pollution of mines and complaint has to resolve as soon as possible not beyond 30 days. In this regard, adequate awareness to be spread among the public to address their grievance to company with simple and easy manner and for which company needs to devise the mechanism. The same shall be reported to IRO within 3 months. A logbook to be maintained by PP on "Public Grievance Redressal and Monitoring System.	Being complied. Public Grievance Redressal and Monitoring System exist in BCCL and link of portal is available on BCCL website vide https://www.bcclweb.in/?page_id=4133&lang=en
1.19	Third-party audit (by NEERI/CIMFR/IIT/NITs) for air & water quality shall be carried out annually to keep a check on the same. PP shall implement the recommendations of the audit and submit the outcome of the audit to the concerned RO of MoEF&CC	Being Complied. IIT (ISM), Dhanbad has submitted the report and copy of the same is enclosed herewith as **annexure VI**
1.20	The status of mine closure activities must be included in every six months compliance report submitted to the state pollution control board and RO of MoEF&CC.	Progressive mine closure activities are being implemented as per approved mine closure plan. Status of the same is enclosed herewith as **Annexure-VII**.
1.21	Hon'ble Supreme Court in an Writ Petition(s) Civil No. 114/2014, Common Cause vs Union of India &Ors vide its judgement dated 8th January, 2020 has directed the Union of India to impose a condition in the mining lease and a similar condition in the environmental clearance and the mining plan to the effect that the mining lease holders shall, after ceasing mining operations, undertake re grassing the mining area and any other area which may have been disturbed due to their mining activities and restore the land to a condition which is fit for growth of fodder, flora, fauna etc. Compliance of this condition after the mining activity is over at the cost of the mining lease holders/Project Proponent". The implementation report of the above said condition shall be sent to the Regional Office of the MoEF&CC.	Grassing on OB dumps is being taken up regularly. Photographs of seed ball distribution on OB dumps is enclosed herewith.
1.22	PP should establish in house (at project site) environment laboratory for measurement of environment parameter with respect to air quality and water (surface and ground. A dedicated team to oversee environment management shall be setup which should comprise of Environment Engineers, Laboratory chemist and staff for monitoring of air, water quality parameters on routine basis. Any non- compliance or infringement should be reported to the concerned authority.	Regular monitoring of ambient air and water (surface and ground) quality is being done by RI-II, CMPDIL Dhanbad (A NABL Accredited Lab).

Sharma

<table>
<tr><td>1.23</td><td>PP shall ensure that all types of plastic waste generated from the plant shall be stored separately in isolated area and disposed of strictly adhering to the Plastic Waste Management Rules 2016 (as amended). In pursuant to the Ministry's OM dated 18/07/2022. PP shall also create awareness among the people working in the project area as well as in its surrounding area on the ban on Single Use Plastic (SUP) in order to ensure compliance of Ministry's Notification published by the Ministry on 12/08/2021. A report along with photograph on the measures taken shall also be included in the six monthly compliance report being submitted by PP.</td><td>Being complied.</td></tr>
<tr><td>1.24</td><td>Total water requirement for the project is 17477 KLD and the same shall be met from groundwater and mine water. PP shall obtain requisite NoC for withdrawal of Groundwater from CGWA prior to the commencement of mining operations.</td><td>Complied. NoC has been obtained from CGWA dated 21.02.2025. Copy of the same is enclosed herewith. Further renewal application has been applied to CGWA (copy is enclosed herewith).</td></tr>
<tr><td>1.25</td><td>Project proponent is advised to implement the 'Ek Ped Maa Ke Naam' Campaign which was launched on 5thJune 2024 on the occasion of the World Environment Day to increase the forest cover across the Country. This plantation drive is other than green belt development. The action in this regard shall be submitted concerned RO in six monthly report.</td><td>Being complied.</td></tr>
<tr><td></td><td>Standard EC Conditions for (Mining of minerals)</td><td></td></tr>
<tr><td colspan="2">1. Statutory Compliance</td><td></td></tr>
<tr><td>1.1</td><td>The Environmental clearance shall be subject to orders of Hon'ble Supreme Court of India, Hon'ble High Courts, NGT and any other Court of Law, from time to time, and as applicable to the project</td><td>Agreed to comply.</td></tr>
<tr><td>1.2</td><td>The project proponent shall obtain clearance from the National Board for Wildlife, if applicable.</td><td>Not applicable for Cluster-III.</td></tr>
<tr><td>1.3</td><td>Solid/hazardous waste generated in the mines needs to addressed in accordance to the Solid Waste Management Rules, 2016/Hazardous & Other Waste Management Rules, 2016.</td><td>Being complied.</td></tr>
<tr><td>1.4</td><td>The maximum production or peak production at any given time shall not exceed the limit as prescribed in the EC.</td><td>Agreed to comply. Coal Production from Cluster-III is within EC limit as mentioned below:
<table>
<tr><th rowspan="2">Sl No</th><th rowspan="2">EC Production Capacity (MTPA)</th><th colspan="3">Actual Production (Million Te)</th></tr>
<tr><th>FY 23-24</th><th>FY 24-25</th><th>FY 25-26</th></tr>
<tr><td>1</td><td>3.600</td><td>0.976296</td><td>1.241</td><td>1.202588</td></tr>
</table></td></tr>
<tr><td>1.5</td><td>Validity of EC would be governed by the existing EC dated 06/02/2013</td><td>Agreed.</td></tr>
<tr><td colspan="2">2. Air Quality Monitoring And Mitigation Measure</td><td></td></tr>
</table>

2.1	Project proponent shall obtain requisite consent from State Pollution Control Board for amalgamated mine with a production capacity of 3.6 MTPA.	Complied. CTE and CTO has been granted by JSPCB (copy is enclosed herewith).
2.2	Adequate ambient air quality monitoring stations shall be established in the core zone as well as in the buffer zone for monitoring of pollutants, namely particulates, SO2 and NOx. Location of the stations shall be decided based on the meteorological data, topographical features and environmentally and ecologically sensitive receptors in consultation with the State Pollution Control Board.	Complied. Monitoring stations have been set up in consultation with JSPCB
2.3	The Ambient Air Quality monitoring in the core zone shall be carried out to ensure the Coal Industry Standards notified vide GSR 742 (E) dated 25th September, 2000 and as amended from time to time by the Central Pollution Control Board. Data on ambient air quality and heavy metals such as Hg, As, Ni, Cd, Cr and other monitoring data shall be regularly reported to the Ministry/Regional Office and to the CPCB/SPCB	Being complied. CMPDIL (A NABL Accredited Lab) carries out AAQM at locations fixed by JSPCB. Monitoring reports are enclosed herewith as **Annexure-VIII.**
2.4	Effective control measures such as regular water sprinkling/rain gun/ Fog cannon /mist sprinkling etc., shall be carried out in critical areas prone to air pollution with higher level of particulate matter all through the coal transport roads, loading/unloading and transfer points. Fugitive dust emissions from all sources shall be controlled regularly. It shall be ensured that the ambient air quality parameters conform to the norms prescribed by the Central/State Pollution Control Board.	Being complied. Regular water sprinkling is being done on dust prone areas. CMPDIL (A NABL Accredited Lab) carries out AAQM at locations fixed by JSPCB. Monitoring reports are enclosed herewith as **Annexure-VIII.**
2.5	Major approach roads shall be black topped and properly maintained.	Being complied. Public coal transportation roads are being converted into PQC roads (Copy of work order issued is enclosed in Annexure-I).
2.6	Vehicular emissions shall be kept under control and regularly monitored. All the vehicles engaged in mining and allied activities shall operate only after obtaining 'PUC' certificate from the authorized pollution testing centres.	Coal transportation vehicles with valid PUC certificates are being used for transportation on public roads.
2.7	PP should Install Wind breaker/shield arrangement along the railway siding for reducing the dust propagation in upwind direction.	Being complied.
2.8	The raw coal shall be stacked properly at earmarked site (s) within stockyards fitted with wind breakers/shields. Adequate measures shall be taken to ensure that the stored mineral does not catch fire.	Being complied. Coal is being stacked at designated place within mine area.
2.9	PP shall submit an action plan for using and developing Renewable Energy for its consumption in its utilities/machinery/equipment instead of using electricity from Grid/generated from Thermal Power Plants. PP shall Install additional solar power generation units.	A rooftop solar plant of 88kwp capacity has been installed. Identification of site for installation of additional solar plant is under process. (Photographs of installed rooftop solar plant is enclosed herewith). Also, 4 nos. EVs are being used in office for official purposes.
2.10	PP shall install the weather monitoring system along with new CAAQMS shall be installed in which all the parameters like PM10, PM2.5, SO2, NOX should be there.	Being complied. 4 nos. CAAQMS have been supplied and are under installation process.
3. Water Quality Monitoring And Mitigation Measures		

3.1	The effluent discharge (mine waste water, workshop effluent) shall be monitored in terms of the parameters notified under the Water Act, 1974 Coal Industry Standards vide GSR 742 (E) dated 25th September, 2000 and as amended from time to time by the Central Pollution Control Board.	Regular monitoring is being done by CMPDIL (A NABL Accredited Lab). Monitoring reports are enclosed herewith as Annexure-VIII.
3.2	The monitoring data shall be uploaded on the company's website and displayed at the project site at a suitable location. The circular No.J-20012/1/2006-IA.11 (M) dated 27th May, 2009 issued by Ministry of Environment, Forest and Climate Change shall also be referred in this regard for its compliance.	Being complied. separate section of "MONITORING" has been created on the website for monitoring data and can be accessed through link https://www.bcclweb.in/?page_id=15361&lang=en
3.3	The project proponent shall not alter major water channels around the site. Appropriate embankment shall be provided along the side of the river/nallah flowing near or adjacent to the mine. The embankment constructed along the river/nallah boundary shall be of suitable dimensions and critical patches shall be strengthened by stone pitching on the river front side, stabilized with plantation so as to withstand the peak water pressure preventing any chance of mine inundation.	Agreed to comply. Embankments have been provided along the water bodies, photographs are attached herewith as **Annexure-IX.**
3.4	Garland drains (of suitable size, gradient and length) around the critical areas i.e. mine shaft and low lying areas, shall be designed keeping at least 50% safety margin over and above the peak sudden rainfall and maximum discharge in the area adjoining the mine sites. The sump capacity shall also provide adequate retention period to allow proper settling of silt material of the surface runoff	Being complied. Garland drain have been constructed around OB dumps at available spaces.
3.5	The water pumped out from the mine, after siltation, shall be utilized for industrial purpose viz. watering the mine area, roads, green belt development etc. The drains shall be regularly desilted particularly after monsoon and maintained properly	Being complied.
3.6	Industrial waste water from coal handling plant and mine water shall be properly collected and treated so as to conform to the standards prescribed under the Environment (Protection) Act, 1986 and the Rules made thereunder, and as amended from time to time. Oil and grease trap shall be installed before discharge of workshop effluent. Sewage treatment plant of adequate capacity shall be installed for treatment of domestic waste water.	Regular monitoring is being done by CMPDIL (A NABL Accredited Lab). Oil & grease trap has been provided at workshop.
3.7	An integrated surface drainage plan including surface water conservation plan for the area of influence affected by the said mining operations shall be prepared, considering the presence of any river/rivulet/pond/lake etc., with impact of mining activities on it, and implemented by the project proponent. The surface drainage plan and/or any diversion of natural water courses shall be as per the provisions of the approved Mining Plan/ EIA-EMP submitted to this Ministry and the same should be done with due approval of the concerned State/GoI Authority. The construction of embankment to prevent any danger against inrush of surface water into the mine should be as per the approved mining plan and as per the permission of DGMS.	Shall be complied. Embankments have been constructed along water bodies. (Photographs of embankments are enclosed herewith). Watershed Management plan has been prepared by IIT ISM, Dhanbad.

Dhanna

3.8	The project proponent shall take all precautionary measures to ensure reverian/ riparian ecosystem in and around the coal mine upto a distance of 5 km. A revarian /riparian ecosystem conservation and management plan should be prepared and implemented in consultation with the irrigation/water resource department in the state government	Agreed to comply. Watershed Management plan has been prepared by IIT ISM, Dhanbad (copy is enclosed herewith as Annexure-III).
3.9	Industrial effluent and domestic wastewater shall be treated in the Effluent treatment Plant (ETP) and Sewage Treatment Plant (STP). After treatment, treated water shall be reused for plantation.	Oil & grease trap has been provided at HEMM workshop.
	4. Noise And Vibration Monitoring And Prevention	
4.1	Adequate measures shall be taken for control of noise levels as per Noise Pollution Rules, 2016 in the work environment. Workers engaged in blasting and drilling operations, operation of HEMM, etc shall be provided with personal protective equipments (PPE) like ear plugs/muffs in conformity with the prescribed norms and guidelines in this regard. Adequate awareness programme for users to be conducted. Progress in usage of such accessories to be monitored.	Regular monitoring of Noise levels is being done by CMPDIL (A NABL Accredited Lab). Regular maintenance of HEMM is being done. ear plugs/muffs are being distributed regularly.
4.2	The noise level survey shall be carried out as per the prescribed guidelines to assess noise exposure of the workmen at vulnerable points in the mine premises, and report in this regard shall be submitted to the Ministry/RO on six-monthly basis.	Regular monitoring of noise levels is being done by CMPDIL (A NABL Accredited Lab). Monitoring reports are enclosed herewith as Annexure-VIII.
	5. Mining Plan	
5.1	Project proponent shall obtain star rating as per the guidelines of Ministry of Coal.	Being Complied.
5.2	Mining shall be carried out under strict adherence to provisions of the Mines Act 1952 and subordinate legislations made there-under as applicable.	Being Complied.
5.3	No change in mining method i.e. UG to OC, calendar programme and scope of work shall be made without obtaining prior approval of the Ministry of Environment, Forests and Climate Change (MoEFCC).	Agreed to comply.
5.4	Mining shall be carried out as per the approved mining plan (including Mine Closure Plan) abiding by mining laws related to coal mining and the relevant circulars issued by Directorate General Mines Safety (DGMS)	Being Complied.
5.5	Environmental conditions of mining place shall be rendered ergonomic and air breathable with adequate illumination in conformance with DGMS standards	Being Complied.
5.6	No mining shall be carried out in forest land without obtaining Forestry Clearance as per Forest (Conservation) Act, 1980 and also adhering to The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 read with provisions of Indian Forest Act, 1927.	Agreed to comply.
	6. Land Recalmation	

6.1	Digital Survey of entire lease hold area/core zone using Satellite Remote Sensing survey shall be carried out at least once in three years for monitoring land use pattern and report in 1:50,000 scale or as notified by Ministry of Environment, Forest and Climate Change (MOEFCC) from time to time shall be submitted to MOEFCC/Regional Office (RO)	CMPDI is conducting "Time series of land use maps based on satellite imagery of the core zone and buffer zone in the scale 1:5000 on cluster basis every 03 year and enclosed herewith as **Annexure-X.**
6.2	Post-mining land be rendered usable for agricultural/forestry purposes and shall be handed over to the respective State Government, as specified in the Guidelines for Preparation of Mine Closure Plan, issued by the Ministry of Coal dated 27th August, 2009 and subsequent amendments.	Includes post mining condition. Shall be complied.
6.3	Regular monitoring of subsidence movement on the surface over and around the working areas and its impact on natural drainage pattern, water bodies, vegetation, structure, roads and surroundings shall be continued till movement ceases completely. In case of observation of any high rate of subsidence beyond the limit prescribed, appropriate effective mitigation measures shall be taken to avoid loss of life and materials. Cracks should be effectively plugged in with ballast and clay soil/suitable material.	Being complied. Regular monitoring is being done.
6.4	A separate team for subsidence monitoring and surface mitigation measures shall be constituted and continuous monitoring & implementation of mitigation measures be carried out.	Being Complied. Separate team has been constituted, copy of office order is enclosed herewith as **Annexure-XI.**
6.5	Thorough inspection of the mine lease area for any cracks developed at the surface due to mining activities below ground shall be carried out to prevent inrush of water in the mine.	Being Complied.
6.6	Quick action/mitigation plan shall be established and implemented in the area affected by subsidence caused due to mining activity.	Being Complied.
6.7	The project proponent shall make necessary alternative arrangements, if grazing land is involved in core zone, in consultation with the State government to provide alternate areas for livestock grazing, if any. In this context, the project proponent shall implement the directions of Hon'ble Supreme Court with regard to acquiring grazing land.	Agreed to comply.
	7. Public Hearing And Human Health Issues	
7.1	Adequate illumination shall be ensured in all mine locations (as per DGMS standards) and monitored.	Being Complied.
7.2	The project proponent shall undertake occupational health survey for initial and periodical medical examination of the personnel engaged in the project and maintain records accordingly as per the provisions of the Mines Rules, 1955 and DGMS circulars. Besides regular periodic health check-up, 20% of the personnel identified from workforce engaged in active mining operations shall be subjected to health	Initial Medical Examination (IME) and Periodical Medical Examination (PME) of all the personnel are carried out as per the Statutes and Director General of Mines Safety (DGMS) guideline. Details are provided in table mentioned below:

	check-up for occupational diseases and hearing impairment, if any, as amended time to time	<table><tr><th>Sl. No</th><th>FY</th><th>IME</th><th>PME</th></tr><tr><td>1</td><td>2025-26</td><td>14</td><td>647</td></tr><tr><td>2</td><td>2024-25</td><td>17</td><td>651</td></tr><tr><td>3</td><td>2023-24</td><td>15</td><td>775</td></tr><tr><td>4</td><td>2022-23</td><td>145</td><td>1075</td></tr></table>
7.3	Personnel (including outsourced employees) working in core zone shall wear protective respiratory devices and shall also be provided with adequate training and information on safety and health aspects	A separate full-fledged Human Resource Development Department Is conducting regular training programme on these issues. Apart from this Vocational Training Centres are existing in Cluster-III which provides periodical training on the safety and occupational health issue to each of the workers working in the mines. **Training provided in FY 2025-26: 705 nos.**
7.4	Skill training as per safety norms specified by DGMS shall be provided to all workmen including the outsourcing employees to ensure high safety standards in mines	Vocational Training Centres are existing in Cluster-III which provides periodical training on the safety and occupational health issue to each of the workers working in the mines, **Training provided in FY 2025-26: 705 nos.**
7.5	Effective arrangement shall be made to provide and maintain at suitable points conveniently situated, a sufficient supply of drinking water for all the persons employed	Drinking water arrangements have been made at suitable places.
7.6	The project proponent shall follow the mitigation measures provided in this Ministry's OM No.Z 11013/5712014-IA.I1 (M) dated 29th October, 2014, titled 'Impact of mining activities on habitations-issues related to the mining projects wherein habitations and villages are the part of mine lease areas or habitations and villages are surrounded by the mine lease area'.	Agreed to comply.
7.7	PP should conduct epidemiology study to (analysis of the distribution, patterns and determinants of health and disease conditions in defined populations).	Being Complied.
8. Corporate Environment Responsibility		
8.1	The company shall have a well laid down environmental policy duly approve by the Board of Directors. The environmental policy should prescribe for standard operating procedures to have proper checks and balances and to bring into focus any infringements/deviation/violation of the environmental/forest/wildlife norms/conditions. The company shall have defined system of reporting infringements/deviation/violation of the environmental/forest/wildlife norms/conditions and/or shareholders/stake holders	A well-defined Corporate Environment Policy has already been laid down and approved by the Board of Directors. This is also posted on BCCL website. https://bcclweb.in/environment/CEP_2025.pdf A hierarchical system of the company to deal with environmental issues from corporate level to mine level already exists. Environment Management cell has been constituted at Area level with GM as Chairman. Internal Monitoring Mechanism is in place.
8.2	A separate Environmental Cell both at the project and company head quarter level, with qualified personnel shall be set up under the control of senior Executive, who will directly to the head of the organization.	Environment Management cell has been constituted at Area level with GM as Chairman. A full-fledged Environment Department, headed by a HOD (Environment) along with a suitable qualified multidisciplinary team of executives has been established in Headquarters.

8.3	Action plan for implementing EMP and environmental conditions along with responsibility matrix of the company shall be prepared and shall be duly approved by competent authority. The year wise funds earmarked for environmental protection measures shall be kept in separate account and not to be diverted for any other purpose. Year wise progress of implementation of action plan shall be reported to the Ministry/Regional Office along with the Six Monthly Compliance Report	Being complied. Details of expenditure made as per EIA/EMP is enclosed herewith.
8.4	Self-environmental audit shall be conducted annually. Every three years third party environmental audit shall be carried out	Agreed to comply.
9. Miscellaneous		
9.1	The project proponent shall make public the environmental clearance granted for their project along with the environmental conditions and safeguards at their cost by prominently advertising it at least in two local newspapers of the District or State, of which one shall be in the vernacular language within seven days and in addition this shall also be displayed in the project proponent's website permanently.	Advertisement has been made in Times of India dated 11.03.2025 and Hindustan Newspaper on 11.03.2025 (copy is enclosed herewith as **annexure-XII)**. Copy of EC is also available on BCCL website and can be accessed through link https://www.bcclweb.in/Environment%20Clearance/Cluster-III_ec_mining_amendment05032025.pdf
9.2	The copies of the environmental clearance shall be submitted by the project proponents to the Heads of local bodies, Panchayats and Municipal Bodies in addition to the relevant offices of the Government who in turn has to display the same for 30 days from the date of receipt	Copy has been submitted to Deputy Commissioner, Dhanbad, Dhanbad Municipal Corporation, RO, JSPCB. Copy of mail sent is enclosed herewith as **Annexure-XIII.**
9.3	The project proponent shall upload the status of compliance of the stipulated environment clearance conditions, including results of monitored data on their website and update the same on half-yearly basis.	Being complied.
9.4	The project proponent shall submit six-monthly reports on the status of the compliance of the stipulated environmental conditions on the website of the ministry of Environment, Forest and Climate Change at environment clearance portal.	Being complied.
9.5	The project proponent shall submit the environmental statement for each financial year in Form-V to the concerned State Pollution Control Board as prescribed under the Environment (Protection) Rules, 1986, as amended subsequently and put on the website of the company	Being complied. Environmental statement is being submitted to JSPCB regularly. Further copy of environmental statement is being uploaded on company's website along with six monthly compliance report (https://bcclweb.in/?page_id=4731). Copy is enclosed as Annexure-XIV.
9.6	The project authorities shall inform to the Regional Office of the MOEFCC regarding commencement of mining operations	Complied.
9.7	The project authorities must strictly adhere to the stipulations made by the State Pollution Control Board and the State Government	Agreed to comply.
9.8	The project proponent shall abide by all the commitments and recommendations made in the EIA/EMP report, commitment made during Public Hearing and also that during their presentation to the Expert Appraisal Committee	Agreed to comply.
9.9	No further expansion or modifications in the plant shall be carried out without prior approval of the Ministry of Environment, Forests and Climate Change (MoEF&CC).	Agreed to comply.

9.10	Concealing factual data or submission of false/fabricated data may result in revocation of this environmental clearance and attract action under the provisions of Environment (Protection) Act, 1986.	Agreed.
9.11	The Ministry may revoke or suspend the clearance, if implementation of any of the above conditions is not satisfactory.	Agreed.
9.12	The Ministry reserves the right to stipulate additional conditions if found necessary. The Company in a time bound manner shall implement these conditions	Agreed.
9.13	The Regional Office of this Ministry shall monitor compliance of the stipulated conditions. The project authorities should extend full cooperation to the officer (s) of the Regional Office by furnishing the requisite data / information/monitoring reports.	Agreed.
9.14	The above conditions shall be enforced, inter-alia under the provisions of the Water (Prevention & Control of Pollution) Act, 1974, the Air (Prevention & Control of Pollution) Act, 1981, the Environment (Protection) Act, 1986, Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 and the Public Liability Insurance Act, 1991 along with their amendments and Rules and any other orders passed by the Hon'ble Supreme Court of India / High Courts and any other Court of Law relating to the subject matter	Agreed.

Annexure-I

Sl No	Activity to address issues under Public Hearing	Total awarded value of work (Crores)	Expenditure done in FY 2025-26 (Crores)
1	800 m. PQC road from NH-32 to SLG railway siding	1.21	1.3295
2	Construction of PQC road within mine	5.29	1.96
3	Renovation of pressure filter plant at Mahthadih,	0.0846390	0.0481995
4	Planation	0.1906	0.6357 (Payment to DFO, Dhanbad and plantation work at south Govindpur colliery).
Total			**3.97 Crores**

To
The Director
Ministry of Environment, Forest & Climate Change
2nd Floor, Headquarter- Jharkhand State Housing Board
Harmu Chowk
Ranchi, Jharkhand-834002

Subject: Six monthly reports on implementation of Environmental measures for the period from October 2024 to March 2025 in respect of Cluster –III, BCCL

Ref.: -EC Order No. J-11015/100/2011-IA. II (M)

Dear Sir,
Kindly find enclosed herewith the six-monthly report on implementation of Environmental measures for the period from **Nov 2024 to March 2025** in respect of Cluster –XV group of mines. Kharkharee colliery having leasehold area 584.00 Ha is under mining operation. Remaining three mines have been closed for production.
This is for your kind information and doing needful, please.

Yours faithfully

General Manager
Barora Area

Revenue Expenditure on Environment Management (Cluster-III)

Sl. No.	Element	Annually Recurring Cost (Rs. in Lakhs) as per EIA/EMP	Actual cost incurred (Lakhs) FY 2025-26	Remarks
1.	Pollution control	20.00	22.38	Diesel cost for Water tanker on haul roads.
2.	Pollution monitoring	5.00	46.47	As per information provided by Env department, HQ; Being done by CMPDIL RI-II, Dhanbad
3.	Occupational health	5.00	22.95	Expenditure incurred on purchase of florescent jackets, rubber and leather gloves ear plugs, Safety helmets, goggles, medical kits, brattice cloth, cement capsule etc. for persons engaged in mining activities.
4.	Green belt & biological reclamation	10.00	64.51	Plantation through DFO Dhanbad
5.	Corporate Social Responsibility	138.45	CSR: 1384.36*	Being dealt at HQ level. Cluster-III is contributor for the same.
6.	Corpus fund for mine-closure	130.00	126.72	Deposited in Escrow account.
7.	Water cess and consent to operate	6.00	3.73	For CTO of Cluster-III
8.	Others (Lump sum)	5.00	0.87	Disposal of bio medical waste and purchase of QR code
9.	Mine Reclamation	25.00	1215.97*	Includes cost of technical reclamation. Reimbursement is subjected to Third party audit of the claim as per approved Mine Closure Plan.
Total *		**344.45**	**287.63**	

*** Cost of CSR expenditure done at corporate level and mine reclamation is not included in total**

Capital cost of Environment Management for Cluster-III

Sl. No.	Activity head as per EMP	Item	Unit Name	Year	Cost (Lakhs)	Remarks
1.	Pollution abatement cost including providing 02 additional water sprinklers.	Procurement of two Mobile water Sprinkler (28 KL Capacity)	New Akashkinaree Colliery	2013-14	126.67	As per information provided by Colliery.
			Block-IV Colliery	2020-21	162.84	
		Procurement of 1 truck mounted fog cannon system	New Akashkinaree Colliery	2023-24	41.95	
2.	Development of green belt (100 Ha and the left out area will be taken up during mine closure period) (Rs. 1 lakh per Ha)	Advance work for bamboo gabion plantation	Maintenance work-I for bamboo gabion plantation in Maheshpur, Jogidih, Govindpur Colliery	2023-24	9.70	By DFO, Dhanbad
		Completion work for bamboo gabion plantation	Completion work for bamboo gabion plantation in SLG siding (150 Nos.)	2023-24	0.90	
3.	Dust suppression & extraction in coal handling plant & feeder breaker	Procurement of 3 nos. trolley mounted fog cannon	SLG Railway Siding	2021-22	20.85	
4.	EMP Report	Preparation of EIA and EMP report	Cluster-III	2012-13	89.34851	As per information provided Env Dept, BCCL HQ
5.	Industrial sewage treatment in workshop	Construction of Oil & Grease trap	New Akashkinaree Colliery and Block-IV Colliery	2020-21	22.40	As per details provided by Area Civil Deptt.
6.	Cost of Anti-pollution measures in mine & Industrial area	Construction of Coal transportation Road	Block-IV Colliery	2020-21	5.78	WBM Road for coal transportation. As per details provided by Area Civil Deptt.
			SLG Siding	2020-21	17.72	
			Maheshpur Colliery	2019-20	21.08	
			New Akashkinaree Colliery	2019-20	19.74	
7.	Other provisions	Development of eco-park	New Akashkinaree Colliery	2023-24	2.61	As per details provided by Area Civil Deptt.
		Purchase of 05 nos. PM10 Online analyzer	Cluster-III	2021-22	62.00	PO by HQ MM deptt.
		Construction of wheel washing ditch		2024-25	24	Civil department
		Installation and commissioning of rooftop solar power plant (88Kwp)		2022-23	42.08	HQ E&M

PROJECT REPORT

ON

PREPARATION OF WATERSHED MANAGEMENT PLAN IN CLUSTER-III, GOVINDPUR AREA, BCCL, DHANBAD

SUBMITTED

BY

Prof. Sukha Ranjan Samadder
Email: samadder@iitism.ac.in

SUBMITTED

TO

Cluster-III, Govindpur Area, BCCL, Dhanbad

CENTRE FOR WATER RESOURCE MANAGEMENT (CWRM)
DEPARTMENT OF ENVIRONMENTAL SCIENCE AND ENGINEERING
INDIAN INSTITUTE OF TECHNOLOGY (INDIAN SCHOOL OF MINES), DHANBAD, JHARKHAND-826004

SEPTEMBER,2025

Table of Content

Sl. No.			Title	Page No.
			Executive Summary	1
Chapter 1			**Introduction of the Study Area, Cluster III Coal Mining Region, Govindpur Area, BCCL, Dhanbad**	6
	1.1		Introduction	6
	1.2		Study Area	7
	1.3		Background	8
		1.3.1	Topography and Drainage	9
		1.3.2	Railway and Transport	9
		1.3.3	Vegetation	10
		1.3.4	Temperature	11
		1.3.5	Relative Humidity	12
		1.3.6	Rainfall Data	12
		1.3.7	Wind	13
		1.3.8	Regional Geology	13
		1.3.9	Local Geology of the Lease Area	15
		1.3.10	Strike and Dip	15
		1.3.11	Socio-Environmental Profile and Resource Management	15
	1.4		Current Challenges	16
	1.5		Scope of the Work	16
Chapter 2			**Morphometric analysis to identify various relationships of morphological parameters for the watershed of the study area.**	20
	2.1		Introduction	20
	2.2		Data Collection and Processing	21
		2.2.1	Preparation of Surface Topography	22
		2.2.2	Generation of Slope Map Using DEM	22
		2.2.3	Calculation of Aspect	25
	2.4		Stream ordering of the drainage network in and around the mine lease area	31
	2.5		Demarcation of the watershed covering the mine lease area	36
	2.6		Conclusion	38
Chapter 3			**Rainfall-runoff modelling to estimate runoff generated in different watersheds of the study area.**	40
	3.1		Introduction	40
	3.2		Methodology Adapted	41

		3.2.1	Rational Method	41
		3.2.2	SCS-Curve Number Method	41
	3.3		Watershed Classification and River Systems	45
	3.4		Results and Discussion	46
		3.4.1	Temporal Variability	46
		3.4.2	Spatial Distribution	46
		3.4.3	Total Cumulative Runoff	46
		3.4.4	Peak Runoff Year: 2024	47
		3.4.5	Per-Second Runoff Volume (m^3/s)	48
	3.5		Conclusion	68
Chapter 4			**Analysis of Spatio-Temporal Variability of Hydro-meteorological Variables and Assessment of Impact of Climate Change on Water Resources in Cluster – III Area of BCCL**	70
	4.1		Introduction	70
	4.2		Materials and Methods	71
		4.2.1	Study Area: BCCL Cluster-III Watershed	71
		4.2.2	Climate Projection Data	72
		4.2.3	Rainfall Pattern in BCCL Cluster-III Area	73
		4.2.3.1	Historical Rainfall Pattern in BCCL Cluster-III (2008-2024) Area	73
		4.2.3.2	Forecasting of the Near Future Monthly Rainfall Pattern in BCCL Cluster-III (2025 - 2030) Area	76
		4.2.3.3	Analysis and Visualization of Daily Extreme Rainfall Events Between 2008 to 2024	80
		4.2.4	Projected Temperature Trends and Climate Variability under SSP Scenarios in BCCL Cluster - III (2020-2039)	83
		4.2.5	Spatio-Temporal Variability of Rainfall (Forecasting for 2020-2039)	86
		4.2.6	Future Runoff Estimation and Hydrological Implications	89
		4.2.6.1	Future Rainfall Projections	89
		4.2.6.2	Runoff Estimation Methodology	90
		4.2.6.3	Estimated Future Runoff	90
		4.2.6.4	Hydrological Implications for 10-year and 50-year return periods	94
	4.3		Conclusion	94
Chapter 5			**Estimation of soil erosion in the study area and mapping of the vulnerable zones**	96
	5.1		Introduction	96

	5.2		Materials and Methodology	96
		5.2.1	Data Acquisition and Preparation	97
		5.2.2	Erosion Potential Index (EPI) and GIS Analysis	97
		5.2.2.1	Rainfall-Runoff Erosivity (R)	98
		5.2.2.2	Soil Erodibility (K)	99
		5.2.2.3	Slope Length and Steepness (Ls)	99
		5.2.2.4	Land-Use Pattern (C)	100
		5.2.2.5	Distance from Drainage Lines (D)	101
		5.2.2.6	Vegetation Type (V)	102
		5.2.3	Factor Reclassification and Standardization	103
		5.2.4	Analytical Hierarchy Process (AHP)	105
		5.2.5	Estimation of EPI	107
		5.2.6	Estimation of Soil Loss	108
	5.3		Results and Discussion	109
		5.3.1	Erosion Potential Index (EPI) in the Cluster-III Area	109
		5.3.2	Soil Loss in Cluster-III Area	110
	5.4		Conclusion	112
Chapter 6			**Site Suitability Analysis for Conservation Structures in Watersheds under Cluster-III Area, BCCL**	113
	6.1		Introduction	113
	6.2		Materials and Methodology	114
		6.2.1	Data Acquisition and Preparation	114
		6.2.2	Thematic Layer Generation and Parameter Influence	115
		6.2.3	Factor Reclassification and Standardization	116
		6.2.4	Weight Assignment Using Analytical Hierarchy Process (AHP)	117
		6.2.5	Weighted Overlay Analysis	119
	6.3		Results and Discussion	119
		6.3.1	Spatial Distribution of Suitability Classes	120
		6.3.2	Delineation of Priority Zones	121
		6.3.3	Identification and Validation of Intervention Sites	121
		6.3.4	Interpretation and Implications	123
	6.4		Conclusion	124
Chapter 7			**Identification of Suitable Locations for Plantation in Different Watershed Regions at Cluster-III (BCCL, Govindpur Area)**	132
	7.1		Introduction	132
	7.2		Materials and Methodology	134
		7.2.1	hematic Layer Generation and Parameter Influence	135

		7.2.1.1	Slope	136
		7.2.1.2	Soil Type	136
		7.2.1.3	Land-use Land Cover (LULC)	137
		7.2.1.4	Drainage Distance	137
		7.2.1.5	Erosion Potential Zone	138
		7.2.2	Weight Assignment Using AHP	140
	7.3		Results and Discussion	142
		7.3.1	Spatial Distribution of Suitability Classes	142
		7.3.2	Delineation of Priority Zones	143
	7.4		Conclusion	145
Chapter 8			**Analysis of water quality parameters to ascertain the impact of mining upon local water quality**	146
	8.1		Introduction	146
	8.2		Water Sampling from the Study Area	147
	8.3		Methodology of Sampling and Analysis	148
	8.4		Results & Discussions	149
		8.4.1	pH	150
		8.4.2	Total Dissolved Solids (TDS)	150
		8.4.3	Electrical Conductivity (EC)	150
		8.4.4	Alkalinity	151
		8.4.5	Hardness	151
		8.4.6	Salinity	151
		8.4.7	Colour	152
		8.4.8	Nitrate (NO_3^-)	152
		8.4.9	Sulphate (SO_4^{2-})	152
		8.4.10	Fluoride (F^-)	153
		8.4.11	Phenolic Compounds	153
	8.5		Conclusion	153
Chapter 9			**Final Recommendations for Preparation of the Watershed Management Plan for Cluster-III, Govindpur Area, BCCL, Dhanbad**	155
	9.1		Introduction	155
	9.2		Soil Erosion Risk Reduction and Sediment Control	157
	9.3		Suitability for Conservation Structures	157
	9.4		Afforestation and Ecological Restoration	161
	9.5		Conclusion	163
			List of References	165

Executive Summary

The BCCL Cluster-III coal mining region, situated in the Govindpur area of Dhanbad, Jharkhand, is part of the larger Jharia Coalfield and plays a vital role in supplying high-grade coking coal essential for steel production in India. This cluster, comprising five operational and two closed mines over a leasehold area of 1420.61 hectares, has witnessed decades of intense underground and opencast mining. While this has significantly contributed to India's industrial development, it has also led to certain environmental concerns, such as localized land degradation, partial vegetation loss, moderate soil erosion, and occasional impacts on water quality. Recognizing these challenges, this study aims to develop a technically sound watershed and environmental management framework and a possible solution for Cluster-III, aligned with the Ministry of Environment, Forest and Climate Change (MoEF&CC) guidelines and other internationally established methodologies from existing literature.

The primary objective of this investigation was to undertake a spatially explicit analysis of hydrological and environmental dynamics using modern geospatial techniques, statistical, and modelling tools. This included morphometric analysis of the watershed, rainfall-runoff modelling & estimation, climate variability assessment, soil erosion estimation, and suitability analysis for both conservation structures and ecological plantations. In addition, water quality monitoring was carried out to understand the impact of mining on local water bodies. The study utilized Digital Elevation Models (DEMs), Remote Sensing imagery, thematic Geographic Information System (GIS) layers, field survey data, and Coupled Model Inter-comparison Project Phase 6 (CMIP6) climate projection datasets to generate actionable insights for environmental management for the period of 2025 to 2039.

Morphometric analysis constituted a fundamental step in delineating 15 micro-watersheds (WS1 to WS15) within the basin areas associated with the two principal drainage systems, namely Bagdighi and Khudia Nala. The terrain of the study area

is predominantly sloping, with slope gradients ranging from 0° to 33°. Elevation within the region varies from a minimum of 122.97 m to a maximum of 274.74 m above mean sea level, resulting in an elevation differential of approximately 151.77 m. This variation in topographic and geomorphological characteristics significantly influences hydrological responses. Smaller watersheds with steeper slopes were found to be more prone to surface runoff and soil erosion, whereas larger watersheds with moderate slopes demonstrated greater infiltration potential. These morphometric parameters served as critical inputs for runoff modelling, erosion risk assessment, and land-use prioritization. Furthermore, stream ordering based on Strahler's method revealed a dominance of first and second-order streams, indicating an early stage of geomorphic development, which is characteristic of mining-impacted catchments. The estimation of surface runoff was carried out using the Soil Conservation Service-Curve Number (SCS-CN) method, which incorporated land-use, soil hydrologic group (HSG), and antecedent moisture conditions (AMC). The results indicated significant spatial and temporal variability in runoff generation between 2015 and 2024. Watersheds contributing to Khudia Nala generated higher cumulative runoff (~17,973 mm) compared to those feeding Bagdighi Nala (~5,193 mm), due to larger contributing areas and less vegetative cover. Runoff peaked in the year 2024 across most watersheds, which aligns with observed extreme rainfall events. These findings underscore the hydrological sensitivity of the region and the need for watershed-specific soil erosion control and conservation infrastructure.

To understand the broader implications of climate variability, spatio-temporal analyses of rainfall and temperature trends were conducted using different climate models. The historical climate data (2008–2024) revealed a gradual increase in both rainfall intensity and temperature, while future projections using CMIP6 data under SSP2-4.5 and SSP5-8.5 scenarios forecast about near future climate impact. A significant rise in daily rainfall extremes is expected to exacerbate surface runoff, soil erosion, and water quality degradation. These projections were integrated with hydrological modelling to estimate future runoff and flood risks. The results

indicate a potential rise in peak flow volumes and the frequency of runoff events, which may gradually influence mining infrastructure and could have localized impacts on nearby human settlements.

Soil erosion was assessed using the Revised Universal Soil Loss Equation (RUSLE), integrating parameters such as rainfall erosivity, soil erodibility, slope, land-use, proximity to drainage, and vegetation type. The erosion potential index (EPI) revealed that more than 31.91% of the study area is under high and very high erosion risk, primarily in steep, unvegetated overburden dumps and degraded mining areas. The estimated annual soil loss was found to be spatially uneven, with the highest losses occurring in areas characterized by steeper slopes and sparse vegetation cover. These findings are essential for prioritizing locations for erosion control interventions such as vegetative barriers, check dams, and contour trenches.

To facilitate the implementation of site-specific restoration measures, suitability mapping was carried out for both conservation structures and plantation interventions using GIS-based Multi-Criteria Decision Analysis (MCDA) integrated with the Analytical Hierarchy Process (AHP). For soil and water conservation structures, thematic layers such as slope, LULC, proximity to drainage, soil type, and erosion potential were evaluated. The results indicated that most of the area falls under the moderate suitability category, covering 44.15% (626.67 ha), followed by low suitability at 40.38% (573.12 ha), and high suitability accounting for 3.96% (56.16 ha). Areas deemed not suitable (11.26%; 159.84 ha), primarily due to the presence of built-up land and water bodies, were excluded from conservation planning, while very low suitability zones made up only 0.26% (3.69 ha). These findings support the feasibility of implementing water conservation structures such as check dams and contour bunding across a substantial portion of the landscape, especially in moderately and highly suitable zones.

In parallel, plantation suitability analysis revealed that 37.69% (535.41 ha) of the area is moderately suitable, followed by low suitability at 31.69% (450.18 ha), and high suitability covering 25.08% (356.31 ha). An additional 2.47% (35.1 ha) was found to

be very highly suitable, offering priority zones for eco-restorative planting. Only 0.87% (13.42 ha) and 2.20% (31.24 ha) of the area were categorized as very low and unsuitable, respectively, due to limiting factors such as slope, soil conditions, or existing land use. These results suggest strong potential for landscape restoration through afforestation and re-vegetation. In identified suitable areas, native species such as *Azadirachta indica* (neem), *Pongamia pinnata* (karanj), and *Dalbergia sissoo* (shisham) are recommended to promote slope stabilization, improve soil health, and enhance overall ecological resilience in the mining-affected terrain.

Water quality monitoring, conducted through field sampling and laboratory analysis, focused on parameters such as pH, TDS, EC, salinity, nitrate, fluoride, sulphate, and phenolic compounds. The results revealed elevated levels of dissolved solids and conductivity in mining-impacted drainage zones, especially during monsoon seasons. Although the majority of samples were within permissible limits, localized contamination near overburden dumps and effluent discharges suggests the need for regular monitoring, and better mine-water management protocols. These insights also indicate a direct correlation between surface runoff pathways and water quality deterioration, further validating the integrated approach adapted in this study.

The key findings of this comprehensive assessment offer valuable insights for policymakers, environmental planners, and mining authorities. One of the major implications is the ability to prioritize specific watersheds based on their vulnerability to runoff and soil erosion. This prioritization enables more effective allocation of restoration resources and targeted implementation of engineering interventions, thereby enhancing the efficiency and impact of land and water management efforts. Second, identification of the high-suitability zones for conservation infrastructure and afforestation can directly feed into the implementation of the Jharia Master Plan and similar policy instruments. Third, integration of the climate projection data ensures that all recommendations are forward-looking and resilient to future climate uncertainties. Finally, the use of

advanced geospatial and hydrological tools offers a replicable framework that can be extended to other mining-affected regions across the Country.

In conclusion, the study successfully demonstrates the efficacy of a multi-pronged, GIS-enabled watershed management strategy personalized to the unique challenges of a mining-dominated terrain. It emphasizes that sustainable land and water management in such regions requires a blend of scientific analysis, stakeholder engagement, and climate-resilient planning. The findings not only contribute to academic understanding but also serve as a strategic guide for on-ground interventions in the BCCL Cluster-III region. The integrated methodology adapted here holds potential for scalability and can inform future environmental impact assessments, mine closure planning, and regional restoration policies.

Chapter 1: Introduction of the study area, Cluster III Coal Mining Region, Govindpur Area, BCCL, Dhanbad

1.1 Introduction

Coal mining has played a pivotal role in India's industrial growth, with the Jharia Coalfield in Jharkhand serving as a major contributor. Within this region, Cluster-III is comprised of an integrated set of mines and is operated by Bharat Coking Coal Limited (BCCL) for coking coal extraction. The Cluster-III region, located in the north-western part comprises both underground and opencast mines, covering an extensive leasehold area of 1420.61 hectares. Though, the coal mining has extremely high economic benefits but, poses significant environmental challenges. Extensive coal extraction results adverse impacts such as land degradation, vegetation loss, soil erosion, underground fires, groundwater depletion, altered drainage patterns, and surface subsidence. The area is intersected by seasonal streams and natural water bodies that are vulnerable to pollution and siltation due to overburden dumps and unregulated runoff. This complex landscape requires an integrated and scientific approach to evaluate and manage its hydrological and environmental dynamics.

To address these challenges, this report outlines a comprehensive plan for watershed delineation and environmental management plan of the Cluster-III region. The primary focus of the study includes morphometric analysis, rainfall-runoff modelling, climate-driven spatiotemporal variability of hydrometeorological parameters, soil erosion estimation, site suitability analysis for suitable water conservation structures, and measurement of water quality. In this study, a watershed management plan has been developed according to the guidelines of Ministry of Environment, Forest and Climate Change (MoEFCC) by integrating the proposed seven objectives of the project. Together, these efforts aim to generate a spatially explicit understanding of watershed behaviours that can support sustainable land and water resource management, mine reclamation planning, and resilience building in the face of climate change.

The study used advanced geospatial technologies, remote sensing data, hydrological modelling, and statistical tools to provide detailed insights on the present environmental condition and recommended suitable conservation plan for the mining-affected terrain. This will aid policymakers, mine managers, and environmental planners in making informed, data-driven decisions to ensure both economic benefits and ecological sustainability in the BCCL Cluster-III coal mining region.

1.2 Study Area

The study area incorporates Cluster-III of BCCL, located in the north-western part of the Jharia Coalfield in Dhanbad district, Jharkhand as shown in Fig.1.1. This region is geographically bounded between latitudes 23°46'46.67" N to 23°48'32.34" N and longitudes 86°14'16.96" E to 86°17'36.91" E and falls within Survey of India topographical sheets 73 I/1, I/2, I/5, and I/6. The leasehold area of Cluster-III spreads across 1420.61 hectares and has five operational and two closed mines. The operational mines include, New Akashkinaree and Block-IV/Koraidih (mixed opencast and underground), Jogidih, Maheshpur, and Govindpur (underground). South Govindpur and Teturiya Collieries are closed currently.

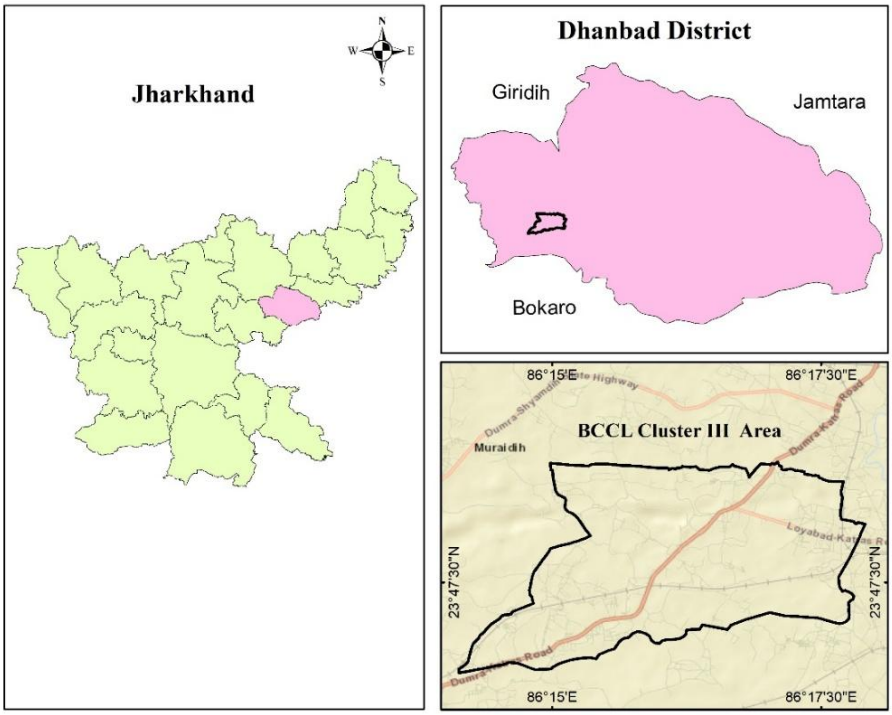


Fig. 1.1: Location of the BCCL Cluster-III Area

1.3 Background

The Jharia Coalfield, one of the India's most significant coal-producing regions, has a long history of mining activity, dating back to the late 19th century. It is the backbone of the nation's metallurgical coal supply, providing high-grade coking coal essential for steel production. Within this coalfield, Cluster-III is pivotal due to its strategic location, extensive coal reserves, and concentration of operational mines under BCCL. The establishment of Cluster-III was intended to facilitate more effective resource management and streamline environmental compliance by consolidating several individual mines into a unified operational framework.

Despite its economic contributions, Cluster-III faces several challenges that arise from decades of intensive mining. These include persistent underground fires, land subsidence, extensive overburden dumps, alteration of surface water quality, and air pollution. Existing overburden dumping practices, deforestation, and a lack of integrated watershed management plan may further aggravate the area's environmental condition. Ground and surface water resources are under increasing

stress due to reduced infiltration capacity and pollution from mining activities. In addition, the risk of soil erosion and sedimentation in nearby watercourses has escalated.

Several environmental monitoring and management strategies have been implemented to address these growing concerns. These include the Jharia Master Plan and the Environmental Action Plan, which emphasize fire control, land reclamation, water treatment, and increased afforestation. However, the success of these initiatives depends on high-resolution spatial analysis and accurate hydrological assessments. The current study is therefore designed to support these broader policy efforts by providing a scientific foundation for watershed planning, erosion control, and climate adaptation at the micro-watershed scale within Cluster-III.

This background forms the rationale for integrating remote sensing, GIS, and hydrological modelling tools in the present investigation. By analyzing morphometric parameters, runoff dynamics, and land suitability for conservation strategies, the study seeks to contribute actionable insights for sustainable land and water resources management in the mining-impacted landscapes of the Cluster-III area.

1.3.1 Topography and Drainage

The region's terrain is gently undulating with an overall slope towards the east-southeast and the drainage system is dominated by dendritic patterns. Two seasonal streams, Khudia and Bagdighi Nala, flow from north to south across the Cluster-III area, and play a significant role in its surface hydrology. These watercourses are the tributary of the Katri River, which consequently merges with the Damodar River.

1.3.2 Railway and Transport

The area is well connected through various modes of transportation, ensuring efficient movement of people and goods. The Dhanbad-Chandrapura railway line passes

directly through the cluster, providing crucial rail connectivity for both passengers and goods, especially coal transport. Major routes include D. B. Road, which connects Katras to Phularitand, and a network of village roads and colliery roads that support internal transport within the mining areas. Additionally, the region is accessible via National Highway 32 (Rajganj–Mohuda section), which links it to broader regional and national road networks. Public Works Department (PWD) roads further enhance local connectivity. The nearest urban city is Dhanbad, located about 8 kilometres from the Cluster-III, offering access to administrative, commercial, and transport facilities. Although, the area does not have its own airport, but air connectivity is available through nearby airports located at Ranchi or Durgapur, which are accessible by road from the region.

1.3.3 Vegetation

Prolonged and intensive mining activities might have significantly influenced the vegetation profile of the Cluster-III region. Historically, the area was covered with natural vegetation dominated by tropical dry deciduous species along with flora and fauna. However, widespread deforestation and land degradation from surface mining have degraded the green cover. However, the ground surveys indicate that most active mining zones lack natural vegetation, with only sparse vegetation observed along roadsides, village boundaries, and non-mineralized patches also supported by the satellite imagery.

The initiative taken by the BCCL for reclamation and afforestation on the degraded land or over burden (OB) as a part of implementation of the Environmental Management Plan (EMP) and the Jharia Action Plan is successfully implemented in the entire study area. These include the creation of green belts along the transport corridors, mine boundaries and alongside of the OB area. High-root-density native species such as neem (Azadirachta indica), karanj (Pongamia pinnata), arjun

(Terminalia arjuna), and shisham (Dalbergia sissoo) are commonly used in plantation efforts to stabilize loose substrates and enhance ecosystem services.

Year-wise satellite imageries confirmed the gradual progress in re-vegetation in the overburden areas being stabilized and reshaped. Apart from ecological functions, vegetation also serves social objectives, including improving aesthetics, reducing dust pollution, and providing shade and microclimatic benefits to nearby settlements. Despite these efforts, challenges such as poor soil quality, low water retention in OB materials, and recurring fires limit the pace of natural and manmade regeneration outcomes. Consequently, the vegetation cover in Cluster-III remains fragmented, and continuous monitoring and adaptive management strategies are necessary to ensure the long-term success of restoration programs.

1.3.4 Temperature

The Cluster-III region of the Jharia Coalfield experiences a tropical climate marked by distinct seasonal variations in temperature. Govindpur experiences a distinctly warm to hot climate throughout the year. Temperature typically ranges between about 53 °F (12 °C) and 100 °F (38 °C), with extremes rarely dipping below 47 °F (8 °C) or rising above 108 °F (42 °C) (weatherspark.com). The hottest period is observed from late March to mid-June, when daytime highs exceed 97 to 95 °F, peaking in May with average highs around 100 to 101 °F (38 °C) and lows near 79 °F (26 °C) (weatherspark.com) (Fig. 1.2). Conversely, the coolest stretch spans from December through February, with daytime temperatures staying below 79 to 82 °F (26 to 28 °C), and January being the coldest month with average lows of 53 to 55 °F (12 to 13 °C) with highs around 74 to 79 °F (23 to 26 °C). Transition seasons bring moderation: in April, highs reach roughly 102 °F with lows near 78 °F, while fall months (September to November) see highs gradually lowering from 88 °F to about 79 °F, and lows from 78 °F to around 57 °F. Overall, Govindpur endures long hot summers and short mild winters with significant temperature variability between day and night.

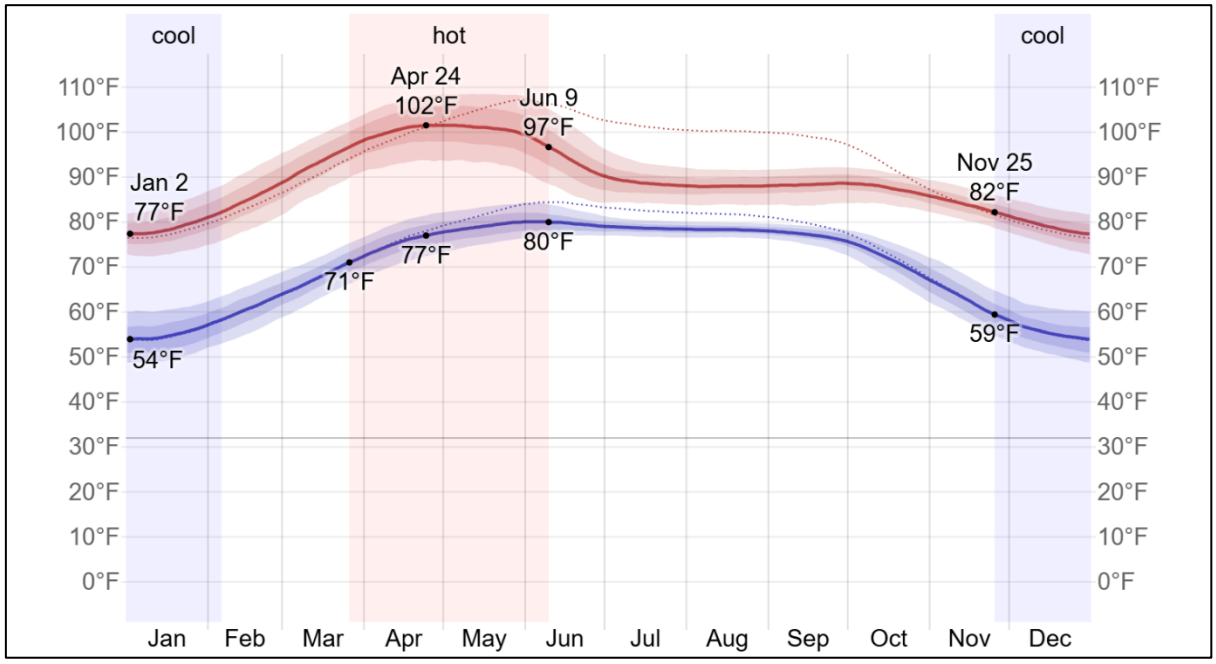


Fig. 1.2: Average Monthly High and Low Temperatures of Cluster III Region, BCCL, Jharia Coalfield (°F)

1.3.5 Relative Humidity

Relative humidity in the Cluster-III region varies seasonally, generally it is high during the monsoon season and low during the summer months. Annual humidity levels typically range between 25% and 90%. During the peak monsoon months (July to September), the humidity frequently exceeds 80%, creating conducive conditions for surface runoff and enhancing the risk of soil erosion. Conversely, relative humidity may drop below 30% during the dry summer months, intensifying the dryness of soils and increasing the chance of dust generation in active mining zones.

1.3.6 Rainfall Data

Cluster-III falls under the influence of the south-west monsoon, which accounts for approximately 75% to 85% of the region's total annual precipitation. The average yearly total rainfall in the area ranges from 1300 mm (51.18 in) to 1400 mm (55.12 in), as the heavy rainfall occurs in the months of July to September and recorded as the wettest months (weatherspark.com). The rainfall pattern is highly seasonal and shows considerable inter-annual variability. The concentration of rainfall within a few months

leads to high surface runoff and occasional localized flooding, particularly in low-lying mining pits, making accurate rainfall-runoff modelling essential for watershed planning and disaster mitigation.

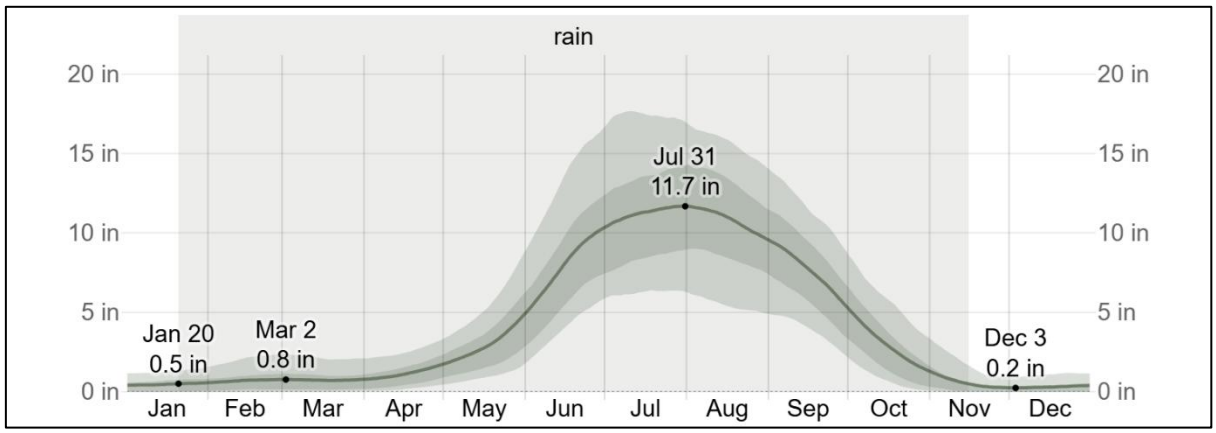


Fig. 1.3: Average Monthly Rainfall in Cluster-III Region, Jharia Coalfield (in inch)

1.3.7 Wind

Wind patterns in Cluster-III are governed by seasonal climatic shifts. Winds predominantly blow from the north-west and west during the pre-monsoon and post-monsoon seasons. In contrast, during the monsoon season, winds shift to a south-east and south-westerly direction. Wind speeds are generally moderate, averaging 5 to 15 km/h. However, occasional high-velocity winds during thunderstorms are also observed in the study area. Understanding wind behaviours is crucial for planning green belt development.

1.3.8 Regional Geology

The Cluster-III mining area lies within the geologically significant Jharia Coalfield which is a part of the Damodar Valley Basin. This region primarily comprises formations from the Lower Gondwana sequence, with the Barakar formation serving as the main coal-bearing unit. The Barakar strata consists of alternating layers of sandstone, shale, and coal seams, with occasional volcanic intrusions. These coal seams are predominantly bituminous and vary in both thickness and quality, making them

well-suited for metallurgical applications. Beneath the Barakar formation, the Talchir Formation lies which is characterized by glacial deposits, while the overlying Barren Measures represents non-coal-bearing formations that cap the sequence.

Geologically, the area is complex and tectonically active, influenced by historical faulting, folding, and crustal movements linked to the Indian Plate's evolution. These structural features result in seam dips that range widely from 10° in relatively undisturbed areas to over 70° near fault zones. Such variability impacts mining layout, safety, and hydrogeological behaviour.

Within Cluster-III, coal seams exhibit varying degrees of thermal instability, with spontaneous combustion being a concern in several zones. Approximately, 72.88 hectares are currently classified as fire affected region. In addition, land-use in the cluster consists of active and abandoned mines, service infrastructure, reclaimed overburden dumps, agricultural fields, and settlements.

Table 1.1: Generalised stratigraphy of the Jharia Coalfields

Formation	Lithology	Maximum Thickness (m)
Supra Panchet	Red and grey sandstones and shales	300
Panchet	Micaceous yellow and grey sandstones, red and greenish shales	600
Raniganj	Grey and greenish soft feldspathic sandstones, shales and coal seams	1050
Ironstone Shales	Dark carbonaceous shales with ironstone bands	360
Barakar	Coarse and medium grey and white sandstones; shales and coal seams	630
Talchir	Coarse sandstones above; greenish shales below (Boulder Bed)	300

1.3.9 Local Geology of the Lease Area

Within Cluster-III, the lease-hold area predominantly comprises of the Barakar Formation of the Lower Gondwana group. This formation hosts multiple coal seams, including Seams I to X, many of which are being exploited through both underground and opencast coal mining methods. The stratigraphy is composed of alternating bands of fine to medium-grained sandstones, carbonaceous shale, and coal seams. The thickness of the coal seams varies across the area, and some zones exhibit multiple seam splits, affecting mining layout and recovery. Fire-affected seams, particularly in the central and northern parts of the leasehold area, are of critical concern and require continuous thermal monitoring and fire-control interventions. The overburden is often composed of weathered sandstone and loose lateritic soils, which contributes to erosion and sedimentation issues for the natural drainage system.

1.3.10 Strike and Dip

The strike and dip of coal seams in Cluster-III exhibit a significant range due to tectonic disturbances. The general strike direction in the area is WNW–ESE to ENE–WSW. The dip of the strata typically varies from 10° to 15° towards the southeast, but in fault-affected zones, the dip can increase drastically, reaching as much as 60° to 70° locally. Faults and folds have disrupted the continuity of coal seams, necessitating detailed structural mapping for effective mine planning. The orientation and inclination of the beds directly influence groundwater flow, mine drainage patterns, and the design of pit slopes in opencast mining operations. Understanding these geological features is essential for ensuring mining safety, optimizing resource recovery, soil loss estimation, finding erosion potential zones and minimizing environmental risks.

1.3.11 Socio-Environmental Profile and Resource Management

Socio-environmentally, the region houses around 3756 project-affected families, with rehabilitation efforts guided by the Jharia Action Plan. The water requirement for the

cluster is estimated at 5745 m^3/day, including 1120 m^3/day for industrial use and 4625 m^3/day for domestic purposes. Environmental and CSR funds are allocated for dust suppression, afforestation, water filtration, and health and safety training. Given its active mining status and associated environmental challenges, Cluster-III presents a complex but crucial landscape for hydrological modelling and watershed-level sustainability planning.

1.4 Current Challenges

Cluster-III faces several interconnected challenges related to land, water, and climate. The absence of proper morphometric analysis makes it difficult to understand landforms and drainage patterns, which affects runoff management and water conservation planning. Rainfall patterns may change due to climate variability, but suitable rainfall-runoff models are lacking, making it hard to predict water flow and flood risks. Hydrometeorological parameters such as rainfall and temperature vary across time and space, adding uncertainty to water resource management planning. Soil erosion is a major issue caused by alteration of land-use due to mining, but without proper estimation, it may continue to damage land and may pollute the nearby water bodies. The lack of site suitability analysis results in poor implementation of water conservation structures. Water quality may also be affected due to seasonal runoff, yet regular monitoring is essential. Moreover, there is requirement of integrated watershed management plan in the study area as per the MoEFCC regulatory framework.

1.5 Scope of the Work

To address the multifaceted issues described above, the present study outlines a comprehensive framework for hydrological and environmental analysis of the Cluster-III mining region. The scope of the work is aligned with seven key objectives:

1. Development of Watershed Management Plan: An integrated and sustainable watershed management plan in line with the MoEFCC guidelines has been developed,

including strategies for land-use planning, water conservation, erosion control, and rehabilitation of degraded areas.

2. Morphometric Analysis: To understand the hydrological response and to identify areas susceptible to erosion, a comprehensive morphometric analysis of the watershed within the coal mining area has been conducted. This involves using Digital Elevation Models (DEMs) to quantitatively assess key parameters like drainage density, stream order, bifurcation ratio, and slope. The findings provide crucial insights into surface runoff patterns and soil erosion potential zones. The expected outcomes provide information on sustainable land management and reclamation strategies in the mining landscape. This analysis is vital for predicting and mitigating the impacts of mining activities on the watershed's hydrological health.

3. Rainfall-Runoff Modeling: The estimation of surface runoff and its spatial distribution across different micro-watersheds could be achieved using hydrological models such as SCS-CN or SWAT. The models have been calibrated with observed rainfall and discharge data to support water resource planning and flood risk assessment.

4. Spatio-Temporal Variability of Hydro-Meteorological Parameters: The statistical methods like Mann-Kendall test and Sen's slope estimator have been used for the computation of seasonal and long-term trends in rainfall and temperature. Climate projections under SSP2-4.5 and SSP5-8.5 from CMIP6 datasets have been done to predict its future variability.

5. Soil Erosion Estimation: The quantification of annual soil loss has been carried out with the help of the Revised Universal Soil Loss Equation (RUSLE) model. The model's key input parameters include rainfall erosivity, soil erodibility, slope length &

steepness, land cover, and conservation practices. The results have been used to identify erosion-prone areas for targeted management.

6. Site Suitability Analysis: The most suitable locations for water and soil conservation structures such as check dams, contour bunds, and afforestation zones have been identified using Multi-Criteria Decision Analysis (MCDA) techniques like AHP and fuzzy logic integrated with GIS tools.

7. Water Quality Parameter Measurement: Assessment of surface and groundwater quality through field sampling and laboratory analysis of key physico-chemical parameters has been carried out in the laboratory at the Department of Environmental Science & Engineering, IIT(ISM), Dhanbad.

8. Final Recommendations: Preparation of the Watershed Management Plan for Cluster-III, Govindpur Area, BCCL, Dhanbad. To address the hydrological and environmental challenges within the Cluster-III mining region of BCCL, Govindpur Area, a comprehensive and multidisciplinary approach has been adapted. The proposed watershed management framework encompasses key thematic domains, aiming to restore and sustainably manage the natural resources impacted by mining operations. The scope of the work is framed around seven interrelated components, which collectively inform the final recommendations for the watershed management plan.

A comprehensive understanding of land degradation within the mining-impacted Cluster-III area is achieved by integrating geospatial technologies, field surveys, and advanced modelling techniques. Degraded zones are primarily identified, and sustainable watershed management practices and effective ecological restoration strategies are then proposed, specifically tailored to this unique terrain. This holistic approach is considered crucial for generating actionable insights to mitigate

environmental degradation. Ultimately, the complex environmental and ecological challenges posed by coal mining will be directly and indirectly addressed by the findings derived from this work, thereby supporting informed decision-making and fostering the long-term environmental well-being of the region.

Chapter 2 : Morphometric analysis to identify various relationships of morphological parameters for the watershed of the study area.

2.1 Introduction

Water is an essential commodity for all human activities all around the world. Water scarcity is one of the major challenges for meeting sustainable development goals in 21st century. The global water scarcity analysis showed that a large share of the world population (up to two-thirds) will be affected by water scarcity over the next few decades in Asia and other regions of the globe. The water available on the earth is estimated to be approximately 1.4 billion cubic kilometers, of which 97 % is salt water and only the remaining 3 % is freshwater. Out of the 3% freshwater, 2 % is locked in glaciers and polar ice caps and leaving only 1 % as surface and groundwater for use. The geographical distribution of this accessible stock of water is highly uneven. Another major problem in the Indian hydrological scenario is the degradation of the water quality.

70% of India's population depends directly or indirectly on agriculture for their livelihood. Agricultural productivity is expected to decline as more areas are becoming unfit for cultivation. The reasons for declining agricultural productivity are the loss and degradation of natural resources, such as soil erosion and degradation of water quality, and the associated problems of declining soil fertility. To address these critical issues, watershed management initiatives have been widely adapted as a sustainable approach to conserve soil and water resources. A watershed, also known as a drainage basin or catchment area, is a physical unit where water converges to a common drainage channel. Though the watershed management approach dates back to the ancient period, it is the only sustainable way to conserve soil and water even today. Watershed management is not a one-time activity but a continuous process.

The term watershed is sometimes referred to as drainage basin, hydrologic basin,

catchment area, catchment, river catchment, and so on. The common terms are watershed, catchment, and basin; morphologically, all these terms convey the same meaning. Within this context, morphometric analysis of watersheds becomes a fundamental component of hydrological investigations. It is a branch of mathematics within geomorphology that quantitatively measures and analyzes the topographic relief and features of the Earth's surface, including parameters like elevation, slope, and other attributes that define landform shape and how they relate to each other. This analysis provides valuable insights into the physical qualities of soil, erosional features, and land processes. By objectively evaluating morphometric parameters such as linear, areal, and relief characteristics of basins, land managers can gain a comprehensive understanding of how drainage morphometry influences landforms and their characteristics, which is essential for informed decision-making in watershed management, land use planning, and environmental conservation.

Hydrologically, a watershed is an area that has only one outlet for draining the surface runoff. For systematic natural resource management in India, the Ministry of Agriculture, Government of India, has developed a watershed atlas of India. The river basins of the country are well organized on a geographical basis, and based on this, six water resource regions have been delineated. The All-India Soil Survey and Land Use division has classified the country into basins, catchments, sub-catchments, and watersheds. Govindpur Cluster-III is in the Khudia and Bagdighi Nala basins and consists of 10 watersheds. The area has more or less slopy terrain with a few hillocks, the highest elevation of the area is 274.74 m and lowest is 122.97 m above mean sea level. This may be the results of erosion by wind and rainwater of the overlying soft lithological formations. The present relief of the locality is being controlled by the hard resistant rocks now exposed to the surface.

2.2 Data Collection and Processing

The present study utilized the Digital Elevation Model (DEM) for hydrological analysis. DEM is a raster dataset capable of giving a 3D representation of elevation

data of the Earth's terrain. Each cell in the raster dataset contains an elevation value of the actual ground terrain. It facilitates drainage network analysis, watershed demarcation, erosion mapping, contour generation, and quantitative analysis like volume-area calculation. CartoSat-1_PAN_CartoDEM-30m is the Digital Elevation Model (DEM) data of the study area that was downloaded from the Indian Space Research Organization's (ISRO) Bhoonidhi portal (http://bhoonidhi.nrsc.gov.in/data/download/index.php, accessed 12 May 2025). The DEM data was collected from Bhoonidhi portal website and details are given in Table 2.1 below.

Table 2.1: Data used for hydrological analysis

Sl. No.	Name	Tile Name	Spatial Resolution	Date of Acquisition	Source
1.	Cartosat-1	P5_PAN_CD_N23_000_E086	30 m	01-05-2024	NRSC, Hyderabad (Bhoonidhi portal)

2.2.1 Preparation of Surface Topography

Surface topography is used to delineate the terrain conditions of any land parcel using satellite imagery. The first derivative of a DEM is used to depict the change in elevation or slope. Slope has been calculated using Spatial Analyst tool available in ArcGIS 10.2.2.

2.2.2 Generation of slope map using DEM

Slope maps are used for analyzing and visualizing landform characteristics and are frequently used to assess watershed units and to estimate slope erosion potential. The Slope tool identifies the steepness at each cell of a surface raster. The lower the slope value, the flatter the terrain; the higher the slope value, the steeper the terrain. In ArcGIS platform, it is processed by using 'Surface' toolset located in 'Spatial Analyst Tools' of ArcToolbox. The input is the raw DEM imagery and output is saved in the desired output folder with image extension such as .tif etc. The output raster can be computed in two-unit types, i.e., degrees or percentage slopes. The

percentage values can be computed by the ratio of Rise to Run with multiplication by 100. The degree values are computed by taking tan of the percentage value. Triangle *B* in Fig. 2.1, when the angle is 45 degrees, the rise is equal to the run, and the percent rise is 100 percent. As the slope angle approaches vertically (90 degree), as in triangle *C* (Fig. 2.1), the percent rise approaches infinity.

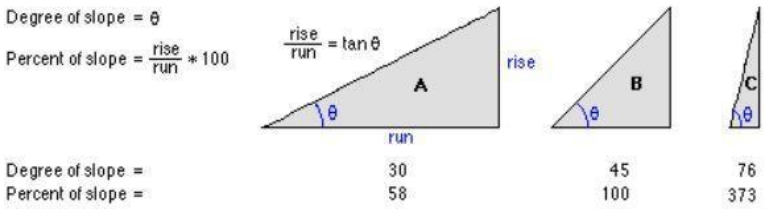


Fig. 2.1: A comparison of the values of slope in degrees & percentage

The red region on the map has a higher steep value and green colored portion shows the lower steep value. The elevation and slope map clearly shows that the northern region of the area has high hills (Fig. 2.2a and 2.2b).

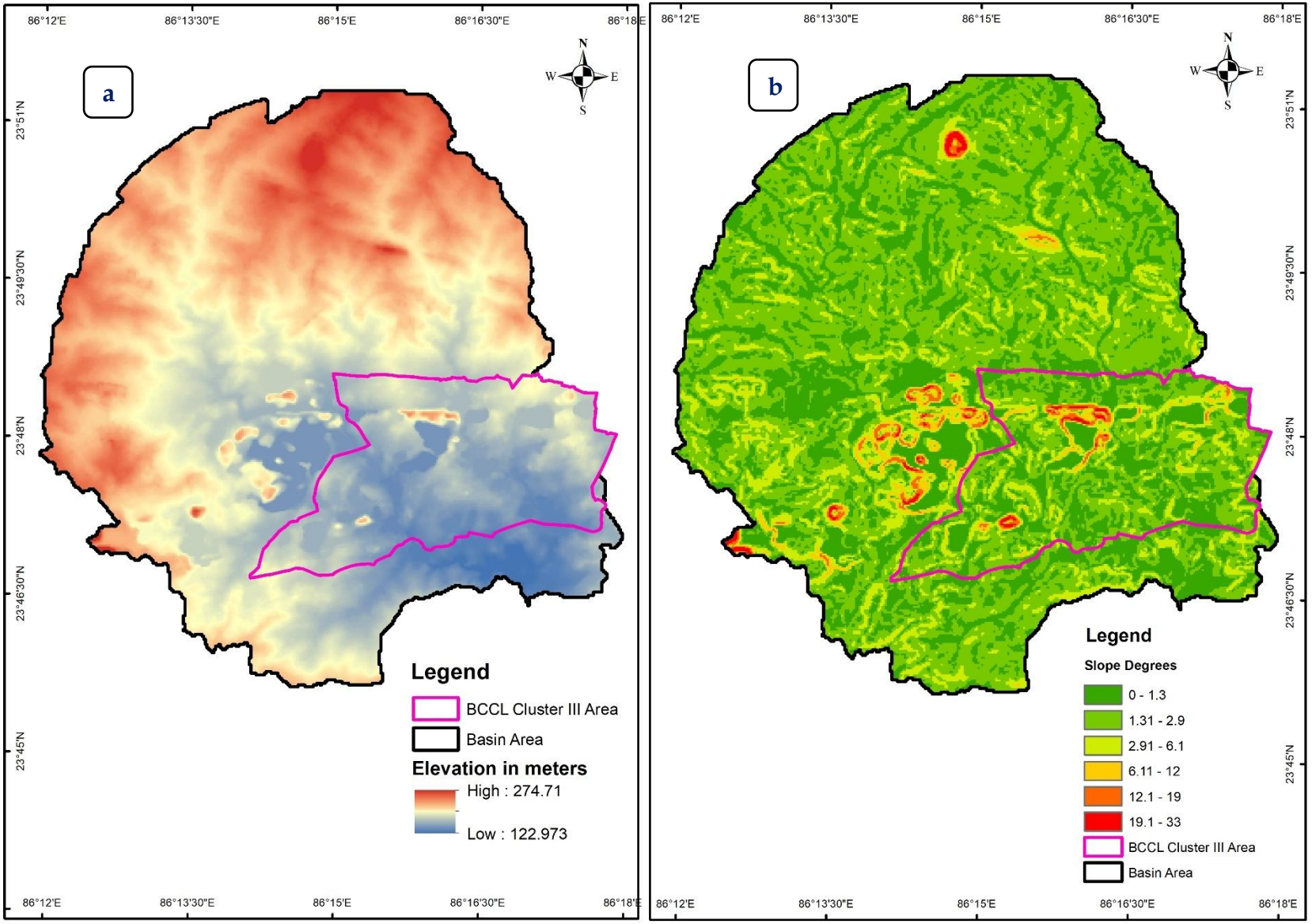


Fig. 2.2: Schematic representation of (a) Elevation and (b) Slope Map of the BCCL Cluster-III Basin Area

2.2.3 Calculation of aspect

An aspect raster identifies the direction that the downhill slope faces. It identifies the downslope direction of the maximum rate of change in value from each cell to its neighbors. In simpler terms, aspect can be thought of as the slope direction; the values of each cell in the output raster indicate the compass direction of the surface faces at that location. It is measured clockwise in degrees from 0 (due north) to 360 (again due north) as shown in Fig. 2.3.

In the ArcGIS platform, it is available in the Surface toolset located in the Spatial Analyst Tools of the ArcToolbox. The input is the raw DEM imagery, and the output is saved in the desired output folder with an image extension such as .tif, etc. The output of the aspect calculation identifies the direction of the downhill slope faces. The values of each cell in the output raster indicate the compass direction of the surface faces at that location, which can be seen in Fig. 2.4.

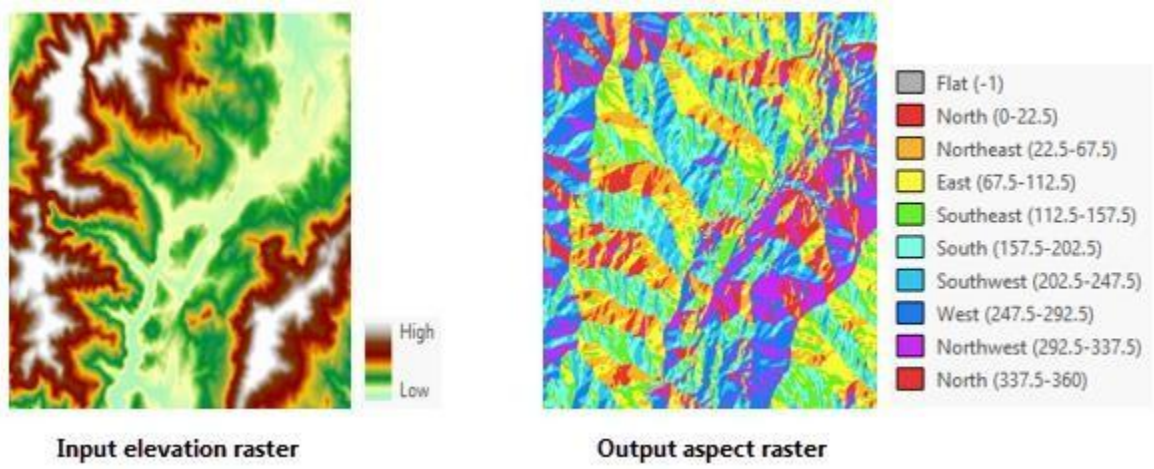


Fig. 2.3: Graphical representation of input elevation grid and output aspect grid

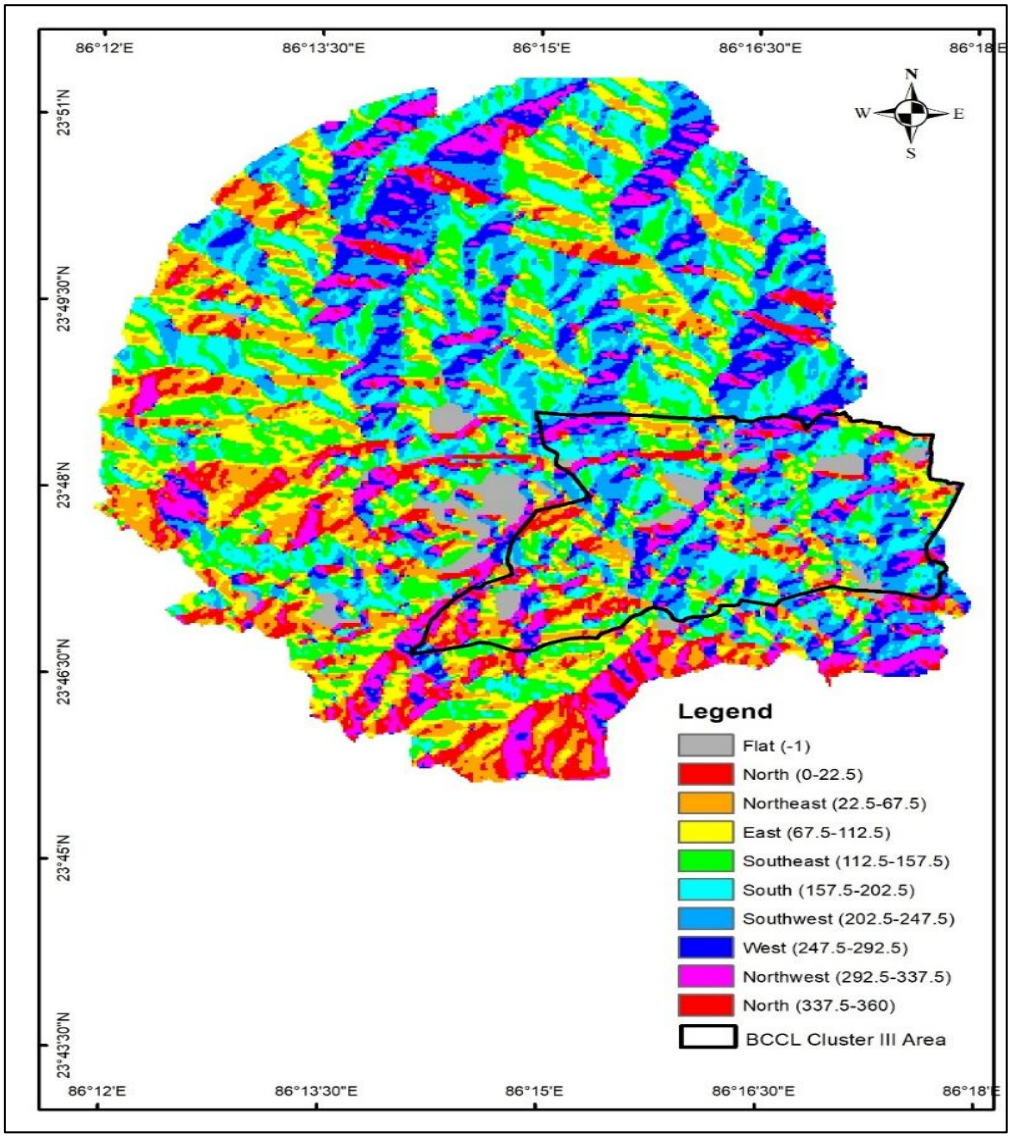


Fig. 2.4: Schematics of the aspect map of the BCCL Cluster-III Basin Area

2.3 Preprocessing of the DEM

Watershed delineation is one of the most commonly performed activities in hydrology and environmental analyses. Digital Elevation Models (DEMs) provide good terrain representation, which can delineate watersheds using GIS Software. The various steps for preprocessing of the DEM for watershed delineation in ArcGIS software are discussed below.

Step 1: Filling of the sinks in raw imagery

After the projection of the raw DEM into a projected coordinate system, the data were processed further for the removal of all sink values in the cells. A sink is a cell with an

undefined drainage direction with no cells surrounding it is at lower elevation than that sink. It is a cell or set of spatially connected cells whose flow direction cannot be assigned in any one of the eight valid values in a flow direction raster. Sinks in elevation data are most commonly due to errors in the data. These errors are often caused by sampling effects and the rounding of elevation values into integer numbers. To remove sinks in the raw data, fill tool is used in the Hydrology toolset located in Spatial Analyst Tool of the ArcToolbox as shown in Fig. 2.5. The next step in the process is the calculation of the flow direction raster.

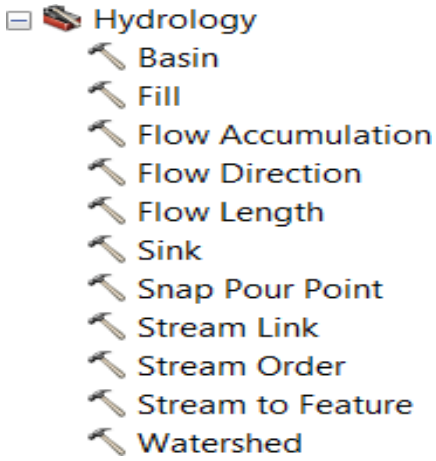
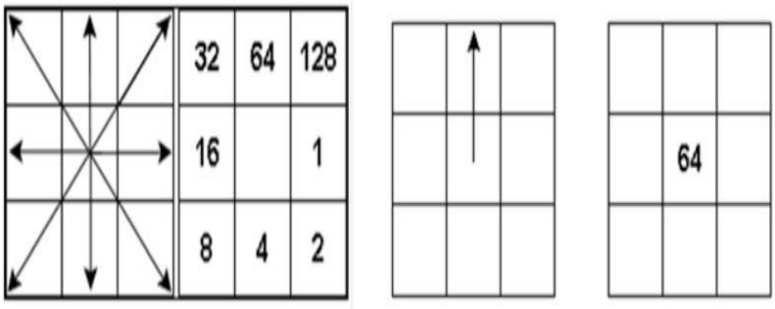


Fig. 2.5: Hydrology Toolset in ArcToolbox of ArcGIS

Step 2: Creation of a flow direction map

The Flow Direction raster function requires a surface DEM as input and creates a raster of flow direction from each pixel to its steepest downslope neighbor. The flow direction is identified by the steepest slope or the direction with the greatest elevation difference. The Flow Direction function supports three flow modeling methods and those are the D8 (eight directions), Multi-Flow Direction (MFD), and D-Infinity (DINF) flow modeling methods. In a given study, D8 algorithm is used to find the flow direction towards steepest descent of 8 neighboring cells. A flow direction grid assigns a value to each cell to indicate the direction of flow that is the direction that water will flow from that particular cell based on the underlying topography of the landscape. The flow direction tool takes a 3×3 cell into consideration and its

neighborhood, then the grid processor finds the lowest neighboring cell from the center. Each number in the matrix below corresponds to a flow direction, i.e. if the center cell flows due north, its value will be 64; if it flows northeast, its value will be 128, etc. as shown in Fig. 2 . 6. In flow direction rasters, the values 1, 2, 4, 8, 16, 32, 64, and 128 represent the eight possible directions a cell's flow can take East, Southeast, South, Southwest, West, Northwest, North, and Northeast directions, respectively. These numbers have no numeric meaning, but they are simply codes that define specific directional values and are determined using the elevation values from the underlying DEM.



Flow direction matrix **Flow direction is north, cell is coded 64**

Fig. 2.6: A schematic diagram of the flow direction matrix

The output of the flow direction gives the direction of the stream flows in each cell as shown in Fig. 2.7 for the entire selected basin area of 73.51 km^2.

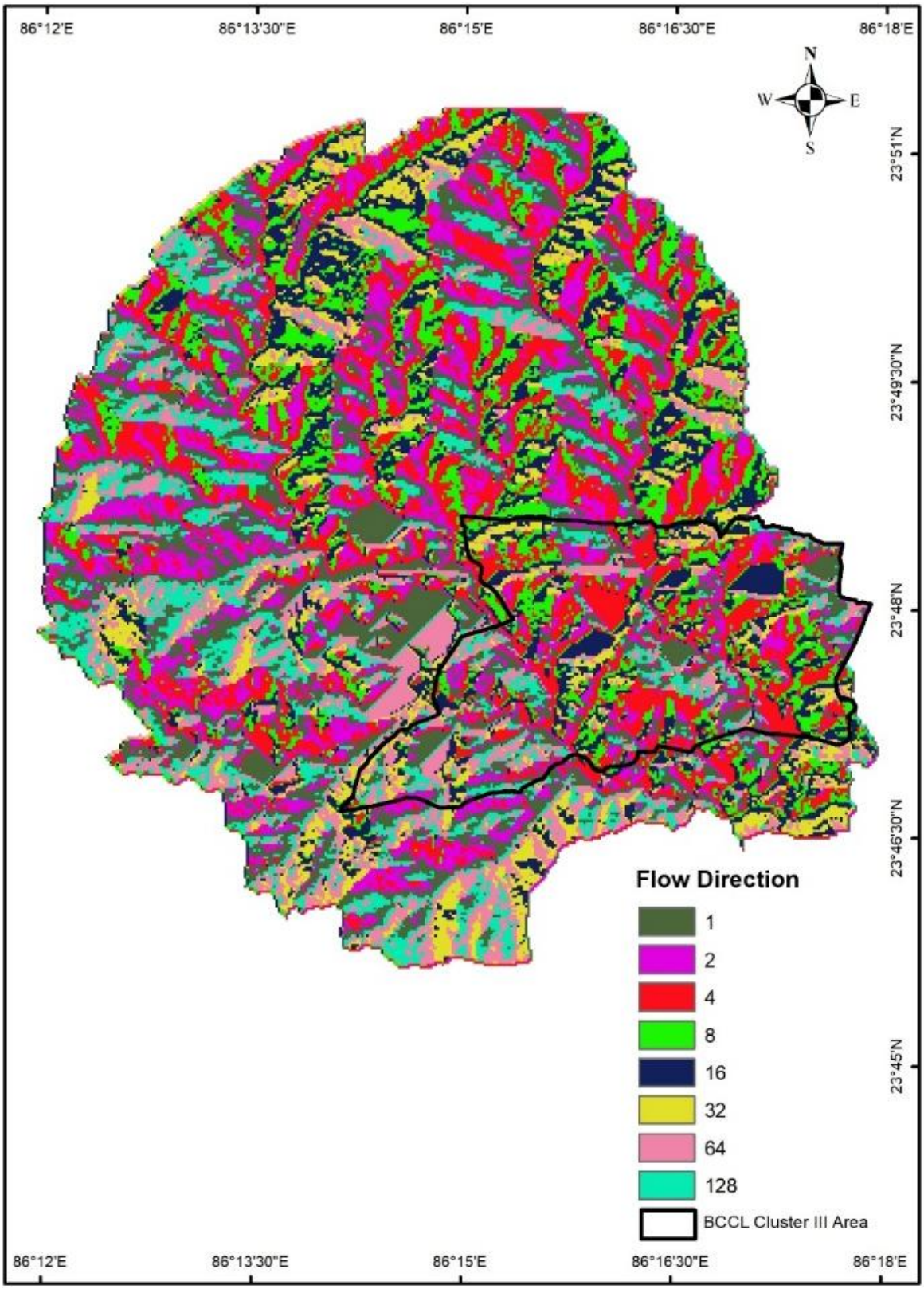


Fig. 2.7: Flow direction map of the BCCL Cluster-III Basin Area

Step 3: Creation of a flow accumulation grid

The flow accumulation tool of ArcGIS calculates accumulated flow as the accumulated weight of all cells flowing into each downslope cell in the output raster. If no weight raster is provided, a weight of 1 is applied to each cell, and the value of cells in the output raster is the number of cells that flow into each cell. The cells with a high value of flow accumulation represent stream channels, while cells with low flow accumulation represent uplands. Cells of undefined flow direction will only receive flow but they do not contribute any downstream flow. The accumulated flow is based on the number of cells flowing into each cell in the output raster. Output cells with a high flow accumulation are areas of concentrated flow and can be used to identify stream channels. Output cells with a flow accumulation of zero are local topographic highs and can be used to identify ridges. Flow accumulations are important because they allow to locate cells with high flow where streams and channels are expected.

The flow accumulation tool is given in the Hydrology toolset located in Spatial Analyst Tool of ArcToolbox as shown in Fig. 2.3. The Flow Accumulation raster, as shown in Figure 2.8, displays the accumulated flow to each cell, which is determined by the sum of the weight of all upslope cells that drain into it. To create a raster representing the stream network, where streams are given a value of 1 and the background is NoData, a threshold would typically be applied to this flow accumulation raster. Cells exceeding a certain flow accumulation threshold are considered part of the stream network, while those below become NoData.

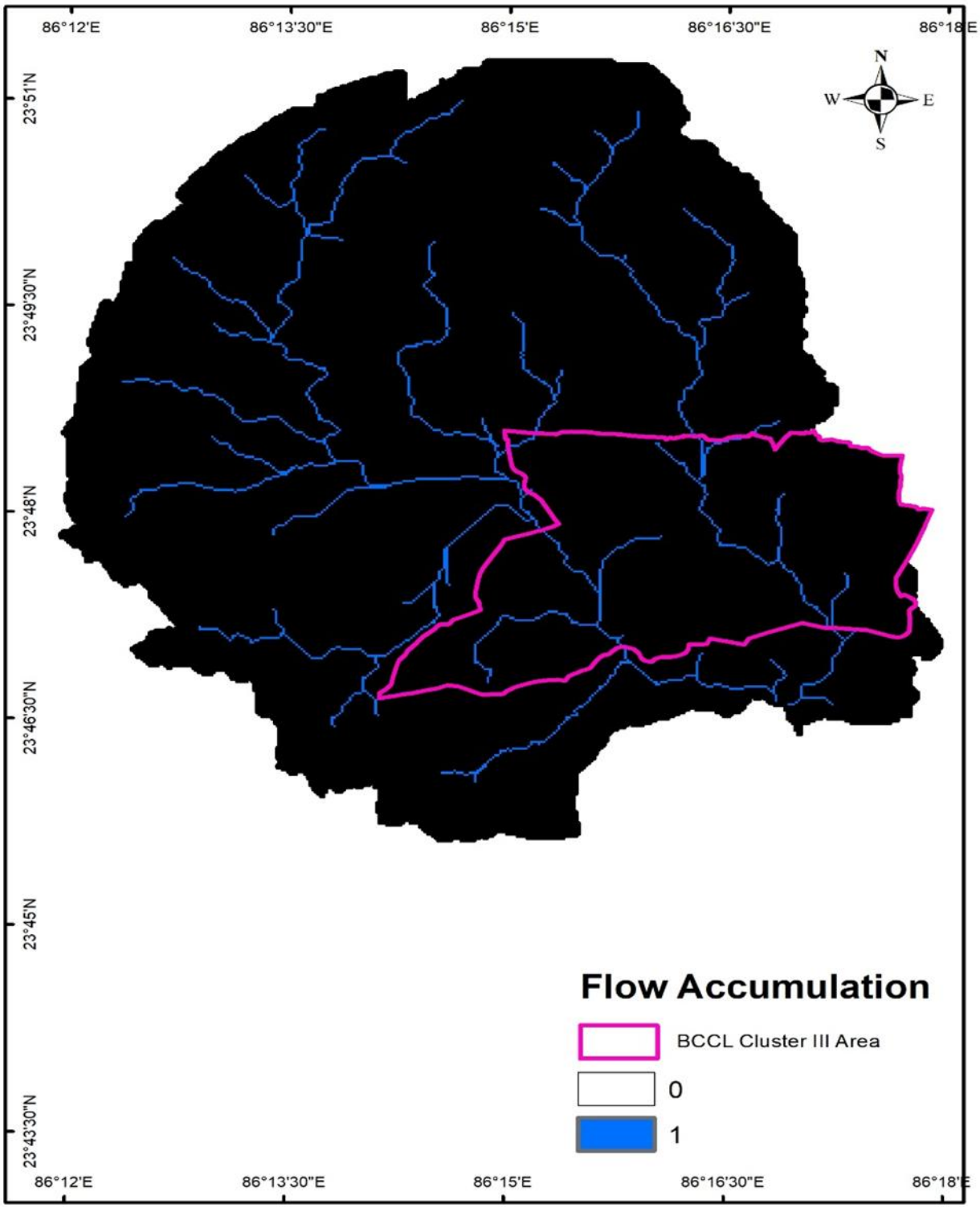


Fig. 2.8: Schematics of flow accumulation map of the BCCL Cluster-III Basin Area

2.4 Stream ordering of the drainage network in and around the mine lease area.

Stream order tool assigns a numeric order and links the stream network based on the

number of tributaries that are joining in a stream. Some characteristics of streams can be inferred by simply knowing their orders. For example, first-order streams are dominated by overland flow of water; they have no upstream concentrated flow. Because of this, they are most susceptible to non-point source pollution and can derive more benefits from wide riparian buffers than other areas of the watershed. The Stream ordering tool has two methods to assign orders. These two methods were proposed by Strahler (1957) and Shreve (1966).

a) Strahler (1957) method of stream ordering

In the Strahler (1957) method, all links without any tributaries are assigned an order of -1 and are referred to as first order. The stream order increases when streams of the same order intersect. Therefore, the intersection of two first-order links will create a second-order link, the intersection of two second-order links will create a third-order link, and so on. The intersection of two links of different orders, however, will not result in an increase in order which can be referred to from the Fig. 2.9. For example, the intersection of a first-order and second-order link will not create a third-order link but will retain the order of the highest ordered link. The Strahler method is the most common and widely used stream ordering method. However, using this method, the order increases only at the intersections of the same order streams, it does not account for all links and can be sensitive to the addition or removal of links (Fig. 2.9).

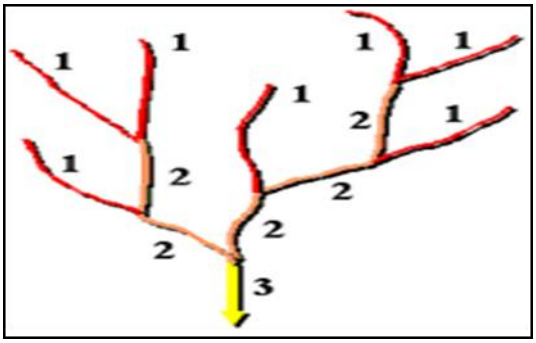


Fig. 2.9: A schematic diagram of Strahler method of Stream ordering

b) Shreve (1966) method of stream ordering

The Shreve (1966) method accounts for all links in the network. As with the Strahler method, all exterior links are assigned an order of 1. For all interior links in the Shreve method, however, the orders are additives which can be seen in the Fig. 2.10 which is given below. For example, the intersection of two first-order links creates a second-order link, the intersection of a first order and second-order link creates a third-order link, and the intersection of a second-order and third-order link creates a fifth-order link and so on. Because the orders are additive, the numbers from the Shreve method are sometimes referred to as magnitudes instead of orders. The magnitude of a link in the Shreve method is the number of upstream links (Fig. 2.9).

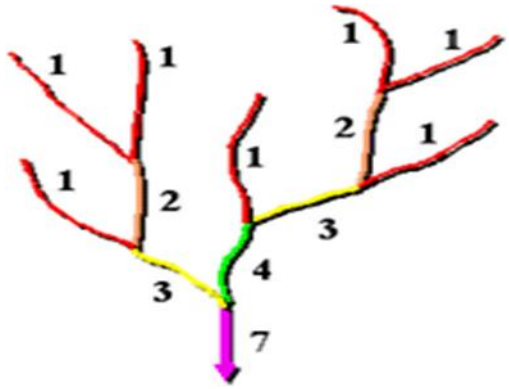


Fig. 2.10: A schematic diagram of Shreve method of stream ordering

Drainage network delineation and stream ordering is a multi-step process. Based on the Strahler method, the stream network and stream ordering of the study area were done. The step wise method for stream order delineation is given below:

Step 1: Determination of stream network

To know the stream order of a particular watershed, first we have to find the stream networks. Stream networks can be delineated from a Digital Elevation Model (DEM) using the output from the Flow Direction and Flow Accumulation tools. Flow accumulation, in its simplest form, is the number of upslope cells that flow into a particular cell. By applying a threshold value to the values of Flow Accumulation, a stream network can be defined that is comprised of catchments that are of the size of

the threshold value. The standard threshold values to identify the stream networks are 5,000 units of flow accumulation and the flow accumulation should be present in at least 30,000 cells. However, depending on the study area the value can change. The threshold flow accumulation value for the present study area was taken as 600 unit, due to its small spatial coverage. The spatial distributions of stream networks in the present study area are presented in Fig. 2. 8.

Step 2: Determination of stream link

Stream links are the linear joints between the junction points of a stream network. A link joins two consecutive junction points, and it is an outlet for the stream flow coming from the upstream region. A schematic diagram of stream link is shown in Fig. 2. 11.

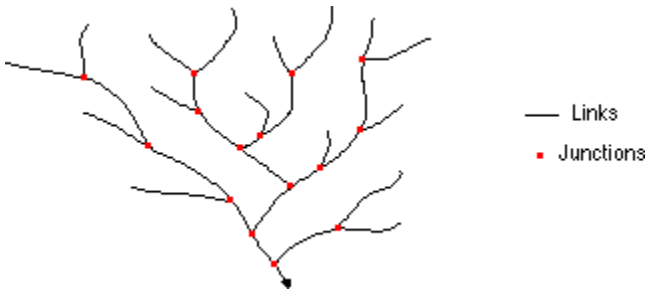


Fig. 2.11: Schematic representation of stream link of a drainage network

The Stream Link function creates a grid of stream links (or segments) that have a unique identification. A link may be a head link or it may be defined as a link between two junctions. All cells in a particular link have the same grid code that is specific to that link. The Stream Link tool only supports a D8 input flow direction raster. The Stream Link tool is given in the Hydrology toolset, located in Spatial Analyst Tool of ArcToolbox as shown in Fig. 2.5. This tool uses the Stream raster and Flow Direction raster as an input and provides a network of streams with junctions and links as the output. The next step is to determine the stream order.

Step 3: Determination of stream order

After determining the stream link, stream order has been determined using either

Strahler (1957) or Shreve (1966) method. Stream order means assigning a numeric order to links in a stream network. This stream ordering is a method for identifying and classifying the types of streams based on their numbers of tributaries. The DEM of Cluster-III area of BCCL was used to determine the Stream Order with Strahler method and it was found that the area has '3' different Stream Orders which can be seen in the given Fig. 2.12 The stream order map was then vectorized to create a stream network dataset. The schematics for the preparation of the stream network are shown in Fig. 2.13.

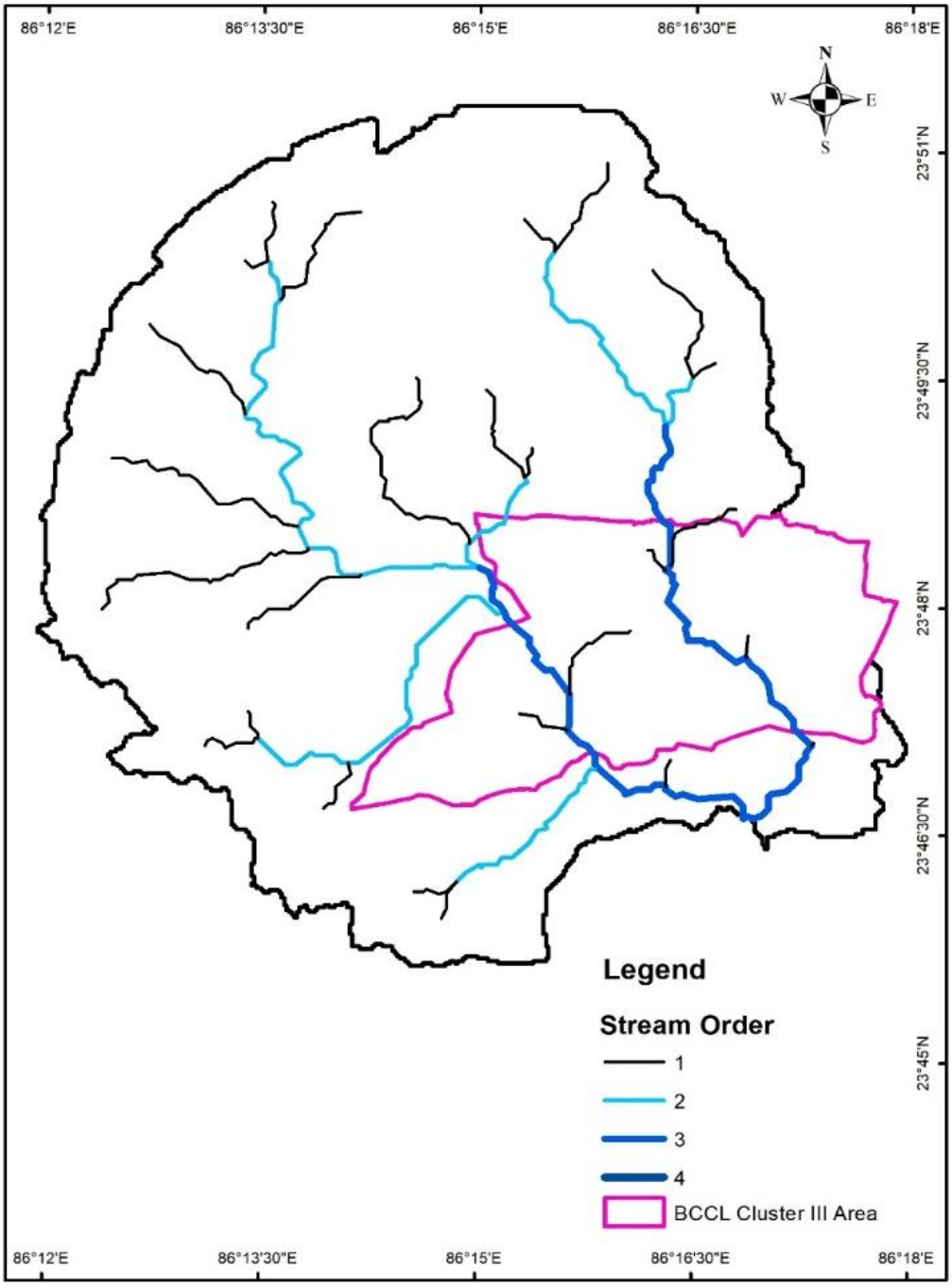


Fig. 2.12: Stream Order map of the BCCL Cluster-III area

2.5 Demarcation of the watershed covering the mine lease area

Watershed, also known as basin, is an area of land that drains water into a specific water body. The main purpose of watershed delineation is to divide the watershed into discrete land areas and stream reaches that drain water into a single outlet. The

geographical extent of a watershed is subdivided into smaller categories known as sub-basins.

Methods for watershed delineation

There are two methods for watershed delineation. The first method is based on the topography using GIS algorithm in which the input data required is DEM and the second method is based on uploading the pre-defined watersheds in which input data required is the known sub basin boundaries and streams.

In the present study the watershed has been delineated using the Cartosat-1 DEM data. Watershed delineation is done by using point-based technique. First, DEM is preprocessed and after preprocessing, the stream network and stream links are extracted from the flow accumulation output. In the final step of watershed delineation, flow direction and stream link raster are used as input. The present watershed has been delineated using the point named as pour point. In basin, the pour point has been added over the stream link at the end point of Khudia and Bagdighi Nala just before reaching the Katri River. Finally, the output watershed has been converted into vector features and then has been extracted as polygon features. The final watershed covering the entire basin area has been presented in Fig. 2.13.

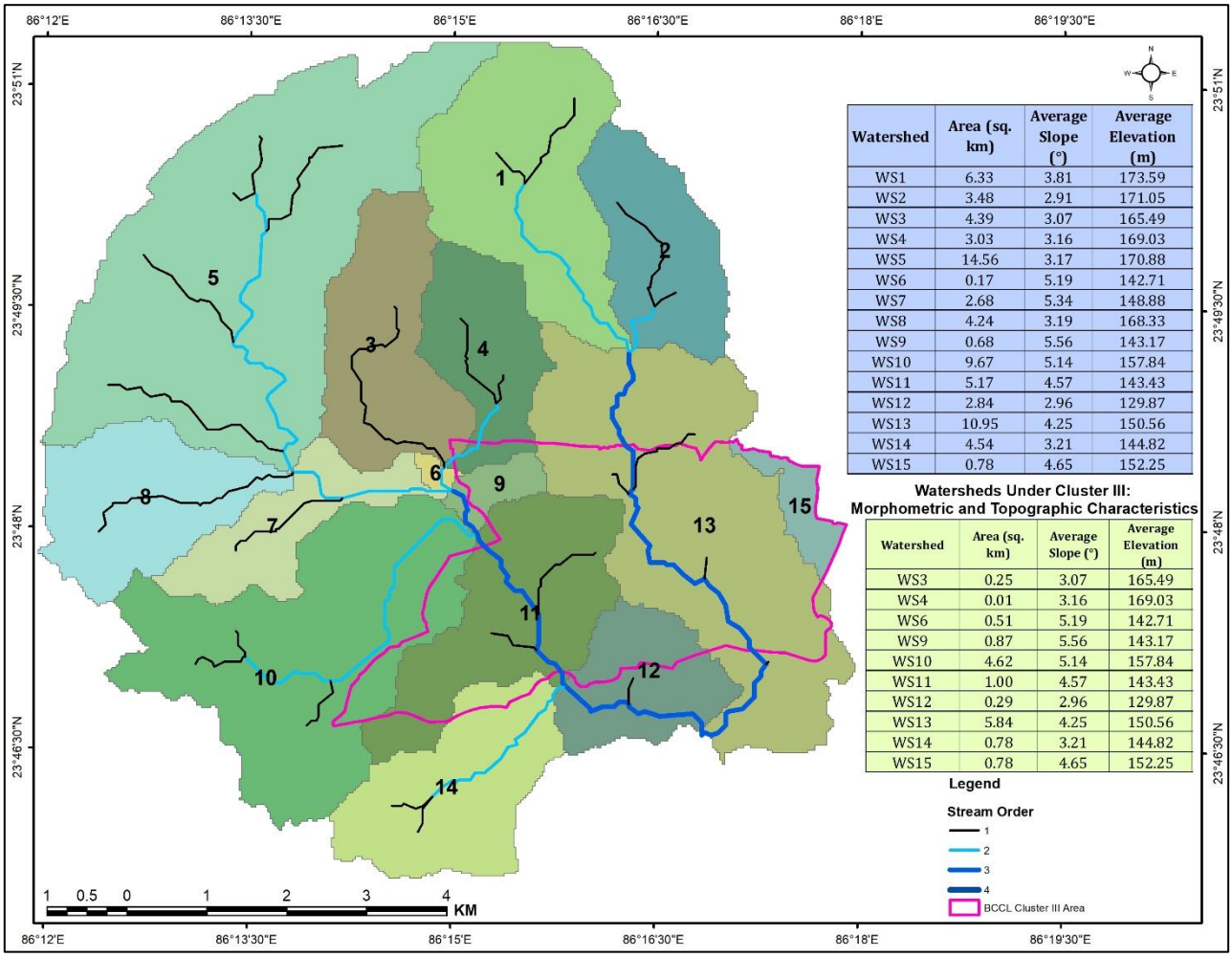


Fig. 2.13: Schematics of morphometric and topographic characteristics along with the demarcation of watershed

2.6. Conclusion

The morphometric analysis of the BCCL Cluster-III area and the broader watershed basin reveals significant spatial heterogeneity in key geomorphological parameters such as area, slope, and elevation that directly may influence the hydrological behavior and surface runoff potential of the region.

In the BCCL Cluster-III area, sub-watersheds range from as small as 0.01 sq. km (WS4) to 5.84 sq. km (WS13), with average slopes between 2.96° and 5.56°, indicating a predominantly undulating to moderately steep terrain. The average elevation in this area ranges from 129.87 m to 165.49 m above mean sea level, which falls within the lower to mid-range of the overall basin elevation.

In contrast, the entire basin exhibits a broader variation in watershed area from 0.17 sq. km (WS6) to 14.56 sq. km (WS5) and covers a wider elevation gradient of 129.87 m to 173.59 m above mean sea level. The slope values span from 2.91° (WS2) to 5.56° (WS9), suggesting varying degrees of potential energy for water movement and erosion susceptibility.

Key insights from morphometric relationships include:

- Watersheds with higher slopes and smaller areas (e.g., WS6, WS9) are likely to exhibit rapid runoff and higher erosion potential.
- Watersheds with larger area and moderate slope (e.g., WS5, WS1) may contribute significantly to base-flow and groundwater recharge, due to greater infiltration potential.
- Low-lying watersheds (e.g., WS12) may serve as accumulation zones or discharge points, potentially vulnerable to flooding or sediment deposition during high rainfall.
- The morphometric variability highlights the complex topographic controls on drainage development, flow dynamics, and sediment transport within the basin. These relationships are vital for:
    - Hydrological modeling and watershed prioritization
    - Designing site-specific soil and water conservation structures
    - Planning sustainable land-use interventions
    - Mitigating risks of erosion and flooding

  This morphometric framework thus provides a crucial scientific basis for integrated watershed management in both mining-affected areas like BCCL Cluster-III and the overall basin landscape.

Chapter 3: Rainfall-runoff modelling to estimate runoff generated in different watersheds of the study area.

3.1 Introduction

Rainfall-runoff modelling is a critical component in the field of hydrology, aimed at understanding and quantifying the transformation of precipitation into surface runoff. Accurate estimation of runoff is essential for the design and operation of hydraulic structures, assessment of water availability, and mitigation of flood risks, particularly in the face of increasing climatic variability and land-use changes. Watersheds exhibit diverse hydrological responses to rainfall due to variations in topography, soil characteristics, land-use, vegetation cover, and climatic conditions. Therefore, modelling runoff generation across different watershed regions requires a robust understanding of these interacting factors and the ability to simulate their complex dynamics. Rainfall-runoff models serve as valuable tools in this regard, enabling the estimation of runoff volumes, flow rates, and spatial distribution under various hydrometeorological scenarios.

This study aims to apply rainfall-runoff modelling techniques to estimate the runoff generated in different watershed regions. By utilizing Rational and Curve Number methods, the runoff flow can be estimated. The most widely used Soil Conservation Service-Curve Number (SCS-CN) method, developed by the USDA, has been selected for the estimation of Runoff in the study area, which is supported by climatic and geospatial data. The study seeks to evaluate the spatial variability in runoff generation and identify key factors influencing the hydrological response of each watershed.

This chapter presents a comprehensive analysis of runoff estimation for the years 2015 to 2024 using the SCS-CN method across 15 delineated watersheds (WS1 to WS15) located in a monsoon-influenced coal mining-dominated catchment. These watersheds drain into two major Nala namely the Khudia and the Bagdighi Nala. The findings of the study are expected to support sustainable watershed management and

adaptation strategies under changing environmental conditions.

3.2 Methodology Adapted

3.2.1 Rational Method

The Rational Method is one of the most widely used empirical techniques for estimating peak surface runoff from small watersheds or urban catchments. It is primarily applied in the design of drainage structures, such as storm water drains, culverts, roadside ditches, detention basins etc. The method assumes that the peak runoff rate occurs when the entire drainage area contributes simultaneously to runoff, typically during short-duration, high-intensity rainfall events. The Rational Method is best suited for small watershed areas (usually less than 200 hectares or 500 acres) where land-use and rainfall intensity are relatively uniform. It provides a quick and straightforward estimate of peak discharge, making it particularly useful in preliminary design and urban storm water planning. The peak rate of runoff can be calculated by using the Eq. 3.1.

$$\boldsymbol{Q = \frac{1}{360} \times CIA} \qquad \textbf{…… (Eq. 3.1)}$$

Where, Q = Peak rate of runoff (m^3/sec), C = runoff coefficient, I = intensity of rainfall (mm/hr), A = area of the catchment (ha), Runoff coefficient C is defined as the ratio of the peak runoff rate to the rainfall intensity. Values of C for different slopes and land-use conditions are determined from field observations (USSCS 1972).

3.2.2 SCS-Curve Number Method

The Soil Conservation Service and Curve Number (SCS-CN) method was developed in 1954 and is documented in Section-4 of the National Engineering Handbook (NEH-4) published by the Soil Conservation Service (now called as Natural Resources Conservation Service) of the United States Department of Agriculture (USDA). The SCS Curve number is an empirical method for estimating direct runoff from rainfall events, especially in ungauged or data-scarce watersheds. It is commonly applied in

agriculture, urban planning, watershed management, and hydrological modeling to assess the impact of land-use, soil type, and antecedent moisture conditions on surface runoff. Unlike the Rational Method, which estimates peak runoff, the SCS-CN method focuses on the depth or volume of runoff and can be extended for event-based, monthly, or annual runoff estimation by aggregating over time. The present study used SCS-CN method to estimate monthly and annual runoff in mm based on precipitation inputs, land-use/land cover, soil type, and hydrologic conditions of the Dhanbad district along with the Govindpur Cluster-III area. The monthly and total annual runoff was computed and aggregated for each watershed connected with the study area. The method uses a dimensionless Curve Number (CN), which reflects the runoff potential of a watershed based on land-use/land cover, hydrologic soil group (HSG), and antecedent moisture condition (AMC) (Bansode et al., 2014). The data for soil properties and hydrologic soil groups were collected from the respective Government Agencies to create thematic layer for runoff potential (https://www.sameti.org/Soil_Inventory/Dhanbad_Soil_Analysis.pdf, accessed on 12th May 2025). The data for soil properties, soil curve number, land-use pattern and other associated parameters were collected and digitized in ArcGIS to create thematic layers for calculating runoff potential. The following equations have been used for calculating the amount of runoff generated using Raster Calculator in ArcMap. Runoff Depth can be calculated by using Eq. 3.2.

$$\boldsymbol{Q = \frac{(P-I_a)^2}{(P-I_a)+S}} \quad \textbf{..... (Eq. 3.2)}$$

Where, Q = Runoff depth in mm, P = Precipitation of the area in mm, S = Potential maximum retention after the start of runoff in mm, Ia = Initial abstraction or losses of the area in mm i.e., losses before runoff in the form of infiltration, interception or evaporation. Here, Ia = 0.3S, this relation was found by analyzing the rainfall in many small agricultural basins for Indian condition (Rao et al., 2010). For Indian condition, the Eq. 3.2 can be simplified as Eq. 3.3.

$$Q = \frac{(P-0.3S)^2}{P+0.7S} \text{ ..... (Eq. 3.3)}$$

Here, S is calculated by Curve Number (CN) values by using Eq. 3.4.

$$S = \frac{25400}{CN} - 254 \text{ ..... (Eq. 3.4)}$$

Here, CN is the curve number which is a dimensionless parameter used to indicate the behavior of runoff of a given area. In this method, it relates to the land-use pattern in the area, the soil moisture conditions, the hydrological conditions and the soil group of the drainage area. The CN value varies from 0 to 100. The number signifies a response of an area to generate runoff with respect to a particular rainfall value. Lower curve number indicates an area with a low potential for runoff generation. Higher CN indicates that a greater portion of the rainfall will flow as runoff (Krois & Schulte, 2014).

Land-use pattern describes the condition of the surface of a drainage basin. Properties of soil also greatly affect the amount of runoff that will be generated. In this method, the soil properties are represented by a parameter called hydrological soil group that can be used to calculate the minimum rate of infiltration that can take place after saturation for a specific soil category. Thus, by this process, the effect of both infiltration rate and horizontal transmission rate are taken into consideration.

The soil is classified into four different hydrological groups that are discussed below:

- **Class A:** This type of soil possesses high water transmission rate. Example: Well drained sand and gravel.
- **Class B:** This type of soil has moderate infiltration rate and a moderate water transmission rate. Example: Moderately drained soil having coarse to fine textures.
- **Class C:** This type of soil has low infiltration rate and low water transmission rate. Example: Clayey loams and sandy loamy soils with moderate to fine textures.

- **Class D:** This type of soil has a very low rate of infiltration and a very low rate of water transmission. Examples: Clayey soils with fine texture.

In the present study area, the soil is found to be inceptisols category which is loamy in structure. It comes under the hydrological group B and C.

The moisture condition of soil in the drainage area before any rainfall is also an important criterion that influences final curve number values. In SCS-CN method, the antecedent moisture condition can be categorized into three classes:

- **AMC I:** Soil present in the drainage area is dry.
- **AMC II:** Soil has average moisture content.
- **AMC III:** Soil is saturated from previous rainfall.

These are classified on the basis of 5-day antecedent rainfall. The AMC condition refers to as the condition of soil moisture just when it starts to rain. The curve number values based on all AMC- I, II, and III conditions taken for each HSG group and corresponding land cover for the entire basin area has been given in Table 3.1.

Table 3.1: Calculated Curve Number (CN) for Various Land-Use Classes (*Source: https://www.hec.usace.army.mil/confluence/hmsdocs/hmstrm/cn-tables*)

Sl. No	LULC Class	HSG Group		Total Area in sq. km		CN Values	
1	Agriculture land	B	C	7.94	0.01	78	85
2	Barren Land	B	C	5.57	3.60	86	91
3	Mining	B	C	3.64	0.79	86	91
4	Nala	B	C	0.33	0.16	100	100
5	National Highway	B	C	0.08	0.07	98	98
6	Railways	B	C	0.38	0.14	85	89
7	Settlements	B	C	7.55	2.16	65	77
8	Sparse Vegetation	B	C	28.20	7.90	69	79
9	Vegetation	B	C	6.80	0.36	61	74
10	Village Road	B	-	0.14	—	89	-
11	Waterbody	B	C	0.55	0.05	100	100

3.3 Watershed Classification and River Systems

Based on detailed investigation, the entire basin area consists of 15 watersheds, which are the tributaries of the two main Nala flowing through the study area (Fig. 3.1). These watersheds are primarily divided into two drainage systems:

i. Khudia Nala: Receives runoff from the watersheds WS3 to WS12 and WS14. The downstream of the Khudia Nala outlet is located at WS12.

ii. Bagdighi Nala: The watersheds WS1, WS2, WS13, and WS15 contribute their runoff into the Bagdighi Nala. The downstream of the Bagdighi Nala outlet falls within the watershed WS15.

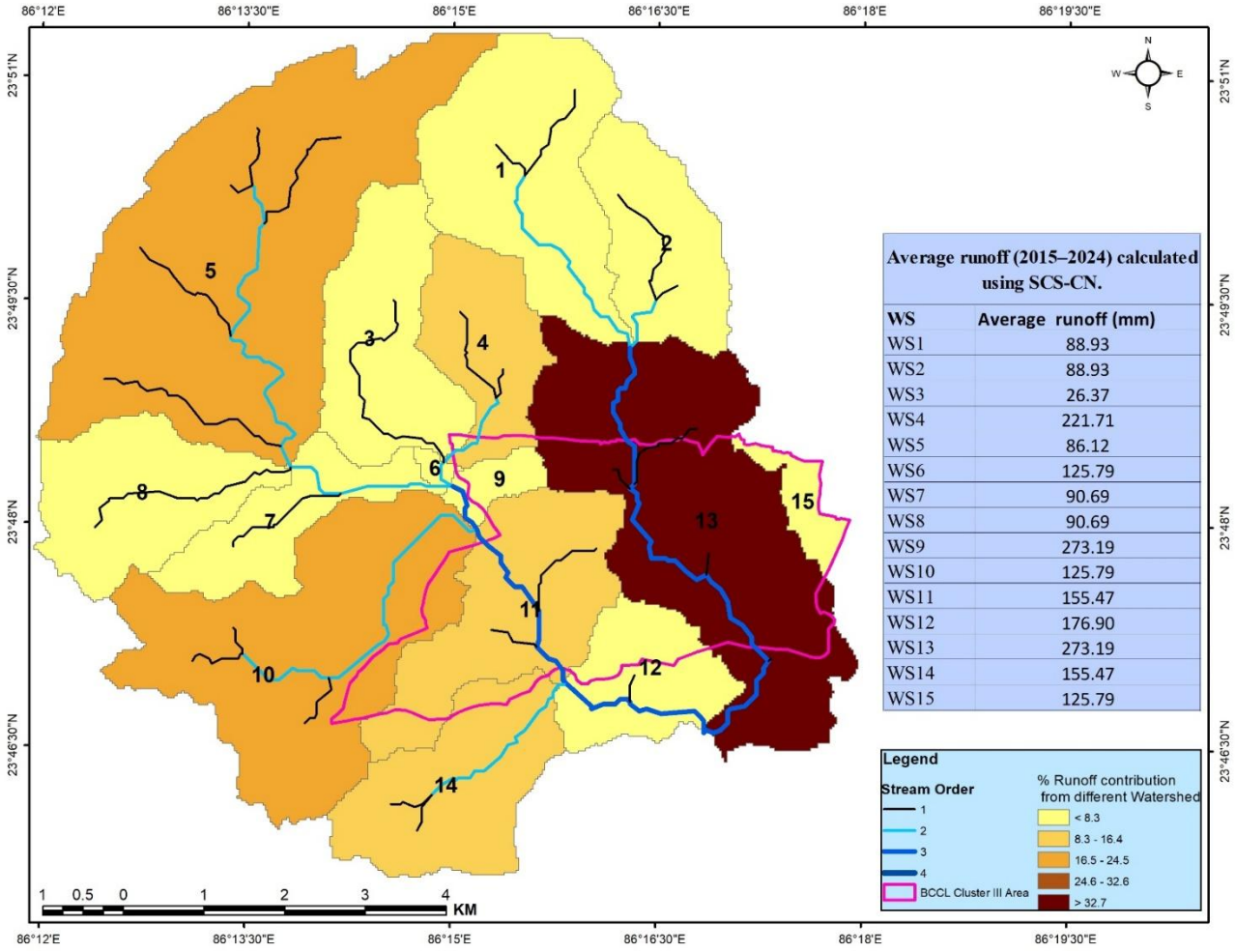


Fig. 3.1: Runoff contribution from different watersheds

3.4. Results and Discussion

3.4.1 Temporal Variability

Runoff generation varied significantly across the study period, with peak runoff occurring consistently in the monsoon months (July to September). The year 2024 recorded the highest runoff, indicating a possible extreme rainfall event.

3.4.2 Spatial Distribution

Watersheds contributing to the Khudia Nala produced substantially more runoff than those feeding the Bagdighi Nala. WS4, WS9, and WS12 were the major contributors, regularly exceeding 300 mm/year. WS13 in the Bagdighi Nala system was the dominant watershed, matching the runoff levels of the top Khudia sub-basins during wet years. The calculated historical annual runoff trend (2015–2024) for Khudia and Bagdighi Nala Systems have been shown in Fig. 3.2.

3.4.3 Total Cumulative Runoff

The cumulative runoff of the watershed of the two different major drainage system has been calculated and shown in the Table 3.2.

Table 3.2: Cumulative Total Runoff (2015–2024) of the existing main drainage system

Rivers	Contributing Watersheds	Total Runoff (2015–2024) in mm
Khudia Nala	WS3–WS12, WS14	17,973.28
Bagdighi Nala	WS1, WS2, WS13, WS15	5,193.38

The Khudia Nala system exhibited a more intense hydrological response, aligning with its larger catchment area and more responsive land cover conditions.

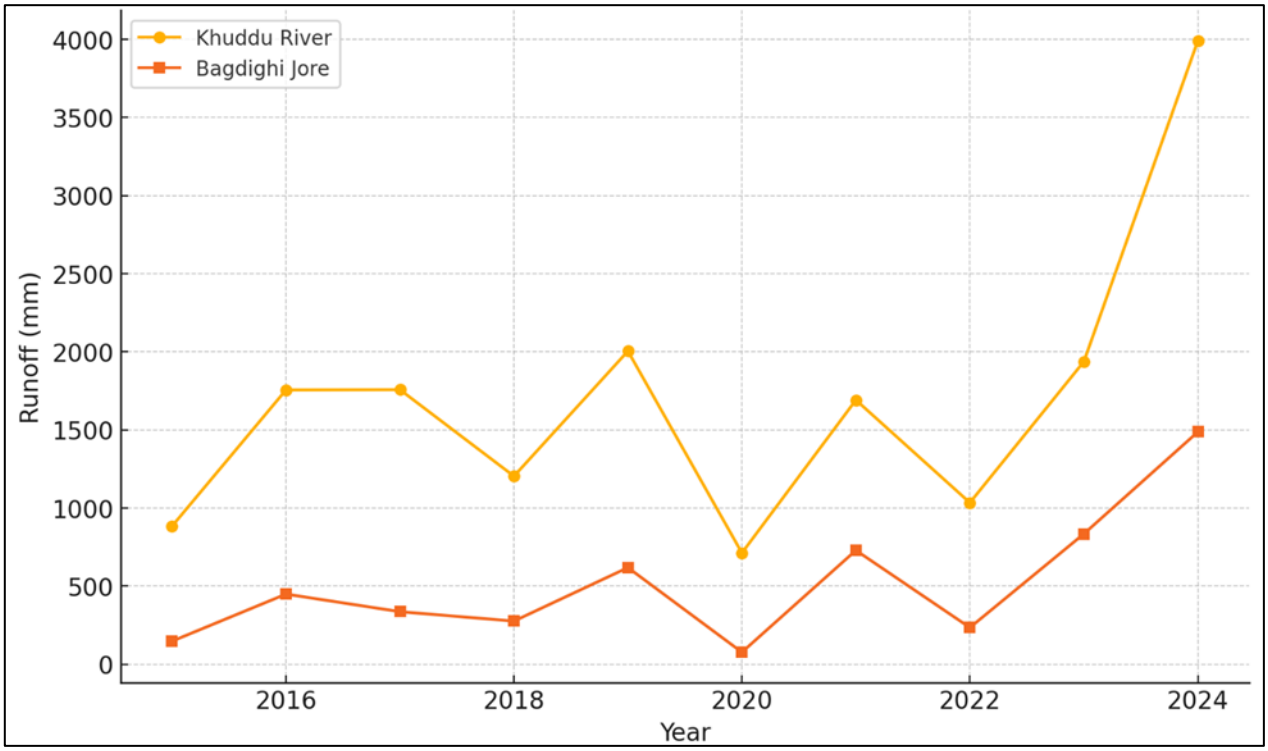


Fig. 3.2: Annual runoff trend (2015–2024) for Khudia and Bagdighi Nala Systems

3.4.4 Peak Runoff Year: 2024

In 2024, runoff values reached record highs across most of the watersheds (Fig. 3.3):

- WS4: 506.76 mm
- WS9: 590.84 mm
- WS12: 438.26 mm
- WS13: 590.84 mm

This highlights the increasing frequency of high-intensity precipitation events and their implications for watershed planning.

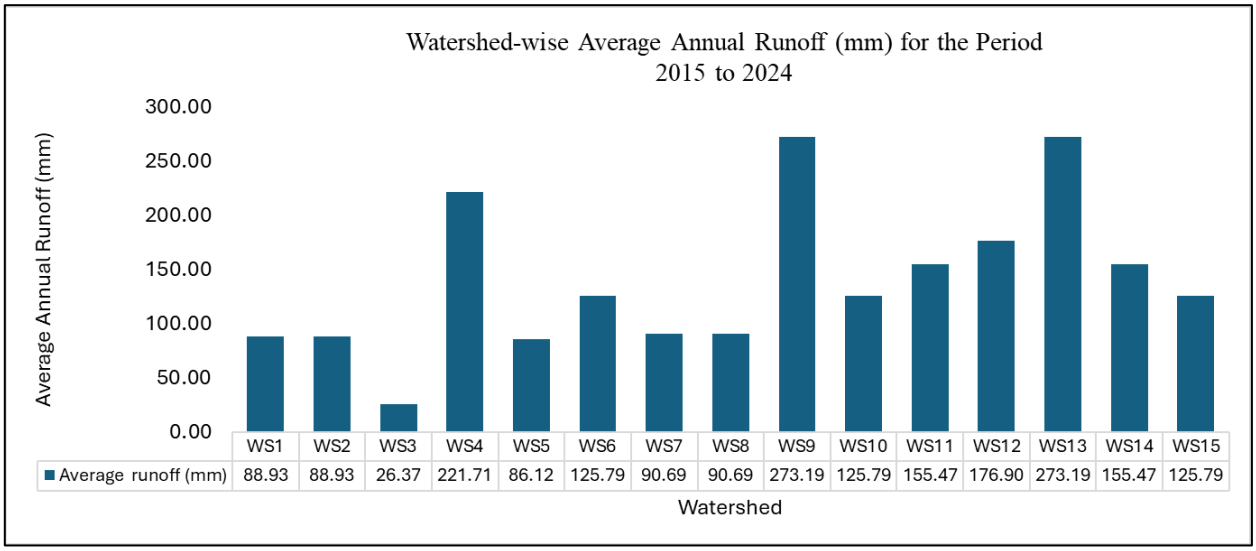


Fig. 3.3: Watershed-wise average annual runoff

3.4.5 Per-Second Runoff Volume (m^3/s)

Monthly runoff flow rates (in cubic meters per second) were also estimated from 2015 to 2024. These values are vital for understanding peak discharge scenarios and designing hydraulic infrastructure. The rainfall runoff depth (mm) of entire basin of different watersheds lying in the study area for the year 2015-2024 is depicted in the Table 3.3 to Table 3.12.

Table 3.3: Calculated runoff values (mm) using the SCS-CN method for the historical period of 2015

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total runoff (mm)
WS1	0.00	0.00	0.00	0.00	0.00	0.00	35.82	0.00	1.17	0.00	0.00	0.00	36.99
WS2	0.00	0.00	0.00	0.00	0.00	0.00	35.82	0.00	1.17	0.00	0.00	0.00	36.99
WS3	0.00	0.00	0.00	0.00	0.00	0.00	8.33	0.00	0.00	0.00	0.00	0.00	8.33
WS4	0.00	0.00	0.00	0.00	0.00	0.19	91.87	4.98	8.27	0.00	0.00	0.00	105.31
WS5	0.00	0.00	0.00	0.00	0.00	0.00	35.82	0.00	1.17	0.00	0.00	0.00	36.99
WS6	0.00	0.00	0.00	0.00	0.00	0.00	54.40	0.00	3.26	0.00	0.00	0.00	57.66
WS7	0.00	0.00	0.00	0.00	0.00	0.00	81.92	2.39	6.98	0.00	0.00	0.00	91.29
WS8	0.00	0.00	0.00	0.00	0.00	0.00	81.92	2.39	6.98	0.00	0.00	0.00	91.29
WS9	0.00	0.00	0.00	0.00	0.00	2.18	116.47	11.24	11.50	0.00	0.00	0.00	141.39
WS10	0.00	0.00	0.00	0.00	0.00	0.00	54.40	0.00	3.26	0.00	0.00	0.00	57.66
WS11	0.00	0.00	0.00	0.00	0.00	0.00	66.52	0.43	4.87	0.00	0.00	0.00	71.82
WS12	0.00	0.00	0.00	0.00	0.00	0.00	73.84	1.38	5.86	0.00	0.00	0.00	81.07
WS13	0.00	0.00	0.00	0.00	0.00	2.18	116.47	11.24	11.50	0.00	0.00	0.00	141.39
WS14	0.00	0.00	0.00	0.00	0.00	0.00	66.52	0.43	4.87	0.00	0.00	0.00	71.82
WS15	0.00	0.00	0.00	0.00	0.00	0.00	54.40	0.00	3.26	0.00	0.00	0.00	57.66

Table 3.4: Calculated runoff values (mm) using the SCS-CN method for the historical period of 2016

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total runoff (mm)
WS1	0.00	0.00	0.00	0.00	0.00	4.83	11.26	23.94	24.66	0.00	0.00	0.00	**64.68**
WS2	0.00	0.00	0.00	0.00	0.00	4.83	11.26	23.94	24.66	0.00	0.00	0.00	**64.68**
WS3	0.00	0.00	0.00	0.00	0.00	0.07	1.83	2.03	2.55	0.00	0.00	0.00	**6.48**
WS4	0.00	0.00	0.00	0.00	0.00	15.96	35.04	105.05	75.90	0.00	0.00	0.00	**231.95**
WS5	0.00	0.00	0.00	0.00	0.00	4.83	11.26	23.94	24.66	0.00	0.00	0.00	**64.68**
WS6	0.00	0.00	0.00	0.00	0.00	8.64	17.07	46.44	40.13	0.00	0.00	0.00	**112.29**
WS7	0.00	0.00	0.00	0.00	0.00	14.19	29.24	88.24	64.69	0.00	0.00	0.00	**196.37**

WS8	0.00	0.00	0.00	0.00	0.00	14.19	29.24	88.24	64.69	0.00	0.00	0.00	**196.37**
WS9	0.00	0.00	0.00	0.00	0.00	21.78	47.95	143.56	105.98	0.00	0.00	0.00	**319.28**
WS10	0.00	0.00	0.00	0.00	0.00	8.64	17.07	46.44	40.13	0.00	0.00	0.00	**112.29**
WS11	0.00	0.00	0.00	0.00	0.00	11.16	22.11	64.64	50.36	0.00	0.00	0.00	**148.27**
WS12	0.00	0.00	0.00	0.00	0.00	12.61	25.70	76.38	57.11	0.00	0.00	0.00	**171.81**
WS13	0.00	0.00	0.00	0.00	0.00	21.78	47.95	143.56	105.98	0.00	0.00	0.00	**319.28**
WS14	0.00	0.00	0.00	0.00	0.00	11.16	22.11	64.64	50.36	0.00	0.00	0.00	**148.27**
WS15	0.00	0.00	0.00	0.00	0.00	8.64	17.07	46.44	40.13	0.00	0.00	0.00	**112.29**

Table 3.5: Calculated runoff values (mm) using the SCS-CN method for the historical period of 2017

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total runoff (mm)
WS1	0.00	0.00	0.00	0.00	0.00	0.00	67.78	15.19	0.00	1.59	0.00	0.00	84.56
WS2	0.00	0.00	0.00	0.00	0.00	0.00	67.78	15.19	0.00	1.59	0.00	0.00	84.56
WS3	0.00	0.00	0.00	0.00	0.00	0.00	16.81	3.50	0.00	0.00	0.00	0.00	20.31
WS4	0.00	0.00	0.00	0.00	0.00	1.79	178.79	37.67	0.00	21.23	0.00	0.00	239.49
WS5	0.00	0.00	0.00	0.00	0.00	0.00	67.78	15.19	0.00	1.59	0.00	0.00	84.56
WS6	0.00	0.00	0.00	0.00	0.00	0.00	103.12	22.27	0.00	6.00	0.00	0.00	131.40
WS7	0.00	0.00	0.00	0.00	0.00	0.50	158.84	33.57	0.00	16.11	0.00	0.00	209.02
WS8	0.00	0.00	0.00	0.00	0.00	0.50	158.84	33.57	0.00	16.11	0.00	0.00	209.02
WS9	0.00	0.00	0.00	0.00	0.00	0.00	114.53	24.58	0.00	7.73	0.00	0.00	146.84
WS10	0.00	0.00	0.00	0.00	0.00	0.00	103.12	22.27	0.00	6.00	0.00	0.00	131.40
WS11	0.00	0.00	0.00	0.00	0.00	0.00	127.37	27.17	0.00	9.85	0.00	0.00	164.39
WS12	0.00	0.00	0.00	0.00	0.00	0.16	142.16	30.13	0.00	12.72	0.00	0.00	185.17
WS13	0.00	0.00	0.00	0.00	0.00	0.00	114.53	24.58	0.00	7.73	0.00	0.00	146.84
WS14	0.00	0.00	0.00	0.00	0.00	0.00	127.37	27.17	0.00	9.85	0.00	0.00	164.39
WS15	0.00	0.00	0.00	0.00	0.00	0.00	103.12	22.27	0.00	6.00	0.00	0.00	131.40

Table 3.6: Calculated runoff values (mm) using the SCS-CN method for the historical period of 2018

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total runoff (mm)
WS1	0.00	0.00	0.00	0.00	0.00	0.00	53.23	0.39	0.00	0.00	0.00	0.00	53.62
WS2	0.00	0.00	0.00	0.00	0.00	0.00	53.23	0.39	0.00	0.00	0.00	0.00	53.62
WS3	0.00	0.00	0.00	0.00	0.00	0.00	22.73	0.00	0.00	0.00	0.00	0.00	22.73
WS4	0.00	0.00	0.00	0.00	0.00	1.53	102.58	11.74	0.00	0.00	0.00	0.00	115.86
WS5	0.00	0.00	0.00	0.00	0.00	0.00	53.23	0.39	0.00	0.00	0.00	0.00	53.62
WS6	0.00	0.00	0.00	0.00	0.00	0.00	71.21	2.49	0.00	0.00	0.00	0.00	73.71
WS7	0.00	0.00	0.00	0.00	0.00	0.46	95.30	8.81	0.00	0.00	0.00	0.00	104.57
WS8	0.00	0.00	0.00	0.00	0.00	0.46	95.30	8.81	0.00	0.00	0.00	0.00	104.57
WS9	0.00	0.00	0.00	0.00	0.16	7.64	119.23	20.41	1.75	0.00	0.00	0.00	149.19
WS10	0.00	0.00	0.00	0.00	0.00	0.00	71.21	2.49	0.00	0.00	0.00	0.00	73.71
WS11	0.00	0.00	0.00	0.00	0.00	0.07	82.36	4.81	0.00	0.00	0.00	0.00	87.23
WS12	0.00	0.00	0.00	0.00	0.00	0.20	88.58	6.54	0.00	0.00	0.00	0.00	95.32
WS13	0.00	0.00	0.00	0.00	0.16	7.64	119.23	20.41	1.75	0.00	0.00	0.00	149.19
WS14	0.00	0.00	0.00	0.00	0.00	0.07	82.36	4.81	0.00	0.00	0.00	0.00	87.23
WS15	0.00	0.00	0.00	0.00	0.00	0.00	71.21	2.49	0.00	0.00	0.00	0.00	73.71

Table 3.7: Calculated runoff values (mm) using the SCS-CN method for the historical period of 2019

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total runoff (mm)
WS1	0.00	0.00	0.00	0.00	0.00	0.00	12.31	0.46	77.29	0.76	0.00	0.00	90.82
WS2	0.00	0.00	0.00	0.00	0.00	0.00	12.31	0.46	77.29	0.76	0.00	0.00	90.82
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	39.23	0.00	0.00	0.00	39.40
WS4	0.00	0.00	0.00	0.00	4.46	7.35	73.90	11.89	130.68	8.04	0.00	0.00	236.32
WS5	0.00	0.00	0.00	0.00	0.00	0.00	12.31	0.46	77.29	0.76	0.00	0.00	90.82
WS6	0.00	0.00	0.00	0.00	0.00	0.15	27.16	2.68	97.30	2.52	0.00	0.00	129.81
WS7	0.00	0.00	0.00	0.00	2.14	4.21	59.81	8.98	123.06	0.00	0.00	0.00	198.21

WS8	0.00	0.00	0.00	0.00	2.14	4.21	59.81	8.98	123.06	0.00	0.00	0.00	198.21
WS9	0.00	0.00	0.00	0.00	9.61	14.26	108.11	22.05	147.74	15.80	0.00	0.00	317.57
WS10	0.00	0.00	0.00	0.00	0.00	0.15	27.16	2.68	97.30	2.52	0.00	0.00	129.81
WS11	0.00	0.00	0.00	0.00	0.43	1.50	40.84	5.05	109.33	3.95	0.00	0.00	161.11
WS12	0.00	0.00	0.00	0.00	1.30	2.97	50.09	6.78	115.96	4.88	0.00	0.00	181.98
WS13	0.00	0.00	0.00	0.00	9.61	14.26	108.11	22.05	147.74	15.80	0.00	0.00	317.57
WS14	0.00	0.00	0.00	0.00	0.43	1.50	40.84	5.05	109.33	3.95	0.00	0.00	161.11
WS15	0.00	0.00	0.00	0.00	0.00	0.15	27.16	2.68	97.30	2.52	0.00	0.00	129.81

Table 3.8: Calculated runoff values (mm) using the SCS-CN method for the historical period of 2020

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total runoff (mm)
WS1	0.00	0.00	0.00	0.00	0.00	0.67	0.00	11.75	0.00	0.00	0.00	0.00	12.42
WS2	0.00	0.00	0.00	0.00	0.00	0.67	0.00	11.75	0.00	0.00	0.00	0.00	12.42
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.20
WS4	0.00	0.00	2.50	1.46	0.00	7.62	5.52	54.27	9.77	0.56	0.00	0.00	81.68
WS5	0.00	0.00	0.00	0.00	0.00	0.67	0.00	11.75	0.00	0.00	0.00	0.00	12.42
WS6	0.00	0.00	0.00	0.00	0.00	2.36	0.34	23.13	0.38	0.00	0.00	0.00	26.20
WS7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS9	0.00	0.00	6.53	4.86	0.00	13.61	12.95	76.88	20.52	1.59	0.00	0.00	136.94
WS10	0.00	0.00	0.00	0.00	0.00	2.36	0.34	23.13	0.38	0.00	0.00	0.00	26.20
WS11	0.00	0.00	0.02	0.02	0.00	3.79	1.33	32.41	1.92	0.01	0.00	0.00	39.51
WS12	0.00	0.00	0.39	0.20	0.00	4.79	2.21	38.45	3.59	0.10	0.00	0.00	49.73
WS13	0.00	0.00	6.53	4.86	0.00	13.61	12.95	76.88	20.52	1.59	0.00	0.00	136.94
WS14	0.00	0.00	0.02	0.02	0.00	3.79	1.33	32.41	1.92	0.01	0.00	0.00	39.51
WS15	0.00	0.00	0.00	0.00	0.00	2.36	0.34	23.13	0.38	0.00	0.00	0.00	26.20

Table 3.9: Calculated runoff values (mm) using the SCS-CN method for the historical period of 2021

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total runoff (mm)
WS1	0.00	0.00	0.00	0.00	0.00	41.14	42.85	0.00	32.11	11.03	0.00	0.00	127.12
WS2	0.00	0.00	0.00	0.00	0.00	41.14	42.85	0.00	32.11	11.03	0.00	0.00	127.12
WS3	0.00	0.00	0.00	0.00	0.00	2.96	0.00	0.00	0.97	1.74	0.00	0.00	5.67
WS4	0.00	0.00	0.00	0.00	0.03	131.29	15.29	0.00	99.67	26.46	0.02	0.00	272.76
WS5	0.00	0.00	0.00	0.00	0.00	41.14	42.85	0.00	32.11	11.03	0.00	0.00	127.12
WS6	0.00	0.00	0.00	0.00	0.00	71.03	2.26	0.00	52.60	0.00	16.49	0.00	142.38
WS7	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.00	0.00	0.29	0.00	0.00	0.61
WS8	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.00	0.00	0.29	0.00	0.00	0.61
WS9	0.00	0.00	0.00	0.00	1.19	167.72	25.57	1.17	123.09	33.20	1.10	0.03	353.07
WS10	0.00	0.00	0.00	0.00	0.00	71.03	2.26	0.00	52.60	0.00	16.49	0.00	142.38
WS11	0.00	0.00	0.00	0.00	0.00	91.22	5.64	0.00	68.46	19.82	0.00	0.00	185.15
WS12	0.00	0.00	0.00	0.00	0.00	103.06	8.33	0.00	100.08	21.71	0.00	0.00	233.18
WS13	0.00	0.00	0.00	0.00	1.19	167.72	25.57	1.17	123.09	33.20	1.10	0.03	353.07
WS14	0.00	0.00	0.00	0.00	0.00	91.22	5.64	0.00	68.46	19.82	0.00	0.00	185.15
WS15	0.00	0.00	0.00	0.00	0.00	71.03	2.26	0.00	52.60	0.00	16.49	0.00	142.38

Table 3.10: Calculated runoff values (mm) using the SCS-CN method for the historical period of 2022

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total runoff (mm)
WS1	0.00	0.00	0.00	0.00	0.00	0.00	1.92	25.19	0.00	1.01	0.00	0.00	28.12
WS2	0.00	0.00	0.00	0.00	0.00	0.00	1.92	25.19	0.00	1.01	0.00	0.00	28.12
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.04	0.00	0.00	0.00	0.00	4.04
WS4	0.00	0.00	0.00	0.00	0.00	0.00	21.77	85.40	0.33	13.67	0.00	0.00	121.17
WS5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS6	0.00	0.00	0.00	0.00	0.00	0.00	6.08	43.73	0.00	3.74	0.00	0.00	53.55
WS7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.28	0.00	0.00	0.00	0.00	1.28
WS8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.28	0.00	0.00	0.00	0.00	1.28

WS9	0.00	0.19	0.00	0.00	0.00	0.00	34.99	116.04	3.13	23.44	0.00	0.00	177.79
WS10	0.00	0.00	0.00	0.00	0.00	0.00	6.08	43.73	0.00	3.74	0.00	0.00	53.55
WS11	0.00	0.00	0.00	0.00	0.00	0.00	10.39	56.85	0.00	6.17	0.00	0.00	73.41
WS12	0.00	0.00	0.00	0.00	0.00	0.00	21.33	64.72	0.00	5.42	0.00	0.00	91.47
WS13	0.00	0.19	0.00	0.00	0.00	0.00	34.99	116.04	3.13	23.44	0.00	0.00	177.79
WS14	0.00	0.00	0.00	0.00	0.00	0.00	10.39	56.85	0.00	6.17	0.00	0.00	73.41
WS15	0.00	0.00	0.00	0.00	0.00	0.00	6.08	43.73	0.00	3.74	0.00	0.00	53.55

Table 3.11: Calculated runoff values (mm) using the SCS-CN method for the historical period of 2023

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total runoff (mm)
WS1	0.00	0.00	0.00	0.00	0.00	0.00	49.92	19.82	7.07	43.27	0.00	0.00	120.08
WS2	0.00	0.00	0.00	0.00	0.00	0.00	49.92	19.82	7.07	43.27	0.00	0.00	120.08
WS3	0.00	0.00	0.00	0.00	0.00	0.00	17.30	1.67	0.44	14.09	0.00	0.00	33.51
WS4	0.00	0.00	0.00	2.21	2.86	0.72	96.20	84.27	25.01	94.56	0.00	0.00	305.84
WS5	0.00	0.00	0.00	0.00	0.00	0.00	49.92	19.82	7.07	43.27	0.00	0.00	120.08
WS6	0.00	0.00	0.00	0.00	0.00	0.00	66.90	36.76	12.57	59.66	0.00	0.00	175.89
WS7	0.00	0.00	0.00	0.00	0.00	0.00	9.00	0.25	0.00	8.30	0.00	0.00	17.56
WS8	0.00	0.00	0.00	0.00	0.00	0.00	9.00	0.25	0.00	8.30	0.00	0.00	17.56
WS9	0.00	0.00	0.00	6.06	7.12	3.32	112.13	117.01	37.62	115.76	0.00	0.00	399.02
WS10	0.00	0.00	0.00	0.00	0.00	0.00	66.90	36.76	12.57	59.66	0.00	0.00	175.89
WS11	0.00	0.00	0.00	0.00	0.07	0.02	77.33	50.97	16.44	70.81	0.00	0.00	215.64
WS12	0.00	0.00	0.00	0.29	0.54	0.12	83.14	60.35	18.77	77.76	0.00	0.00	240.96
WS13	0.00	0.00	0.00	6.06	7.12	3.32	112.13	117.01	37.62	115.76	0.00	0.00	399.02
WS14	0.00	0.00	0.00	0.00	0.07	0.02	77.33	50.97	16.44	70.81	0.00	0.00	215.64
WS15	0.00	0.00	0.00	0.00	0.00	0.00	66.90	36.76	12.57	59.66	0.00	0.00	175.89

Table 3.12: Calculated runoff values (mm) using the SCS-CN method for the historical period of 2024

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total runoff (mm)
WS1	0.00	0.00	0.00	0.00	0.00	0.00	20.40	167.39	83.06	0.00	0.00	0.00	270.84
WS2	0.00	0.00	0.00	0.00	0.00	0.00	20.40	167.39	83.06	0.00	0.00	0.00	270.84
WS3	0.00	0.00	0.00	0.00	0.00	0.00	2.72	84.89	35.46	0.00	0.00	0.00	123.07
WS4	0.00	0.00	0.00	0.00	0.00	0.00	63.18	299.49	144.08	0.00	0.00	0.00	506.76
WS5	0.00	0.00	0.00	0.00	0.00	0.00	20.40	167.39	83.06	0.00	0.00	0.00	270.84
WS6	0.00	0.00	0.00	0.00	0.00	0.00	33.83	214.66	106.57	0.00	0.00	0.00	355.06
WS7	0.00	0.00	0.00	0.00	0.00	0.00	0.33	64.97	22.71	0.00	0.00	0.00	88.01
WS8	0.00	0.00	0.00	0.00	0.00	0.00	0.33	64.97	22.71	0.00	0.00	0.00	88.01
WS9	0.00	0.00	0.00	0.00	0.00	0.00	82.31	345.64	162.89	0.00	0.00	0.00	590.84
WS10	0.00	0.00	0.00	0.00	0.00	0.00	33.83	214.66	106.57	0.00	0.00	0.00	355.06
WS11	0.00	0.00	0.00	0.00	0.00	0.00	43.43	244.47	120.32	0.00	0.00	0.00	408.22
WS12	0.00	0.00	0.00	0.00	0.00	0.00	49.20	261.28	127.78	0.00	0.00	0.00	438.26
WS13	0.00	0.00	0.00	0.00	0.00	0.00	82.31	345.64	162.89	0.00	0.00	0.00	590.84
WS14	0.00	0.00	0.00	0.00	0.00	0.00	43.43	244.47	120.32	0.00	0.00	0.00	408.22
WS15	0.00	0.00	0.00	0.00	0.00	0.00	33.83	214.66	106.57	0.00	0.00	0.00	355.06

The calculation of total runoff of the entire basin as per the SCS-CN method depicted in Table 3.13 to Table 3.22.

Table 3.13: Estimated runoff values (m^3/s) using SCS-CN method for the historical period of 2015

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m^3/s)
WS1	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.09
WS2	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.05
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01
WS4	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.01	0.01	0.00	0.00	0.00	0.12
WS5	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.01	0.00	0.00	0.00	0.21

WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS7	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.01	0.00	0.00	0.00	0.09
WS8	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.01	0.00	0.00	0.00	0.15
WS9	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.04
WS10	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.01	0.00	0.00	0.00	0.22
WS11	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.01	0.00	0.00	0.00	0.14
WS12	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.01	0.00	0.00	0.00	0.09
WS13	0.00	0.00	0.00	0.00	0.00	0.01	0.49	0.05	0.05	0.00	0.00	0.00	0.60
WS14	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.01	0.00	0.00	0.00	0.13
WS15	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.02

Table 3.14: Estimated runoff values (m^3/s) using SCS-CN method for the historical period of 2016

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m^3/s)
WS1	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.06	0.06	0.00	0.00	0.00	0.16
WS2	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.03	0.03	0.00	0.00	0.00	0.09
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
WS4	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.12	0.09	0.00	0.00	0.00	0.27
WS5	0.00	0.00	0.00	0.00	0.00	0.03	0.06	0.13	0.14	0.00	0.00	0.00	0.36
WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
WS7	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.09	0.07	0.00	0.00	0.00	0.20
WS8	0.00	0.00	0.00	0.00	0.00	0.02	0.05	0.14	0.11	0.00	0.00	0.00	0.32
WS9	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.04	0.03	0.00	0.00	0.00	0.08
WS10	0.00	0.00	0.00	0.00	0.00	0.03	0.06	0.17	0.15	0.00	0.00	0.00	0.42
WS11	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.13	0.10	0.00	0.00	0.00	0.30
WS12	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.08	0.06	0.00	0.00	0.00	0.19
WS13	0.00	0.00	0.00	0.00	0.00	0.09	0.20	0.61	0.45	0.00	0.00	0.00	1.35
WS14	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.11	0.09	0.00	0.00	0.00	0.26

WS15	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.03

Table 3.15: Estimated runoff values (m^3/s) using SCS-CN method for the historical period of 2017

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m^3/s)
WS1	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.04	0.00	0.00	0.00	0.00	0.21
WS2	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.02	0.00	0.00	0.00	0.00	0.11
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.03
WS4	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.04	0.00	0.02	0.00	0.00	0.28
WS5	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.09	0.00	0.01	0.00	0.00	0.48
WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01
WS7	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.03	0.00	0.02	0.00	0.00	0.22
WS8	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.05	0.00	0.03	0.00	0.00	0.34
WS9	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.04
WS10	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.08	0.00	0.02	0.00	0.00	0.49
WS11	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.05	0.00	0.02	0.00	0.00	0.33
WS12	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.03	0.00	0.01	0.00	0.00	0.20
WS13	0.00	0.00	0.00	0.00	0.00	0.00	0.48	0.10	0.00	0.03	0.00	0.00	0.62
WS14	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.05	0.00	0.02	0.00	0.00	0.29
WS15	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.04

Table 3.16: Estimated runoff values (m^3/s) using SCS-CN method for the historical period of 2018

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m^3/s)
WS1	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.13
WS2	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.07
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.04
WS4	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.01	0.00	0.00	0.00	0.00	0.14

WS5	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.30
WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS7	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.01	0.00	0.00	0.00	0.00	0.11
WS8	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.01	0.00	0.00	0.00	0.00	0.17
WS9	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.04
WS10	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.01	0.00	0.00	0.00	0.00	0.27
WS11	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.01	0.00	0.00	0.00	0.00	0.17
WS12	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.01	0.00	0.00	0.00	0.00	0.10
WS13	0.00	0.00	0.00	0.00	0.00	0.03	0.50	0.09	0.01	0.00	0.00	0.00	0.63
WS14	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.01	0.00	0.00	0.00	0.00	0.15
WS15	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.02

Table 3.17: Estimated runoff values (m^3/s) using SCS-CN method for the historical period of 2019

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m^3/s)
WS1	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.19	0.00	0.00	0.00	0.22
WS2	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.10	0.00	0.00	0.00	0.12
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.07
WS4	0.00	0.00	0.00	0.00	0.01	0.01	0.09	0.01	0.15	0.01	0.00	0.00	0.28
WS5	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.43	0.00	0.00	0.00	0.51
WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01
WS7	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.01	0.13	0.00	0.00	0.00	0.20
ssWS8	0.00	0.00	0.00	0.00	0.00	0.01	0.10	0.01	0.20	0.00	0.00	0.00	0.32
WS9	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.04	0.00	0.00	0.00	0.08
WS10	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.01	0.36	0.01	0.00	0.00	0.48
WS11	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.01	0.22	0.01	0.00	0.00	0.32
WS12	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.01	0.13	0.01	0.00	0.00	0.20
WS13	0.00	0.00	0.00	0.00	0.04	0.06	0.46	0.09	0.62	0.07	0.00	0.00	1.34
WS14	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.01	0.19	0.01	0.00	0.00	0.28

WS15	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.03	0.00	0.00	0.00	0.04

Table 3.18: Estimated runoff values (m^3/s) using SCS-CN method for the historical period of 2020

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m^3/s)
WS1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.03
WS2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.02
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS4	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.06	0.01	0.00	0.00	0.00	0.10
WS5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.07
WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.04
WS10	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.09	0.00	0.00	0.00	0.00	0.10
WS11	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.06	0.00	0.00	0.00	0.00	0.08
WS12	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.04	0.00	0.00	0.00	0.00	0.05
WS13	0.00	0.00	0.03	0.02	0.00	0.06	0.05	0.32	0.09	0.01	0.00	0.00	0.58
WS14	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.06	0.00	0.00	0.00	0.00	0.07
WS15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01

Table 3.19: Estimated runoff values (m^3/s) using SCS-CN method for the historical period of 2021

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m^3/s)
WS1	0.00	0.00	0.00	0.00	0.00	0.10	0.10	0.00	0.08	0.03	0.00	0.00	0.31
WS2	0.00	0.00	0.00	0.00	0.00	0.06	0.06	0.00	0.04	0.01	0.00	0.00	0.17
WS3	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01

WS4	0.00	0.00	0.00	0.00	0.00	0.15	0.02	0.00	0.12	0.03	0.00	0.00	0.32
WS5	0.00	0.00	0.00	0.00	0.00	0.23	0.24	0.00	0.18	0.06	0.00	0.00	0.71
WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
WS7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS9	0.00	0.00	0.00	0.00	0.00	0.04	0.01	0.00	0.03	0.01	0.00	0.00	0.09
WS10	0.00	0.00	0.00	0.00	0.00	0.26	0.01	0.00	0.20	0.00	0.06	0.00	0.53
WS11	0.00	0.00	0.00	0.00	0.00	0.18	0.01	0.00	0.14	0.04	0.00	0.00	0.37
WS12	0.00	0.00	0.00	0.00	0.00	0.11	0.01	0.00	0.11	0.02	0.00	0.00	0.26
WS13	0.00	0.00	0.00	0.00	0.01	0.71	0.11	0.00	0.52	0.14	0.00	0.00	1.49
WS14	0.00	0.00	0.00	0.00	0.00	0.16	0.01	0.00	0.12	0.03	0.00	0.00	0.32
WS15	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.00	0.00	0.04

Table 3.20: Estimated runoff values (m^3/s) using SCS-CN method for the historical period of 2022

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m^3/s)
WS1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.07
WS2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.04
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01
WS4	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.10	0.00	0.02	0.00	0.00	0.14
WS5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS9	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.00	0.01	0.00	0.00	0.05
WS10	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.16	0.00	0.01	0.00	0.00	0.20
WS11	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.11	0.00	0.01	0.00	0.00	0.15
WS12	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.07	0.00	0.01	0.00	0.00	0.10
WS13	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.49	0.01	0.10	0.00	0.00	0.75
WS14	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.10	0.00	0.01	0.00	0.00	0.13

WS15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.02

Table 3.21: Estimated runoff values (m^3/s) using SCS-CN method for the historical period of 2023

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m^3/s)
WS1	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.05	0.02	0.11	0.00	0.00	0.29
WS2	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.03	0.01	0.06	0.00	0.00	0.16
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.02	0.00	0.00	0.06
WS4	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.10	0.03	0.11	0.00	0.00	0.36
WS5	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.11	0.04	0.24	0.00	0.00	0.67
WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
WS7	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.02
WS8	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.03
WS9	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.01	0.03	0.00	0.00	0.10
WS10	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.14	0.05	0.22	0.00	0.00	0.66
WS11	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.10	0.03	0.14	0.00	0.00	0.43
WS12	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.07	0.02	0.09	0.00	0.00	0.26
WS13	0.00	0.00	0.00	0.03	0.03	0.01	0.47	0.49	0.16	0.49	0.00	0.00	1.69
WS14	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.09	0.03	0.12	0.00	0.00	0.38
WS15	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.02	0.00	0.00	0.05

Table 3.22: Estimated runoff values (m^3/s) using SCS-CN method for the historical period of 2024

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m^3/s)
WS1	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.41	0.20	0.00	0.00	0.00	0.66
WS2	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.23	0.11	0.00	0.00	0.00	0.36
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.06	0.00	0.00	0.00	0.21
WS4	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.35	0.17	0.00	0.00	0.00	0.59
WS5	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.94	0.47	0.00	0.00	0.00	1.52

WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.02
WS7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.02	0.00	0.00	0.00	0.09
WS8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.04	0.00	0.00	0.00	0.14
WS9	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.09	0.04	0.00	0.00	0.00	0.15
WS10	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.80	0.40	0.00	0.00	0.00	1.32
WS11	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.49	0.24	0.00	0.00	0.00	0.81
WS12	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.29	0.14	0.00	0.00	0.00	0.48
WS13	0.00	0.00	0.00	0.00	0.00	0.00	0.35	1.46	0.69	0.00	0.00	0.00	2.50
WS14	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.43	0.21	0.00	0.00	0.00	0.72
WS15	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.07	0.03	0.00	0.00	0.00	0.11

The calculation of total runoff from the Govindpur Cluster-III area as per the SCS-CN method is depicted in Table 3.23 to Table 3.32.

Table 3.23: Calculated runoff (m^3/sec) using SCS-CN method for the historical period of 2015

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m^3/s)
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS4	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01
WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS9	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.03
WS10	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.02
WS11	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.01	0.00	0.00	0.00	0.13
WS12	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.03
WS13	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.03	0.03	0.00	0.00	0.00	0.32
WS14	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01

WS15	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.02

Table 3.24: Calculated runoff (m^3/sec) using SCS-CN method for the historical period of 2016

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m^3/s)
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.02
WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS9	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.02	0.00	0.00	0.00	0.06
WS10	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.01	0.00	0.00	0.00	0.04
WS11	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.12	0.09	0.00	0.00	0.00	0.26
WS12	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.02	0.00	0.00	0.00	0.07
WS13	0.00	0.00	0.00	0.00	0.00	0.05	0.11	0.32	0.24	0.00	0.00	0.00	0.72
WS14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.02
WS15	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.03

Table 3.25: Calculated runoff (m^3/sec) using SCS-CN method for the historical period of 2017

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m^3/s)
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS4	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.02
WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS9	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.03
WS10	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.04

WS11	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.05	0.00	0.02	0.00	0.00	0.29
WS12	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.01	0.00	0.00	0.00	0.00	0.07
WS13	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.06	0.00	0.02	0.00	0.00	0.33
WS14	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.02
WS15	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.04

Table 3.26: Calculated runoff (m^3/sec) using SCS-CN method for the historical period of 2018

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m^3/s)
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS4	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01
WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS9	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.03
WS10	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.02
WS11	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.01	0.00	0.00	0.00	0.00	0.16
WS12	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.04
WS13	0.00	0.00	0.00	0.00	0.00	0.02	0.27	0.05	0.00	0.00	0.00	0.00	0.34
WS14	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01
WS15	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.02

Table 3.27: Calculated runoff (m^3/sec) using SCS-CN method for the historical period of 2019

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m^3/s)
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS4	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.02
WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS9	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.03	0.00	0.00	0.00	0.06

WS10	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.03	0.00	0.00	0.00	0.04
WS11	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.01	0.19	0.01	0.00	0.00	0.29
WS12	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.04	0.00	0.00	0.00	0.07
WS13	0.00	0.00	0.00	0.00	0.02	0.03	0.24	0.05	0.33	0.04	0.00	0.00	0.72
WS14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.02
WS15	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.03	0.00	0.00	0.00	0.04

Table 3.28: Calculated runoff (m^3/sec) using SCS-CN method for the historical period of 2020

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m^3/s)
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01
WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.03
WS10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01
WS11	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.06	0.00	0.00	0.00	0.00	0.07
WS12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.02
WS13	0.00	0.00	0.01	0.01	0.00	0.03	0.03	0.17	0.05	0.00	0.00	0.00	0.31
WS14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01

Table 3.29: Calculated runoff (m^3/sec) using SCS-CN method for the historical period of 2021

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m3/s)
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS4	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.03
WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS9	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.00	0.02	0.01	0.00	0.00	0.07

WS10	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.01	0.00	0.05
WS11	0.00	0.00	0.00	0.00	0.00	0.16	0.01	0.00	0.12	0.04	0.00	0.00	0.33
WS12	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.04	0.01	0.00	0.00	0.09
WS13	0.00	0.00	0.00	0.00	0.00	0.38	0.06	0.00	0.28	0.07	0.00	0.00	0.80
WS14	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.02
WS15	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.00	0.00	0.04

Table 3.30: Calculated runoff (m^3/sec) using SCS-CN method for the historical period of 2022

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m3/s)
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01
WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS9	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.04
WS10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.02
WS11	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.10	0.00	0.01	0.00	0.00	0.13
WS12	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.00	0.00	0.00	0.00	0.04
WS13	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.26	0.01	0.05	0.00	0.00	0.40
WS14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01
WS15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.02

Table 3.31: Calculated runoff (m^3/sec) using SCS-CN method for the historical period of 2023

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m3/s)
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS4	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.00	0.00	0.03
WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

WS9	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.01	0.02	0.00	0.00	0.08
WS10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS11	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.02	0.01	0.02	0.00	0.00	0.07
WS12	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.11	0.03	0.14	0.00	0.00	0.43
WS13	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.05	0.01	0.04	0.00	0.00	0.15
WS14	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.11	0.04	0.16	0.00	0.00	0.49
WS15	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.02

Table 3.32: Calculated runoff (m^3/sec) using SCS-CN method for the historical period of 2024

WS	January	February	March	April	May	June	July	August	September	October	November	December	Total Runoff (m^3/s)
WS3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS4	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.01	0.00	0.00	0.00	0.05
WS6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WS9	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.07	0.03	0.00	0.00	0.00	0.12
WS10	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.07	0.04	0.00	0.00	0.00	0.12
WS11	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.44	0.21	0.00	0.00	0.00	0.73
WS12	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.10	0.05	0.00	0.00	0.00	0.17
WS13	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.78	0.37	0.00	0.00	0.00	1.33
WS14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.00	0.00	0.00	0.05
WS15	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.07	0.03	0.00	0.00	0.00	0.11

Summary of the rainfall-runoff calculations

As expected, highest per-second flows into the two major streams of the study area were recorded in the monsoon season, particularly from the month July to September. In 2024 (during which the rainfall was highest since 2015), the calculated peak flows for the different watersheds are shown in the Fig. 3.4. From Fig. 3.4, it is evident that watershed 13 (WS13) contributed the highest flow (2.50 m^3/s) followed by watershed 5 (WS5: 1.52 m^3/s), watershed 10 (WS10: 1.32 m^3/s), and watershed 11 (WS11: 0.81 m^3/s). Watersheds 2 (WS2), 3 (WS3), 6 (WS6), 8 (WS8), 9 (WS9), and 15 (WS15) contributed negligible flows into the streams.

Annual variations in flow highlight the impact of inter-annual rainfall variability and watershed conditions. These values reinforce the spatial dominance of a few specific watersheds and that will help to plan hydrological infrastructure development and flood control strategies in the study area.

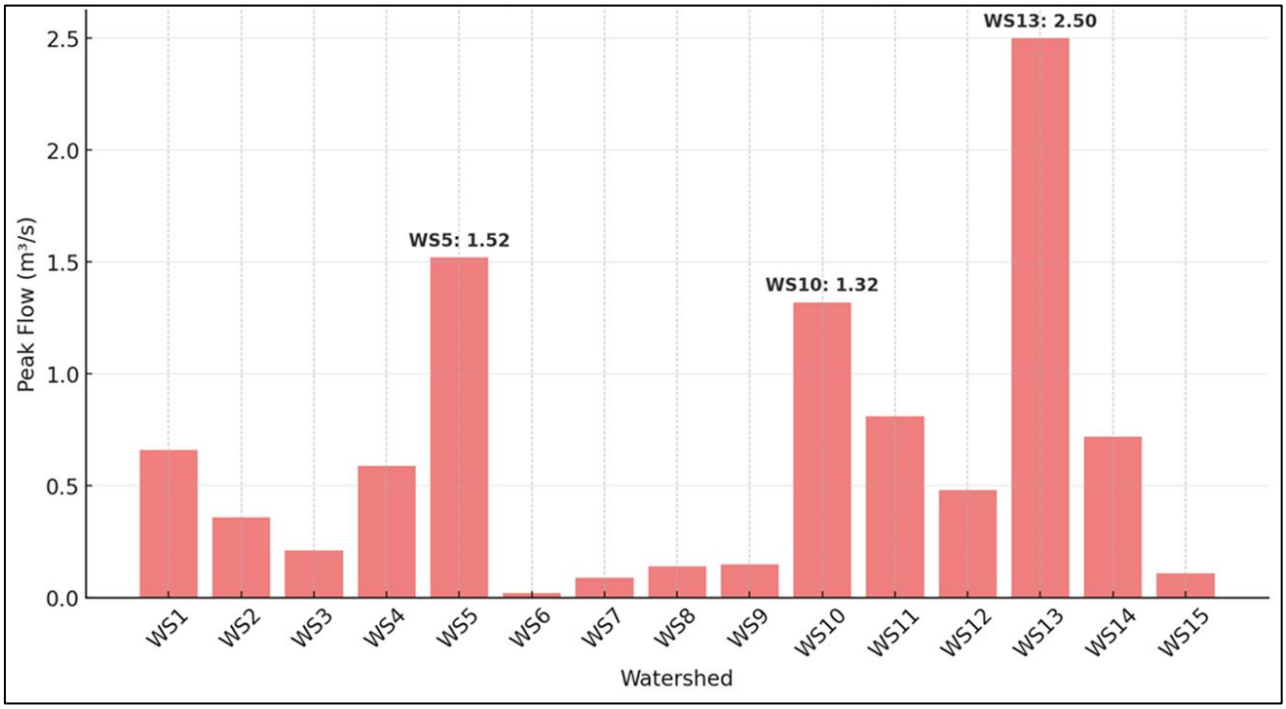


Fig. 3.4: Monthly peak runoff flow (m^3/s) (during 2015 to 2024) per watershed

3.5 Conclusion

The decade-long analysis of runoff using the SCS-CN method reveals a strong monsoon influence on hydrological behaviour. The Khudia Nala basin shows

significantly higher cumulative runoff accumulation (2015 to 2024) of 17,973.28 mm as its watersheds have greater spatial coverage and catchment dynamics.

Chapter 4: Analysis of Spatio-Temporal Variability of Hydro-meteorological Variables and Assessment of Impact of Climate Change on Water Resources in Cluster – III Area of BCCL

4.1 Introduction

The BCCL Cluster-III watershed in Govindpur, Dhanbad lies at the centre of the Damodar River Basin which is one of the India's most intensive coal mining regions. The area is characterized by undulating terrain and a moderate drainage network developed by natural processes and prolonged mining activities. Climatologically, the region is governed by a subtropical monsoon climate, receiving an average annual rainfall of 1300 to 1400 mm, of which approximately 75 to 85 % rainfall occurs between June and September, driven by the southwest monsoon. Historically, meteorological records show that mean summer temperatures in the Cluster-III region range between 32 °C and 45 °C, while winter temperatures can drop to between 7 °C and 10 °C. Notably, over the past two decades, the region has experienced a measurable warming trend, with average annual maximum temperatures increasing at a rate of approximately 0.2 °C per decade. At the same time, rainfall patterns have become increasingly variable, with evidence of short-duration, high-intensity events and a rising number of dry spells within the monsoon season.

Hydrologically, the watershed exhibits seasonal variability in stream discharge, with peak flow from July to August and base flow conditions from November to March. Empirical studies from adjacent sub-basins indicate that the post-monsoon base flow discharge, typically ranging from 0.5 to 2.0 m^3/s, has declined by over 25%, due to reduced infiltration and declining groundwater tables. These trends reflect a broader set of weather and climate anomalies, including delayed monsoon onset, increased frequency of localized storms, and seasonal shifts in evapotranspiration patterns. Such variations have significant implications for runoff generation, aquifer recharge, surface water availability, and mine water drainage systems, particularly in regions under hydrological stress.

Understanding the spatio-temporal variability of hydro-meteorological variables, namely rainfall, temperature, and discharge, is thus essential for assessing both present and future vulnerabilities of water resources in the region. Quantifying this variability helps in delineating the zones of hydrological sensitivity and supports adaptive planning in the face of ongoing climatic shifts.

This chapter adapts a dual approach for hydroclimatic assessment. First, it statistically analyses historical rainfall trends, utilizing the data collected from the India Meteorological Department (IMD) for the years 2008 to 2024, and then forecasts monthly trends for 2025 to 2030 using time-series models like Autoregressive Integrated Moving Average (ARIMA) and Error Trend Seasonal (ETS).

Second, the chapter also evaluates the future climatic stress. This involves analyzing various climate change scenarios and projections from global climate models. Ultimately, these combined findings aim to inform future water management strategies. The major goal is to identify patterns and projections of climatic stress, which could impact the surface and sub-surface hydrological systems in this coal mining-dominated region.

4.2 Materials and Methods

4.2.1 Study Area: BCCL Cluster-III Watershed

The BCCL Cluster-III encompasses seven mines (a mix of operational underground, opencast, and closed mines) within the Jharia Coalfield, Dhanbad district, Jharkhand, India. The watershed's hydrogeological regime is primarily influenced by the Khudia and Bagdighi Nala, which pass through the Cluster–III area and meet the broader Damodar River. Groundwater resources are primarily accessed via shallow aquifers, utilized through dug wells, dug-cum-bore wells, and shallow bore wells. Persistent challenges include land degradation, erosion, and alterations of the surface and sub-surface water flow regimes due to mining activities.

4.2.2 Climate Projection Data

The climate projection data utilized in this analysis are derived from the global climate model compilations of the Coupled Model Inter-comparison Projects (CMIPs), specifically the CMIP6 dataset, providing insights into future climate scenarios. Data are presented at a high resolution of 0.25^{o} x 0.25^{o} (approximately 25 km x 25 km) and include various Shared Socioeconomic Pathways (SSPs). These SSPs are essentially different plausible future that describe how global society, demographics, and economics might change over the coming century, and how these changes could influence greenhouse gas emissions. For instance:

- ***SSP1-2.6 (Sustainability):*** This scenario depicts a future with sustainable development, focusing on environmental protection and low greenhouse gas emissions. It's an optimistic pathway where the world shifts towards a more sustainable path, leading to a radiative forcing of 2.6 W/m² by 2100.
- ***SSP2-4.5 (Middle of the Road):*** This scenario represents a continuation of historical patterns, with moderate challenges to sustainable development and an intermediate level of greenhouse gas emissions, leading to a radiative forcing of 4.5 W/m² by 2100.
- ***SSP3-7.0 (Regional Rivalry):*** This scenario portrays a future characterized by strong regional rivalries, leading to slow development, high population growth, and high greenhouse gas emissions, resulting in a radiative forcing of 7.0 W/m² by 2100.
- ***SSP5-8.5 (Fossil-fueled Development):*** This is a high-emission scenario where the world continues to rely heavily on fossil fuels and experiences rapid economic growth but with little environmental concern, leading to a radiative forcing of 8.5 W/m² by 2100.

For this study, projections for SSP1-2.6, SSP2-4.5, SSP3-7.0, and SSP5-8.5 scenarios were analysed across the period 2020-2039, which serves as the closest available proxy for the 2025 - 2039 range. All projections are relative to a reference period of 1995 - 2014 and are presented as multi-model ensembles. The CMIP6 data were accessed and downloaded from the Earth System Grid Federation (ESGF) nodes

(June 26, 2025.), which serve as the primary distributed archive for CMIP project outputs.

4.2.3 Rainfall Pattern in BCCL Cluster-III Area

4.2.3.1 Historical Rainfall Pattern in BCCL Cluster-III (2008-2024) Area

The historical rainfall data from 2008 to 2024 in the BCCL Cluster - III region show seasonal and yearly variations, mainly influenced by the southwest monsoon. Most rainfall is concentrated between June and September, contributing over 75% of the annual total. July and August are consistently the wettest months, with August 2024 recording the highest monthly rainfall of 529.63 mm, followed by July 2008 (493.36 mm) and July 2017 (485.01 mm). In contrast, the pre-monsoon (January to May) and post-monsoon (October to December) months usually receive very low rainfall, often less than 10 mm, and in many years, certain months, especially December, recorded no rainfall.

The annual rainfall varied significantly over the years. The lowest recorded annual rainfall was 815.91 mm in 2015, marking it a drought-prone year. The highest was 1376.04 mm in 2016, reflecting intense monsoon. In recent years, such as 2023 and 2024, high annual rainfall was also recorded, each exceeding 1300 mm, possibly indicating a trend of increasing rainfall influenced by regional climate change. These fluctuations could be related to large-scale climatic phenomena such as El Niño-Southern Oscillation (ENSO), Indian Ocean Dipole (IOD), and local factors like land-use changes caused by mining, deforestation, and soil compaction, which affect infiltration and local weather patterns.

The dataset presented in Table 4.1 is important for identifying rainfall trends, estimating runoff, and planning for water availability. It also forms the basis for forecasting future rainfall using time-series models like ARIMA. The ARIMA model was used to forecast monthly rainfall from 2025 to 2030 based on 17 years of historical data. Forecasting of rainfall is crucial as rainfall variability increases and extreme events are becoming more frequent due to climate change. Accurate predictions of total and extreme rainfall events are essential for designing adequate

drainage and water management systems. While advanced models like Long Short-Term Memory (LSTM) and Prophet are available, ARIMA remains reliable for this analysis due to its proven accuracy and data suitability for monthly and yearly analysis.

Table 4.1: Monthly historical rainfall (2008 - 2024) received by the BCCL Cluster - III Area (in mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2008	4.58	3.32	11.68	9.55	20.46	159.95	493.36	259.71	217.21	27.94	0.00	0.00	1207.76
2009	2.81	0.00	8.24	0.14	97.55	48.76	207.04	272.47	230.60	41.51	8.40	1.02	918.54
2010	0.00	6.01	1.41	17.42	60.07	157.78	196.81	275.32	236.82	43.87	0.30	3.35	999.17
2011	0.00	1.35	14.69	9.55	84.46	265.45	173.20	405.74	277.73	24.37	1.81	0.00	1258.34
2012	24.03	4.13	2.83	48.90	13.97	91.58	379.52	270.71	189.90	60.34	51.25	8.74	1145.90
2013	0.00	19.16	0.58	8.43	61.65	217.14	179.83	290.05	164.07	250.55	0.00	0.00	1191.46
2014	10.12	46.61	11.47	0.24	86.85	109.99	286.19	227.88	158.92	28.07	0.00	0.00	966.35
2015	15.66	2.14	5.55	51.12	6.68	131.60	339.88	178.06	66.57	16.04	0.00	2.62	815.91
2016	3.69	11.83	3.46	0.00	56.21	185.77	253.99	403.07	436.80	21.21	0.00	0.00	1376.04
2017	7.29	0.00	7.18	25.73	45.15	120.72	485.01	239.61	95.74	204.56	0.12	0.00	1231.10
2018	0.00	0.00	0.00	85.69	53.94	235.44	241.38	188.98	110.97	15.48	0.00	14.56	946.45
2019	0.00	19.92	6.16	44.10	70.55	111.46	325.75	251.83	311.72	165.77	0.00	5.69	1312.95
2020	15.35	6.76	66.50	42.81	69.72	185.50	224.39	230.03	179.08	56.94	0.60	0.00	1077.69
2021	0.00	0.00	9.23	1.14	122.36	331.54	225.70	123.77	293.52	117.12	33.40	23.00	1280.77
2022	11.33	74.57	0.00	0.99	90.59	108.25	152.55	340.67	177.23	88.73	0.00	0.46	1045.36
2023	0.00	0.00	10.98	59.98	64.67	86.55	230.47	316.13	288.12	203.40	0.00	50.23	1310.54
2024	2.87	23.30	30.70	2.18	63.79	39.40	262.96	529.63	291.54	71.32	0.00	0.00	1317.70

4.2.3.2 Forecasting of the Near Future Monthly Rainfall Pattern in BCCL Cluster-III (2025 - 2030) Area

For forecasting the future monthly rainfall pattern in the BCCL Cluster-III region from 2025 to 2030, two of the most commonly used time series forecasting methods, ARIMA and ETS, were employed, and their results were compared using test data series.

The ARIMA model is a generalization of the simpler Auto-Regressive Moving Average model that incorporates the concept of integration. It is characterized by three main components viz. 'p' (lag order, representing the number of lag observations), 'd' (degree of difference, representing the number of times raw observations are differenced for stationarity), and 'q' (order of moving average, indicating the size of the moving average window). Fitting of the ARIMA model involves calculating the Auto-correlation Function (ACF) and Partial Auto-correlation Function (PACF) with lags from 1 to 12 months, where the first significant spike in these plots helps to determine the 'p' and 'q' values.

The ETS model is another approach for univariate time series forecasting, specifically designed to model trend and seasonal components using exponential smoothing. Its flexibility lies in its ability to adapt to different characteristics of these components. The three states of occurrence for ETS components are Additive (A), Additive Damped (Ad), and None (N), which dictate how parameters are applied in the exponential non-parametric regression.

When an ETS model only has "additive components", it means that the different parts of the forecast (like the overall level, the trend, and the seasonal pattern) are simply added together. In such cases, the "ETS point forecasts are equal to the medians of their forecast distributions, which are normal" means that the most likely future value (the "point forecast") is the middle value of all possible future outcomes. These possible outcomes, when plotted, form a bell-shaped curve, which is what "normal distribution" refers to, suggesting that values closer to the median are most probable.

The future monthly rainfall pattern for the BCCL Cluster-III region from 2025 to 2030 has been projected using these ARIMA and ETS time-series models. As illustrated in Fig. 4.1, both the models indicate a pronounced monsoon season, with peak rainfall expected between June and September. The highest rainfall is specifically anticipated in August, with the ARIMA model forecasting values around 301.85 to 301.97 mm, while the ETS estimates slightly lower but comparable values. July also shows consistently high rainfall across all six projected years, with ARIMA predictions ranging from 258.83 to 258.95 mm, and ETS values consistently higher, reaching up to 284.47 mm. In contrast, the non-monsoon months (January to May and October to December) are projected to receive significantly less rainfall, generally below 100 mm, with January, February, November, and December showing minimal rainfall amounts. The ETS model typically estimates slightly higher rainfall than ARIMA in these drier months. These forecasts detailed in Table 4.2, revealed a stable seasonal pattern with minimal year-to-year variability, thereby emphasizing the region's continued reliance on monsoon rainfall. This information is crucial for future water resource planning, flood risk management, and infrastructure development in mining-affected areas that are particularly vulnerable to rainfall extremes.

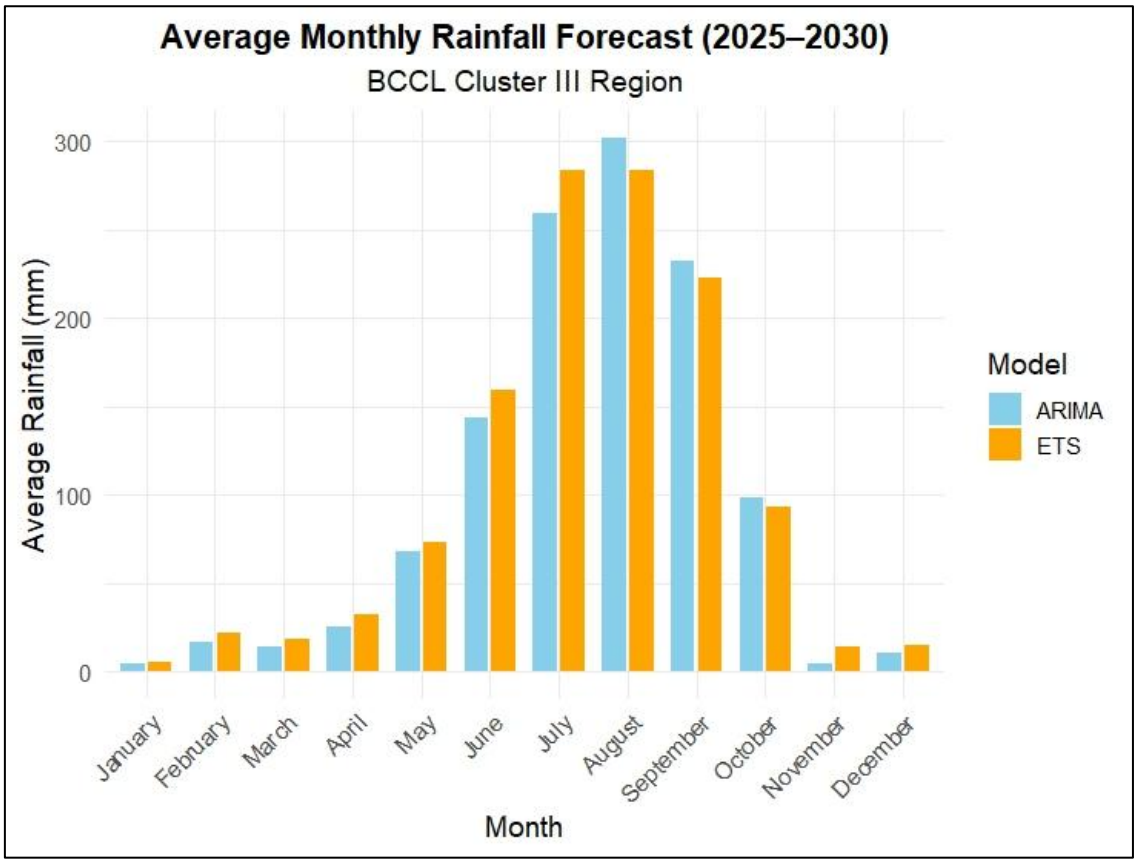


Fig. 4.1: Average Monthly Rainfall Forecast (2025-2030) in BCCL Cluster-III Region

Table 4.2: Monthly Rainfall Forecast (2025-2030) in BCCL Cluster-III Area using ARIMA and ETS Models (in mm)

Year	2025		2026		2027		2028		2029		2030	
	ARIMA	ETS	ARIMA	ETS	ARIMA	ETS	ARIMA	ETS	ARIMA	ETS	ARIMA	ETS
Jan	4.88	2.88	4.85	4.72	4.83	5.92	4.80	6.71	4.78	7.22	4.76	7.56
Feb	16.74	19.05	16.77	20.82	16.80	21.98	16.82	22.74	16.85	23.24	16.87	23.56
Mar	14.13	16.08	14.10	17.80	14.07	18.92	14.05	19.65	14.02	20.13	14.00	20.44
Apr	25.64	29.63	25.67	31.29	25.69	32.37	25.72	33.08	25.74	33.54	25.76	33.84
May	68.20	70.29	68.17	71.89	68.14	72.93	68.12	73.61	68.10	74.06	68.07	74.35
Jun	143.41	156.92	143.43	158.46	143.46	159.47	143.48	160.12	143.51	160.56	143.53	160.84
Jul	258.95	280.69	258.92	282.18	258.89	283.15	258.87	283.79	258.85	284.20	258.83	284.47
Aug	301.85	281.10	301.87	282.54	301.90	283.48	301.92	284.09	301.94	284.49	301.97	284.75
Sep	231.89	220.08	231.86	221.47	231.83	222.37	231.81	222.97	231.79	223.35	231.77	223.61
Oct	98.71	91.17	98.73	92.51	98.76	93.38	98.78	93.95	98.80	94.33	98.82	94.57
Nov	4.52	11.91	4.50	13.20	4.47	14.04	4.45	14.60	4.43	14.96	4.40	15.19
Dec	10.39	13.18	10.42	14.42	10.44	15.24	10.47	15.77	10.49	16.12	10.51	16.35

4.2.3.3 Analysis and Visualization of Daily Extreme Rainfall Events Between 2008 to 2024

Daily extreme rainfall events in the BCCL Cluster - III Area are defined as those exceeding the 95th percentile of historical daily rainfall data, a threshold of approximately 19.26 mm for the present dataset. Between 2008 and 2024, 311 such events were identified, and their frequency was calculated for each year. For visualization and interpretation, several plots were generated. Fig. 4.2, a bar plot, clearly illustrates the annual occurrence of these events, providing a straightforward representation of their frequency over time. Furthermore, Fig. 4.3, a line plot, displays the maximum extreme rainfall amount recorded yearly, offering insight into the intensity of the most extreme events annually. The analysis, supported by these visualizations, highlights the number of days with extreme rainfall in each year based on the defined threshold and the maximum rainfall amount during an extreme event in each year. The plots provide valuable insights into the inter-annual variability in the frequency and intensity of extreme rainfall events.

Regarding extreme rainfall frequency analysis and return periods, the maximum annual rainfall values were successfully extracted for each year from 2008 to 2024 to conduct an extreme value analysis. The Gumbel and Generalized Extreme Value (GEV) distributions were fitted to this annual maximum rainfall data.

For the Gumbel distribution, the estimated parameters are as follows:
Location (μ) ≈ 72.54: In the context of the Gumbel distribution, the location parameter is like the mean in a normal distribution. It indicates the central tendency of the data, essentially where the distribution is centred. A higher location parameter would suggest that larger extreme rainfall events are more common.

Scale (β) ≈ 22.00: The scale parameter describes the spread or variability of the data. A larger scale parameter indicates a wider spread of extreme rainfall values, meaning there's a greater range between the smallest and largest extreme events.

In contrast, the GEV distribution yielded estimated the following parameters:

Shape (c) ≈ -0.33: The shape parameter is unique to the GEV distribution and dictates the tail behaviour of the distribution, which is crucial for extreme value analysis. A negative shape parameter, as seen here, indicates that the distribution has an upper bound, meaning there's a theoretical maximum value that rainfall events are unlikely to exceed.

Location (μ) ≈ 69.01: Like the Gumbel distribution, this parameter indicates the central tendency of the GEV distribution.

Scale (β) ≈18.24: Also like the Gumbel distribution, this parameter describes the spread or variability of the extreme rainfall data for the GEV distribution.

Visual inspection of the Q-Q plots (Fig. 4.4) indicated that both the distributions reasonably fit the observed annual maximum rainfall data, with most points closely aligning with their respective theoretical lines. However, the calculated extreme rainfall values for various return periods exhibited differences between the two distributions. For a 10-year return period (probability 0.9), the Gumbel distribution estimates 122.05 mm, while the GEV distribution estimates 130.02 mm. This divergence becomes more pronounced for extended returns such as, for a 50-year return period (probability 0.98), the Gumbel distribution estimates 158.39 mm, whereas, the GEV distribution predicts a higher value of 214.64 mm. Similarly, for a 100-year return period (probability 0.99), Gumbel estimates 173.75 mm, while GEV estimates a significantly larger amount of 266.92 mm. The observed maximum annual rainfall in the dataset was 169.15 mm. The return period for this observed maximum was calculated to be approximately 81.24 years (with a probability of 0.9877) according to the Gumbel distribution, but only approximately 23.30 years (with a probability of 0.9571) based on the GEV distribution. The relationship between these return periods and the extreme rainfall values was further analysed visually, as presented in Fig. 4.5 Return Period vs. Extreme Rainfall value with Fitted Distributions, showing the extrapolated curves for both the fitted

distributions alongside the empirical plotting positions of the observed annual maximums.

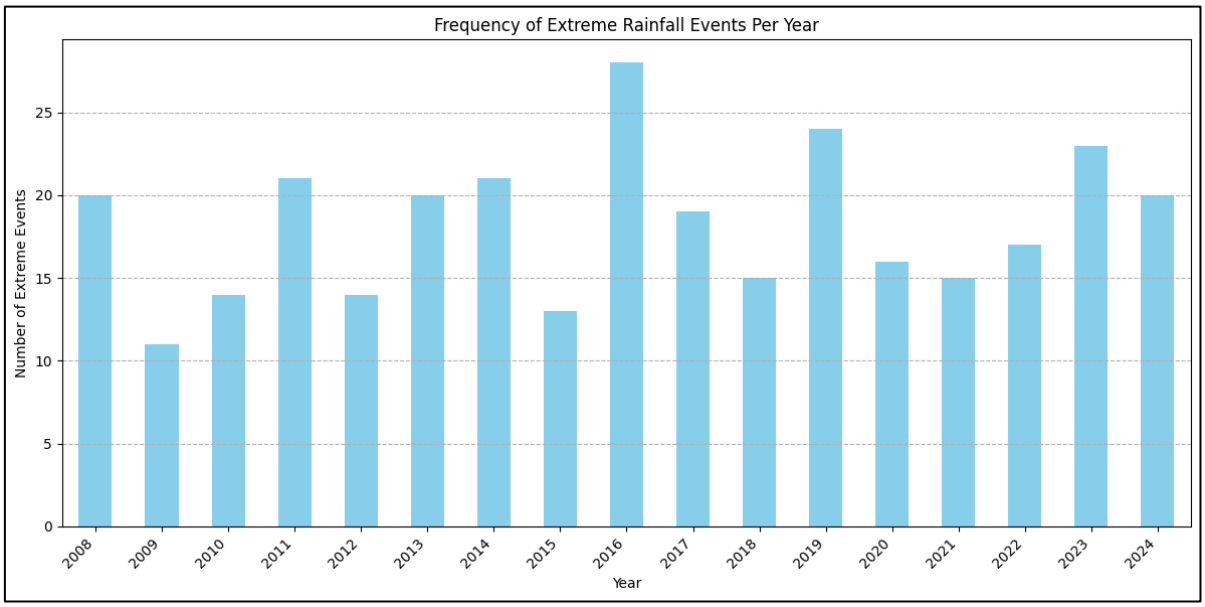


Fig. 4.2: Number of Extreme Rainfall Events for Each Year (2008-2024)

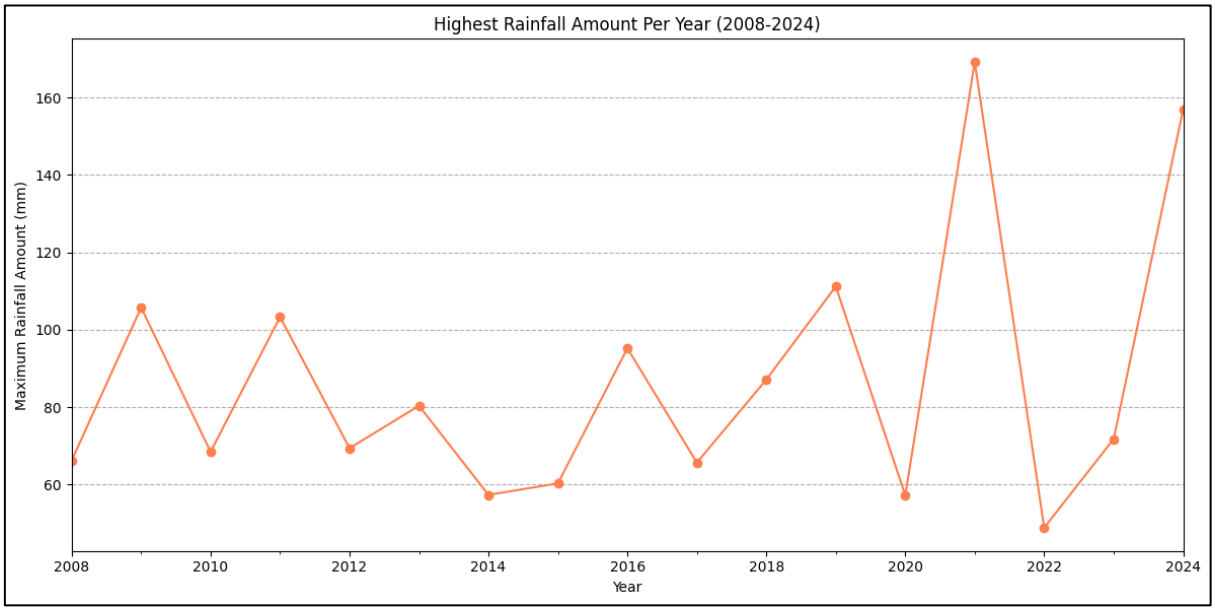


Fig. 4.3: Maximum Annual Extreme Rainfall values (2008-2024)

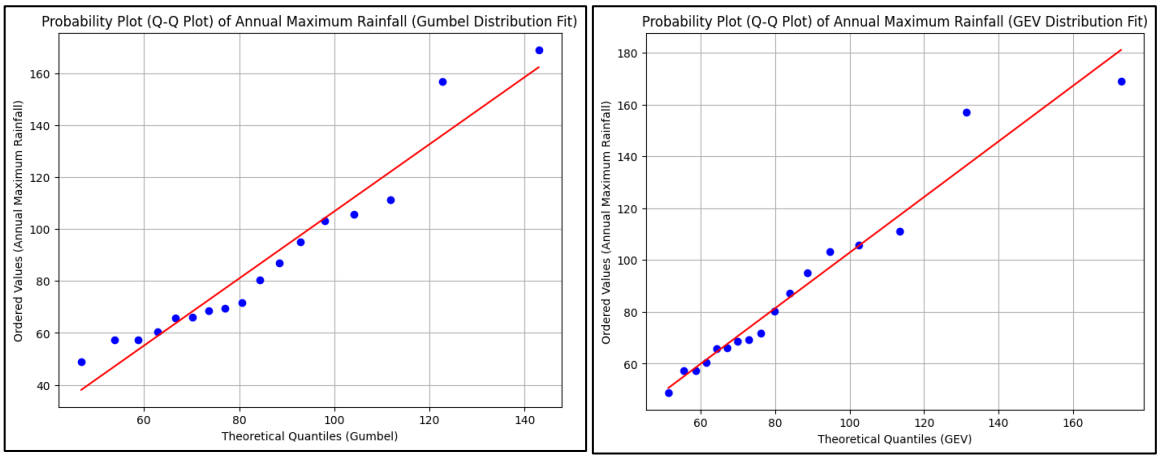


Fig. 4.4: Comparison of the Observed and the Predicted Maximum Daily Rainfall Using Gumbel and GEV Distributions

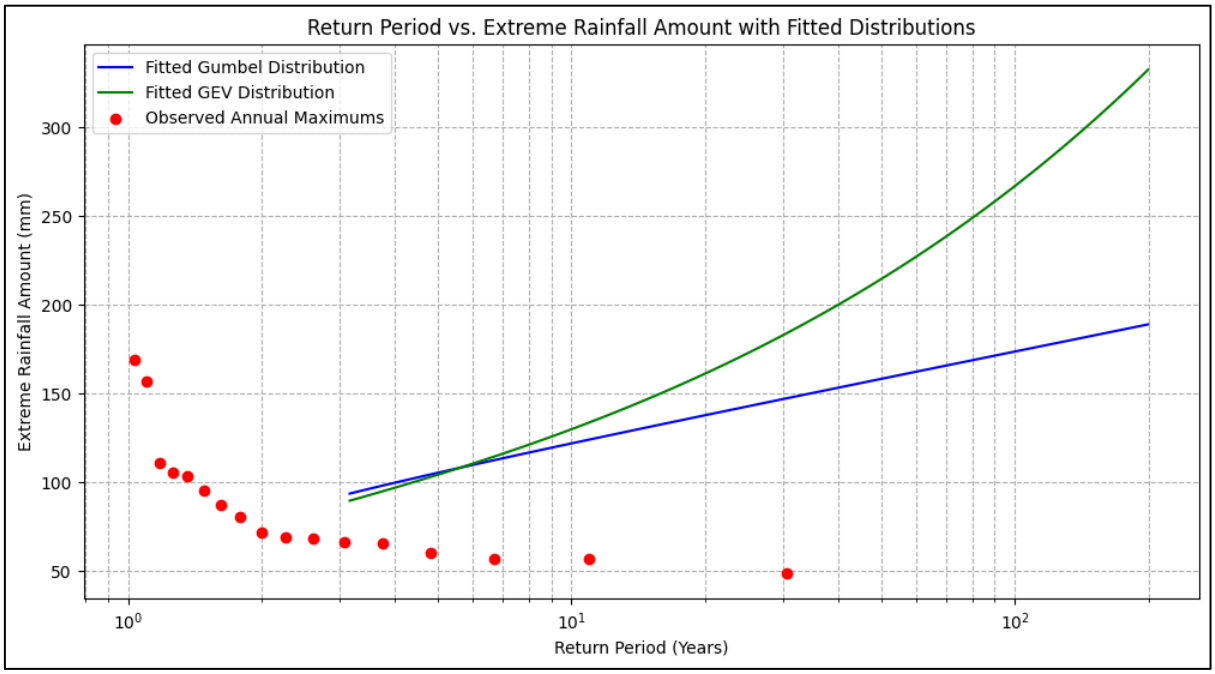


Fig. 4.5: Plot of Return Period vs. Extreme Rainfall Values with the Gumbel and GEV Fitted Distributions

4.2.4 Projected Temperature Trends and Climate Variability under SSP Scenarios in BCCL Cluster - III (2020-2039)

Future climate projections for the BCCL Cluster-III area have been analysed using multi-model ensemble outputs from CMIP6 datasets under four representative Shared Socioeconomic Pathways (SSPs), viz. SSP1-2.6, SSP2-4.5, SSP3-7.0, and SSP5-8.5. These scenarios represent varying degrees of global climate mitigation efforts and socioeconomic development, ranging from sustainable pathways to fossil-fuel intensive growth. The temperature changes are assessed for the near-future period

2020-2039. This 19-year period serves as the closest available proxy for the 2025-2039 range, which is the specific timeframe of interest for the present study. All the four scenarios, when assessed against a historical reference baseline of 1995-2014, consistently show a clear warming trend in the Cluster-III region. Among these, SSP1-2.6 projects the least warming, while SSP5-8.5 indicates the highest. Fig. 4.6 (Monthly Average, Minimum, and Maximum Temperatures in BCCL Cluster-III) illustrates the expected seasonal temperature variation up to the year 2039, highlighting significant warming during the pre-monsoon (March-May) and summer months. During these periods, maximum temperatures are projected to exceed 40 °C, especially under high-emission pathways. This anticipated increase poses a possible impact on the mining area.

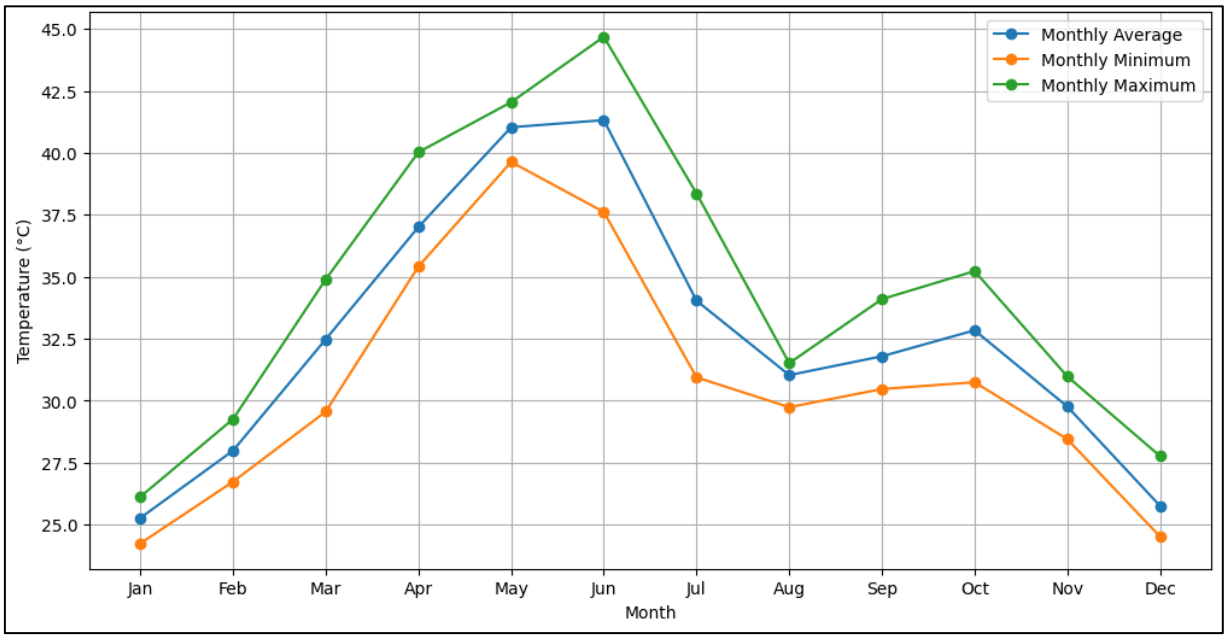


Fig. 4.6: ***Monthly Average, Minimum, and Maximum Temperatures in BCCL Cluster-III Area (2020-2039)***

Fig. 4.7 (Annual Surface Temperature Trend under Multiple SSPs) illustrates the national-scale temperature projections up to 2100, showing a sharp divergence between scenarios after 2040. For the near term (2020-2039), a steady temperature rise is observed across all the pathways, with SSP3-7.0 and SSP5-8.5, showing accelerated warming compared to the more stabilized trends of SSP1-2.6 and SSP2-4.5.

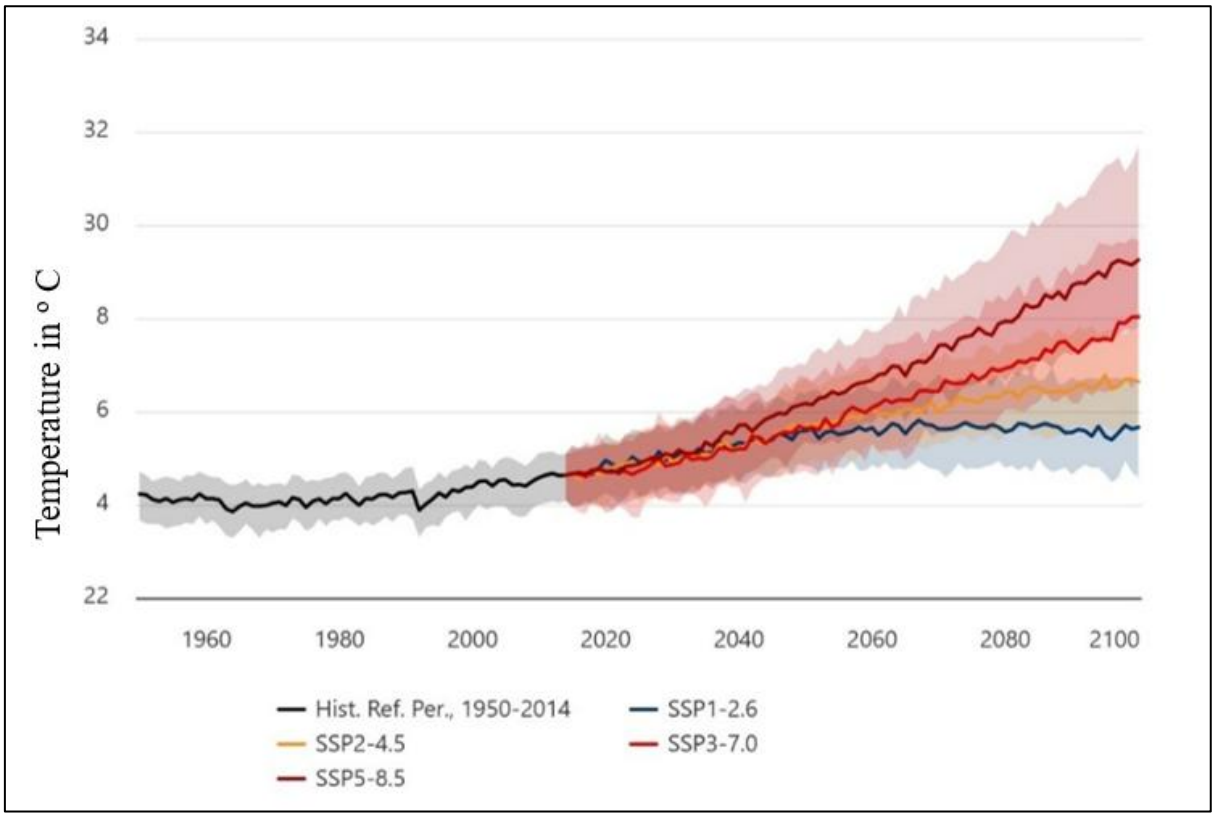


Fig. 4.7: Projected Annual Mean Surface Air Temperature under Multiple SSP Scenarios (1950-2100) (Compares SSP1-2.6, SSP2-4.5, SSP3-7.0, and SSP5-8.5 with historical reference)

Model-wise projections for Dhanbad under SSP5-8.5 as presented in Fig. 4.8 indicate a 0.5-1.2 °C temperature rise by 2039, with the taiesm1 model showing the highest increase. This figure illustrates inter-model variation and projected warming. While analysis of all SSP scenarios for BCCL Cluster-III (Dhanbad) shows a moderate warming trend, particularly in pre-monsoon and summer, the projected 0.5-1.2 °C increase is gradual and unlikely to severely disrupt mining operations, infrastructure, or water availability in the short term. Though slight influences on evapotranspiration and surface water are possible, the overall hydrological impact remains limited, and extreme heat stress is not expected to critically affect productivity. Therefore, current projections suggest no immediate adverse threat to mining activities, but integrating climate-resilient planning and water conservation measures is still recommended for long-term sustainability.

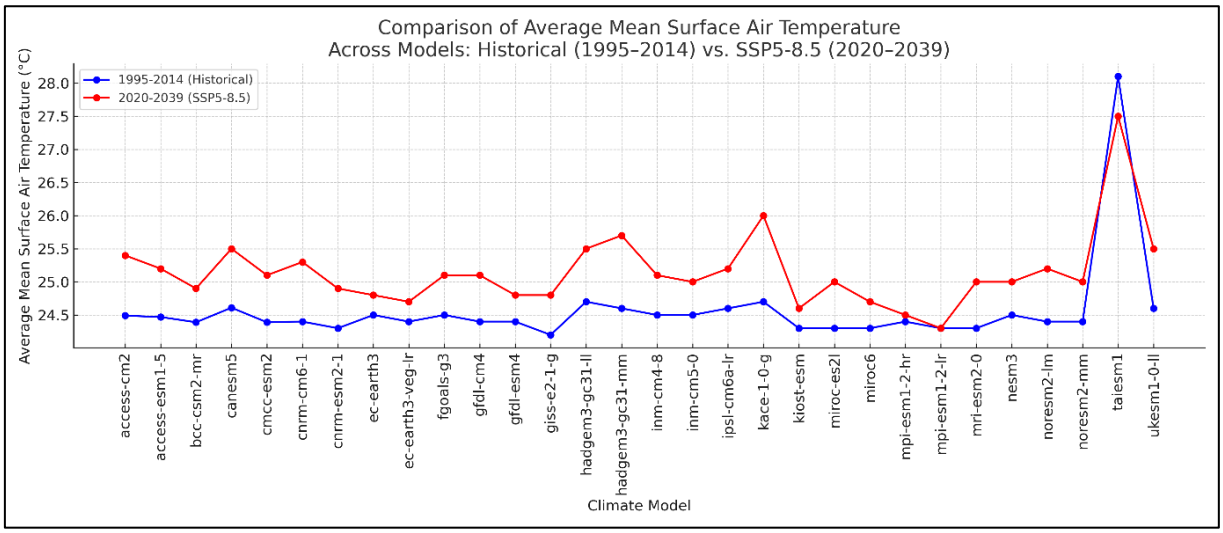


Fig. 4.8: Comparison of Average Mean Surface Air Temperature across Models: Historical (1995-2014) vs SSP5-8.5 (2020-2039) (Illustrates inter-model variation and projected warming under high-emission scenario)

4.2.5 Spatio-Temporal Variability of Rainfall (Forecasting for 2020-2039)

While, Section 4.3 presents the historical rainfall patterns in the BCCL Cluster-III region, this section focuses on projected changes in precipitation for the near-term period 2020-2039 based on CMIP6 multi-model outputs under SSP5-8.5 scenario. These projections highlight the expected increase in total rainfall and a greater likelihood of extreme precipitation events. This aligns with observed recent increases in rainfall in 2023 and 2024. The analysis integrates monthly variability, distribution shifts, and model-based seasonal precipitation trends to evaluate potential impacts on water resources and mining operations.

Fig. 4.9 (Monthly average, minimum, mean, and maximum surface air temperature and precipitation for Dhanbad District) shows the historical seasonal rainfall peak during the monsoon months (June-September), aligned with rising temperatures. The historical data from 2008 to 2024 confirms a consistent monsoon pattern with maximum rainfall in July and August, contributing significantly to the annual water budget.

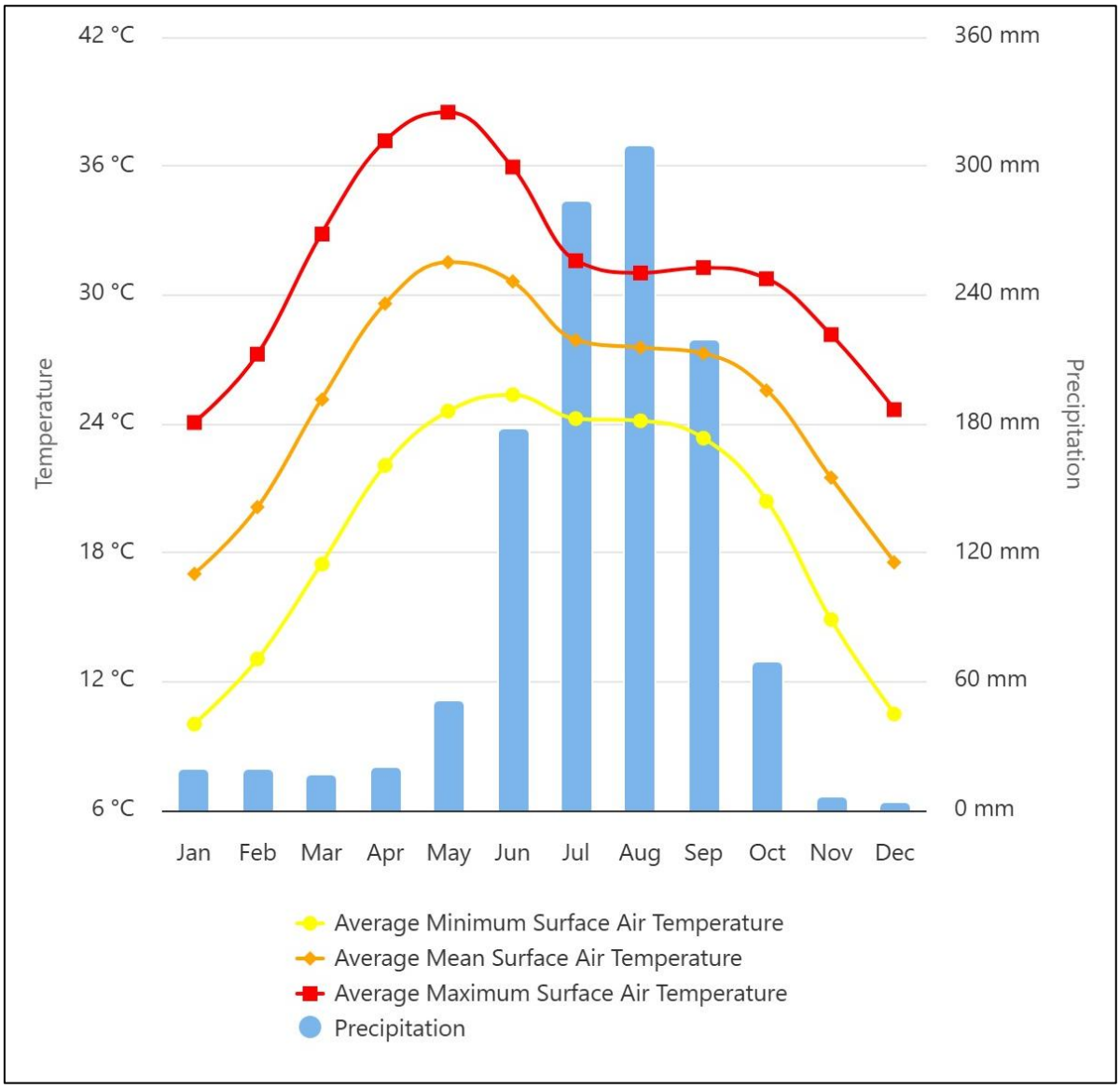


Fig. 4.9: Monthly Average, Minimum, Mean, and Maximum Surface Air Temperature and Precipitation in Dhanbad, India (1991-2020)

According to Fig. 4.10 (Projected Distribution Shift in Precipitation; SSP5-8.5), the distribution of annual precipitation in Jharkhand is projected to shift towards higher values in the 2020-2039 period compared to the 1995-2014 baseline. The peak of the distribution curve moves from approximately 1250 mm to 1350 mm, indicating a modest but notable increase in average annual rainfall. In this context, the Y-axis of the distribution plot represents the probability density of observing a particular annual precipitation value, showing how often different rainfall amounts are expected. This shift, however, is not extreme and remains within a manageable range for the current mining and hydrological infrastructure.

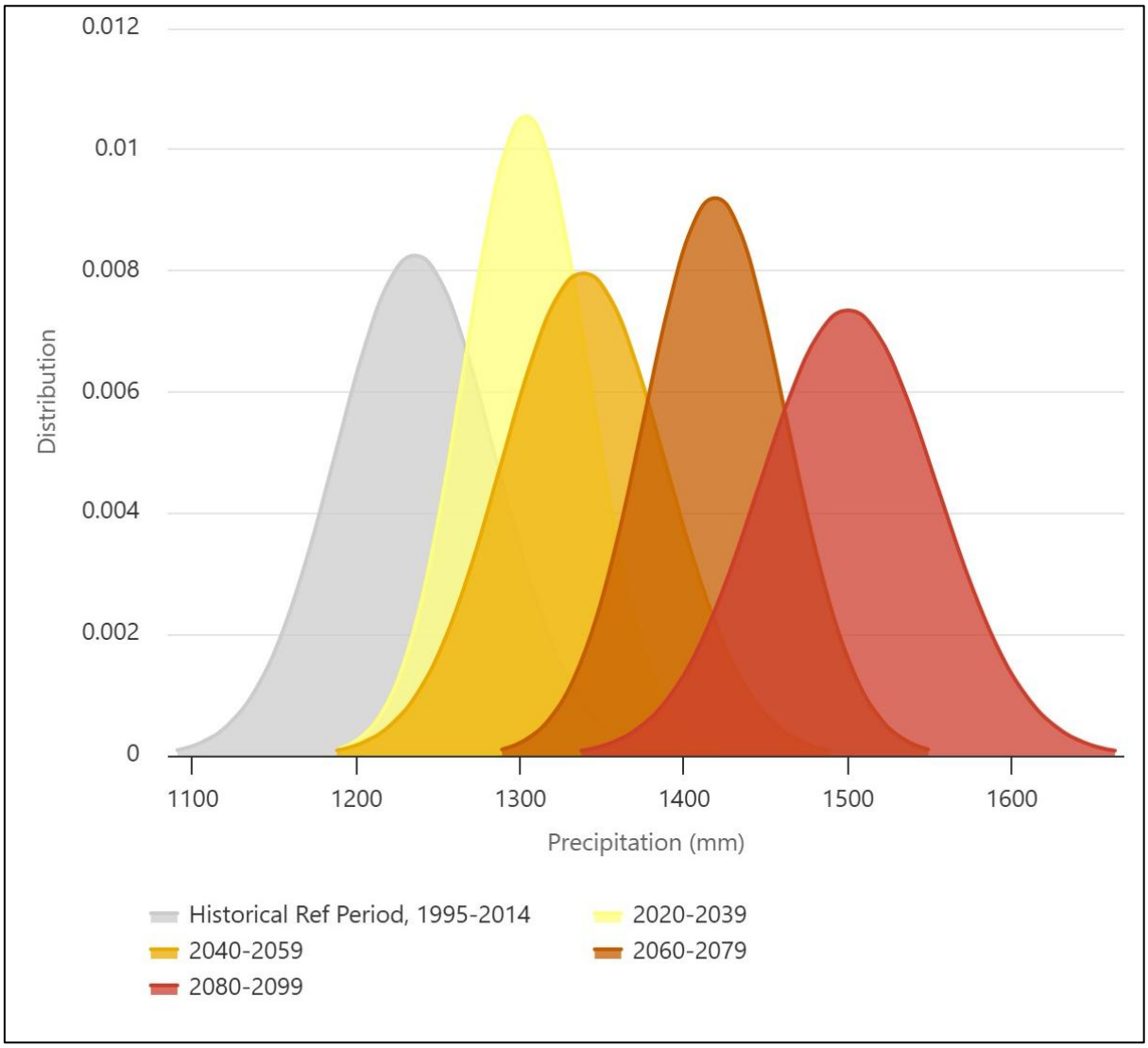


Fig. 4.10: Projected Change in Distribution of Annual Precipitation under SSP5-8.5 for (2020-2099)

Additionally, Fig. 4.10 (Projected Monthly Precipitation Trends across Seasonal Cycle; SSP5-8.5) displays future monthly rainfall variability for 2020-2099, showing that July and August continue to dominate in terms of peak rainfall. For the 2020-2039 period, model points cluster around historically observed rainfall magnitudes, with no significant deviation in peak intensity or timing of monsoon onset and retreat. This suggests stable seasonal patterns are likely to persist till 2039, albeit with slightly higher interannual variability.

Cross-referencing with historical data in Table 4.1 and the forecast values (2025-2030) confirms this stability. ARIMA and ETS models indicate sustained rainfall

trends with peak values in July and August, projecting monthly rainfall between 280 - 300 mm, consistent with historical observations from 2008-2024.

In summary, while the region is expected to experience a slight increase in total precipitation and intensity of rainfall events, the seasonal distribution remains unchanged. These changes are not severe and are unlikely to adversely impact mining operations in BCCL Cluster-III area in the short term period up to 2039. However, the increase in 1-day extreme rainfall events, as seen in broader CMIP6 analysis, may warrant future infrastructure updates for drainage and water management systems.

4.2.6 Future Runoff Estimation and Hydrological Implications

The estimation of future runoff for the BCCL Cluster-III area is critical for proactive water management and risk mitigation. This section presents an estimation of future runoff for the return periods of 10 and 50 years, integrating projected extreme rainfall events from Gumbel and Generalized Extreme Value (GEV) distributions with land-use/land cover (LULC) characteristics and hydrologic soil groups (HSG) using the Soil Conservation Service Curve Number (SCS-CN) method.

4.2.6.1 Future Rainfall Projections

Analysis of extreme rainfall events reveals a significant divergence in future projections. For a 10-year return period (indicating a 0.9 probability of being exceeded once in 10 years), the Gumbel distribution estimates an annual extreme rainfall event of 122.05 mm, while the GEV distribution predicts a higher 130.02 mm for an annual event. This disparity becomes more pronounced with longer return periods; for a 50-year return period (with a 0.98 probability of being exceeded once in 50 years), Gumbel projects an annual extreme rainfall of 158.39 mm, whereas GEV indicates a substantially higher 214.64 mm for an annual event. This trend suggests that the GEV distribution, by consistently predicting higher rainfall magnitudes for longer return periods, points towards a potentially more intense future extreme annual rainfall regime.

The observed maximum annual rainfall in the dataset, which is 169.15 mm, further highlights this uncertainty. Its return period is estimated at approximately 81.24 years by the Gumbel distribution but only 23.30 years by the GEV distribution. This significant difference underscores how sensitive the calculation of return periods for extreme events is to the specific statistical distribution chosen for the analysis.

4.2.6.2 Runoff Estimation Methodology

Runoff was estimated for each LULC class, considering both Hydrologic Soil Group B (HSG B) and Hydrologic Soil Group C (HSG C), for the projected 10-year and 50-year future rainfall scenarios. The SCS-CN method was employed, which calculates direct runoff based on rainfall amount (P) and a Curve Number (CN) that reflects the land cover, soil type, and antecedent moisture conditions. The study uses the SCS-CN method formula (Eq. 4.1).

$$\boldsymbol{Q = \frac{(P-I_a)^2}{(P-I_a)+S}} \quad \textbf{…….. (Eq. 4.1)}$$

Where, Q = Runoff depth in mm, P = Precipitation of the area in mm, S = Potential maximum retention after the start of runoff in mm, I_a = initial abstraction or losses of the area in m, i.e., losses before runoff in the form of infiltration, interception, or evaporation. Here, I_a = 0.3S; this relation was found by analysing the rainfall in many small agricultural basins for Indian conditions (Rao et al., 2010). The HSG group and the corresponding land cover for the entire basin area have been given in Table 4.3.

4.2.6.3 Estimated Future Runoff

The calculated runoff values for each LULC class demonstrate a clear response to the projected increase in rainfall for the 10-year and 50-year return periods. Generally, higher rainfall amounts, particularly those from the GEV distribution, lead to significantly higher runoff. The influence of Hydrologic Soil Group is also evident, with HSG C (representing soils with lower infiltration rates and higher runoff potential) consistently generating greater runoff compared to HSG B for the

same LULC class and rainfall event. These patterns highlight the combined influence of land-use and soil characteristics on surface hydrological response (Table 4.4 Estimated Runoff (mm)) for Different LULC Classes under Various Rainfall Scenarios and Hydrologic Soil Groups HSG B and HSG C).

Key observations from the runoff calculations include:

- **High Runoff Contributors:** LULC classes such as 'Nala Stram' and 'Waterbody', having Curve Numbers (CN) of 100, are projected to convert nearly all rainfall into runoff across all 10-year and 50-year scenarios. For instance, under a 50-year GEV rainfall of 214.64 mm, these areas would generate 214.64 mm of runoff. Similarly, 'National Highway' (CN 98) shows very high runoff, converting a 50-year GEV rainfall into approximately 208.54 mm of runoff.
- **Varying LULC Response:** Even for the same rainfall, runoff varies significantly by LULC. 'Vegetation' (HSG B, CN 61) under a 10-year Gumbel rainfall (122.05 mm) generates approximately 31.84 mm of runoff, while 'Barren Land' (HSG B, CN 86) for the same rainfall yields about 83.45 mm. This highlights the role of land cover in modulating hydrological response.
- **Impact of Extreme Events:** Comparing the 10-year Gumbel scenario with the the 50-year GEV scenario for 'Settlements' (HSG B, CN 65), runoff increases from approximately 38.74 mm to 108.24 mm. For 'Sparse Vegetation' (HSG C, CN 79), runoff increases from about 66.92 mm (10-year Gumbel) to 150.59 mm (50-year GEV). These substantial increases underscore the amplified hydrological response under more extreme rainfall conditions.

Table 4.3: Land-Use/Land Cover (LULC) and Hydrologic Soil Group (HSG) Characteristics with Corresponding Curve Numbers (CNs) and Rainfall Scenarios for Runoff Estimation

Sl. No	LULC Class	Rainfall Scenario (mm)				HSG Group		Total Basin Area in sq. km		CN Values	
		10-year Gumbel	10-year GEV	50-year Gumbel	50-year GEV						
1	Agriculture land	122.05	130.02	158.39	214.64	B	C	7.94	0.01	78	85
2	Barren Land					B	C	5.57	3.6	86	91
3	Mining					B	C	3.64	0.79	86	91
4	Nalla Stram					B	C	0.33	0.16	100	100
5	National Highway					B	C	0.08	0.07	98	98
6	Railways					B	C	0.38	0.14	85	89
7	Settlements					B	C	7.55	2.16	65	77
8	Sparse Vegetation					B	C	28.2	7.9	69	79
9	Vegetation					B	C	6.8	0.36	61	74
10	Village Road					B	-	0.14	—	89	-
11	Waterbody					B	C	0.55	0.05	100	100

Table 4.4: Estimated Runoff (mm) for Different LULC Classes under Various Rainfall Scenarios and Hydrologic Soil Groups (HSG B and HSG C)

Sl. No	LULC Class	Runoff (mm)							
		HSG Group B				HSG Group C			
		10-year Gumbel	10-year GEV	50-year Gumbel	50-year GEV	10-year Gumbel	10-year GEV	50-year Gumbel	50-year GEV
1	Agriculture land	64.70	71.45	96.21	147.54	80.99	88.34	114.94	168.87
2	Barren Land	83.45	90.88	117.70	171.92	96.34	104.08	131.78	187.18
3	Mining	83.45	90.88	117.70	171.92	96.34	104.08	131.78	187.18
4	Nalla Stram	122.05	130.02	158.39	214.64	122.05	130.02	158.39	214.64
5	National Highway	116.04	124.00	152.33	208.54	116.04	124.00	152.33	208.54
6	Railways	80.99	88.34	114.94	168.87	91.07	98.70	126.09	181.08
7	Settlements	38.74	44.02	64.12	108.24	62.50	69.16	93.62	144.50
8	Sparse Vegetation	46.15	51.92	73.61	120.27	66.92	73.77	98.83	150.59

9	Vegetation	31.84	36.60	54.99	96.31	56.13	62.47	85.96	135.39
10	Village Road	91.07	98.70	126.09	181.08	–	–	–	–
11	Waterbody	122.05	130.02	158.39	214.64	122.05	130.02	158.39	214.64
	Total	880.54	956.85	1234.48	1803.98	910.45	984.64	1252.12	1792.62

4.2.6.4 Hydrological Implications for 10-year and 50-year return periods

Despite the historical period of 2008–2024 showing no major hydrological hazards and limited short-term impacts, projections for 2025–2039 suggest potential long-term challenges due to increased rainfall intensity and runoff, particularly for 10-year and 50-year return periods. Historically, peak flows have remained manageable; for instance, in 2024, observed flows, predominantly from July to September, included 2.50 m^3/s for WS13, 1.52 m^3/s for WS5, 1.32 m^3/s for WS10, and 0.81 m^3/s for WS11 (Detailed delineation and mapping of the mentioned watersheds are provided in Section 3.4.5 and Figure 3.4.)

However, continuation or intensification of these projected trends could render existing drainage systems insufficient. This may pose high risks of waterlogging, soil erosion, and degradation of water quality. Over time, such conditions may place significant stress on water infrastructure and adversely affect both surface and groundwater systems. Consequently, there is a need for proactive planning and adaptive management strategies. These must encompass upgrading and expanding drainage infrastructure, implementing green infrastructure solutions (e.g., permeable pavements, rain gardens, detention ponds) to enhance infiltration, enforcing strict land-use zoning to minimize development in flood-prone areas, and adapting robust soil conservation practices in agricultural and barren lands in the future. Furthermore, the development and deployment of early warning systems for extreme rainfall and flood events will be increasingly critical to bolster community preparedness and disaster risk reduction in the near future.

4.3 Conclusion

This chapter on hydro-meteorological variability in the BCCL Cluster-III watershed highlights important trends in rainfall, temperature, and runoff in the future. Historical data from 2008 to 2024 show that most rainfall occurs during the monsoon months (June to September), with July and August receiving the highest rainfall. However, rainfall patterns have become more variable in recent years, with an increase in short, intense rainfall events and irregular monsoon behaviour. At

the same time, average temperatures have been rising steadily, especially during the summer months.

Using time-series models (ARIMA and ETS), rainfall forecasts for 2025 to 2030 indicate that the monsoon will remain the dominant season for rainfall. The forecasts also suggest only minor year-to-year changes, with no major shifts in rainfall patterns. Climate change projections from global models (CMIP6) for the period 2020 to 2039 also show a moderate rise in temperature (0.5°C to 1.2°C) and a slight increase in total rainfall, especially under the high-emission scenario (SSP5-8.5). These changes are not expected to cause significant disruption to current mining operations or water systems in the short term.

However, extreme rainfall events, those that occur rarely but with high intensity, are projected to become more frequent and expected to be severe in log-term period. Analysis using Gumbel and GEV distributions shows that these extreme events may produce significantly more rainfall during 10-year and 50-year return periods. Runoff estimation using the SCS-CN method shows that land-use and soil type strongly influence how much rainfall becomes surface runoff. Areas like highways and barren lands generate the highest runoff, especially during extreme events.

In summary, while climate change is expected to bring moderate increases in rainfall and temperature over the next 10 to 15 years, these changes are not likely to severely affect current hydrological conditions or infrastructure in BCCL Cluster-III area. However, some adjustments are recommended. These include improving drainage systems, encouraging water infiltration through green infrastructure, managing soil erosion, and preparing for extreme rainfall events through early warning systems. Overall, the region is not facing an immediate threat from climate change, but proactive planning is needed to make the water management system more resilient and sustainable in the near future.

Chapter 5: Estimation of soil erosion in the study area and mapping of the vulnerable zones

5.1 Introduction

Soil erosion is a critical environmental concern that significantly affects land productivity, water quality, and ecosystem health, particularly in watershed regions where topographical, climatic, and anthropogenic factors interact intensively. The detachment and transport of soil particles by agents such as water and wind not only lead to the degradation of fertile topsoil but also contribute to sedimentation in rivers, reservoirs, streams, and irrigation systems, thereby impairing their functioning and lifespan. In watershed areas, the risk and intensity of soil erosion vary spatially due to differences in rainfall pattern, surface slope or gradient, land-use/land cover (LULC), soil characteristics, and land management practices. Therefore, accurate estimation of soil erosion and spatial mapping of soil erosion potential zones are essential for prioritizing conservation efforts and implementing sustainable land and watershed management strategies. This chapter of the present study aims to estimate soil erosion rates within the watershed under consideration using scientifically validated models such as the Revised Universal Soil Loss Equation (RUSLE), and to develop erosion vulnerability maps using geospatial techniques. By integrating Remote Sensing (RS) and Geographic Information System (GIS) aided tools with erosion modelling, the study seeks to provide spatially explicit information on high-risk areas, thus supporting targeted soil and water conservation interventions.

5.2 Materials and Methodology

The methodological framework adapted for estimation of the Erosion Potential Index (EPI) is depicted in Fig. 5.1. It comprises several sequential stages viz. data acquisition & processing, preparation of thematic layers corresponding to the selected parameters, assignment of criteria weights using the Analytical Hierarchy Process (AHP), and finally, weighted overlay analysis to generate the final map.

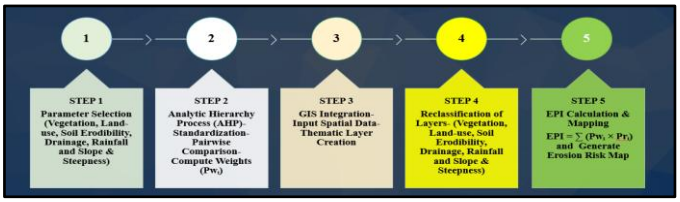


Fig. 5.1: Methodology flowchart for estimation of the EPI

5.2.1 Data Acquisition and Preparation

The study area, encompassing 1420.61 hectares, is located within a larger basin that covers approximately 8000 hectares. Therefore, a single satellite image scene was sufficient to cover the entire study area including the larger basin. Planet satellite data of 12th April 2025 was obtained from the PlanetScope archive of the European Space Agency (https://earth.esa.int/eogateway/missions/planetscope, accessed: 13th May 2025). The captured image with a ground sampling distance (GSD) of 3.9 m, the image exhibits 100 % clear sky conditions with no cloud, haze, or shadow interference, ensuring high-quality visual data. CartoSat-1_PAN_CartoDEM-30m is the Digital Elevation Model (DEM) data of the study area that was downloaded from the Indian Space Research Organization's (ISRO) Bhoonidhi portal (http://bhoonidhi.nrsc.gov.in/data/download/index.php, accessed 12th May 2024). However, daily gridded rainfall data of 10 years (2015 - 2024) of the study area (Cluster-III) was taken from 9395 grid cells of the IMD, with a resolution of 0.25×0.25 degrees. Soil data were obtained from the State Agricultural Management & Extension Training Institute (SAMETI), Jharkhand (https://www.sameti.org/Soil_Inventory/Dhanbad_Soil_Analysis.pdf, accessed on 12th May 2025). All the datasets were projected to a standard coordinate system (UTM Zone 45 WGS 84) and resampled to a uniform spatial resolution to ensure geometric consistency for the overlay analysis.

5.2.2 Erosion Potential Index (EPI) and GIS Analysis

For the present work, an Erosion Potential Index (EPI) model was developed and used as an indicator of potential zones of soil erosion in the study area. The EPI for the study area was developed by aggregating the parameters that are responsible for erosion and sediment transport to the existing high-order drainage system. Parameter selection in this study was based on the input required for the Universal

Soil Loss Equation (USLE) and RUSLE, as these two models are well accepted and widely used for the calculation of erosion potential globally. Development of spatial relations amongst the input parameters using GIS can help to deal with interception, transport, and deposition of sediment through erosion (Karan & Samadder, 2016). In this study, Rainfall-Runoff erosivity, Soil erodibility, Slope length & steepness, Land-use, Vegetation type, and Distance from drainage lines were selected as the main parameters influencing the EPI for the study. Some of the parameters selected for the present study may have physical dimensions, and their aggregation may result in erroneous results. Hence, unit less scores were assigned to the different sub-ranges of every parameter based on their relative importance in causing erosion. Detailed description of the selected parameters and the rationale behind the assignment of these unit-less scores are explained in the following sections.

5.2.2.1 Rainfall runoff erosivity (R)

According to Wischmeier and Smith (1978), the USLE-based erosion index is directly proportional to the erosive force of a specific rainfall event. Keeping other parameters constant, losses from rainfall events are directly related to the product of total kinetic energy *(E)* of the storm multiplied by its maximum 30 min intensity *(I_{30})*. Availability of long-term pluviographic data at fine spatial and temporal scales is operose (Jain & Das, 2010), which is required to realistically estimate EI_{30}. Several studies have attempted to estimate rainfall erosivity using long-term or annual pluviographic data. Babu et al. (2004) developed an equation (Eq. 5.1) to estimate rainfall erosivity based on the linear relationships between annual rainfalls and computed annual average rainfall (Karan et al., 2019; Ganasri & Ramesh, 2016). The equation developed by Babu et al. (2004) has been used for estimating rainfall erosivity in the present study area, as this method was recommended for coal mining areas. As the rainfall in the study area is found to be nearly uniform, the annual average rainfall over a 10-year period (2015 - 2024) was utilized for mean annual rainfall calculations (R_N). The mean annual rainfall for the 10 years of the study area was found to be 1171.45 mm, and the rainfall runoff erosivity (R) was found to be 526.65 MJ mm $ha^{-1}h^{-1}year^{-1}$.

$$\boldsymbol{R = 81.5 + 0.38\,(R_N)} \quad \text{…….. (Eq. 5.1)}$$

Where, R_N corresponds to mean annual rainfall in mm, and R corresponds to rainfall runoff erosivity.

5.2.2.2 Soil erodibility (K)

According to the soil dataset provided by SAMETI (State Agricultural Management & Extension Training Institute), Jharkhand, the study area is classified into three soil types based on texture viz. Sandy Clay Loam, Loam, and Sandy Loam. The corresponding soil erodibility (K) factor values for each category have been adapted from Karan et al. (2019). The soil erodibility factor (K) estimates the sensitivity of soil or surface materials to detachment and transportation due to the rainfall and subsequent runoff (Renard et al., 1997). Soil erodibility factor has been defined as the rate of soil loss per erosion index unit for a specified soil as measured on a unit plot (Wischmeier & Smith, 1978). It is reported that silt and very fine sand are most easily eroded, whereas, aggregated soil is less susceptible to erosion (Kim, 2006). The details about the three defined textures, along with the K-factor and erosion risk level (as per Renard et al. 1997), are shown in Table 5.1.

Table 5.1: Properties of soil in the study area as per the SAMETI user-soil dataset

Soil Type	K-factor (t ha h MJ-1 mm-1 ha-1)	Erosion Risk Level	Reference
Loam	0.2449	Very High	Karan et al.,2019
Sandy Clay Loam	0.2592	High	Karan et al.,2019
Sandy Loam	0.2512	Moderate	Karan et al.,2019

5.2.2.3 Slope length and steepness (Ls)

In the RUSLE model (Renard et al., 1997), the effect of topography on soil erosion is accounted for by the slope length and slope steepness factor (Ls). CartoSat-1 DEM data was used for estimating the slope length and slope steepness factor. The DEM data was projected to UTM Zone 45N datum WGS 1984 projection system. Sinks in the DEM data were filled using the fill tool under the hydrology tools available in ArcGIS 10.2.2 for resolving errors from rounding of elevation values to the nearest integer values. Flow direction and accumulation were estimated using the hydrology toolset of the ArcGIS 10.2.2 toolbar. Eq. 5.2 was used to estimate the slope length and slope steepness factor of the study area as per Luvai et al. (2022). In this

study area, the values of Ls range from 0 to 18, representing low to high erosion risk levels, respectively. The selected range is comparable with that reported by Biswas and Pani (2015) as depicted in the Table. 5.2.

$$L_s = \left\{\left(\frac{FlowAcc \times cell\ size}{22.13}\right)^{0.4} \times \left(\frac{Sin(Slope^{\circ}) \times 0.1745}{0.09}\right)^{1.4}\right\} \ldots\ldots\ldots\ldots\ldots \textbf{(Eq. 5.2)}$$

Where, Flow Acc is the accumulated weight of all cells of the DEM flowing into each downslope cell in the output raster.

Table 5.2: Slope Length and Steepness (LS) Factor Values for the Study Area

Parameter	Value	Erosion Risk Level
Slope length and steepness (Ls)	< 3.6	Very Low
	3.6 – 7.2	Low
	7.21 – 10.80	Moderate
	10.81 – 14.40	High
	>14.40	Very High

5.2.2.4 Land-use pattern (C)

Land-use pattern (C) is an important parameter influencing erosion and sediment transport. In RUSLE, the C-factor indicates how the conservation plan will affect the average annual soil loss and how that soil-loss potential will be distributed in time during construction activities, crop rotations or other management schemes. Atmospherically corrected planet data were used for delineation of the land-use pattern of the present study area. Using digitization tool of ArcGIS 10.2.2, the study area was delineated in eleven distinct classes (Waterbody, Railways, Nala/Stream, Village Road, National Highways, Sparse Vegetation, Vegetation, Agricultural Land/Fallow Land, Mining, Settlements, Barren lands, Overburden, and Plantation on Overburden). The distribution of land-use land cover in the study area along with their corresponding C-factor and erosion risk level are shown in Table 5.3.

Table 5.3: Distribution of land-use land cover in the study area along with their corresponding C-factor and erosion risk level

Parameter	Sub Parameter	C-Factor (Unitless)	Erosion Risk Level	Reference
	Waterbody	0.00	Very Low	Karan et al., 2019; Ganasar &

Land Use/Land Cover (C)				Ramesh (2016)
	Railways	0.00	Very Low	
	Nala	0.001	Very Low	
	Village Road	0.01	Low	
	National Highways	0.001	Very Low	
	Vegetation (Vegetation, Sparse Vegetation, and Plantation on OB)	0.006	Moderate	Karan et al., 2019; Biswas & Pani (2015)
	Agricultural Fallow Land	0.05	Moderate	Gelagaya & Minale (2016)
	Mining	1.00	Very High	Karan et al.,2019
	Settlements	1.00	Very High	Karan et al., 2019; Biswas & Pani (2015)
	Barren lands	1.00	Very High	Karan et al., 2019; Chatterjee et al.,2014
	Overburden	1.00	Very High	

5.2.2.5 Distance from drainage lines (D)

Runoff through natural drainage lines during rainfall events promotes sediment transport and erosion. The risk of erosion and sediment transport may be higher in areas closer to the natural drainage pattern due to higher mechanical forces of erosion. The drainage map of the Cluster-III area was extracted from the DEM of the study area using the flow accumulation tool in the hydrology toolset of ArcGIS 10.2.2. All values less than 600 were set to null, and the resultant raster was converted into a stream feature using the stream to feature tool in the hydrology toolset of ArcGIS 10.2.2. To analyse the influence of proximity to drainage on erosion potential, multiple buffer zones were created at distances of 50 m, 100 m, 150 m, and > 150 m from the extracted stream features using the Multiple Ring Buffer tool in ArcGIS 10.2.2 and shown in Table 5.4.

Table 5.4: Buffer Zone Analysis of Erosion Risk Based on Distance from drainage lines.

Parameter	Values (meter)	Erosion Risk Level
Distance from drainage lines (D)	< 50	Very High
	50 - 100	High
	100 - 150	Moderate
	>150	Low

5.2.2.6 Vegetation type (V)

Both the vegetation type and its density are important parameters governing erosion and sediment transport (Lieskovský & Kenderessy, 2014). Atmospherically corrected planet data were used for estimating the spatial distribution of vegetation in the study area. Normalized Difference Vegetation Index (NDVI) was used to estimate the spatial distribution of vegetation types in the study area. NDVI calculation is based on the concept of the normalized ratio of scattering of radiation in the near infrared (NIR) zone of the electromagnetic spectrum to that of radiation absorbed by the chlorophyll present in the canopy in the red wavelength. It is the most popular of all the vegetation indices, and the values of NDVI range from −1 to +1 depending on the types of features available in the area. Vegetation is generally present when the NDVI values are between 0.2 and 1. Lower NDVI value signifies low vegetation density, herb/shrub, and cropland. Higher values of NDVI signify dense vegetation (Carlson & Ripley, 1997). In the present study, NDVI was calculated using Eq. 5.3.

$$NDVI = \frac{NIR-RED}{NIR-RED} \quad \text{..... (Eq. 5.3)}$$

Where NIR is the Near Infra-red spectrum image band, and RED is the red spectrum image band. The NDVI values in the study area ranged from - 0.02 to 0.29. As per the calculated NDVI distribution, the study area was successfully classified into 5 distinct classes (Waterbody, Dense herbs, vegetation grassland, and Barren Land) as shown in the Table. 5.5.

Table 5.5: Vegetation Classification of the Study Area Using NDVI

Parameter	Vegetation Type	Erosion Risk Level

Vegetation type (V)	Waterbody	Very Low
	Dense Herbs and Shrubs	Low
	Vegetation	Moderate
	Grassland	Very High
	Barren Land	Very High

5.2.3 Factor Reclassification and Standardization

The parameters were reclassified and assigned suitability scores based on their influence on erosion risk and is depicted in Table 5.6. For instance, regarding Land-Use/Land Cover (C-Factor), settlements, mining, barren lands, and overburden were assigned a very high suitability score of 5, indicating very high erosion potential. Conversely, water bodies, railways, Nala, and village roads received a very low suitability score of 1. In terms of Soil Erodibility (K Factor), loam soil exhibited a very high suitability score of 5, while sandy loam was classified as moderate with a score of 3.

Furthermore, the distance from drainage lines (D) plays a crucial role, with areas lesser than 50 m from the drainage lines scoring a very high value of 5, and those greater than 150 meters scoring a low value of 2. The Rainfall Runoff Erosivity (R) was uniformly very high at a score of 5 for a Rainfall Runoff Erosivity value of 565.55 MJ mm $ha^{-1}h^{-1}year^{-1}$. Slope length and steepness (Ls) showed increasing suitability scores with increasing slope, with values greater than 14.40 receiving a very high score of 5. Lastly, for Vegetation Type, grassland with low density and barren land area scored a very high value of 5, while dense herbs and shrubs scored a low value of 2, as shown in Fig. 5.2.

Table 5.6: Reclassification Criteria and Suitability Scores for Thematic Layers

Parameter	Sub-Parameter/Value	Suitability Score	Suitability Class
Land Use/Land Cover (C)	Waterbody	1	Very Low
	Railways	1	Very Low
	Nala	1	Very Low
	Village Road	2	Low
	National Highways	1	Very Low

	(Vegetation, Sparse Vegetation, and Plantation on OB)	3	Moderate
	Agricultural Fallow Land	3	Moderate
	Mining	5	Very High
	Settlements	5	Very High
	Barren lands	5	Very High
	Overburden	5	Very High
Soil Erodibility (K) (tons $hMJ^{-1}m^{-1}$)	Loam	5	Very High
	Sandy Clay Loam	5	High
	Sandy Loam	3	Moderate
Distance from drainage lines (D) (meters)	50	5	Very High
	100	4	High
	150	3	Moderate
	>150	2	Low
Rainfall runoff erosivity (R) ($MJmmha^{-1}h^{-1}year^{-1}$)	565.55	5	Very High
Slope length and steepness (Ls)	0.00 – 3.6	1	Very Low
	3.7 – 7.2	2	Low
	7.3 – 10.80	3	Moderate
	10.81 – 14.40	4	High
	>14.40	5	Very High
Vegetation type (V)	Dense Herbs and Shrubs	1	Low
	Vegetation	3	Moderate
	Grassland	5	Very High
	Barren Land	5	Very High

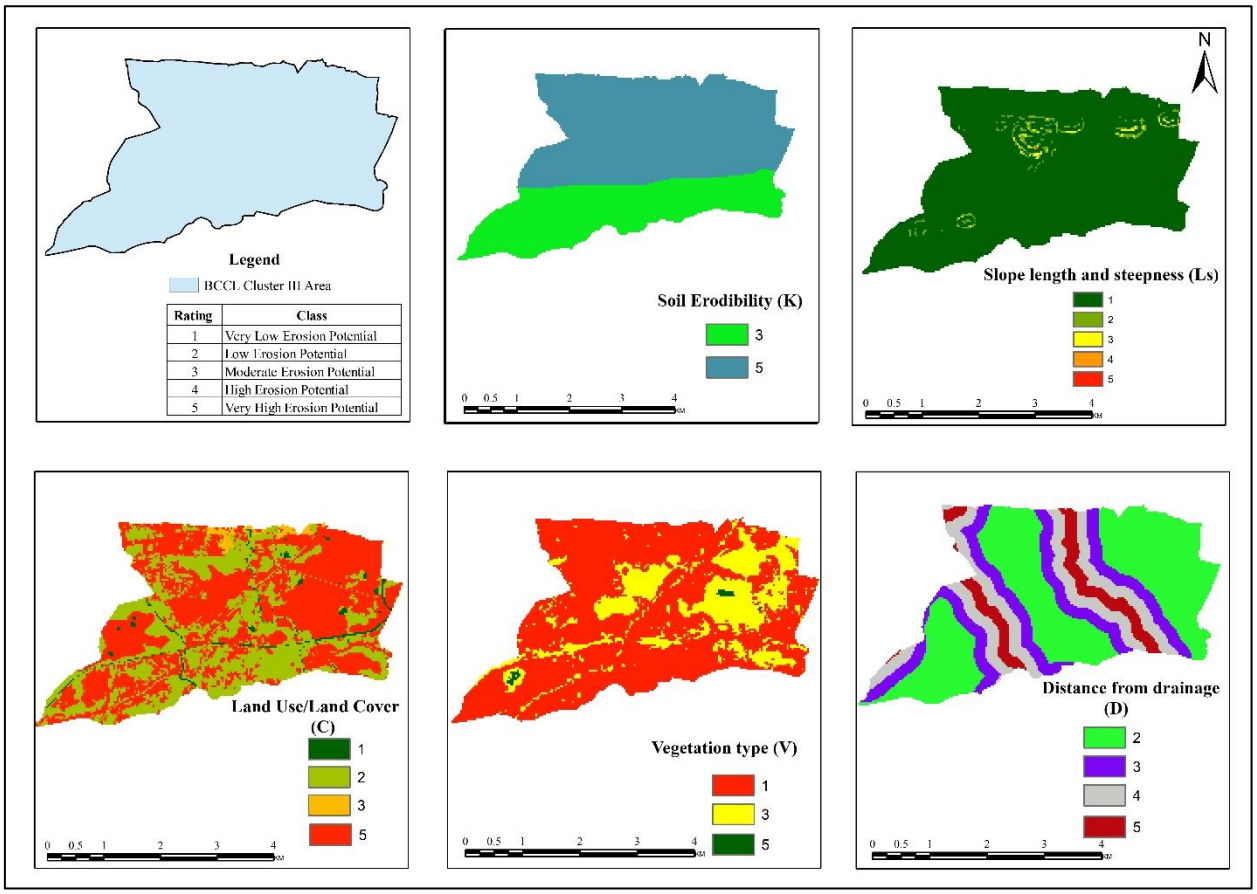


Fig. 5.2: Thematic Layers Used for EPI Analysis in BCCL Cluster-III Area

5.2.4 Analytic Hierarchy Process (AHP)

Building upon the insights from these reclassified parameters, the rationale of the erosion model is based on the rough concept of the USLE and its subsequent modifications, such as the RUSLE. While the primary purpose of the USLE model and its modifications was to assess soil loss at catchment scales, and most of these models involve the direct multiplication of factors responsible for erosion, it is recognized that not all parameters may contribute equally to the erosion process. Therefore, to create a more robust model capable of identifying areas more vulnerable to erosion, a weighted addition of the selected factors is required. Moreover, rainfall-runoff erosivity and soil erodibility factors within the RUSLE model possess physical dimensions. Consequently, directly creating an index by spatially overlaying them may yield erroneous results due to inconsistencies in units. To effectively address this issue, the AHP is employed to assign numerical, unit less weights to these parameters. This approach significantly helps in

maintaining coherency during the overlaying and indexing process, ensuring that each parameter's contribution is appropriately justified.

To further facilitate a comparative analysis, each thematic layer was standardized onto a standard five-point numerical scale, ranging from 1 (Very Low Erosion) to 5 (Very High Erosion). The classification thresholds for these layers were meticulously established based on existing literature, standard hydrological guidelines, and expert judgment for the study region.

In AHP, the off-diagonal relationships among the selected parameters were systematically examined using a 5-point scale in this study, which ranged from 1 (indicating equal importance) to 5 (signifying absolute importance). While, a 9-point scale is the standard and widely accepted practice in AHP, offering a broader range for expressing relative preferences and finer discrimination between criteria, but a 5-point scale (or any other reduced scale) could theoretically be used. The 9-point scale, as proposed by Saaty, is specifically designed to capture the full spectrum of human judgment on relative importance more effectively, thereby allowing for a more precise and consistent elicitation of priorities in complex decision-making scenarios. The AHP matrix, specifically utilized to evaluate the weights of the selected parameters, is presented in Table 5.7. A numerical score of 1 was consistently assigned to the diagonal elements of this matrix. To meticulously assess the consistency of the AHP matrix, a consistency index (CI) was computed using (Eq. 5.4). Sener and Davraz (2013) reported that the CI could be associated with a stochastic matrix (SM), such that the ratio between CI and SM constitutes the consistency ratio (CR). As a widely accepted guideline for AHP, the CR should ideally be less than or equal to 0.1 (i.e., CI/SM ≤ 0.1) (Saaty, 2003).

$$\boldsymbol{CI = \frac{\lambda_{max} - n}{n-1}} \quad \textbf{..... (Eq. 5.4)}$$

Where, λ_{max} is the largest principal eigenvalue of the matrix, and n is the number of parameters. Determination of rates of each parameter was performed by aggregating the computed results of the weights of each sub-parameter multiplied by the rate of each alternative.

Table 5.7: AHP matrix for calculating weight of each parameter of the Erosion Potential Index (Consistency Ratio: 0.031)

Parameters	Rainfall runoff erosivity *(R)*	Soil erodibility *(K)*	Slope length and steepness *(Ls)*	Land-use *(C)*	Distance from drainage lines *(D)*	Vegetation type *(V)*
Rainfall runoff erosivity *(R)*	1	2	3	4	3	5
Soil erodibility *(K)*	0.5	1	2	3	2	4
Slope length and steepness *(Ls)*	0.33	0.5	1	3	0.5	3
Land-use *(C)*	0.25	0.33	0.33	1	0.33	2
Distance from drainage lines *(D)*	0.33	0.5	2	3	1	4
Vegetation type *(V)*	0.2	0.25	0.33	0.5	0.25	1

5.2.5 Estimation of EPI

For estimation of the EPI, the methodological hierarchy shown in Fig. 5.1 was followed. The first step of the hierarchy is the selection of relevant parameters based on the USLE model. The second step includes the estimation of the weights and rates of the parameters using AHP. In the third step, the parameters were converted into the required format compatible with ArcGIS, and subsequently, in the next step, the parameters were reclassified to their respective weighted value (Table 5.8) calculated in the second step. Finally, the parameters were aggregated to estimate the EPI of the Cluster-III area using (Eq. 5.5).

$$\boldsymbol{EPI = \sum_{i=1}^{n} P_{wi} P_{ri}} \quad \textbf{…….. (Eq. 5.5)}$$

Where EPI is the erosion potential index, n is the number of parameters responsible for causing erosion; wi and ri in subscripts represent the respective weights and ratings of the parameter i. The reclassified parameters were scaled to a resolution of 30 m to maintain consistency during the aggregation process. The parameters were aggregated, and the EPI was estimated using (Eq. 5.6) in the raster calculator tool available under the Map Algebra Toolkit of ArcGIS 10.2.2.

$$EPI = R_w R_r + K_w K_r + Ls_w Ls_r + C_w C_r + D_w D_r + V_w V_r \ldots\ldots\ldots\ldots \text{(Eq. 5.6)}$$

Where, R is the rainfall-runoff erosivity, K is soil erodibility, L_s is the slope length and steepness factor, C is land-use, D is the distance from drainage lines, and V is the vegetation type.

Table 5.8: Weights of different parameters calculated using AHP

Parameters	Weight (Unitless)
Rainfall runoff erosivity *(R)*	0.35
Soil erodibility *(K)*	0.22
Slope length and steepness *(Ls)*	0.13
Land-use *(C)*	0.08
Distance from drainage lines *(D)*	0.17
Vegetation type *(V)*	0.05

5.2.6 Estimation of soil loss

Soil loss is measured in terms of tons per hectare per year. For the present study, the RUSLE model was used for estimating the soil loss for the Cluster-III area. The rationale of RUSLE model is based on the spatial multiplication of the factors affecting soil loss and erosion. These factors are (R) rainfall-runoff erosivity factor (MJmm $ha^{-1}h^{-1}year^{-1}$), (K) soil erodibility factor (t ha h $MJ^{-1}mm^{-1}ha^{-1}$), (Ls) slope length and steepness factor, (C) land cover management factor, and (P) the conservation supporting practice factor (unitless). The value of P is assigned using a practice analogy that is not readily available. Therefore, in the absence of conservation practices data (P) of the study area, the P factor was assumed as 1 (consistent with Pradhan et al., 2012). The soil loss equation uses spatial multiplication of the parameters, and the calculation was done using (Eq. 5.7).

$$A = R \times K \times L_s \times C \times P \ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(Eq. 5.7)}$$

Where, A is the annual soil loss (in tons ha^{-1} $year^{-1}$). The parameters were reclassified into their respective ranges in ArcGIS environment. Raster calculator tool available in the map algebra toolbar of ArcGIS 10.2.2 was used to evaluate soil

loss using (Eq. 5.7) for the present study. All the parameters were scaled to a uniform spatial scale for error-free analysis.

5.3 Results and Discussion

5.3.1 Erosion Potential Index (EPI) in the Cluster-III Area

The numerical values of the composite EPI ranged from 3.0 (signifying lowest vulnerability to erosion) to > 4.12 (signifying highest vulnerability to erosion) for the entire Cluster-III area. The range of EPI was divided into 4 distinct classes (Low, Moderate, High, and Very High) based on equal interval division of EPI (Table 5.9). The results of the weighted linear combination of the parameters revealed that about 42.66% area of the Cluster-III area lies in the moderate EPI zone, and 25.43 of % area lies in the low EPI zone (Table 5.9). About 28.74% and 3.17 % area of the total study area lie in the high and very high EPI zones, respectively (Fig. 5.3). Critical observation on the model results revealed that the north, north-western, and south-eastern regions of the Cluster-III area had the highest vulnerability to erosion. Additionally, very high EPI values were found for the regions closer to the drainage lines located near overburden dumps, which indicate the presence of loose soil.

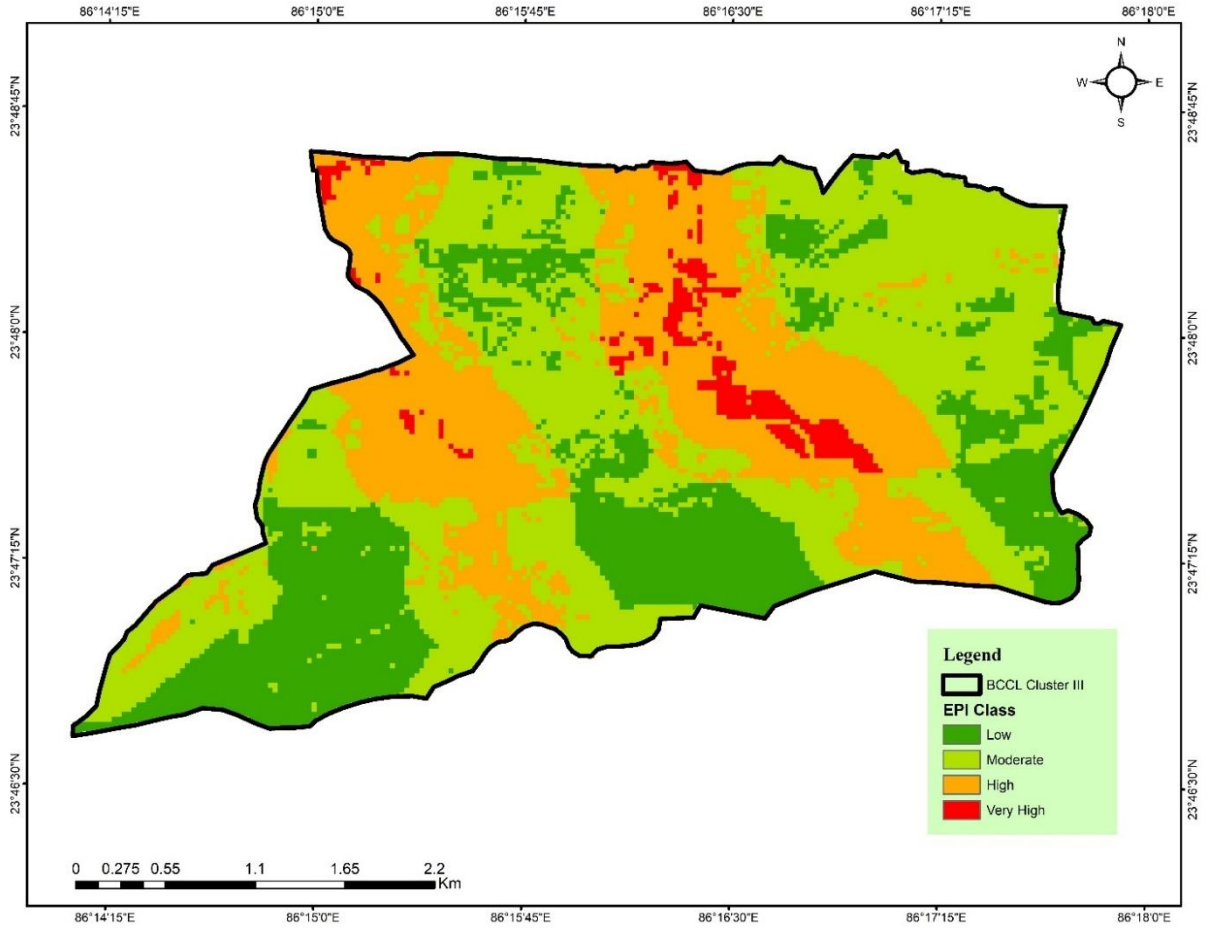


Fig. 5.3: Distribution of EPI zones in the Cluster-III area of BCCL

Table 5.9: Percentage distribution of EPI in the Cluster -III area based on EPI values

EPI Class	EPI class	Area %	Area (Hectare)
Low	3.00 – 3.38	25.43	361.089
Moderate	3.39– 3.75	42.66	605.81
High	3.76 – 4.12	28.74	408.226
Very High	>4.12	3.17	45.0802
Total Area = 1420.20 ha.			

5.3.2 Soil loss in the Cluster-III area

In the Cluster-III study area, the estimated soil loss ranged from 0 to 2023 tons ha^{-1} $year^{-1}$, with the RUSLE model employed to quantify annual soil erosion. The severity of soil erosion was categorized into five distinct classes based on soil loss rates namely Very Low (0 – 5 t ha^{-1} yr^{-1}), Low (6 – 10 t ha^{-1} yr^{-1}), Moderate (11 – 25 t ha^{-1} yr^{-1}), Severe (26 – 50 t ha^{-1} yr^{-1}), and Extreme Severe (>50 t ha^{-1} yr^{-1}). This classification scheme closely aligns with the ranges adapted in previous studies by

Ganasri and Ramesh (2016) and Karan et al. (2019). The detailed classification is presented in Table 5.10. A substantial portion of the study area, about 74.46%, is approximately 1057.51 ha falls under the Very Low erosion class, suggesting minimal soil degradation. This is followed by 1.90% (26.92 ha) in the Low erosion class, and 6.20% (88.10 ha) in the Moderate erosion category. The areas experiencing Severe and Extreme Severe erosion are relatively limited, covering 6.88% (97.67 ha) and 10.56% (149.99 ha), respectively, as shown in Fig.5.4.

Table 5.10: Distribution of soil loss in Cluster-III area in hectares

Soil loss (tons ha^{-1} year^{-1})	Class	Area %	Area (hectare)
0-5	Very Low	74.46	1057.51
6-10	Low	1.90	26.9229
11-25	Moderate	6.20	88.1031
26-50	Severe	6.88	97.6737
>50	Extreme Severe	10.56	149.999
	Total =1420.20 ha		

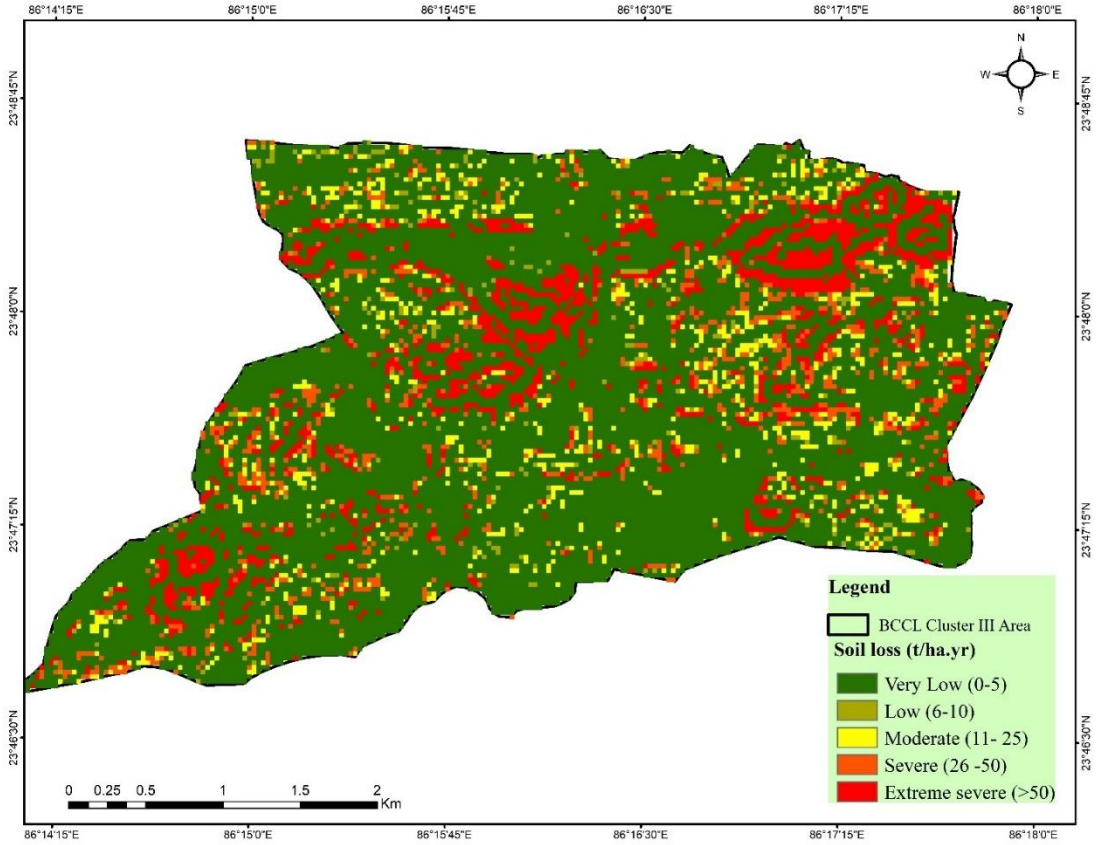


Fig. 5.4: Distribution of annual soil loss (tons ha^{-1} year^{-1}) in the Cluster III area of BCCL

5.4 Conclusion

Based on the Erosion Potential Index (EPI) and soil loss estimations, the Cluster-III area exhibits varying degrees of erosion vulnerability. The accurate estimation and spatial mapping of these zones are essential for prioritizing conservation efforts and implementing sustainable land and watershed management strategies. Approximately 25.43% (361.08 ha) of the Cluster-III area falls under the low erosion potential category (EPI: 3.0–3.38), indicating relatively stable regions with minimal risk of soil erosion. A significant portion, 42.66% (605.81 ha), is classified under the moderate EPI zone (EPI: 3.39–3.75), requiring targeted soil conservation interventions. About 28.74% (408.22 ha) of the total study area is in the high EPI zone, and 3.17% (45.08 ha) is in the very high EPI zone (EPI > 4.12), indicating the most vulnerable regions with high risk of soil erosion.

Regarding soil loss, a substantial 74.46% (1057.51 ha) of the Cluster-III area falls under the very low soil loss category (0-5 tons/hectare/year), suggesting minimal soil degradation and relatively stable regions. The low soil loss category (6-10 t ha^{-1} yr^{-1}) accounts for 1.90% (26.92 ha) of the area. Moderate soil loss (11-25 t ha^{-1} yr^{-1}) is observed in 6.20% (88.10 ha) of the area, necessitating targeted soil conservation interventions. Areas experiencing severe (26-50 t ha^{-1} yr^{-1}) and extremely severe (>50 t ha^{-1} yr^{-1}) erosion are relatively limited, covering only 6.88% (97.67 ha) and 10.56% (150 ha) area of the Cluster-III area respectively.

Critical observations reveal that the northern, north-western, and south-eastern regions of the basin exhibit the highest EPI values, indicating these areas are most vulnerable to erosion due to a combination of topographic and land-use factors. As expected, areas near natural drainage lines and overburden showed elevated erosion potential, confirming that runoff concentration significantly impacts sediment transport and erosion. These findings provide spatially explicit information on high-risk areas, thus supporting targeted soil and water conservation interventions within the watershed of the Cluster-III area. This aligns with the study's aim to provide information that assists in implementing sustainable land and watershed management strategies.

Chapter 6: Site Suitability Analysis for Conservation Structures in Watersheds under Cluster-III Area, BCCL

6.1 Introduction

Effective watershed management is contingent upon the strategic placement of conservation structures to mitigate hydrological extremes, enhance water availability, and promote sustainable land utilization. The Cluster-III of Govindpur area in the Jharia Coalfield regions are affected by mining and require proper water management to reduce land degradation, conserve soil, and enhance the water availability for the local commodities. One of the most effective ways to achieve this is by constructing the conservation structures i.e., check dams, farm ponds, and contour bunds. However, the success of these structures largely depends on selecting the most suitable locations based on physical and environmental factors. This chapter focuses on identifying the best locations for conservation structures within the watersheds of Cluster-III, using a scientific and spatial approach. The analysis is based on multiple criteria such as slope, land-use land cover, soil type, drainage density, flow accumulation, runoff potential, and soil erosion risk.

The study uses an integrated method combining Geographic Information System (GIS) and the Analytical Hierarchy Process (AHP) to evaluate and prioritize potential sites. GIS helps to process and visualize spatial data, while AHP provides a way to assign importance (weights) to each factor based on expert judgment and literature. The site suitability map highlighting the expected suitable areas for the construction of conservation structures will be the main outcome of the present chapter.

Applying this approach, the study aims to support better planning and implementation of water conservation efforts in the mining-affected landscape. This will improve local water resources and contribute to sustainable development and environmental restoration in the Cluster-III area.

6.2 Materials and Methodology

The methodological framework adapted for this study is depicted in Fig. 6.1. It comprises several sequential stages: data acquisition & preparation, derivation of thematic layers corresponding to the selected parameters, assignment of weights using AHP, and finally, integrating these layers through a weighted overlay analysis to generate the final site suitability map.

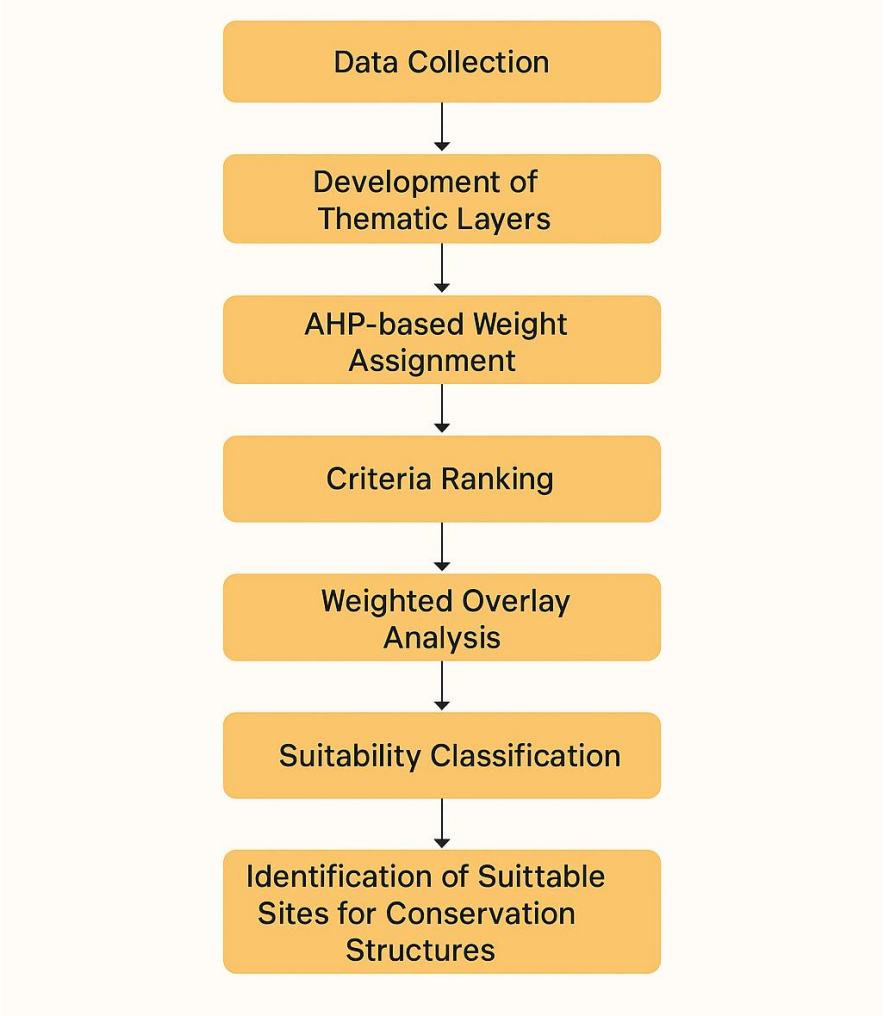


Fig. 6.1: A detailed flowchart illustrating the methodology for site suitability analysis

6.2.1 Data Acquisition and Preparation

Planet satellite data of 12th April 2025 was obtained from PlanetScope archive of European space agency (https://earth.esa.int/eogateway/missions/planetscope, accessed: 13th May 2025). The study area covers approximately 80 km², hence a single scene was downloaded to cover the entire study area. Captured image with a ground sampling distance (GSD) of 3.9 m, the image exhibits 100% clear sky conditions with no cloud, haze, or shadow interference, ensuring high-quality

visual data. CartoSat-1_PAN_CartoDEM-30m is the Digital Elevation Model (DEM) data of the study area that was downloaded from the Indian Space Research Organization's (ISRO) Bhoonidhi portal (http://bhoonidhi.nrsc.gov.in/data/download/index.php, accessed 12th May 2025). However, daily gridded rainfall data of 10 years (2015 - 2024) of the study area (Cluster-III) was taken from 9395 grid cell number of IMD of high spatial resolution (0.25×0.25 degree). Soil data were obtained from State Agricultural Management & Extension Training Institute (SAMETI), Jharkhand (https://www.sameti.org/Soil_Inventory/Dhanbad_Soil_Analysis.pdf, accessed on 12th May 2025). All datasets were projected to a standard coordinate system (UTM Zone 45 WGS 84) and resampled to a uniform spatial resolution to ensure geometric consistency for the overlay analysis.

6.2.2 Thematic Layer Generation and Parameter Influence

The selection of parameters was done on their established influence on hydrological and geomorphological processes pertinent to water conservation. Eight key parameters were identified, and their corresponding thematic layers were generated within the ArcGIS environment. The rationale for their inclusion is detailed in Table 6.1.

Table 6.1: Parameters for Site Suitability Analysis and their Hydro-geomorphological Influence

Parameter	Influence on Site Suitability for Conservation Structures
Slope	Governs runoff velocity, soil erosion potential, and the engineering feasibility of water impoundment. Gentle slopes are preferred to facilitate greater retention time and reduce construction costs.
Land-use/Land Cover (LULC)	Determines the rainfall-runoff coefficient. Barren and agricultural lands generate higher runoff than forested areas, making them priority zones for intervention.
Soil Texture	Controls infiltration rates and water holding capacity. Loamy and clayey soils with lower permeability are more suitable for water storage structures than sandy soils.
Drainage Density	Represents the total length of streams per unit area. Higher drainage density indicates a well-developed drainage network and concentrated surface flow, offering potential impoundment sites.

Flow Accumulation	A proxy for the volume of upstream water that would flow to a given point. Areas with moderate to high flow accumulation are ideal for capturing significant quantities of runoff.
Distance from Stream	Proximity to existing drainage channels is critical for building structures like check dams. Locations closer to streams are more suitable for intercepting and storing channel flow.
10-Year Surface Runoff	Represents the estimated surface runoff for a 1-in-10-year rainfall event. This hydrological parameter directly quantifies the water yield potential, with higher runoff zones being prime targets.
Soil Erosion Zones	Identifies areas with high rates of soil loss. Placing structures in these zones serves a dual purpose of water conservation and critical soil stabilization.

6.2.3 Factor Reclassification and Standardization

To facilitate a comparative analysis, each thematic layer was standardized onto a standard five-point numerical scale, ranging from 1 (Very Low Suitability) to 5 (Very High Suitability). The classification thresholds were established based on the existing literatures, standard hydrological guidelines, and expert judgment specific to the agro-ecological conditions of the study region. The reclassification scheme is detailed in Table 6.2.

Table 6.2 Reclassification Criteria and Suitability Scores for Thematic Layers

Parameter	Class/Range	Suitability Score	Suitability Class
Slope (%)	>15	1	Very Low
	10 – 15	2	Low
	5 – 10	3	Moderate
	2 – 5	4	High
	0 – 2	5	Very High
Land-use/Land Cover (LULC)	Forest/Water Body	1	Very Low
	Built-up Area	2	Low
	Scrubland	3	Moderate
	Fallow Land	4	High
	Agricultural Land	5	Very High
Soil Texture	Sandy	1	Very Low
	Sandy Loam	2	Low
	Clay / Silty Clay	3	Moderate
	Clay Loam	4	High
	Loam / Silty Loam	5	Very High
Drainage Density (km/km^2)	0 – 0.5	2	Low
	0.5 – 1.5	5	High
	>1.5	3	Moderate
	<500	1	Very Low

Flow Accumulation (cells)	500 – 1000	3	Moderate
	>1000	5	High
Distance from Stream (m)	>300	1	Low
	100 – 300	3	Moderate
	0 – 100	5	High
10-Year Surface Runoff (mm)	Low Runoff (<100 mm)	2	Low
	Medium Runoff (100–250 mm)	4	High
	High Runoff (>250 mm)	5	Very High
Erosion Potential Index (EPI)	3.00 -3.38	1	Very Low
	3.39-3.75	3	Moderate
	3.76-4.12	4	High
	>4.12	5	Very High Priority

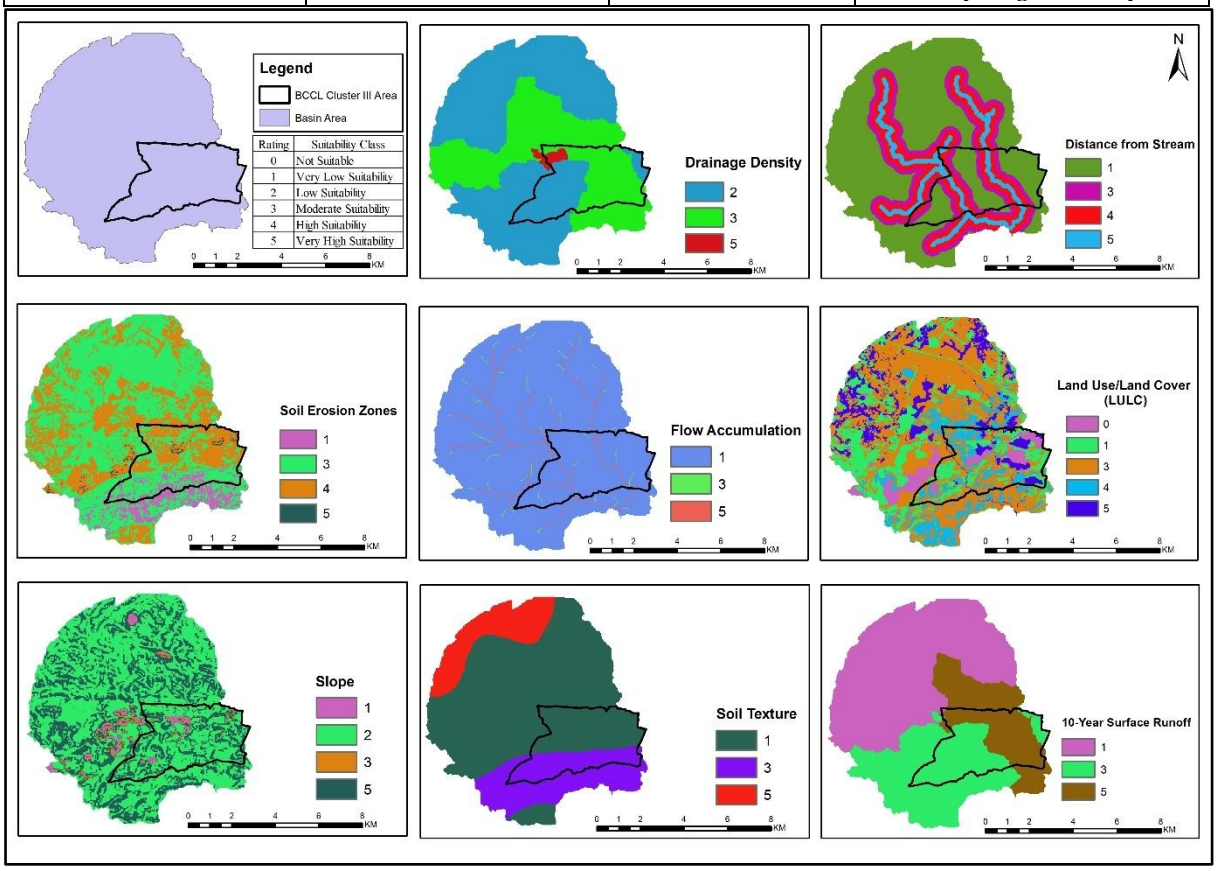


Fig. 6.2: Thematic Layers Used for Site Suitability Analysis in BCCL Cluster-III Watershed Region

6.2.4 Weight Assignment Using Analytical Hierarchy Process (AHP)

The determination of the relative importance of each parameter is a critical step that significantly influences the outcome of the analysis. The AHP, a multi-criteria decision-making technique developed by Saaty (1980), was employed for this purpose. The process involved constructing a pairwise comparison matrix where

each parameter was compared against every other parameter based on a 5-point scale of relative importance. The consistency of these judgments was evaluated by calculating the Consistency Ratio (CR) (Eq. 6.1).

$$\boldsymbol{CR = \frac{CI}{RI}} \quad \textbf{…….. (Eq. 6.1)}$$

Where, CI is the Consistency Index and RI is the Random Inconsistency Index.
A CR value of less than 0.10 indicates an acceptable level of consistency in the pairwise judgments. For this study, the calculated CR value was 0.021, which is well within the acceptable threshold, validating the robustness of the derived weights. The final normalized principal eigenvectors, representing the weights of the parameters, are presented in Table 6.3.

Table 6.3: Final Weights of Parameters Derived from AHP

Parameter	Weight (%)
Slope	27
Land-use/Land Cover (LULC)	15
Soil Texture	11
Drainage Density	15
Flow Accumulation	9
Distance from Stream	5
10-Year Surface Runoff	10
Soil Erosion Zones	8
Total	100

Table 6.4: AHP matrix for assigning weight to site suitability analysis.

Criteria	Slope	LULC	Soil Texture	Drainage Density	Flow Accumulation	Distance from Stream	Surface Runoff	Soil erosion
Slope	1	2	3	2	4	5	3	2
LULC	0.5	1	2	1	2	3	2	2
Soil Texture	0.33	0.5	1	1	2	2	1	1
Drainage Density	0.5	1	1	1	2	3	2	2
Flow Accumulation	0.25	0.5	0.5	0.5	1	2	1	1

Distance from Stream	0.2	0.33	0.5	0.33	0.5	1	0.5	0.5
Surface Runoff	0.3	0.5	1	0.5	1	2	1	2
Soil Erosion	0.5	0.5	1	0.5	1	2	0.5	1

6.2.5 Weighted Overlay Analysis

The final stage involved integrating the reclassified thematic layers using the weighted overlay tool in GIS. The suitability index (S) for each pixel was computed by summing the product of the reclassified raster value (suitability score) and its corresponding AHP-derived weight for each parameter (Eq. 6.2).

$$S = \sum_{i=1}^{n} (W_i \times C_i) \quad \text{..... (Eq. 6.2)}$$

Where, S = Final suitability index; W_i = Weight of the i^{th} parameter; C_i = Reclassified suitability score of the i^{th} parameter; and n = Total number of parameters.

The resulting composite suitability index values were then grouped into four final suitability classes: Very Low, Low, Moderate, and High. No areas with Very High suitability were identified across the region.

6.3 Results and Discussion

The application of the weighted overlay analysis yielded a final site suitability map for the Cluster-III watershed region, as depicted in Fig. 6.3. The produced map delineates the distinct zones of suitability for implementing soil and water conservation structures.

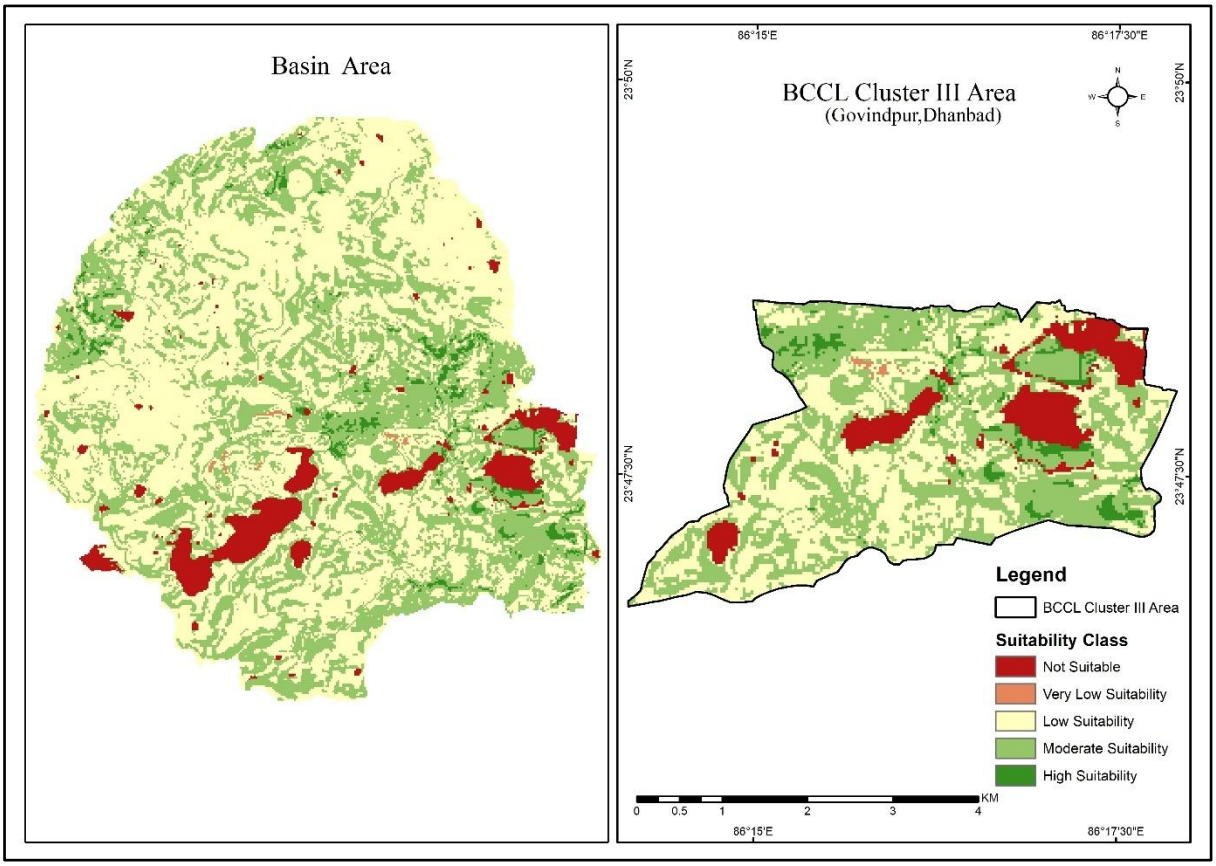


Fig. 6.3: The final Site Suitability Map for Conservation Structures in Cluster-III Watershed

6.3.1 Spatial Distribution of Suitability Classes

The weighted overlay analysis, conducted using 30 m spatial resolution raster data across eight thematic layers, categorized the watershed into four suitability classes for the implementation of conservation structure. The classification reflects the integrated influence of slope, land use/land cover, soil texture, flow accumulation, drainage characteristics, proximity to streams, runoff potential, and erosion vulnerability.

The spatial distribution of suitability classes within the Cluster III Area is as follows:

- **Not Suitable (Value 0):** 11.26% (1,776 pixels; 159.84 ha), mainly comprising built-up areas and water bodies that are excluded from final intervention planning.
- **Very Low Suitability (Value 1):** 0.26% (41 pixels; 3.69 ha)
- **Low Suitability (Value 2):** 40.38% (6,368 pixels; 573.12 ha)
- **Moderate Suitability (Value 3):** 44.15% (6,963 pixels; 626.67 ha)

- **High Suitability (Value 4):** 3.96% (624 pixels; 56.16 ha)

The 'Moderate' and 'Low' suitability zones constitute most of the watershed, indicating the presence of moderately favourable terrain and hydrological conditions, which may be improved through engineered interventions. The 'High Suitability' zones, covering approximately 4% of Cluster III, are regarded as top-priority areas for conservation interventions, such as check dam or contour bund construction, based on their favourable site characteristics. The 'Very Low' and 'Not Suitable' zones collectively account for ~11.5 % of the area, primarily due to steep slopes, mining area, settlements, or permanent water coverage, and thus, were excluded from physical intervention recommendations.

6.3.2 Delineation of Priority Zones

The analysis identified that zones classified as 'High' suitability closely correspond with biophysical conditions favourable for water conservation interventions. These priority areas are primarily characterized by gentle slopes (0 – 5%), loamy soil textures, and land-use types such as agriculture or fallow land, which enhance their potential for surface water harvesting, infiltration, and trapping of the sediments. Spatially, these zones are aligned with regions of moderate to high flow accumulation and are located near natural drainage lines. Furthermore, these areas demonstrate high 10-year surface runoff potential and moderate to high vulnerability to soil erosion. This combination of factors confirms their strategic suitability for conservation structures to improve water availability and stabilize soil in the mining-impacted Cluster-III region.

6.3.3 Identification and Validation of Intervention Sites

Based on the suitability model and subsequent field validation, specific sites for two types of conservation structures were identified.

Check Dams (CDs): Three strategic locations were identified through the analysis. The model's predictive accuracy was confirmed, as two sites (CD1 and CD2) coincided with existing check dams. The third site (CD3) was in a high-priority zone with substantial runoff convergence and favourable biophysical conditions. However, field investigations revealed that this location (CD3) is unsuitable for the

construction of a Check Dam because of active coal mining activities. Fig. 6.4 shows an overview of all the identified and existing Check Dam sites. Fig. 6.5 presents the detailed spatial context and surroundings of the CD3 location.

Contour Bunding / Retaining wall (CB): Four locations were identified as suitable for contour bunding, which functions as retention wall along natural slope. These structures intercept & slow down the velocity of surface runoff and prevent erosion of soil and overburden material. In mining-impacted areas, retention walls also act as barriers to stabilize loose overburden dumps, control gully formation, and reduce sedimentation in nearby streams and reservoirs. Thus, they play a dual role, conserving soil moisture for agriculture and supporting slope stabilization in mine reclamation efforts.

Field verification was done to verify the model outputs that led to the following site-specific recommendations:

- **CB1:** New bund construction is strongly recommended at this site. Field inspection revealed concentrated runoff and significant erosion risks impacting the adjoining Bagdighi Nala. A retention wall of approximately 850 meters in length is proposed to stabilize the soil, enhance water conservation and to minimize erosion potential.
- **CB2:** Although, this site was identified as suitable during the analysis but, this site is located near active mining and overburden dumps. Any constructed bund at this site may be destabilized due to the existing mining activities as the mining operations are progressing towards the proposed site located at CB2. Thus, the site CB2 is unsuitable for constructing contour bund.
- **CB3:** An existing bund of approximately 450 meters was observed at this site, validating the model's prediction. However, reinforcement and possible extension are recommended to improve its effectiveness and ensure long-term stability.
- **CB4:** Partial bunding of approximately 250 meters already exists at this location, further validating the model's output. It is recommended that the

bund be strengthened and extended by an additional 150 meters to provide enhanced protection against erosion and overburden movement.

Fig. 6.6 to Fig. 6.9 present detailed spatial views of the four contour bunding sites. Collectively, these interventions are expected to minimize soil erosion, stabilize mine dumps, reduce overburden failures, and enhance land productivity in the Cluster-III watershed.

Table 6.4: Identified Locations for Check Dams and Contour Bunding in Cluster-III Watershed Region

Sites Name	Latitude	Longitude
Check Dams (CD)		
CD1	23°48'21.35"N	86°16'21.20"E
CD2	23°47'5.29"N	86°15'45.48"E
CD3	23°47'26.96"N	86°17'2.33"E
Contour Bunding (CB)		
CB1	23°47'15.88"N	86°17'14.74"E
CB2	23°48'13.05"N	86°17'18.57"E
CB3	23°47'48.21"N	86°16'39.37"E
CB4	23°48'13.47"N	86°16'20.12"E

6.3.4 Interpretation and Implications

The spatial distribution of identified intervention sites highlights the strong influence of critical factors such as 10-year surface runoff and soil erosion potential, which carried higher weights in the AHP framework. These parameters guided prioritization towards zones with high water yield and urgent stabilization needs. The use of AHP ensured that decision-making was scientifically embedded in the spatial model, producing results that are not only robust but also management-relevant. The suitability map and identified intervention points provide actionable guidance for implementing climate-resilient water conservation structures in a mining-impacted environment.

In particular, the identification of retention wall sites underscores their importance in mining reclamation and watershed management. By reducing runoff velocity, enhancing infiltration, and stabilizing overburden dumps, retention walls reduce erosion hazards while improving agricultural productivity. Their effectiveness in controlling sediment transport also supports downstream ecosystem health.

Thus, the combined implementation of check dams and retention walls offers a synergistic approach to land restoration, mine reclamation, and sustainable watershed development in the Cluster-III region.

6.4 Conclusion

This chapter demonstrated the effectiveness of an integrated GIS–AHP-based methodology for robust site suitability analysis of water conservation structures in a mining-impacted watershed. By systematically evaluating eight critical biophysical parameters, the study produced a spatially explicit and quantitative decision-support tool, moving beyond generalized recommendations. The results were further validated in the field, enhancing confidence in the model outputs. For check dams, two existing sites (CD1 and CD2) were accurately captured, while a new site (CD3) was proposed at a high-priority runoff-convergent zone. But field visit confirmed that construction of check dam at location CD3 is not possible due to active coal mining activities and other mining operation difficulties. For contour bunding/retention walls, the model identified four suitable sites, which were refined through field observations. A new contour bund construction at location CB1 with approximate length of 850 m has been proposed and two existing bunds located at CB3 and CB4 have been recommended for strengthening and extending the length. The model based identification of location for contour bund at CB2 was found unsuitable as the mining activities are progressing towards to proposed site.

The strong consistency of the AHP model (CR = 0.021) underscores the reliability of the analysis. More importantly, the incorporation of retention walls adds a critical dimension to watershed management in mining regions, as they simultaneously serve soil conservation, slope stabilization, and mine land reclamation functions. In conclusion, the suitability analysis provides a scientifically grounded, field-validated, and policy-relevant framework for the planning and implementation of

water conservation structures in the Cluster-III watershed. These findings form a crucial input for subsequent phases of research, including detailed hydrological modelling and impact assessment of the proposed interventions.

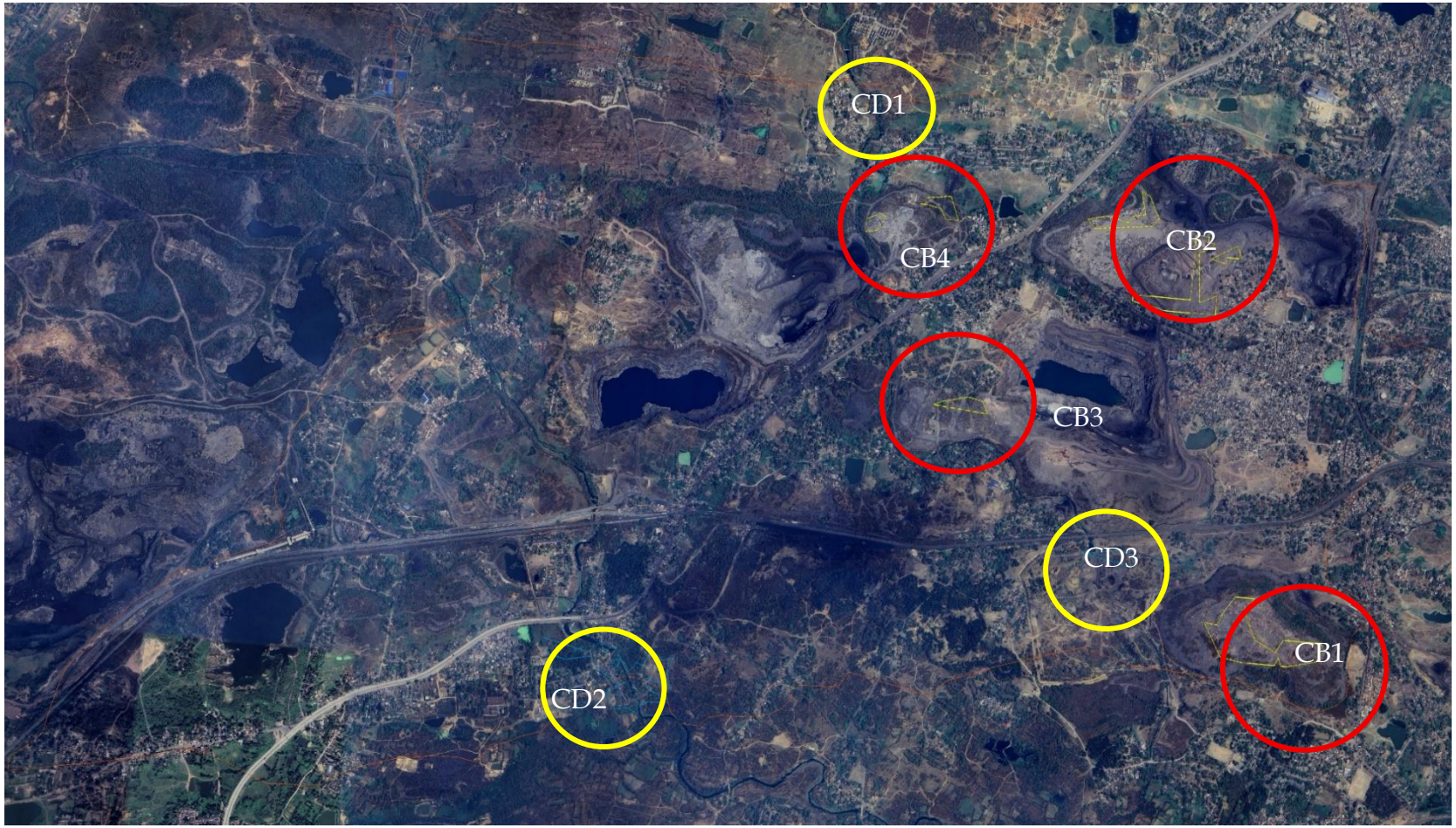


Fig. 6.4: Overall site suitability map showing locations of conservation structures (CD1–CD3 and CB1–CB4)

Fig. 6.5: Detailed location of the initially proposed Check Dam site CD3 (excluded due to existing coal mining activities)

Fig. 6.6: Detailed location of the proposed Contour Bund site CB1

Fig. 6.7: Detailed location of the initially proposed Contour Bund site CB2 (excluded due to proximity to active mining and overburden dumping).

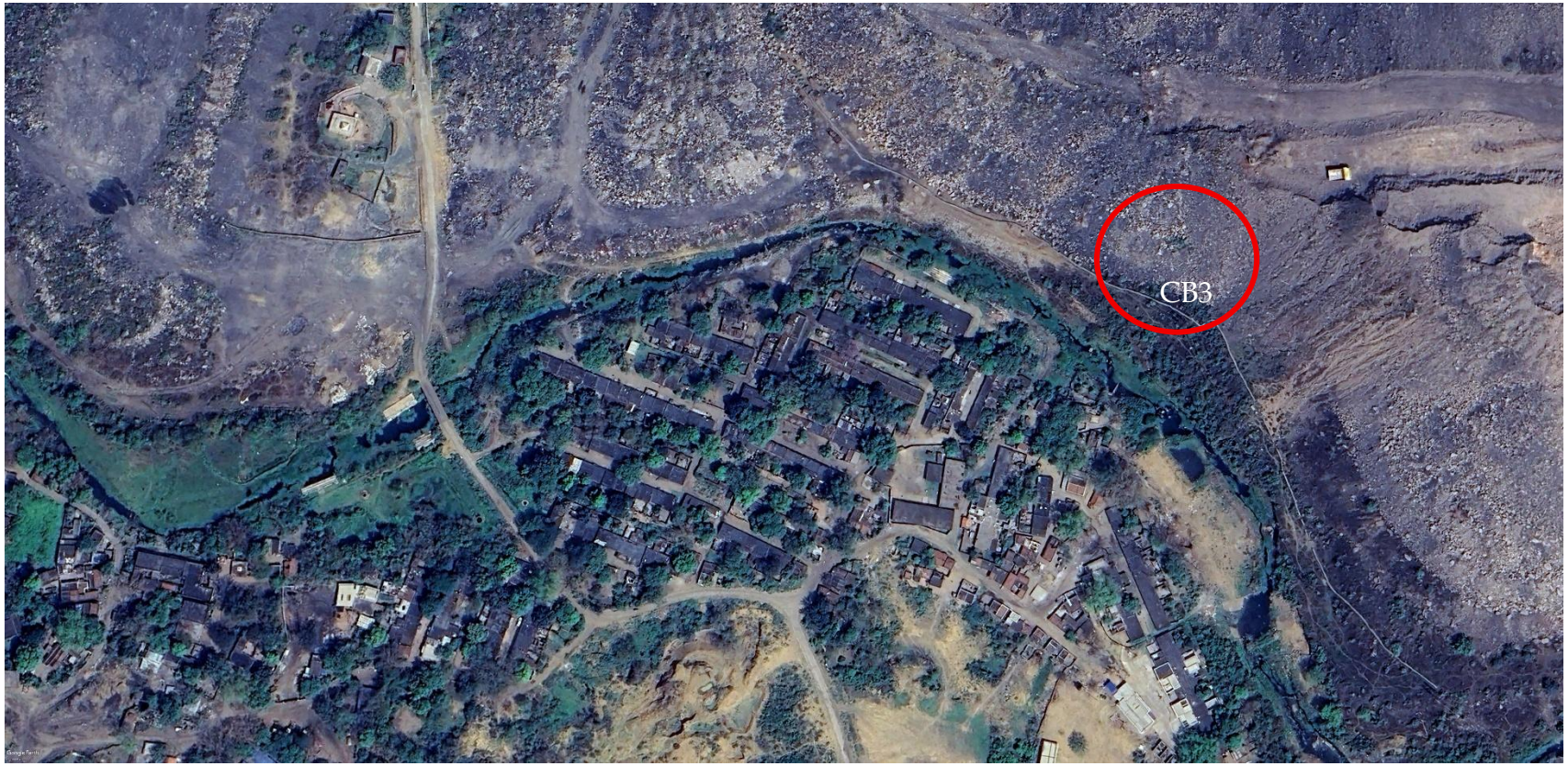


Fig. 6.8: Detailed location of the existing Contour Bund site CB3 (with recommended reinforcement and extension).

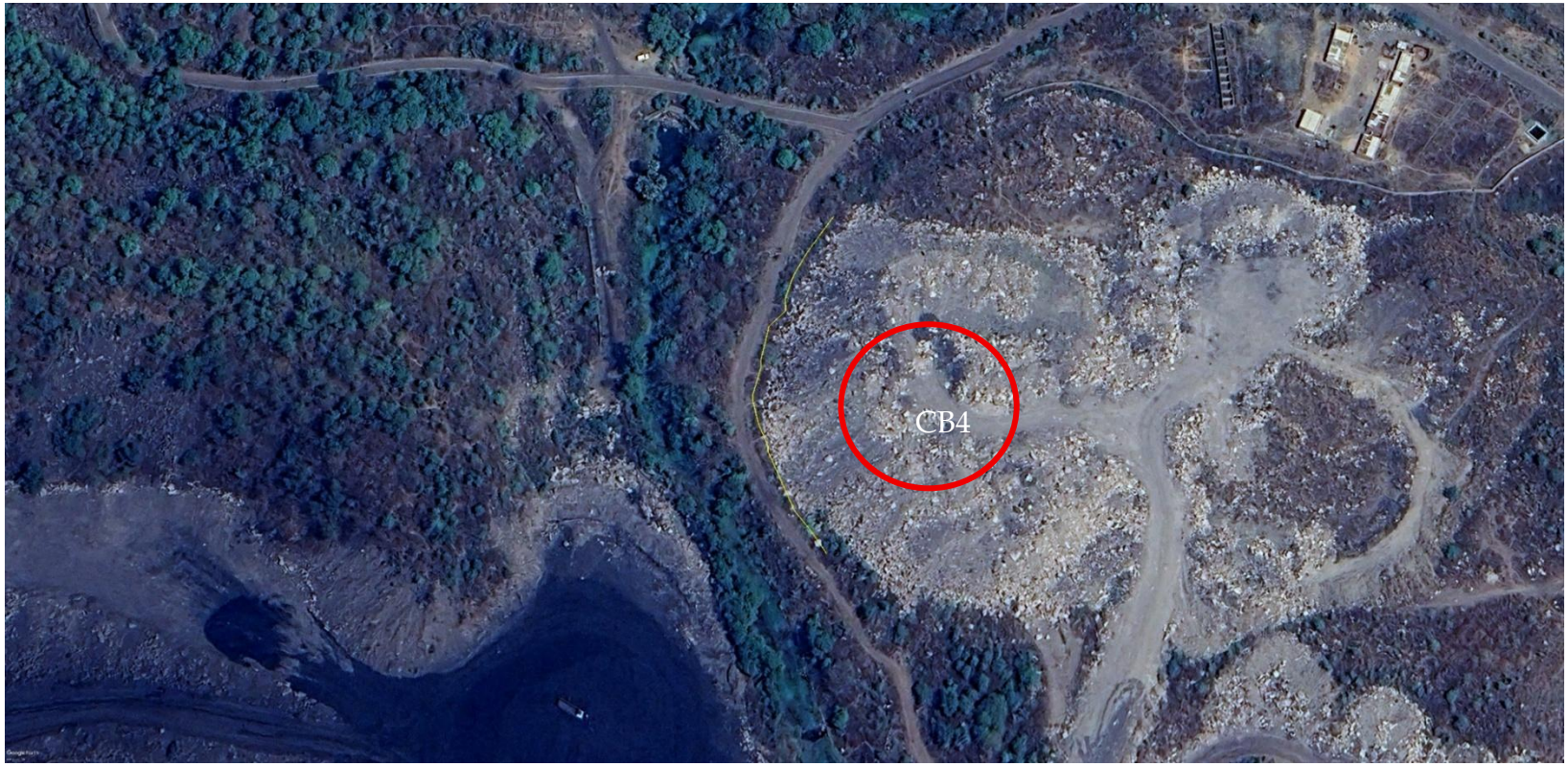


Fig. 6.9: Detailed location of the partially existing Contour Bund site CB4, identified for reinforcement

Chapter 7: Identification of Suitable Locations for Plantation in Different Watershed Regions at Cluster-III (BCCL, Govindpur Area)

7.1 Introduction

The Cluster-III region of BCCL, located in the Govindpur Area of Jharkhand, has experienced significant ecological degradation due to decades of coal mining operations. The large-scale excavation, removal of topsoil, formation of overburden dumps, and exposure of sub-surface geological strata have led to disruption of the natural landscape. This disturbance has significantly altered the hydrological balance and increased the area's vulnerability to soil erosion and uncontrolled surface runoff with sediment. The consequences are particularly pronounced during monsoon season, when the absence of adequate vegetation and poor surface retention exacerbate sediment transport and slope instability.

The existing Land use and Land Cover (LULC) patterns indicate a significant presence of degraded land types, including barren land, exposed overburden dumps, fallow areas, and sparsely vegetated regions. The absence of adequate vegetative cover in these areas has critical implications, as vegetation plays a key role in intercepting rainfall, stabilizing soil particles, minimizing soil erosion, and enhancing groundwater recharge. This degradation highlights the urgent need for sustainable, nature-based interventions, particularly afforestation and plantation initiatives, as essential bioengineering strategies for ecological restoration and landscape stabilization.

The decision to introduce plantation interventions arises directly from the need to stabilize slopes, reduce raindrop impact on bare soil, enhance infiltration, and limit sediment transport. Vegetation not only provides a protective ground cover but also contributes to long-term ecological recovery. Plantation, in combination with structural interventions such as contour bunding and check dams, forms a holistic watershed management strategy. Contour bunding reduces runoff velocity and promotes in-situ moisture conservation on undulating terrain, while check dams help in controlling

gully erosion, reducing downstream sedimentation, and facilitating groundwater recharge.

Empirical analysis of erosion dynamics based on the Erosion Potential Index (EPI) further validates the need for conservation interventions. Approximately 25.43% of the study area (361.09 ha) falls under the low erosion potential category, while a significant area of 42.66% (605.81 ha) is classified as moderate, and 28.74% (408.23 ha) as high. Additionally, about 3.17% (45.08 ha) of the area is under very high erosion risk, primarily concentrated near overburden dumps, natural drainage lines, and steep slopes. The soil loss pattern clearly indicates that topographic and anthropogenic factors are intensifying localized zones of severe to extremely severe erosion, necessitating immediate mitigation strategies such as vegetative barriers, check dams, and slope stabilization.

To identify Suitable Locations for Plantation in different watersheds, a GIS-based Analytic Hierarchy Process (AHP) model was developed, integrating eight key biophysical criteria such as slope, soil type, LULC, proximity to drainage, and erosion risk. The model produced a spatially explicit suitability map, validated with a high consistency ratio (CR = 0.021), enabling data-driven prioritization of restoration sites.
In this chapter, identification of the suitable sites for tree plantation within the watersheds of Cluster-III Area is systematically presented. A plantation suitability map has been developed using spatial analysis techniques, providing a scientifically grounded basis for site selection. This map is intended to function as a strategic tool to support planning and policy decisions, particularly in the context of integrated watershed management. By guiding the implementation of nature-based solutions, such as afforestation, the map contributes to ecological restoration and landscape stability. Furthermore, while the present focus is on plantation suitability, it forms an integral part of a broader watershed management framework. In this context, complementary interventions including contour bunds and check dams are also essential, and their technical details and spatial planning are elaborated in Chapter 6.

7.2 Materials and Methodology

The methodological framework adapted in this study, as illustrated in Figure 7.1, follows a structured and sequential approach integrating Geographical Information Systems (GIS) with the AHP based Multi-Criteria Decision Making (MCDM) technique. This approach was employed to identify optimal sites for plantation-based bioengineering interventions in the erosion-prone watersheds of Cluster-III, with the overarching objective of minimizing soil erosion and enhancing landscape resilience. The process originated with the acquisition and preprocessing of relevant spatial datasets, viz., slope, LULC, soil type, erosion potential zones, and drainage distance. These steps have already been described in detail in Chapter 6, Section 6.2.1, and serve as the foundational input for this stage of analysis. From these datasets, thematic layers were derived for each biophysical parameter, representing their spatial variation across the study area.

Each thematic layer was then reclassified and ranked according to its relative influence on plantation suitability. AHP was applied to construct a pairwise comparison matrix, facilitating the derivation of normalized weights based on expert judgment. To ensure logical consistency, the consistency ratio (CR) was computed and verified to be within acceptable limits. Subsequently, the weighted overlay analysis (WOA) was performed in the GIS environment, integrating the reclassified layers using the derived weights to produce a composite plantation suitability map. To validate the reliability of the output, an accuracy assessment was undertaken using actual field data.

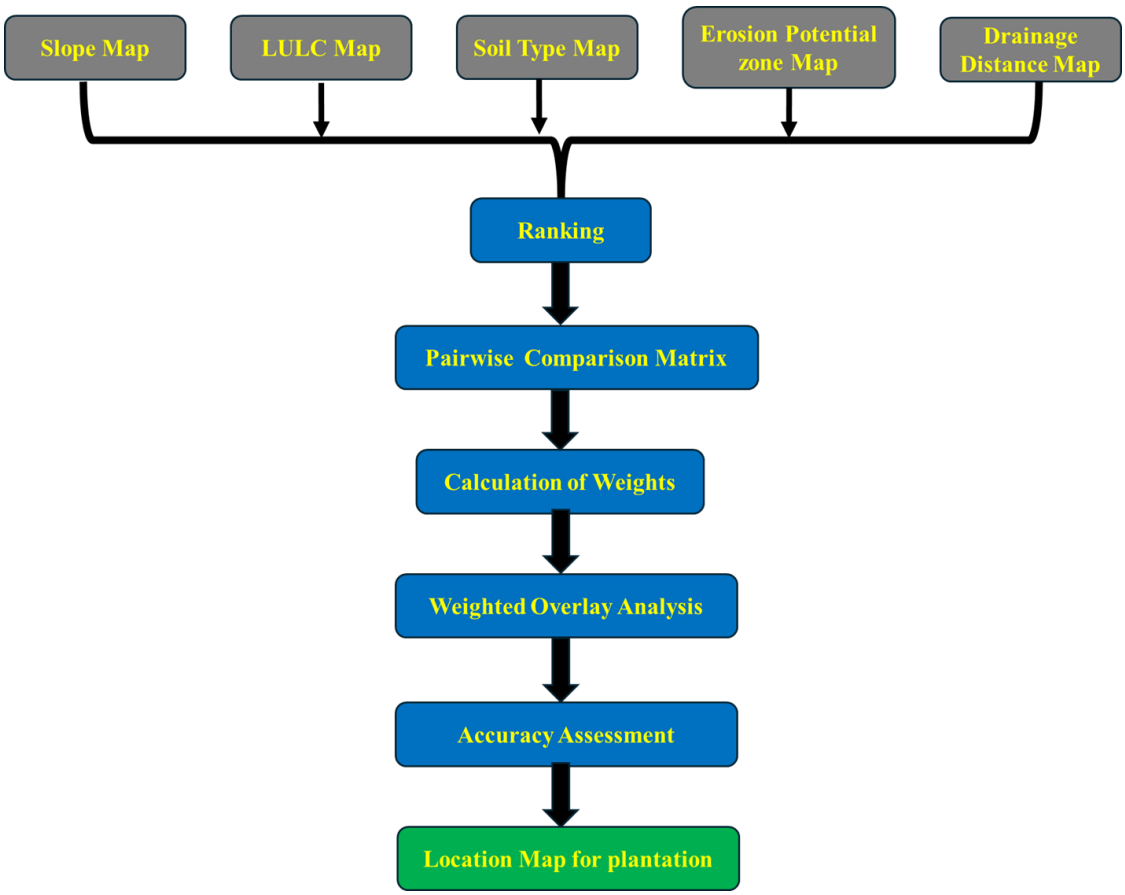


Fig. 7.1: Methodology adapted for locating suitable sites for plantation

7.2.1 Thematic Layer Generation and Parameter Influence

Five key biophysical parameters, namely slope, soil type, LULC, drainage distance, and erosion potential, were selected as primary criteria for the spatial analysis using the WOA technique. These parameters were identified based on their critical influence on plantation success and their direct association with soil erosion dynamics and hydrological processes, particularly within a mining-impacted landscape. Each parameter was spatially represented through thematic mapping and subsequently reclassified into discrete suitability classes with AHP-derived scores (ranging from 1 to 5) assigned to their respective sub-categories to reflect relative suitability and presented in Fig. 7.2; where, 1 indicates low suitability and 5 indicates high suitability. The rationale for the selection of each parameter is summarized in Table 7.1, while the associated scoring and reclassification criteria are summarized in Table 7.2.

7.2.1.1 Slope

Slope is a pivotal topographic factor controlling runoff intensity, erosion risk, and planting feasibility. Gentle slopes promote infiltration and enhance plantation viability due to reduced runoff velocity, enhanced moisture content, and increased soil stability. Conversely, steeper slopes are associated with increased runoff energy, less moisture content, and reduced soil stability, posing greater challenges for plantation establishment and success.

For this study, slope gradients were derived from a 30-meter resolution CartoDEM (CartoSat-1) dataset. The continuous slope data was categorized into five suitability classes, reflecting the ease of planting and erosion control potential across varying slopes. AHP ratings, ranging from 1 (very low suitability) to 5 (very high suitability), were assigned to each class.

7.2.1.2 Soil Type

Soil type plays a vital role in determining the suitability of an area for plantation due to its direct influence on crucial factors such as water retention, aeration, and nutrient availability and all these factors are essential for healthy plant growth and survival. Based on the SAMETI soil dataset, the study area's soil was categorized into two predominant textural classes, viz., Loam and Sandy Clay Loam. In the present study, Loam soil was assigned the highest AHP suitability rating of 5, indicating its very high suitability for plantation. This is primarily attributed to its optimal balance of sand, silt, and clay, which collectively support root development, superior moisture retention capacity, and adequate aeration. Sandy Clay Loam received a suitability rating of 3, signifying moderate suitability due to its comparatively lower water-holding capacity and reduced nutrient availability (FAO, 2006; Brady & Weil, 2016). The AHP ratings represent suitability scores assigned to each soil textural class based on their inherent properties to support successful plantation and growth.

7.2.1.3 Land-use Land Cover (LULC)

LULC is an important parameter for site suitability analysis as it provides insights into the existing land condition, human activity, and inherent potential for ecological restoration. AHP suitability ratings were assigned to each LULC class based on its appropriateness as a target for new plantation interventions aimed at rehabilitation and erosion control. Non-vegetated or built-up features, such as Water bodies, Railways, Nala, Village Road, National Highways, and Settlements, were assigned a very low suitability score of 1, as they are restricted areas where plantation is not possible. Agricultural lands were similarly rated low (1) to avoid disrupting their productive use. The existing vegetation on overburden dumps was also assigned a very low suitability rating of 1 for a new plantation, as these areas are already under some form of rehabilitation and are not primary targets for additional interventions.

Conversely, degraded lands requiring urgent rehabilitation were assigned high suitability scores. Barren lands were assigned the highest suitability rating of 5, identifying them as prime targets for plantation due to their lack of vegetative cover and high erosion susceptibility. Mining areas, classified as severely disturbed and erosion-prone sites that exhibit a critical long-term need for restorative efforts, but mining areas were determined to possess very low suitability for immediate plantation due to ongoing mining activities. Overburden dumps, another significantly disturbed category, received a high suitability rating of 4. Areas with Sparse Vegetation and existing Vegetation were assigned moderate suitability ratings of 3, indicating potential for enrichment planting but lower priority for large-scale new plantations compared to severely degraded lands.

7.2.1.4 Drainage Distance

Proximity to drainage channels significantly affects plantation viability by influencing moisture availability and rooting conditions. In the present study, a 5-meter buffer on either side of drainage lines was excluded from plantation consideration due to high runoff concentration zones that may destabilize.

Beyond this buffer, the landscape was stratified into suitability zones based on proximity. Areas within 0 – 30 m (excluding the 0 – 5 m buffer) from drainage lines were rated very high (5), offering optimal moisture without erosion risk. Zones between 30 – 100 m were rated high (4), while 100 – 250 meters were rated moderate (3). Areas beyond 250 meters, where moisture support diminishes, were considered low suitability (1). This classification balances hydrological benefit with risk mitigation of plantation success.

7.2.1.5 Erosion Potential Zone

The EPI quantifies susceptibility to soil erosion and thus, guides prioritization for vegetative intervention. While low erosion areas present lesser risks, high erosion zones demand urgent stabilization through the plantation. Accordingly, areas with very high EPI values > 4.12 were assigned top suitability scores (5), reflecting their need for soil-binding vegetation. Conversely, low-risk areas with EPI < 3.38 were assigned lower suitability scores (1), as they are not immediate targets for erosion control. This logic ensures resource allocation is aligned with landscape vulnerability.

Table 7.1: Parameters for Site Suitability Analysis and their Influence on Plantation

Parameter	Influence on Plantation Suitability
Slope (Degree)	Governs surface runoff velocity and soil stability. Lower slopes (gentle terrain) enhance water infiltration and reduce erosion, promoting easier establishment and survival of planted vegetation. Higher slopes pose increased erosion risk and logistical challenges for the plantation.
Soil Type	Directly impacts plant growth and survival through its influence on water retention capacity, aeration, and nutrient availability. Optimal soil types (e.g., Loam) provide balanced conditions for root development and moisture supply.
Land Use/Land Cover (LULC)	Reflects the existing land condition and its degradation status. Degraded or barren lands (e.g., overburden dumps, barren lands) are highly susceptible to erosion and represent primary targets for rehabilitation through plantation.
Drainage Distance	Proximity to natural drainage lines ensures access to soil moisture, which is vital for plant establishment and growth, particularly during the periods other than the monsoon season. Closer proximity generally indicates higher suitability due to enhanced water availability.
Erosion Potential Index (EPI)	Quantifies the inherent susceptibility of an area to soil erosion. Higher EPI values indicate greater erosion risk, identifying critical zones where plantation interventions are most urgently required to stabilize soil and prevent further degradation.

Table 7.2: Reclassification Criteria and Suitability Scores for Thematic Layers

Parameter	Sub-Criteria	Class Name	Suitability Score (AHP Rating 1–5)
Slope	< 2 Degrees	Very High	5
	3 – 5 Degrees	High	4
	6 – 10 Degrees	Moderate	3
	10 – 20 Degrees	Low	2
	> 20 Degrees	Very Low	1
Soil Type	Loam	Very High	5
	Sandy Clay Loam	Moderate	3
Land Use/Land Cover (LULC)	Barren lands	Very High	5
	Overburden	High	4
	Sparse Vegetation	Moderate	3
	Waterbody including Nalla	Very Low	1
	Railways	Very Low	1
	Village Road	Very Low	1
	National Highways	Very Low	1
	Agricultural Land	Very Low	1
	Settlements	Very Low	1
	Plantation on Overburden	Very Low	1
	Mining	Very Low	1
Drainage Distance	0 – 30 m (excluding 0-5 m buffer)	Very High	5
	30 – 100 m	High	4
	100 – 250 m	Moderate	3
	> 250 m	Very Low	1
Erosion Potential Index (EPI)	> 3.50	Very High	5
	3.21 – 3.50	High	4
	2.91 – 3.20	Moderate	3
	< 2.90	Low	1

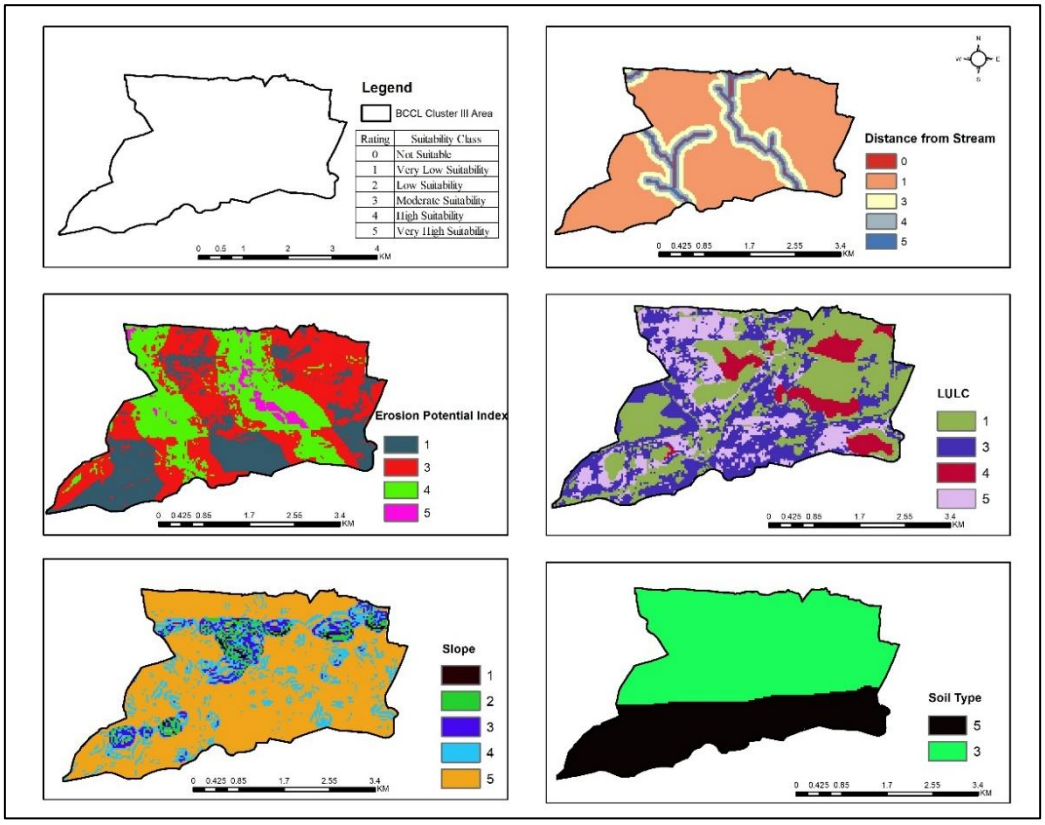


Fig. 7.2: Thematic Layers Used for Plantation Site Suitability Analysis in Cluster-III, Govindpur Area, BCCL

7.2.2 Weight Assignment Using AHP

The integration of thematic layers for plantation suitability analysis was enabled through the AHP, a structured multi-criteria decision-support technique used to derive criteria weights based on expert-driven pairwise comparisons. This methodological step builds upon the procedures described in Sections 6.2.4 and 6.2.5 of Chapter 6, where the construction of the AHP matrix and the operationalization of the WOA were previously outlined in detail.

In this chapter, five key thematic raster layers, slope, LULC, soil type, drainage distance, and erosion potential, were utilized to model plantation suitability. Each layer was first reclassified into discrete suitability classes and assigned a corresponding suitability score ranging from 1 (Very Low Suitable) to 5 (Very High Suitable), based on its influence on plantation success. These scores were then combined with AHP-derived criteria weights, which quantify the relative importance of each parameter as

determined through expert judgement. The complete pairwise comparison matrix and the resulting normalized weights for each parameter are presented in Table 7.3.

The integration of all weighted raster layers was conducted using the WOA tool in ArcGIS 10.2.2, which enables the normalization and aggregation of diverse spatial criteria onto a common evaluation scale. This technique is particularly effective for complex land suitability assessments in heterogeneous landscapes such as those influenced by coal mining activities.

To ensure comparability, all input rasters were standardized to the same scale (1 to 5), and each pixel value was multiplied by its corresponding criteria weight. The final Plantation Suitability Area (PSA) was computed through cell-wise summation of these weighted values using the Eq. 7.1.

$$\boldsymbol{PSA = \sum_{i=1}^{n} (W_i \times C_i)} \quad \textbf{..... (Eq. 7.1)}$$

Where, *PSA* = Final plantation suitability area, W_i = Weight of the ith parameter, C_i = Reclassified suitability score of the ith parameter, and, n = Total number of parameters. The resulting composite suitability index values were then grouped into five final suitability classes namely, Very Low, Low, Moderate, High, and Very High.

Table 7.3: AHP matrix for assigning weight to each parameter of PSA

Criteria	Land Use/Land Cover	Soil type	Slope (degree)	Erosion Potential Zone	Drainage Distance	Criteria Weight (CW)
Land Use/Land Cover	1	5	3	2	4	0.44
Soil type	0.2	1	2	1	2	0.17
Slope (degree)	0.33	0.5	1	1	2	0.14
Erosion Potential zone	0.5	1	1	1	2	0.17
Drainage Distance	0.25	0.5	0.5	0.5	1	0.08

7.3 Results and Discussion

The plantation suitability assessment was undertaken using the FAO land evaluation framework, integrated with a GIS-based multi-criteria evaluation approach. The Weighted Overlay Analysis (WOA), incorporating AHP-derived weights and parameter-specific scores, generated a spatially explicit Plantation Suitability Map (PSM) (Fig. 7.3). The final classification delineated the study area into five suitability categories: Very High, High, Moderate, Low, and Very Low. This stratification enables a prioritized ecological restoration strategy for degraded lands in the Cluster-III region.

7.3.1 Spatial Distribution of Suitability Classes

The spatial distribution of suitability classes was derived from the integrated overlay of five biophysical parameters: slope, land use/land cover (LULC), soil type, drainage proximity, and erosion potential. The areal extent of each class is summarized in Table 7.4.

Table 7.4: Areal Distribution of Plantation Suitability Classes

Suitability Class	Value	Pixel Count	Area (ha)	Percentage (%)
(Unsuitable)	0	347	31.24	2.20
Very Low	1	138	13.42	0.87
Low	2	5002	450.18	31.69
Moderate	3	5949	535.41	37.69
High	4	3959	356.31	25.08
Very High	5	390	35.1	2.47

The final site suitability map (Fig.7.3) clearly illustrates spatial variation in plantation feasibility, with a significant concentration of suitable land occurring along either side of the higher-order drainage channels. These zones are characterized by favourable biophysical conditions such as moderate slopes and accessible moisture regimes, all of which enhance the potential for successful plantation development. Approximately 69.38% of the total study area falls within the moderate to low suitability classes. These areas present moderate constraints for eco-restorative plantation interventions and may require additional site-specific treatments or conservation measures to improve

feasibility. On the other hand, a substantial 25.08% of the land area is categorized as highly suitable for plantation efforts. These zones are typically found in proximity (within 100 meters) to drainage lines and are often characterized by barren or fallow lands with gentle to moderate slopes, offering optimal conditions for eco-restorative initiatives.

In stark contrast, only 2.20% of the area is classified as unsuitable for plantations. These zones are primarily located within immediate buffer zones of drainage channels, where high surface runoff and frequent inundation hinder vegetation establishment and long-term plant survival.

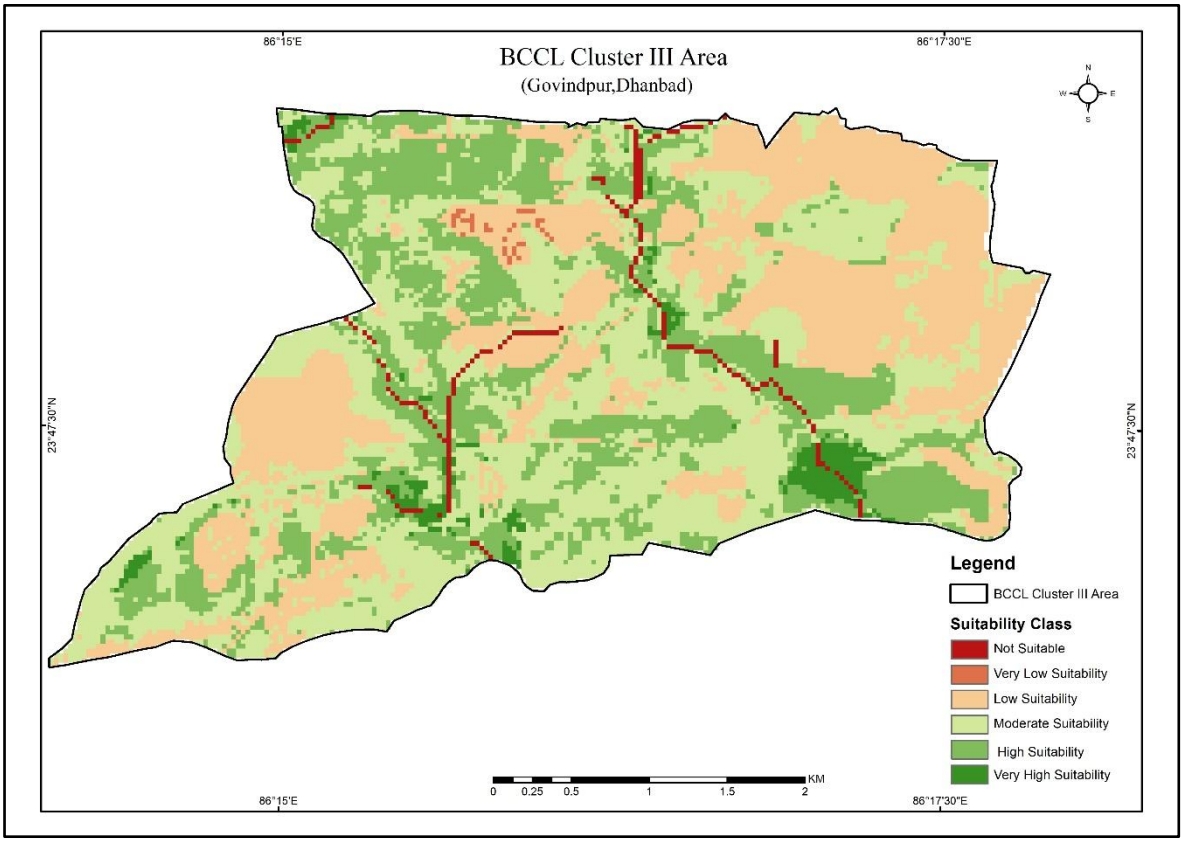


Fig. 7.3: The final Site Suitability Map for Plantation sites in Cluster-III Area

7.3.2 Delineation of Priority Zones

The Very High suitability class (Value = 5) was used to delineate plantation priority zones. These areas (35.1 ha; 390 pixels) represent optimal combinations of barren land, drainage proximity, loamy to sandy clay soils, and moderate erosion risk. The

identified zones were digitized and validated against high-resolution Google Earth imagery. Their spatial extent is shown in Fig. 7.4.

Within these zones, three plantation sites (PS-1 to PS-4) were identified (Fig. 7.4). While the GIS–AHP model initially classified all sites as highly suitable, but field visits and ground verification revealed the following observations:

PS-1 (23°48′30.70″N, 86°15′3.58″E): Not feasible, as the site is designated for a proposed opencast mining operation.

PS-2 (23°47′53.29″N, 86°16′28.86″E): Partially feasible. Based on the field assessments, areas located at the left side of the National Highway (NH) may be considered for plantation.

PS-3 (23°47′12.57″N, 86°15′38.89″E): Not feasible. Field verification confirmed that the land belongs to the Indian Railway and falls under the proposed mining expansion.

PS-4 (23°47′17.94″N, 86°17′5.62″E): Not feasible, owing to overlap with the existing mining activities.

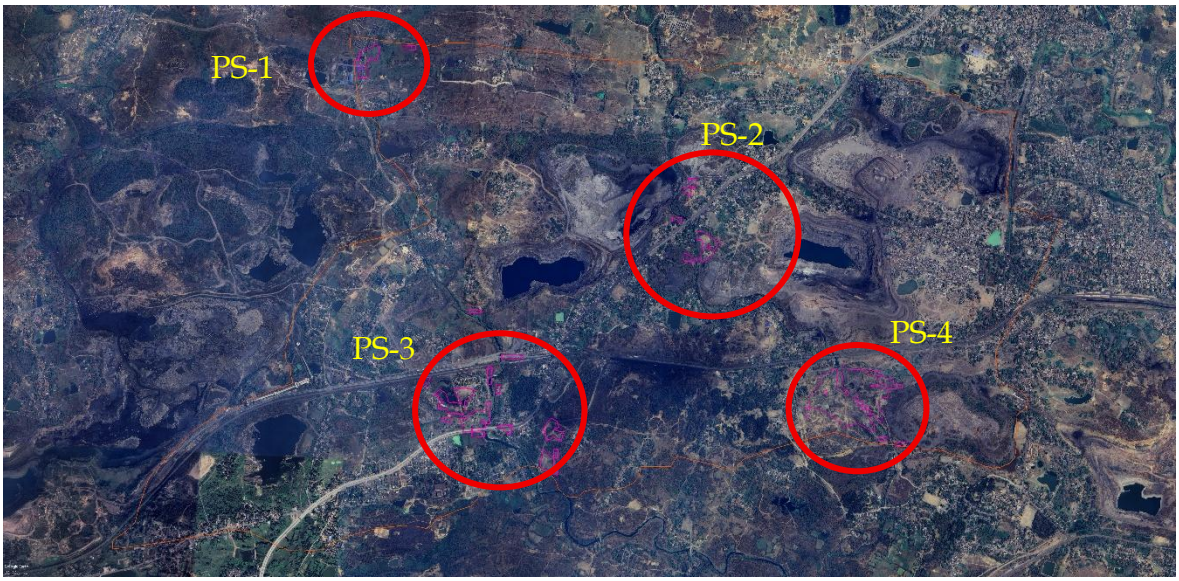


Fig. 7.4: ***Locations of the Plantation Zones in Cluster-III, Govindpur Area, BCCL***

7.4 Conclusion

The GIS–AHP plantation suitability model effectively delineated potential areas for eco-restorative interventions in the Cluster-III mining landscape. However, field visits revealed that land-use conflicts significantly constrain actual feasibility. Specifically, three sites (PS-1, PS-3, and PS-4) were deemed unfeasible due to overlaps with proposed & existing mining activities and railway land, while a portion of PS-2, situated on the left side of the NH, remains viable for plantation efforts.

These findings underscore the importance of integrating spatial modelling with rigorous field validation, ensuring that eco-restorative planning is grounded in both biophysical suitability and socio-economic realities. The results also emphasize the dynamic challenges of restoration planning in mining-affected areas, where operational activities frequently override biophysical potential. The approach demonstrated here thus, offers a replicable framework for prioritizing ecological interventions in complex and contested landscapes.

Chapter 8: Analysis of water quality parameters to ascertain the impact of mining upon local water quality

8.1 Introduction

Mining activities, particularly related to coal mining, have long been recognized as a major anthropogenic source of surface and groundwater contamination, especially in mineral-rich regions like Jharkhand, India. The Govindpur area, falling under Cluster-III of the Bharat Coking Coal Limited (BCCL) operational zone in Dhanbad district, is characterized by both open-cast and underground coal mining. This region is hydrologically influenced by the Khudia Nala, Bagdighi Nala, and by the discharge of mine water, all of which serve as the sources for agricultural and other ecological purposes.

The interaction between mining operations and the surrounding hydrological systems may result in the mobilization of various contaminants, including suspended solids, sulphates, nitrates, colours, phenolic compounds, etc. These pollutants significantly alter the physicochemical properties of water bodies, by degrading their quality and posing risks to aquatic ecosystems and human health. The Khudia and Bagdighi Nala, in particular, receive both surface runoff and effluents from mining sites, while the pumped-out mine water is often directly released into these streams or surrounding lowland areas.

Therefore, this chapter of the present study aims to systematically analyse key water quality parameters such as pH, electrical conductivity (EC), total dissolved solids (TDS), sulphates, nitrates, fluoride, and other parameters to evaluate the extent of mining-induced impacts on water quality in the Govindpur area. By comparing the observed values against standard permissible limits and identifying spatial trends, the study seeks to provide a scientific basis for understanding the environmental implications of mining and to support sustainable water resource management in the region.

8.2 Water Sampling from the Study Area

Water samples were collected from five locations to assess the impact of coal mining on local water quality of the study area. The five locations are (i) Upstream of Khudia Nala (SW1, surface water), (ii) Downstream of Khudia Nala (SW2, surface water), (iii) Upstream of Bagdighi Nala (SW3, surface water), (iv) Downstream of Bagdighi Nala (SW4, surface water), and (v) Mine Water at Cluster-III area (MW, groundwater). The mine water (MW) is basically the seepage water that is accumulated inside the mine pits and thus, this has been considered as the groundwater in the present study.

The selection of five specific sampling locations in the Cluster-III, Govindpur area of BCCL is scientifically rational and strategically optimized to evaluate the spatial and anthropogenic influence of mining on local water quality. These sites were chosen to ensure comprehensive representative sampling of both surface water and direct mine effluents (groundwater) within the study area.

The Khudia and Bagdighi Nala are the two principal surface water bodies passing through the mining region, making them hydrologically and environmentally significant receptors of potential contamination from mining operations. By incorporating both upstream (SW1 and SW3) and downstream (SW2 and SW4) points of each of the two water bodies, the sampling design facilitates a gradient-based analysis that distinguishes natural baseline water quality from downstream degradation attributable to mining discharge, sediment runoff, and associated anthropogenic activities. This upstream–downstream comparative approach is widely recognized in environmental monitoring for its effectiveness in identifying pollution sources and quantifying their impacts. The inclusion of the mine water sample (MW) provides critical information on the physicochemical characteristics of effluents discharged directly from the mining operation, serving as a control to correlate observed changes in surface water quality with specific pollutants originating from mining activities. Such a source-pathway-receptor linkage enables a mechanistic understanding of contaminant transport within the aquatic environment. Moreover,

the sampling strategy is scientifically consistent and ensures feasibility, cost-effectiveness, avoids redundancy, and focuses on hydrologically relevant locations. This aligns with national and international environmental monitoring guidelines (e.g., CPCB, MoEF&CC), which advocate for representative sampling along critical exposure pathways to support impact assessment and regulatory compliance. Therefore, the selected five sampling points provide a balanced, scientifically robust, and practically implementable framework for assessing the impact of coal mining on local water resources in the study area.

8.3 Methodology of sampling and analysis

Water samples were collected as per the standard method. The surface and mine water samples were collected and analysed in the laboratory of the Department of Environmental Science and Engineering, IIT(ISM), Dhanbad. The water quality parameters and their measured values (in triplicate) are presented in the Table 8.1. The sampling locations have been shown in Fig. 8.1.

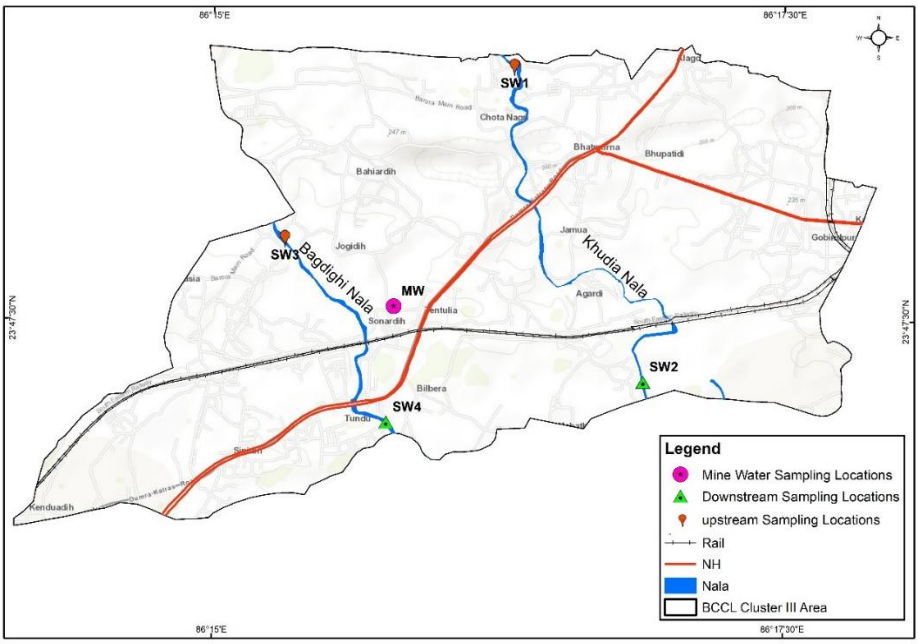


Fig. 8.1: Water sampling locations at upstream (SW1 & SW3) & downstream (SW2 & SW4) of Khudia and Bagdighi Nalas and Mine Water (MW)

Table 8.1: Results of the surface water and mine water (groundwater) quality analysis

Water Quality Parameters	SW1	SW2	SW3	SW4	IS: 2296 INLAND SURFACE WATER [1982] Class 'C	MW	MOEF -SCH-VI STANDARDS Class 'A'
PH	6.62	7.02	7.1	7.41	6.5-8.5	7.18	5.5 to 9.0
TDS (ppm)	486	790	476	651	1500	872	_
EC (µS/cm)	686	1090	670	918	-	1202	_
Alkalinity (mg/L as $CaCO_3$)	260	246	240	250	-	438	_
Hardness (mg/L as $CaCO_3$)	314	386	352	366	-	840	_
Salinity (ppt)	245	348	264	358	-	497	_
Colour (Hazen Units)	1	2	1	1	10	1	_
Nitrate (mg/l)	38.22	35.50	24.14	36.62	50	<0.5	10
Sulphate (mg/l)	262.30	356	236	342	400	46	_
Fluoride (mg/l)	0.46	0.68	0.34	0.48	1.5	0.52	2
Phenolic compounds (mg/l, as C_6H_5OH)	<0.002	<0.002	<0.002	<0.002	0.005	<0.001	_

8.4 Results & Discussions

The detailed assessment of water quality parameters at the upstream (SW1 and SW3) and downstream (SW2 and SW4) locations of Khudia and Bagdigi Nala, along with mine water (MW) from the study area, reveals an anthropogenic influence of mining activities on local surface water systems. Upstream, water samples at SW1 (Khudia Nala) and SW3 (Bagdigi Nala), show relatively lower concentrations of the water quality parameters, indicating minimal disturbance and representing natural background conditions. In contrast, downstream sites, SW2 and SW4, exhibit slight deterioration in water quality, with increases in total dissolved solids (TDS), electrical conductivity (EC), salinity, alkalinity, and hardness. The results of various individual water quality parameters are discussed below for both surface water and mine water.

8.4.1 pH:

The pH levels across all surface water samples (SW1–SW4) remained within the acceptable range of 6.5 to 8.5 as prescribed by IS:2296:1982 (BIS standard for inland surface water quality), indicating a near-neutral nature of the water bodies. Specifically, Khudia Nala recorded pH values of 6.62 upstream (SW1) and 7.02 downstream (SW2), while Bagdighi Nala showed slightly higher readings of 7.1 upstream (SW3) and 7.41 downstream (SW4). The pH of mine water (MW) was measured at 7.18, which also falls well within the permissible limits of 5.5 to 9.0 set under Schedule VI of the Environment (Protection) Rules, 1986 by MoEFCC for effluent discharge. These consistent results suggest that mining operations in the Govindpur Cluster-III region have not significantly influenced the acid–base balance of local surface or mine water systems.

8.4.2 Total Dissolved Solids (TDS):

TDS values across surface water samples ranged from 476 ppm to 790 ppm, remaining below the IS:2296 permissible limit of 1500 ppm. However, a noticeable increase in TDS was observed at downstream locations, which reflects the contribution of dissolved minerals from mining activities. In Khudia Nala, TDS increased from 486 ppm at SW1 to 790 ppm at SW2, and in Bagdighi Nala, from 476 ppm (SW3) to 651 ppm (SW4). The mine water (MW) sample exhibited a TDS concentration of 872 ppm, which, while exceeding the acceptable drinking water limit of 500 ppm, remains well within the general permissible threshold of 2000 ppm for groundwater and mine effluents.

8.4.3 Electrical Conductivity (EC):

Electrical conductivity values in surface water ranged from 670 µS/cm to 1090 µS/cm, indicating moderate ionic concentration. Although, IS:2296 standard does not prescribe a standard for EC, a clear upward trend was evident at downstream points SW2 (1090 µS/cm) compared to SW1 (686 µS/cm), and SW4 (918 µS/cm) versus SW3 (670 µS/cm). Mine water exhibited the highest EC at 1202 µS/cm. This elevated EC signifies an

increased ionic burden associated with mining activities and mineral dissolution processes.

8.4.4 Alkalinity:

The alkalinity of surface water samples, expressed as $CaCO_3$, ranged between 240 mg/L and 260 mg/L. Though IS:2296 standard does not specify a limit for alkalinity, elevated values were found at downstreams (SW2: 246 mg/L, SW4: 250 mg/L), compared to upstream sites (SW1: 260 mg/L, SW3: 240 mg/L). Mine water recorded a substantially higher alkalinity of 438 mg/L, which exceeds the acceptable limit of 200 mg/L and approaches the upper threshold of 600 mg/L. The increase in alkalinity is likely due to carbonate dissolution and buffering reactions facilitated by coal seam interactions with water.

8.4.5 Hardness:

Surface water hardness varied between 314 mg/L and 386 mg/L, though it is not regulated under IS:2296 standards. Minor increase in hardness was observed at downstreams, with Khudia Nala showing a rise from 314 mg/L (SW1) to 386 mg/L (SW2), and Bagdighi Nala from 352 mg/L (SW3) to 366 mg/L (SW4). Mine water exhibited high hardness at 840 mg/L. This might have resulted due to leaching of calcium and magnesium ions from geological formations.

8.4.6 Salinity:

Salinity, measured in milligrams per liter (mg/L), ranged from 245 mg/L to 358 mg/L in surface water. Although the IS:2296 standard does not prescribe limits for salinity, the increasing concentrations at downstream locations—348 mg/L at SW2 and 358 mg/L at SW4 compared to 245 mg/L (SW1) and 264 mg/L (SW3) upstream—suggest salt accumulation, likely influenced by mining runoff. Mine water exhibited an even higher salinity of 497 mg/L, indicating a strong influence of anthropogenic salt loading with potential implications for aquatic ecosystems and water usability.

8.4.7 Colour:

The color of surface water samples, measured in Hazen Units, remained low across all sites (1–2 Hazen Units), well within the IS:2296 aesthetic limit of 10 Hazen Units for surface water. Mine water also exhibited minimal coloration (1 Hazen Unit), complying with the permissible limit of 5 Hazen Units specified under Schedule VI of the Environment (Protection) Rules, 1986 (MoEFCC). This indicates negligible visual impact or discoloration due to mining activities, despite underlying chemical alterations in water quality..

8.4.8 Nitrate (NO_3^-):

Nitrate concentrations in surface water ranged from 24.14 mg/L to 38.22 mg/L, remaining below the IS:2296 permissible limit of 50 mg/L for Class 'C' inland surface waters. Notably, elevated nitrate levels were observed at both upstream (SW1: 38.22 mg/L) and downstream (SW2: 35.50 mg/L) locations of Khudia Nala, and to a lesser extent in Bagdighi Nala (SW4: 36.62 mg/L). The relatively high values at upstream sites might have resulted from non-mining sources such as agricultural runoff, domestic sewage intrusion, or nutrient leaching from the surrounding catchment, rather than from mining activities. In contrast, the mine water (MW) sample showed a very low nitrate concentration (<0.5 mg/L), well below the MOEF SCH-VI standard of 10 mg/L, confirming that mining effluents are not a significant contributor to nitrate levels in the region's water bodies. These findings highlight the role of land use practices and sanitation conditions in influencing nutrient loads, particularly in upstream stretches outside of the mine lease area).

8.4.9 Sulphate (SO_4^{2-}):

Sulphate levels in surface water ranged from 236 mg/L to 356 mg/L, all within the IS:2296 standard permissible limit of 400 mg/L. Higher concentrations were evident in downstream locations SW2 (356 mg/L) and SW4 (342 mg/L), likely due to oxidation of sulphide-bearing rocks exposed during mining. Mine water showed a comparatively

low sulphate level of 46 mg/L, indicating that localized sulphate enrichment mainly affects the surrounding surface water rather than direct mine discharge.

8.4.10 Fluoride (F^-):

Fluoride levels in all surfaces and mine water samples were below respective permissible limits. Surface water fluoride concentrations ranged from 0.34 mg/L to 0.68 mg/L, and mine water had a value of 0.52 mg/L, well within the IS:2296 standard limit of 1.5 mg/L and MOEF SCH-VI standard of 2 mg/L. These results suggest minimal fluoride pollution and indicate that mining operations do not significantly influence fluoride concentrations in the region.

8.4.11 Phenolic Compounds:

Phenolic compounds in surface water were found to be below 0.002 mg/L, and in mine water, below 0.001 mg/L. These values are significantly under the IS:2296 standard permissible limit of 0.005 mg/L for surface water and the MOEF SCH-VI limit of 0.002 mg/L for mine water. The extremely low concentrations indicate that phenolic contamination is not a concern in the study area, and mining activities are not contributing to organic pollutant loads in this category.

8.5 Conclusion

The analysis demonstrates that mining activities in the Govindpur Cluster-III region are exerting measurable physicochemical pressure on local water bodies, particularly evident in parameters such as Total Dissolved Solids (TDS), Electrical Conductivity (EC), hardness, and alkalinity, with downstream sites consistently reflecting higher as compared to upstream. While the overall quality of local water bodies remains within permissible limits, certain parameters—specifically TDS and EC—were notably elevated at downstream locations compared to upstream reference points, suggesting localized impacts from mining activities. However, other parameters such as pH, color, nitrate, sulphate, fluoride, and phenolic compounds remained within acceptable

regulatory thresholds, indicating only partial or site-specific effects. These findings underscore the need for continuous water quality monitoring and the implementation of mitigation measures, including proper effluent treatment and runoff control, to safeguard surface water resources in mining-influenced zones.

Chapter 9: Final Recommendations for Preparation of the Watershed Management Plan for Cluster-III, Govindpur Area, BCCL, Dhanbad

9.1 Introduction

Integrated watershed management has emerged as a critical pillar of sustainable environmental governance, particularly in areas where Land-use Land Cover transformation is very frequent. Mining-impacted landscapes are especially vulnerable to hydrological imbalances, accelerated soil erosion, and long-term ecosystem instability. In this context, the development and implementation of spatially explicit, scientifically grounded strategies is essential not only to mitigate existing environmental risks but also to guide future operational planning and policy integration.

This study is based on geospatial technology, environmental modelling, and climate-adaptive land management. Through the integration of advanced tools such as remote sensing, digital terrain analysis, hydrological modelling, and multi-criteria evaluation, the study establishes a comprehensive and systems-based approach for watershed planning for the present study area, i.e., Cluster-III, Govindpur Area, BCCL. The methodology recognizes the interrelated dynamics of terrain morphology, land cover patterns, rainfall variability, and anthropogenic interventions, offering an actionable framework for ecological restoration and resource optimization.

A distinctive contribution of this study is its application of multiple modelling techniques, namely morphometric analysis, the Revised Universal Soil Loss Equation (RUSLE), the Soil Conservation Service Curve Number (SCS-CN) method, and climate projection scenarios to understand current and future watershed behaviors. The Analytic Hierarchy Process (AHP) also enables a transparent, object-oriented, and spatially optimized prioritization of areas suitable for conservation structures and afforestation.

Beyond its technical contributions, the study aligns with broader national and institutional policy frameworks such as Environmental Management Plans (EMPs), mine closure guidelines, and climate adaptation strategies. By demonstrating the applicability of geospatially enabled and science-driven approaches to long-term planning & decision support systems, the study offers a replicable model for integrated watershed management in other resource-intensive regions. The analytical components of watershed delineation, erosion risk zoning, runoff modeling, and land suitability analysis collectively inform a climate-adaptive, operationally feasible, and policy-aligned watershed management plan for Cluster-III in the Govindpur Area of BCCL.

The final set of strategic recommendations presented in the following sections is grounded in the detailed, multi-dimensional analysis conducted throughout this study. Each preceding chapter has identified critical environmental and hydrological challenges to the Cluster-III region. The morphometric analysis (Chapter 2) revealed that those micro-watersheds with steep gradients and complex drainage networks are increasingly vulnerable to runoff and erosion. Rainfall-runoff modelling (Chapter 3) demonstrated pronounced spatial and temporal variability, with watersheds draining into Khudia and Bagdighi Nala showing particularly high runoff during peak rainfall years like 2024. Near-future climate projections (Chapter 4) indicate a slight increase in daily rainfall intensity, which is expected to intensify surface runoff and exacerbate soil erosion. The soil erosion assessment (Chapter 5) identified over 31.91 % of the area as being at high to very high erosion risk, particularly in exposed and disturbed mining zones. Suitability analyses (Chapters 6 and 7) underscored the need for strategically placing conservation structures and plantations, as few high-risk zones are currently inadequately managed. Finally, water quality evaluations (Chapter 8) indicated that the quality of local water bodies remains within permissible limits; however, some parameters such as TDS and conductivity were elevated compared to upstream reference points, suggesting localized impacts from mining activities.

These insights reinforce the necessity of implementing a scientifically informed, spatially targeted, and climate-resilient watershed management plan to address the challenges and opportunities within the Cluster-III mining landscape. The following sections outline the final set of strategic recommendations derived from this comprehensive analysis. These recommendations directly and indirectly respond to the challenges identified in the previous chapters and represent actionable measures necessary to address the study area's current and emerging environmental concerns.

9.2 Soil Erosion Risk Reduction and Sediment Control

In the fifth objective (Chapter 5), the RUSLE-based modelling identified that more than 31.91% of the landscape falls under high and very high erosion potential zones. These areas, particularly overburden dumps and exposed mining slopes, are critically vulnerable and require stabilization. Recommended interventions, such as constructing check dams along natural drainage channels and contour bunding around the unstable overburden, are advised. These measures will help mitigate soil loss, enhance slope stability, and support long-term ecological restoration in mining-disturbed areas.

9.3 Suitability for Conservation Structures

A crucial component of the watershed management strategy for Cluster-III is the identification and prioritization of locations suitable for implementing soil and water conservation structures. Using a GIS-based Multi-Criteria Evaluation (MCE) framework integrated with the Analytic Hierarchy Process (AHP), eight key biophysical parameters viz. slope, land use/land cover, soil texture, drainage density, runoff potential, erosion risk, and proximity to drainage lines, were analysed to generate a spatial suitability model. The AHP framework achieved a high consistency ratio (CR = 0.021), indicating reliable weight assignments and internal coherence.Field validation of the model outputs confirmed the appropriateness of two categories of conservation structures for this mining-impacted watershed: check dams and contour bunds (retention walls). These structures were identified as ecologically and

geomorphologically relevant for regulating runoff, reducing erosion, and stabilizing overburden dumps.

Check Dams (CDs): The suitability model initially identified three locations for check dams. Field surveys confirmed the presence of existing check dams at two sites (CD1 and CD2), thereby validating the predictive accuracy of the model. The third location (CD3), although delineated as highly suitable due to its hydrological convergence and favourable slope conditions, was found unsuitable during field visits for constructing check dam due to existing and proposed coal mining activities.

CD1 (23°48′21.35″N, 86°16′21.20″E): Existing check dam (validated).

CD2 (23°47′05.29″N, 86°15′45.48″E): Existing check dam (validated).

CD3 (23°47′26.96″N, 86°17′02.33″E): Initially identified as suitable but excluded due to existing and proposed coal mining activities.

For a comprehensive discussion and validation details, it is suggested to refer Section 6.3.3: Identification and Validation of Intervention Sites. Fig. 9.1 shows the spatial distribution of the identified check dam sites in Cluster-III. CD1 and CD2 represent existing check dams (validated), while CD3 was initially identified by the analysis but excluded during field verification due to existing and proposed coal mining activities.

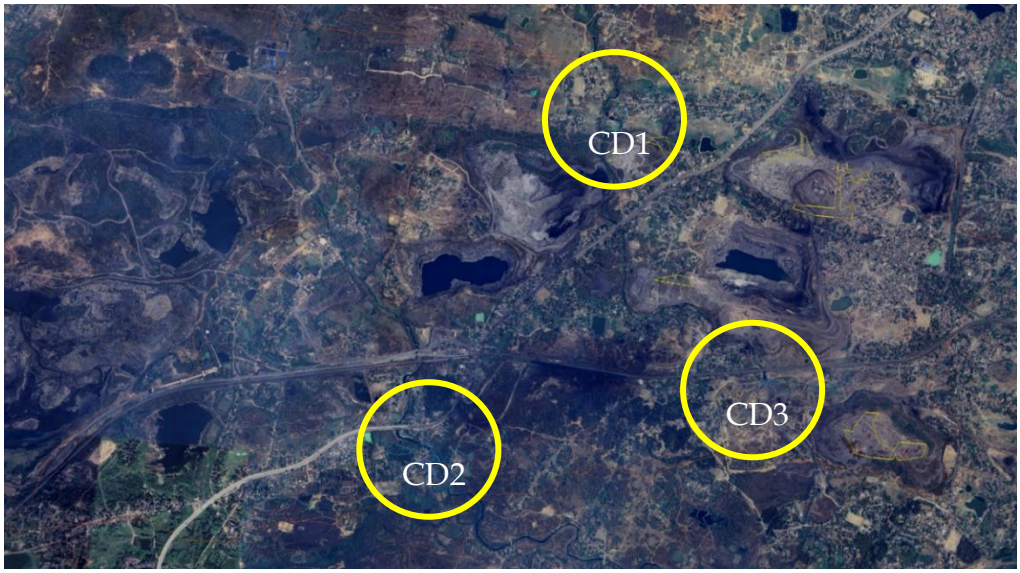


Fig. 9.1: Location map of (CD1–CD3)

Identification of Contour Bunding / Retention Wall Sites: The model further delineated four sites as suitable for contour bunding. These structures act as slope-aligned retention walls to intercept runoff, reduce flow velocity, promote infiltration, and prevent erosion of soil and overburden. In mining-impacted areas, they also stabilize loose dumps and reduce sediment inflow into drainage channels.

Field verification was done to verify the model outputs that led to the following site-specific recommendations:

- **CB1 (23°47′15.88″N, 86°17′14.74″E):** New bund construction is strongly recommended at this site. Field inspection revealed concentrated runoff and significant erosion risks impacting the adjoining Bagdighi Nala. A retention wall of approximately 850 m in length is proposed to stabilize the soil, enhance water conservation and to minimize erosion potential.
- **CB2 (23°48′13.05″N, 86°17′18.57″E):** Although, this site was identified as suitable during the analysis but, this site is located near active mining and overburden dumps. Any constructed bund at this site may be destabilized due to the existing mining activities as the mining operations are progressing towards the proposed site located at CB2. Thus, the site CB2 is unsuitable for constructing contour bund.
- **CB3 (23°47′48.21″N, 86°16′39.37″E):** An existing bund of approximately 450 m was observed at this site, validating the model's prediction. However, reinforcement and possible extension are recommended to improve its effectiveness and ensure long-term stability.
- **CB4 (23°48′13.47″N, 86°16′20.12″E):** Partial bunding of approximately 250 m already exists at this location, further validating the model's output. It is recommended that the bund be strengthened and extended by an additional 150 m to provide enhanced protection against erosion and overburden movement.

- For a comprehensive discussion and validation details, it is requested to refer Section 6.3.3: Identification and Validation of Intervention Sites. Fig. 9.2 presents the location map of CB1–CB4.

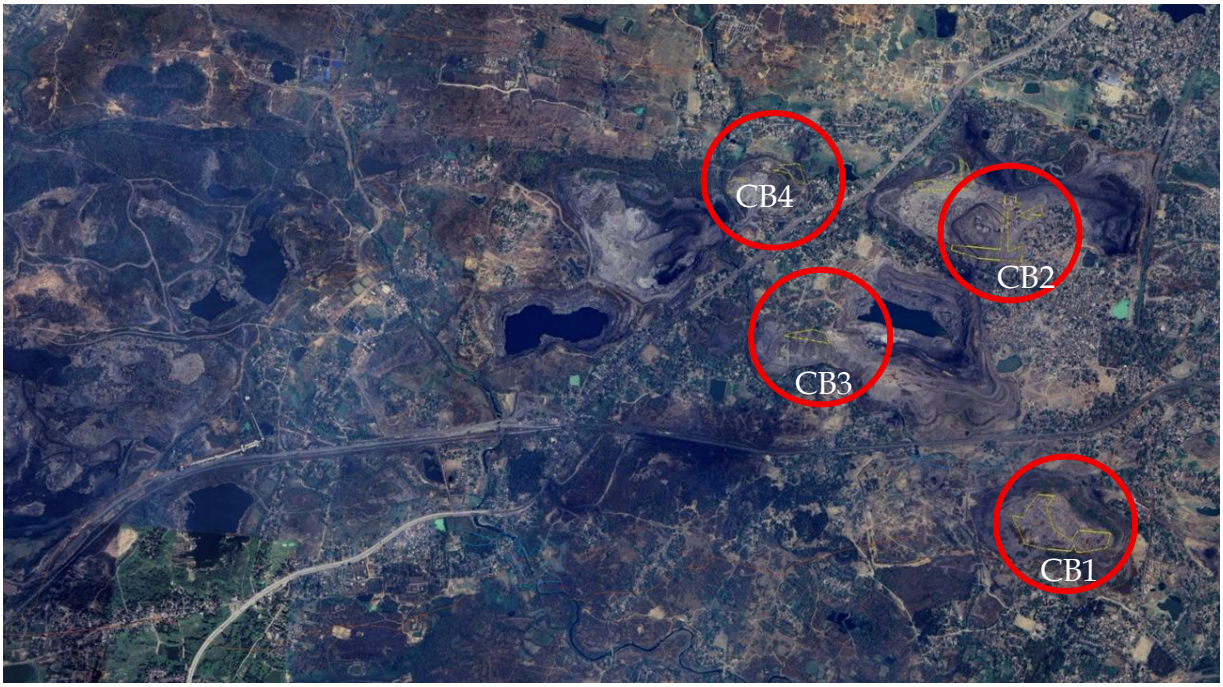


Fig. 9.2: Location map of CB1–CB4.

The spatial distribution of check dams and contour bunding sites highlights the dominant role of parameters such as runoff potential, erosion potential, and field validation in driving the final site suitability. The validation of existing structures (CD1, CD2, CB3, CB4) lends strong credibility to the model outputs, while the exclusion of sites such as CD3 and CB2 underscores the importance of field verification in mining landscapes. The identification of retention walls is particularly significant for mining reclamation, as they provide dual benefits: reducing soil erosion and runoff while stabilizing overburden dumps. Together with check dams, these structures form a complementary strategy to enhance soil moisture retention, control sediment transport, and support agricultural productivity in reclaimed areas. These outputs are of direct operational relevance for BCCL Environmental Management Plans (EMPs), providing scientific guidance for design, phasing, and budgeting of eco-hydrological interventions in the Cluster-III watershed.

9.4 Afforestation and Ecological Restoration

Afforestation and ecological restoration represent critical components of integrated watershed management, particularly in coal mining-impacted landscapes where degradation, erosion, and disruption of ecological services are evident. Following the objective of identifying and prioritizing suitable plantation sites, a comprehensive land evaluation was undertaken using the FAO framework integrated with GIS-based multi-criteria decision-making. This approach generated a spatially explicit Plantation Suitability Map (PSM) for the Cluster-III region of the Govindpur Area, BCCL.The analysis incorporated five biophysical parameters viz. slope, land use/land cover (LULC), soil type, proximity to drainage, and erosion potential with their relative weights derived using the Analytic Hierarchy Process (AHP). The Weighted Overlay Analysis (WOA) classified the study area into five suitability classes: Very High, High, Moderate, Low, and Very Low. This stratification provides the foundation for a prioritized, evidence-based afforestation strategy.

Spatial Distribution and Priority Classification

The areal distribution of suitability classes (Table 9.1) shows that 25.08% of the study area is classified as highly suitable and 2.47% as very highly suitable for plantation. These zones are predominantly situated near higher-order drainage channels and characterized by gentle to moderate slopes, barren or fallow land, and loamy to sandy-clay soils, which are conducive to plant establishment. By contrast, 2.20% of the area is deemed unsuitable, largely due to frequent inundation, high runoff, or poor rooting conditions within drainage buffers.

Table 9.1: Areal Distribution of Plantation Suitability Classes

Suitability Class	Value	Pixel Count	Area (ha)	Percentage (%)
(Unsuitable)	0	347	31.24	2.20
Very Low	1	138	13.42	0.87
Low	2	5002	450.18	31.69
Moderate	3	5949	535.41	37.69
High	4	3959	356.31	25.08
Very High	5	390	35.1	2.47

Identification of Priority Plantation Zones

Within the Very High suitability class (Value = 5), a total of 35.10 ha was delineated as priority plantation zones (Fig. 9.3). Four plantation sites (PS-1 to PS-4) were initially identified through GIS-based analysis, supported by high-resolution imagery interpretation. However, based on the field visits and ground validation, the following recommendations are made:

- **PS-1 (23°48′30.70″N, 86°15′3.58″E):** Not feasible, as the site is designated for a proposed opencast mining operation.
- **PS-2 (23°47′53.29″N, 86°16′28.86″E):** Partially feasible. Based on the field assessments, areas located at the left side of the National Highway (NH) may be considered for plantation initially.
- **PS-3 (23°47′12.57″N, 86°15′38.89″E):** Not feasible. Field verification confirmed that a part of the land belongs to the Indian Railway and the remaining land falls under the proposed mining expansion.
- **PS-4 (23°47′17.94″N, 86°17′5.62″E):** Not feasible, owing to overlap with the existing and proposed mining activities.

Thus, only a part of the area under PS-2 (as mentioned above) is feasible for afforestation under current and proposed land-use pattern.

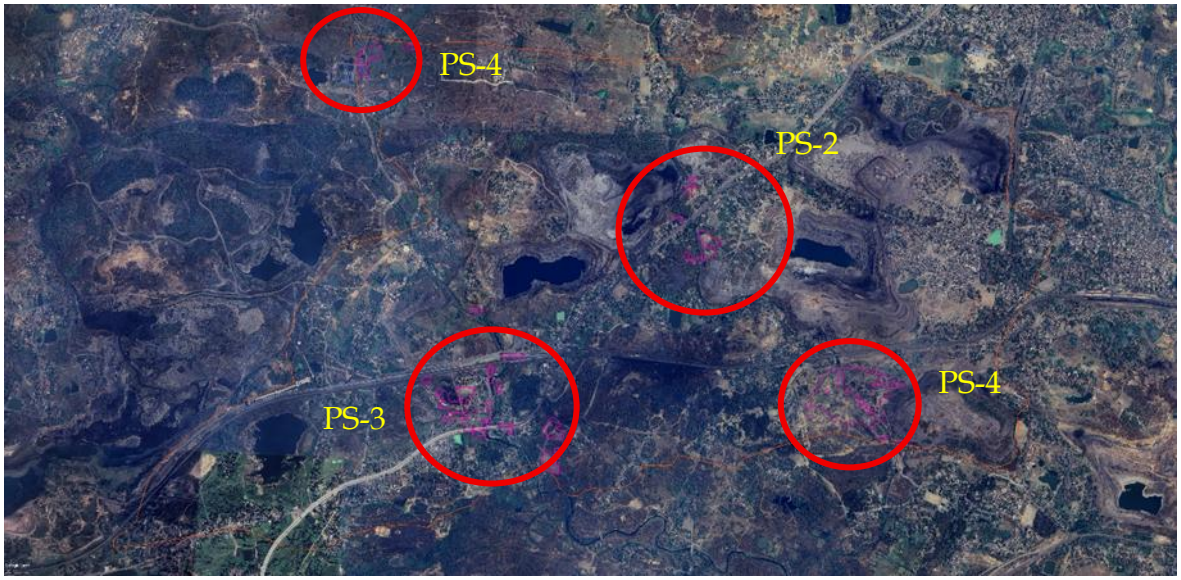


Fig. 9.3: Locations of the Plantation Zones in Cluster-III, Govindpur Area, BCCL

Implementation Strategy and Species Selection

For the partially feasible PS-2 zone, species selection is guided by ecological resilience and restoration potential. Recommended native species include the following:

Azadirachta indica (Neem) – valued for drought resistance and soil improvement.

Tectona grandis (Teak) – for long-term timber value and canopy cover.

Terminalia arjuna – effective in riparian and erosion-prone areas.

In the context of coal mining regions, the prioritized plantation zones can play a crucial role in stabilizing overburden dumps, reducing dust emissions, and reclaiming degraded land. These interventions not only support environmental compliance but also enhance the ecological restoration of the post-mining landscape.

9.5 Conclusion

The preparation of a watershed management plan for Cluster-III in the Govindpur Area of BCCL represents a proactive step towards sustainable ecological management in a mining-impacted region. Although, the area does not currently exhibit severe environmental stress, the cumulative impacts of coal mining, evolving land-use dynamics, and localized vulnerabilities such as overburden dumps, steep slopes, and

sparsely vegetated zones necessitate targeted interventions to safeguard ecological stability. The integrated methodology employed in this study, combining geospatial analysis with CMPI6, RUSLE, SCS-CN, and AHP-based site prioritization, proved effective in generating spatially explicit, technically robust, and context-specific guidance for watershed-scale management. Conservation measures such as check dams, contour bunds, and afforestation were identified as critical interventions, with field validation confirming both the reliability of the model outputs and the necessity of adaptive refinements based on field visits.

The plantation suitability analysis further highlighted that, despite the model delineating four suitable sites (PS-1 to PS-4), field verification restricted feasibility to only a portion of PS-2, while PS-1, PS-3, and PS-4 were excluded due to overlaps with existing & proposed mining activities and railway land. This underscores the essential role of ground-truthing in translating model predictions into actionable strategies in mining-affected landscapes.

Afforestation within the feasible PS-2 zone, supported by native species such as *Azadirachta indica*, *Tectona grandis*, and *Terminalia arjuna*, can contribute to ecological restoration by stabilizing degraded slopes, reducing erosion, and enhancing biodiversity. In parallel, the incorporation of structural measures such as check dams and contour bunds offers synergistic benefits for runoff regulation, soil conservation, and slope stabilization. In conclusion, the Cluster-III watershed exemplifies how science-based modelling, integrated with rigorous field validation, provides a scalable and policy-relevant framework for ecological restoration in coal mining regions. While spatial analysis identifies potential opportunities, adaptive management and continuous monitoring remain vital to address the dynamic land-use pressures that characterize such landscapes. The framework developed here not only strengthens site-specific restoration planning but also serves as a transferable model for long-term land and water management in similar mining-affected regions across India.

List of Reference

Bansode, A. B., & Patil, J. R. (2014). Runoff estimation using SCS-CN method and GIS for agricultural watershed: A case study. *International Journal of Emerging Technology and Advanced Engineering, 4*(5), 464–471.

Bansode, A., & Patil, K. A. (2014). Estimation of runoff by using SCS curve number method and ArcGIS. *International Journal of Scientific and Engineering Research, 5*(7), 1283–1287.

Beveridge, S., & Oickle, C. (1994). A comparison of Box–Jenkins and objective methods for determining the order of a non-seasonal ARMA model. *Journal of Forecasting, 13*(5), 419–434. https://doi.org/10.1002/for.3980130502

Bureau of Indian Standards. (1982). *IS 2296: Tolerance limits for inland surface waters*. New Delhi, India: Bureau of Indian Standards.

Gujarat Mineral Development Corporation. (2018). *Tadkeshwar Lignite Project, October 30, 2018* [Project report].

Hydrologic Engineering Center (HEC). (n.d.). *Curve number tables for hydrologic modeling*. U.S. Army Corps of Engineers. Retrieved July 2025, from https://www.hec.usace.army.mil/confluence/hmsdocs

Hyndman, R. J., & Athanasopoulos, G. (2018). *Forecasting: Principles and practice* (2nd ed.). OTexts. https://otexts.com/fpp2/

Jackson, T. J., & Rawls, W. J. (1981). SCS urban curve numbers from Landsat databases. *Water Resources Bulletin, 17*, 857–862.

Jia Yi, T., Mahmud, M. R., Md Reba, M. N., Hashim, M., Norman, M., & Wan Jaafar, W. S. (2021). Forecasting the near future of rainfall in humid tropics using the high-resolution satellite precipitation data. *Physics and Chemistry of the Earth, Parts A/B/C*, 103069. https://doi.org/10.1016/j.pce.2021.103069

Karan, S. K., Ghosh, S., & Samadder, S. R. (2019). Identification of spatially distributed hotspots for soil loss and erosion potential in mining areas of Upper Damodar Basin, India. *CATENA, 182*, 104144. https://doi.org/10.1016/j.catena.2019.104144

Karan, S. K., Kumar, A., & Samadder, S. R. (2017). Evaluation of geotechnical properties of overburden dump for better reclamation success in mining areas. *Environmental Earth Sciences, 76*(22), 770. https://doi.org/10.1007/s12665-017-7116-5

Karan, S. K., Samadder, S. R., & Maiti, S. K. (2016). Assessment of the capability of remote sensing and GIS techniques for monitoring reclamation success in coal mine degraded lands. *Journal of Environmental Management, 182*, 272–283. https://doi.org/10.1016/j.jenvman.2016.07.070

Krois, J., & Schulte, A. (2014). GIS-based multi-criteria evaluation to identify potential sites for soil and water conservation techniques in the Ronquillo watershed, northern Peru. *Applied Geography, 51*, 131–142.

Krois, J., & Schulte, A. (2014). Modeling the hydrological response of a mesoscale Andean catchment to land-use change. *Hydrological Sciences Journal, 59*(8), 1520–1536.

Li, M., Jin, H., & Shao, Q. (2021). Improvements in subseasonal forecasts of rainfall extremes by statistical postprocessing methods. *Weather and Climate Extremes, 34*, 100384. https://doi.org/10.1016/j.wace.2021.100384

Ministry of Environment, Forest and Climate Change. (1986). *Environment (Protection) Rules – Schedule VI: General standards for discharge of environmental pollutants*. Government of India. Retrieved from https://moef.gov.in

National Remote Sensing Centre (NRSC), Indian Space Research Organisation. (2025). *CartoSAT-1 DEM data: Bhoonidhi portal*. Retrieved from http://bhoonidhi.nrsc.gov.in

Odisha Mining Corporation. (n.d.). *Comprehensive hydrogeological survey in and around Guali Iron Ore Mine and assessment of impact due to mining*

Rao, K. N., Narendra, K., & Latha, P. S. (2010). An integrated study of geospatial information technologies for surface runoff estimation in an agricultural watershed, India. *Journal of the Indian Society of Remote Sensing, 38*(2), 255–267.

Rao, K. S., & Dey, P. (2010). Application of SCS-CN method in runoff estimation: A case study. *Journal of Indian Water Resources Society, 30*(3), 23–28.

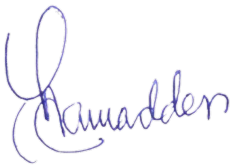
SAMETI Jharkhand. (2025). *Soil inventory: Soil properties and hydrologic soil grouping of Dhanbad district*. Retrieved from https://www.sameti.org/Soil_Inventory/Dhanbad_Soil_Analysis.pdf

Singh, V., Karan, S. K., Singh, C., & Samadder, S. R. (2023). Assessment of the capability of SWAT model to predict surface runoff in open cast coal mining areas. *Journal of Environmental Management*. (In press or pre-publication, if DOI is not available)

United States Department of Agriculture. (1986). *Urban hydrology for small watersheds (Technical Release 55)*. Soil Conservation Service.

WeatherSpark. (n.d.). *Climate and weather year-round in Govindpur, Jharkhand, India*. Retrieved July 2025, from https://weatherspark.com

End of the Report



Prof. S. R. Samadder, Professor,
Centre for Water Resource Management (CWRM)
(Consultant In-charge of the Project)
Department of Environmental Science & Engineering
IIT(ISM) Dhanbad
Email: samadder@iitism.ac.in

Annexure-IV

पत्र संख्या: BCCL/Ar.III/GM/Envt/25-26/ 12

Date: 19.04.2025

सेवा में,

वन प्रमंडल पदाधिकारी,

धनबाद

विषय: **Work Order for carrying afforestation over 1.755 Ha land in Maheshpur Colliery under Govindpur Area, BCCL.**

संदर्भ:

(i) BCCL letter vide letter **no. BCCL/GM/Ar.III/Envt./24-25/120 dated 04.02.2025**
(ii) Your letter vides no. letter no. **694 dated 19.03.3025**

माननीय महोदय,

This has reference to the aforesaid letters; the Competent Authority is pleased to award the work for **"1.755 ha plantation in Maheshpur Colliery under Govindpur Area, BCCL"** for a total value of **Rs. 19,06,745.00 (Nineteen Lakh Six Thousand Seven hundred and Forty-Five rupees only)** with the following terms and conditions in respect of above-mentioned work: -

1. The Period of work from the date of acceptance of work order will be 6 years (as advance and completion work will be done in FY 2025-26) and subsequent Five years maintenance work as per the estimate provided by Forest Department.

2. The aforesaid work is to be carried out at 1.755 Ha land in Maheshpur Colliery Under Govindpur Area.

3. The Forest department shall conduct all its afforestation activities subject to all laws, rules, statutory orders and regulations applicable to the site and the nature of the work.

4. The Forest department shall take up afforestation works with due expertise and supervision as per the scheme & estimates duly sanctioned as per the estimate submitted by forest department.

5. The Forest Deparment Shall submit the surface plan/location plan for the aforesaid sites.

6. **SCOPE OF WORK**
This work shall be done with the following attributes:

(i) Self-sustaining / healthy plantation at the end of project period.

(ii) As the site is degraded protected forest land, therefore, plants planted shall be of native species, high root density, soil binding species, thick canopy and/or fruit bearing. The forest department shall identify such native species and plant at the site with the purpose of regeneration of the forest with native flora and fauna.

पंजीकृत कार्यालय: कोयला भवन, कोयला नगर, बीसीसीएल टाउनशिप, धनबाद, झारखंड -826005, भारत, फोन : 0326-2236000, वेबसाइट : www.bcclweb.in
Registered Office: Koyla Bhawan, Koyla Nagar, BCCL Township, Dhanbad, Jharkhand-826005, India, CIN: U10101JH1972GOI000918

(iii) Survival of the plantation shall not be less than 80 per cent at the end of the project period.

7. Annual Joint Inspection report of the inspection carried out by joint team of Forest Department and representatives of GM, Govindpur Area, BCCL after the completion of each year work with the report indicating name of the site, year of plantation, number of plants, name of the species present, date of inspection and survival rate.

8. The display boards shall be installed at sites indicating the name of the site, the no. of plantation, species planted, funded by BCCL and plantation year.

9. All the materials & manpower required with regard to the aforesaid work shall be arranged by you at your own cost.

10. At the end of the project period, a certificate for successful completion of the project shall be submitted to BCCL.

11. The Forest Department Shall engaged local community/people or SHGs wherever possible, for aforesaid work.

12. At the end of the each year, no. of local community/people or SHG's engaged in aforementioned work may be provided to BCCL for onward submission to the concerned regulatory authorities.

13. TERMS OF PAYMENT

Total project cost is as per the estimate submitted by Forest Department. The payment schedule will be as follows: -

S No	Year of work	Financial Year	Name of the work	Estimated Amount (₹) by DFO, Dhanbad including contingency @ 5%
1.	1st year	2025-26	Advance and Completion work	13,14,085.68
2.	2nd year	2026-27	Maintenance work-1	2,12,008.78
3.	3rd year	2027-28	Maintenance work-2	1,93,847.24
4.	4th year	2028-29	Maintenance work-3	83,722.80
5.	5th year	2029-30	Maintenance work-4	51,540.30
6.	6th year	2030-31	Maintenance work-5	51,540.30
	TOTAL			**19,06,745.00**

14. The Forest department shall pay wages not less than the minimum wages fixed by the Govt of Jharkhand to the labourers engaged in the execution of the aforesaid work and it will be the responsibility of the Forest department to ensure the compliance of the payment of wages to its workmen/labourers as per law and company shall not be held responsible for the same.

15. The estimate has been submitted by Forest Department based on annual increment of 15% on prevailing labour wages of Govt of Jharkhand. However, the payment of Completion work, subsequent years' maintenance work will be made as per the actual labour wages of Govt of Jharkhand prevailing in the corresponding year. Therefore, the forest department shall certify the rate of labour wages for the corresponding year and raise demand letter/ bill based on the actual rates of labour wages to that corresponding year.

पंजीकृत कार्यालय: कोयला भवन, कोयला नगर, बीसीसीएल टाउनशिप, धनबाद, झारखंड -826005, भारत, फोन : 0326-2236000, वेबसाइट : www.bcclweb.in

16. In case of revision of minimum wages by the Govt of Jharkhand during the work, a revised estimate of the corresponding year of the scheme as per the work order shall be submitted to the company by Forest Department and claim/adjust the amount of difference in wages payable/paid due to increase in labour wages on the basis of man days works on revised wage for which the forest department shall certify.

17. **Paying Authority:** AFM, Govindpur Area, BCCL

18. All the payment will be made by ELECTRONIC MODE through bank in the account of DFO, Dhanbad. You are required to fill the format of Electronic Fund Transfer (EFT) in triplicate which is enclosed as annexure-A.

19. For release of the payment, you have to submit
    a) Utilization certificate of the preceding payment made to you in respect of this work order
    b) Joint inspection report of preceding year's work.
    c) Demand letter/Bill based on the actual rates of minimum wages by the Govt of Jharkhand to that corresponding year for payment.

    The utilization certificates along with joint inspection report shall be accepted by the accepting authority i.e. General Manager, Govindpur Area, BCCL.

20. BCCL shall not have any liability in case of any accident etc. towards Forest Department's personnel/ staffs /workers during the execution of the work.

21. As Child labour is prohibited and shall not be deployed in the aforesaid work.

22. All other conditions stipulated in aforementioned reference letters shall be complied.

23. Matter relating to any dispute or difference arising out of this work order shall be subject to the jurisdiction of Dhanbad court only.

19/04/2025

General Manager
Govindpur Area, BCCL

Copy to: -
1. GM (Envt), BCCL- for kind information please.
2. Project officer, Maheshpur Colliery
3. AM(Env)/AFM, Govindpur Area
4. Office copy

ANNEXURE-A

PROFORMA FOR COLLECTING PAYMENT THROUGH ELECTRONIC MODE INCLUDING ELECTRONIC FUND TRANSFER (ETF) & ELECTRONIC CLEARING SYSTEM (ECS)

1	VENDOR/SUPPLIER/CONTRACTOR/CUSTOMER'S NAME & ADDRESS (With Telephone No. and Fax No.)	
2	PARTICULARS OF BANK ACCOUNT	
	A) BANK NAME	
	B) BRANCH NAME (Including RTGS Code)	
	ADDRESS	
	TELEPHONE No. & FAX No.	
	C) 9 – DIGIT CODE NUMBER OF THE BANK & BRANCH (Appearing on the MICR cheque issued on the bank) OR 5 – digit code No. OF SBI	
	D) ACCOUNT TYPE (S.B. Account/Current Account OR Cash Credit with code 10/11/13)	
	E) LEDGER No./LEDGER FOLIO No.	
	F) ACCOUNT NUMBER (CORE BANKING) & STYLE OF ACCOUNT (As appearing on the cheque Book)	
3	DATE OF EFFECT	

I hereby declare that the particulars given above are correct and complete. If the transaction is delayed or not effected at all for reasons of incomplete or incorrect information, I would not hold the user institution responsible. I have read the option invitation letter and agree to discharge responsibility expected of me as a participant under the scheme. Any Bank charges levied by the Bank of such e-transfer shall be borne by us.

Date:

Signature of the Contractor

Certified that the particulars furnished above are correct as per our records.

Signature of the Authorized Officials
from the Bank

BHARAT COKING COAL LIMITED
(A Subsidiary of Coal India Ltd.)
भारत कोकिंग कोल लिमिटेड
Bharat Coking Coal Ltd
Govindpur area,,
PO: Sonardih,Dist- Dhanbad,Jharkhand,India-828125

Coal India Limited
A Maharatna Company
www.coalindia.in

Phone :
Fax :
Website : Email :
CIN : U10101JH1972GOI000918 GSTN : 20AAACB7934MFZB

SERVICE PURCHASE ORDER

PO No. : 5700440227 Date : 25/07/2025

To,
MANOJ KUMAR SINGH

AT.- SALANPUR, PO.- KATRASGARH

DHANBAD
DHANBAD
828113
Jharkhand
India

Vendor Code: 10021723
PAN: JMXPS9952M
GSTIN: 20JMXPS9952M1ZQ
Delivery Date: 31/03/2026
Department: Environment

Header Text:

Work order for plantation work at South Govindpur Colliery, Govindpur Area.

Detailed terms and conndition are prescribed in work order issued by Area Manager (Civil), Govindpur Area.

Item	Material/Service		Qty	Unit	Unit Price	Value	Net Value
10	plantation work at south govindpur						
	10	digging holes in ordinary soil	7500	NO	17.04 per 1 unit	127800.00	
	20	supplying & stacking at site good earth	357.670	M3	478.60 per 1 unit	171180.86	

	30	supply and stack cow dung manure	178.830	M3	246.57 per 1 unit	44094.11	933759.96
	40	mixing earth and sludge	536.500	M3	31.30 per 1 unit	16792.45	
	50	spreading of sludge	536.500	M3	45.03 per 1 unit	24158.60	
	60	earth work in excavation by mechanical	1312.200	M3	154.90 per 1 unit	203259.78	
	70	surface dressing of ground	6750	M2	20.40 per 1 unit	137700.00	
					Gross Price	724,985.8	
					Quoted Rate in %(9.15)	66,336.2	
					Goods & Services Tax	142,437.96	
					Value exclusive of Tax	791,322	
					Inp-Eligible- CGST-9%, SGST-9%, No TCS	142,437.96	

Net value	**933759.96**	INR

Amount in words :NINE LAKH THIRTY THREE THOUSAND SEVEN HUNDRED FIFTY NINE RUPEES NINETY SIX PAISE

Released By : OF(ENV)_2007

ANNEXURE-V

Report on

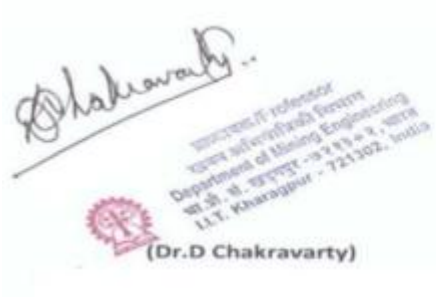
Study on Carbon Sequestration Status Including Carbon Emissions from Coal Mining in Cluster-III, Govindpur Area, BCCL

Submitted to:

CLUSTER-III, GOVINDPUR AREA, BCCL

Submitted by:

BISWAJIT SAMANTA
TAPAS BANDYOPADHYAY
DEBASHISH CHAKRAVARTY



IIT KHARAGPUR
JANUARY, 2026

Contents

Disclaimer 2
1.0 Introduction 3
2.0 Objectives 5
3.0 Scope of work 5
4.0 Description of the mine 6
5.0 Background approaches 6
5.1 Carbon emissions 6
Types of carbon emissions 7
5.2 Carbon sequestration potential 9
5.3 National and international standard 10
5.3.1 National guidelines 10
5.3.2 International standard: ISO 14064-1:2018 (Greenhouse Gases Quantification and Reporting of GHG Emissions and Removals at the Organizational Level) [15] 12
5.4 Compliance 13
6.0 Present study 14
7.0 Purpose of the present study 15
8.0 Methodology followed in the present study 17
8.1 Data source 17
8.2 CO_2 emission estimate 17
8.3 Use of electricity during proposed mining activities 18
8.4 Carbon sequestration due to afforestation/plantation 18
8.5: Geological carbon sequestration 20
9.0 Results and discussions 20
10.0 Recommendations 26
11.0 References 27

Disclaimer

It is appropriate to mention here that neither the day-to-day mining operations would be under the control of the authors of this report, nor it is possible to have any such control on the execution of the recommendations mentioned in this report. This report merely contains scientific analysis of some of the data and facts provided to the study team by the mine officials related to carbon dioxide sequestration and carbon emissions. Due to the dearth of data, some essential factors are assumed for this report. However, under the process of this study and preparation of the final report everything essential has been attempted to be considered and investigated based on their availability to the study team. The mine authorities have also been part of the final scrutiny of the results and interpretations. It is only after obtaining the acceptance from the mine authorities that the current report is being submitted. Calculation has been carried out with reasonable efforts and realistic assumptions wherever felt necessary. However, the authors and their organization is not anyway liable for any UN-intentional error in calculation and or analysis. The study team is willing to mention that the summary and suggestive methods drawn are purely based on the current scenario and the existing conditions which would definitely change in future as the activities progress. Thus the mining authorities need to get the similar scientific studies conducted in a regular manner for better understanding of the situations.

1.0 Introduction

Climate and environmental changes are becoming challenges day-by-day. Increase of greenhouse gases with toxic emissions including those due to anthropogenic activities, are among the major sources of environmental changes [1, 2, 3]. Although small amount of greenhouse gases is necessary for the formation and preservation of the life but increase in amount leads to violation of the ecological balance, both at the regional and global levels [1, 2, 3]. The greenhouse gas emissions directly or indirectly from human activity is commonly referred to as the carbon footprint [1, 2, 3], which is expressed in the carbon dioxide equivalent (CO_2e). It is considered to be the equivalent of carbon dioxide by multiplying the mass of a specific greenhouse gas by its global warming potential [3, 4]. Although different countries (Great Britain, the USA, France, etc.) and different international organizations (the UN, the World Resources Institute, the International Organization for Standardization, the World Bank, etc.) have different approaches to calculating the carbon footprint [3, 5, 6], but the goal is the same - to reduce the negative impacts of greenhouse gases.

Climate change has many health consequences for people around the world. There are three ways in which climate change affects human health. These are changes in weather conditions (heat, drought, heavy rains, etc.); the spread of diseases (vector-borne, water, and food); and social unrest (hunger, inequality, conflicts, etc.) [3, 7]. Thus, the increase in GHG emissions is considered as the cause of infectious and non-communicable diseases, negative consequences for nutrition, water security, and other social upheavals [3, 8].

In spite of the recent trend of a transition to “clean” energy, the coal industry still plays a significant role in the global energy and economy. The constant need for raw materials and energy for production leads to an environmental challenge - an increase in the content of greenhouse gases in the atmosphere. The extraction and use of coal are some of the main sources associated to this adventure.

The goal of this study is to analyze carbon footprint from the CLUSTER III mines of the BCCL and to provide suggestions on the ways to reduce the negative impacts of carbon footprint of the environment.

Electric power production organization and transport sector are the major sources of GHG emissions (like, sulphur dioxide, nitrous oxide, methane, sulphur hexafluoride, hydrofluorocarbons, perfluorocarbons, etc.). It has also been observed that deforestation and other changes in land use led to the release of carbon dioxide and methane into the atmosphere [3, 9].

Additionally, coal mines are also one of the largest sources of anthropogenic methane emissions [3, 10]. Coal mining releases methane trapped in the coal and surrounding formations.

The changes in global emissions are mainly caused by changes in the extraction and use of coal, while the growth in the use of oil and gas has not weakened since 1980 after the oil crises of the 1970s. Coal mining, processing enterprises, and the use of coal as fuel are among the sources of greenhouse gases that simultaneously pollute the environment with coal dust, emit toxic elements into groundwater, etc. [3, 10, 11].

Many analysts suggest that the use of coal may have reached its peak. The decline in the use of coal in the countries of the Organization for Economic Cooperation and Development (OECD) has decreased by 25% over the past decade. During the decade, a complete abandonment of fossil fuels, including hydrocarbons, as an energy source is unlikely, but the trend toward decarbonization is relevant and will continue, changing the economic structures of countries [3, 11].

In addition to the transition to renewable energy sources, in order to reduce the negative impact of coal mining enterprises on the environment and preserve the health of the local population, the following measures are relevant: efficient coal mining, intelligent mine construction, the development and modernization of key technologies and equipment for efficient coal processing, underground gasification, intelligent and flexible coal-based electricity generation technology, electricity production technology based on a new energy cycle, the development of special coal-based fuels, bulk and special coal-based chemicals, energy conservation and a reduction in consumption, large-scale and inexpensive carbon capture, and the utilization and storage of CO_2 [3, 11].

Mitigating measures for reducing greenhouse gas emissions initiated long back at the end of 20^{th} century. For example, the Protocol on Greenhouse Gas Emissions (Kyoto Protocol) entered into force around 2005 with an aim of stabilizing the concentration of greenhouse gases (GHG)

through a quota-based protocol for GHG emissions [3, 12, 13]. The Paris Agreement of 2015 provided a new mechanism for international climate management after 2020 and set a goal to control the increase in the global temperature by no more than 2°C and strive to ensure that it does not exceed 1.5°C in order to protect the ecological safety of the Earth.

This study is aimed at assessing the current state of the cluster III mines, studying the degree of the environmental impact of coal mining enterprises through the carbon footprint, and considering possible ways to reduce the negative consequences arising from the extraction and use of coal.

2.0 Objectives

The objectives have been summarized as follows:

(i) To determine and calculate CO_2 release from mining activities in Cluster III, Govindpur Area

(ii) To estimate CO_2 mitigation measure through plantation drive

(iii) To suggest suitable measures / steps to achieve net zero CO_2 emission

3.0 Scope of work

The following five becomes the scope for the present study:

i. **Quantification of Carbon Emissions:** Estimation of carbon emissions from coal mining operations based on Direct Emissions from Coal Mining and Processing including tra1sportation of coal. Indirect Emissions from Purchased Electricity for mining operations.

ii. **Current Carbon Sequestration Estimation:** (a) Evaluation of the existing carbon sequestration activities undertaken by BCCL, including afforestation, land reclamation. and soi! carbon enhancement. (b) Quantification of CO_2: absorbed through plantation programs based on species type, age, and density. (c) Assessment of carbon storage in rehabilitated mine-overburden dumps and reclaimed lands.

iii. **Carbon Sequestration Potential Enhancement:** (a) identification of additional carbon sequestration techniques such as expanded afforestation. biochar application, and carbon capture and storage (CCS). (b) Potential for increasing sequestration through improved plantation models. agroforestry, and soil carbon enhancement practices.

iv. **Compliance with International and National Standards:** Carbon accounting methodology aligned with ISO 14064-1:2018 (Greenhouse Gases Quantification and Reporting of GHG Emissions and Removals at the Organizational Level).

v. **Policy and Strategic Recommendations:** Development of a carbon-neutral roadmap for coal mining operations in Cluster-III., BCCL.

4.0 Description of the mine

The CLUSTER III is in the westernmost part of the Jharia coalfield. It includes Jogidih Colliery, Maheshpur Colliery, South Govindpur Colliery, Teturiya Colliery, Govindpur Colliery, New Akasshkinaree Mine and Block IV Kooridih Mixed Mine as per E. C. No. J-11015/213/2010-IA. II(M) dated 06.02.2013 and later all seven mines are amalgamated to a single mine Named Cluster III with OC cum UG with Highway Mining method with no change in lease area and production capacity. The cluster - III is situated about 40 - 45 kms from Dhanbad Railway Station. The mines of this cluster - III are operating since pre nationalization period (prior to 1972-73). It is connected by both Railway and Road. The drainage of the area is governed by Khudia and Bagdighi Nala. The Project has Environmental Clearance from Ministry of Environment, Forest and Climate Change (MoEF&CC) for a rated capacity of 2.769 MTPA (normative) and 3.6 MTPA peak capacity of coal production vide letter No E. C. No. J-11015/213/2010-IA. II(M) dated 06.02.2013 later with E. C. No. J-11015/213/2010-IA. II(M) dated 03.03.2025.

5.0 Background approaches

5.1 Carbon emissions

The main sources of CO_2 emissions from coal mining include energy use, GHG emissions, spontaneous combustion of coal, waste rock and stock yard. Many gases formed as a result of combustion are formed during conventional coal mining, but the concentrations of these gases vary depending on environmental changes, so there is no unified approach to assessing greenhouse gas emissions during coal oxidation.

Other sources of CO_2 emissions also include drainage systems, ventilation systems, staff energy consumption per day, office space consumption, transport systems, etc. In open-pit coal mining, the following stages at which carbon dioxide emissions are generated must be taken into account: use of materials (concrete, steel, etc.), as well as appropriate machines (road builder, excavator, etc.). It is necessary to take into account the processes of crushing, loading, transporting, fixing the roof, and processing coal on site. All processes generate a large amount of carbon dioxide.

The use of machinery, explosive and blasting are the main sources of carbon emissions considered for the mine. Spray-type pumping stations that consume electricity are widely used in the face to reduce the amount of dust; they produce GHG emissions.

Types of carbon emissions

Understanding the different types of carbon emissions is essential for developing effective measurement and mitigation strategies. Carbon emissions largely impact climate change, environmental health, and regulatory compliance. By recognizing the two primary categories—direct and indirect emissions—one can better assess the contributions to global warming. The following sections will delve into each type, highlighting the distinctions, implications, and their relevance in carbon accounting.

Direct Emissions

Direct emissions refer to greenhouse gases released from sources owned or controlled by an entity. This includes emissions from fossil fuels, combustion in vehicles, heating systems, and production operations in mining. Measuring these emissions is relatively straightforward. Organizations can directly tally the amount of fuel used and the corresponding emissions produced. Key considerations for direct emissions include:

Source Identification: Companies must identify specific operations contributing to emissions.

Measurement Accuracy: Reliable data collection methods are required to ensure that calculations reflect actual emissions.

Regulatory Compliance: Organizations must adhere to local and international regulations governing emissions reporting.

Direct emissions are critical in determining an entity's overall carbon footprint. As such, they are often the initial focus for environmental initiatives aimed at reducing impact. By reducing direct emissions, organizations can make significant strides in achieving their sustainability goals.

Indirect Emissions

Indirect emissions arise from the generation of purchased electricity, steam, heating, and cooling consumed by an entity. Unlike direct emissions, these emissions occur at facilities not owned or controlled by the entity. They reflect energy usage rather than the immediate control of emissions sources. They often represent a significant portion of an organization's total carbon footprint. Addressing indirect emissions is crucial for a comprehensive climate strategy. It reflects the entire lifecycle of a product, from production to disposal. Different measurement techniques are used to assess carbon emissions. Understanding these techniques are crucial in managing, monitoring and assessing emission level. Proper analysis and interpretation of collected data would help in policy development measures. By employing precise measurement methods, stakeholders can better assess their carbon footprints and the resulting implications on sustainability efforts. The accuracy of these methodologies, as mentioned below, helps to ensure that resources are allocated effectively, thus maximizing the impact of any initiated solutions.

Top-down Approaches

Top-down approaches for measuring carbon emissions primarily involve aggregated data collection. This technique uses national or sector-wide statistics to estimate emissions. The process often relies on existing government databases and broad economic indicators. For instance, a country might analyze its total energy consumption to estimate the resulting greenhouse gas emissions. One of the main benefits of top-down methodologies is their efficiency. They can provide quick estimates without needing specific data from every individual source. However, this method has drawbacks. It may overlook localized emission sources, leading to significant discrepancies in understanding actual emissions.

Bottom-up Approaches

Bottom-up approaches, conversely, focus on more granular data collection. These methodologies gather specific data from individual sources, like factories or businesses, to

create a more detailed picture of emissions. For example, a corporation may track its energy usage and waste processes closely to calculate its total emissions. The precision of bottom-up approaches means they often yield more accurate emissions estimates. However, they can be resource-intensive and time-consuming. Businesses may need to invest in robust data collection systems to compile and analyze this detailed information.

Hybrid Approaches

Hybrid approaches combine aspects of both top-down and bottom-up methodologies. This integration allows for comprehensive data collection and representation of emissions across various scales. For instance, national-level estimates might be adjusted based on sector-specific data to fine-tune accuracy. Hybrid methodologies aim to leverage the strengths of both techniques, offering a more balanced view of emissions. They not only increase reliability but also promote better policy formulation. Nevertheless, implementing hybrid approaches can be complex, as they require coordination between various agencies and stakeholders. Nonetheless, the potential for a more informed understanding of carbon emissions makes this approach valuable in the fight against climate change.

5.2 Carbon sequestration potential

According to reported literature [14], about 11.5 % of the global terrestrial area is affected by mining activities. Ecologically damaged mining areas are usually featured by soil depletion and low organic carbon content, and ecological restoration may help improve carbon sequestration potential in these regions. Vegetation restoration is considered to be an effective method to increase the organic matter input to soils and promote the soil carbon sequestration. Mining activities can also induce a series of problems, such as enrichment of toxic elements, soil acidification, and groundwater disturbances, which further restrict the vegetation growth at the mining sites. For example, tailings and waste land which are rich in heavy metals concentration are in general, deficient in essential nutrients for vegetation growth. Therefore, tailings and waste land is highly unsuitable for seed germination and plant growth. Notably, dynamic response of SOC varies with the vegetation restoration type, which might have a direct influence on the litter mass. Usually, the litter mass of herbaceous plants is higher than that of ligneous plants. According to some studies, the SOC reserve may increase, decrease, or remain

constant after afforestation, depending on the forest age, climate, soil type, and many other factors. Researchers [14] found that compared with ligneous plants, herbaceous plants exhibit a higher efficiency in accumulating the SOC and nutrients during vegetation restoration in mining areas, which may be explained by the higher biomass decomposition rate of herbaceous plants. Other researchers had shown that the type of vegetation was a primarily reason affecting the changes in the soil carbon and its dynamics, as it influences the physical and chemical protections offered by soil aggregates for organic matters. Studies on soil and vegetation development at the early stage of vegetation succession during ecological restoration in mining areas indicated that the soil carbon content decreases significantly under the restoration of ligneous vegetation. It is also clear that vegetation restoration in degraded mining areas takes considerable time. However, the nutrient cycling and ecosystem carbon sequestration mediated by plant-soil interactions may not overlap in spatial and temporal orders. For this reason, the timing of introducing different forest stands, number of years of vegetation restoration, and plant combination can have a dramatic impact on carbon sequestration potential in mining areas.

5.3 National and international standard

5.3.1 National guidelines

In line with India's Panchamrit & Nationally Determined Contribution (NDC) commitments, Ministry of Coal is promoting sustainable coal mining and reduction in carbon footprint by encouraging the following as presented below in verbatim.

1. Greening Initiatives—Bio-Reclamation/Plantation: The Coal/Lignite PSUs have been constantly making efforts to minimize the footprints of coal mining through sustained reclamation and afforestation of areas in and around their operating mines.
2. Energy Efficiency Measures: Coal/Lignite PSUs have been taking various energy conservation and efficiency measures over the years to reduce carbon intensity such as replacement of conventional lights with LED lights, installation of energy-efficient air conditioners, super fans, deployment of EVs and installation of efficient water heaters, energy-efficient motors for pumps, auto timers in street lights etc.
3. Green Credit Programme: Coal PSUs are also participating in extensive plantation under Green Credit Program launched by MoEF&CC.

4. First Mile Connectivity (FMC) projects: The Coal PSUs have taken steps to upgrade the mechanized coal transportation and loading system under 'First Mile Connectivity' projects. Commissioning of FMC projects in coal mining areas reduces consumption of diesel significantly and therefore reduces carbon emissions.
5. Deployment of Blast free technology in coal mining: Coal companies are deploying modern equipment having environment friendly features, like Surface Miner, Continuous Miner in coal mining, which eliminates the drilling, blasting and crushing operations in coal and hence, in turn, obviates pollution caused due to these operations. Rippers are also being deployed for blast-less removal of overburden in some mines.
6. Renewable Energy and clean coal initiatives: Coal PSUs have also started commissioning Renewable Energy power projects. Additionally, they are venturing into various clean coal technologies like Coal gasification, Coal Bed methane (CBM) etc.

Sustainable coal production is being promoted by ensuring compliance with applicable environmental laws like prior Environmental Clearance (EC), Forest Clearance (FC), Consent to Operate (CTO), Consent to Establish (CTE) etc. In addition, the steps adopted to reduce carbon emissions and environmental impact due to coal mining includes:

- Use of surface miners, continuous miners, highwall / longwall mining, etc.
- Increasing installation & usage of First Mile Connectivity (FMC) initiatives to reduce coal transport via roads.
- Improving energy efficiency across coal mining projects. Reclamation and eco-restoration of mined-out areas including development of eco-parks, mine tourism sites, etc.
- Conceptualizing re-purposing of de-coaled areas for sustainable uses like installation of renewable energy generation plants, development of agricultural avenues for surrounding communities, development of mine sumps, etc.
- At present, there is no specific directive / guideline stipulating the number of times mining companies are required to review their Environmental Impact Assessment (EIA), particularly with reference to carbon emissions.

5.3.2 International standard: ISO 14064-1:2018 (Greenhouse Gases Quantification and Reporting of GHG Emissions and Removals at the Organizational Level) [15]

ISO has specific standards on GHG Quantification, Reporting and Removals at the Organizational Level. The main principles and requirements for designing, developing, managing and reporting organization-level for GHG are summarized here. It includes requirements for determining GHG emission and removal boundaries, quantifying an organization's GHG emissions and removals, and identifying specific actions or activities aimed at improving GHG management. It also includes requirements and guidance on inventory quality management, reporting, internal auditing and the organization's responsibilities in verification activities.

ISO 14064-2 details principles and requirements for determining baselines, and monitoring, quantifying and reporting of project emissions. It focuses on GHG projects or project-based activities specifically designed to reduce GHG emissions and/or enhance GHG removals. It provides the basis for GHG projects to be verified and validated.

ISO 14064-3 details requirements for verifying GHG statements related to GHG inventories, GHG projects, and carbon footprints of products. It describes the process for verification or validation, including verification or validation planning, assessment procedures, and the evaluation of organizational, project and product GHG statements.

ISO 14065 defines requirements for bodies that validate and verify GHG statements. Its requirements cover impartiality, competence, communication, validation and verification processes, appeals, complaints and the management system of validation and verification bodies. It can be used as a basis for accreditation and other forms of recognition in relation to the impartiality, competence and consistency of validation and verification bodies.

ISO 14066 specifies competence requirements for validation teams and verification teams. It includes principles and specifies competence requirements based on the tasks that validation teams or verification teams have to be able to perform.

ISO 14067 defines the principles, requirements and guidelines for the quantification of the carbon footprint of products. The aim of ISO 14067 is to quantify GHG emissions associated with the life cycle stages of a product, beginning with resource extraction and raw material sourcing and extending through the production, use and end-of-life phases of the product.

ISO/TR 14069 assists users in the application of this document, providing guidelines and examples for improving transparency in the quantification of emissions and their reporting. It does not provide additional guidance to this document. The relationship among the ISO 14060 family on GHG is presented below.

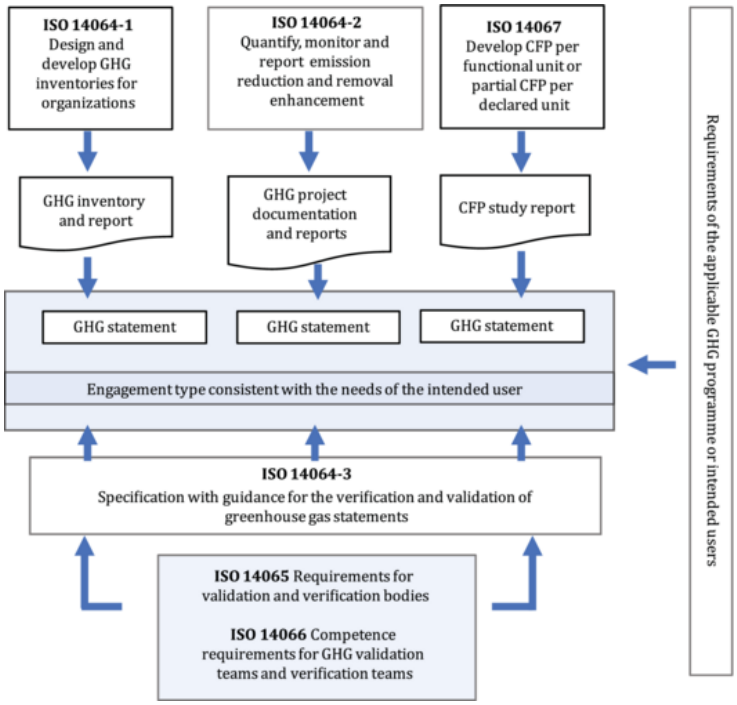


Figure 1: Diagrammatic illustrations of the relationship among the ISO 14060 family of GHG standards [3].

5.4 Compliance

Compliance with ISO 14064-1:2018 means that carbon accounting methodology quantifies and reports organizational greenhouse gas (GHG) emissions and removals according to international standards, covering design, management, reporting, and verification, ensuring credibility, transparency, and alignment with global climate goals by categorizing emissions and facilitating reduction strategies, often alongside the GHG Protocol.

Key Aspects of ISO 14064-1:2018 Compliance:

- **Organizational Boundary:** Defines the scope of emissions and removals to include (e.g., operational control, equity share).

- **Quantification:** Calculates GHG emissions and removals for specific categories (e.g., direct, imported energy, transport, product use).
- **Reporting:** Ensures transparent reporting of methodologies, data, and results, enhancing credibility.
- **Verification:** Provides requirements for internal and external auditing to confirm inventory accuracy.
- **Management:** Supports developing strategies for emissions reduction and tracking performance.

Benefits of Alignment:

- **Credibility:** Increases trust in environmental data through consistent, transparent methodologies.
- **Regulatory Readiness:** Helps meet evolving national and international climate regulations.
- **Strategic Improvement:** Identifies opportunities for effective GHG management and mitigation.
- **Global Recognition:** Aligns practices with frameworks like the UN SDGs and supports carbon neutrality goals.

By adhering to ISO 14064-1:2018, organizations establish a robust, verifiable framework for their carbon footprint, moving beyond basic measurement to effective management and reporting.

6.0 Present study

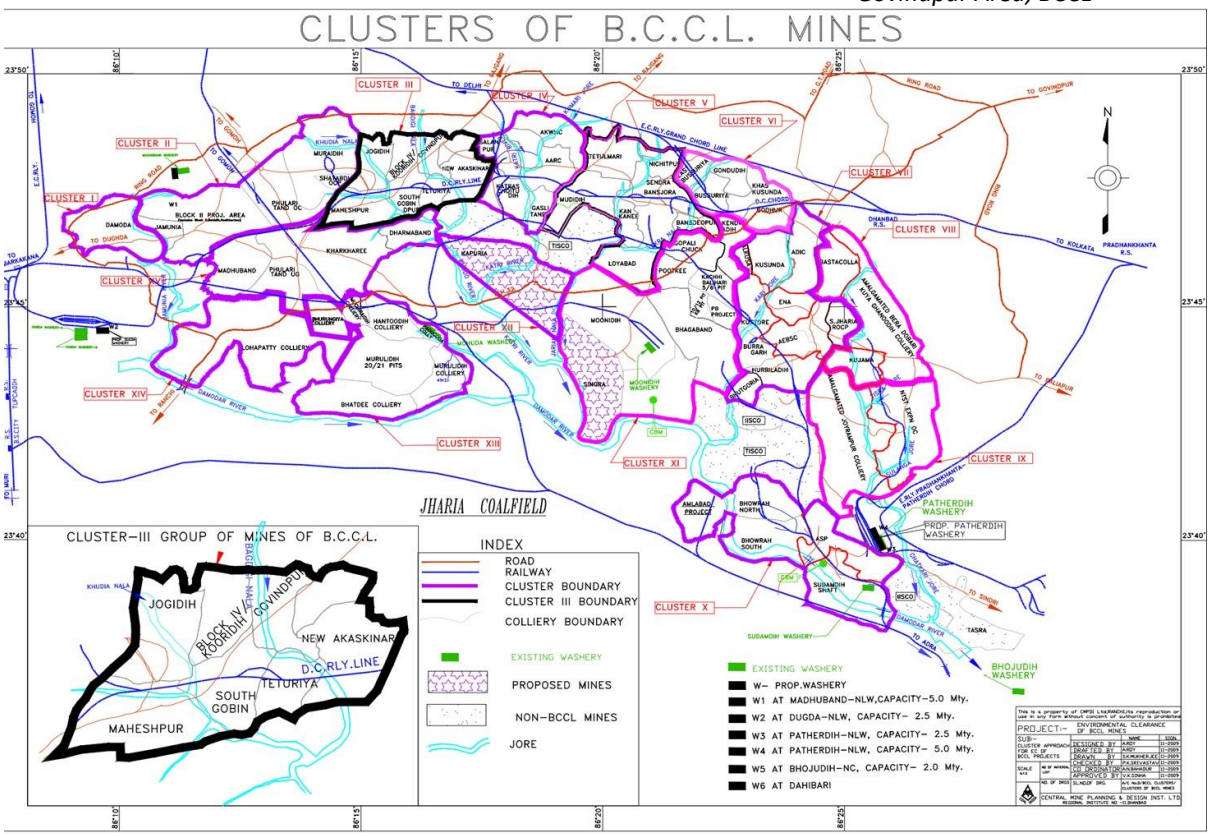
Bharat Coking Coal Limited (BCCL) is a major Indian public sector coal mining company, formed in 1972. Govindpur is a major coal hub in India's coal belt, managed by BCCL for significant coal output, integrating modern mining practices with extensive regional management. The extraction and operation method impacts environment that includes flora, fona along with ecosystem as a whole. It impacts air, water quality that further affect human health.

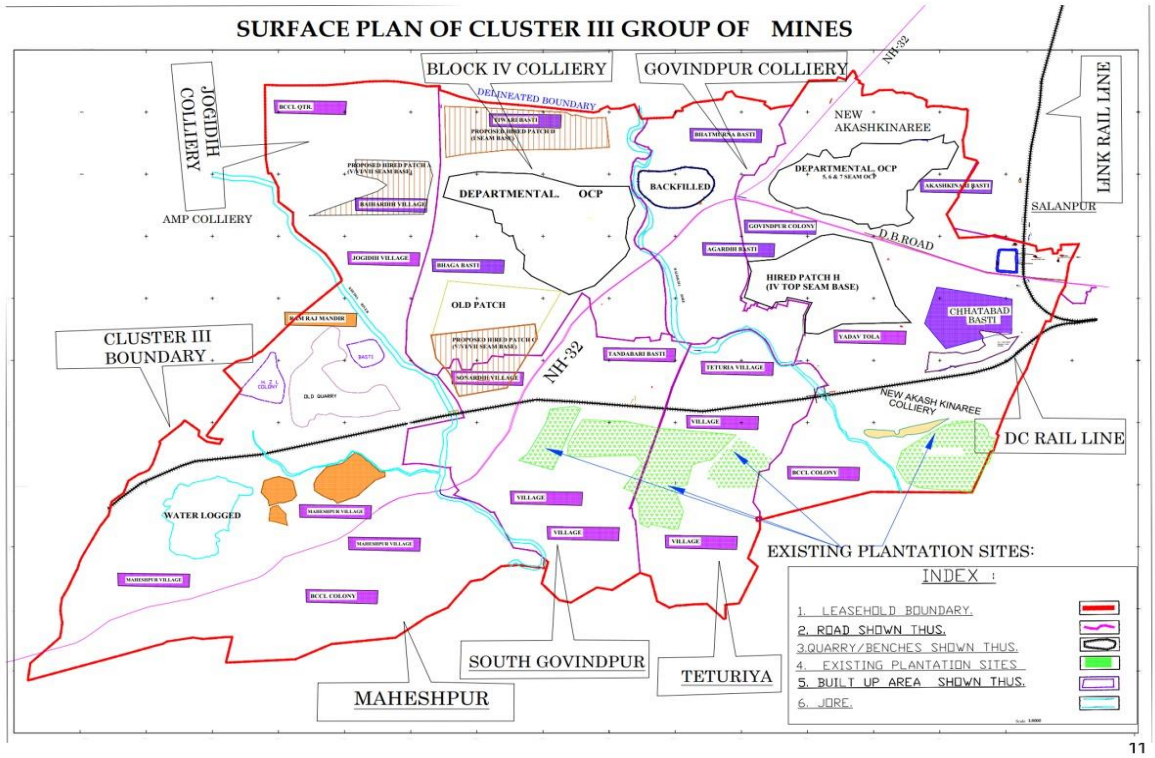
The Cluster III coal mines (Figure 1) of Govindpur area, face typical coal mining environmental issues as mentioned, the mine has implemented mitigation measures such as

water treatment plants, extensive reclamation, and habitat restoration plans, with ongoing monitoring for heavy metals and dust, aiming to balance mining with environmental protection in the Jharia coalfield region. These should be continued with proper monitoring and scientific analyses for strengthening their endeavour.

7.0 Purpose of the present study

According to global emission regulations, greenhouse gas (GHG) emissions have become one of the most critical environmental challenges faced by every nation. The world has been increasingly witnessing natural disasters such as floods, storms, wildfires, heatwaves, droughts, poor air quality, bushfires, and cyclones that are expected to intensify in both frequency and severity in the near future as per the various regulatory and environmental agencies.





B

Figure 1: Location and Surface Maps of (A) BCCL Clusters and (B) Cluster III Mine of Govindpur area

Among all greenhouse gases, carbon dioxide (CO_2) is the most significant contributor, accounting for the largest share of total emissions. According to the Intergovernmental Panel on Climate Change (IPCC), the concentration of CO_2 in the atmosphere has increased by approximately 40% since the pre-industrial era. Coal Mines under operation contribute significantly in CO_2 generation in form of fleet movement, power consumption etc. Govindpur coal mines produces good amount of coking and non-coking coal from open pit and underground mines. Mining activities lead to generation of GHG, CO_2. Authority has desired to achieve "Net Zero CO_2 emission". In this regard, BCCL authority has approached to IIT Kharagpur study team to take up a study for assessing present status of CO_2 emission and possible suggestions for sequestration measures. IIT study team visited the site along mine officials to comprehend overall gamut of the study.

8.0 Methodology followed in the present study

8.1 Data source

As provided and or collected during field visit. The same is represented as follows;

- Energy consumption, Vehicular Movement and Plantation Data are attached in Exhibit

8.2 CO_2 emission estimate

Diesel Consumption

Mining machinery will discharge carbon dioxide into the environment. The emission of same carbon dioxide increases the carbon footprint. Further, it is considered that a diesel vehicle contributes to CO_2 emissions, though generally less than a gasoline vehicle per kilometer driven due to its better fuel efficiency; it still produces a significant amount of CO_2 that contributes to climate change.

There is large variation in data on diesel consumption. Diesel consumption for the entire year for HEMM has been considered as 3.2 million liter (32 lac liter). However, on account of vehicle trips for coal despatch from the mine to the destination during the period of 01.01.2025 to 30.06.2025, it is noted that total distance travelled is 141929.55 km. On this basis, the diesel consumption due to this vehicular movement is 37847.88 litre (considering, per-liter fuel efficiency for a mining dumper in India is highly variable, but figures like 3.0 to 5.0 kilometers per liter (kmpl) are common for unloaded and loaded conditions, respectively, while a heavier dumper may average around 3.75 to 4 kmpl). Hence, accounting both the consumptions

together, diesel used per year has been calculated as 3654175 liter.

From the literature (https://www.autolexicon.net/en/articles/vypocet-emisi-co2/), CO_2 produced due to burning of one-liter diesel fuel is approximately 2.64 kilograms. Hence, CO_2 produced per year due to diesel fuel consumption is 9647 ton per year.

8.3 Use of electricity in mining activities

Electricity used during mining operations is a secondary source of CO_2 emission for the mine. The data records from the mine suggest that the total electricity consumed by the mine due to various operations is 85698736 kwh over the period of one year (considering progressive energy consumption instead of base level). It is also found that solar panels installed in the mine produced 88 kWp at present (1 kWp generates ~1400-1600 kWh/year) (https://www.eai.in/ref/ae/sol/rooftop/power_output). Assuming, an average value of 1500 kWh/year, the equivalent electric energy that is produced from the solar roof top is 132,000 kWh/year. Hence, adjusted amount of CO_2 due to electricity consumption is 38077 ton of CO_2 per year. It may be noted that the global average for CO_2 produced per kWh of electricity is 445 grams (g CO_2/kWh) in 2024 (https://www.iea.org/reports/electricity-2025/emissions).

Mining-induced deforestation

It is reported that mining induced deforestation is significant. Literature suggest between 2001 and 2020, mining and related activities removed 1.4 million hectares of trees, emitting 36 million tonnes of CO2 equivalent annually. The same has not considered in the present study.

• Carbon Sequestration Measure

8.4 Carbon sequestration due to afforestation/plantation

It is reported that a significant increase in carbon footprint would be observed due to felling of trees. On the contrary, substantial amount of CO_2 sequestration occurs during plantation/afforestation by photosynthetic activities.

Hence, it is required to calculate and analyse the amount of carbon dioxide that will be sequestrated due to plantation drive.

There is, as such, no standard methodology to calculate carbon sequestration due to afforestation. The most cited method with some assumptions has been used for the present study [Source: https://www.ecomatcher.com/how-to-calculate-co2-sequestration/].

The formula used for the present work is as follows;

- Yearly rate of CO_2 sequestration/ CO_2 due to afforestation (TCx3.67)/ Age of tree.
- TC= TDW x 0.5; TDW= 0.725 x TB, TB= AGB + 0.2 BGB;
- AGB= 0.25 xD^2x H; [TC: TOTAL CARBON; TDW: TOTAL DRY WEIGHT, AGB: ABOVE GROUND LEVEL, D: MEAN OF GIRTH DIAMETER, TB: TOTAL BIOMASS, H: HEIGHT OF TREE ASSUMED TO BE 50 x D]

8.4.1: Carbon sequestration through Algal Biomass:

Research indicates that the use of microalgae for CO_2 sequestration helps in mitigating global warming.

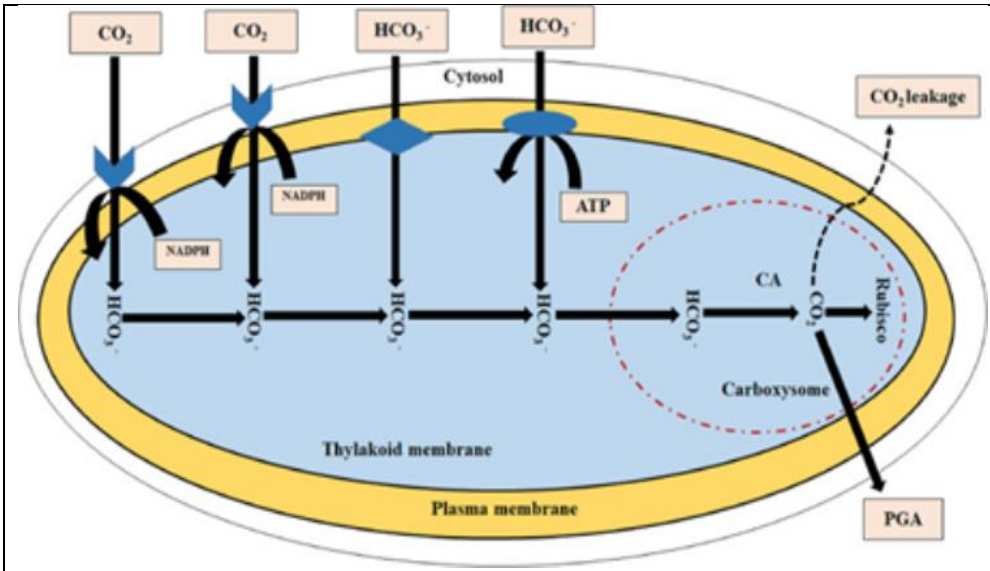


Figure 2: CO_2 sequestration in microalgae species: Calvin cycle.; source: https://doi.org/10.1016/j.clce.2022.100044

Carbon uptake by microalgae varies from species to species. CO_2 uptake rates is of 160–175 mg of biomass per liter per day approximately. Carbon sequestration efficiency of some variety of microalgae is around 4.8 kg of CO_2 per kg of biomass. However, the commercial viability of microalgae has been challenged by high production costs, technical complexities, and regulatory gaps. But, it is expected to be considered one of the viable option in near future, eg creation of small water body, cultivation of microalgae of proper variety.

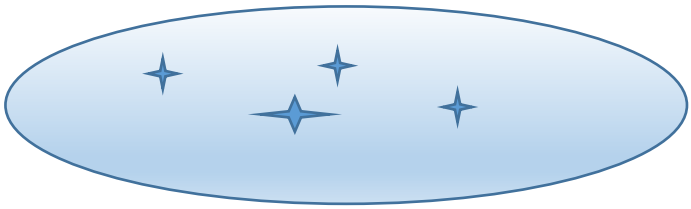


Figure 3: Water body and microalgae cultivation

However, contribution of this factor is unknown due to lack of data.

8.5: Geological carbon sequestration

The geological sequestration of CO_2 in coal seams holds significant implications for coalbed methane development and greenhouse gas mitigation. Methods includes transportation and injecting it via wells.

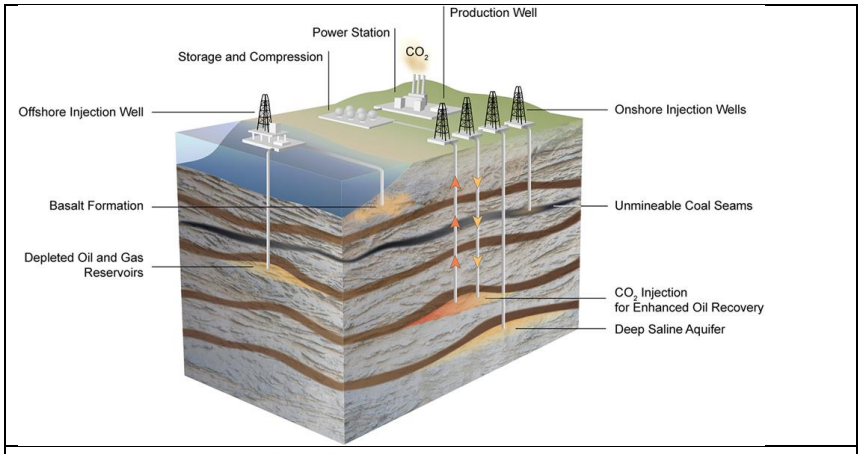


Figure 4: Geological carbon sequestration;
source: https://doi.org/10.1016/j.earscirev.2021.103895

However, contribution of this factor is unknown due to lack of data.

Soil Carbon Sequestration

Soil store carbon as Soil organic matter. Soil Carbon Sequestration is calculated using the formula, SOC content x BD x Soil Depth. [SOC=Soil Organic Carbon, BD=Bulk Density].

9.0 Results and Discussions

This section summarises the outcomes of the study including calculations of emissions based on the available data following the IPCC and other standards. The outputs are presented in the following sub-sections:

1. Quantification of Carbon Emissions (in the form of CO_2)

Table 1: **Quantification of Carbon Emissions (in the form of CO_2)**

Key Emission Sources	Factors	Amount (ton / year)	Remarks
Energy Consumption (Indirect Emissions)			
	Electricity: Factor for purchased electricity (kg CO_2e/kWh).	38077	
	Fuel Combustion (Vehicles, Machinery): EFs for diesel, petrol (kg CO_2/litre) based on IPCC guidelines, considering fuel type and usage.	9647	
Methane (CH4) Emissions (Direct), NO_X and SO_X			
	Fugitive Methane: Varies greatly; use IPCC Tier 1 (global average, e.g., 10-25 m^3/tonne coal) or Tier 2 (country-specific, measured) factors.	Unknown	Continuous monitoring data for SO_x and NO_x data are available. However, CO_2 equivalent of the above emissions are considered in diesel and explosive related emission.
	Spontaneous Combustion: Factors for CH_4 release from burning coal/gangue.	75.02 to 286.03 g /s / m^2	Stockyard area is unknown.
Explosives			
	EFs for emissions from explosives used in blasting.	337 ton of CO_{2e} /yr (@0.19 kg CO_{2e}/ ton of explosives and 1773 tonne explosive/yr)	Details of site-specific factors (e.g., explosive composition, rock type, blast design, and weather conditions) are unknown.
Other Sources			
	Ventilation/Drainage: Factors for compressed air and drainage (e.g., 1.01 x 10^{-2} t CO_2/m^3 for ventilation).	Not applicable.	Not applicable.

2. Current Carbon Sequestration Estimation

Table 2: Current Carbon Sequestration Estimation

Key Emission Sources	Factors	Amount (ton / year)	Remarks
For Plants/Trees			
	Measure Biomass: Measure tree height, diameter (DBH), and circumference to estimate above-ground biomass	1293	Details are in EXHIBIT.

	(AGB) using established formulas. Estimate below-ground biomass (BGB) using root-to-shoot ratios, often tied to AGB. Total Biomass (TB) = AGB + BGB		
	Calculate Carbon Content: Carbon (C) = Total Biomass (dry weight) × 0.50 (50%). Convert to CO_2 Equivalent (CO_2e): CO_2e = Carbon (C) × 3.67 (ratio of CO_2 molecular weight to Carbon's). For annual sequestration, divide the total CO_2e by the tree's age or use growth rates.		
For Soil			
	Sample: Collect soil samples from different locations within your area. Analyze: Dry samples, measure their mass, and determine the percentage of organic carbon content (%). Calculate Stock Change: Compare measurements over time, accounting for soil bulk density and depth, to find the change in stored carbon.	Soil samples data are available for core zone as well as nearby villages (Pl. see exhibit)	Parameters of organic carbon, types of soil, soil density may be useful to estimate SOC. Based on the data, equivalent CO_2e is 7.5 ton/Ha. On this basis, amount sequestrated to be 750 ton.

3. Carbon Sequestration Potential Enhancement

Table 3: Suggestive Measures for Carbon Sequestration Potential Enhancement

Key Sources	**Factors**	**Action Plan**	**Remarks**
Ecological Restoration and Land Management			
	Revegetation with Optimal Species: Planting appropriate vegetation is the primary way to sequester atmospheric CO_2 into plant biomass and soil organic carbon (SOC). Forestland is a major carbon sink Species Selection Multi-tier Vegetation	270 Ha plantation considering existing plantation drive along with capacity of 2.4 MT per year. However, it will be 423 Ha for 3.6 MT per year capacity. Around 4.8 kg of CO_2 per kg of biomass	The same will reduced to 23.3 Ha and 38.6 Ha for 2.4 MT/year and 3.6 MT/year production capacity respectively using Miyawaki plantation with plant density 25000 per Ha. Exploration of biomass cultivation in water bodies is suggested.
	Soil Reconstruction and Improvement: Mining activities often leave behind poor quality soil (mine spoil) that lacks organic matter. Topsoil Management Organic Amendments Soil Aggregation	Soil organic carbon contain in the core zone and surrounding villages are measured to be 0.5%	-----
	Sustainable Land Use Planning: Long-term carbon sequestration requires a shift to sustainable land use.	-------	--------

	Reclaimed land can be repurposed for: Agriculture Ecotourism or Protected Areas		
Technological and Engineering Solutions			
	Renewable Energy Integration: Utilizing abandoned mine land for renewable energy infrastructure can indirectly enhance carbon sequestration efforts by displacing fossil fuel use. **Solar Farms Pumped Storage Hydropower**	To generate 1 kWh (1unit) of electricity daily, you generally need about **80 to 100 square feet (approx. 8–10 square meters) from solar Panel**	May adopt Solar Panel Installation

4. Compliance with International and National Standards

This needs to be complied with the national policy issues.

5. Policy and Strategic Recommendations

1. Bio-Reclamation/Plantation: The mine is continuously doing plantation to minimize the footprints of coal mining through sustained reclamation and afforestation. This should be continued and possibly further enhanced.
2. Non-efficient / old machinery to be replaced by energy-efficient new ones.
3. It is suggested to take various energy conservation and efficiency measures over the years like replacement of conventional lights with LED lights, installation of energy-efficient air conditioners, super fans, deployment of EVs and installation of efficient water heaters, energy-efficient motors for pumps, auto timers in street lights etc.
4. Use and deployment of Blast free technology in coal mining to be encouraged.
5. Modern equipment having environment friendly features, for Surface Miner, Continuous Miner etc., which eliminates the drilling, blasting and crushing operations in coal, to be increased in operations.
6. The mine is using solar panels which should be further propagated.

Table-1

Year	Land, Ha	Plant density	Total Plant	Total Plants	Survival (0.95)	Height (m)	Diameter (m)	AGB	BGB	Total	TDW	TC	Yearly rate (TC/yr)	Age of Tree (yr)	Total CO_2 (kg)	Per year CO_2 (tonne)
2017-18	17.5	2500	43750	43750	41563	10.5	3.5	9.18	1.83	11	7.99	3.99	14.66738	7	609613	87.09
2018-19	5	2500	12500	12500	11875	9	3	6.75	1.35	8.1	5.87	2.94	10.77604	6	127965.45	21.33
2020-21	9.5	2500	23750	23750	22563	6	2	3	0.6	3.6	2.61	1.31	4.78935	4	108059.71	27.01
2021-22	23	2500	57500	57500	54625	4.5	1.5	1.69	0.34	2.03	1.47	0.73	2.694009	3	147160.26	49.05
2010	10	2500	25000	25000	23750	15	6	22.5	4.5	27	19.58	9.79	35.92013	15	853102.97	56.87
2000	43	2500	107500	107500	102125	25	9	56.2	11.25	67.5	48.94	24.5	89.80031	25	9170856.91	366.83

Where:

TC: Total Carbon
TDW: Total Dry Weight
AGB: Above Ground Level, kg
D: Mean of Girth Diameter, m
TB: Total Biomass, kg
H: Height of Tree Assumed to be 50 x D (m)

10.0 Recommendations

It is observed from above tables that there is huge gap of carbon dioxide generation due to mining activities and carbon dioxide fixation due to plantation. The calculated gap with present capacity of 2.4 MT per year is 46768 ton per year. In order to reduce the gap, there is a requirement of huge plantation drive i.e 708606 number. Considering present plant density (2500 per Ha), plantation area that is required is 270 Ha.

Further, the same may be increased to 1092295 number of plants with plantation area 423 Ha. for increased capacity of 3.6 MT production per year.

Hence, it is observed that traditional approach i.e through plantation drive is not practically feasible to achieve "Net Zero" production, even with carbon dioxide solely.

Alternative approach may be the mixed method along with existing plantation mode and/ or type such as;

(A) May consider Miyawaki plant with average plant density 25000 per Ha, if agro climatic condition permit the same. [https://doi.org/10.1016/j.tfp.2025.100925]. Further, literature

support that the said plant can grow in India [https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=1983156].

Calculation reflects that the plantation drive with Miyawaki plant with presumption of carbon capture capacity of normal mature plant, the plantation area requirement may be reduced drastically.

The additional plantation requirement for net zero with the above stated plantation, Miyawaki drive for 2.4 MT per year capacity may be 23.3 Ha and for 3.6 MT per year may be 38.6 Ha approximately.

(B) Partial microalgae cultivation in water body. The same will generate alternative business avenue in the form of biomass that is having fuel and/or food value.

(C) Using fleet management, the diesel consumption may further be curbed. Further, there is a need of proper monitoring of diesel consumption. Published literature indicate implementation of AI for management of HEMM, dumper etc. Further research paper such as (J. Phys.: Conf. Ser. 2683 012010) suggested different alternative approaches to reduce carbon.

(D) Auditing of energy/electricity consumption in base level and installation of solar roof top with higher kWp may be adopted. To generate 1 kWh (1 unit) of electricity daily, you generally need

about 80 to 100 square feet (approx. 8–10 square meters. May think about 1000 sq mt solar installation to generate 100kWp.

Hypothetical Model

Assuming a hypothetical model mine along with activities to achieve "NET ZERO" with targeted capacity of 3.6 MT/year.

a) Microalgae cultivation in water body. Consider 30 Ha. water body for cultivation. Biomass/microalgae that can be cultivated in waterbody with yield around 25 ton/Ha/year. Total cultivation =750 ton/year. One ton of microalgae biomass can sequestrate roughly 1.83 tons of CO_2. Hence, the carbon sequestration through microalgae = 1372 ton per year.

b) Diesel consumption may be reduced to 25,00,000 liter/year, resulting in 7150 ton/year of CO_2 produced. The same can be accomplished with alternative use of material transport that include EV.

c) Net use of Energy/Electricity may be reduced using solar roof top installation with higher capacity, and any other renewable energy sources so that resulting CO_2 produced would be 2025 ton/year. It is reported that A 1 kWp (kilowatt-peak) solar power system typically reduces CO_2 emissions by approximately 0.7 to 0.9 tonnes (700-900 kg) per year.

d) To generate 1 kWh (1 unit) of electricity daily, you generally need about 80 to 100 square feet (approx. 8–10 square meters); through solar panel CO2 emission can be reduced. 100 kWp solar installation reduces CO2 emission by approximately 150 ton per year.

e) Soil Organic Carbon sequestration should be also considered

Taking (a), (b), and (c) along with present plantation, it is observed that the gap is reduced to 6510 ton of carbon dioxide per year. The same can be met up using plantation area of 39.45 Ha using present plantation density. However, the same will be reduced to 3.945 Ha with Miyawaki plantation as suggested. Further the same will be reduced, if (d) and (e) are considered.

11.0 References

1. IPCC (2000). IPCC special report on Land Use, Land Use Change, and Forestry, Summary for Policy makers. Cambridge, UK: Cambridge University Press.
2. IPCC (2006). Agriculture, forestry and other land use. In: Eggleston, HS et al., (Eds.), IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme. IGES, Japan.
3. Pachauri and Meyer, 2014, IPCC, Core Writing Team, R.K. Pachauri, L.A. Meyer (Eds.), Climate change 2014: Synthesis report. Contribution of working groups I, II and III to the

fifth assessment report of the Intergovernmental Panel on Climate Change, IPCC (2014), p. 151

4. C.Ö. Karacan, F.A. Ruiz, M. Cotè, S. Phipps (2011), Coal mine methane: A review of capture and utilization practices with benefits to mining safety and to greenhouse gas reduction, International Journal of Coal Geology, 86 (2–3) (2011), pp. 121-156
5. T. Igogo, K. Awuah-Offei, A. Newman, T. Lowder, J. Engel-Cox, (2021) Integrating renewable energy into mining operations: Opportunities, challenges, and enabling approaches, Applied Energy, 300 (2021), Article 117375
6. P.C. Frumhoff, R. Heede, N. Oreskes, 2015, The climate responsibilities of industrial carbon producers, Climatic Change, 132 (2) (2015), pp. 157-171
7. Y. Wang, W. Wang, G. Mao, H. Cai, J. Zuo, L. Wang, P. Zhao, 2013, Industrial CO_2 emissions in China based on the hypothetical extraction method: Linkage analysis, Energy Policy, 62 (2013), pp. 1238-1244
8. Greenhouse Gas Protocol, An accounting and reporting standard for estimating the greenhouse gas effects of policies and actions, prepared by World Resource Institute and Advisory Committee, (2014).
9. Bray, J.R., Gorham, E. (1964). Litter production in forest of the world. In: Gragg, J.B. (Ed.), Advances in Ecological Research, vol. II. Academic Press, New York.
10. Brown, S. (1997). Estimating biomass and biomass change of tropical forests: a primer (Vol. 134). Food & Agriculture Org.
11. Brown, S., Gillespie, A. J., and Lugo, A. E. (1989). Biomass estimation methods for tropical forests with applications to forest inventory data. Forest science, 35(4), 881-902.
12. Cairns, M. A., Brown, S., Helmer, E. H., Baumgardner, G. A. (1997). Root biomass allocation in the world's upland forests. Oecologia, 111: 1-11.
13. Recommendations for Reducing Greenhouse Gas Emissions, visit: https://www.iema.net/resources
14. S. Luckeneder, S. Giljum, A. Schaffartzik, V. Maus, M. Tost, 2021, Surge in global metal mining threatens vulnerable ecosystems. Global Environmental Change-Human and Policy
15. ISO 14064-1:2018 (Greenhouse Gases Quantification and Reporting of GHG Emissions and Removals at the Organizational Level) at https://www.iso.org/standard/66453.html.

EXHIBIT

भारत कोकिंग कोल लिमिटेड
(एक मिनीरत्न कम्पनी)
कोल इण्डिया लिमिटेड का एक अंग
[कम्पनी)
महाप्रबंधक का कार्यालय,
पोस्ट-सानारडीह, जिला-धनबाद
पिन-828125 (झारखण्ड)

BHARAT COKING COAL LIMITED
(A Mini ... mpany)
A Subsidiary of Coal India Limited
(A Maharatna Co
Office of the General Manager
Govindpur Area
PO-Sonardih Dist-Dhanbad
Pin-828125(Jharkhand)

L/AREA-III/E&M/2025-26/08

Date: 08.04.2025

5

Sl. No.					
1	Area Water Treatment Plant		Industria		
2	Govindpur Colliery				
3	Block-IV Colliery				
4	Maheshpur Colliery				
	South Govindpur Colliery				6877830
6	Kharkharee Colliery				4460348
7	Jogidih Colliery				
8	New Akashkinaree Colliery				
9					
10	CHP				
11	SILO, Maheshpur				
12	Central Excavation Workshop				
	TOTAL				

EXHIBIT

Date: 2025-07-29 11:39:51	User: GOVINDPUR						
BCCL VTS TRIP REPORT							
From: 2025-01-01 00:00 Hrs To: 2025-07-01 23:59 Hrs							
Area: GOVINDPUR							
SNo	Vehicle Number	Area Transporter	Source	End Date & Time	Destination	Total Time	Total Distance
1	JH10BS6157	GOVINDPUR Mundane	1/2 Seamed C_Dump	30-06-2025 14:03	NEW MCW End	0d 0h 48m 49s	15.94 Km
2	JH10BS6157	GOVINDPUR Mundane	1/2 Seamed C_Dump	30-06-2025 01:21	NEW MCW End	0d 0h 35m 27s	15.82 Km
Total Trips of JH10BS6157 on 2025-06-30:	2						
1	JH10BS6157	GOVINDPUR Mundane	1/2 Seamed C_Dump	29-06-2025 19:22	NEW MCW End	0d 0h 45m 1s	16.08 Km
2	JH10BS6157	GOVINDPUR Mundane	1/2 Seamed C_Dump	29-06-2025 15:45	NEW MCW End	0d 0h 52m 26s	15.78 Km
3	JH10BS6157	GOVINDPUR Mundane	1/2 Seamed C_Dump	29-06-2025 06:16	NEW MCW End	0d 0h 41m 35s	16.19 Km
Total Trips of JH10BS6157 on 2025-06-29:	3						
1	JH10BS6157	GOVINDPUR Mundane	1/2 Seamed C_Dump	28-06-2025 21:54	NEW MCW End	0d 0h 57m 28s	16.46 Km
2	JH10BS6157	GOVINDPUR Mundane	1/2 Seamed C_Dump	28-06-2025 14:43	NEW MCW End	0d 0h 45m 50s	15.94 Km
3	JH10BS6157	GOVINDPUR Mundane	1/2 Seamed C_Dump	28-06-2025 06:12	NEW MCW End	0d 0h 35m 57s	16.08 Km
Total Trips of JH10BS6157 on 2025-06-28:	3						
1	JH10BS6157	GOVINDPUR		27-06-2025 22:21	NEW MCW End		16.43 Km

		Mundane	1/2 Seamed C_Dump			0d 1h 22m 32s	
2	JH10BS6157	GOVINDPUR Mundane	1/2 Seamed C_Dump	27-06-2025 14:51	NEW MCW End	0d 0h 46m 21s	15.99 Km
Total Trips of JH10BS6157 on 2025-06-27:	2						
1	JH10BS6157	GOVINDPUR Mundane	1/2 Seamed C_Dump	26-06-2025 23:37	NEW MCW End	0d 1h 28m 50s	16.44 Km
2	JH10BS6157	GOVINDPUR Mundane	1/2 Seamed C_Dump	26-06-2025 17:48	NEW MCW End	0d 0h 44m 46s	15.91 Km
Total Trips of JH10BS6157 on 2025-06-26:	2						
1	JH10BS6157	GOVINDPUR Mundane	1/2 Seamed C_Dump	25-06-2025 17:30	NEW MCW End	0d 0h 39m 3s	16.27 Km
Total Trips of JH10BS6157 on 2025-06-25:	1						
1	JH10BS6157	GOVINDPUR Mundane	1/2 Seamed C_Dump	24-06-2025 12:58	NEW MCW End	0d 0h 41m 38s	15.90 Km
2	JH10BS6157	GOVINDPUR Mundane	1/2 Seamed C_Dump	24-06-2025 06:50	NEW MCW End	0d 0h 34m 34s	16.21 Km
Total Trips of JH10BS6157 on 2025-06-24:	2						
1	JH10BS6157	GOVINDPUR Mundane	1/2 Seamed C_Dump	24-06-2025 00:18	NEW MCW End	0d 0h 36m 46s	15.93 Km
2	JH10BS6157	GOVINDPUR Mundane	1/2 Seamed C_Dump	23-06-2025 17:23	NEW MCW End	0d 0h 42m 3s	16.09 Km
3	JH10BS6157	GOVINDPUR Mundane	1/2 Seamed C_Dump	23-06-2025 12:14	NEW MCW End	0d 0h 39m 58s	15.82 Km
Total Trips of JH10BS6157 on 2025-06-23:	3						
1	JH10BS6157	GOVINDPUR Mundane	1/2 Seamed C_Dump	22-06-2025 02:36	NEW MCW End	0d 0h 34m 33s	15.74 Km

Total Trips of JH10BS6157 on 2025-06-22:	1						
1	JH10BS6157	GOVINDPUR Mundane	1/2 Seamed C_Dump	21-06-2025 20:44	NEW MCW End	0d 0h 38m 45s	16.10 Km
2	JH10BS6157	GOVINDPUR Mundane	1/2 Seamed C_Dump	21-06-2025 16:08	NEW MCW End	0d 0h 35m 13s	16.33 Km
3	JH10BS6157	GOVINDPUR Mundane	1/2 Seamed C_Dump	21-06-2025 06:46	NEW MCW End	0d 0h 41m 24s	16.18 Km
Total Trips of JH10BS6157 on 2025-06-21:	3						
1	JH10BS6157	GOVINDPUR Mundane	1/2 Seamed C_Dump	21-06-2025 00:42	NEW MCW End	0d 0h 43m 3s	16.23 Km
2	JH10BS6157	GOVINDPUR Mundane	1/2 Seamed C_Dump	20-06-2025 19:24	NEW MCW End	0d 0h 46m 58s	15.91 Km
3	JH10BS6157	GOVINDPUR Mundane	Maheshpur Dump	20-06-2025 13:19	NEW MCW End	0d 1h 2m 37s	14.37 Km
4	JH10BS6157	GOVINDPUR Mundane	Maheshpur Dump	20-06-2025 10:52	NEW MCW End	0d 1h 1m 46s	14.60 Km
Total Trips of JH10BS6157 on 2025-06-20:	4						
1	JH10BS6157	GOVINDPUR Mundane	Maheshpur Dump	19-06-2025 16:38	NEW MCW End	0d 1h 23m 27s	14.91 Km
Total Trips of JH10BS6157 on 2025-06-19:	1						
1	JH10BS6157	GOVINDPUR Mundane	1/2 Seamed C_Dump	18-06-2025 20:32	NEW MCW End	0d 0h 48m 19s	16.15 Km
2	JH10BS6157	GOVINDPUR Mundane	1/2 Seamed C_Dump	18-06-2025 06:01	NEW MCW End	0d 0h 38m 18s	16.14 Km
Total Trips of JH10BS6157 on 2025-06-18:	2						
1	JH10BS6157	GOVINDPUR Mundane	1/2 Seamed C_Dump	17-06-2025 22:24	NEW MCW End	0d 1h 45m 14s	16.28 Km

2	JH10BS6157	GOVINDPUR Mundane	1/2 Seamed C_Dump	17-06-2025 14:59	NEW MCW End	0d 1h 36m 18s	16.37 Km
3	JH10BS6157	GOVINDPUR Mundane	1/2 Seamed C_Dump	17-06-2025 01:28	NEW MCW End	0d 0h 33m 59s	16.02 Km

EXHIBIT

AMBIENT AIR QUALITY DATA

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Air Quality Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Test Report for Ambient Air Samples

Month & Year	**10/2025**	**Cluster**	**Cluster III**			**ULR NO.**	**TC1432125000002188F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**05.12.2025**
Project	**Block-IV**		**Sample Ref. No.**	**REM/BCCL/2025/10**	**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**	
Date of Sampling	10.10.25		29.10.25	**Period of Analysis**	10.10.2025 25.11.2025	**Zone of Station:**	**Core Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)** A4676	A4760	**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
1	PM_{10}	IS -5182(Part 23):2006, R-2017	75	70	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	37	35	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	33	29	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*
***All units are in µg/m3, 24 hourly Average,*

ANALYSED BY (Gaurav Kant) ***REVIEWED BY*** (Kumar Vaibhav) ***Authorised Signatory***

***Note**: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.*

---- End of Report ----

Page -1 of 1

EXHIBIT

Sl no	Site	Area (Ha)	Plantation type	Plantation Year	Agency
1.	Block-IV Colliery	4.5	OB dump	FY 2020-21	Forest Department, Dhanbad
2.	New Akashkinaree Colliery	17.5	Backfilled	FY 2014-15 to 2017-18	Departmental Manpower
		5	OB dump	FY 2020-21	Forest Department, Dhanbad
3.		23	OB dump	FY 2021-22	Forest Department, Dhanbad
4.	Maheshpur Colliery	5	OB dump	FY 2018-19	Departmental Manpower
		43		FY 2010	
		10		FY 2000	

Period: 15th March 2024 to 15th June 2024 **Location:-** Block-IV (Core Zone)

Sl. No.	Parameters	Observed Value		
		SS1		
		(0-30cm)	(30-60cm)	(60-90cm)
1	Soil Texture	Sandy loam	Sandy Loam	Sandy Loam
2	**Grain Size,%**			
	a) Sand	64.3	66.3	65.2
	b) Silt content	24.6	23.5	24.8
	c) Clay content	11.1	10.2	10.0
3	Porosity, %	25.4	24.6	24.1
4	Maximum water holding capacity(WHC max,%)	24.5	26.2	23.3
5	Field moisture (%)	15.6	16.2	17.1
6	Wilting Coefficient (%)	0.78	0.66	0.45
7	Bulk density (g/cc)	1.39	1.42	1.46
8	pH (1:2.5;w/v)	7.45	7.35	7.32
9	Electrical conductivity (micro S/cm;1.2.5;w/v)	188.6	186.5	185.8
10	Soil Organic Carbon (%)	0.65	0.48	0.36
11	Available N (kg/ha)	100.2	82.35	79.64
12	Phosphorous as P_2O_5 kg/ha	11.8	9.7	8.3
13	Potash as K_2O, kg/ha	107.5	98.3	85.8
14	Sodium Adsorption Ratio	0.59	0.52	0.48
15	Cation Exchange Capacity,Meq/100gm	21.2	20.5	17.6

Soil Fertility Quality Standard w.r.t C: N: P: K

Sl. No.	PARAMETERS	QUALITY STATUS		
		Poor	Medium	Fertile
1	Organic Carbon %	<0.5	0.5 to 0.75	>0.75
2	Nitrogen as N, kg/ha	<280	280 to 560	>560
3	Phosphorus as P_2O_5, kg/ha	<23	23 to 57	>57
4	Potash as K_2O, kg/ha	<133	133 to 337	>337

Period: 15th March 2024 to 15th June 2024 **Location:** -Bamandiha (Forest)

Sl. No.	Parameters	Observed Value		
		SS2		
		(0-30cm)	(30-60cm)	(60-90cm)
1	Soil Texture	Sandy Loam	Sandy Loam	Sandy Loam
2	**Grain Size,%**			
	a) Sand	54.0	58.5	59.2
	b) Silt content	33.8	31.8	29.1
	c) Clay content	12.2	9.7	11.7
3	Porosity, %	33.5	32.2	30.2
4	Maximum water holding capacity(WHC max,%)	36.2	37.7	38.5
5	Field moisture (%)	20.5	21.2	22.7
6	Wilting Coefficient (%)	0.87	0.85	0.84
7	Bulk density (g/cc)	1.51	1.54	1.56
8	pH (1:2.5;w/v)	7.12	7.21	6.98
9	Electrical conductivity (micro S/cm;1.2.5;w/v)	180.5	175.3	171.6
10	Soil Organic Carbon (%)	0.44	0.39	0.36
11	Available N (kg/ha)	145.2	139.5	134.5
12	Phosphorous as P_2O_5 kg/ha	10.1	9.5	9.3
13	Potash as K_2O, kg/ha	133.5	132.5	138.2
14	Sodium Adsorption Ratio	1.03	1.01	1.05
15	Cation Exchange Capacity,Meq/100gm	18.5	19.2	22.2

Soil Fertility Quality Standard w.r.t C: N: P: K

Sl. No.	PARAMETERS	QUALITY STATUS		
		Poor	Medium	Fertile
1	Organic Carbon %	<0.5	0.5 to 0.75	>0.75
2	Nitrogen as N, kg/ha	<280	280 to 560	>560
3	Phosphorus as P_2O_5, kg/ha	<23	23 to 57	>57
4	Potash as K_2O, kg/ha	<133	133 to 337	>337

Soil Characteristics of Core zone and nearby villages

Period: 15th March 2024 to 15th June 2024 **Location:** Muraidih Village (Agriculture)

Sl. No.	Parameters	Observed Value		
		SS3		
		(0-30cm)	(30-60cm)	(60-90cm)
1	Soil Texture	Sandy Clay Loam	Sandy Clay Loam	Sandy Clay Loam
2	**Grain Size,%**			
	a) Sand	52.4	50.0	50.5
	b) Silt content	19.6	23.2	25.4
	c) Clay content	28.0	26.8	24.1
3	Porosity, %	30.1	29.4	28.1
4	Maximum water holding capacity(WHC max,%)	30.4	33.2	35.5
5	Field moisture (%)	19.8	19.4	18.7
6	Wilting Coefficient (%)	0.81	0.85	0.85
7	Bulk density (g/cc)	1.44	1.51	1.53
8	pH (1:2.5;w/v)	7.35	7.12	6.96
9	Electrical conductivity (micro S/cm;1.2.5;w/v)	199.6	187.5	181.2
10	Soil Organic Carbon (%)	0.55	0.40	0.39
11	Available N (kg/ha)	134.6	127.1	125.3
12	Phosphorous as P_2O_5 kg/ha	14.6	13.5	13.2
13	Potash as K_2O, kg/ha	114.6	104.2	96.8
14	Sodium Adsorption Ratio	0.44	0.35	0.26
15	Cation Exchange Capacity,Meq/100gm	25.3	24.1	25.3

Soil Fertility Quality Standard w.r.t C:N:P:K

Sl. No.	PARAMETERS	QUALITY STATUS		
		Poor	Medium	Fertile
1	Organic Carbon %	<0.5	0.5 to 0.75	>0.75
2	Nitrogen as N, kg/ha	<280	280 to 560	>560
3	Phosphorus as P_2O_5, kg/ha	<23	23 to 57	>57
4	Potash as K_2O, kg/ha	<133	133 to 337	>337

EXHIBIT

FrameCnt: 1207, DiffTime: 33ms
2024-09-19 13:34:52.571
[focal_len: 24.00] [dzoom_ratio: 1.00], [latitude: 23.790132] [longitude: 86.270618]
[rel_alt: 25.643 abs_alt: 188.616] [gb_yaw: -164.1 gb_pitch: -9.8 gb_roll: 0.0]

FrameCnt: 1194, DiffTime: 33ms
2024-09-13 14:02:13.098
[focal_len: 24.00] [dzoom_ratio: 1.00], [latitude: 23.805357] [longitude: 86.283465]
[rel_alt: 49.721 abs_alt: 250.446] [gb_yaw: 51.7 gb_pitch: -34.3 gb_roll: 0.0]

FrameCnt: 1009, DiffTime: 33ms
2024-09-13 13:25:39.971
[focal_len: 24.00] [dzoom_ratio: 1.00], [latitude: 23.806281] [longitude: 86.289854]
[rel_alt: 59.682 abs_alt: 225.645] [gb_yaw: 26.8 gb_pitch: -32.0 gb_roll: 0.0]

FrameCnt: 2468, DiffTime: 33ms
2024-09-13 13:46:04.768
[focal_len: 24.00] [dzoom_ratio: 1.00], [latitude: 23.789578] [longitude: 86.292891]
[rel_alt: 58.408 abs_alt: 227.131] [gb_yaw: -65.7 gb_pitch: -21.4 gb_roll: 0.0]

FrameCnt: 1517, DiffTime: 33ms
2024-09-13 13:25:56.920
[focal_len: 24.00] [dzoom_ratio: 1.00], [latitude: 23.806282] [longitude: 86.289854]
[rel_alt: 62.653 abs_alt: 228.615] [gb_yaw: -85.9 gb_pitch: -30.7 gb_roll: 0.0]

FrameCnt: 491, DiffTime: 33ms
2024-09-13 13:18:22.764
[focal_len: 24.00] [dzoom_ratio: 1.00], [latitude: 23.805993] [longitude: 86.288166]
[rel_alt: 28.051 abs_alt: 200.753] [gb_yaw: 75.5 gb_pitch: -24.7 gb_roll: 0.0]

FrameCnt: 740, DiffTime: 33ms
2024-09-13 13:25:30.994
[focal_len: 24.00] [dzoom_ratio: 1.00], [latitude: 23.806281] [longitude: 86.289851]
[rel_alt: 52.902 abs_alt: 218.864] [gb_yaw: 74.6 gb_pitch: -25.9 gb_roll: 0.0]

FrameCnt: 1731, DiffTime: 33ms
2024-09-13 13:45:40.178
[focal_len: 24.00] [dzoom_ratio: 1.00], [latitude: 23.788985] [longitude: 86.294459]
[rel_alt: 52.449 abs_alt: 221.172] [gb_yaw: -69.8 gb_pitch: -16.5 gb_roll: 0.0]

DEPARTMENT OF ENVIRONEMNAL SCIENCE & ENGINEERING
(CENTRE OF MINING ENVIRONMENT)
INDIAN INSTITUTE OF TECHNOLOGY (INDIAN SCHOOL OF MINES), DHANBAD – 826004

ESE/2025-26/ BCCL/04 Date: 18.02.2026
Ref: PO No. : 5700470848 Dated 25/11/2025

Report on Third party audit of air & water quality in Cluster-III, BCCL

Air and water sampling in core and buffer zone of Cluster III group of Mines, BCCL

Date of Sampling: 05.01.2026 to 09.01.2026

Air sample analysis

S.N	Locations	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	NO_2 ($\mu g/m^3$)
Core Zone					
1	**Block IV PO office**	92	58	1.33	10.56
Buffer Zone					
2	**Kharkharee Village**	95	57	1.16	11.82
3	**Govindpur Village**	92	61	1.87	10.49
4	**Muraidih OCP**	101	62	0.26	8.01

Water sample analysis

Parameter	Sample 1
pH	7.79
TSS (mg/l)	110
Oil & Grease (mg/l)	6.3
COD (mg/l)	39

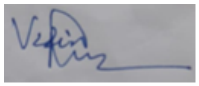
Date of Sampling: 19.01.2026 to 23.01.2026

Air sample analysis

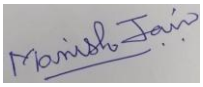
S.N	Locations	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	NO_2 ($\mu g/m^3$)
Core Zone					
1	**Block IV PO office**	98	48	1.53	20.21
Buffer Zone					
2	**Kharkharee Village**	96	53	3.41	15.51
3	**Govindpur Village**	85	44	0.87	7.06
4	**Muraidih OCP**	105	63	1.13	18.41

Water sample analysis

Parameter	Sample 2
pH	7.73
TSS (mg/l)	114
Oil & Grease (mg/l)	4.1
COD (mg/l)	44



Prof. Vipin Kumar



Prof. Manish Kumar Jain

Telephone: +91-326-2235476, 9431711095, manish@iitism.ac.in
Fax: +91-326- 2296624, Website: www.iitism.ac.in

DEPARTMENT OF ENVIRONEMNAL SCIENCE & ENGINEERING
(CENTRE OF MINING ENVIRONMENT)
INDIAN INSTITUTE OF TECHNOLOGY (INDIAN SCHOOL OF MINES), DHANBAD – 826004

METHODOLOGY

As given by CPCB, the methodology used for the different analyses of the concentrations of PM_{10}, $PM_{2.5}$, oxides of sulphur and nitrogen (SO_2 & NO_2), is given in Table 1.

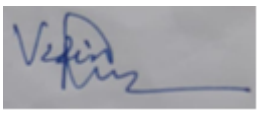
Table 1: Brief Methodology

Pollutants	Methods of Measurement
Sulphur Dioxide (SO_2), µg/m^3	**Improved West and Gaeke Method** (IS 5182 Part 2 Method of Measurement of Air Pollution: Sulphur dioxide)
Nitrogen Dioxide (NO_2), µg/m^3	**Modified Jacob & Hochheiser Method** (IS 5182 Part 6 Methods for Measurement of Air Pollution: Oxides of Nitrogen)
Particulate Matter (Size less than 10µm) or PM_{10}, µg/m^3	**Gravimetric Method** (Method IO-2.1 Sampling of Ambient Air for Total Suspended Particulate Matter (SPM) and PM Using High Volume (HV) Sampler)
Particulate Matter (Size less than 2.5µm) or $PM_{2.5}$, µg/m^3	**Gravimetric Method** (Method IO-2.1 Sampling of Ambient Air for Total Suspended Particulate Matter (SPM) and PM Using High Volume (HV) Sampler)

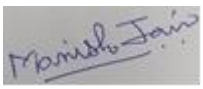
Standards

S.N	Locations	PM_{10} (µg/m^3)	$PM_{2.5}$ (µg/m^3)	SO_2 (µg /m^3)	NO_2 (µg/m^3)
1	**GSR-742 (E), dated 25.09.2000**				
	Existing Mines, 24 Hrs	300	-	120	120
	New Coal Mines, 24 Hrs	250	-	120	120
2	**NAAQS 2009**				
		100	60	80	80

Parameter	Standard value-IS2490	Method
pH	6.5-8.5	pH Meter
TSS (mg/l)	<500	Gravimetric
Oil & Grease (mg/l)	<10	Gravimetric
COD (mg/l)	<200	Closed Reflux



Prof. Vipin Kumar



Prof. Manish Kumar Jain

Telephone: +91-326-2235476, 9431711095, manish@iitism.ac.in
Fax: +91-326- 2296624, Website: www.iitism.ac.in

DEPARTMENT OF ENVIRONEMNAL SCIENCE & ENGINEERING
(CENTRE OF MINING ENVIRONMENT)
INDIAN INSTITUTE OF TECHNOLOGY (INDIAN SCHOOL OF MINES), DHANBAD – 826004

FIELD IMAGES

Sampling from 05.01.2026 to 09.01.2026

L1- **Muraidih OCP**

L1- **Muraidih OCP**

L2- **Kharkharee Village**

L2- **Kharkharee Village**

L3- **Block IV PO office**

L3- **Block IV PO office**

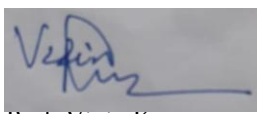
L4- **Govindpur Village**

L4- **Govindpur Village**

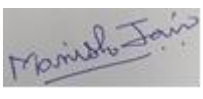
Water Sampling

Water Sampling

Figure 1: Field images of four sites during the first set of sampling



Prof. Vipin Kumar



Prof. Manish Kumar Jain

Telephone: +91-326-2235476, 9431711095, manish@iitism.ac.in
Fax: +91-326- 2296624, Website: www.iitism.ac.in

DEPARTMENT OF ENVIRONEMNAL SCIENCE & ENGINEERING
(CENTRE OF MINING ENVIRONMENT)
INDIAN INSTITUTE OF TECHNOLOGY (INDIAN SCHOOL OF MINES), DHANBAD – 826004

Sampling from 19.01.2026 to 23.01.2026

L1- **Muraidih OCP**

L1- **Muraidih OCP**

L2- **Kharkharee Village**

L2- **Kharkharee Village**

L3- **Block IV PO office**

L3- **Block IV PO office**

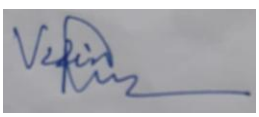
L4- **Govindpur Village**

L4- **Govindpur Village**

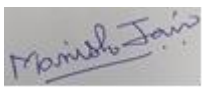
Water Sampling

Water Sampling

Figure 2: Field images of four sites during the second set of sampling



Prof. Vipin Kumar



Prof. Manish Kumar Jain

Telephone: +91-326-2235476, 9431711095, manish@iitism.ac.in
Fax: +91-326- 2296624, Website: www.iitism.ac.in

ANNEXURE-VII

भारत कोकिंग कोल लिमिटेड
(एक मिनीरत्न कंपनी)
(कोल इण्डिया लिमिटेड की एक अनुषंगी कंपनी)
(भारत सरकार का उपक्रम)

बीसीसीएल BCCL
भारत कोकिंग कोल लिमिटेड
Bharat Coking Coal Limited

Bharat Coking Coal Limited
(A Miniratna Company)
(A Subsidiary of Coal India Limited)
(A Government of India Undertaking)

Ref- BCCL/Ar.III/GM/25-26/154 18-03-2026

To
AFM
Govindpur Area

Subject: Provisional Progressive Mine Closure Expenditure for Cluster-III group of Mines in FY 2025-26

Provisional Mine Closure Expenditure for Cluster-III group of Mines in FY 2025-26				
		Head of expense as per accounts		**Total (Crores)**
Activity description	**Permissible amount for entire life of mine (66 years)**	**Plantation**	**technical reclamation of OB dump**	
Landscaping and plantation	88.96 Crores	0.65 Crores	0	**0.65**
Technical and biological Reclamation of Mined cut of land and OB Dump	258.47 Crores	0	11.50971 Crores (consist of departmental manpower, diesel cost for dozer, grader, water tanker)	**11.50971**
The above mentioned amount is provisional amount for FY 2025-26 in respect of expenditure on progressive mine closure activities. This amount shall not be used as receivable to BCCL because actual amount of reimbursement from Coal Controller Organization (CCO) is subject to third party audit, CCO audit and maximum reimbursement from CCO can be **50% of the amount deposited in escrow account for corresponding FY**				

Yours faithfully

18/03/2026
Area Manager (Env)
Govindpur Area

STRICTLY RESTRICTED
FOR COMPANY USE ONLY RESTRICTED
The information given in this report is not to be communicated either directly or indirectly to the press or to any person not holding an official position in the CIL /GOVERNMENT.

ENVIRONMENTAL MONITORING REPORT OF BHARAT COKING COAL LIMITED, CLUSTER – III

(FOR THE MONTH OCTOBER, 2025)

E. C. no. J-11015/213/2010-IA. II(M) dated 03.03.2025.

CMPDI
ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

CONTENTS

SL. NO.	CHAPTER	PARTICULARS	PAGE NO.
1.	CHAPTER - I	EXECUTIVE SUMMARY	3-5
2.	CHAPTER-II	INTRODUCTION	6
3.	CHAPTER-III	RESULTS	7-19
4.	CHAPTER-IV	STANDARDS AND PLANS	20-21

EXECUTIVE SUMMARY

1.0 Introduction

The purpose of environmental monitoring is to assess the quality of various attributes that affects the fauna and flora. In accordance with the quality of these attributes appropriate strategy is to be developed to control the pollution level within the permissible limits. The three major attributes are air, water and noise level.

Bharat Coking Coal Limited (BCCL), a Subsidiary company of Coal India Limited is operating Underground and Opencast Mines in Jharia Coalfield (JCF) is a part of Gondwana Coalfields located in Dhanbad district of Jharkhand, the JCF is bounded by $23^0$37' N to $23^0$52' N latitudes and $86^0$09' E to $86^0$30' E longitude occupying an area of 450 Sq.km. BCCL has awarded Environmental monitoring work of Jharia Coalfield (JCF) to Central Mine Planning & Design Institute Limited (CMPDIL). The environmental monitoring has been carried out as per the conditions laid down by the MoEF&CC while granting environmental clearance of project, consent letter issued by the respective SPCB, and other statutory requirements.

2.0 Sampling location and rationale

2.1 Ambient air sampling locations

The ambient air quality monitoring stations were selected to represent core, buffer zone area. The rationale has been based on the guidelines stipulated by MoEF&CC, consent letter of SPCB, as well as other statutory requirements.

2.2 Water sampling stations

The Water sampling stations were selected for mine sump water.

2.3 Noise level monitoring locations

Noise levels vary depending on the various activities in mining areas. The monitoring of noise level in different locations will be helpful to take appropriate mitigating measures. The rationale has been based on the guidelines stipulated by MoEF&CC, consent letter of SPCB, as well as other statutory requirements.

3.0 Methodology of sampling and analysis

3.1 Ambient air quality

Parameters chosen for assessment of ambient air quality were Particulate Matter (PM_{10}), Fine Particulate Matter ($PM_{2.5}$), Sulphur Di-oxide (SO_2) and Nitrogen Oxides (NO_X). Respirable Dust Samplers (RDS) and Fine Dust Sampler ($PM_{2.5}$

sampler) were used for sampling of $PM_{10,}$ SO_2, & NO_X and Fine Dust Sampler ($PM_{2.5}$ sampler) were used for sampling of $PM_{2.5}$ at 24 hours interval once in a fortnight and the same for the gaseous pollutants. The samples were analysed in Environmental Laboratory of CMPDI, RI-II, Dhanbad.

3.2 Water quality

Water samples were collected as per standard practice. The Mine effluent samples were collected and analysed for four parameters on fortnightly basis. Thereafter the samples were preserved and analysed at the Environmental Laboratory of CMPDI, RI- II, Dhanbad.

3.3 Noise level monitoring

Noise level measurements in form of 'L_{EQ}' were taken using Integrated Data Logging Sound Level Meter. Noise levels were measured in Decibels, 'A' weighted average, i.e. dB(A).

4.0 Results and interpretations

4.1 Air quality

It has been seen from the analysis results that the 24 hours average concentration parameters like $PM_{10,}$ $PM_{2.5}$, SO_2 and NO_X are mostly within the permissible limits in all sampling locations as per MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000 Standards for Coal Mines and National Ambient Air Quality Standard -2009. Sometimes the concentration of PM_{10}& $PM_{2.5}$ exceeds the limits due to heavy public traffic, poor road condition, coke oven plants, burning of coal by surrounding habitants, brick making, municipal waste dumps and industries like Steel Plant, thermal Plants including their fly ash etc.

The following preventive and suppressive mitigative measures can be undertaken to contain the pollution level within prescribed level:-

- Wet drilling and controlled blasting should be practice.
- Explosive used should be optimised to restrict the dust generation.
- Transportation roads should be permanently asphalted free of ruts, potholes etc.
- Water should be sprayed on coal transportation road, service road more frequently and at regular interval.
- Dust from roads should be removed physically or mechanically.
- Greenbelts around industrial sites, service building area besides Avenue plantation along roads should be created.
- Coal dust should be suppressed by using fixed sprinklers.
- Regular maintenance of plant and machinery should be undertaken.

4.2 Water quality

The test results indicate that the major parameters compared with MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000 Standards for Coal Mines, are within permissible limits.

4.3 Noise Level

During the noise level survey it has been observed that the noise level in the sampling locations is within the permissible limits prescribed as per MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000 Standards for Coal Mines for Industrial Area and Noise pollution (Regulation and Control) Rules, 2000.

INTRODUCTION

Any industry and development activities including coal mining is bound to affect environmental attributes. There are positive as well as negative impacts of such operations. For controlling the adverse impacts a regular monitoring is essential. The environmental monitoring is being done as per the guide-lines stipulated by Ministry of Environment, Forest and Climate Change (MoEF&CC), Govt. of India.

The very purpose of environmental monitoring is to assess the quality of various attributes which affects the environment. As per quality of these attributes appropriate strategy is to be developed to control the pollution level within the permissible limits. The three major attributes are air, water and noise level.

Bharat Coking Coal has awarded Environmental Monitoring work of all Projects, Cluster wise, to Central Mine Planning & Design Institute Limited (CMPDIL). The environmental monitoring has been carried out as per conditions laid down by MoEF&CC while granting environmental clearance to different projects. CMPDI has trained manpower and well equipped laboratory to carry out monitoring, analysis and R&D work in the field of environment.

The CLUSTER III is in the westernmost part of the Jharia coalfield. It includes Jogidih Colliery, Maheshpur Colliery, South Govindpur Colliery, Teturiya Colliery, Govindpur Colliery, New Akasshkinaree Mine and Block IV Kooridih Mixed Mine as per **E. C. no. J-11015/213/2010-IA.II**(M) dated 06.02.2013 and later all seven mines are amalgamated to single mine Named Cluster III with OC cum UG with Highway Mining method with no change in lease area and production capacity. The cluster – III is situated about 40 - 45 kms from Dhanbad Railway Station. The mines of this cluster-III are operating since pre nationalization period (prior to 1972-73). It is connected by both Railway and Road. The drainage of the area is governed by Khudia and Bagdighi Nala.

The Project has Environmental Clearance from Ministry of Environment, Forest and Climate Change (MoEF&CC) for a rated capacity of 2.769 MTPA (normative) and 3.6 MTPA peak capacity of coal production vide letter no **E. C. no. J-11015/213/2010-IA. II**(M) dated 06.02.2013 later with **E. C. no. J-11015/213/2010-IA. II**(M) dated 03.03.2025.

Ministry of Environment, Forest and Climate Change while granting environmental clearance has given one of the General conditions that " Four ambient air quality monitoring stations should be established in the core zone as well as in the buffer zone for PM_{10}, $PM_{2.5}$, SO_2, NOx monitoring. Location of the stations should be decided based on the meteorological data, topographical features and environmentally and ecologically sensitive targets, other conditions regarding water / effluent and noise level monitoring in consultation with the State Pollution Control Board."

In compliance of these conditions the Environmental Monitoring has been carried out & report prepared for submission to MoEF&CC & JSPCB and other statutory authorities.

AMBIENT AIR QUALITY MONITORING

2.1 Location of sampling station and their rationale:

(As per G.S.R. 742 (E) dt. 25th December, 2000)

2.1.1 Ambient Air Quality Sampling Locations

CORE ZONE Monitoring Location

i) Block IV Kooridih OCP (A6): Industrial Area

The location of the sampling station is at 23°47'54.00"N & 86°16'20.00"E. The sampler was placed at 1.5 m above the ground level near Safety office of Block IV OCP.

BUFFER ZONE Monitoring Location

i) Muraidih OCP (A5) : Industrial Area

The sampler was placed at a height of 1.5 m from the ground level at Muraidih project office.

ii) Ramkanali Workshop (A7) : Industrial area

The location of the sampling station is 23°48'34.00"N & 86°18'22.00"E. The sampler was placed at height of 1.5 m above the ground level at AARC agent Office, Ramkanali.

iii) Kharkharee(A21): **Industrial Area**

The location of the sampling station is 23°46'29.00"N & 86°14'37.08"E. The sampler was placed at a height of 1.5 m above the ground level at Kharkharee Colliery.

AMBIENT AIR QUALITY DATA

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Air Quality Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Test Report for Ambient Air Samples

Month & Year	**10/2025**	**Cluster**	**Cluster III**	**ULR NO.**	**TC1432125000002188F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**05.12.2025**
Project	**Block-IV**	**Sample Ref. No.**	**REM/BCCL/2025/10**	**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**
Date of Sampling	10.10.25 – 29.10.25	**Period of Analysis**	10.10.2025 – 25.11.2025	**Zone of Station:**	**Core Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)** A4676	A4760	**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
1	PM_{10}	IS -5182(Part 23):2006, R-2017	75	70	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	37	35	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	33	29	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*

***All units are in µg/m3, 24 hourly Average,*

ANALYSED BY (Gaurav Kant) ***REVIEWED BY*** (Kumar Vaibhav) ***Authorised Signatory***

***Note**: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.*

---- End of Report ----

TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

Ambient Air Quality Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850

Test Report for Ambient Air Samples

Month & Year	**10/2025**	**Cluster**	**Cluster III**			**ULR NO.**	**TC1432125000002188F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**05.12.2025**
Project	**Ramkanali Workshop**	**Sample Ref. No.**	**REM/BCCL/2025/10**		**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**	
Date of Sampling	13.10.25	29.10.25	**Period of Analysis**	13.10.2025	25.11.2025	**Zone of Station:**	**Buffer Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			A4682	A4762				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	70	73	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	34	37	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	29	30	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*

***All units are in µg/m3, 24 hourly Average,*

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

***Note**: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.*

---- End of Report ----

Page -1 of 1

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Air Quality Test Report

Test Report for Ambient Air Samples

Month & Year	**10/2025**	**Cluster**	**Cluster III**			**ULR No.**	**TC1432125000002188F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**05.12.2025**
Project	**Muraidih**		**Sample Ref. No.**	**REM/BCCL/2025/10**	**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**	
Date of Sampling	06.10.25		21.10.25	**Date of Sampling**	06.10.2025 25.11.2025	**Zone of Station:**	**Buffer Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)** A4629	A4707	**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
1	PM_{10}	IS -5182(Part 23):2006, R-2017	71	69	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	30	29	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	24	28	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*

***All units are in µg/m3, 24 hourly Average,*

ANALYSED BY (Gaurav Kant) ***REVIEWED BY*** (Kumar Vaibhav) ***Authorised Signatory***

***Note**: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.*

---- End of Report ----

Page -1 of 1

TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Air Quality Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Test Report for Ambient Air Samples

Month & Year	**10/2025**	**Cluster**	**Cluster III**			**ULR NO.**	**TC1432125000002188F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**05.12.2025**
Project	**Kharkharee**		**Sample Ref. No.**	**REM/BCCL/2025/10**	**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**	
Date of Sampling	10.10.25		28.10.25	**Period of Analysis**	10.10.2025 – 25.11.2025	**Zone of Station:**	**Buffer Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			A4674	A4674				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	73	70	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	35	35	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	34	29	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

***All units are in µg/m3, 24 hourly Average, * LDL indicates Lower Detection Limit,*

ANALYSED BY

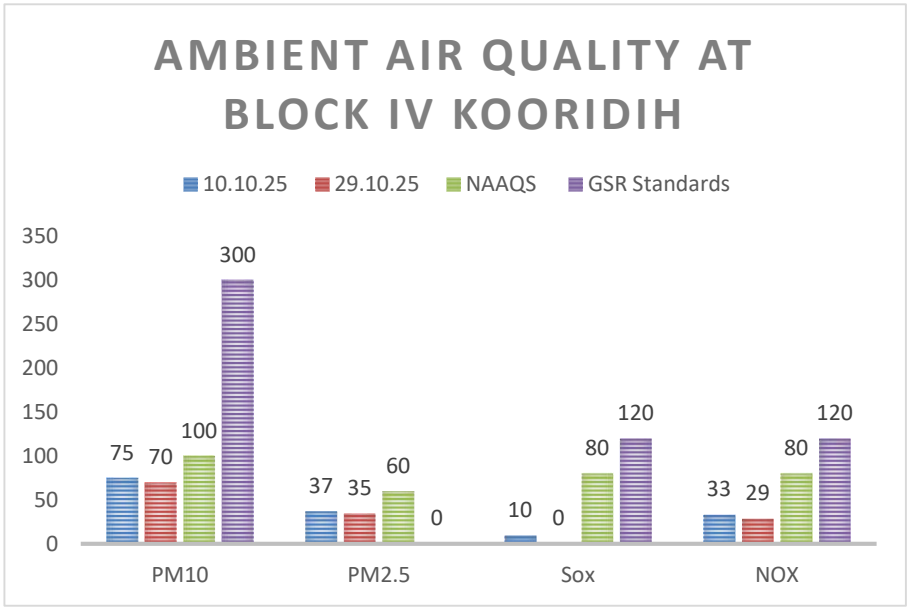
(Gaurav Kant)
REVIEWED BY

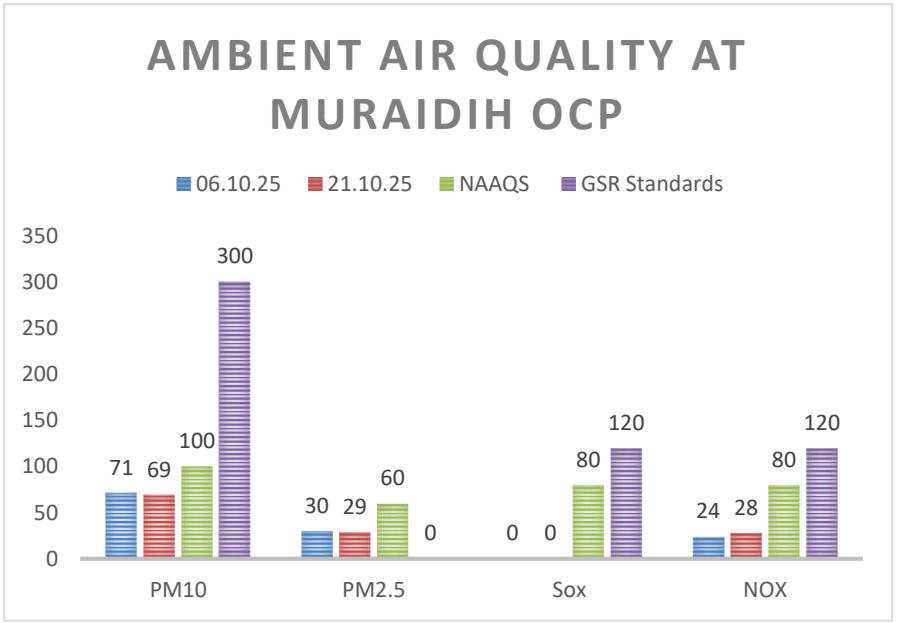
(Kumar Vaibhav)
Authorised Signatory

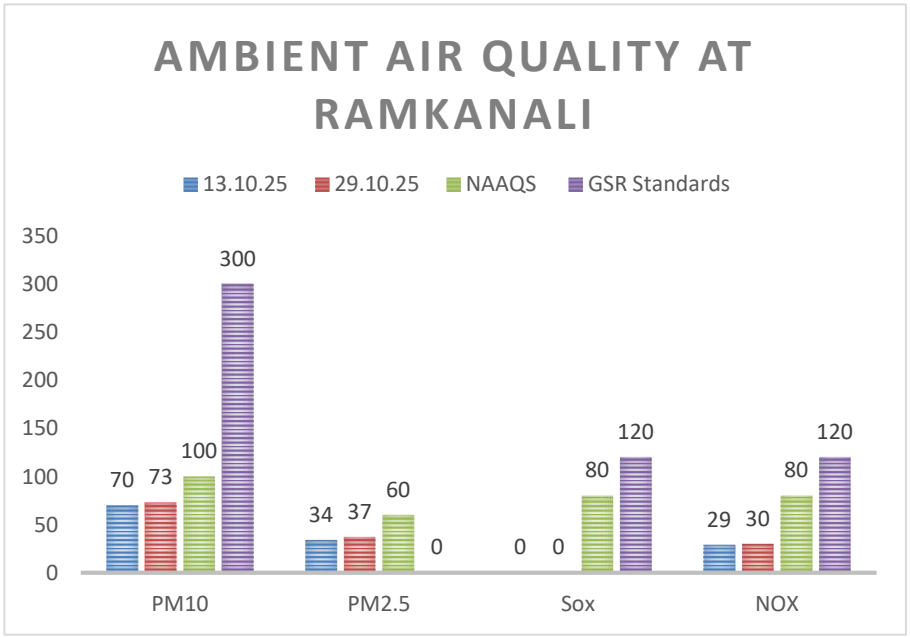
***Note**: The results above relate to the samples tested as received. This report cannot be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.*

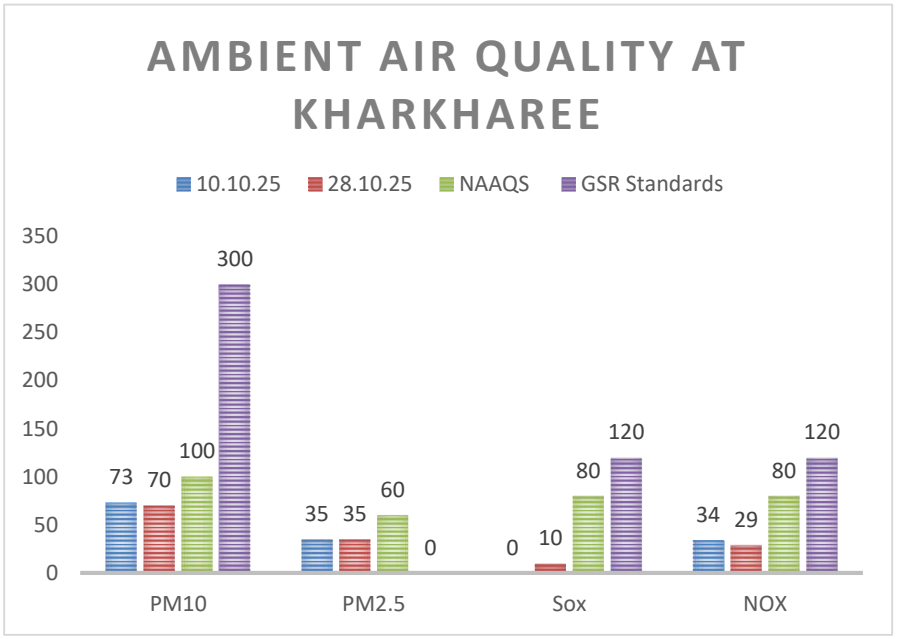
---- End of Report ----

Page -1 of 1


AMBIENT AIR QUALITY AT BLOCK IV KOORIDIH
10.10.25
29.10.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
75 70 100 300
37 35 60 0
10 0 80 120
33 29 80 120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT MURAIDIH OCP
06.10.25
21.10.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
71 69 100 300
30 29 60 0
0 0 80 120
24 28 80 120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT RAMKANALI
13.10.25
29.10.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
70 73 100 300
34 37 60 0
0 0 80 120
29 30 80 120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT KHARKHAREE
10.10.25
28.10.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
73 70 100 300
35 35 60 0
0 10 80 120
34 29 80 120
PM10
PM2.5
Sox
NOX

WATER QUALITY MONITORING

3.1 Location of sampling sites

(Refer **Plate No. – II**)

i) Mine Discharge of Govindpur (MW3)

A sampling point is fixed to assess the effluent quality of Mine discharge. This location is selected to monitor effluent discharge in to Khudia Nala and Bagdighi Nala.

3.2 Methodology of sampling and analysis

Water samples were collected as per standard practice. The effluent samples were collected and analysed for four parameters on fortnightly basis at the Environmental Laboratory of CMPDI RI-II, Dhanbad.

3.3 Results & Interpretations

The results are given in tabular form along with the applicable standards. Results are compared with Schedule - VI, effluent prescribed by MoEF&CC. Results show that most of the parameters are within the permissible limits.

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
MINE EFFLUENT TEST REPORT

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Test Report for Mine Effluent samples

Month & Year	**10/2025**	**Cluster**	**Cluster III**	**ULR NO.**		**TC1432125000002206F**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**05.12.2025**
Project		**Sampling Ref. No.**	**REM/BCCL/2025/10**	**Sampling Method**	**IS 3025 (Part-1) CMPDI/RI-II/LPM 13**		
Sampling Stations	**(i)**	**Govindpur**	**Sample Collected in 2.5 Ltr Jerricane , Color as observed is transparent**			**Period of Analysis**	**15.10.25 to 31.10.2025**
			Date of Sampling	15.10.25	31.10.25		

Sl. No.	Parameter	Method of Analysis	Observed Values		STANDARDS FOR COAL MINES (Stipulated by Ministry of Environment and Forests (MoEF), Vide Notification No. GSR 742(E), Dt: 25.09.2000)	LDL
			M1788	M1816		
1	Total Suspended Solids	IS 3025/17:1984, R :2017, Gravimetric	48	47	*100 (Max)*	10
2	pH	IS-3025/11:1983, R-2017, Electrometric	7.39	7.37	*5.5 - 9.0*	0.2
3	Oil & Grease	IS 3025/39:1991, R : 2019, Partition Gravimetric	<4.0	<4.0	*10 (Max)*	2
4	COD	APHA 23rd Edition 5220 C Titrimetric Method	36	32	*250 (Max)*	4

***All units in mg/L unless specified otherwise. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*
***Grab sampling carried out for water samples.*

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

NOISE LEVEL QUALITY MONITORING

4.1 Location of sampling sites

i) **Block-IV (N6)**

ii) **Nichitpur (N5)**

iii) **Govindpur Village (N7)**

i) **Kharkharee (N21)**

4.2 Methodology of sampling and analysis

Noise level measurements in form of 'L_{EQ}' were taken using Integrated Data Logging Sound Level Meter during day time & night time. Noise levels were measured for the complete day & night time, the Intergration time taken was one hour or 3600 seconds. Noise levels were measured in Decibels, 'A' weighted average, i.e. dB (A).

4.2 Results & Interpretations

Ambient noise levels were recorded during day time & night time and the observed values were compared with standards prescribed by MoEF&CC. The results of Noise levels recorded during day & night time on fortnightly basis are presented in tabular form along with the applicable standard permissible limits. The observed values in terms of L_{EQ} are presented**.** The observed values at all the monitoring locations are found to be within permissible limits.

TC-14321

cmpdi A Mini Ratna Company

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Noise Level Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Month & Year	**10/2025**	**Cluster**	**Cluster III**			**ULR NO.**	**TC1432125000002222F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**05.12.2025**
Project		**Sample Ref. No.**	**REM/BCCL/2025/10**		**Sampling Method**	**CMPDI/RI-II/LPM 13**	
Sampling Stations	**i**	**Block IV**	**Date of Sampling**	10.10.25	29.10.25	**Zone Category of Station:**	**Core Zone**

Sl. No.	Parameter	Hour / Time of day	Observed Values (in Leq dB(A)) First Fortnight	Observed Values (in Leq dB(A)) Second Fortnight	Method of Analysis	Range Of Testing	LDL	NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards	
								Zones	Limits in dB
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	54.6	53.3	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	58.8	57.7					
3		08:00 - 09:00	60	58.7					
4		09:00 – 10:00	63.2	62.3					
5		10:00 - 11:00	62.7	61.7					
6		11:00 - 12:00	64	63.5					
7		12:00 - 13:00	63.6	62.3					
8		13:00 - 14:00	63.9	64.6					
9		14:00 - 15:00	64.3	63.4					
10		15:00 - 16:00	67.2	65.5					
11		16:00 - 17:00	68	67.8					
12		17:00 - 18:00	68.9	68.7					
13		18:00 - 19:00	67.6	65.5					
14		19:00 - 20:00	67.1	66.5					
15		20:00 - 21:00	60.5	59.6					
16		21:00 - 22:00	53.6	52.1					
		Leq DAY	64.7	64.0					
1	Noise Level dB(A)Leq -Night	22:00-23:00	49.2	47.9	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	48.5	46.4					
3		00:00- 01:00	46.7	45.8					
4		01.00-02.00	41.9	42.2					
5		02.00-03.00	41.5	41.7					
6		03.00-04.00	44.4	42.9					
7		04.00-05.00	42.6	42.1					
8		05:00-06:00	42.9	43.9					
		Leq NIGHT	45.7	44.7					

**LDL indicates Lower Detection Limit*

***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants
ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Noise Level Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Month & Year	**10/2025**	**Cluster**	**Cluster III**			**ULR No.**	**TC1432125000002222F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**05.12.2025**
Project		**Sample Ref. No.**	**REM/BCCL/2025/10**		**Sampling Method**	**CMPDI/RI-II/LPM 13**	
Sampling Stations	**i**	**Muraidih OCP**	**Date of Sampling**	06.10.25	21.10.25	**Zone Category of Station:**	**Buffer Zone**

Sl. No.	Parameter	Hour / Time of day	Observed Values (in Leq dB(A)) First Fortnight	Observed Values (in Leq dB(A)) Second Fortnight	Method of Analysis	Range Of Testing	LDL	NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards Zones	Limits in dB
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	45.1	45.7	CPCB, Protocol for Ambient Level Noise Monitoring -2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	46.3	48.2					
3		08:00 - 09:00	51.3	50.8					
4		09:00 – 10:00	52.5	53.2					
5		10:00 - 11:00	53.3	53.7					
6		11:00 - 12:00	56	55.6					
7		12:00 - 13:00	56.8	57.8					
8		13:00 - 14:00	52.2	53					
9		14:00 - 15:00	53.3	53.7					
10		15:00 - 16:00	55.8	57					
11		16:00 - 17:00	50.5	49.4					
12		17:00 - 18:00	46.2	46.2					
13		18:00 - 19:00	44.7	44.6					
14		19:00 - 20:00	45.1	44.9					
15		20:00 - 21:00	44.6	44.7					
16		21:00 - 22:00	44.4	43.5					
		Leq DAY	52.0	52.4					
1	Noise Level dB(A)Leq - Night	22:00-23:00	40.9	40.4	CPCB, Protocol for Ambient Level Noise Monitoring -2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	40.5	38.8					
3		00:00- 01:00	40.2	38.1					
4		01.00-02.00	40.1	37.9					
5		02.00-03.00	39.7	37.8					
6		03.00-04.00	39.2	38.4					
7		04.00-05.00	40.7	40.1					
8		05:00-06:00	40.7	40.6					
		Leq NIGHT	40.3	39.2					

**LDL indicates Lower Detection Limit*

***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

Page -1 of 1

TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

Ambient Noise Level Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Month & Year	**10/2025**	**Cluster**	**Cluster III**	**ULR No.**	**TC1432125000002222F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**05.12.2025**
Project		**Sample Ref. No.**	**REM/BCCL/2025/10**	**Sampling Method**	**CMPDI/RI-II/LPM 13**
Sampling Stations	**i**	**Ramkanali**	**Date of Sampling** 13.10.25	29.10.25	**Zone Category of Station:** **Buffer Zone**

Sl. No.	Parameter	Hour / Time of day	Observed Values (in Leq dB(A)) First Fortnight	Observed Values (in Leq dB(A)) Second Fortnight	Method of Analysis	Range Of Testing	LDL	NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards	
								Zones	Limits in dB
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	52.5	51.5	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	55.1	54.3					
3		08:00 - 09:00	57.8	57.4					
4		09:00 – 10:00	63	63.3					
5		10:00 - 11:00	65.7	64.6					
6		11:00 - 12:00	64.1	63.3					
7		12:00 - 13:00	67.2	68.7					
8		13:00 - 14:00	68.8	67.7					
9		14:00 - 15:00	61.7	61.7					
10		15:00 - 16:00	60.6	60.6					
11		16:00 - 17:00	60.2	60.2					
12		17:00 - 18:00	60.5	59.7					
13		18:00 - 19:00	59.7	58.8					
14		19:00 - 20:00	58.5	57.7					
15		20:00 - 21:00	58.5	53.6					
16		21:00 - 22:00	54.3	52.6					
		Leq DAY	62.7	62.4					
1	Noise Level dB(A)Leq -Night	22:00-23:00	49.6	48.9	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	49.5	48.7					
3		00:00- 01:00	46.5	46.6					
4		01.00-02.00	44.6	44.4					
5		02.00-03.00	44.2	44.2					
6		03.00-04.00	44	44					
7		04.00-05.00	46	45.7					
8		05:00-06:00	46.9	46.7					
		Leq NIGHT	46.9	46.5					

**LDL indicates Lower Detection Limit*

***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

Page -1 of 1

TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Noise Level Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Month & Year	**10/2025**	**Cluster**	**Cluster III**	**ULR No.**	**TC1432125000002222F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**05.12.2025**
Project		**Sample Ref. No.**	**REM/BCCL/2025/10**	**Sampling Method**	**CMPDI/RI-II/LPM 13**
Sampling Stations	**i**	**Kharkharee**	**Date of Sampling**	10.10.25 / 28.10.25	**Zone Category of Station:** **Buffer Zone**

Sl. No.	Parameter	Hour / Time of day	Observed Values (in Leq dB(A)) First Fortnight	Observed Values (in Leq dB(A)) Second Fortnight	Method of Analysis	Range Of Testing	LDL	NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards	
								Zones	Limits in dB
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	43.7	44.5	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	59.1	59					
3		08:00 - 09:00	70.2	70.4					
4		09:00 – 10:00	70.1	69.8					
5		10:00 - 11:00	66.5	65.4					
6		11:00 - 12:00	63.6	63.2					
7		12:00 - 13:00	61.2	62.2					
8		13:00 - 14:00	59.6	58.9					
9		14:00 - 15:00	57.4	56.7					
10		15:00 - 16:00	55.8	56.1					
11		16:00 - 17:00	56.1	56.8					
12		17:00 - 18:00	55.9	56.5					
13		18:00 - 19:00	53.3	53.3					
14		19:00 - 20:00	51.5	51.6					
15		20:00 - 21:00	49.5	49.7					
16		21:00 - 22:00	48.9	49.3					
		Leq DAY	63.1	63.0					
1	Noise Level dB(A)Leq -Night	22:00-23:00	43.6	41.6	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	41	41.5					
3		00:00- 01:00	41.1	41.5					
4		01.00-02.00	39.4	40.5					
5		02.00-03.00	39.1	36.2					
6		03.00-04.00	38.6	39.9					
7		04.00-05.00	38.4	37.4					
8		05:00-06:00	37.2	35.2					
		Leq NIGHT	40.2	39.8					

**LDL indicates Lower Detection Limit*

***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants
ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

Page -1 of 1

Ambient Air Quality Standards for Jharia Coal Field
As per the Environment (Protection) Amendment Rules, 2000 notified vide notification G.S.R. 742(E), dated 25.9.2000.

Category	Pollutant	Time weighted average	Concentration in Ambient Air	Method of Measurement
1	2	3	4	5
III Coal mines located in the coal fields of • Jharia • Raniganj • Bokaro	Suspended Particulate Matter (SPM)	Annual Average * 24 hours **	500 µg/m^3 700 µg/m^3	- High Volume Sampling (Average flow rate not less than 1.1 m^3
	Respirable Particulate Matter (size less than 10 µm) (RPM)	Annual Average * 24 hours **	250 µg/m^3 300 µg/m^3	Respirable Particulate Matter sampling and analysis
	Sulphur Dioxide (SO_2)	Annual Average * 24 hours **	80 µg/m^3 120 µg/m^3	1.Improvedwest and Gaeke method 2.Ultraviolet fluorescene
	Oxide of Nitrogen as NO_2	Annual Average * 24 hours **	80 µg/m^3 120 µg/m^3	1. Jacob & Hochheiser Modified (Na-Arsenic) Method 2. Gas phase Chemilumine-scence

Note:

* Annual Arithmetic mean for the measurements taken in a year, following the guidelines for frequency of sampling laid down in clause2.

** 24hourly/8hourlyvaluesshallbemet 92%ofthetimeinayear.However,8% of the time it may exceed but not on two consecutive days.

NATIONAL AMBIENT AIR QUALITY STANDARDS

New Delhi the 18th November 2009

In exercise of the powers conferred by Sub-section (2) (h) of section 16 of the Air (Prevention and Control of Pollution) Act, 1981 (Act No. 14 of 1981), and in supersession of the notification No(s).S.O.384(E), dated 11th April 1994 and S.O.935(E), dated 14th NOVEMBER 1998, the Central Pollution Control Board hereby notify the National Ambient Air Quality Standards with immediate effect.

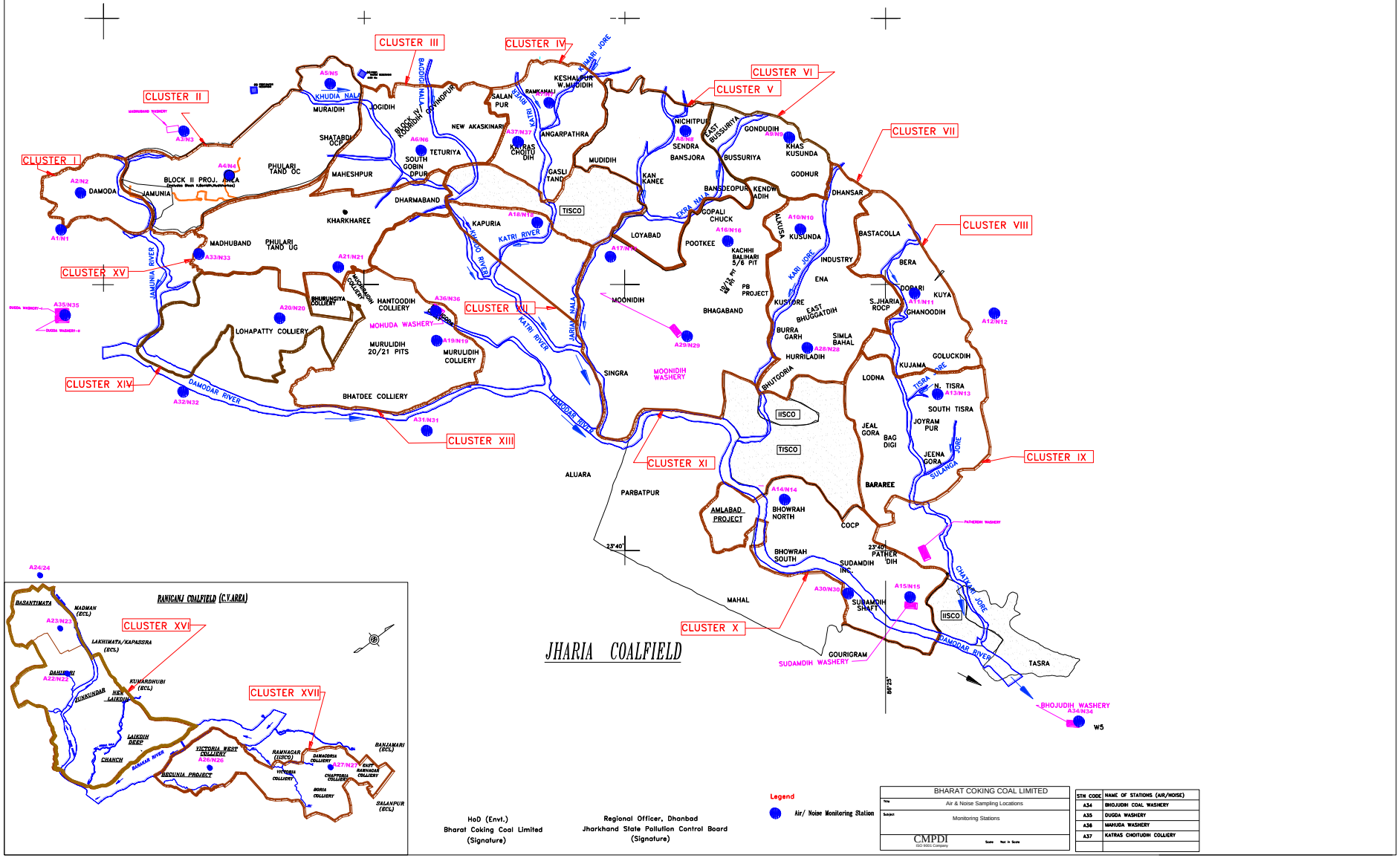
Pollutant	Time Weighted Average	Concentration in Ambient Air		Methods of Measurement
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)	
Sulphur Dioxide (SO_2), µg/m³	Annual * 24 Hours **	50 80	20 80	-Improved West and Gaeke Method -Ultraviolet Fluorescence
Nitrogendioxide (NO_2), µg/m³	Annual * 24 Hours **	40 80	30 80	-Jacob &Hochheiser modified ($NaOH$-$NaAsO_2$) Method -Gas Phase Chemiluminescence
Particulate Matter (Size less than 10µm) or PM_{10}, µg/m³	Annual * 24 Hours **	60 100	60 100	-Gravimetric -TEOM -Beta attenuation
Particulate Matter (Size less than 2.5µm) or $PM_{2.5}$, µg/m³	Annual * 24 Hours **	40 60	40 60	-Gravimetric -TEOM -Beta attenuation
Ozone (O_3) , µg/m³	8 Hours * 1 Hour **	100 180	100 180	-UV Photometric -Chemiluminescence -Chemical Method
Lead (Pb) , µg/m³	Annual * 24 Hours **	0.50 1.0	0.50 1.0	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper -ED-XRF using Teflon filter
Carbon Monoxide (CO), mg/m³	8 Hours ** 1 Hour **	02 04	02 04	-Non dispersive Infrared (NDIR) Spectroscopy
Ammonia (NH_3), µg/m³	Annual * 24 Hours **	100 400	100 400	-Chemiluminescence -Indophenol blue method
Benzene (C_6H_6), µg/m³	Annual *	05	05	-Gas Chromatography (GC) based continuous analyzer -Adsorption and desorption followed by GC analysis
Benzo(a)Pyrene (BaP) Particulate phase only, ng/m³	Annual *	01	01	-Solvent extraction followed byHPLC/GC analysis
Arsenic (As), ng/m³	Annual *	06	06	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper
Nickel (Ni), ng/m³	Annual *	20	20	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper

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

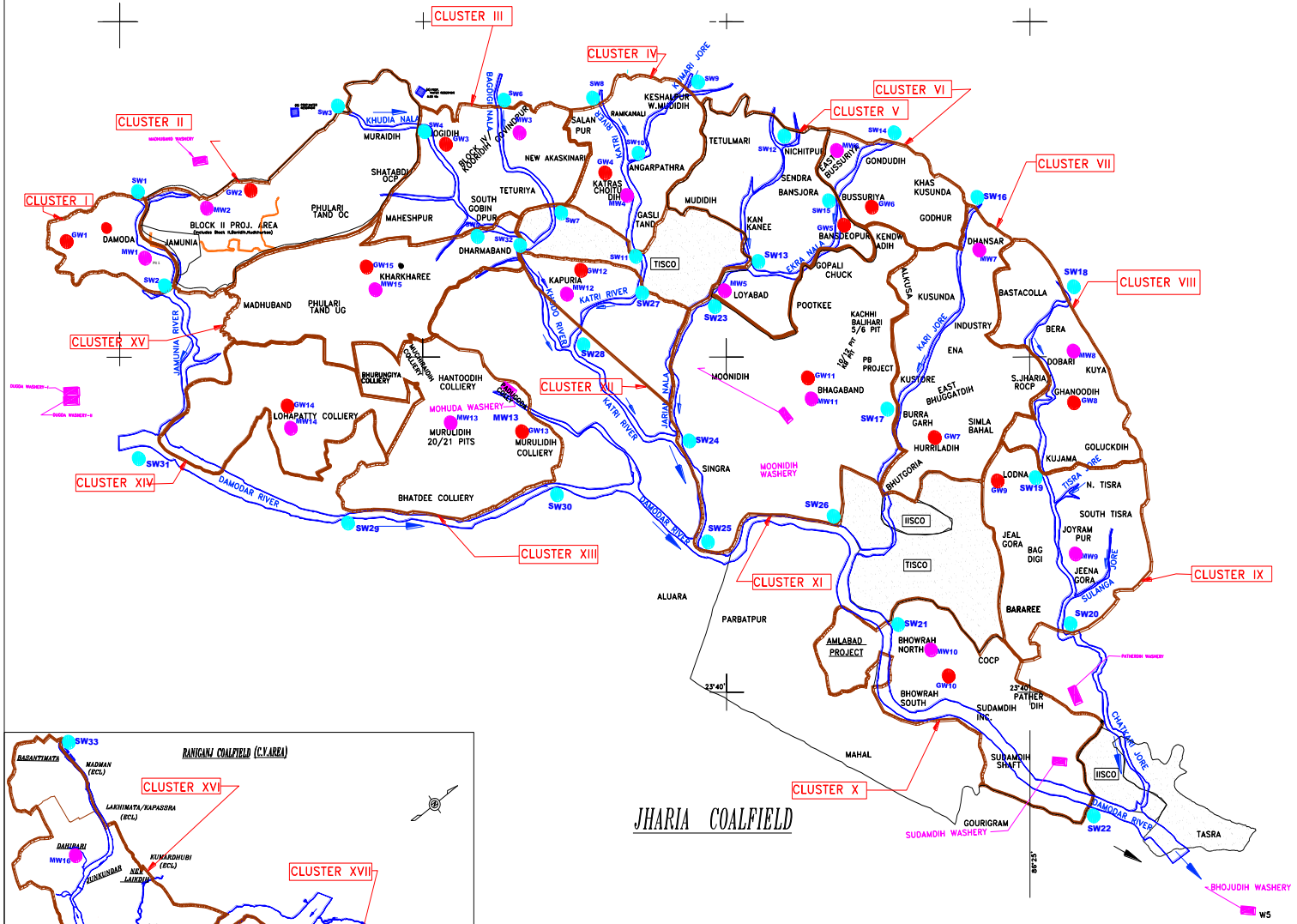
** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they JUNE exceed the limits but not on two consecutive days of monitoring.

NOTE: Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigations.

Location of Air & Noise Monitoring Stations in BCCL



Water Sampling Locations in BCCL



INDEX

Cluster	Suface Water (U/S, D/S)	Name of River/ Nala / Jore	Mine/ Effluent Water	Sampling Location	Ground Water	Sampling Location
I	SW1, SW2	Jamunia River	MW1	Damoda Area	GW1	Ghutway Village
II	SW3, SW4	Khudia Nala	MW2	Block II OCP	GW2	Joyrampur Village
III	SW4, SW5, SW6, SW7	Khudia Nala, Bagdigi Nala	MW3	Govindpur Colliery	GW3	Jogidih Village
IV	SW8, SW11, SW9, SW10	Katri River, Kumari Jore	MW4	Chotudih	GW4	Kankanee Village
V	SW12, SW13, SW15	Jarian Nala, Ekra Nala	MW5	Mudidih	GW5	Nichitpur
VI	SW14, SW15	Ekra Nala	MW6	East Bassuria UGP	GW6	Bansjora Borewell
VII	SW16, SW17	Kari Jore	MW7	Dhansar UGP	GW7	Hurriladih
VIII	SW18, SW19	Kashi Jore	MW8	Dobari UGP	GW8	Ghanudih
IX	SW19, SW20	Kashi Jore	MW9	Jeenagora	GW9	Lodna
X	SW21, SW22	Damodar River	MW10	Bhowrah North	GW10	Bhowrah South
XI	SW23, SW24, SW25, SW26	Jarian Nala, Damodar River	MW11	Bhagaband h UGP	GW11	Bhagabandh
XII	SW27, SW28	Katri River	MW12	Kapuria	GW12	Kapuria
XIII	SW29, SW30	Damodar River	MW13	Murulidih (20/21)	GW13	Murilidih
XIV	SW31, SW29	Damodar River	MW14	Lohapatti	GW14	Lohapatti
XV	SW5, SW32	Khudia Nala	MW15	Kharkharee UGP	GW15	Kharkharee
XVI	SW33, SW34	Khudia River	MW16	Dahibari OCP	GW16	Patlabari Village
XVII	SW35, SW36	Barakar River	MW17	Damagoria Colliery	GW17	Chaptoria

STRICTLY RESTRICTED
FOR COMPANY USE ONLY RESTRICTED
The information given in this report is not to be communicated either directly or indirectly to the press or to any person not holding an official position in the CIL /GOVERNMENT.

ENVIRONMENTAL MONITORING REPORT OF BHARAT COKING COAL LIMITED, CLUSTER – III

(FOR THE MONTH NOVEMBER, 2025)

E. C. no. J-11015/213/2010-IA. II(M) dated 03.03.2025.

CMPDI
ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

CONTENTS

SL. NO.	CHAPTER	PARTICULARS	PAGE NO.
1.	CHAPTER - I	EXECUTIVE SUMMARY	3-5
2.	CHAPTER-II	INTRODUCTION	6
3.	CHAPTER-III	RESULTS	7-19
4.	CHAPTER-IV	STANDARDS AND PLANS	20-21

EXECUTIVE SUMMARY

1.0 Introduction

The purpose of environmental monitoring is to assess the quality of various attributes that affects the fauna and flora. In accordance with the quality of these attributes appropriate strategy is to be developed to control the pollution level within the permissible limits. The three major attributes are air, water and noise level.

Bharat Coking Coal Limited (BCCL), a Subsidiary company of Coal India Limited is operating Underground and Opencast Mines in Jharia Coalfield (JCF) is a part of Gondwana Coalfields located in Dhanbad district of Jharkhand, the JCF is bounded by $23^0$37' N to $23^0$52' N latitudes and $86^0$09' E to $86^0$30' E longitude occupying an area of 450 Sq.km. BCCL has awarded Environmental monitoring work of Jharia Coalfield (JCF) to Central Mine Planning & Design Institute Limited (CMPDIL). The environmental monitoring has been carried out as per the conditions laid down by the MoEF&CC while granting environmental clearance of project, consent letter issued by the respective SPCB, and other statutory requirements.

2.0 Sampling location and rationale

2.1 Ambient air sampling locations

The ambient air quality monitoring stations were selected to represent core, buffer zone area. The rationale has been based on the guidelines stipulated by MoEF&CC, consent letter of SPCB, as well as other statutory requirements.

2.2 Water sampling stations

The Water sampling stations were selected for mine sump water.

2.3 Noise level monitoring locations

Noise levels vary depending on the various activities in mining areas. The monitoring of noise level in different locations will be helpful to take appropriate mitigating measures. The rationale has been based on the guidelines stipulated by MoEF&CC, consent letter of SPCB, as well as other statutory requirements.

3.0 Methodology of sampling and analysis

3.1 Ambient air quality

Parameters chosen for assessment of ambient air quality were Particulate Matter (PM_{10}), Fine Particulate Matter ($PM_{2.5}$), Sulphur Di-oxide (SO_2) and Nitrogen Oxides (NO_X). Respirable Dust Samplers (RDS) and Fine Dust Sampler ($PM_{2.5}$

sampler) were used for sampling of $PM_{10,}$ SO_2, & NO_X and Fine Dust Sampler ($PM_{2.5}$ sampler) were used for sampling of $PM_{2.5}$ at 24 hours interval once in a fortnight and the same for the gaseous pollutants. The samples were analysed in Environmental Laboratory of CMPDI, RI-II, Dhanbad.

3.2 Water quality

Water samples were collected as per standard practice. The Mine effluent samples were collected and analysed for four parameters on fortnightly basis. Thereafter the samples were preserved and analysed at the Environmental Laboratory of CMPDI, RI- II, Dhanbad.

3.3 Noise level monitoring

Noise level measurements in form of 'L_{EQ}' were taken using Integrated Data Logging Sound Level Meter. Noise levels were measured in Decibels, 'A' weighted average, i.e. dB(A).

4.0 Results and interpretations

4.1 Air quality

It has been seen from the analysis results that the 24 hours average concentration parameters like $PM_{10,}$ $PM_{2.5}$, SO_2 and NO_X are mostly within the permissible limits in all sampling locations as per MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000 Standards for Coal Mines and National Ambient Air Quality Standard -2009. Sometimes the concentration of PM_{10}& $PM_{2.5}$ exceeds the limits due to heavy public traffic, poor road condition, coke oven plants, burning of coal by surrounding habitants, brick making, municipal waste dumps and industries like Steel Plant, thermal Plants including their fly ash etc.

The following preventive and suppressive mitigative measures can be undertaken to contain the pollution level within prescribed level:-

- Wet drilling and controlled blasting should be practice.
- Explosive used should be optimised to restrict the dust generation.
- Transportation roads should be permanently asphalted free of ruts, potholes etc.
- Water should be sprayed on coal transportation road, service road more frequently and at regular interval.
- Dust from roads should be removed physically or mechanically.
- Greenbelts around industrial sites, service building area besides Avenue plantation along roads should be created.
- Coal dust should be suppressed by using fixed sprinklers.
- Regular maintenance of plant and machinery should be undertaken.

4.2 Water quality

The test results indicate that the major parameters compared with MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000 Standards for Coal Mines, are within permissible limits.

4.3 Noise Level

During the noise level survey it has been observed that the noise level in the sampling locations is within the permissible limits prescribed as per MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000 Standards for Coal Mines for Industrial Area and Noise pollution (Regulation and Control) Rules, 2000.

INTRODUCTION

Any industry and development activities including coal mining is bound to affect environmental attributes. There are positive as well as negative impacts of such operations. For controlling the adverse impacts a regular monitoring is essential. The environmental monitoring is being done as per the guide-lines stipulated by Ministry of Environment, Forest and Climate Change (MoEF&CC), Govt. of India.

The very purpose of environmental monitoring is to assess the quality of various attributes which affects the environment. As per quality of these attributes appropriate strategy is to be developed to control the pollution level within the permissible limits. The three major attributes are air, water and noise level.

Bharat Coking Coal has awarded Environmental Monitoring work of all Projects, Cluster wise, to Central Mine Planning & Design Institute Limited (CMPDIL). The environmental monitoring has been carried out as per conditions laid down by MoEF&CC while granting environmental clearance to different projects. CMPDI has trained manpower and well equipped laboratory to carry out monitoring, analysis and R&D work in the field of environment.

The CLUSTER III is in the westernmost part of the Jharia coalfield. It includes Jogidih Colliery, Maheshpur Colliery, South Govindpur Colliery, Teturiya Colliery, Govindpur Colliery, New Akasshkinaree Mine and Block IV Kooridih Mixed Mine as per **E. C. no. J-11015/213/2010-IA.II**(M) dated 06.02.2013 and later all seven mines are amalgamated to single mine Named Cluster III with OC cum UG with Highway Mining method with no change in lease area and production capacity. The cluster – III is situated about 40 - 45 kms from Dhanbad Railway Station. The mines of this cluster-III are operating since pre nationalization period (prior to 1972-73). It is connected by both Railway and Road. The drainage of the area is governed by Khudia and Bagdighi Nala.

The Project has Environmental Clearance from Ministry of Environment, Forest and Climate Change (MoEF&CC) for a rated capacity of 2.769 MTPA (normative) and 3.6 MTPA peak capacity of coal production vide letter no **E. C. no. J-11015/213/2010-IA. II**(M) dated 06.02.2013 later with **E. C. no. J-11015/213/2010-IA. II**(M) dated 03.03.2025.

Ministry of Environment, Forest and Climate Change while granting environmental clearance has given one of the General conditions that " Four ambient air quality monitoring stations should be established in the core zone as well as in the buffer zone for PM_{10}, $PM_{2.5}$, SO_2, NOx monitoring. Location of the stations should be decided based on the meteorological data, topographical features and environmentally and ecologically sensitive targets, other conditions regarding water / effluent and noise level monitoring in consultation with the State Pollution Control Board."

In compliance of these conditions the Environmental Monitoring has been carried out & report prepared for submission to MoEF&CC & JSPCB and other statutory authorities.

AMBIENT AIR QUALITY MONITORING

2.1 Location of sampling station and their rationale:

(As per G.S.R. 742 (E) dt. 25th December, 2000)

2.1.1 Ambient Air Quality Sampling Locations

CORE ZONE Monitoring Location

i) Block IV Kooridih OCP (A6): Industrial Area

The location of the sampling station is at 23°47'54.00"N & 86°16'20.00"E. The sampler was placed at 1.5 m above the ground level near Safety office of Block IV OCP.

BUFFER ZONE Monitoring Location

i) Muraidih OCP (A5) : Industrial Area

The sampler was placed at a height of 1.5 m from the ground level at Muraidih project office.

ii) Ramkanali Workshop (A7) : Industrial area

The location of the sampling station is 23°48'34.00"N & 86°18'22.00"E. The sampler was placed at height of 1.5 m above the ground level at AARC agent Office, Ramkanali.

iii) Kharkharee(A21): **Industrial Area**

The location of the sampling station is 23°46'29.00"N & 86°14'37.08"E. The sampler was placed at a height of 1.5 m above the ground level at Kharkharee Colliery.

AMBIENT AIR QUALITY DATA

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Air Quality Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Test Report for Ambient Air Samples

Month & Year	**11/2025**	**Cluster**	**Cluster III**			**ULR NO.**	**TC1432125300002242F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**12.01.2025**
Project	**Block-IV**		**Sample Ref. No.**	**REM/BCCL/2025/11**	**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**	
Date of Sampling	07.11.25		21.11.25	**Period of Analysis**	07.11.25 – 25.12.2025	**Zone of Station:**	**Core Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			A4816	A4894				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	86	94	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	45	51	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	35	28	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*

***All units are in µg/m3, 24 hourly Average,*

ANALYSED BY (Gaurav Kant) ***REVIEWED BY*** (Kumar Vaibhav) ***Authorised Signatory***

***Note**: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.*

---- End of Report ----

TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Air Quality Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850

Test Report for Ambient Air Samples

Month & Year	**11/2025**	**Cluster**	**Cluster III**	**ULR NO.**	**TC1432125300002242F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**12.01.2025**
Project	**Ramkanali Workshop**	**Sample Ref. No.**	**REM/BCCL/2025/11**	**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**
Date of Sampling	14.11.25	28.11.25	**Period of Analysis**	14.11.25 – 25.12.2025	**Zone of Station:** **Buffer Zone**

Sl. No.	Parameter	Method of Analysis	Observed Values (in µg/m³) A4858	Observed Values (in µg/m³) A4936	Range Of Testing	LDL	MoEF Standards Notification dated 25th September,2000 (GSR 742 E)	NAAQS, 2009
1	PM_{10}	IS -5182(Part 23):2006, R-2017	84	86	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	44	46	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	39	33	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*

***All units are in µg/m3, 24 hourly Average,*

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

***Note**: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.*

---- End of Report ----

Page -1 of 1

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Air Quality Test Report

Test Report for Ambient Air Samples

Month & Year	**11/2025**	**Cluster**	**Cluster III**			**ULR No.**	**TC1432125300002242F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**12.01.2025**
Project	**Muraidih**		**Sample Ref. No.**	**REM/BCCL/2025/11**	**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**	
Date of Sampling	05.11.25		19.11.25	**Date of Sampling**	05.11.25	25.12.2025	**Zone of Station:**	**Buffer Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			A4801	A4879				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	90	91	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	41	48	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	10	12	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	23	28	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*

***All units are in µg/m3, 24 hourly Average,*

ANALYSED BY	(Gaurav Kant) ***REVIEWED BY***	(Kumar Vaibhav) ***Authorised Signatory***

Note*: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.*

---- End of Report ----

Page -1 of 1

TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Air Quality Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Test Report for Ambient Air Samples

Month & Year	**11/2025**	**Cluster**	**Cluster III**			**ULR NO.**	**TC1432125300002242F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**12.01.2025**
Project	**Kharkharee**	**Sample Ref. No.**	**REM/BCCL/2025/11**		**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**	
Date of Sampling	06.11.25	20.11.25	**Period of Analysis**	06.11.25	25.12.2025	**Zone of Station:**	**Buffer Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			A4808	A4886				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	90	91	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	46	48	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	12	10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	27	22	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

***All units are in µg/m3, 24 hourly Average, * LDL indicates Lower Detection Limit,*

ANALYSED BY

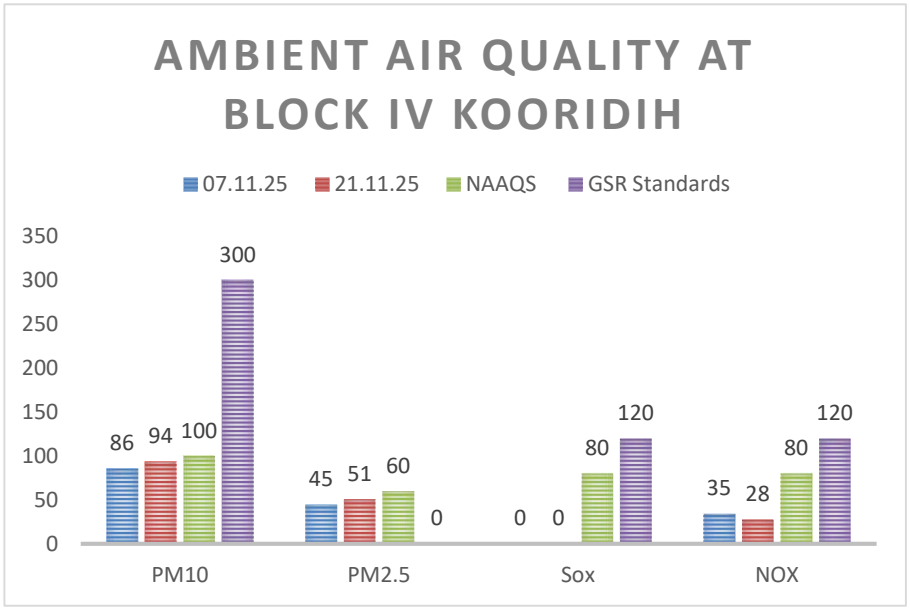
(Gaurav Kant)
REVIEWED BY

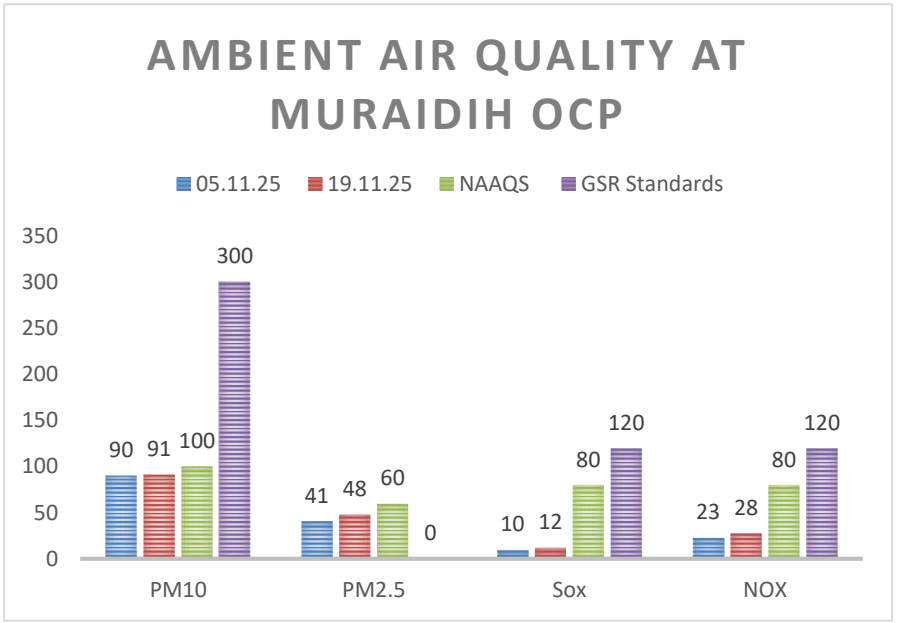
(Kumar Vaibhav)
Authorised Signatory

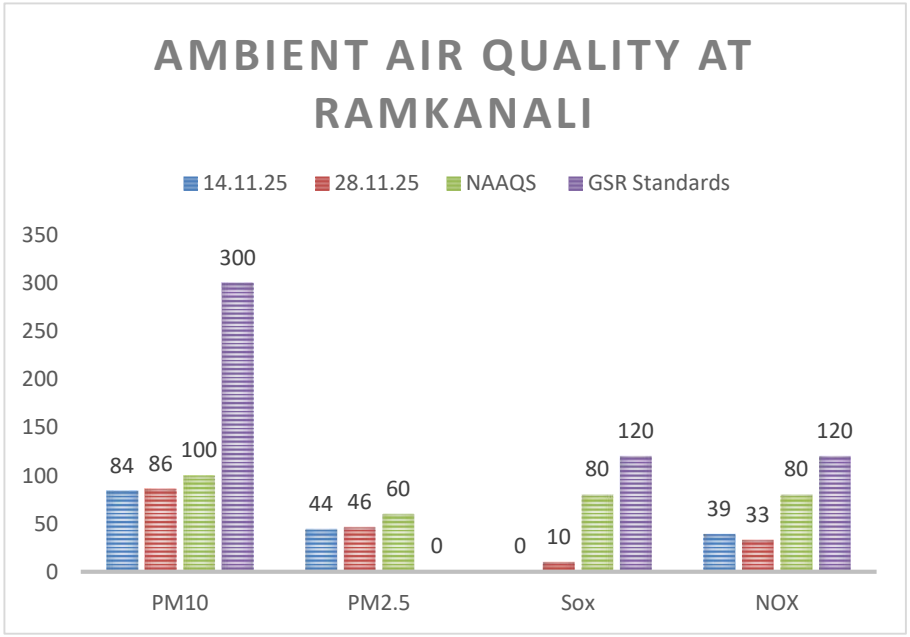
***Note**: The results above relate to the samples tested as received. This report cannot be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.*

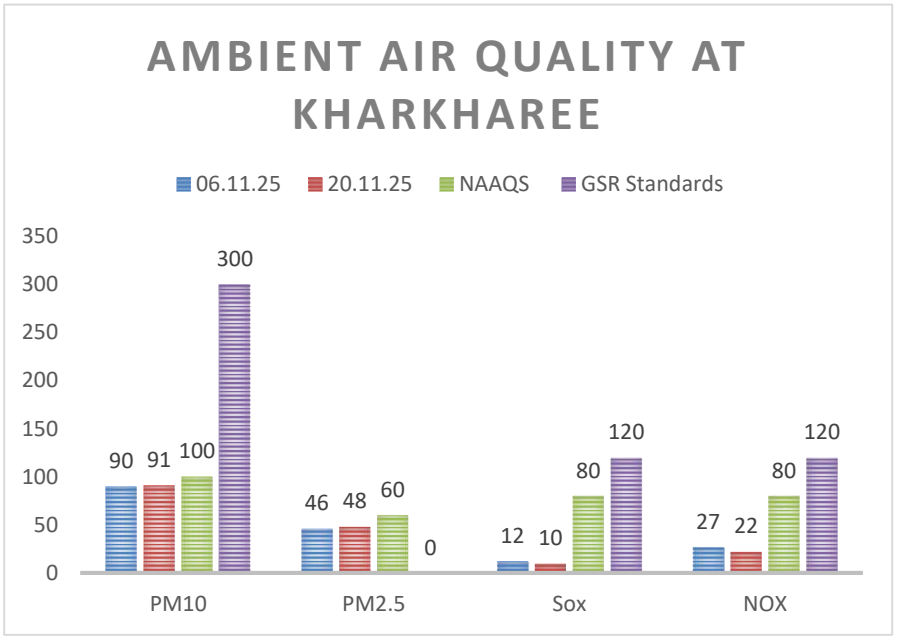
---- End of Report ----

Page -1 of 1


AMBIENT AIR QUALITY AT BLOCK IV KOORIDIH
07.11.25
21.11.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
86 94 100 300
45 51 60 0
0 0 80 120
35 28 80 120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT MURAIDIH OCP
05.11.25
19.11.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
90 91 100 300
41 48 60 0
10 12 80 120
23 28 80 120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT RAMKANALI
14.11.25
28.11.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
84 86 100 300
44 46 60 0
0 10 80 120
39 33 80 120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT KHARKHAREE
06.11.25
20.11.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
90 91 100 300
46 48 60 0
12 10 80 120
27 22 80 120
PM10
PM2.5
Sox
NOX

WATER QUALITY MONITORING

3.1 Location of sampling sites

(Refer **Plate No. – II**)

i) Mine Discharge of Govindpur (MW3)

A sampling point is fixed to assess the effluent quality of Mine discharge. This location is selected to monitor effluent discharge in to Khudia Nala and Bagdighi Nala.

3.2 Methodology of sampling and analysis

Water samples were collected as per standard practice. The effluent samples were collected and analysed for four parameters on fortnightly basis at the Environmental Laboratory of CMPDI RI-II, Dhanbad.

3.3 Results & Interpretations

The results are given in tabular form along with the applicable standards. Results are compared with Schedule - VI, effluent prescribed by MoEF&CC. Results show that most of the parameters are within the permissible limits.

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
MINE EFFLUENT TEST REPORT

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Test Report for Mine Effluent samples

Month & Year	**11/2025**	**Cluster**	**Cluster III**	**ULR NO.**		**TC14321252100002260F**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**12.01.2025**
Project		**Sampling Ref. No.**	**REM/BCCL/2025/11**	**Sampling Method**	**IS 3025 (Part-1) CMPDI/RI-II/LPM 13**		
Sampling Stations	**(i)**	**Govindpur**	**Sample Collected in 2.5 Ltr Jerricane , Color as observed is transparent**			**Period of Analysis**	**10.11.25 TO 30.11.2025**
			Date of Sampling	10.11.25	24.11.25		

Sl. No.	Parameter	Method of Analysis	Observed Values		STANDARDS FOR COAL MINES (Stipulated by Ministry of Environment and Forests (MoEF), Vide Notification No. GSR 742(E), Dt: 25.09.2000)	LDL
			M1840	**M1866**		
1	Total Suspended Solids	IS 3025/17:1984, R :2017, Gravimetric	47	49	*100 (Max)*	10
2	pH	IS-3025/11:1983, R-2017, Electrometric	7.77	7.78	*5.5 - 9.0*	0.2
3	Oil & Grease	IS 3025/39:1991, R : 2019, Partition Gravimetric	<4.0	<4.0	*10 (Max)*	2
4	COD	APHA 23rd Edition 5220 C Titrimetric Method	28	28	*250 (Max)*	4

***All units in mg/L unless specified otherwise. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*
***Grab sampling carried out for water samples.*

ANALYSED BY | (Gaurav Kant) ***REVIEWED BY*** | (Kumar Vaibhav) ***Authorised Signatory***

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

NOISE LEVEL QUALITY MONITORING

4.1 Location of sampling sites

i) **Block-IV (N6)**

ii) **Nichitpur (N5)**

iii) **Govindpur Village (N7)**

i) **Kharkharee (N21)**

4.2 Methodology of sampling and analysis

Noise level measurements in form of 'L_{EQ}' were taken using Integrated Data Logging Sound Level Meter during day time & night time. Noise levels were measured for the complete day & night time, the Intergration time taken was one hour or 3600 seconds. Noise levels were measured in Decibels, 'A' weighted average, i.e. dB (A).

4.2 Results & Interpretations

Ambient noise levels were recorded during day time & night time and the observed values were compared with standards prescribed by MoEF&CC. The results of Noise levels recorded during day & night time on fortnightly basis are presented in tabular form along with the applicable standard permissible limits. The observed values in terms of L_{EQ} are presented**.** The observed values at all the monitoring locations are found to be within permissible limits.

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

Ambient Noise Level Test Report

Month & Year	**11/2025**	**Cluster**	**Cluster III**			**ULR NO.**	**TC143212537000022 76F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**12.01.2025**
Project		**Sample Ref. No.**	**REM/BCCL/2025/11**		**Sampling Method**	**CMPDI/RI-II/LPM 13**	
Sampling Stations	**i**	**Block IV**	**Date of Sampling**	07.11.25	21.11.25	**Zone Category of Station:**	**Core Zone**

Sl. No.	Parameter	Hour / Time of day	Observed Values (in Leq dB(A)) First Fortnight	Observed Values (in Leq dB(A)) Second Fortnight	Method of Analysis	Range Of Testing	LDL	NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards	
								Zones	Limits in dB
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	52.6	51.3	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	56.5	55.6					
3		08:00 - 09:00	57.5	56.4					
4		09:00 – 10:00	60.8	59.9					
5		10:00 - 11:00	60.3	59.4					
6		11:00 - 12:00	61.6	61.1					
7		12:00 - 13:00	63.2	59.9					
8		13:00 - 14:00	61.5	62.2					
9		14:00 - 15:00	62.3	61					
10		15:00 - 16:00	64.8	63					
11		16:00 - 17:00	65.4	65.2					
12		17:00 - 18:00	64.2	66.1					
13		18:00 - 19:00	65.1	63					
14		19:00 - 20:00	64.7	64					
15		20:00 - 21:00	55.2	57.4					
16		21:00 - 22:00	51.6	50.1					
		Leq DAY	62.1	61.5					
1	Noise Level dB(A)Leq -Night	22:00-23:00	50	46.8	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	47.4	45.3					
3		00:00- 01:00	45.7	44.8					
4		01.00-02.00	40.9	41.2					
5		02.00-03.00	40.6	40.7					
6		03.00-04.00	43.4	42					
7		04.00-05.00	41.7	41.1					
8		05:00-06:00	42	42.9					
		Leq NIGHT	45.3	43.6					

**LDL indicates Lower Detection Limit*

***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants
ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Noise Level Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Month & Year	**11/2025**	**Cluster**	**Cluster III**			**ULR No.**	**TC143212537000022 76F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**12.01.2025**
Project		**Sample Ref. No.**	**REM/BCCL/2025/11**		**Sampling Method**	**CMPDI/RI-II/LPM 13**	
Sampling Stations	**i**	**Muraidih OCP**	**Date of Sampling**	05.11.25	19.11.25	**Zone Category of Station:**	**Buffer Zone**

Sl. No.	Parameter	Hour / Time of day	Observed Values (in Leq dB(A)) First Fortnight	Observed Values (in Leq dB(A)) Second Fortnight	Method of Analysis	Range Of Testing	LDL	NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards Zones	Limits in dB
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	43.5	43.9	CPCB, Protocol for Ambient Level Noise Monitoring -2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	42.1	46.4					
3		08:00 - 09:00	49.4	48.9					
4		09:00 – 10:00	50.5	51.2					
5		10:00 - 11:00	51.3	51.7					
6		11:00 - 12:00	53.7	53.5					
7		12:00 - 13:00	53.1	55.7					
8		13:00 - 14:00	50.2	51					
9		14:00 - 15:00	51.3	51.7					
10		15:00 - 16:00	53.7	54.8					
11		16:00 - 17:00	48.6	47.6					
12		17:00 - 18:00	44.5	44.5					
13		18:00 - 19:00	43	42.9					
14		19:00 - 20:00	43.5	43.2					
15		20:00 - 21:00	42.9	43					
16		21:00 - 22:00	42.7	41.9					
		Leq DAY	49.6	50.4					
1	Noise Level dB(A)Leq - Night	22:00-23:00	39	39.5	CPCB, Protocol for Ambient Level Noise Monitoring -2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	39.6	38					
3		00:00- 01:00	39.2	37.2					
4		01.00-02.00	39.1	37					
5		02.00-03.00	38.8	36.9					
6		03.00-04.00	38.3	37.6					
7		04.00-05.00	39.8	39.1					
8		05:00-06:00	39.8	39.7					
		Leq NIGHT	39.2	38.3					

**LDL indicates Lower Detection Limit*

***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

Page -1 of 1

TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

Ambient Noise Level Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Month & Year	**11/2025**	**Cluster**	**Cluster III**	**ULR No.**	**TC14321253700002276F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**12.01.2025**
Project		**Sample Ref. No.**	**REM/BCCL/2025/11**	**Sampling Method**	**CMPDI/RI-II/LPM 13**
Sampling Stations	**i**	**Ramkanali**	**Date of Sampling** 14.11.25	28.11.25	**Zone Category of Station:** **Buffer Zone**

Sl. No.	Parameter	Hour / Time of day	Observed Values (in Leq dB(A)) First Fortnight	Observed Values (in Leq dB(A)) Second Fortnight	Method of Analysis	Range Of Testing	LDL	NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards	
								Zones	Limits in dB
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	50.5	49.6	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	53	52.3					
3		08:00 - 09:00	55.7	55.2					
4		09:00 – 10:00	61.7	60.9					
5		10:00 - 11:00	63.2	62.2					
6		11:00 - 12:00	61.7	60.9					
7		12:00 - 13:00	64.8	66.1					
8		13:00 - 14:00	66.2	65.1					
9		14:00 - 15:00	59.4	59.4					
10		15:00 - 16:00	58.4	58.4					
11		16:00 - 17:00	57.9	57.9					
12		17:00 - 18:00	58.3	57.5					
13		18:00 - 19:00	57.5	56.5					
14		19:00 - 20:00	56.3	55.6					
15		20:00 - 21:00	56.3	51.6					
16		21:00 - 22:00	52.3	50.6					
		Leq DAY	60.4	60.0					
1	Noise Level dB(A)Leq -Night	22:00-23:00	46	47.8	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	48.4	47.6					
3		00:00- 01:00	45.5	45.6					
4		01.00-02.00	43.6	43.4					
5		02.00-03.00	43.1	42					
6		03.00-04.00	42.9	42.3					
7		04.00-05.00	45	42.3					
8		05:00-06:00	45.9	44.1					
		Leq NIGHT	45.4	45.0					

**LDL indicates Lower Detection Limit*

***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

Page -1 of 1

TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Noise Level Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Month & Year	**11/2025**	**Cluster**	**Cluster III**	**ULR No.**	**TC14321253700002276F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**12.01.2025**
Project		**Sample Ref. No.**	**REM/BCCL/2025/11**	**Sampling Method**	**CMPDI/RI-II/LPM 13**
Sampling Stations	**i**	**Kharkharee**	**Date of Sampling**	06.11.25 / 20.11.25	**Zone Category of Station:** **Buffer Zone**

Sl. No.	Parameter	Hour / Time of day	Observed Values (in Leq dB(A)) First Fortnight	Observed Values (in Leq dB(A)) Second Fortnight	Method of Analysis	Range Of Testing	LDL	NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards	
								Zones	Limits in dB
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	42	42.8	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	56.8	56.7					
3		08:00 - 09:00	67.6	67.8					
4		09:00 – 10:00	69	67.2					
5		10:00 - 11:00	64	62.9					
6		11:00 - 12:00	61.3	60.8					
7		12:00 - 13:00	58.9	59.8					
8		13:00 - 14:00	57.4	56.6					
9		14:00 - 15:00	55.2	54.5					
10		15:00 - 16:00	53.7	54.1					
11		16:00 - 17:00	53.1	54.6					
12		17:00 - 18:00	53.8	54.4					
13		18:00 - 19:00	51.3	51.3					
14		19:00 - 20:00	49.6	49.7					
15		20:00 - 21:00	45.3	47.9					
16		21:00 - 22:00	45	47.5					
		Leq DAY	61.1	60.5					
1	Noise Level dB(A)Leq -Night	22:00-23:00	42.7	40.6	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	40.1	40.6					
3		00:00- 01:00	40.2	40.6					
4		01.00-02.00	38.5	39.6					
5		02.00-03.00	38.3	35.3					
6		03.00-04.00	37.8	38.9					
7		04.00-05.00	37.6	36.5					
8		05:00-06:00	36.3	34.4					
		Leq NIGHT	39.4	38.9					

**LDL indicates Lower Detection Limit*

***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants
ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

Page -1 of 1

Ambient Air Quality Standards for Jharia Coal Field
As per the Environment (Protection) Amendment Rules, 2000 notified vide notification G.S.R. 742(E), dated 25.9.2000.

Category	Pollutant	Time weighted average	Concentration in Ambient Air	Method of Measurement
1	2	3	4	5
III Coal mines located in the coal fields of • Jharia • Raniganj • Bokaro	Suspended Particulate Matter (SPM)	Annual Average * 24 hours **	500 µg/m^3 700 µg/m^3	- High Volume Sampling (Average flow rate not less than 1.1 m^3
	Respirable Particulate Matter (size less than 10 µm) (RPM)	Annual Average * 24 hours **	250 µg/m^3 300 µg/m^3	Respirable Particulate Matter sampling and analysis
	Sulphur Dioxide (SO_2)	Annual Average * 24 hours **	80 µg/m^3 120 µg/m^3	1.Improvedwest and Gaeke method 2.Ultraviolet fluorescene
	Oxide of Nitrogen as NO_2	Annual Average * 24 hours **	80 µg/m^3 120 µg/m^3	1. Jacob & Hochheiser Modified (Na-Arsenic) Method 2. Gas phase Chemilumine-scence

Note:

* Annual Arithmetic mean for the measurements taken in a year, following the guidelines for frequency of sampling laid down in clause2.

** 24hourly/8hourlyvaluesshallbemet 92%ofthetimeinayear.However,8% of the time it may exceed but not on two consecutive days.

NATIONAL AMBIENT AIR QUALITY STANDARDS

New Delhi the 18th November 2009

In exercise of the powers conferred by Sub-section (2) (h) of section 16 of the Air (Prevention and Control of Pollution) Act, 1981 (Act No. 14 of 1981), and in supersession of the notification No(s).S.O.384(E), dated 11th April 1994 and S.O.935(E), dated 14th NOVEMBER 1998, the Central Pollution Control Board hereby notify the National Ambient Air Quality Standards with immediate effect.

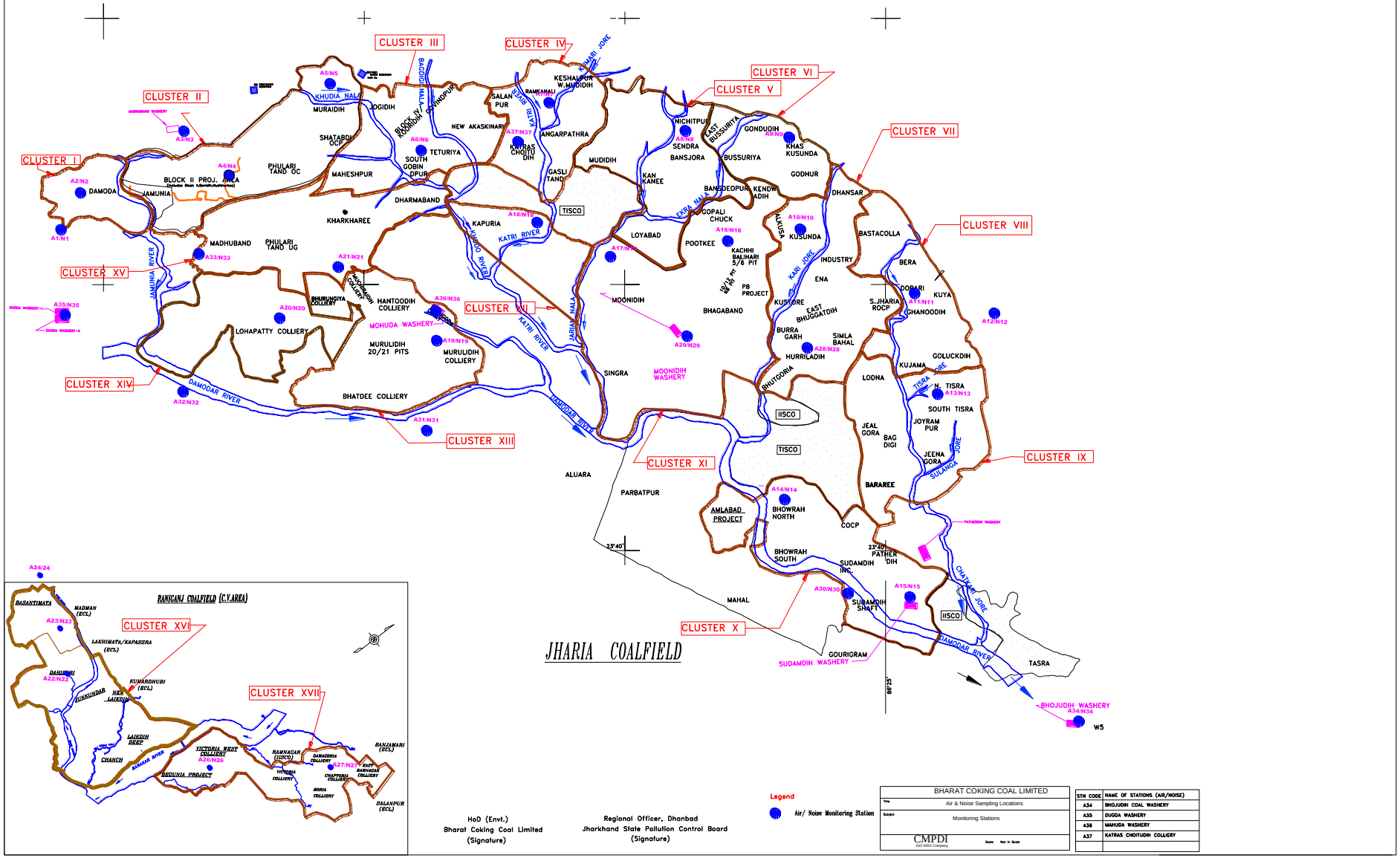
Pollutant	Time Weighted Average	Concentration in Ambient Air		Methods of Measurement
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)	
Sulphur Dioxide (SO_2), µg/m³	Annual * 24 Hours **	50 80	20 80	-Improved West and Gaeke Method -Ultraviolet Fluorescence
Nitrogendioxide (NO_2), µg/m³	Annual * 24 Hours **	40 80	30 80	-Jacob &Hochheiser modified ($NaOH$-$NaAsO_2$) Method -Gas Phase Chemiluminescence
Particulate Matter (Size less than 10µm) or PM_{10}, µg/m³	Annual * 24 Hours **	60 100	60 100	-Gravimetric -TEOM -Beta attenuation
Particulate Matter (Size less than 2.5µm) or $PM_{2.5}$, µg/m³	Annual * 24 Hours **	40 60	40 60	-Gravimetric -TEOM -Beta attenuation
Ozone (O_3) , µg/m³	8 Hours * 1 Hour **	100 180	100 180	-UV Photometric -Chemiluminescence -Chemical Method
Lead (Pb) , µg/m³	Annual * 24 Hours **	0.50 1.0	0.50 1.0	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper -ED-XRF using Teflon filter
Carbon Monoxide (CO), mg/m³	8 Hours ** 1 Hour **	02 04	02 04	-Non dispersive Infrared (NDIR) Spectroscopy
Ammonia (NH_3), µg/m³	Annual * 24 Hours **	100 400	100 400	-Chemiluminescence -Indophenol blue method
Benzene (C_6H_6), µg/m³	Annual *	05	05	-Gas Chromatography (GC) based continuous analyzer -Adsorption and desorption followed by GC analysis
Benzo(a)Pyrene (BaP) Particulate phase only, ng/m³	Annual *	01	01	-Solvent extraction followed byHPLC/GC analysis
Arsenic (As), ng/m³	Annual *	06	06	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper
Nickel (Ni), ng/m³	Annual *	20	20	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper

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

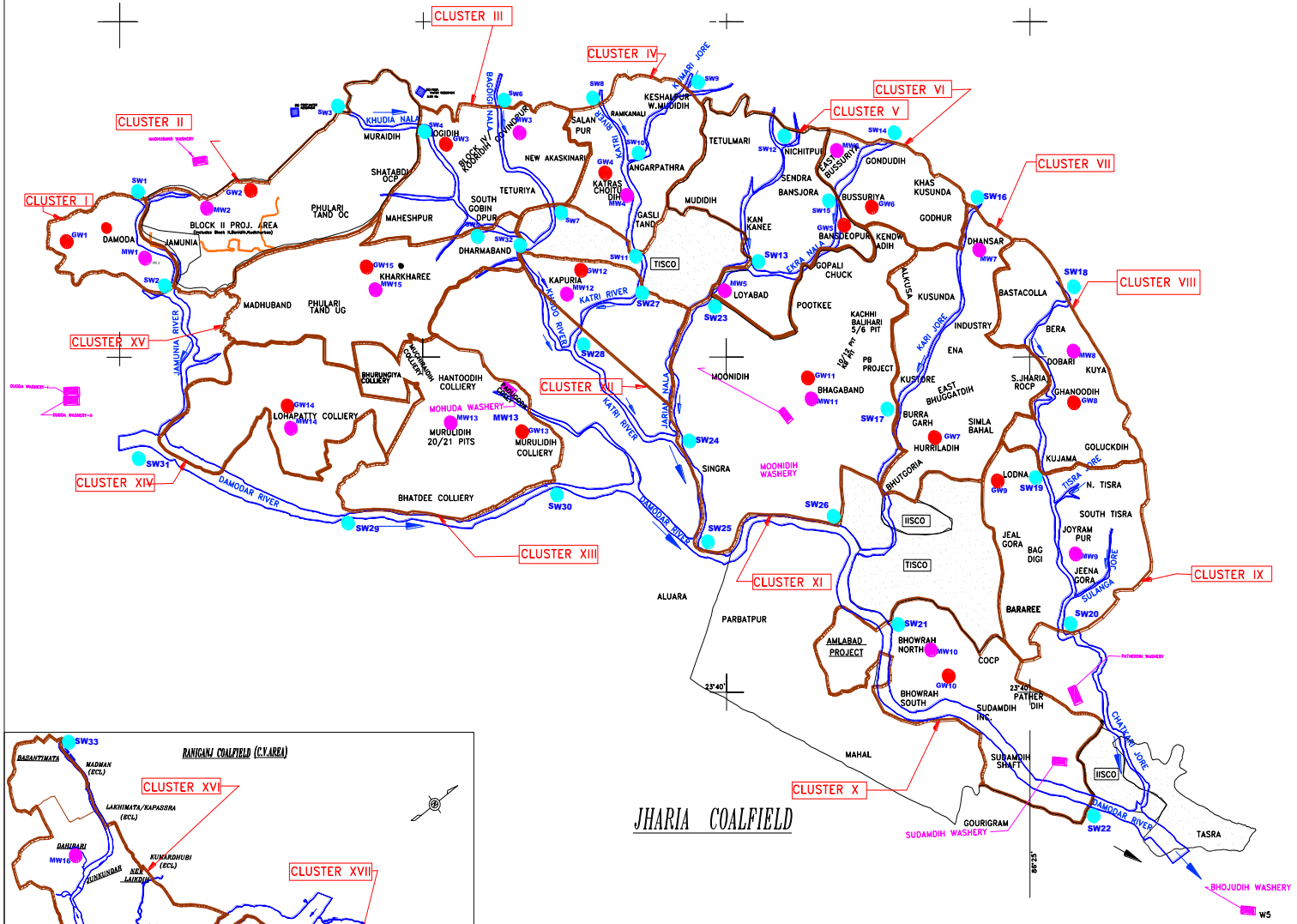
** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they JUNE exceed the limits but not on two consecutive days of monitoring.

NOTE: Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigations.

Location of Air & Noise Monitoring Stations in BCCL



Water Sampling Locations in BCCL



INDEX

Cluster	Suface Water (U/S, D/S)	Name of River/ Nala / Jore	Mine/ Effluent Water	Sampling Location	Ground Water	Sampling Location
I	SW1, SW2	Jamunia River	MW1	Damoda Area	GW1	Ghutway Village
II	SW3, SW4	Khudia Nala	MW2	Block II OCP	GW2	Joyrampur Village
III	SW4, SW5, SW6, SW7	Khudia Nala, Bagdigi Nala	MW3	Govindpur Colliery	GW3	Jogidih Village
IV	SW8, SW11, SW9, SW10	Katri River, Kumari Jore	MW4	Chotudih	GW4	Kankanee Village
V	SW12, SW13, SW15	Jarian Nala, Ekra Nala	MW5	Mudidih	GW5	Nichitpur
VI	SW14, SW15	Ekra Nala	MW6	East Bassuria UGP	GW6	Bansjora Borewell
VII	SW16, SW17	Kari Jore	MW7	Dhansar UGP	GW7	Hurriladih
VIII	SW18, SW19	Kashi Jore	MW8	Dobari UGP	GW8	Ghanudih
IX	SW19, SW20	Kashi Jore	MW9	Jeenagora	GW9	Lodna
X	SW21, SW22	Damodar River	MW10	Bhowrah North	GW10	Bhowrah South
XI	SW23, SW24, SW25, SW26	Jarian Nala, Damodar River	MW11	Bhagaband h UGP	GW11	Bhagabandh
XII	SW27, SW28	Katri River	MW12	Kapuria	GW12	Kapuria
XIII	SW29, SW30	Damodar River	MW13	Murulidih (20/21)	GW13	Murilidih
XIV	SW31, SW29	Damodar River	MW14	Lohapatti	GW14	Lohapatti
XV	SW5, SW32	Khudia Nala	MW15	Kharkharee UGP	GW15	Kharkharee
XVI	SW33, SW34	Khudia River	MW16	Dahibari OCP	GW16	Patlabari Village
XVII	SW35, SW36	Barakar River	MW17	Damagoria Colliery	GW17	Chaptoria

STRICTLY RESTRICTED
FOR COMPANY USE ONLY RESTRICTED
The information given in this report is not to be communicated either directly or indirectly to the press or to any person not holding an official position in the CIL /GOVERNMENT.

ENVIRONMENTAL MONITORING REPORT OF BHARAT COKING COAL LIMITED, CLUSTER – III

(FOR THE MONTH DECEMBER, 2025)

E. C. no. J-11015/213/2010-IA. II(M) dated 03.03.2025.

CMPDI
ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

CONTENTS

SL. NO.	CHAPTER	PARTICULARS	PAGE NO.
1.	CHAPTER - I	EXECUTIVE SUMMARY	3-5
2.	CHAPTER-II	INTRODUCTION	6
3.	CHAPTER-III	RESULTS	7-19
4.	CHAPTER-IV	STANDARDS AND PLANS	20-21

EXECUTIVE SUMMARY

1.0 Introduction

The purpose of environmental monitoring is to assess the quality of various attributes that affects the fauna and flora. In accordance with the quality of these attributes appropriate strategy is to be developed to control the pollution level within the permissible limits. The three major attributes are air, water and noise level.

Bharat Coking Coal Limited (BCCL), a Subsidiary company of Coal India Limited is operating Underground and Opencast Mines in Jharia Coalfield (JCF) is a part of Gondwana Coalfields located in Dhanbad district of Jharkhand, the JCF is bounded by $23^0$37' N to $23^0$52' N latitudes and $86^0$09' E to $86^0$30' E longitude occupying an area of 450 Sq.km. BCCL has awarded Environmental monitoring work of Jharia Coalfield (JCF) to Central Mine Planning & Design Institute Limited (CMPDIL). The environmental monitoring has been carried out as per the conditions laid down by the MoEF&CC while granting environmental clearance of project, consent letter issued by the respective SPCB, and other statutory requirements.

2.0 Sampling location and rationale

2.1 Ambient air sampling locations

The ambient air quality monitoring stations were selected to represent core, buffer zone area. The rationale has been based on the guidelines stipulated by MoEF&CC, consent letter of SPCB, as well as other statutory requirements.

2.2 Water sampling stations

The Water sampling stations were selected for mine sump water.

2.3 Noise level monitoring locations

Noise levels vary depending on the various activities in mining areas. The monitoring of noise level in different locations will be helpful to take appropriate mitigating measures. The rationale has been based on the guidelines stipulated by MoEF&CC, consent letter of SPCB, as well as other statutory requirements.

3.0 Methodology of sampling and analysis

3.1 Ambient air quality

Parameters chosen for assessment of ambient air quality were Particulate Matter (PM_{10}), Fine Particulate Matter ($PM_{2.5}$), Sulphur Di-oxide (SO_2) and Nitrogen Oxides (NO_X). Respirable Dust Samplers (RDS) and Fine Dust Sampler ($PM_{2.5}$

sampler) were used for sampling of $PM_{10,}$ SO_2, & NO_X and Fine Dust Sampler ($PM_{2.5}$ sampler) were used for sampling of $PM_{2.5}$ at 24 hours interval once in a fortnight and the same for the gaseous pollutants. The samples were analysed in Environmental Laboratory of CMPDI, RI-II, Dhanbad.

3.2 Water quality

Water samples were collected as per standard practice. The Mine effluent samples were collected and analysed for four parameters on fortnightly basis. Thereafter the samples were preserved and analysed at the Environmental Laboratory of CMPDI, RI- II, Dhanbad.

3.3 Noise level monitoring

Noise level measurements in form of 'L_{EQ}' were taken using Integrated Data Logging Sound Level Meter. Noise levels were measured in Decibels, 'A' weighted average, i.e. dB(A).

4.0 Results and interpretations

4.1 Air quality

It has been seen from the analysis results that the 24 hours average concentration parameters like $PM_{10,}$ $PM_{2.5}$, SO_2 and NO_X are mostly within the permissible limits in all sampling locations as per MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000 Standards for Coal Mines and National Ambient Air Quality Standard -2009. Sometimes the concentration of PM_{10}& $PM_{2.5}$ exceeds the limits due to heavy public traffic, poor road condition, coke oven plants, burning of coal by surrounding habitants, brick making, municipal waste dumps and industries like Steel Plant, thermal Plants including their fly ash etc.

The following preventive and suppressive mitigative measures can be undertaken to contain the pollution level within prescribed level:-

- Wet drilling and controlled blasting should be practice.
- Explosive used should be optimised to restrict the dust generation.
- Transportation roads should be permanently asphalted free of ruts, potholes etc.
- Water should be sprayed on coal transportation road, service road more frequently and at regular interval.
- Dust from roads should be removed physically or mechanically.
- Greenbelts around industrial sites, service building area besides Avenue plantation along roads should be created.
- Coal dust should be suppressed by using fixed sprinklers.
- Regular maintenance of plant and machinery should be undertaken.

4.2 Water quality

The test results indicate that the major parameters compared with MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000 Standards for Coal Mines, are within permissible limits.

4.3 Noise Level

During the noise level survey it has been observed that the noise level in the sampling locations is within the permissible limits prescribed as per MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000 Standards for Coal Mines for Industrial Area and Noise pollution (Regulation and Control) Rules, 2000.

INTRODUCTION

Any industry and development activities including coal mining is bound to affect environmental attributes. There are positive as well as negative impacts of such operations. For controlling the adverse impacts a regular monitoring is essential. The environmental monitoring is being done as per the guide-lines stipulated by Ministry of Environment, Forest and Climate Change (MoEF&CC), Govt. of India.

The very purpose of environmental monitoring is to assess the quality of various attributes which affects the environment. As per quality of these attributes appropriate strategy is to be developed to control the pollution level within the permissible limits. The three major attributes are air, water and noise level.

Bharat Coking Coal has awarded Environmental Monitoring work of all Projects, Cluster wise, to Central Mine Planning & Design Institute Limited (CMPDIL). The environmental monitoring has been carried out as per conditions laid down by MoEF&CC while granting environmental clearance to different projects. CMPDI has trained manpower and well equipped laboratory to carry out monitoring, analysis and R&D work in the field of environment.

The CLUSTER III is in the westernmost part of the Jharia coalfield. It includes Jogidih Colliery, Maheshpur Colliery, South Govindpur Colliery, Teturiya Colliery, Govindpur Colliery, New Akasshkinaree Mine and Block IV Kooridih Mixed Mine as per **E. C. no. J-11015/213/2010-IA.II**(M) dated 06.02.2013 and later all seven mines are amalgamated to single mine Named Cluster III with OC cum UG with Highway Mining method with no change in lease area and production capacity. The cluster – III is situated about 40 - 45 kms from Dhanbad Railway Station. The mines of this cluster-III are operating since pre nationalization period (prior to 1972-73). It is connected by both Railway and Road. The drainage of the area is governed by Khudia and Bagdighi Nala.

The Project has Environmental Clearance from Ministry of Environment, Forest and Climate Change (MoEF&CC) for a rated capacity of 2.769 MTPA (normative) and 3.6 MTPA peak capacity of coal production vide letter no **E. C. no. J-11015/213/2010-IA. II**(M) dated 06.02.2013 later with **E. C. no. J-11015/213/2010-IA. II**(M) dated 03.03.2025.

Ministry of Environment, Forest and Climate Change while granting environmental clearance has given one of the General conditions that " Four ambient air quality monitoring stations should be established in the core zone as well as in the buffer zone for PM_{10}, $PM_{2.5}$, SO_2, NOx monitoring. Location of the stations should be decided based on the meteorological data, topographical features and environmentally and ecologically sensitive targets, other conditions regarding water / effluent and noise level monitoring in consultation with the State Pollution Control Board."

In compliance of these conditions the Environmental Monitoring has been carried out & report prepared for submission to MoEF&CC & JSPCB and other statutory authorities.

AMBIENT AIR QUALITY MONITORING

2.1 Location of sampling station and their rationale:

(As per G.S.R. 742 (E) dt. 25th December, 2000)

2.1.1 Ambient Air Quality Sampling Locations

CORE ZONE Monitoring Location

i) Block IV Kooridih OCP (A6): Industrial Area

The location of the sampling station is at 23°47'54.00"N & 86°16'20.00"E. The sampler was placed at 1.5 m above the ground level near Safety office of Block IV OCP.

BUFFER ZONE Monitoring Location

i) Muraidih OCP (A5) : Industrial Area

The sampler was placed at a height of 1.5 m from the ground level at Muraidih project office.

ii) Ramkanali Workshop (A7) : Industrial area

The location of the sampling station is 23°48'34.00"N & 86°18'22.00"E. The sampler was placed at height of 1.5 m above the ground level at AARC agent Office, Ramkanali.

iii) Kharkharee(A21): **Industrial Area**

The location of the sampling station is 23°46'29.00"N & 86°14'37.08"E. The sampler was placed at a height of 1.5 m above the ground level at Kharkharee Colliery.

AMBIENT AIR QUALITY DATA

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Air Quality Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Test Report for Ambient Air Samples

Month & Year	**12/2025**	**Cluster**	**Cluster III**	**ULR NO.**	TC14321265900002298F
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**13.02.2026**
Project	**Block-IV**	**Sample Ref. No.**	**REM/BCCL/2025/12**	**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**
Date of Sampling	11.12.25 TO 25.12.25		**Period of Analysis** 11.12.25 – 20.01.26	**Zone of Station:**	**Core Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			A4845	**A4916**				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	87	96	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	42	48	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	28	36	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*

***All units are in µg/m3, 24 hourly Average,*

ANALYSED BY (Gaurav Kant) ***REVIEWED BY*** (Kumar Vaibhav) ***Authorised Signatory***

***Note**: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.*

---- End of Report ----

TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

Ambient Air Quality Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850

Test Report for Ambient Air Samples

Month & Year	**12/2025**	**Cluster**	**Cluster III**	**ULR NO.**	TC14321265900002298F
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**13.02.2026**
Project	**Ramkanali Workshop**	**Sample Ref. No.**	**REM/BCCL/2025/12**	**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**
Date of Sampling	12.12.25 TO 30.12.25		**Period of Analysis**	12.12.25 to 20.01.26	**Zone of Station:** **Buffer Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			A4854	**A4937**				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	88	90	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	41	47	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	26	33	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*

***All units are in µg/m3, 24 hourly Average,*

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

***Note**: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.*

---- End of Report ----

Page -1 of 1

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Air Quality Test Report

Test Report for Ambient Air Samples

Month & Year	**12/2025**	**Cluster**	**Cluster III**			**ULR No.**	TC14321265900002298F
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**13.02.2026**
Project	**Muraidih**		**Sample Ref. No.**	**REM/BCCL/2025/12**	**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**	
Date of Sampling	10.12.25 TO 24.12.25			**Date of Sampling**	10.12.25 20.01.26	**Zone of Station:**	**Buffer Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			A4838	**A4909**				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	91	90	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	39	45	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	37	31	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*

***All units are in µg/m3, 24 hourly Average,*

ANALYSED BY	(Gaurav Kant) ***REVIEWED BY***	(Kumar Vaibhav) ***Authorised Signatory***

***Note**: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.*

---- End of Report ----

Page -1 of 1

TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

Ambient Air Quality Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Test Report for Ambient Air Samples

Month & Year	**12/2025**	**Cluster**	**Cluster III**			**ULR NO.**	TC14321265900002298F
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**13.02.2026**
Project	**Kharkharee**		**Sample Ref. No.**	**REM/BCCL/2025/12**	**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**	
Date of Sampling	01.12.25 TO 16.12.25			**Period of Analysis**	01.12.25 – 20.01.26	**Zone of Station:**	**Buffer Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			A4785	**A4863**				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	88	87	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	42	47	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	10	11	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	30	36	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

***All units are in µg/m3, 24 hourly Average, * LDL indicates Lower Detection Limit,*

ANALYSED BY

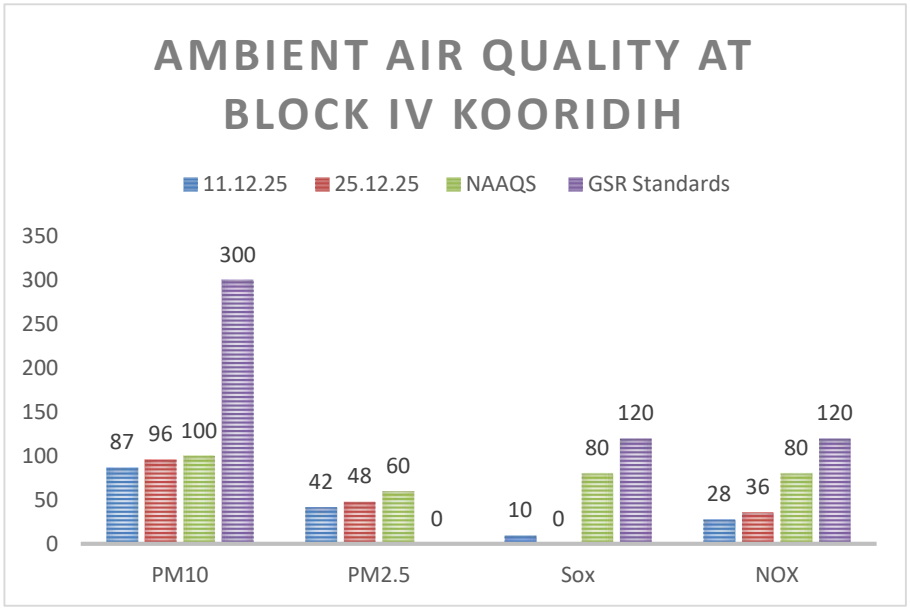
(Gaurav Kant)
REVIEWED BY

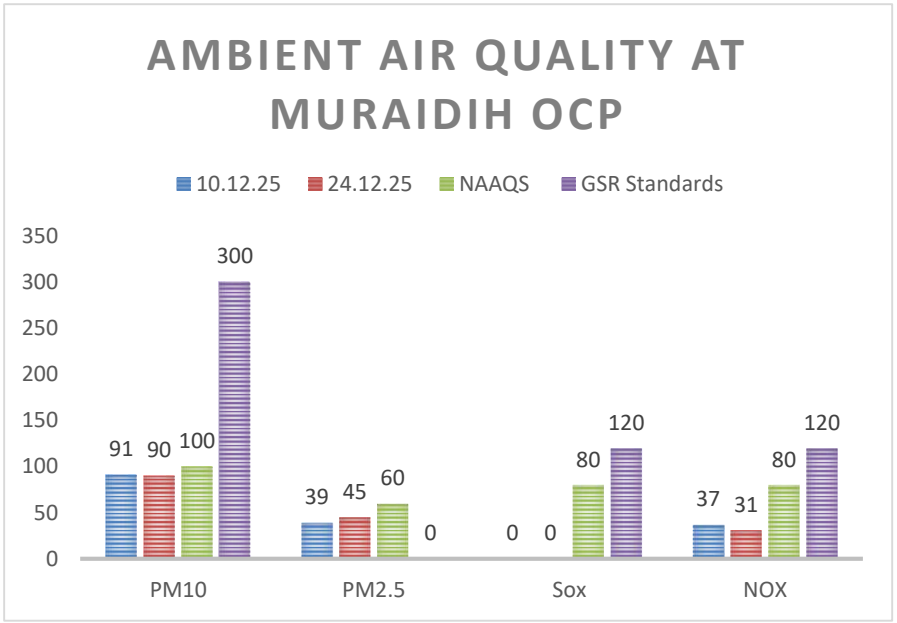
(Kumar Vaibhav)
Authorised Signatory

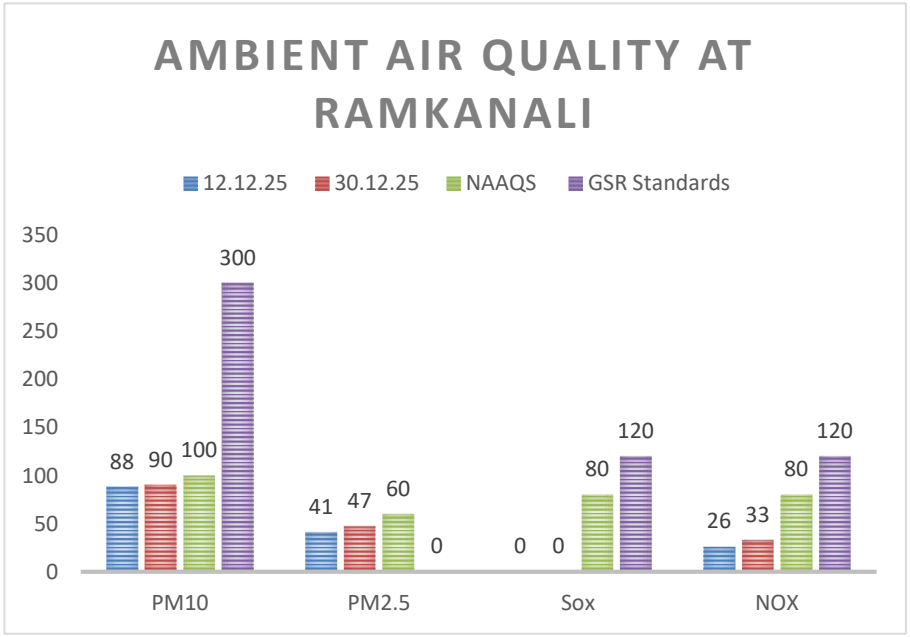
***Note**: The results above relate to the samples tested as received. This report cannot be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.*

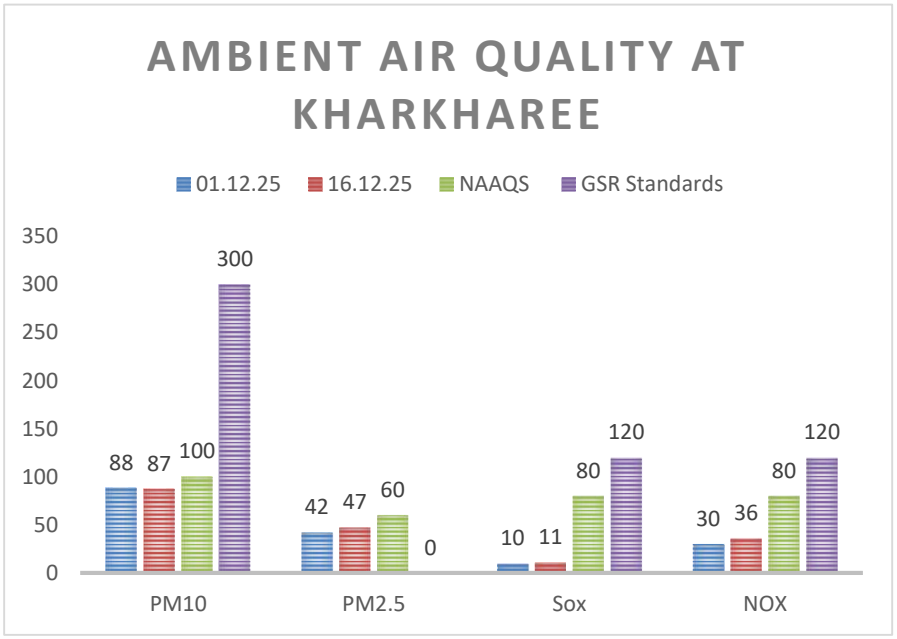
---- End of Report ----

Page -1 of 1


AMBIENT AIR QUALITY AT BLOCK IV KOORIDIH
11.12.25
25.12.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
87 96 100 300
42 48 60 0
10 0 80 120
28 36 80 120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT MURAIDIH OCP
10.12.25
24.12.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
91 90 100 300
39 45 60 0
0 0 80 120
37 31 80 120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT RAMKANALI
12.12.25
30.12.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
88 90 100 300
41 47 60 0
0 0 80 120
26 33 80 120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT KHARKHAREE
01.12.25
16.12.25
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
88 87 100 300
42 47 60 0
10 11 80 120
30 36 80 120
PM10
PM2.5
Sox
NOX

WATER QUALITY MONITORING

3.1 Location of sampling sites

(Refer **Plate No. – II**)

i) Mine Discharge of Govindpur (MW3)

A sampling point is fixed to assess the effluent quality of Mine discharge. This location is selected to monitor effluent discharge in to Khudia Nala and Bagdighi Nala.

3.2 Methodology of sampling and analysis

Water samples were collected as per standard practice. The effluent samples were collected and analysed for four parameters on fortnightly basis at the Environmental Laboratory of CMPDI RI-II, Dhanbad.

3.3 Results & Interpretations

The results are given in tabular form along with the applicable standards. Results are compared with Schedule - VI, effluent prescribed by MoEF&CC. Results show that most of the parameters are within the permissible limits.

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
MINE EFFLUENT TEST REPORT

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Test Report for Mine Effluent samples

Month & Year	**12/2025**	**Cluster**	**Cluster III**	**ULR NO.**		TC14321267700002316F	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**02.02.2025**
Project		**Sampling Ref. No.**	**REM/BCCL/2025/12**	**Sampling Method**	**IS 3025 (Part-1) CMPDI/RI-II/LPM 13**		
Sampling Stations	**(i)**	**Govindpur**	**Sample Collected in 2.5 Ltr Jerricane , Color as observed is transparent**			**Period of Analysis**	**15.12.2025 TO 30.12.2025**
			Date of Sampling	15.12.25	29.12.25		

Sl. No.	Parameter	Method of Analysis	Observed Values		STANDARDS FOR COAL MINES (Stipulated by Ministry of Environment and Forests (MoEF), Vide Notification No. GSR 742(E), Dt: 25.09.2000)	LDL
			M1897	**M1913**		
1	Total Suspended Solids	IS 3025/17:1984, R :2017, Gravimetric	41	46	*100 (Max)*	10
2	pH	IS-3025/11:1983, R-2017, Electrometric	7.58	7.51	*5.5 - 9.0*	0.2
3	Oil & Grease	IS 3025/39:1991, R : 2019, Partition Gravimetric	<4.0	<4.0	*10 (Max)*	2
4	COD	APHA 23rd Edition 5220 C Titrimetric Method	32	36	*250 (Max)*	4

***All units in mg/L unless specified otherwise. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*
***Grab sampling carried out for water samples.*

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

NOISE LEVEL QUALITY MONITORING

4.1 Location of sampling sites

i) **Block-IV (N6)**

ii) **Nichitpur (N5)**

iii) **Govindpur Village (N7)**

i) **Kharkharee (N21)**

4.2 Methodology of sampling and analysis

Noise level measurements in form of 'L_{EQ}' were taken using Integrated Data Logging Sound Level Meter during day time & night time. Noise levels were measured for the complete day & night time, the Intergration time taken was one hour or 3600 seconds. Noise levels were measured in Decibels, 'A' weighted average, i.e. dB (A).

4.2 Results & Interpretations

Ambient noise levels were recorded during day time & night time and the observed values were compared with standards prescribed by MoEF&CC. The results of Noise levels recorded during day & night time on fortnightly basis are presented in tabular form along with the applicable standard permissible limits. The observed values in terms of L_{EQ} are presented**.** The observed values at all the monitoring locations are found to be within permissible limits.

TC-14321

cmpdi
A Mini Ratna Company

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Noise Level Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Month & Year	**12/2025**	**Cluster**	**Cluster III**			**ULR NO.**	TC14321269300002332F
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**02.02.2025**
Project		**Sample Ref. No.**	**REM/BCCL/2025/12**		**Sampling Method**	**CMPDI/RI-II/LPM 13**	
Sampling Stations	**i**	**Block IV**	**Date of Sampling**	11.12.25	25.12.25	**Zone Category of Station:**	**Core Zone**

Sl. No.	Parameter	Hour / Time of day	Observed Values (in Leq dB(A)) First Fortnight	Observed Values (in Leq dB(A)) Second Fortnight	Method of Analysis	Range Of Testing	LDL	NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards Zones	Limits in dB
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	52.6	51.3	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	56.6	55.6					
3		08:00 - 09:00	57.4	56.5					
4		09:00 – 10:00	60.8	60					
5		10:00 - 11:00	60.3	59.4					
6		11:00 - 12:00	61.7	61.1					
7		12:00 - 13:00	61.3	60					
8		13:00 - 14:00	61.6	62.2					
9		14:00 - 15:00	61.9	60.9					
10		15:00 - 16:00	64.7	63					
11		16:00 - 17:00	65.5	65.3					
12		17:00 - 18:00	66.3	66.1					
13		18:00 - 19:00	65.1	63					
14		19:00 - 20:00	64.6	64					
15		20:00 - 21:00	58.3	57.3					
16		21:00 - 22:00	57.1	55.9					
		Leq DAY	62.3	61.6					
1	Noise Level dB(A)Leq -Night	22:00-23:00	50	46.8	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	47.4	45.3					
3		00:00- 01:00	45.7	44.8					
4		01.00-02.00	40.9	41.2					
5		02.00-03.00	40.6	40.7					
6		03.00-04.00	43.4	42					
7		04.00-05.00	41.7	41.1					
8		05:00-06:00	42	42.9					
		Leq NIGHT	45.3	43.6					

**LDL indicates Lower Detection Limit*
***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants
ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

TC-14321

cmpdi A Mini Ratna Company

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Noise Level Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Month & Year	**12/2025**	**Cluster**	**Cluster III**			**ULR No.**	TC14321269300002332F
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**02.02.2025**
Project		**Sample Ref. No.**	**REM/BCCL/2025/12**		**Sampling Method**	**CMPDI/RI-II/LPM 13**	
Sampling Stations	**i**	**Muraidih OCP**	**Date of Sampling**	10.12.25	24.12.25	**Zone Category of Station:**	**Buffer Zone**

Sl. No.	Parameter	Hour / Time of day	Observed Values (in Leq dB(A)) First Fortnight	Observed Values (in Leq dB(A)) Second Fortnight	Method of Analysis	Range Of Testing	LDL	NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards Zones	Limits in dB
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	44.5	44.4	CPCB, Protocol for Ambient Level Noise Monitoring -2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	44.6	46.4					
3		08:00 - 09:00	49.4	48.8					
4		09:00 – 10:00	50.6	51.2					
5		10:00 - 11:00	51.3	51.6					
6		11:00 - 12:00	53.7	53.5					
7		12:00 - 13:00	54.8	55.7					
8		13:00 - 14:00	50.3	51					
9		14:00 - 15:00	51.3	51.6					
10		15:00 - 16:00	53.7	54.8					
11		16:00 - 17:00	48.6	48.8					
12		17:00 - 18:00	44.5	44.5					
13		18:00 - 19:00	43	42.9					
14		19:00 - 20:00	43.4	43.4					
15		20:00 - 21:00	42.9	43.6					
16		21:00 - 22:00	42.7	43					
		Leq DAY	50.0	50.5					
1	Noise Level dB(A)Leq - Night	22:00-23:00	39	39.5	CPCB, Protocol for Ambient Level Noise Monitoring -2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	39.6	38					
3		00:00- 01:00	39.2	37.2					
4		01.00-02.00	39.1	37					
5		02.00-03.00	38.8	36.9					
6		03.00-04.00	38.3	37.6					
7		04.00-05.00	39.8	39.1					
8		05:00-06:00	39.8	39.7					
		Leq NIGHT	39.2	38.3					

**LDL indicates Lower Detection Limit*

***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

Page -1 of 1

TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

Ambient Noise Level Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Month & Year	**12/2025**	**Cluster**	**Cluster III**	**ULR No.**	TC14321269300002332F
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**02.02.2025**
Project		**Sample Ref. No.**	**REM/BCCL/2025/12**	**Sampling Method**	**CMPDI/RI-II/LPM 13**
Sampling Stations	**i**	**Ramkanali**	**Date of Sampling** 12.12.25 – 30.12.25	**Zone Category of Station:**	**Buffer Zone**

Sl. No.	Parameter	Hour / Time of day	Observed Values (in Leq dB(A)) First Fortnight	Observed Values (in Leq dB(A)) Second Fortnight	Method of Analysis	Range Of Testing	LDL	NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards	
								Zones	Limits in dB
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	50.6	49.6	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	53.1	52.3					
3		08:00 - 09:00	55.7	55.2					
4		09:00 – 10:00	61.8	60.9					
5		10:00 - 11:00	63.2	62.2					
6		11:00 - 12:00	61.8	60.9					
7		12:00 - 13:00	64.7	66.1					
8		13:00 - 14:00	66.2	65.2					
9		14:00 - 15:00	59.4	59.4					
10		15:00 - 16:00	58.4	58.4					
11		16:00 - 17:00	57.9	57.9					
12		17:00 - 18:00	58.3	57.4					
13		18:00 - 19:00	57.4	56.6					
14		19:00 - 20:00	56.3	56.5					
15		20:00 - 21:00	56.3	55.9					
16		21:00 - 22:00	54.5	55.4					
		Leq DAY	60.4	60.1					
1	Noise Level dB(A)Leq -Night	22:00-23:00	46	47.8	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	48.4	47.6					
3		00:00- 01:00	45.5	45.6					
4		01.00-02.00	43.6	43.4					
5		02.00-03.00	43.1	42					
6		03.00-04.00	42.9	42.3					
7		04.00-05.00	45	42.3					
8		05:00-06:00	45.9	44.1					
		Leq NIGHT	45.4	45.0					

**LDL indicates Lower Detection Limit*

***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants

ANALYSED BY

(Gaurav Kant)

REVIEWED BY

(Kumar Vaibhav)

Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Noise Level Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Month & Year	**12/2025**	**Cluster**	**Cluster III**	**ULR No.**	TC14321269300002332F
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**02.02.2025**
Project		**Sample Ref. No.**	**REM/BCCL/2025/12**	**Sampling Method**	**CMPDI/RI-II/LPM 13**
Sampling Stations	**i**	**Kharkharee**	**Date of Sampling** 01.12.25	16.12.25	**Zone Category of Station:** **Buffer Zone**

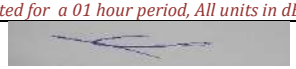
Sl. No.	Parameter	Hour / Time of day	Observed Values (in Leq dB(A)) First Fortnight	Observed Values (in Leq dB(A)) Second Fortnight	Method of Analysis	Range Of Testing	LDL	NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards Zones	Limits in dB
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	42.1	42.8	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	56.9	56.8					
3		08:00 - 09:00	67.6	67.8					
4		09:00 – 10:00	67.5	67.3					
5		10:00 - 11:00	64	62.9					
6		11:00 - 12:00	61.3	60.8					
7		12:00 - 13:00	59	59.9					
8		13:00 - 14:00	57.3	56.7					
9		14:00 - 15:00	55.2	54.5					
10		15:00 - 16:00	53.7	54					
11		16:00 - 17:00	54	54.6					
12		17:00 - 18:00	53.8	54.4					
13		18:00 - 19:00	51.3	51.3					
14		19:00 - 20:00	49.6	49.8					
15		20:00 - 21:00	47.7	47.9					
16		21:00 - 22:00	47.1	47.5					
		Leq DAY	60.6	60.5					
1	Noise Level dB(A)Leq -Night	22:00-23:00	42.7	40.6	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	40.1	40.6					
3		00:00- 01:00	40.2	40.6					
4		01.00-02.00	38.5	39.6					
5		02.00-03.00	38.3	35.3					
6		03.00-04.00	37.8	38.9					
7		04.00-05.00	37.6	36.5					
8		05:00-06:00	36.3	34.4					
		Leq NIGHT	39.4	38.9					

**LDL indicates Lower Detection Limit*

***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants
ANALYSED BY

(Gaurav Kant)
REVIEWED BY



(Kumar Vaibhav)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

Page -1 of 1

Ambient Air Quality Standards for Jharia Coal Field
As per the Environment (Protection) Amendment Rules, 2000 notified vide notification G.S.R. 742(E), dated 25.9.2000.

Category	Pollutant	Time weighted average	Concentration in Ambient Air	Method of Measurement
1	2	3	4	5
III Coal mines located in the coal fields of • Jharia • Raniganj • Bokaro	Suspended Particulate Matter (SPM)	Annual Average * 24 hours **	500 µg/m^3 700 µg/m^3	- High Volume Sampling (Average flow rate not less than 1.1 m^3
	Respirable Particulate Matter (size less than 10 µm) (RPM)	Annual Average * 24 hours **	250 µg/m^3 300 µg/m^3	Respirable Particulate Matter sampling and analysis
	Sulphur Dioxide (SO_2)	Annual Average * 24 hours **	80 µg/m^3 120 µg/m^3	1.Improvedwest and Gaeke method 2.Ultraviolet fluorescene
	Oxide of Nitrogen as NO_2	Annual Average * 24 hours **	80 µg/m^3 120 µg/m^3	1. Jacob & Hochheiser Modified (Na-Arsenic) Method 2. Gas phase Chemilumine-scence

Note:

* Annual Arithmetic mean for the measurements taken in a year, following the guidelines for frequency of sampling laid down in clause2.

** 24hourly/8hourlyvaluesshallbemet 92%ofthetimeinayear.However,8% of the time it may exceed but not on two consecutive days.

NATIONAL AMBIENT AIR QUALITY STANDARDS

New Delhi the 18th November 2009

In exercise of the powers conferred by Sub-section (2) (h) of section 16 of the Air (Prevention and Control of Pollution) Act, 1981 (Act No. 14 of 1981), and in supersession of the notification No(s).S.O.384(E), dated 11th April 1994 and S.O.935(E), dated 14th NOVEMBER 1998, the Central Pollution Control Board hereby notify the National Ambient Air Quality Standards with immediate effect.

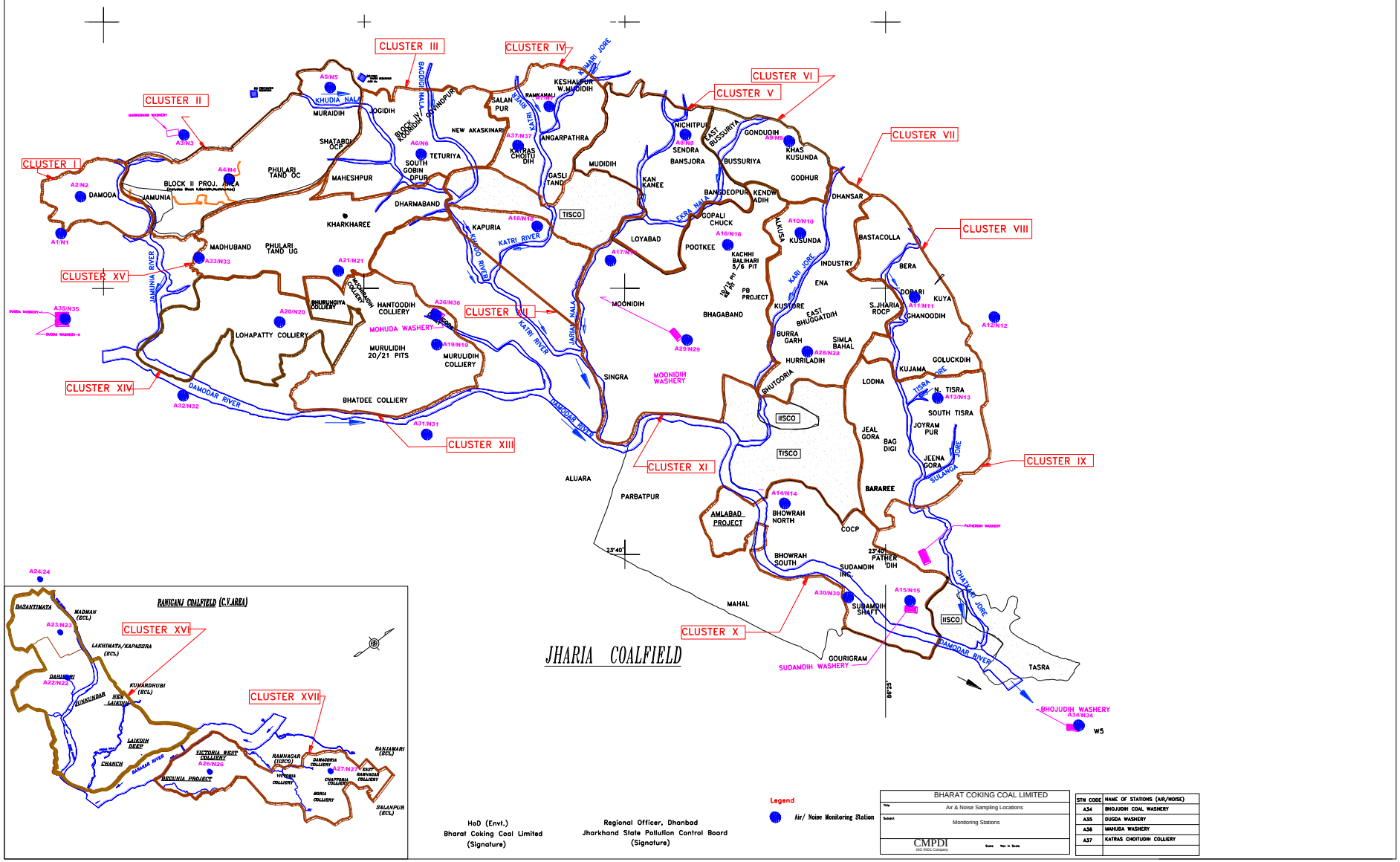
Pollutant	Time Weighted Average	Concentration in Ambient Air		Methods of Measurement
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)	
Sulphur Dioxide (SO_2), µg/m³	Annual * 24 Hours **	50 80	20 80	-Improved West and Gaeke Method -Ultraviolet Fluorescence
Nitrogendioxide (NO_2), µg/m³	Annual * 24 Hours **	40 80	30 80	-Jacob &Hochheiser modified ($NaOH$-$NaAsO_2$) Method -Gas Phase Chemiluminescence
Particulate Matter (Size less than 10µm) or PM_{10}, µg/m³	Annual * 24 Hours **	60 100	60 100	-Gravimetric -TEOM -Beta attenuation
Particulate Matter (Size less than 2.5µm) or $PM_{2.5}$, µg/m³	Annual * 24 Hours **	40 60	40 60	-Gravimetric -TEOM -Beta attenuation
Ozone (O_3) , µg/m³	8 Hours * 1 Hour **	100 180	100 180	-UV Photometric -Chemiluminescence -Chemical Method
Lead (Pb) , µg/m³	Annual * 24 Hours **	0.50 1.0	0.50 1.0	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper -ED-XRF using Teflon filter
Carbon Monoxide (CO), mg/m³	8 Hours ** 1 Hour **	02 04	02 04	-Non dispersive Infrared (NDIR) Spectroscopy
Ammonia (NH_3), µg/m³	Annual * 24 Hours **	100 400	100 400	-Chemiluminescence -Indophenol blue method
Benzene (C_6H_6), µg/m³	Annual *	05	05	-Gas Chromatography (GC) based continuous analyzer -Adsorption and desorption followed by GC analysis
Benzo(a)Pyrene (BaP) Particulate phase only, ng/m³	Annual *	01	01	-Solvent extraction followed byHPLC/GC analysis
Arsenic (As), ng/m³	Annual *	06	06	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper
Nickel (Ni), ng/m³	Annual *	20	20	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper

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

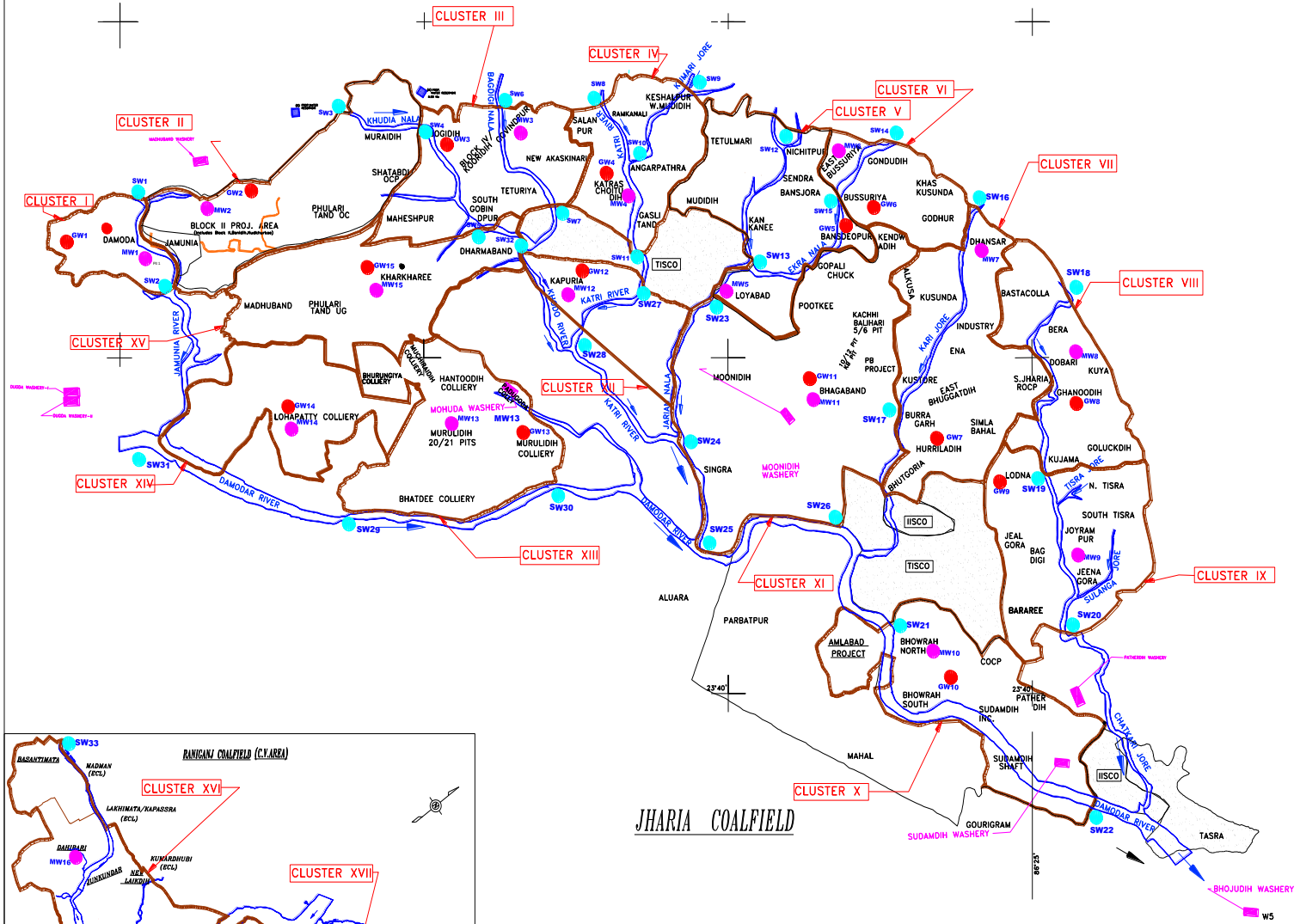
** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they JUNE exceed the limits but not on two consecutive days of monitoring.

NOTE: Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigations.

Location of Air & Noise Monitoring Stations in BCCL



Water Sampling Locations in BCCL



INDEX

Cluster	Suface Water (U/S, D/S)	Name of River/ Nala / Jore	Mine/ Effluent Water	Sampling Location	Ground Water	Sampling Location
I	SW1, SW2	Jamunia River	MW1	Damoda Area	GW1	Ghutway Village
II	SW3, SW4	Khudia Nala	MW2	Block II OCP	GW2	Joyrampur Village
III	SW4, SW5, SW6, SW7	Khudia Nala, Bagdigi Nala	MW3	Govindpur Colliery	GW3	Jogidih Village
IV	SW8, SW11, SW9, SW10	Katri River, Kumari Jore	MW4	Chotudih	GW4	Kankanee Village
V	SW12, SW13, SW15	Jarian Nala, Ekra Nala	MW5	Mudidih	GW5	Nichitpur
VI	SW14, SW15	Ekra Nala	MW6	East Bassuria UGP	GW6	Bansjora Borewell
VII	SW16, SW17	Kari Jore	MW7	Dhansar UGP	GW7	Hurriladih
VIII	SW18, SW19	Kashi Jore	MW8	Dobari UGP	GW8	Ghanudih
IX	SW19, SW20	Kashi Jore	MW9	Jeenagora	GW9	Lodna
X	SW21, SW22	Damodar River	MW10	Bhowrah North	GW10	Bhowrah South
XI	SW23, SW24, SW25, SW26	Jarian Nala, Damodar River	MW11	Bhagaband h UGP	GW11	Bhagabandh
XII	SW27, SW28	Katri River	MW12	Kapuria	GW12	Kapuria
XIII	SW29, SW30	Damodar River	MW13	Murulidih (20/21)	GW13	Murilidih
XIV	SW31, SW29	Damodar River	MW14	Lohapatti	GW14	Lohapatti
XV	SW5, SW32	Khudia Nala	MW15	Kharkharee UGP	GW15	Kharkharee
XVI	SW33, SW34	Khudia River	MW16	Dahibari OCP	GW16	Patlabari Village
XVII	SW35, SW36	Barakar River	MW17	Damagoria Colliery	GW17	Chaptoria

HoD (Envt.)
Bharat Coking Coal Limited
(Signature)

Regional Officer, Dhanbad
Jharkhand State Pollution Control Board
(Signature)

Legend
- Sampling Locations of Surface Water (Upstream/ Downstream)
- Sampling Locations of Mine Water
- Sampling Locations of Ground/ Drinking Water

Customer	BHARAT COKING COAL LIMITED
Title	WATER SAMPLING LOCATIONS
Subject	MONITORING STATIONS
CMPDI (ISO 9001 Company)	Scale: Not to Scale

STRICTLY RESTRICTED
FOR COMPANY USE ONLY RESTRICTED
The information given in this report is not to be communicated either directly or indirectly to the press or to any person not holding an official position in the CIL /GOVERNMENT.

ENVIRONMENTAL MONITORING REPORT OF BHARAT COKING COAL LIMITED, CLUSTER – III

(FOR THE MONTH JANUARY, 2026)

E. C. no. J-11015/213/2010-IA. II(M) dated 03.03.2025.

CMPDI
ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

CONTENTS

SL. NO.	CHAPTER	PARTICULARS	PAGE NO.
1.	CHAPTER - I	EXECUTIVE SUMMARY	3-5
2.	CHAPTER-II	INTRODUCTION	6
3.	CHAPTER-III	RESULTS	7-19
4.	CHAPTER-IV	STANDARDS AND PLANS	20-21

EXECUTIVE SUMMARY

1.0 Introduction

The purpose of environmental monitoring is to assess the quality of various attributes that affects the fauna and flora. In accordance with the quality of these attributes appropriate strategy is to be developed to control the pollution level within the permissible limits. The three major attributes are air, water and noise level.

Bharat Coking Coal Limited (BCCL), a Subsidiary company of Coal India Limited is operating Underground and Opencast Mines in Jharia Coalfield (JCF) is a part of Gondwana Coalfields located in Dhanbad district of Jharkhand, the JCF is bounded by $23^0$37' N to $23^0$52' N latitudes and $86^0$09' E to $86^0$30' E longitude occupying an area of 450 Sq.km. BCCL has awarded Environmental monitoring work of Jharia Coalfield (JCF) to Central Mine Planning & Design Institute Limited (CMPDIL). The environmental monitoring has been carried out as per the conditions laid down by the MoEF&CC while granting environmental clearance of project, consent letter issued by the respective SPCB, and other statutory requirements.

2.0 Sampling location and rationale

2.1 Ambient air sampling locations

The ambient air quality monitoring stations were selected to represent core, buffer zone area. The rationale has been based on the guidelines stipulated by MoEF&CC, consent letter of SPCB, as well as other statutory requirements.

2.2 Water sampling stations

The Water sampling stations were selected for mine sump water.

2.3 Noise level monitoring locations

Noise levels vary depending on the various activities in mining areas. The monitoring of noise level in different locations will be helpful to take appropriate mitigating measures. The rationale has been based on the guidelines stipulated by MoEF&CC, consent letter of SPCB, as well as other statutory requirements.

3.0 Methodology of sampling and analysis

3.1 Ambient air quality

Parameters chosen for assessment of ambient air quality were Particulate Matter (PM_{10}), Fine Particulate Matter ($PM_{2.5}$), Sulphur Di-oxide (SO_2) and Nitrogen Oxides (NO_X). Respirable Dust Samplers (RDS) and Fine Dust Sampler ($PM_{2.5}$

sampler) were used for sampling of $PM_{10,}$ SO_2, & NO_X and Fine Dust Sampler ($PM_{2.5}$ sampler) were used for sampling of $PM_{2.5}$ at 24 hours interval once in a fortnight and the same for the gaseous pollutants. The samples were analysed in Environmental Laboratory of CMPDI, RI-II, Dhanbad.

3.2 Water quality

Water samples were collected as per standard practice. The Mine effluent samples were collected and analysed for four parameters on fortnightly basis. Thereafter the samples were preserved and analysed at the Environmental Laboratory of CMPDI, RI- II, Dhanbad.

3.3 Noise level monitoring

Noise level measurements in form of 'L_{EQ}' were taken using Integrated Data Logging Sound Level Meter. Noise levels were measured in Decibels, 'A' weighted average, i.e. dB(A).

4.0 Results and interpretations

4.1 Air quality

It has been seen from the analysis results that the 24 hours average concentration parameters like $PM_{10,}$ $PM_{2.5}$, SO_2 and NO_X are mostly within the permissible limits in all sampling locations as per MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000 Standards for Coal Mines and National Ambient Air Quality Standard -2009. Sometimes the concentration of PM_{10}& $PM_{2.5}$ exceeds the limits due to heavy public traffic, poor road condition, coke oven plants, burning of coal by surrounding habitants, brick making, municipal waste dumps and industries like Steel Plant, thermal Plants including their fly ash etc.

The following preventive and suppressive mitigative measures can be undertaken to contain the pollution level within prescribed level:-

- Wet drilling and controlled blasting should be practice.
- Explosive used should be optimised to restrict the dust generation.
- Transportation roads should be permanently asphalted free of ruts, potholes etc.
- Water should be sprayed on coal transportation road, service road more frequently and at regular interval.
- Dust from roads should be removed physically or mechanically.
- Greenbelts around industrial sites, service building area besides Avenue plantation along roads should be created.
- Coal dust should be suppressed by using fixed sprinklers.
- Regular maintenance of plant and machinery should be undertaken.

4.2 Water quality

The test results indicate that the major parameters compared with MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000 Standards for Coal Mines, are within permissible limits.

4.3 Noise Level

During the noise level survey it has been observed that the noise level in the sampling locations is within the permissible limits prescribed as per MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000 Standards for Coal Mines for Industrial Area and Noise pollution (Regulation and Control) Rules, 2000.

INTRODUCTION

Any industry and development activities including coal mining is bound to affect environmental attributes. There are positive as well as negative impacts of such operations. For controlling the adverse impacts a regular monitoring is essential. The environmental monitoring is being done as per the guide-lines stipulated by Ministry of Environment, Forest and Climate Change (MoEF&CC), Govt. of India.

The very purpose of environmental monitoring is to assess the quality of various attributes which affects the environment. As per quality of these attributes appropriate strategy is to be developed to control the pollution level within the permissible limits. The three major attributes are air, water and noise level.

Bharat Coking Coal has awarded Environmental Monitoring work of all Projects, Cluster wise, to Central Mine Planning & Design Institute Limited (CMPDIL). The environmental monitoring has been carried out as per conditions laid down by MoEF&CC while granting environmental clearance to different projects. CMPDI has trained manpower and well equipped laboratory to carry out monitoring, analysis and R&D work in the field of environment.

The CLUSTER III is in the westernmost part of the Jharia coalfield. It includes Jogidih Colliery, Maheshpur Colliery, South Govindpur Colliery, Teturiya Colliery, Govindpur Colliery, New Akasshkinaree Mine and Block IV Kooridih Mixed Mine as per **E. C. no. J-11015/213/2010-IA.II**(M) dated 06.02.2013 and later all seven mines are amalgamated to single mine Named Cluster III with OC cum UG with Highway Mining method with no change in lease area and production capacity. The cluster – III is situated about 40 - 45 kms from Dhanbad Railway Station. The mines of this cluster-III are operating since pre nationalization period (prior to 1972-73). It is connected by both Railway and Road. The drainage of the area is governed by Khudia and Bagdighi Nala.

The Project has Environmental Clearance from Ministry of Environment, Forest and Climate Change (MoEF&CC) for a rated capacity of 2.769 MTPA (normative) and 3.6 MTPA peak capacity of coal production vide letter no **E. C. no. J-11015/213/2010-IA. II**(M) dated 06.02.2013 later with **E. C. no. J-11015/213/2010-IA. II**(M) dated 03.03.2025.

Ministry of Environment, Forest and Climate Change while granting environmental clearance has given one of the General conditions that " Four ambient air quality monitoring stations should be established in the core zone as well as in the buffer zone for PM_{10}, $PM_{2.5}$, SO_2, NOx monitoring. Location of the stations should be decided based on the meteorological data, topographical features and environmentally and ecologically sensitive targets, other conditions regarding water / effluent and noise level monitoring in consultation with the State Pollution Control Board."

In compliance of these conditions the Environmental Monitoring has been carried out & report prepared for submission to MoEF&CC & JSPCB and other statutory authorities.

AMBIENT AIR QUALITY MONITORING

2.1 Location of sampling station and their rationale:

(As per G.S.R. 742 (E) dt. 25th December, 2000)

2.1.1 Ambient Air Quality Sampling Locations

CORE ZONE Monitoring Location

i) Block IV Kooridih OCP (A6): Industrial Area

The location of the sampling station is at 23°47'54.00"N & 86°16'20.00"E. The sampler was placed at 1.5 m above the ground level near Safety office of Block IV OCP.

BUFFER ZONE Monitoring Location

i) Muraidih OCP (A5) : Industrial Area

The sampler was placed at a height of 1.5 m from the ground level at Muraidih project office.

ii) Ramkanali Workshop (A7) : Industrial area

The location of the sampling station is 23°48'34.00"N & 86°18'22.00"E. The sampler was placed at height of 1.5 m above the ground level at AARC agent Office, Ramkanali.

iii) Kharkharee(A21): **Industrial Area**

The location of the sampling station is 23°46'29.00"N & 86°14'37.08"E. The sampler was placed at a height of 1.5 m above the ground level at Kharkharee Colliery.

AMBIENT AIR QUALITY DATA

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Air Quality Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Test Report for Ambient Air Samples

Month & Year	**01/2026**	**Cluster**	**Cluster III**	**ULR NO.**	**TC143212611200002352F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**05.03.2026**
Project	**Block-IV**	**Sample Ref. No.**	**REM/BCCL/2026/01**	**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**
Date of Sampling	13.01.26 – 27.01.26	**Period of Analysis**	13.01.2026 – 25.02.2026	**Zone of Station:**	**Core Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)** A5160	A5232	**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
1	PM_{10}	IS -5182(Part 23):2006, R-2017	97	89	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	52	45	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	26	20	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*

***All units are in µg/m3, 24 hourly Average,*

ANALYSED BY (Gaurav Kant) ***REVIEWED BY*** (Kumar Vaibhav) ***Authorised Signatory***

***Note**: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.*

---- End of Report ----

TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

Ambient Air Quality Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850

Test Report for Ambient Air Samples

Month & Year	**01/2026**	**Cluster**	**Cluster III**	**ULR NO.**	**TC143212611200002352F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**05.03.2026**
Project	**Ramkanali Workshop**	**Sample Ref. No.**	**REM/BCCL/2026/01**	**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**
Date of Sampling	13.01.26	27.01.26	**Period of Analysis**	13.01.26 – 25.02.2026	**Zone of Station:** **Buffer Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			A5161	A5233				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	94	126	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	54	64	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	25	24	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*

***All units are in µg/m3, 24 hourly Average,*

ANALYSED BY (Gaurav Kant) ***REVIEWED BY*** (Kumar Vaibhav) ***Authorised Signatory***

***Note**: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.*

---- End of Report ----

Page -1 of 1

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Air Quality Test Report

Test Report for Ambient Air Samples

Month & Year	**01/2026**	**Cluster**	**Cluster III**			**ULR No.**	**TC143212611200002352F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**05.03.2026**
Project	**Muraidih**		**Sample Ref. No.**	**REM/BCCL/2026/01**	**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**	
Date of Sampling	12.01.26		26.01.26	**Date of Sampling**	12.01.2026 – 25.02.2026	**Zone of Station:**	**Buffer Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			A5153	A5225				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	116	135	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	63	72	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	17	24	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*

***All units are in µg/m3, 24 hourly Average,*

ANALYSED BY | (Gaurav Kant) ***REVIEWED BY*** | (Kumar Vaibhav) ***Authorised Signatory***

***Note**: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.*

---- End of Report ----

TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

Ambient Air Quality Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Test Report for Ambient Air Samples

Month & Year	**01/2026**	**Cluster**	**Cluster III**	**ULR NO.**	**TC143212611200002352F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**05.03.2026**
Project	**Kharkharee**	**Sample Ref. No.**	**REM/BCCL/2026/01**	**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**
Date of Sampling	01.01.26	16.01.26	**Period of Analysis**	01.01.2026 – 25.02.2026	**Zone of Station:** **Buffer Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)** A5101	A5178	**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
1	PM_{10}	IS -5182(Part 23):2006, R-2017	115	126	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	64	65	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	28	23	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

***All units are in µg/m3, 24 hourly Average, * LDL indicates Lower Detection Limit,*

ANALYSED BY

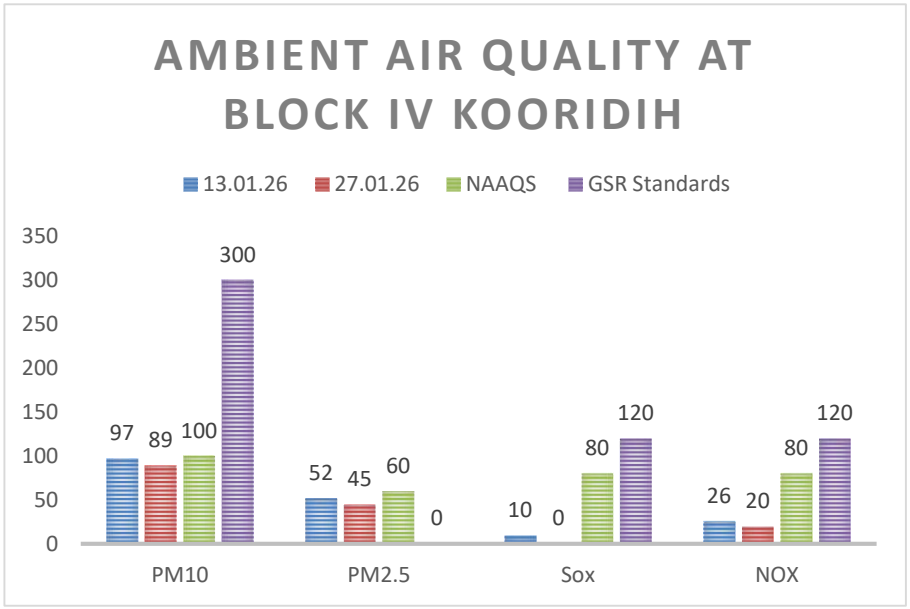
(Gaurav Kant)
REVIEWED BY

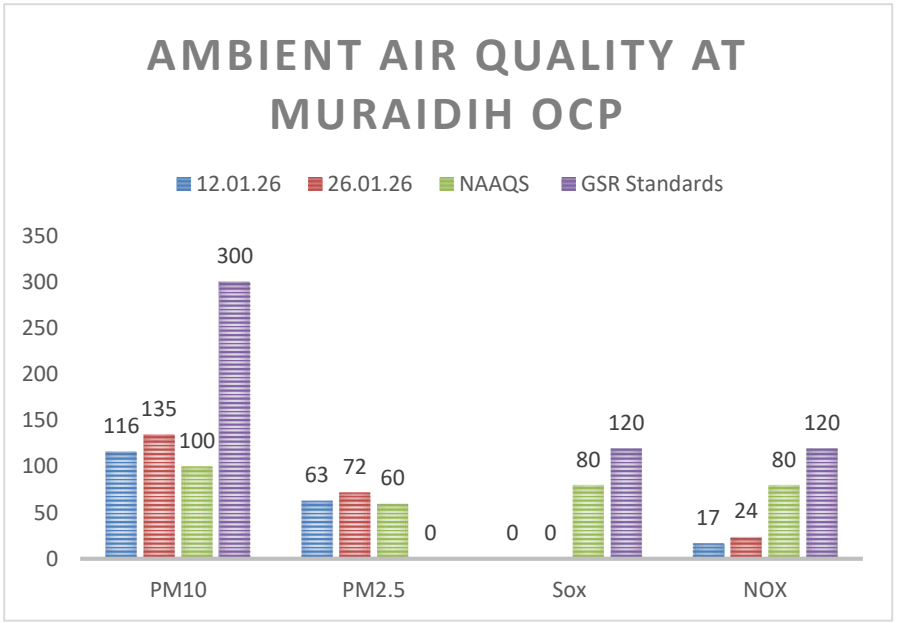
(Kumar Vaibhav)
Authorised Signatory

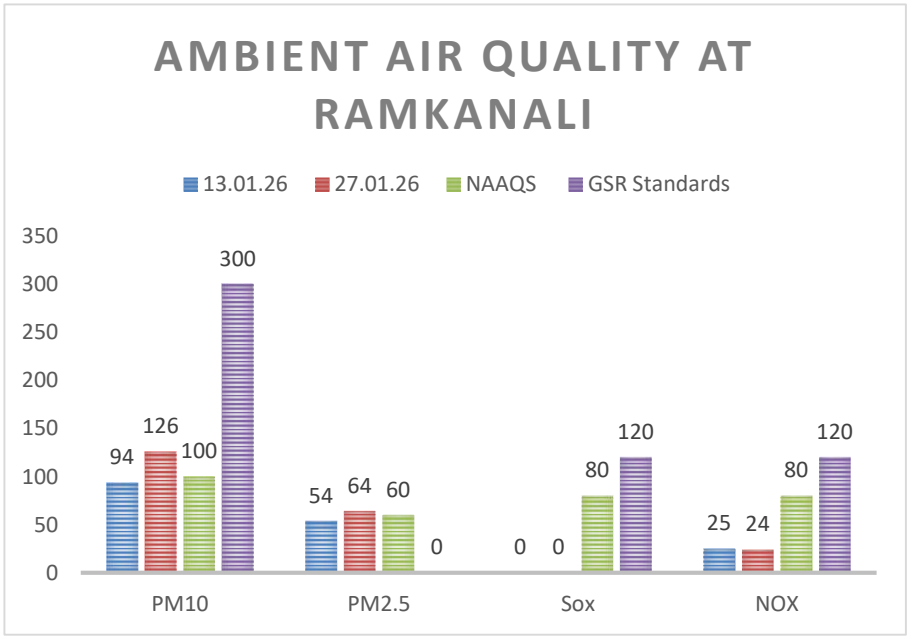
***Note**: The results above relate to the samples tested as received. This report cannot be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.*

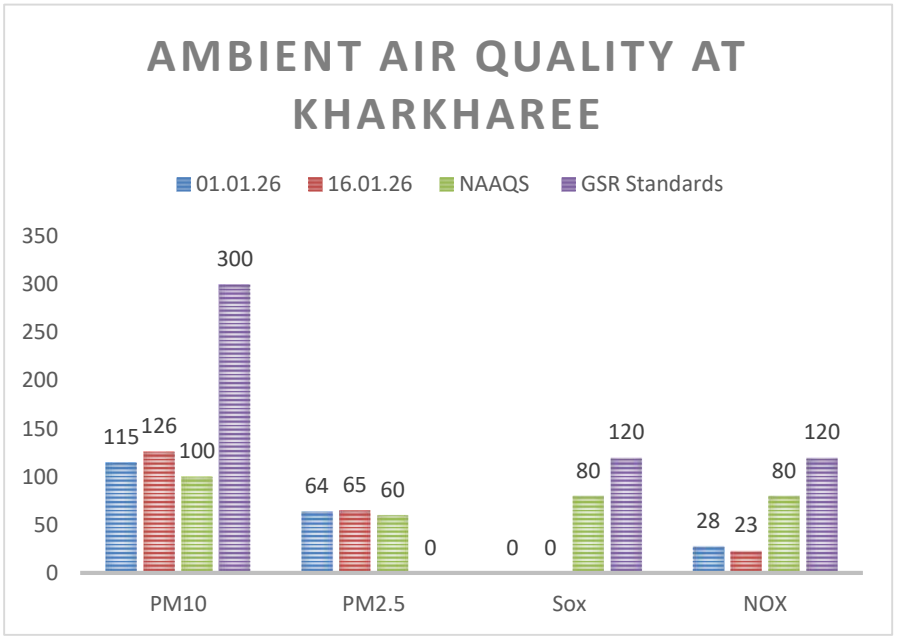
---- End of Report ----

Page -1 of 1


AMBIENT AIR QUALITY AT BLOCK IV KOORIDIH
13.01.26
27.01.26
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
97
89
100
300
52
45
60
0
10
0
80
120
26
20
80
120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT MURAIDIH OCP
12.01.26
26.01.26
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
116
135
100
300
63
72
60
0
0
0
80
120
17
24
80
120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT RAMKANALI
13.01.26
27.01.26
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
94
126
100
300
54
64
60
0
0
0
80
120
25
24
80
120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT KHARKHAREE
01.01.26
16.01.26
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
115
126
100
300
64
65
60
0
0
0
80
120
28
23
80
120
PM10
PM2.5
Sox
NOX

WATER QUALITY MONITORING

3.1 Location of sampling sites

(Refer **Plate No. – II**)

i) Mine Discharge of Govindpur (MW3)

A sampling point is fixed to assess the effluent quality of Mine discharge. This location is selected to monitor effluent discharge in to Khudia Nala and Bagdighi Nala.

3.2 Methodology of sampling and analysis

Water samples were collected as per standard practice. The effluent samples were collected and analysed for four parameters on fortnightly basis at the Environmental Laboratory of CMPDI RI-II, Dhanbad.

3.3 Results & Interpretations

The results are given in tabular form along with the applicable standards. Results are compared with Schedule - VI, effluent prescribed by MoEF&CC. Results show that most of the parameters are within the permissible limits.

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
MINE EFFLUENT TEST REPORT

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Test Report for Mine Effluent samples

Month & Year	**01/2026**	**Cluster**	**Cluster III**	**ULR NO.**		**TC143212613000002370F**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**05.03.2026**
Project		**Sampling Ref. No.**	**REM/BCCL/2026/01**	**Sampling Method**	**IS 3025 (Part-1) CMPDI/RI-II/LPM 13**		
Sampling Stations	**(i)**	**Govindpur**	**Sample Collected in 2.5 Ltr Jerricane , Color as observed is transparent**			**Period of Analysis**	**12.01.2026 to 31.01.2026**
			Date of Sampling	12.01.26	26.01.26		

Sl. No.	Parameter	Method of Analysis	Observed Values		STANDARDS FOR COAL MINES (Stipulated by Ministry of Environment and Forests (MoEF), Vide Notification No. GSR 742(E), Dt: 25.09.2000)	LDL
			M1949	M1968		
1	Total Suspended Solids	IS 3025/17:1984, R :2017, Gravimetric	31	32	*100 (Max)*	10
2	pH	IS-3025/11:1983, R-2017, Electrometric	7.89	7.93	*5.5 - 9.0*	0.2
3	Oil & Grease	IS 3025/39:1991, R : 2019, Partition Gravimetric	<2.0	<2.0	*10 (Max)*	2
4	COD	APHA 23rd Edition 5220 C Titrimetric Method	28	32	*250 (Max)*	4

***All units in mg/L unless specified otherwise. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*
***Grab sampling carried out for water samples.*

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

NOISE LEVEL QUALITY MONITORING

4.1 Location of sampling sites

i) **Block-IV (N6)**

ii) **Nichitpur (N5)**

iii) **Govindpur Village (N7)**

i) **Kharkharee (N21)**

4.2 Methodology of sampling and analysis

Noise level measurements in form of 'L_{EQ}' were taken using Integrated Data Logging Sound Level Meter during day time & night time. Noise levels were measured for the complete day & night time, the Intergration time taken was one hour or 3600 seconds. Noise levels were measured in Decibels, 'A' weighted average, i.e. dB (A).

4.2 Results & Interpretations

Ambient noise levels were recorded during day time & night time and the observed values were compared with standards prescribed by MoEF&CC. The results of Noise levels recorded during day & night time on fortnightly basis are presented in tabular form along with the applicable standard permissible limits. The observed values in terms of L_{EQ} are presented**.** The observed values at all the monitoring locations are found to be within permissible limits.

TC-14321

cmpdi A Mini Ratna Company

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

Ambient Noise Level Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Month & Year	**01/2026**	**Cluster**	**Cluster III**			**ULR NO.**	**TC143212614600002386F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**05.03.2026**
Project		**Sample Ref. No.**	**REM/BCCL/2026/01**		**Sampling Method**	**CMPDI/RI-II/LPM 13**	
Sampling Stations	**i**	**Block IV**	**Date of Sampling**	13.01.26	27.01.26	**Zone Category of Station:**	**Core Zone**

Sl. No.	Parameter	Hour / Time of day	Observed Values (in Leq dB(A)) First Fortnight	Observed Values (in Leq dB(A)) Second Fortnight	Method of Analysis	Range Of Testing	LDL	NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards	
								Zones	Limits in dB
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	54.6	53.3	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	58.8	57.7					
3		08:00 - 09:00	59.7	58.7					
4		09:00 – 10:00	63.2	62.3					
5		10:00 - 11:00	62.7	61.7					
6		11:00 - 12:00	64	63.5					
7		12:00 - 13:00	63.6	62.3					
8		13:00 - 14:00	63.9	64.6					
9		14:00 - 15:00	64.3	63.4					
10		15:00 - 16:00	67.2	65.5					
11		16:00 - 17:00	68	67.8					
12		17:00 - 18:00	68.9	68.7					
13		18:00 - 19:00	67.6	65.5					
14		19:00 - 20:00	67.1	66.5					
15		20:00 - 21:00	60.5	59.6					
16		21:00 - 22:00	53.6	52.1					
		Leq DAY	64.7	64.0					
1	Noise Level dB(A)Leq -Night	22:00-23:00	51.6	50.2	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	50.8	48.6					
3		00:00- 01:00	49	48					
4		01.00-02.00	43.9	44.2					
5		02.00-03.00	43.5	43.7					
6		03.00-04.00	46.6	45					
7		04.00-05.00	44.7	44.1					
8		05:00-06:00	45	46					
		Leq NIGHT	46.5	45.5					

**LDL indicates Lower Detection Limit*

***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants
ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Noise Level Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Month & Year	**01/2026**	**Cluster**	**Cluster III**				**ULR No.**	**TC143212614600002386F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**						**Date of Issue**	**05.03.2026**
Project		**Sample Ref. No.**	**REM/BCCL/2026/01**		**Sampling Method**		**CMPDI/RI-II/LPM 13**	
Sampling Stations	**i**	**Muraidih OCP**	**Date of Sampling**	12.01.26	26.01.26	**Zone Category of Station:**	**Buffer Zone**	

Sl. No.	**Parameter**	**Hour / Time of day**	**Observed Values (in Leq dB(A)) First Fortnight**	**Observed Values (in Leq dB(A)) Second Fortnight**	**Method of Analysis**	**Range Of Testing**	**LDL**	**NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards**	
								Zones	**Limits in dB**
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	45.7	45.1	CPCB, Protocol for Ambient Level Noise Monitoring -2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	48.2	46.3					
3		08:00 - 09:00	50.8	51.3					
4		09:00 – 10:00	53.2	52.5					
5		10:00 - 11:00	53.7	53.3					
6		11:00 - 12:00	55.6	55.8					
7		12:00 - 13:00	57.8	57					
8		13:00 - 14:00	53	52.2					
9		14:00 - 15:00	53.7	53.3					
10		15:00 - 16:00	57	55.8					
11		16:00 - 17:00	49.4	50.5					
12		17:00 - 18:00	46.2	46.2					
13		18:00 - 19:00	44.6	44.7					
14		19:00 - 20:00	44.9	45.1					
15		20:00 - 21:00	44.7	44.6					
16		21:00 - 22:00	43.5	44.4					
		Leq DAY	52.4	52.0					
1	Noise Level dB(A)Leq - Night	22:00-23:00	42.9	42.4	CPCB, Protocol for Ambient Level Noise Monitoring -2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	42.5	40.7					
3		00:00- 01:00	42.1	39.9					
4		01.00-02.00	42	39.7					
5		02.00-03.00	41.6	39.6					
6		03.00-04.00	41.1	40.3					
7		04.00-05.00	42.7	42					
8		05:00-06:00	42.7	42.6					
		Leq NIGHT	41.6	40.2					

**LDL indicates Lower Detection Limit*

***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

Page -1 of 1

TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

Ambient Noise Level Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Month & Year	**01/2026**	**Cluster**	**Cluster III**	**ULR No.**	**TC143212614600002386F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**05.03.2026**
Project		**Sample Ref. No.**	**REM/BCCL/2026/01**	**Sampling Method**	**CMPDI/RI-II/LPM 13**
Sampling Stations	**i**	**Ramkanali**	**Date of Sampling**	13.01.26 – 27.01.26	**Zone Category of Station: Buffer Zone**

Sl. No.	Parameter	Hour / Time of day	Observed Values (in Leq dB(A)) First Fortnight	Observed Values (in Leq dB(A)) Second Fortnight	Method of Analysis	Range Of Testing	LDL	NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards	
								Zones	Limits in dB
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	50.5	49.6	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	53	52.3					
3		08:00 - 09:00	55.7	55.2					
4		09:00 – 10:00	61.7	60.9					
5		10:00 - 11:00	63.2	62.2					
6		11:00 - 12:00	61.7	60.9					
7		12:00 - 13:00	64.8	66.1					
8		13:00 - 14:00	66.2	65.1					
9		14:00 - 15:00	59.4	59.4					
10		15:00 - 16:00	58.4	58.4					
11		16:00 - 17:00	57.9	57.9					
12		17:00 - 18:00	58.3	57.5					
13		18:00 - 19:00	57.5	56.5					
14		19:00 - 20:00	56.3	55.6					
15		20:00 - 21:00	56.3	51.6					
16		21:00 - 22:00	52.3	50.6					
		Leq DAY	60.4	60.0					
1	Noise Level dB(A)Leq -Night	22:00-23:00	46	47.8	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	48.4	47.6					
3		00:00- 01:00	45.5	45.6					
4		01.00-02.00	43.6	43.4					
5		02.00-03.00	43.1	42					
6		03.00-04.00	42.9	42.3					
7		04.00-05.00	45	42.3					
8		05:00-06:00	45.9	44.1					
		Leq NIGHT	45.4	45.0					

**LDL indicates Lower Detection Limit*

***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

Page -1 of 1

TC-14321

cmpdi A Mini Ratna Company

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Noise Level Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Month & Year	**01/2026**	**Cluster**	**Cluster III**	**ULR No.**	**TC143212614600002386F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**05.03.2026**
Project		**Sample Ref. No.**	**REM/BCCL/2026/01**	**Sampling Method**	**CMPDI/RI-II/LPM 13**
Sampling Stations	**i**	**Kharkharee**	**Date of Sampling**	01.01.26 to 16.01.26	**Zone Category of Station: Buffer Zone**

Sl. No.	Parameter	Hour / Time of day	Observed Values (in Leq dB(A)) First Fortnight	Observed Values (in Leq dB(A)) Second Fortnight	Method of Analysis	Range Of Testing	LDL	NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards Zones	Limits in dB
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	42	42.8	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial	75
2		07:00 - 08:00	56.8	56.7				Commercial	65
3		08:00 - 09:00	67.6	67.8				Residential	55
4		09:00 – 10:00	69	67.2				Silence	50
5		10:00 - 11:00	64	62.9					
6		11:00 - 12:00	61.3	60.8					
7		12:00 - 13:00	58.9	59.8					
8		13:00 - 14:00	57.4	56.6					
9		14:00 - 15:00	55.2	54.5					
10		15:00 - 16:00	53.7	54.1					
11		16:00 - 17:00	53.1	54.6					
12		17:00 - 18:00	53.8	54.4					
13		18:00 - 19:00	51.3	51.3					
14		19:00 - 20:00	49.6	49.7					
15		20:00 - 21:00	45.3	47.9					
16		21:00 - 22:00	45	47.5					
		Leq DAY	61.1	60.5					
1	Noise Level dB(A)Leq -Night	22:00-23:00	42.7	40.6	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial	70
2		23:00- 00:00	40.1	40.6				Commercial	55
3		00:00- 01:00	40.2	40.6				Residential	45
4		01.00-02.00	38.5	39.6				Silence	50
5		02.00-03.00	38.3	35.3					
6		03.00-04.00	37.8	38.9					
7		04.00-05.00	37.6	36.5					
8		05:00-06:00	36.3	34.4					
		Leq NIGHT	39.4	38.9					

**LDL indicates Lower Detection Limit*

***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants
ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report cannot be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

Page -1 of 1

Ambient Air Quality Standards for Jharia Coal Field
As per the Environment (Protection) Amendment Rules, 2000 notified vide notification G.S.R. 742(E), dated 25.9.2000.

Category	Pollutant	Time weighted average	Concentration in Ambient Air	Method of Measurement
1	2	3	4	5
III Coal mines located in the coal fields of • Jharia • Raniganj • Bokaro	Suspended Particulate Matter (SPM)	Annual Average * 24 hours **	500 µg/m^3 700 µg/m^3	- High Volume Sampling (Average flow rate not less than 1.1 m^3
	Respirable Particulate Matter (size less than 10 µm) (RPM)	Annual Average * 24 hours **	250 µg/m^3 300 µg/m^3	Respirable Particulate Matter sampling and analysis
	Sulphur Dioxide (SO_2)	Annual Average * 24 hours **	80 µg/m^3 120 µg/m^3	1.Improvedwest and Gaeke method 2.Ultraviolet fluorescene
	Oxide of Nitrogen as NO_2	Annual Average * 24 hours **	80 µg/m^3 120 µg/m^3	1. Jacob & Hochheiser Modified (Na-Arsenic) Method 2. Gas phase Chemilumine-scence

Note:

* Annual Arithmetic mean for the measurements taken in a year, following the guidelines for frequency of sampling laid down in clause2.

** 24hourly/8hourlyvaluesshallbemet 92%ofthetimeinayear.However,8% of the time it may exceed but not on two consecutive days.

NATIONAL AMBIENT AIR QUALITY STANDARDS

New Delhi the 18th November 2009

In exercise of the powers conferred by Sub-section (2) (h) of section 16 of the Air (Prevention and Control of Pollution) Act, 1981 (Act No. 14 of 1981), and in supersession of the notification No(s).S.O.384(E), dated 11th April 1994 and S.O.935(E), dated 14th NOVEMBER 1998, the Central Pollution Control Board hereby notify the National Ambient Air Quality Standards with immediate effect.

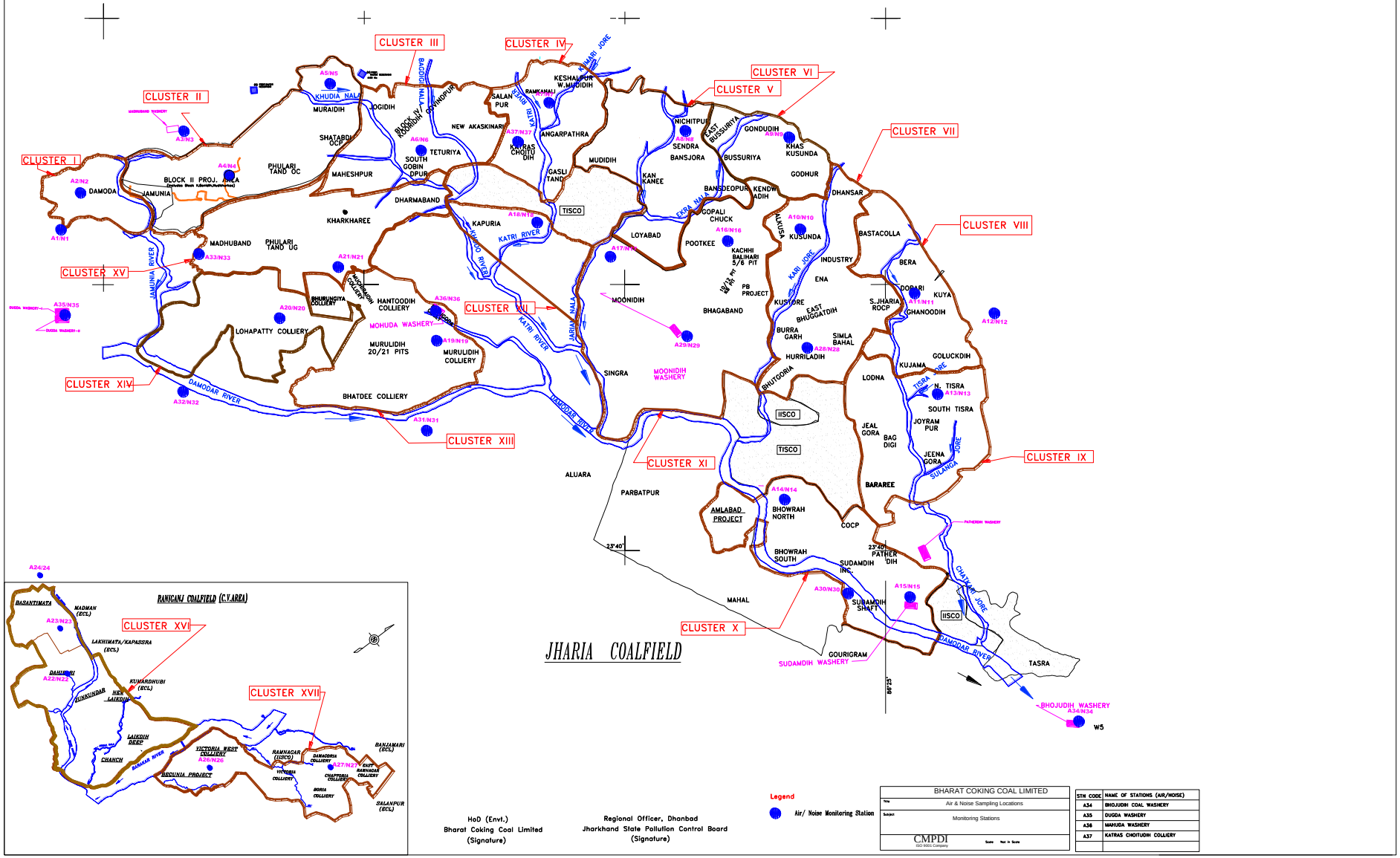
Pollutant	Time Weighted Average	Concentration in Ambient Air		Methods of Measurement
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)	
Sulphur Dioxide (SO_2), µg/m³	Annual * 24 Hours **	50 80	20 80	-Improved West and Gaeke Method -Ultraviolet Fluorescence
Nitrogendioxide (NO_2), µg/m³	Annual * 24 Hours **	40 80	30 80	-Jacob &Hochheiser modified ($NaOH$-$NaAsO_2$) Method -Gas Phase Chemiluminescence
Particulate Matter (Size less than 10µm) or PM_{10}, µg/m³	Annual * 24 Hours **	60 100	60 100	-Gravimetric -TEOM -Beta attenuation
Particulate Matter (Size less than 2.5µm) or $PM_{2.5}$, µg/m³	Annual * 24 Hours **	40 60	40 60	-Gravimetric -TEOM -Beta attenuation
Ozone (O_3) , µg/m³	8 Hours * 1 Hour **	100 180	100 180	-UV Photometric -Chemiluminescence -Chemical Method
Lead (Pb) , µg/m³	Annual * 24 Hours **	0.50 1.0	0.50 1.0	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper -ED-XRF using Teflon filter
Carbon Monoxide (CO), mg/m³	8 Hours ** 1 Hour **	02 04	02 04	-Non dispersive Infrared (NDIR) Spectroscopy
Ammonia (NH_3), µg/m³	Annual * 24 Hours **	100 400	100 400	-Chemiluminescence -Indophenol blue method
Benzene (C_6H_6), µg/m³	Annual *	05	05	-Gas Chromatography (GC) based continuous analyzer -Adsorption and desorption followed by GC analysis
Benzo(a)Pyrene (BaP) Particulate phase only, ng/m³	Annual *	01	01	-Solvent extraction followed byHPLC/GC analysis
Arsenic (As), ng/m³	Annual *	06	06	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper
Nickel (Ni), ng/m³	Annual *	20	20	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper

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

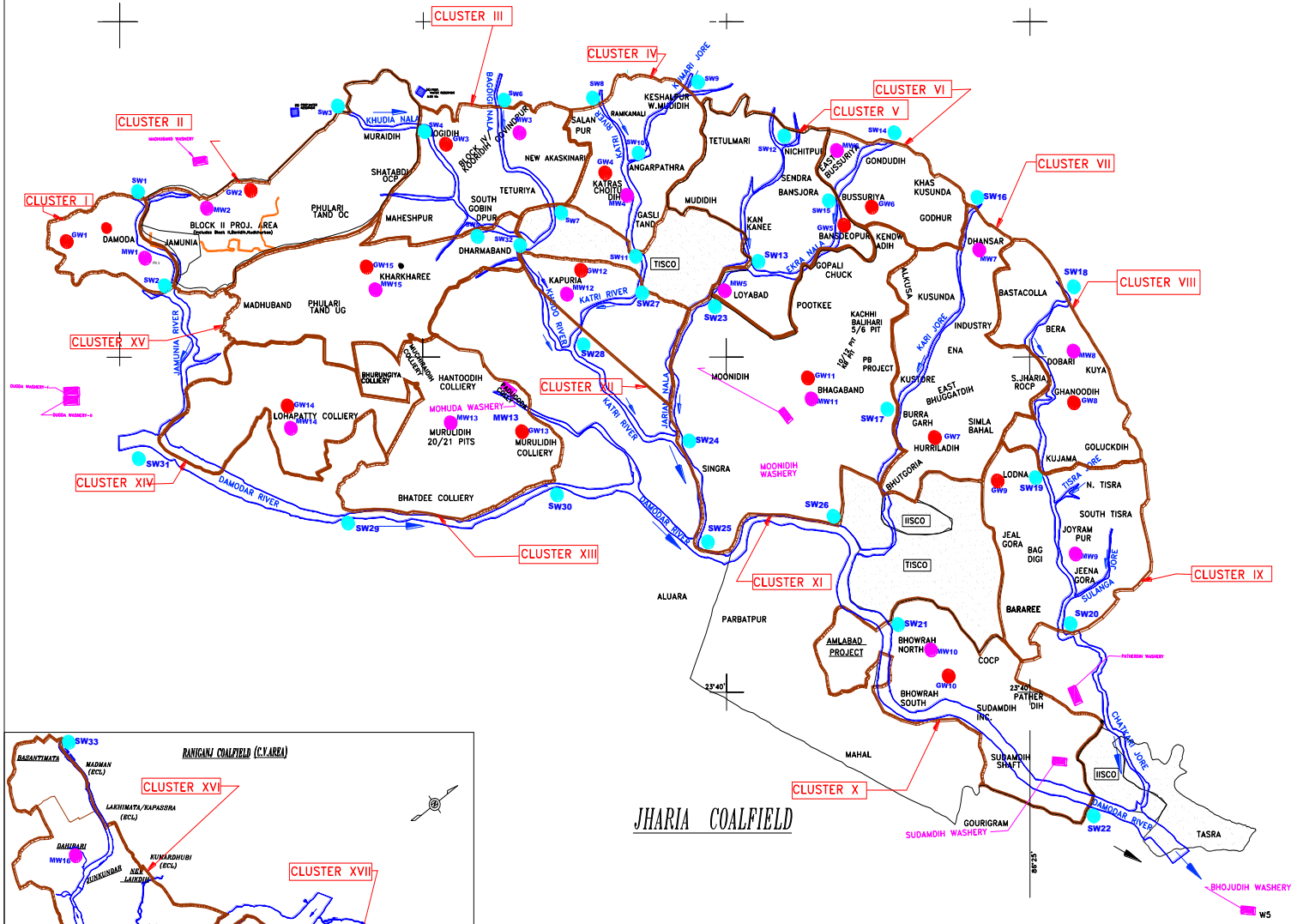
** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they JUNE exceed the limits but not on two consecutive days of monitoring.

NOTE: Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigations.

Location of Air & Noise Monitoring Stations in BCCL



Water Sampling Locations in BCCL



INDEX

Cluster	Suface Water (U/S, D/S)	Name of River/ Nala / Jore	Mine/ Effluent Water	Sampling Location	Ground Water	Sampling Location
I	SW1, SW2	Jamunia River	MW1	Damoda Area	GW1	Ghutway Village
II	SW3, SW4	Khudia Nala	MW2	Block II OCP	GW2	Joyrampur Village
III	SW4, SW5, SW6, SW7	Khudia Nala, Bagdigi Nala	MW3	Govindpur Colliery	GW3	Jogidih Village
IV	SW8, SW11, SW9, SW10	Katri River, Kumari Jore	MW4	Chotudih	GW4	Kankanee Village
V	SW12, SW13, SW15	Jarian Nala, Ekra Nala	MW5	Mudidih	GW5	Nichitpur
VI	SW14, SW15	Ekra Nala	MW6	East Bassuria UGP	GW6	Bansjora Borewell
VII	SW16, SW17	Kari Jore	MW7	Dhansar UGP	GW7	Hurriladih
VIII	SW18, SW19	Kashi Jore	MW8	Dobari UGP	GW8	Ghanudih
IX	SW19, SW20	Kashi Jore	MW9	Jeenagora	GW9	Lodna
X	SW21, SW22	Damodar River	MW10	Bhowrah North	GW10	Bhowrah South
XI	SW23, SW24, SW25, SW26	Jarian Nala, Damodar River	MW11	Bhagaband h UGP	GW11	Bhagabandh
XII	SW27, SW28	Katri River	MW12	Kapuria	GW12	Kapuria
XIII	SW29, SW30	Damodar River	MW13	Murulidih (20/21)	GW13	Murilidih
XIV	SW31, SW29	Damodar River	MW14	Lohapatti	GW14	Lohapatti
XV	SW5, SW32	Khudia Nala	MW15	Kharkharee UGP	GW15	Kharkharee
XVI	SW33, SW34	Khudia River	MW16	Dahibari OCP	GW16	Patlabari Village
XVII	SW35, SW36	Barakar River	MW17	Damagoria Colliery	GW17	Chaptoria

STRICTLY RESTRICTED
FOR COMPANY USE ONLY RESTRICTED
The information given in this report is not to be communicated either directly or indirectly to the press or to any person not holding an official position in the CIL /GOVERNMENT.

ENVIRONMENTAL MONITORING REPORT OF BHARAT COKING COAL LIMITED, CLUSTER – III

(FOR THE MONTH FEBRUARY, 2026)

E. C. no. J-11015/213/2010-IA. II(M) dated 03.03.2025.

CMPDI
ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

CONTENTS

SL. NO.	CHAPTER	PARTICULARS	PAGE NO.
1.	CHAPTER - I	EXECUTIVE SUMMARY	3-5
2.	CHAPTER-II	INTRODUCTION	6
3.	CHAPTER-III	RESULTS	7-19
4.	CHAPTER-IV	STANDARDS AND PLANS	20-21

EXECUTIVE SUMMARY

1.0 Introduction

The purpose of environmental monitoring is to assess the quality of various attributes that affects the fauna and flora. In accordance with the quality of these attributes appropriate strategy is to be developed to control the pollution level within the permissible limits. The three major attributes are air, water and noise level.

Bharat Coking Coal Limited (BCCL), a Subsidiary company of Coal India Limited is operating Underground and Opencast Mines in Jharia Coalfield (JCF) is a part of Gondwana Coalfields located in Dhanbad district of Jharkhand, the JCF is bounded by $23^0$37' N to $23^0$52' N latitudes and $86^0$09' E to $86^0$30' E longitude occupying an area of 450 Sq.km. BCCL has awarded Environmental monitoring work of Jharia Coalfield (JCF) to Central Mine Planning & Design Institute Limited (CMPDIL). The environmental monitoring has been carried out as per the conditions laid down by the MoEF&CC while granting environmental clearance of project, consent letter issued by the respective SPCB, and other statutory requirements.

2.0 Sampling location and rationale

2.1 Ambient air sampling locations

The ambient air quality monitoring stations were selected to represent core, buffer zone area. The rationale has been based on the guidelines stipulated by MoEF&CC, consent letter of SPCB, as well as other statutory requirements.

2.2 Water sampling stations

The Water sampling stations were selected for mine sump water.

2.3 Noise level monitoring locations

Noise levels vary depending on the various activities in mining areas. The monitoring of noise level in different locations will be helpful to take appropriate mitigating measures. The rationale has been based on the guidelines stipulated by MoEF&CC, consent letter of SPCB, as well as other statutory requirements.

3.0 Methodology of sampling and analysis

3.1 Ambient air quality

Parameters chosen for assessment of ambient air quality were Particulate Matter (PM_{10}), Fine Particulate Matter ($PM_{2.5}$), Sulphur Di-oxide (SO_2) and Nitrogen Oxides (NO_X). Respirable Dust Samplers (RDS) and Fine Dust Sampler ($PM_{2.5}$

sampler) were used for sampling of $PM_{10,}$ SO_2, & NO_X and Fine Dust Sampler ($PM_{2.5}$ sampler) were used for sampling of $PM_{2.5}$ at 24 hours interval once in a fortnight and the same for the gaseous pollutants. The samples were analysed in Environmental Laboratory of CMPDI, RI-II, Dhanbad.

3.2 Water quality

Water samples were collected as per standard practice. The Mine effluent samples were collected and analysed for four parameters on fortnightly basis. Thereafter the samples were preserved and analysed at the Environmental Laboratory of CMPDI, RI- II, Dhanbad.

3.3 Noise level monitoring

Noise level measurements in form of 'L_{EQ}' were taken using Integrated Data Logging Sound Level Meter. Noise levels were measured in Decibels, 'A' weighted average, i.e. dB(A).

4.0 Results and interpretations

4.1 Air quality

It has been seen from the analysis results that the 24 hours average concentration parameters like $PM_{10,}$ $PM_{2.5}$, SO_2 and NO_X are mostly within the permissible limits in all sampling locations as per MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000 Standards for Coal Mines and National Ambient Air Quality Standard -2009. Sometimes the concentration of PM_{10}& $PM_{2.5}$ exceeds the limits due to heavy public traffic, poor road condition, coke oven plants, burning of coal by surrounding habitants, brick making, municipal waste dumps and industries like Steel Plant, thermal Plants including their fly ash etc.

The following preventive and suppressive mitigative measures can be undertaken to contain the pollution level within prescribed level:-

- Wet drilling and controlled blasting should be practice.
- Explosive used should be optimised to restrict the dust generation.
- Transportation roads should be permanently asphalted free of ruts, potholes etc.
- Water should be sprayed on coal transportation road, service road more frequently and at regular interval.
- Dust from roads should be removed physically or mechanically.
- Greenbelts around industrial sites, service building area besides Avenue plantation along roads should be created.
- Coal dust should be suppressed by using fixed sprinklers.
- Regular maintenance of plant and machinery should be undertaken.

4.2 Water quality

The test results indicate that the major parameters compared with MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000 Standards for Coal Mines, are within permissible limits.

4.3 Noise Level

During the noise level survey it has been observed that the noise level in the sampling locations is within the permissible limits prescribed as per MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000 Standards for Coal Mines for Industrial Area and Noise pollution (Regulation and Control) Rules, 2000.

INTRODUCTION

Any industry and development activities including coal mining is bound to affect environmental attributes. There are positive as well as negative impacts of such operations. For controlling the adverse impacts a regular monitoring is essential. The environmental monitoring is being done as per the guide-lines stipulated by Ministry of Environment, Forest and Climate Change (MoEF&CC), Govt. of India.

The very purpose of environmental monitoring is to assess the quality of various attributes which affects the environment. As per quality of these attributes appropriate strategy is to be developed to control the pollution level within the permissible limits. The three major attributes are air, water and noise level.

Bharat Coking Coal has awarded Environmental Monitoring work of all Projects, Cluster wise, to Central Mine Planning & Design Institute Limited (CMPDIL). The environmental monitoring has been carried out as per conditions laid down by MoEF&CC while granting environmental clearance to different projects. CMPDI has trained manpower and well equipped laboratory to carry out monitoring, analysis and R&D work in the field of environment.

The CLUSTER III is in the westernmost part of the Jharia coalfield. It includes Jogidih Colliery, Maheshpur Colliery, South Govindpur Colliery, Teturiya Colliery, Govindpur Colliery, New Akasshkinaree Mine and Block IV Kooridih Mixed Mine as per **E. C. no. J-11015/213/2010-IA.II**(M) dated 06.02.2013 and later all seven mines are amalgamated to single mine Named Cluster III with OC cum UG with Highway Mining method with no change in lease area and production capacity. The cluster – III is situated about 40 - 45 kms from Dhanbad Railway Station. The mines of this cluster-III are operating since pre nationalization period (prior to 1972-73). It is connected by both Railway and Road. The drainage of the area is governed by Khudia and Bagdighi Nala.

The Project has Environmental Clearance from Ministry of Environment, Forest and Climate Change (MoEF&CC) for a peak capacity of 3.6 MTPA of coal production vide letter no **E. C. no. J-11015/213/2010-IA. II**(M) dated 06.02.2013 later with **E. C. no. J-11015/213/2010-IA. II**(M) dated 03.03.2025.

Ministry of Environment, Forest and Climate Change while granting environmental clearance has given one of the General conditions that " Four ambient air quality monitoring stations should be established in the core zone as well as in the buffer zone for PM_{10}, $PM_{2.5}$, SO_2, NOx monitoring. Location of the stations should be decided based on the meteorological data, topographical features and environmentally and ecologically sensitive targets, other conditions regarding water / effluent and noise level monitoring in consultation with the State Pollution Control Board."

In compliance of these conditions the Environmental Monitoring has been carried out & report prepared for submission to MoEF&CC & JSPCB and other statutory authorities.

AMBIENT AIR QUALITY MONITORING

2.1 Location of sampling station and their rationale:

(As per G.S.R. 742 (E) dt. 25th December, 2000)

2.1.1 Ambient Air Quality Sampling Locations

CORE ZONE Monitoring Location

i) Block IV Kooridih OCP (A6): Industrial Area

The location of the sampling station is at 23°47'54.00"N & 86°16'20.00"E. The sampler was placed at 1.5 m above the ground level near Safety office of Block IV OCP.

BUFFER ZONE Monitoring Location

i) Muraidih OCP (A5) : Industrial Area

The sampler was placed at a height of 1.5 m from the ground level at Muraidih project office.

ii) Ramkanali Workshop (A7) : Industrial area

The location of the sampling station is 23°48'34.00"N & 86°18'22.00"E. The sampler was placed at height of 1.5 m above the ground level at AARC agent Office, Ramkanali.

iii) Kharkharee(A21): **Industrial Area**

The location of the sampling station is 23°46'29.00"N & 86°14'37.08"E. The sampler was placed at a height of 1.5 m above the ground level at Kharkharee Colliery.

AMBIENT AIR QUALITY DATA

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Air Quality Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Test Report for Ambient Air Samples

Month & Year	**02/2026**	**Cluster**	**Cluster III**	**ULR NO.**	**TC1432126000002404F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**20.03.2026**
Project	**Block-IV**	**Sample Ref. No.**	**REM/BCCL/2026/02**	**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**
Date of Sampling	12.02.26	26.02.26	**Period of Analysis**	12.02.26 – 10.03.26	**Zone of Station:** **Core Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			A5316	A5394				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	109	93	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	54	46	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	15	33	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*

***All units are in µg/m3, 24 hourly Average,*

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

***Note**: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.*

---- End of Report ----

Test Report for Ambient Air Samples

Month & Year	**02/2026**	**Cluster**	**Cluster III**			**ULR No.**	**TC1432126000002404F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**20.03.2026**
Project	**Muraidih**		**Sample Ref. No.**	**REM/BCCL/2026/02**	**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**	
Date of Sampling	11.02.26		25.02.26	**Date of Sampling**	11.02.26	10.03.2026	**Zone of Station:**	**Buffer Zone**

Sl. No.	Parameter	Method of Analysis	Observed Values (in µg/m³)		Range Of Testing	LDL	MoEF Standards Notification dated 25th September,2000 (GSR 742 E)	NAAQS, 2009
			A5308	A5386				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	124	143	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	66	76	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	11	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	22	33	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*

***All units are in µg/m3, 24 hourly Average,*

ANALYSED BY (Gaurav Kant) ***REVIEWED BY*** (Kumar Vaibhav) ***Authorised Signatory***

***Note**: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.*

---- End of Report ----

Page -1 of 1

TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Air Quality Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850

Test Report for Ambient Air Samples

Month & Year	**02/2026**	**Cluster**	**Cluster III**	**ULR NO.**	**TC1432126000002404F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**20.03.2026**
Project	**Ramkanali Workshop**	**Sample Ref. No.**	**REM/BCCL/2026/02**	**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**
Date of Sampling	13.02.26	27.02.26	**Period of Analysis**	13.02.26 10.03.2026	**Zone of Station:** **Buffer Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			A5324	A5402				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	98	133	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	56	67	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	21	25	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

** LDL indicates Lower Detection Limit,*

***All units are in µg/m3, 24 hourly Average,*

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

***Note**: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.*

---- End of Report ----

Page -1 of 1

TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Air Quality Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Test Report for Ambient Air Samples

Month & Year	**02/2026**	**Cluster**	**Cluster III**			**ULR NO.**	**TC1432126000002404F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**20.03.2026**
Project	**Kharkharee**		**Sample Ref. No.**	**REM/BCCL/2026/02**	**Sampling Method**	**CMPDI/RI-II/LPM 13 , (IS 5182)**	
Date of Sampling	02.02.26		16.02.26	**Period of Analysis**	02.02.26 10.03.2026	**Zone of Station:**	**Buffer Zone**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values (in µg/m³)**		**Range Of Testing**	**LDL**	**MoEF Standards Notification dated 25th September,2000 (GSR 742 E)**	**NAAQS, 2009**
			A5253	A5331				
1	PM_{10}	IS -5182(Part 23):2006, R-2017	121	129	10 µg/m³ - 1000 µg/m³	10 µg/m³	300	100
2	$PM_{2.5}$	IS -5182(Part 24):2019	67	68	10 µg/m³ - 400 µg/m³	10 µg/m³	Not Specified	60
3	SO_2	IS-5182(Part-2): 2001 , R-2017	<10	<10	10 µg/m³ - 1050 µg/m³	10 µg/m³	120	80
4	NO_2	IS-5182 (Part-6): 2006 , R-2017	21	25	06 µg/m³ - 420 µg/m³	06 µg/m³	120	80

***All units are in µg/m3, 24 hourly Average, * LDL indicates Lower Detection Limit,*

ANALYSED BY

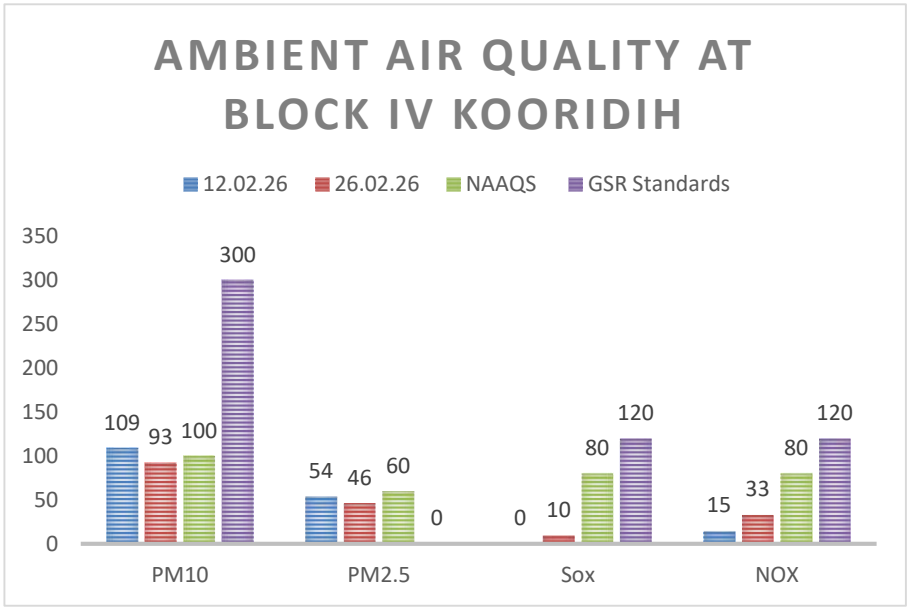
(Gaurav Kant)
REVIEWED BY

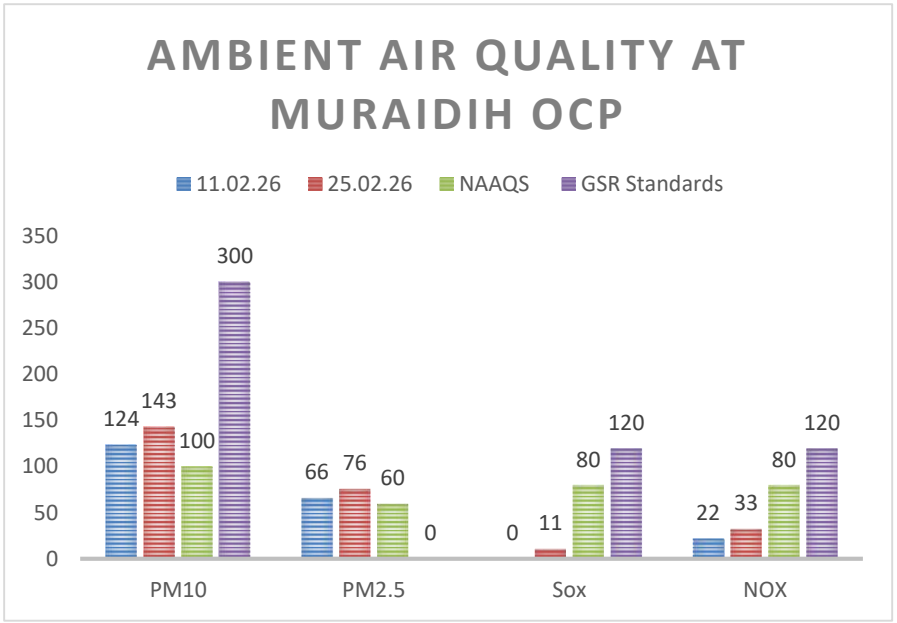
(Kumar Vaibhav)
Authorised Signatory

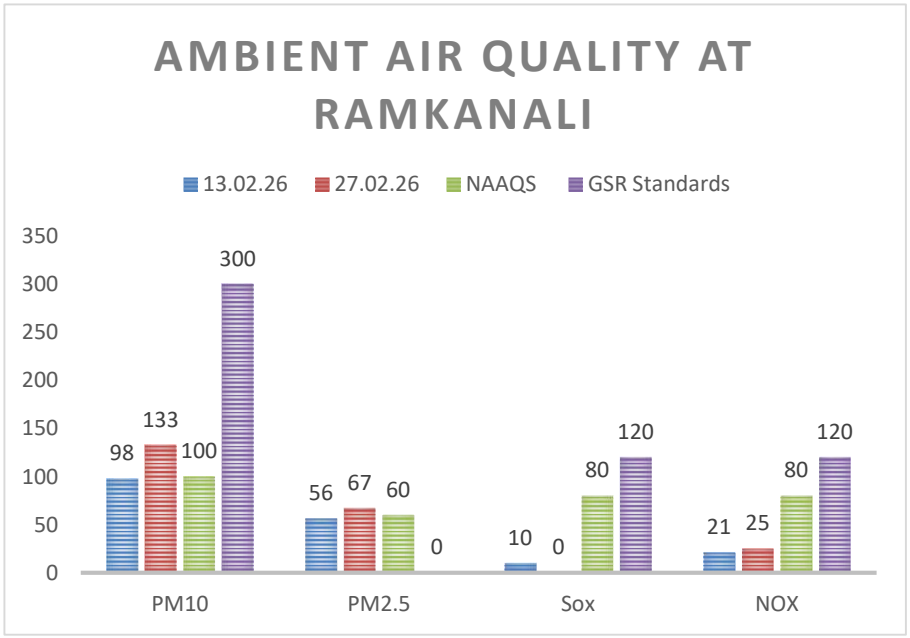
***Note**: The results above relate to the samples tested as received. This report cannot be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.*

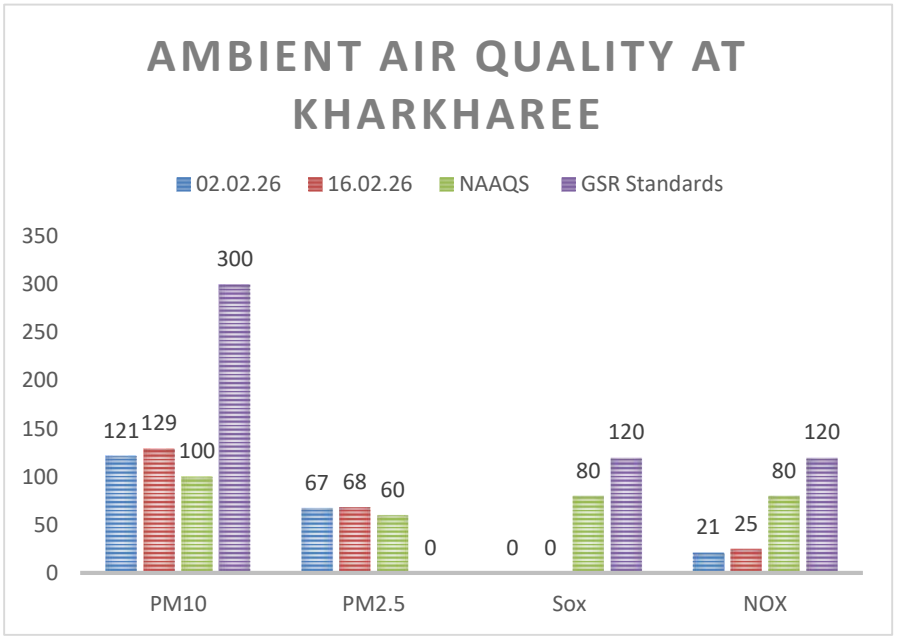
---- End of Report ----

Page -1 of 1


AMBIENT AIR QUALITY AT BLOCK IV KOORIDIH
12.02.26
26.02.26
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
109
93
100
300
54
46
60
0
0
10
80
120
15
33
80
120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT MURAIDIH OCP
11.02.26
25.02.26
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
124
143
100
300
66
76
60
0
0
11
80
120
22
33
80
120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT RAMKANALI
13.02.26
27.02.26
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
98
133
100
300
56
67
60
0
10
0
80
120
21
25
80
120
PM10
PM2.5
Sox
NOX


AMBIENT AIR QUALITY AT KHARKHAREE
02.02.26
16.02.26
NAAQS
GSR Standards
350
300
250
200
150
100
50
0
121
129
100
300
67
68
60
0
0
0
80
120
21
25
80
120
PM10
PM2.5
Sox
NOX

WATER QUALITY MONITORING

3.1 Location of sampling sites

(Refer **Plate No. – II**)

i) Mine Discharge of Govindpur (MW3)

A sampling point is fixed to assess the effluent quality of Mine discharge. This location is selected to monitor effluent discharge in to Khudia Nala and Bagdighi Nala.

3.2 Methodology of sampling and analysis

Water samples were collected as per standard practice. The effluent samples were collected and analysed for four parameters on fortnightly basis at the Environmental Laboratory of CMPDI RI-II, Dhanbad.

3.3 Results & Interpretations

The results are given in tabular form along with the applicable standards. Results are compared with Schedule - VI, effluent prescribed by MoEF&CC. Results show that most of the parameters are within the permissible limits.

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
MINE EFFLUENT TEST REPORT

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Test Report for Mine Effluent samples

Month & Year	**02/2026**	**Cluster**	**Cluster III**	**ULR NO.**		**TC1432126000002423F**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**20.03.2026**
Project		**Sampling Ref. No.**	**REM/BCCL/2026/02**	**Sampling Method**	**IS 3025 (Part-1) CMPDI/RI-II/LPM 13**		
Sampling Stations	**(i)**	**Govindpur**	**Sample Collected in 2.5 Ltr Jerricane , Color as observed is transparent**			**Period of Analysis**	**09.02.2026 to 28.02.2026**
			Date of Sampling	**09.02.2026**	**23.02.26**		

Sl. No.	Parameter	Method of Analysis	Observed Values		STANDARDS FOR COAL MINES (Stipulated by Ministry of Environment and Forests (MoEF), Vide Notification No. GSR 742(E), Dt: 25.09.2000)	LDL
			M2003	M2030		
1	Total Suspended Solids	IS 3025/17:1984, R :2017, Gravimetric	41	42	*100 (Max)*	10
2	pH	IS-3025/11:1983, R-2017, Electrometric	7.39	7.34	*5.5 - 9.0*	0.2
3	Oil & Grease	IS 3025/39:1991, R : 2019, Partition Gravimetric	<4.0	<4.0	*10 (Max)*	2
4	COD	APHA 23rd Edition 5220 C Titrimetric Method	36	32	*250 (Max)*	4

***All units in mg/L unless specified otherwise. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*
***Grab sampling carried out for water samples.*

ANALYSED BY | (Gaurav Kant) ***REVIEWED BY*** | (Kumar Vaibhav) ***Authorised Signatory***

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

NOISE LEVEL QUALITY MONITORING

4.1 Location of sampling sites

i) **Block-IV (N6)**

ii) **Nichitpur (N5)**

iii) **Govindpur Village (N7)**

i) **Kharkharee (N21)**

4.2 Methodology of sampling and analysis

Noise level measurements in form of 'L_{EQ}' were taken using Integrated Data Logging Sound Level Meter during day time & night time. Noise levels were measured for the complete day & night time, the Intergration time taken was one hour or 3600 seconds. Noise levels were measured in Decibels, 'A' weighted average, i.e. dB (A).

4.2 Results & Interpretations

Ambient noise levels were recorded during day time & night time and the observed values were compared with standards prescribed by MoEF&CC. The results of Noise levels recorded during day & night time on fortnightly basis are presented in tabular form along with the applicable standard permissible limits. The observed values in terms of L_{EQ} are presented**.** The observed values at all the monitoring locations are found to be within permissible limits.

TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Noise Level Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Month & Year	**02/2026**	**Cluster**	**Cluster III**			**ULR NO.**	**TC1432126000002439F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**20.03.2026**
Project		**Sample Ref. No.**	**REM/BCCL/2026/02**		**Sampling Method**	**CMPDI/RI-II/LPM 13**	
Sampling Stations	**i**	**Block IV**	**Date of Sampling**	12.02.26	26.02.26	**Zone Category of Station:**	**Core Zone**

Sl. No.	Parameter	Hour / Time of day	Observed Values (in Leq dB(A)) First Fortnight	Observed Values (in Leq dB(A)) Second Fortnight	Method of Analysis	Range Of Testing	LDL	NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards Zones	Limits in dB
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	50.4	49.2	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	54.2	53.3					
3		08:00 - 09:00	55.1	54.2					
4		09:00 – 10:00	58.3	57.5					
5		10:00 - 11:00	57.9	57					
6		11:00 - 12:00	59.1	58.6					
7		12:00 - 13:00	58.7	57.5					
8		13:00 - 14:00	59	59.7					
9		14:00 - 15:00	59.4	58.5					
10		15:00 - 16:00	62.1	55.3					
11		16:00 - 17:00	62.8	62.6					
12		17:00 - 18:00	63.6	63.4					
13		18:00 - 19:00	62.4	58.5					
14		19:00 - 20:00	62	61.4					
15		20:00 - 21:00	55.9	55					
16		21:00 - 22:00	49.5	48.1					
		Leq DAY	59.7	58.5					
1	Noise Level dB(A)Leq -Night	22:00-23:00	50.3	49	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	49.5	47.4					
3		00:00- 01:00	47.8	46.8					
4		01.00-02.00	42.7	43					
5		02.00-03.00	42.3	42.5					
6		03.00-04.00	45.5	43.9					
7		04.00-05.00	43.5	42.9					
8		05:00-06:00	43.9	44.9					
		Leq NIGHT	46.7	45.7					

**LDL indicates Lower Detection Limit*

***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants
ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Noise Level Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Month & Year	**02/2026**	**Cluster**	**Cluster III**				**ULR No.**	**TC1432126000002439F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**						**Date of Issue**	**20.03.2026**
Project		**Sample Ref. No.**	**REM/BCCL/2026/02**		**Sampling Method**		**CMPDI/RI-II/LPM 13**	
Sampling Stations	**i**	**Muraidih OCP**	**Date of Sampling**	11.02.26	25.02.26	**Zone Category of Station:**	**Buffer Zone**	

Sl. No.	**Parameter**	**Hour / Time of day**	**Observed Values (in Leq dB(A)) First Fortnight**	**Observed Values (in Leq dB(A)) Second Fortnight**	**Method of Analysis**	**Range Of Testing**	**LDL**	**NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards**	
								Zones	**Limits in dB**
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	41.7	42.2	CPCB, Protocol for Ambient Level Noise Monitoring -2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	42.7	44.5					
3		08:00 - 09:00	47.4	46.8					
4		09:00 – 10:00	48.4	49.1					
5		10:00 - 11:00	49.2	49.6					
6		11:00 - 12:00	53.2	55.4					
7		12:00 - 13:00	52.6	53.4					
8		13:00 - 14:00	48.2	52.3					
9		14:00 - 15:00	49.2	49.6					
10		15:00 - 16:00	51.5	52.6					
11		16:00 - 17:00	46.6	45.6					
12		17:00 - 18:00	42.6	42.6					
13		18:00 - 19:00	41.2	41.1					
14		19:00 - 20:00	41.7	41.4					
15		20:00 - 21:00	41.1	41.2					
16		21:00 - 22:00	40.9	40.1					
		Leq DAY	48.1	49.4					
1	Noise Level dB(A)Leq - Night	22:00-23:00	41.8	41.3	CPCB, Protocol for Ambient Level Noise Monitoring -2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	41.4	39.6					
3		00:00- 01:00	41	38.9					
4		01.00-02.00	40.9	38.7					
5		02.00-03.00	40.5	38.6					
6		03.00-04.00	40	39.2					
7		04.00-05.00	41.6	40.9					
8		05:00-06:00	41.6	41.5					
		Leq NIGHT	41.1	40.0					

**LDL indicates Lower Detection Limit*
***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Noise Level Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Month & Year	**02/2026**	**Cluster**	**Cluster III**	**ULR No.**	**TC1432126000002439F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**20.03.2026**
Project		**Sample Ref. No.**	**REM/BCCL/2026/02**	**Sampling Method**	**CMPDI/RI-II/LPM 13**
Sampling Stations	**i**	**Ramkanali**	**Date of Sampling**	13.02.26 – 27.02.26	**Zone Category of Station: Buffer Zone**

Sl. No.	Parameter	Hour / Time of day	Observed Values (in Leq dB(A)) First Fortnight	Observed Values (in Leq dB(A)) Second Fortnight	Method of Analysis	Range Of Testing	LDL	NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards	
								Zones	Limits in dB
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	48.4	47.6	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	75 65 55 50
2		07:00 - 08:00	50.9	50.1					
3		08:00 - 09:00	53.4	52.9					
4		09:00 – 10:00	59.2	58.4					
5		10:00 - 11:00	60.6	59.7					
6		11:00 - 12:00	61.1	58.4					
7		12:00 - 13:00	62.1	63.4					
8		13:00 - 14:00	63.5	62.5					
9		14:00 - 15:00	57	57					
10		15:00 - 16:00	56	56					
11		16:00 - 17:00	55.6	55.6					
12		17:00 - 18:00	55.9	55.1					
13		18:00 - 19:00	55.1	54.2					
14		19:00 - 20:00	54.1	53.3					
15		20:00 - 21:00	54.1	49.5					
16		21:00 - 22:00	50.1	48.5					
		Leq DAY	58.0	57.4					
1	Noise Level dB(A)Leq -Night	22:00-23:00	50.7	50	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial Commercial Residential Silence	70 55 45 50
2		23:00- 00:00	50.6	49.8					
3		00:00- 01:00	47.6	47.7					
4		01.00-02.00	45.6	45.5					
5		02.00-03.00	45.2	45.2					
6		03.00-04.00	45	45					
7		04.00-05.00	47	46.7					
8		05:00-06:00	48	47.8					
		Leq NIGHT	48.0	47.6					

**LDL indicates Lower Detection Limit*

***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants

ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

Page -1 of 1

TC-14321

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
Ambient Noise Level Test Report

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Month & Year	02/2026	**Cluster**	**Cluster III**	**ULR No.**	**TC1432126000002439F**
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**20.03.2026**
Project		**Sample Ref. No.**	**REM/BCCL/2026/02**	**Sampling Method**	**CMPDI/RI-II/LPM 13**

Sampling Stations	**i**	**Kharkharee**	**Date of Sampling**	02.02.26	16.02.26	**Zone Category of Station:**	**Buffer Zone**	
Sl. No.	**Parameter**	**Hour / Time of day**	**Observed Values (in Leq dB(A))** First Fortnight	**Observed Values (in Leq dB(A))** Second Fortnight	**Method of Analysis**	**Range Of Testing**	**LDL**	**NOISE POLLUTION (REGULATION AND CONTROL) RULES, 2000 Standards** Zones / Limits in dB
1	Noise Level dB(A)Leq - Day	06:00 - 07:00	46.5	43	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial 75
2		07:00 - 08:00	55.4	54.4				Commercial 65
3		08:00 - 09:00	64.7	64.9				Residential 55
4		09:00 – 10:00	66.4	64.4				Silence 50
5		10:00 - 11:00	62.4	60.3				
6		11:00 - 12:00	58.7	58.3				
7		12:00 - 13:00	59.8	57.4				
8		13:00 - 14:00	56.7	54.3				
9		14:00 - 15:00	54.6	52.3				
10		15:00 - 16:00	52.7	51.8				
11		16:00 - 17:00	51.8	52.4				
12		17:00 - 18:00	50.8	52.1				
13		18:00 - 19:00	49.2	49.2				
14		19:00 - 20:00	47.6	47.7				
15		20:00 - 21:00	45.7	45.9				
16		21:00 - 22:00	45.2	45.5				
		Leq DAY	59.0	57.8				
1	Noise Level dB(A)Leq -Night	22:00-23:00	44.6	42.4	CPCB, Protocol for Ambient Level Noise Monitoring - 2015	35 dB-135 dB	35 dB(A)	Industrial 70
2		23:00- 00:00	41.9	42.3				Commercial 55
3		00:00- 01:00	42	42.3				Residential 45
4		01.00-02.00	40.2	41.4				Silence 50
5		02.00-03.00	39.9	36.9				
6		03.00-04.00	39.4	40.7				
7		04.00-05.00	39.2	38.2				
8		05:00-06:00	38	35.9				
		Leq NIGHT	41.1	40.6				

**LDL indicates Lower Detection Limit*

***All noise measurements are integrated for a 01 hour period, All units in dB(A)*

Sampling Assistants
ANALYSED BY

(Gaurav Kant)
REVIEWED BY

(Kumar Vaibhav)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report cannot be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

Page -1 of 1

Ambient Air Quality Standards for Jharia Coal Field
As per the Environment (Protection) Amendment Rules, 2000 notified vide notification G.S.R. 742(E), dated 25.9.2000.

Category	Pollutant	Time weighted average	Concentration in Ambient Air	Method of Measurement
1	2	3	4	5
III Coal mines located in the coal fields of • Jharia • Raniganj • Bokaro	Suspended Particulate Matter (SPM)	Annual Average * 24 hours **	500 µg/m^3 700 µg/m^3	- High Volume Sampling (Average flow rate not less than 1.1 m^3
	Respirable Particulate Matter (size less than 10 µm) (RPM)	Annual Average * 24 hours **	250 µg/m^3 300 µg/m^3	Respirable Particulate Matter sampling and analysis
	Sulphur Dioxide (SO_2)	Annual Average * 24 hours **	80 µg/m^3 120 µg/m^3	1.Improvedwest and Gaeke method 2.Ultraviolet fluorescene
	Oxide of Nitrogen as NO_2	Annual Average * 24 hours **	80 µg/m^3 120 µg/m^3	1. Jacob & Hochheiser Modified (Na-Arsenic) Method 2. Gas phase Chemilumine-scence

Note:

* Annual Arithmetic mean for the measurements taken in a year, following the guidelines for frequency of sampling laid down in clause2.

** 24hourly/8hourlyvaluesshallbemet 92%ofthetimeinayear.However,8% of the time it may exceed but not on two consecutive days.

NATIONAL AMBIENT AIR QUALITY STANDARDS

New Delhi the 18th November 2009

In exercise of the powers conferred by Sub-section (2) (h) of section 16 of the Air (Prevention and Control of Pollution) Act, 1981 (Act No. 14 of 1981), and in supersession of the notification No(s).S.O.384(E), dated 11th April 1994 and S.O.935(E), dated 14th NOVEMBER 1998, the Central Pollution Control Board hereby notify the National Ambient Air Quality Standards with immediate effect.

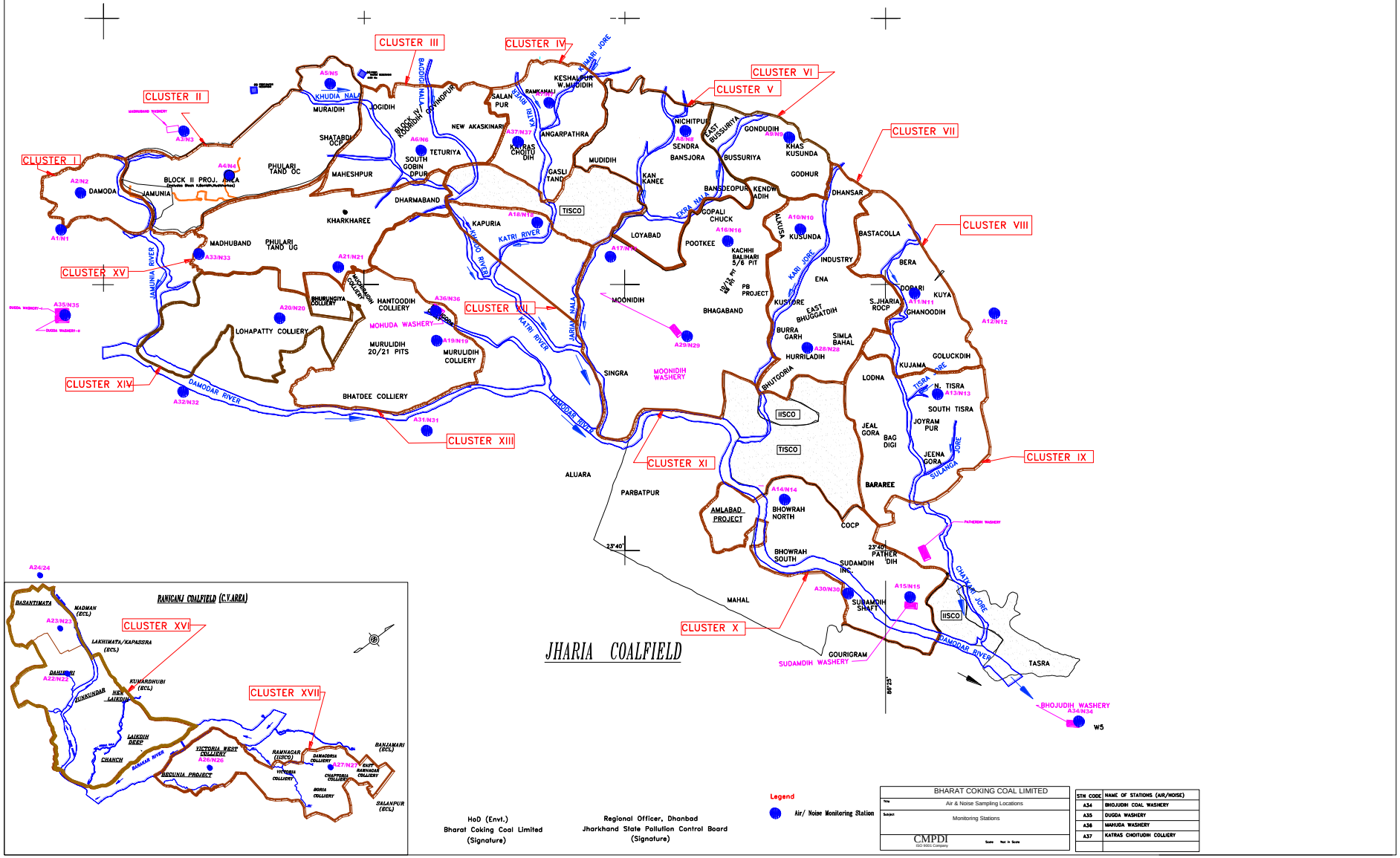
Pollutant	Time Weighted Average	Concentration in Ambient Air		Methods of Measurement
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)	
Sulphur Dioxide (SO_2), µg/m³	Annual * 24 Hours **	50 80	20 80	-Improved West and Gaeke Method -Ultraviolet Fluorescence
Nitrogendioxide (NO_2), µg/m³	Annual * 24 Hours **	40 80	30 80	-Jacob &Hochheiser modified ($NaOH$-$NaAsO_2$) Method -Gas Phase Chemiluminescence
Particulate Matter (Size less than 10µm) or PM_{10}, µg/m³	Annual * 24 Hours **	60 100	60 100	-Gravimetric -TEOM -Beta attenuation
Particulate Matter (Size less than 2.5µm) or $PM_{2.5}$, µg/m³	Annual * 24 Hours **	40 60	40 60	-Gravimetric -TEOM -Beta attenuation
Ozone (O_3) , µg/m³	8 Hours * 1 Hour **	100 180	100 180	-UV Photometric -Chemiluminescence -Chemical Method
Lead (Pb) , µg/m³	Annual * 24 Hours **	0.50 1.0	0.50 1.0	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper -ED-XRF using Teflon filter
Carbon Monoxide (CO), mg/m³	8 Hours ** 1 Hour **	02 04	02 04	-Non dispersive Infrared (NDIR) Spectroscopy
Ammonia (NH_3), µg/m³	Annual * 24 Hours **	100 400	100 400	-Chemiluminescence -Indophenol blue method
Benzene (C_6H_6), µg/m³	Annual *	05	05	-Gas Chromatography (GC) based continuous analyzer -Adsorption and desorption followed by GC analysis
Benzo(a)Pyrene (BaP) Particulate phase only, ng/m³	Annual *	01	01	-Solvent extraction followed byHPLC/GC analysis
Arsenic (As), ng/m³	Annual *	06	06	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper
Nickel (Ni), ng/m³	Annual *	20	20	-AAS/ICP Method after sampling on EPM 2000 or equivalent filter paper

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

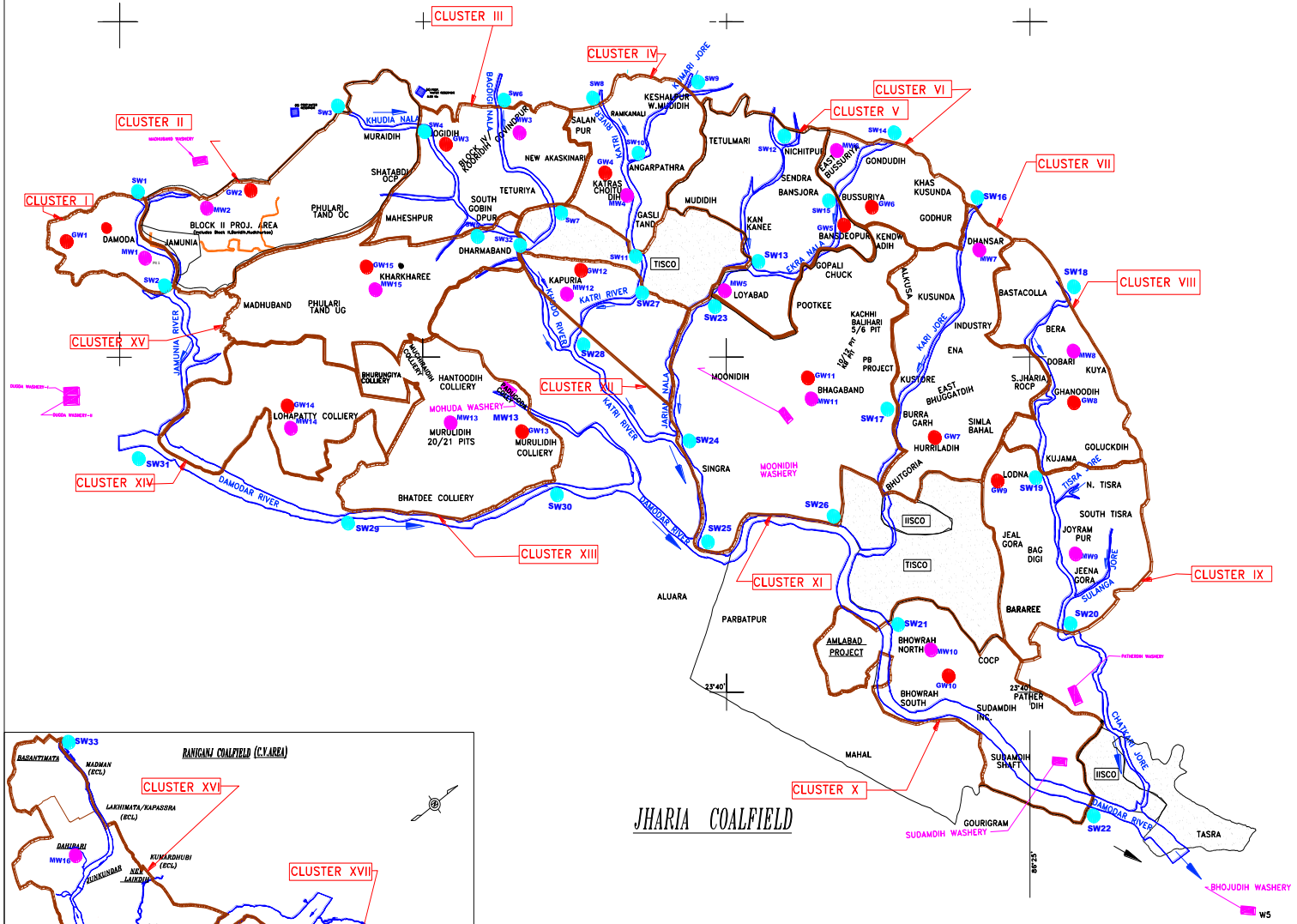
** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they JUNE exceed the limits but not on two consecutive days of monitoring.

NOTE: Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigations.

Location of Air & Noise Monitoring Stations in BCCL



Water Sampling Locations in BCCL



INDEX

Cluster	Suface Water (U/S, D/S)	Name of River/ Nala / Jore	Mine/ Effluent Water	Sampling Location	Ground Water	Sampling Location
I	SW1, SW2	Jamunia River	MW1	Damoda Area	GW1	Ghutway Village
II	SW3, SW4	Khudia Nala	MW2	Block II OCP	GW2	Joyrampur Village
III	SW4, SW5, SW6, SW7	Khudia Nala, Bagdigi Nala	MW3	Govindpur Colliery	GW3	Jogidih Village
IV	SW8, SW11, SW9, SW10	Katri River, Kumari Jore	MW4	Chotudih	GW4	Kankanee Village
V	SW12, SW13, SW15	Jarian Nala, Ekra Nala	MW5	Mudidih	GW5	Nichitpur
VI	SW14, SW15	Ekra Nala	MW6	East Bassuria UGP	GW6	Bansjora Borewell
VII	SW16, SW17	Kari Jore	MW7	Dhansar UGP	GW7	Hurriladih
VIII	SW18, SW19	Kashi Jore	MW8	Dobari UGP	GW8	Ghanudih
IX	SW19, SW20	Kashi Jore	MW9	Jeenagora	GW9	Lodna
X	SW21, SW22	Damodar River	MW10	Bhowrah North	GW10	Bhowrah South
XI	SW23, SW24, SW25, SW26	Jarian Nala, Damodar River	MW11	Bhagaband h UGP	GW11	Bhagabandh
XII	SW27, SW28	Katri River	MW12	Kapuria	GW12	Kapuria
XIII	SW29, SW30	Damodar River	MW13	Murulidih (20/21)	GW13	Murilidih
XIV	SW31, SW29	Damodar River	MW14	Lohapatti	GW14	Lohapatti
XV	SW5, SW32	Khudia Nala	MW15	Kharkharee UGP	GW15	Kharkharee
XVI	SW33, SW34	Khudia River	MW16	Dahibari OCP	GW16	Patlabari Village
XVII	SW35, SW36	Barakar River	MW17	Damagoria Colliery	GW17	Chaptoria

STRICTLY RESTRICTED
FOR COMPANY USE ONLY RESTRICTED
The information given in this report is not to be communicated either directly or indirectly to the press or to any person not holding an official position in the CIL / GOVERNMENT.

TRACE METAL CONCENTRATION OF AMBIENT AIR QUALITY REPORT OF BHARAT COKING COAL LIMITED,

(FOR THE HALF YEAR ENDING, DECEMBER, 2025)

CMPDI

ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

(FOR THE Q.E. DECEMBER**, 2025)**

CONTENTS

SL. NO.	CHAPTER	PARTICULARS
1.	CHAPTER - I	EXECUTIVE SUMMARY INTRODUCTION
2.	CHAPTER-II	AIR SAMPLING & ANALYSIS
3.	**PLATES:** PLATE NO. - I	SURFACE PLAN SHOWING AIR & NOISE MONITORING LOCATIONS

EXECUTIVE SUMMARY

1.0 Introduction

The purpose of environmental monitoring is to assess the quality of various attributes that affects the environment around us. In accordance with the quality of these attributes appropriate strategy is to be developed to control the pollution level within the permissible limits. One of these major attributes is water.

Bharat Coking Coal Limited (BCCL), a Subsidiary company of Coal India Limited is operating Underground and Opencast Mines in Jharia Coalfield (JCF) is a part of Gondwana Coalfields located in Dhanbad district of Jharkhand, the JCF is bounded by $23^0$37' N to $23^0$52' N latitudes and $86^0$09' E to $86^0$30' E longitude occupying an area of 450 Sq.km. BCCL has awarded Environmental monitoring work of Jharia Coalfield (JCF) to Central Mine Planning & Design Institute Limited (CMPDIL). The environmental monitoring has been carried out as per the conditions laid down by the MoEF&CC while granting environmental clearance of project, consent letter issued by the respective SPCB, and other statutory requirements.

2.0 Sampling location and rationale

2.1 Ambient air sampling locations

The ambient air quality monitoring stations were selected to represent core, buffer zone area. The rationale has been based on the guidelines stipulated by MoEF&CC, consent letter of SPCB, as well as other statutory requirements.

3.0 Methodology of sampling and analysis

3.1 Heavy Metal in Ambient Air

Parameters chosen for assessment of Heavy metal in Ambient Air Quality were Cadmium (Cd), Mercury (Hg), Arsenic (As), Chromium (Cr), Nickel (Ni), and Lead (Pb). Respirable Dust Samplers (RDS) were used for sampling these heavy metals on EPM filter paper. These heavy metals are analyzed regularly on half yearly basis. The samples were analyzed in Environment Laboratory of CMPDI, RI-II, Dhanbad.

4.0 Results and interpretations

4.1 Heavy Metal in Ambient Air

The results of Heavy metal in Ambient Air Quality are presented in tabular form for each monitoring station. The concentration of heavy metals in ambient air is well within the permissible limit.

CHAPTER - I

INTRODUCTION

1.0 Any industry and development activities including coal mining is bound to affect environmental attributes. There are positive as well as negative impacts of such operations. For controlling the adverse impacts a regular monitoring is essential. The environmental monitoring is being done as per the guidelines stipulated by Ministry of Environment, Forest and Climate Change (MoEF&CC), Govt. of India.

The very purpose of environmental monitoring is to assess the quality of various attributes which affects the environment. As per quality of these attributes appropriate strategy is to be developed to control the pollution level within the permissible limits. The three major attributes are air, water and noise level.

Bharat Coking Coal Limited (BCCL), a subsidiary company of Coal India Limited (CIL) is operating UG Mines and Opencast Mines in Jharia Coalfield (JCF). The Jharia Coalfield (JCF) having an area of 450 Sq.KM.

Bharat Coking Coal has awarded Environmental Monitoring work of all Projects, Cluster wise, to Central Mine Planning & Design Institute Limited (CMPDIL). The environmental monitoring has been carried out as per conditions laid down by MoEF&CC while granting environmental clearance to different projects. CMPDI has trained manpower and well equipped laboratory to carry out monitoring, analysis and R&D work in the field of environment.
In compliance of these conditions the Environmental Monitoring has been carried out & report prepared for submission to MoEF&CC & JSPCB and other statutory authorities.

CHAPTER – II

AMBIENT AIR QUALITY MONITORING

2.1 Results and interpretations

The results of Heavy metal in Ambient Air Quality are presented in tabular form for each monitoring station. The concentration of heavy metals in ambient air is well within the permissible limit.

TRACE METAL CONCENTRATION IN AMBIENT AIR QUALITY

Name of the Company: **Bharat Coking Coal Limited** Year : **2025-26.**

PERIOD: **HALF YEAR ENDING DECEMBER, 2025**

HEAVY METAL ANALYSIS REPORT OF AMBIENT AIR QUALITY

Results of 6 Heavy Metal for the month of NOV-2025								
SAMPLE CODE	**DATE**	**Station Name**	**Cd CONC. IN µg/m3**	**Hg CONC. IN µg/m3**	**As CONC. IN ng/m3**	**Cr CONC. IN µg/m3**	**Ni CONC. IN ng/m3**	**Pb CONC. IN µg/m3**
A1	24.11.25	Karmatand Village	<0.001	<0.001	<1.0	<0.01	<2.0	<0.005
A2	18.11.25	Damoda	<0.001	<0.001	<1.0	<0.01	<2.0	<0.005
A3	19.11.25	Madhuband Washery	<0.001	<0.001	<1.0	<0.01	<2.0	<0.005
A4	25.11.25	Block-II	<0.001	<0.001	<1.0	<0.01	<2.0	<0.005
A5	19.11.25	Muraidih	<0.001	<0.001	<1.0	<0.01	2.05	<0.005
A6	21.11.25	Block-IV	<0.001	<0.001	<1.0	<0.01	<2.0	<0.005
A7	28.11.25	Govindpur/Ramkanali	<0.001	<0.001	<1.0	<0.01	<2.0	0.016
A8	24.11.25	Nichitpur	<0.001	<0.001	<1.0	<0.01	<2.0	0.005
A9	27.11.25	East Basseriya	<0.001	<0.001	<1.0	<0.01	<2.0	<0.005
A10	24.11.25	Dhansar/Kusunda	<0.001	<0.001	<1.0	<0.01	<2.0	<0.005
A11	21.11.25	Dobari	<0.001	<0.001	<1.0	<0.01	<2.0	0.005
A12	21.11.25	Kusmatand Village	<0.001	<0.001	<1.0	<0.01	<2.0	<0.005
A13	26.11.25	Jeenagora	<0.001	<0.001	<1.0	<0.01	<2.0	<0.005
A14	26.11.25	Bhowrah North	<0.001	<0.001	<1.0	<0.01	<2.0	<0.005
A15	25.11.25	Sudamdih Washery	<0.001	0.001	<1.0	<0.01	<2.0	<0.005
A16	26.11.25	Pootki	<0.001	<0.001	<1.0	<0.01	<2.0	<0.005
A17	27.11.25	Moonidih UGP	<0.001	<0.001	<1.0	<0.01	<2.0	<0.005
A18	21.11.25	Rudih Basti	<0.001	<0.001	<1.0	<0.01	<2.0	0.007
A19	27.11.25	Murlidih 20/21	<0.001	<0.001	<1.0	<0.01	<2.0	<0.005
A20	21.11.25	Lohapatti	<0.001	<0.001	<1.0	<0.01	<2.0	<0.005

Results of 6 Heavy Metal for the month of NOV-2025								
SAMPLE CODE	**DATE**	**Station Name**	**Cd CONC. IN µg/m3**	**Hg CONC. IN µg/m3**	**As CONC. IN ng/m3**	**Cr CONC. IN µg/m3**	**Ni CONC. IN ng/m3**	**Pb CONC. IN µg/m3**
A21	20.11.25	Kharkharee	<0.001	<0.001	<1.0	<0.01	<2.0	<0.005
A22	20.11.25	Dahibari	<0.001	<0.001	<1.0	<0.01	<2.0	0.020
A23	20.11.25	Basantimata	<0.001	<0.001	<1.0	<0.01	<2.0	<0.005
A24	20.11.25	Gopinathpur	<0.001	<0.001	<1.0	<0.01	<2.0	<0.005
A25	21.11.25	Guliardih	<0.001	<0.001	<1.0	<0.01	<2.0	0.005
A26	18.11.25	Begunia	<0.001	<0.001	<1.0	<0.01	<2.0	0.011
A27	17.11.25	Damagoria	<0.001	<0.001	<1.0	<0.01	<2.0	0.020
A28	26.11.25	Hurriladih	<0.001	<0.001	<1.0	<0.01	<2.0	0.014
A29	27.11.25	Moonidih Washery	<0.001	0.005	<1.0	<0.01	<2.0	<0.005
A30	24.11.25	Sitanala	<0.001	<0.001	<1.0	<0.01	<2.0	<0.005
A31	25.11.25	Dumarda	<0.001	<0.001	<1.0	<0.01	<2.0	<0.005
A32	20.11.25	Telmacho Bridge	<0.001	<0.001	<1.0	<0.01	<2.0	<0.005
A33	24.11.25	Madhuband UGP	<0.001	0.001	<1.0	<0.01	<2.0	<0.005
A34	24.11.25	Bhojudih Washery	<0.001	0.015	<1.0	<0.01	<2.0	0.024
A35	17.11.25	Dugda Washery	<0.001	0.006	<1.0	<0.01	<2.0	0.016
A36	28.11.25	Mahuda	<0.001	0.005	<1.0	<0.01	<2.0	<0.005
A37	28.11.25	Katras Choitudih	<0.001	<0.001	<1.0	<0.01	<2.0	<0.005
A38	26.11.25	Sinidih Workshop	<0.001	<0.001	<1.0	<0.01	<2.0	<0.005
A39	25.11.25	Patherdih	<0.001	<0.001	<1.0	<0.01	<2.0	<0.005
A40	20.11.25	Koyla Nagar	<0.001	<0.001	<1.0	<0.01	<2.0	<0.005
A41	25.11.25	Sudamdih Shaft	<0.001	<0.001	<1.0	<0.01	<2.0	<0.005
A42	20.11.25	RHB	<0.001	<0.001	<1.0	<0.01	2.04	<0.005
A43	17.11.25	Pandwabhita	<0.001	<0.001	<1.0	<0.01	<2.0	<0.005
A44	17.11.25	Sadariadih	<0.001	<0.001	<1.0	<0.01	<2.0	<0.005
A45	24.11.25	Bhojudih Buffer	<0.001	<0.001	<1.0	<0.01	<2.0	<0.012
A46	17.11.25	C.H.D	<0.001	<0.001	<1.0	<0.01	<2.0	<0.005

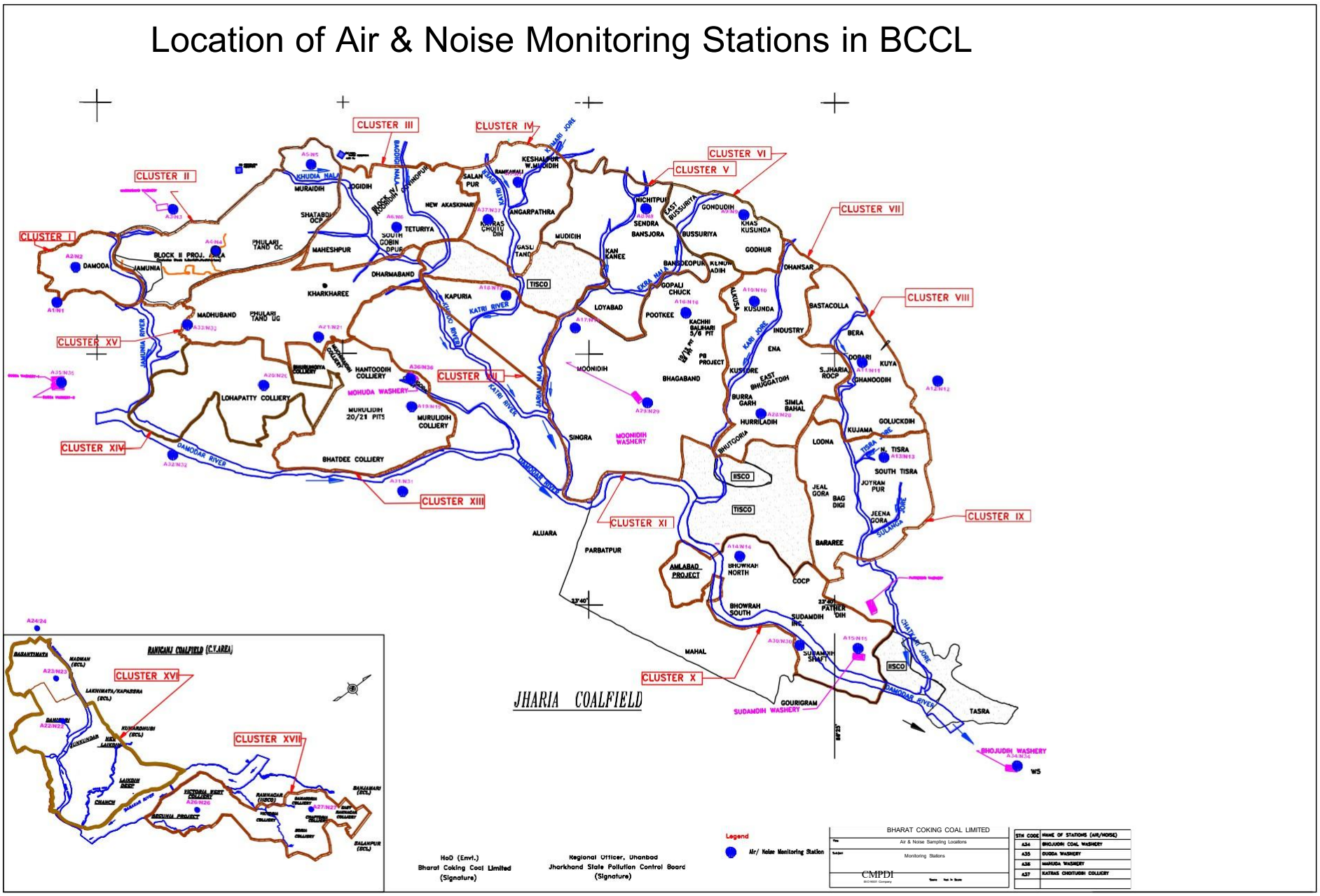
#BDL-Below detection limit

Metal	BDL	Standard as per NAAQS
Hg (µg/m^3)	0.001	*Standard Not defined
Cr(µg/m^3)	0.01	*Standard Not defined
As (ng/m^3)	1	6
Pb (µg/m^3)	0.005	0.5
Ni (ng/m^3)	2	20
Cd (µg/m^3)	0.001	*Standard Not defined

Analysed By
JSA/SA/SSA

Checked By
Lab In Charge
RI-2, CMPDI, Dhanbad

Location of Air & Noise Monitoring Stations in BCCL



STN CODE	NAME OF STATIONS (AIR/NOISE)
A34	BHOJUDIH COAL WASHERY
A35	DUGDA WASHERY
A36	MAHUDA WASHERY
A37	KATRAS CHOITUDIH COLLIERY

STRICTLY RESTRICTED
FOR COMPANY USE ONLY RESTRICTED
The information given in this report is not to be communicated either directly or indirectly to the press or to any person not holding an official position in the CIL / GOVERNMENT.

TRACE METAL CONCENTRATION OF AMBIENT AIR QUALITY REPORT OF BHARAT COKING COAL LIMITED,

(FOR THE HALF YEAR ENDING, JUNE, 2025)

CMPDI

ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

(FOR THE Q.E. JUNE, 2025)

CONTENTS

SL. NO.	CHAPTER	PARTICULARS
1.	CHAPTER - I	EXECUTIVE SUMMARY INTRODUCTION
2.	CHAPTER-II	AIR SAMPLING & ANALYSIS
3.	**PLATES:** PLATE NO. - I	SURFACE PLAN SHOWING AIR & NOISE MONITORING LOCATIONS

EXECUTIVE SUMMARY

1.0 Introduction

The purpose of environmental monitoring is to assess the quality of various attributes that affects the environment around us. In accordance with the quality of these attributes appropriate strategy is to be developed to control the pollution level within the permissible limits. One of these major attributes is water.

Bharat Coking Coal Limited (BCCL), a Subsidiary company of Coal India Limited is operating Underground and Opencast Mines in Jharia Coalfield (JCF) is a part of Gondwana Coalfields located in Dhanbad district of Jharkhand, the JCF is bounded by $23^0$37' N to $23^0$52' N latitudes and $86^0$09' E to $86^0$30' E longitude occupying an area of 450 Sq.km. BCCL has awarded Environmental monitoring work of Jharia Coalfield (JCF) to Central Mine Planning & Design Institute Limited (CMPDIL). The environmental monitoring has been carried out as per the conditions laid down by the MoEF&CC while granting environmental clearance of project, consent letter issued by the respective SPCB, and other statutory requirements.

2.0 Sampling location and rationale

2.1 Ambient air sampling locations

The ambient air quality monitoring stations were selected to represent core, buffer zone area. The rationale has been based on the guidelines stipulated by MoEF&CC, consent letter of SPCB, as well as other statutory requirements.

3.0 Methodology of sampling and analysis

3.1 Heavy Metal in Ambient Air

Parameters chosen for assessment of Heavy metal in Ambient Air Quality were Cadmium (Cd), Mercury (Hg), Arsenic (As), Chromium (Cr), Nickel (Ni), and Lead (Pb). Respirable Dust Samplers (RDS) were used for sampling these heavy metals on EPM filter paper. These heavy metals are analyzed regularly on half yearly basis. The samples were analyzed in Environment Laboratory of CMPDI, RI-II, Dhanbad.

4.0 Results and interpretations

4.1 Heavy Metal in Ambient Air

The results of Heavy metal in Ambient Air Quality are presented in tabular form for each monitoring station. The concentration of heavy metals in ambient air is well within the permissible limit.

CHAPTER - I

INTRODUCTION

1.0 Any industry and development activities including coal mining is bound to affect environmental attributes. There are positive as well as negative impacts of such operations. For controlling the adverse impacts a regular monitoring is essential. The environmental monitoring is being done as per the guidelines stipulated by Ministry of Environment, Forest and Climate Change (MoEF&CC), Govt. of India.

The very purpose of environmental monitoring is to assess the quality of various attributes which affects the environment. As per quality of these attributes appropriate strategy is to be developed to control the pollution level within the permissible limits. The three major attributes are air, water and noise level.

Bharat Coking Coal Limited (BCCL), a subsidiary company of Coal India Limited (CIL) is operating UG Mines and Opencast Mines in Jharia Coalfield (JCF). The Jharia Coalfield (JCF) having an area of 450 Sq.KM.

Bharat Coking Coal has awarded Environmental Monitoring work of all Projects, Cluster wise, to Central Mine Planning & Design Institute Limited (CMPDIL). The environmental monitoring has been carried out as per conditions laid down by MoEF&CC while granting environmental clearance to different projects. CMPDI has trained manpower and well equipped laboratory to carry out monitoring, analysis and R&D work in the field of environment.
In compliance of these conditions the Environmental Monitoring has been carried out & report prepared for submission to MoEF&CC & JSPCB and other statutory authorities.

CHAPTER – II

AMBIENT AIR QUALITY MONITORING

2.1 Results and interpretations

The results of Heavy metal in Ambient Air Quality are presented in tabular form for each monitoring station. The concentration of heavy metals in ambient air is well within the permissible limit.

TRACE METAL CONCENTRATION IN AMBIENT AIR QUALITY

Name of the Company: **Bharat Coking Coal Limited** Year : **2025-26.**

PERIOD: **HALF YEAR ENDING JUNE, 2025**

HEAVY METAL ANALYSIS REPORT OF AMBIENT AIR QUALITY

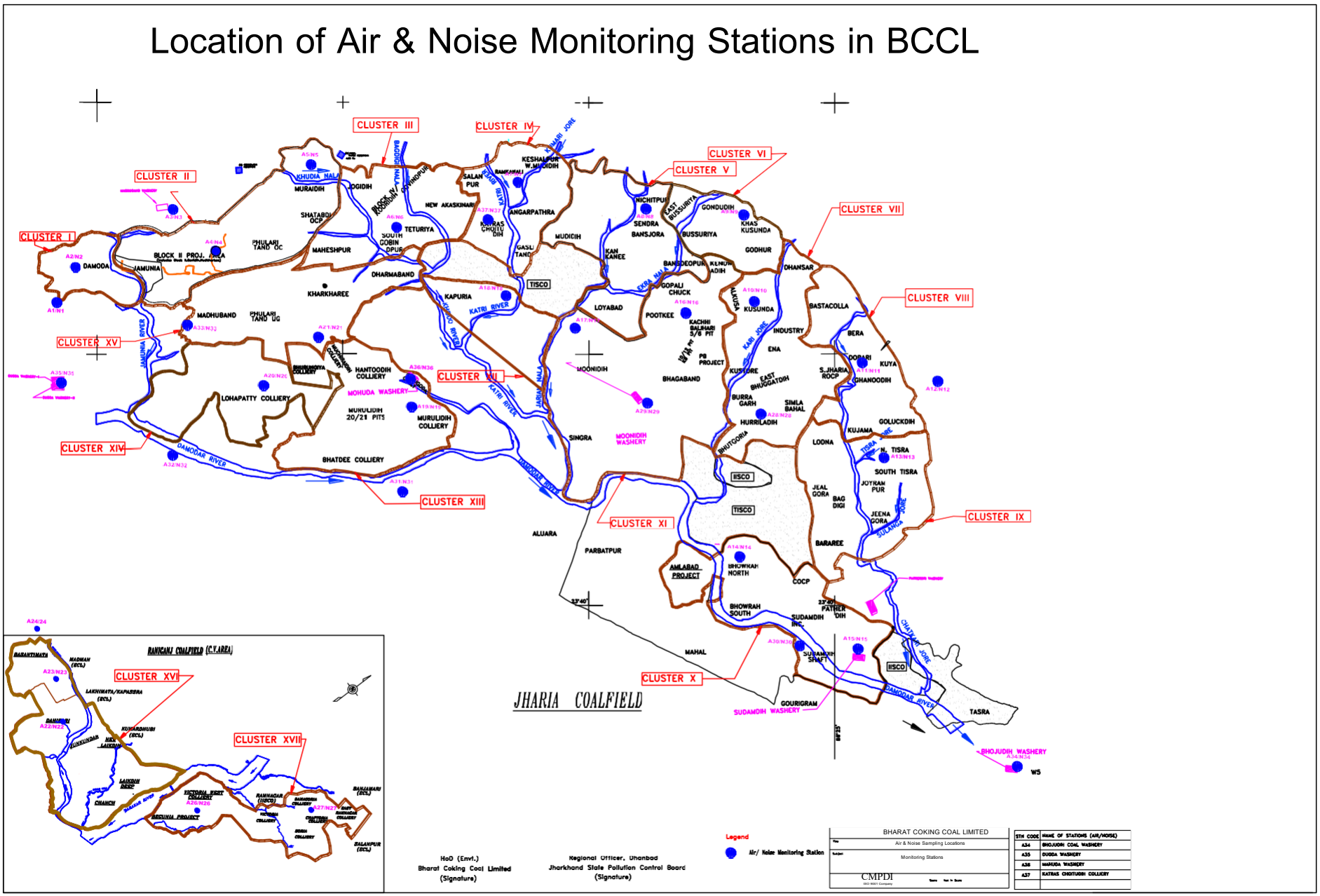
Results of 6 Heavy Metal for the month of May-2025								
SAMPLE CODE	**DATE**	**Station Name**	**Cd** CONC. IN µg/m3	**Hg** CONC. IN µg/m3	**As** CONC. IN ng/m3	**Cr** CONC. IN µg/m3	**Ni** CONC. IN ng/m3	**Pb** CONC. IN µg/m3
A1	20.05.25	Karmatand Village	BDL	BDL	BDL	BDL	2.03	0.005
A2	19.05.25	Damoda	BDL	BDL	BDL	BDL	2.14	BDL
A3	20.05.25	Madhuband Washery	BDL	BDL	BDL	BDL	BDL	BDL
A4	19.05.25	Block-II	BDL	BDL	BDL	BDL	BDL	0.006
A5	16.05.25	Muraidih	BDL	BDL	BDL	BDL	2.25	BDL
A6	29.05.25	Block-IV	BDL	BDL	BDL	BDL	BDL	BDL
A7	30.05.25	Govindpur/Ramkanali	BDL	BDL	BDL	BDL	BDL	0.032
A8	26.05.25	Nichitpur	BDL	BDL	BDL	BDL	BDL	BDL
A9	27.05.25	East Basseriya	BDL	BDL	BDL	BDL	BDL	BDL
A10	16.05.25	Dhansar/Kusunda	BDL	BDL	BDL	BDL	BDL	BDL
A11	16.05.25	Dobari	BDL	BDL	BDL	BDL	BDL	0.006
A12	30.05.25	Kusmatand Village	BDL	BDL	BDL	BDL	BDL	BDL
A13	30.05.25	Jeenagora	BDL	BDL	BDL	BDL	BDL	BDL
A14	22.05.25	Bhowrah North	BDL	BDL	BDL	BDL	BDL	BDL
A15	20.05.25	Sudamdih Washery	BDL	0.001	BDL	BDL	BDL	0.030
A16	21.05.25	Pootki	BDL	BDL	BDL	BDL	BDL	0.015
A17	21.05.25	Moonidih UGP	BDL	BDL	BDL	BDL	BDL	BDL
A18	22.05.25	Rudih Basti	BDL	BDL	BDL	BDL	BDL	0.007
A19	28.05.25	Murlidih 20/21	BDL	BDL	BDL	BDL	BDL	BDL
A20	21.05.25	Lohapatti	BDL	BDL	BDL	BDL	BDL	BDL
A21	26.05.25	Kharkharee	BDL	BDL	BDL	BDL	BDL	BDL

Results of 6 Heavy Metal for the month of May-2025								
SAMPLE CODE	**DATE**	**Station Name**	**Cd** CONC. IN µg/m3	**Hg** CONC. IN µg/m3	**As** CONC. IN ng/m3	**Cr** CONC. IN µg/m3	**Ni** CONC. IN ng/m3	**Pb** CONC. IN µg/m3
A22	29.05.25	Dahibari	BDL	BDL	BDL	BDL	BDL	0.010
A23	29.05.25	Basantimata	BDL	BDL	BDL	BDL	BDL	BDL
A24	30.05.25	Gopinathpur	BDL	BDL	BDL	BDL	BDL	BDL
A25	28.05.25	Guliardih	BDL	BDL	BDL	BDL	BDL	0.005
A26	27.05.25	Begunia	BDL	BDL	BDL	BDL	2.32	0.021
A27	26.05.25	Damagoria	BDL	BDL	BDL	BDL	BDL	0.030
A28	16.05.25	Hurriladih	BDL	BDL	BDL	BDL	BDL	0.010
A29	21.05.25	Moonidih Washery	BDL	0.005	BDL	BDL	BDL	BDL
A30	19.05.25	Sitanala	BDL	BDL	BDL	BDL	BDL	0.025
A31	30.05.25	Dumarda	BDL	BDL	BDL	BDL	BDL	BDL
A32	21.05.25	Telmacho Bridge	BDL	BDL	BDL	BDL	BDL	BDL
A33	27.05.25	Madhuband UGP	BDL	0.002	BDL	BDL	BDL	BDL
A34	19.05.25	Bhojudih Washery	BDL	0.01	BDL	BDL	BDL	0.033
A35	21.05.25	Dugda Washery	BDL	0.001	BDL	BDL	BDL	0.026
A36	22.05.25	Mahuda	BDL	0.002	BDL	BDL	BDL	BDL
A37	30.05.25	Katras Choitudih	BDL	BDL	BDL	BDL	BDL	BDL
A38	29.05.25	Sinidih Workshop	BDL	BDL	BDL	BDL	BDL	0.010
A39	20.05.25	Patherdih	BDL	BDL	BDL	BDL	BDL	BDL
A40	22.05.25	Koyla Nagar	BDL	BDL	BDL	BDL	BDL	BDL
A41	20.05.25	Sudamdih Shaft	BDL	BDL	BDL	BDL	BDL	0.020
A42	16.05.25	RHB	BDL	BDL	BDL	BDL	2.05	0.010
A43	16.05.25	Pandwabhita	BDL	BDL	BDL	BDL	BDL	BDL
A44	16.05.25	Sadariadih	BDL	BDL	BDL	BDL	BDL	0.005
A45	19.05.25	Bhojudih Buffer	BDL	BDL	BDL	BDL	BDL	BDL
A46	22.05.25	C.H. D	BDL	BDL	BDL	BDL	BDL	BDL

#BDL-Below detection limit

Metal	BDL	Standard as per NAAQS
Hg (µg/m^3)	0.001	*Standard Not defined
Cr(µg/m^3)	0.01	*Standard Not defined
As (ng/m^3)	1	6
Pb (µg/m^3)	0.005	0.5
Ni (ng/m^3)	2	20
Cd (µg/m^3)	0.001	*Standard Not defined

Location of Air & Noise Monitoring Stations in BCCL



STRICTLY RESTRICTED
FOR COMPANY USE ONLY

RESTRICTED

The information given in this report is not to be communicated either directly or indirectly to the press or to any person not holding an official position in the CIL/ Government.

GROUNDWATER LEVEL & QUALITY REPORT

FOR CLUSTERS OF MINES, BCCL

(Assessment year – 2025-26)

[CLUSTER – I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XIII, XIV, XV, XVI & XVII of Mines, BCCL]

JHARIA COALFIELD AND RANIGANJ COALFIELD (PART)

For
(BHARAT COKING COAL LIMITED)

(A Subsidiary of Coal India Limited)

KOYLA BHAWAN (DHANBAD)

Prepared by

Geology Department

Regional Institute-II

CMPDI, Dhanbad

MARCH – 2026

Job no - 200425004

PERSONS ASSOCIATED

Poulomi Baksi
Manager (Geology)
Geology Department
CMPDI RI-II, Dhanbad

Jayjit Banerjee
Dy. Manager (Geology)
Geology Department
CMPDI RI-II, Dhanbad

Kumar Vaibhav
Manager (Environment)
Regional Institute - II
CMPDI, Dhanbad

CMPDIL
CENTRAL MINE PLANING & DESIGN INSTITUTE
HYDROGEOLOGY SECTION, EXPLORATION DEPARTMENT
GONDWANA PLACE, KANKE ROAD, RANCHI, JHARKHAND– 834031

(Accredited Groundwater Professional Institutions by CGWA)

(Accredited as a GWCO by QCI-NABET)

(Accredited by NABL, CMPDI, RI-II, Lab)

CONTENT

Sl. No	Contents	Page No
1	Annexure-I Details of The Report	1
2	Annexure-II Groundwater Level and Quality Report for Cluster of Mines of BCCL	2-130
3	**Chapter-1.0 Introduction**	2-7
4	1.1 Location details and brief about the report	2
5	1.2 Objective of the study	2
6	1.3 Scope of the report	2
7	1.4 Topography and Drainage	4
8	1.5 Details regarding Wetland	4
9	1.6 Climate & Rainfall	5-7
10	**Chapter-2.0 Geology & Hydrogeological Set-up of the Area**	7-10
11	2.1 Regional Geology of the Coalfield	7
12	2.2 Hydrogeological setup	8
13	2.3 Aquifers Description	8-9
14	2.4 General Aquifer Parameters	9-10
15	**Chapter-3.0 Ground Water Level data of the Cluster of Mines of BCCL**	11-43
16	3.1 Historical groundwater level	12
17	3.2 Groundwater level scenario (mining/non-mining)	13
18	3.3 Quarterly groundwater level, Cluster of mines during 2023-24	13
	A. Ground Water Levels of Cluster-I	14-15
	B. Ground Water Levels of Cluster-II	16-17
	C. Ground Water Levels of Cluster-III	18-19
	D. Ground Water Levels of Cluster-IV	20-21
	E. Ground Water Levels of Cluster-V	22-23
	F. Ground Water Levels of Cluster-VI	24-25
	G. Ground Water Levels of Cluster-VII	26-27
	H. Ground Water Levels of Cluster-VIII	28-29
	I. Ground Water Levels of Cluster-IX	30-31
	J. Ground Water Levels of Cluster-X	32-33
	K. Ground Water Levels of Cluster-XI	34-35
	L. Ground Water Levels of Cluster-XIII	36-37
	M. Ground Water Levels of Cluster-XIV	38-39

	N. Ground Water Levels of Cluster-XV	40-41
	O. Ground Water Levels of Cluster-XVI	42-43
	P. Ground Water Levels of Cluster-XVII	
19	**Chapter-4.0 Ground water level scenario**	44
20	**Chapter-5.0 Details of Piezometers**	45-46
21	**Chapter-6.0 Groundwater Quality**	46-48
22	**Chapter-7.0 Stage of Groundwater extraction**	49-50
23	**Chapter-8.0 Impact of Mining on Ground Water Regime**	51
24	8.1 General consequences of Coal Mines on ambient Hydrogeological Regime	51
25	8.2 Potential consequences of OC & UG coal mines on Hydrogeological Regime	51
26	8.3 Estimation of Radius of Mine Influence zone	52
27	**Chapter-9.0 Conservation measures & future strategy**	52-53
28	**Chapter-10.0 Existing / Proposed Rainwater harvesting structures in BCCL coal mines**	54-59
29	**Annexure-III List of RAMSAR Wetlands as given on official website of MoEF & CC**	60
30	**Annexure-IV Rainfall Data**	61-62
31	**Annexure-V Location of Hydrograph Stations (Dug Wells)**	63-64
32	**Annexure-VA Deatils of Hydrograph Stations (Dug Wells)**	65-68
	Annexure-VB Historical Water Level data of Hydrograph Stations	69-71
33	**Annexure-VI Ground Water Level Hydrographs**	72-88
	Annexure-VIA Piezometer Hydrographs	89-94
33	**Annexure-VII Ground Water Quality analysis data**	95-130
34	Abbreviations	131

LIST OF TABLES

Fig No	Contents	Page No
1	Regional Geological Succession of JCF	8
2	Generalized Hydrogeological Units developed in the study Area	9
3	Aquifer parameters considered for the study Area	10
4	Historical Groundwater Level	12
5	Depth to water table	13

6	Average hydraulic gradient	13
7	GW level data Cluster wise	44
8	GW level data in Piezometers	45-46
9A, B	Block / Cluster wise GW Development scenario	49-50

LIST OF PLATES

Sl No	Plate No	Contents	Scale
1	I	Location Map of Groundwater Level Monitoring stations	1:205000
2	II	Location Map of Groundwater Quality Monitoring stations	1:205000
3	III	Location Map of Proposed Piezometers	1:205000
4	IVA	Water table Contour Map of JCF, Pre Monsoon (May'23)	1:205000
	IVB	Water table Contour Map of JCF, Post Monsoon (Nov'23)	1:205000
5	VA	Depth to Groundwater Level map of JCF, Pre Monsoon (May'23)	1:205000
	VB	Depth to Groundwater Level map of JCF, Post Monsoon (Nov'23)	1:205000
6	VI	Drainage Map (Part of Raniganj Coalfield under BCCL Command Area)	1:180,000

LIST OF FIGURES

Table No	Contents	Page No
1 & 2	Historical Rainfall trend at Jharkhand	6-7
3 to 15	Existing / Proposed Rainwater Harvesting Structure	54-59

Annexure – I

DETAILS OF THE REPORT

Sl No.	ITEMS	INFORMATIONS
1	Geographical Area	Jharia Coalfield (JCF): 453.0 sq. km. Raniganj Coalfield (BCCL area): 19.64 sq. km.
2	Major Physiographic Units	Dissected Pediplain with surface Reduced Level (RL) varies from 160 m to 220 m above mean sea level (AMSL) in JCF and 100 m to 140 m AMSL in RCF part
3	Drainage System	Damodar River is the master drainage flowing along western boundary of the JCF. Jamunia River, Khudia River, Katri River, Jarian Nala, Ekra Jore, Kari Jore, Kashi Jore, Chatkari Jore and their tributaries are flowing through the JCF area. Damodar River, Barakar River is the master drainage of the part of RCF area (CV Area).
4	Annual Rainfall (IMD-report)	Jharkhand State: 1185.40 mm (year 2024) Rainfall data given in **Annexure-IV**.
5	Geological Formations	Gondwana Formation (Talchir Formation, Barakar Formation, Barren Measure Formation & Raniganj Formation)
6	Aquifer System	Unconfined/Phreatic Aquifer – thickness 25 m (Avg.) Semi-confined to confined Aquifer – thickness from 50 m upto 650 m
7	Hydrogeological properties (Aquifer Pump Test)	Unconfined Aquifer: Hydraulic Conductivity – 0.50 - 0.90 m/day Transmissivity – 10 - 42 m^2/day
		Semi-confined to confined Aquifer: Hydraulic Conductivity – 0.0006-1.44 (0.05 avg.) m/day Transmissivity – 0.06 – 15.0 m^2/day
8	Groundwater Level Monitoring Network	Out of total 139 nos. of monitoring stations 73 nos. located within core mining area and rest comes within Buffers zone. 55 Nos. of Groundwater monitoring well (Dug Wells) network established by CMPDI to record groundwater level data in and around the Core Zone of JCF and 18 Nos. of Groundwater monitoring well (Dug Wells) in RCF (CV Area).
9	Groundwater Levels Below Ground Level (bgl)	JCF area: Pre-monsoon – 1.30 to 10.74 m (Avg. 6.07 m bgl) in '2025-26 Post-monsoon – 0.75 to 9.30 m (Avg. 3.56 m bgl) in '2025-26 RCF area (part): Pre-monsoon – 1.60 to 9.30 m (Avg. 4.55 m bgl) in '2025-26 Post-monsoon – 0.95 to 4.25 m (Avg. 2.10 m bgl) in '2025-26
10	Groundwater Quality	Potable as per BIS (**Annexure- VIII**)
11	Piezometers	Piezometers (23 nos.) to monitor impact of coal mining on groundwater regime within the coalfield area (JCF & part of RCF)
12	Stage of Groundwater Development (CGWB)	Dhanbad District-Safe to Over-exploited category (GWRE:2023-24)

GROUNDWATER LEVEL & QUALITY REPORT FOR CLUSTER OF MINES OF BCCL

1.0 INTRODUCTION

1.1 LOCATION DETAILS AND BRIEF ABOUT THE PROJECT

The 16 nos. Cluster of mines (Cluster-I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XIII, XIV, XV XVI and XVII) of BCCL is located in the Jharia coalfield in Bokaro and Dhanbad districts of Jharkhand and part of Raniganj coalfield in Dhanbad district of Jharkhand.

The area of Jharia Coalfield (JCF) is 453 sq. km. and Raniganj Coalfield (RCF part) is 19.64 sq. km. (CV area). Located about 3.0 km south-west of Dhanbad town and 10.0 km north-east of Bokaro town. The coalfield bounded by Jamunia River in the west, Damodar river in the south, and Metamorphics (hard rock) in the north and east side. **(Plate-I)**.

1.2 OBJECTIVE OF THE STUDY:

The objective of the report is to conduct hydrogeological study by quarterly monitoring of groundwater level and quality of the Jharia coalfield and Raniganj coalfield (part) within BCCL command area for 16 Cluster of mines. The data collected shall be submitted to the MoEF&CC, CPCB & SPCB within stipulated timeframe. The work is being done yearly and required to be continued as per the specific condition mentioned invariably in Environmental Condition (EC) for all of the Clusters of BCCL.

1.3 SCOPE OF THE STUDY:

The following scope has been taken into account for hydro-geological investigation of the study area.

i) To monitor the groundwater levels four times/year during (May, August, Nov and Jan).
ii) To monitor the groundwater quality during April including Arsenic and Fluoride.
iii) To evaluate the status of ground water level condition in the area.
iv) To study the ground water flow direction in the mining areas.
v) To study the depth to ground water level condition in the mining areas.
vi) To study the ground water quality data and interpretation in the mining areas.

File No. 08HBDD/JRRI/BCCL/ENV/0003/2018-BD Divn.-CMPDI (Computer No. 68378)
Receipt No : 188686/2018/O/e HEAD OF BUSINESS DEVELOPMENT, CMPDI HQ

भारत कोकिंग कोल लिमिटेड
एक मिनी रत्न कंपनी
(कोल इंडिया लिमिटेड का एक अंग)
कोयलाभवन, कोयलानगर,धनबाद –826005

Bharat Coking Coal Limited
A Mini Ratna Company
(A Subsidiary of Coal India Limited)
Regd.Off: Koyla Bhawan, Koyla Nagar

CIN: U10101JH1972GOI000918
Environment Department

पत्र संख्या भाकोकोलि/उप महाप्रबंधक(पर्या0)/संचिका-/18/1086-1088/H) दिनांक : 14.06.2018

सेवा में,
महाप्रबंधक
व्यापार विकास
सीएमपीडीआई - कांके रोड रांची ८३४०३१-

Sub: For work of Ground water level and quality monitoring

महोदय,

This is with reference to earlier letter ref no. BCCL/HOD(Env)/F-Env/13/161 dated 11.02.2014 regarding conducting hydrological study by quarterly monitoring of groundwater level and quality of the study to be carried out by establishing a network of existing wells. The monitoring for quantity shall be done four times a year in pre-monsoon (May), monsoon (August), post-monsoon (November) and winter (January) season and for quality including Arsenic and Fluoride during month of May. Data thus collected shall be submitted to the Ministry of Environment & Forest and to Central Pollution Control Board/SPCB quarterly within one month of monitoring.

The above work is being done yearly and required to be continued as per the specific condition mentioned invariably in Environment Clearance order of all clusters of BCCL.

This is for your kind information and further necessary action

भवदीय

14/6/18

उप-महाप्रबंधक (पर्यावरण)

Copy To:
१ महाप्रबंधक (गवेषण), कांके रोड रांची ८३४०३१-

1.4 TOPOGRAPHY AND DRAINAGE

Northern part of the JCF area is covered with hills and thin forest. In general, the altitude of the study area varies from 220 m above mean sea level (AMSL) in Barora area (Cluster-I) to 160 m AMSL in Sudamdih area (Cluster-X). Pediplains have developed over sedimentary rocks or Gondwana formation consisting of Sandstone, Shale, coal, etc. Dissected pediplains developed over Gondwana formations found in Jharia, Baghmara, Katras areas etc. However, in RCF (part) area, the altitude varies from 100 m to 140 m AMSL (Cluster-XVI). The general slope of the topography is towards south, i.e. Damodar River.

The drainage pattern of the area is dendritic in nature. The drainage system of the area is the part of Damodar sub-basin. All the rivers that originate or flow through the coalfield area have an easterly or southeasterly course and ultimately joins Damodar River - the master drainage. The drainage of the JCF is mainly controlled by Jamuniya River (5th order), Khudia nala (3rd order), Katri River (4th) and Chatkari nala (3rd order) flowing from north to south and joins Damodar River. Whereas, Barakar River and Khudia River are controlling the drainage pattern of RCF (part) and joins Damodar River in the south. Damodar River is the main drainage channel and flows from west to east along the southern boundary of JCF and RCF.

The drainage map of the JCF and part of RCF has been prepared on topographic map of scale 1:50,000 (***Plate-I***). The watershed of all tributary rivers (Jamuniya River to Barakar River) falls within the north-western part of Damodar sub-basin which comes under Lower Ganga Basin.

Besides, a large number of ponds/tanks distributed in and around JCF, out of which one prominent lake is located at Topchanchi in the north-western part. Two reservoirs, Maithon dam on Barakar River and Panchet dam on Damodar River near to Chanch Victoria Area of BCCL (part of RCF), are the main source of water supply to the nearby area. Jharia Water Board, Damodar Water Supply Scheme and Mineral Area Development Authority (MADA) are supplying water.

1.5 DETAILS REGARDING WETLANDS

A **wetland** is a distinct ecosystem that gets flooded by water, either permanently or seasonally. The primary factor that distinguishes **wetlands** from other landforms or water bodies is its characteristic vegetation (aquatic plants). Wetland are protective ecosystem as per new guidelines of CGWA & MoEF&CC. There are no Wetlands in and around the area (Jharia coalfield and Raniganj coalfield) as per the list available on official website of MoEF&CC, Govt. of India. The list enclosed as **Annexure-III.**

1.6 CLIMATE & RAINFALL

The Jharia Coalfield (JCF) and part of Raniganj Coalfield (RCF) area in Dhanbad District belongs to sub-humid tropical climatic region. The maximum temperature during summer shoots up to 45^{o} C and falls between 10^{o} C to 5^{o} C in winter. The maximum rainfall occurs during the period between June and September. Rainfall data of IMD Dhanbad and Mine Rescue Station Dhanbad given in ***Annexure-IV***.

In Jharkhand state, Daily Rainfall data from 1989 to 2018 considered for analysis of trend variability and mean rainfall patterns. From the daily rainfall data, monthly rainfall series of each station is computed and then monthly district rainfall series is constructed by considering arithmetic average of all the station rainfall values within the district. The monthly rainfall series of the state is computed by using area weighted rainfall values of all the districts within the state. The objective of the analysis is to:

1. Identify the spatial pattern of the mean rainfall
2. Understand district wise observed rainfall trend and variability in annual and SW monsoon season (June, July, August and September).

Daily station rainfall data is utilized for identification of the mean spatial patterns and rainfall intensity trends. From mean and standard deviation (SD), the coefficient of variation (CV) is calculated using following equation:

Coefficient of variation (CV) = [Standard Deviation / Mean] × 100

The analysis has been done in two parts. For identification of the spatial pattern mean rainfall and variability and observed trends, we have used district rainfall series and results have been brought out for four southwest monsoon months viz. June, July, August, September, for the southwest monsoon season and also for annual.

Table shows the mean rainfall (mm) and coefficient of variation of the state for the monsoon months, southwest monsoon season and annual during the period 1989-2018. It can be seen that the state gets highest rainfall (31%) of southwest monsoon rainfall in July month while the August month get 28% of the southwest monsoon rainfall. June and September receive 19% and 22% of southwest monsoon rainfall. Also, more than 84% of annual rainfall received during the southwest monsoon season only. The variability of monsoon or annual rainfall is also very less.

Jharkhand State

	June	July	August	September	Sub-total	Annual
Mean	190.3	313.9	289.2	225.7	1019.1	1211.4
CV	44.4	29.0	24.8	37.0	18.7	16.9

Dhanbad District

	June	July	August	September	Sub-total	Annual
Mean	203.9	327.7	302.5	271.5	1105.6	1332.2
CV	41.0	35.0	33.5	48.7	20.8	19.4

Fig. 1 and 2 show the time series of rainfall in mm for the months of June, July, August and September along with southwest monsoon season and annual rainfall. The trend lines are displayed for each of the series. Neither monthly rainfall nor seasonal rainfall shows any significant increasing/decreasing trend while annual rainfall shows significant decreasing trend. The monthly rainfall during June, July, August and September as well as seasonal rainfall show decreasing trend. During the last 30 years, highest rainfall of 390.3 mm was received in June in the year 1994, 492.1 mm was received in July in the year 2017, 431.5 mm was received in August in the year 1997, while highest rainfall of 395.2 in September was received in the year 1995. Highest annual rainfall of 1587.9 mm was received in the year 1999 and highest southwest monsoon rainfall of 1364.6 mm was received in the year 1994 (Climate Research and Services, IMD, Ministry of Earth Sciences, Pune, Jan'2020).

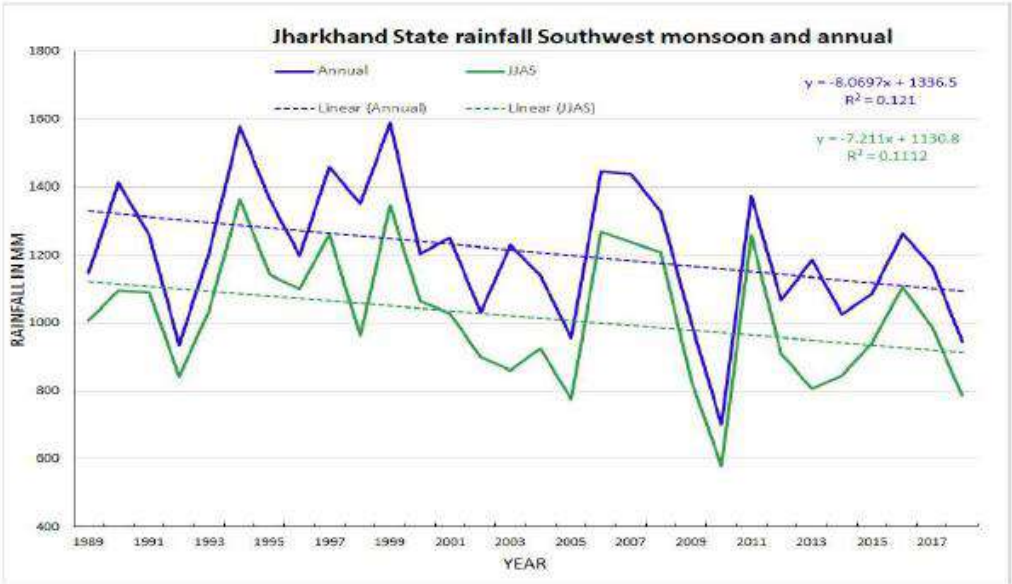


Fig-1.

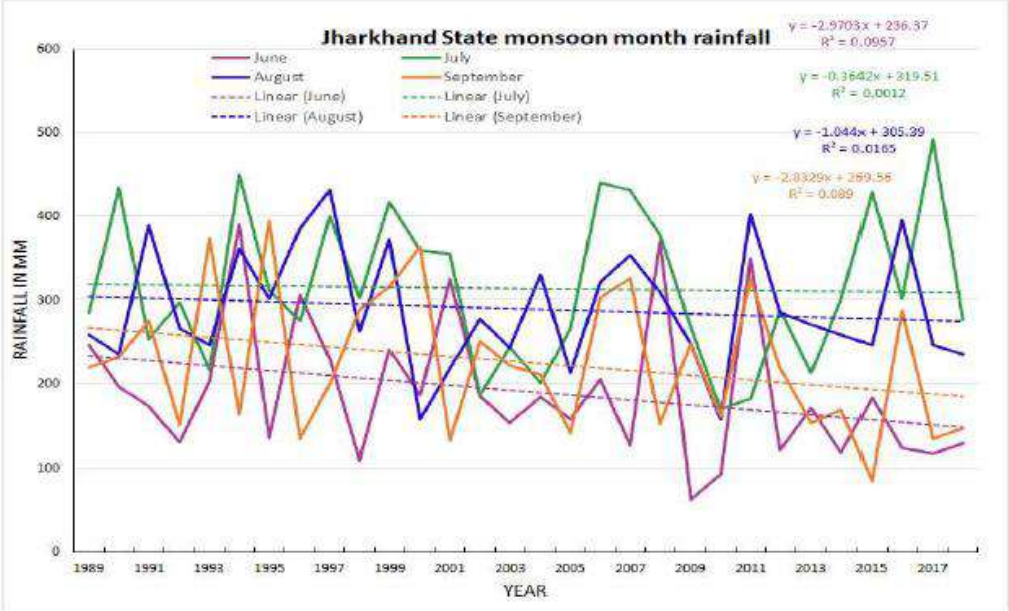


Fig-2.

2.0 GEOLOGY AND HYDROGEOLOGICAL SETUP OF THE AREA

2.1 REGIONAL GEOLOGY

The Jharia Coalfield covering an area of 453 sq. km. is located in Dhanbad District, Jharkhand. The non-coal bearing Talchir Formation is exposed in patches along the northern fringe of the Coalfield. The Barakar Formation (Coal Bearing horizon) overlies the Talchir and covers the most part of the Jharia Coalfield and have an area of 218 sq. km. This is successively overlain by the non-coal bearing Barren Measures Formation which is mainly exposed in the central part of the Coalfield. This, in turn, is overlain by the Raniganj Formation (Coal Bearing horizon) in the south-west part of the Coalfield and covers an area of 54 sq. km.

Chanch-Victoria Area is located in the western part of Raniganj Coalfield. The Raniganj coalfield represents the eastern most coal basin in the Damodar Valley Region, located at the border of Dhanbad District of Jharkhand and Bardhaman District of West Bengal. The Coalfield is almost elliptical in shape and covers an area of about 1530 sq. km. Out of this, only 35 sq. km. comes under leasehold area of BCCL within which 19.64 sq. km is the study area (Cluster-XVI only). The coal bearing formations of the area belongs to Barakar Formation of the Lower Gondwana in **Table-1**.

Table – 1: Regional Geological Succession of Jharia Coalfield

Geological Formations		Age
Quaternary/Recent	Soil cover/Weathered mantle	Recent
Post-Gondwana	Dolerite	Upper Cretaceous
	Lamprophyres	Jurassic
Damoda Group	Raniganj Formation	Upper Permian
	Barren Measures Formation	Middle Permian
	Barakar Formation	Lower Permian
	Karharbari	
	Talchir Formaton	Upper Carboniferous
----------Unconformity----------		
Metamorphics		Proterozoic

2.2 HYDROGEOLOGICAL SET- UP

The permeable formations, are mainly composed of sandstone, which behave as aquifer units. The coal seam and shales developed in the area act as impermeable beds i.e. aquiclude. The aquifer materials of Gondwana Formation constitute of fine to coarse grain sandstone having primary porosity of inter-granular void space. The secondary porosity formed due to presence of faults, fracture, joints, etc. Sandstones of Gondwana formation in JCF and RCF are very hard, compact and cemented and form less potential aquifer, particularly in deeper aquifer system. The secondary porosity along with primary porosity forms a conduit system making these formations good aquifers for movement and storage of ground water.

2.3 AQUIFERS DESCRIPTION

The aquifer system for shallow and deeper aquifer has been established through hydrogeological studies, exploration, surface and subsurface geophysical studies in the JCF and RCF (part) covering all geological formations. The aquifer can be divided into two zones – Un-confined/Phreatic (shallow) and Semi-confined to confined (deeper) aquifer.

PHREATIC/UN-CONFINED AQUIFER

The top aquifer occurred above the top most coal seam/shale bed is called un-confined or water table aquifer and it consists of relatively permeable formation such as weathered sandstone and loose soil. The thickness of the un-confined aquifer is varying from few meters to 50 m. This un-confined aquifer is more potential than semi-confined to confined aquifer.

SEMI-CONFINED TO CONFINED AQUIFER

The semi-confined to confined aquifer consisting of sandstone bed is sandwiched between coal seams/shale beds and thus, multiple aquifer system developed due to presence of multiple number of coal seams/shale beds. With the presence of intercalated shale and carbonaceous shale beds and reduction in permeability with depth, the lower aquifers are poor in potentiality.

Table –2: Generalized Hydrogeological Units developed in the study Area

Sl. No.	Type of Aquifer	Depth range (m)	Core zone (within 2 km)	Buffer zone (within 10 km)
1.	Unconfined	0 – 50 (Avg. 25)	Alluvium, weathered sandstone	Alluvium, weathered sandstone
2.	Semiconfined/ confined	50 to 650 m	Multiple Sandstone horizons in Barakar formation	Multiple Barakar sandstone, Barren Measure, Raniganj sandstone, Talchir shale and Metamorphics

2.4 GENERAL AQUIFER PARAMETERS

PHREATIC/UN-CONFINED AQUIFER

The wells tested by CMPDI for determination of aquifer parameters in Damuda (BJ Section) and Block-III area of JCF. The hydraulic conductivity of the un-confined aquifer is 0.50 to 0.90 m/day as computed from pumping tests on the wells. The transmissivity of the unconfined aquifer ranges from 10.68 m^2 /day to 41.48 m^2 /day.

SEMI-CONFINED TO CONFINED AQUIFER

The sandstone partings in-between impervious layers of shale and coal seams is designated as semi-confined / confined aquifers. The sandstones in these aquifers are fine to coarse grained, hard and compact with very low porosity. Mostly groundwater occurs in the weak zones formed due to weathering, fracture, faults, which create the secondary porosity. The hydrogeological parameter has determined by CMPDI in Sitanala Block by conducting aquifer performance test (APT) and also various piezometers within Cluster of mines BCCL during 2022-23. The hydraulic conductivity (K) of semi-confined aquifer in Barakar Formation ranges from 0.0006 m/day to 1.44 m/day. The hydrogeological parameter has also been determined at Kumari OCP Block in the central JCF by conducting aquifer performance test. The hydraulic conductivity (K) of semi-confined aquifer in Barakar Formation in this area ranges from 0.0027 m/day to 0.05 m/day.

Table – 3: Aquifer parameters determined from piezometers constructed in BCCL

Sl no.	Piezometer No.	Aquifer / Formation	Depth of the well (Meters)	Aquifer thickness (Meters)	Static Water Level (Meters)	Discharge (LPS)	Test duration (Minutes)	**K** (m/day)	**T** (m^2/day)
1	PZ-1A	Phreatic Aquifer	40	15	12.15	4.70	275	9.71×10^{-1}	14.6
2	PZ-1B	Barakar Formation (JCF)	115	30	27	2.85	275	6.33×10^{-2}	1.9
3	PZ-2A		87	15	28.1	1.5	960	5.88×10^{-2}	0.88
4	PZ-3A		172	42	17.55	3.0	157	4.04×10^{-2}	1.70
5	PZ-4A		70	18	15.55	1.65	167	5.00×10^{-2}	0.89
6	PZ-8A		140	24	68.72	1.05	275	6.53×10^{-2}	1.57
7	PZ-9B		100	30	34.68	2.45	390	6.68×10^{-2}	2.00
8	PZ-10A		135	30	5	4.7	865	1.52×10^{-1}	4.55
9	PZ-11A	Barren Measure Formation (JCF)	300	66	60.60	3.05	300	3.9×10^{-2}	2.57
10	PZ-13A	Ranigunj Formation (JCF)	80	24	30.9	1.75	400	6.37×10^{-2}	1.53
11	PZ-14B		162	24	12.15	2.75	475	7.48×10^{-2}	1.80
12	PZ-16A	Barakar Formation (part of RCF)	90	18	31.5	2.0	385	5.59×10^{-2}	1.01

3.0 GROUND WATER LEVEL MONITORING

To collect the representative groundwater levels in the study area, CMPDI has established a monitoring network of total 139 monitoring stations out of which 73 located within core zone and rest falls in Buffer zone. Total 105 nos. dug well within JCF and 34 nos. dug well within RCF (part) area (Details of the Hydrograph stations & water level given in **Annexure-V, VA** & **VB**) spread over the entire BCCL leasehold area, **Plate-I**. Water level data collection in all monitoring stations has been done on quarterly basis (May'25, Aug'25, Nov'25 and Jan'26).

Depth to water level of the water table depict the inequalities in the position of water table with respect to ground surface and is useful in delineating recharge / discharge areas, planning of artificial recharge structure and shows the overall status of the groundwater level in the area. Historical groundwater level (GWL) of entire JCF and part of RCF with fluctuation, GWL of Non-mining / Mining areas and GWL of the Cluster of Mines of BCCL are shown in this report to assess the effect of Coal mining activity on the groundwater regime in and around the Coalfield area.

Mining is a dynamic phenomenon. The mining activity creates dis-equilibrium in environmental scenario of the area and disturbs the groundwater conditions/regime in particular. The impact on shallow water regime due to mining activity can be broadly viewed as under:

- Historical GWL with annual fluctuation over the years
- GWL scenario in Non-mining and Mining area (OC/UG mines)
- GWL scenario of Cluster of mines of BCCL

3.1 HISTORICAL GROUNDWATER LEVEL (GWL)

Historical GWL of JCF and part of RCF of CMPDI monitoring stations given from 2005 to 2024 (total 64 stations within Coalfield area). Pre-monsoon and Post-monsoon GWL with Fluctuation has been mentioned below in the table.

Table – 4: Historical Groundwater Level

Period		(Water level in metre below ground level)								
		Pre-Monsoon (April/May)			Post-Monsoon (Nov/Dec)			Fluctuation		
		From	To	Average	From	To	Average	From	To	Average
JCF	2005	0.07	19.08	6.29	0.84	12.13	3.20	0.12	12.45	3.21
	2007	0.40	19.27	5.66	0.35	8.21	2.87	0.02	16.15	2.96
	2008	0.45	18.35	5.42	0.35	14.20	3.62	0.03	9.22	2.45
	2010	0.85	14.47	5.24	0.10	15.88	4.48	0.02	5.55	1.54
	2012	1.27	18.68	5.58	0.15	7.80	2.72	0.08	13.45	2.96
	2013	0.70	19.20	5.65	0.45	8.35	2.77	0.29	15.88	3.17
	2014	0.70	16.28	4.92	0.75	14.98	3.27	0.25	10.15	2.17
	2015	1.38	17.20	6.00	0.45	14.58	3.92	0.28	7.62	2.15
	2016	0.78	16.73	5.64	0.30	12.43	3.19	0.23	6.35	2.88
	2017	0.67	16.28	5.61	0.15	6.97	2.41	0.10	12.10	3.25
	2018	1.20	14.58	5.55	0.40	7.17	2.83	0.20	9.45	2.68
	2019	0.95	15.88	5.46	0.45	5.95	2.34	0.20	13.40	3.05
	2020	0.80	16.25	4.95	0.75	10.10	3.26	0.25	11.05	2.15
	2021	0.62	11.26	5.23	0.05	7.62	2.28	0.15	9.03	2.94
	2022	0.42	11.90	5.12	0.29	11.12	3.32	0.03	7.2	1.80
	2023	1.70	11.38	6.33	0.60	8.03	3.77	0.10	6.55	2.56
	2024	1.95	12.50	6.73	0.65	8.22	3.80	1.30	4.28	2.93
	2025	1.30	10.74	6.07	0.75	9.30	3.56	0.29	5.99	2.51
RCF (part)	2008	5.02	10.50	7.59	2.85	4.90	3.71	1.82	6.60	3.87
	2010	2.20	8.85	4.74	2.78	9.58	4.63	0.68	1.10	0.89
	2011	3.57	8.02	4.98	2.50	6.21	3.75	0.55	1.90	1.23
	2012	3.10	7.34	4.59	1.55	7.00	3.66	0.05	2.78	0.94
	2013	1.70	9.87	6.54	2.90	8.85	4.71	1.02	5.54	2.84
	2014	3.27	6.48	4.57	2.13	3.03	2.63	0.54	3.45	1.94
	2015	3.38	9.52	5.33	2.68	8.20	5.11	1.06	1.32	1.81
	2016	3.61	10.65	6.24	0.90	6.50	3.18	1.63	4.40	3.06
	2017	1.93	5.80	3.25	1.63	3.78	2.47	1.63	3.78	0.78
	2018	2.34	8.70	4.35	1.75	5.70	2.75	0.41	2.55	1.59
	2019	1.60	9.35	5.29	0.80	3.88	2.10	0.80	5.47	3.20
	2020	2.30	9.70	4.30	1.75	5.50	2.70	0.40	2.75	1.60
	2021	2.00	6.20	3.34	1.10	5.25	2.44	0.80	0.95	0.90
	2022	1.73	2.68	2.20	1.63	2.2	1.91	0.10	0.48	0.29
	2023	2.10	9.50	5.22	1.50	5.18	3.06	0.60	4.32	2.16
	2024	2.14	10.26	5.17	1.14	7.34	3.10	1.00	2.92	2.07
	2025	1.60	9.30	4.55	0.95	4.25	2.10	0.25	5.85	2.45

3.2 DEPTH TO WATER LEVEL & HYDRAULIC GRADIENT

Depth to water level (DTW) range in different formations with respect to mining and non-mining areas is summarized in the Table-5.

Table – 5: Avg. Depth to water table

Formation	*Area*	*DTW (bgl, m) [Year-2025-26]*	
		Pre-monsoon (May'25)	*Post-monsoon (Nov'25)*
Sedimentary (Gondwana Formation / Core Zone)	Non-mining	2.25-10.74	0.75-9.30
	Mining	2.20-9.46	0.95-6.34
Metamorphics (Hard rock)	Peripheral part of the Coalfield	5.10-9.40	1.50-7.85

The study revealed that water table is in shallow depth and there is no significant stress in the water table due to coal mining activity. Mining and non-mining areas shows barely any difference in water table condition in JCF and RCF (part) area. The average hydraulic gradient of the water table within mining and non-mining areas is given in Table-6. No significant change in hydraulic gradient is observed. Relatively steep gradient near active opencast mining areas w.r.t., non-mining, underground mines and Metamorphics areas is observed.

Table – 6: Average hydraulic gradient

Sl. No	*Formation*	*Area*	*Average hydraulic gradient*
1	Sedimentary (Gondwana Formation / Core Zone)	Non-Mining	1.0×10^{-3} to 2×10^{-3}
		Mining	1.0×10^{-2} to 1.5×10^{-3}
2	Metamorphics (Buffer Zone)	Peripheral part of the Coalfield	1.0×10^{-3} to 3.5×10^{-3}

3.3 GROUND WATER LEVEL DATA OF THE CLUSTER OF MINES OF BCCL

A GROUND WATER LEVEL OF CLUSTER-I

Cluster-I (Damuda Group of Mines consisting of Damuda UG, Albion OCP, Proposed BJ Section OCP and Abandoned Gutway OCP) of Barora area, BCCL is located in the western most part of Jharia coalfield in Bokaro district of Jharkhand. The life of the project has been worked out to be up to 15 years considering annual target production of 1.17 MTPA. It is located in the extreme western part of JCF in Bokaro district of Jharkhand (Toposheet no – 73 I/1).

The present leasehold area of Cluster-I is 575.0 Ha. The Damuda block area marked by more or less flat and gently undulating topography. The RL varies from 179 m to 208 m AMSL and the general slope of topography is towards east. Jamuniya River, Kari Jore, Podo Jore and its tributaries are controlling the drainage system of the area. The area comes under the watershed of Jamuniya River.

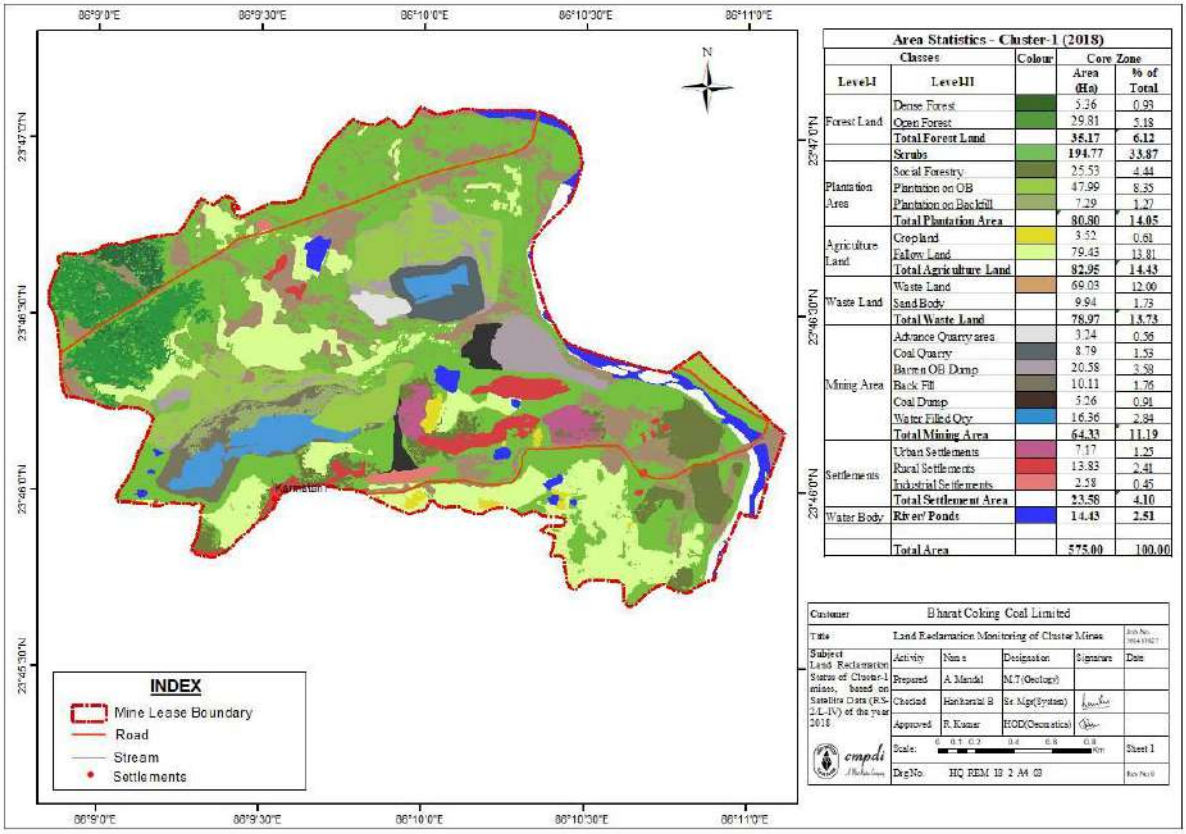
Monitoring stations (**B015, B051 and B053**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has done in the months of May'25, August'25, and Nov'25 and January'26. The Ground water level data is presented in the table below:

Sl	Well	Location	Water level (bgl in meters)											
No.	No.		2025-26				2024-25				2023-24			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	B015	Bera Basti	3.45	0.50	0.74	1.36	3.35	0.70	0.91	1.54	3.20	0.80	1.00	2.72
2	B051	Taranga	6.54	2.45	4.28	4.68	6.40	2.66	4.47	5.05	5.20	2.51	4.45	4.95
3	B053	Karmatanr	3.65	1.34	1.34	1.26	3.10	1.02	1.21	1.45	2.62	1.33	1.13	1.66
Average WL (bgl)			4.55	1.43	2.12	2.43	3.67	1.55	4.28	1.46	2.20	2.68	3.67	1.55

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 2.62 m Max –6.54 m
Post-monsoon GW Level (m): Min – 0.74 m Max – 4.45 m

LAND USE / LAND COVER MAP OF THE CLUSTER-I MINES, BCCL



Sl no	Land Use Details	Existing (sq. meter)	Proposed (sq. meter)	Grand Total (sq. meter)
1	Green Belt Area	393.69 x 10^4	0.0	393.69 x 10^4
2	Open Land	204.89 x 10^4	0.0	204.89 x 10^4
3	Road/ Paved Area	09.0 x 10^4	0.0	09.0 x 10^4
4	Rooftop area of building/ sheds	14.58 x 10^4	0.0	14.58 x 10^4
5	Total	575.00 x 10^4	0.0	575.00 x 10^4

B. GROUND WATER LEVEL OF CLUSTER-II

Cluster-II consists of seven mines namely; Block II Mixed mines (OCP & UGP), Jamunia OCP, Shatabdi OCP, Muraidih Mixed mines (OCP & UGP), and Phularitand OCP of BCCL is located in the western most part of Jharia coalfield in Bokaro district and Dhanbad district of Jharkhand. The life of the project has been worked out to be up to 30 years considering annual target production of 20.215 MTPA. It is located in the extreme western part of Jharia Coalfield in Dhanbad district of Jharkhand (Toposheet no- 73 I/1 and I/5).

The present leasehold area of Cluster-II is 2260.54 Ha. The Damuda block area marked by more or less flat and gently undulating topography. The RL varies from 176 m to 235 m AMSL. Jamuniya River, Khudia River and its tributaries are controlling the drainage system of the area. The area comes under the watershed of Jamuniya River and Khudia River.

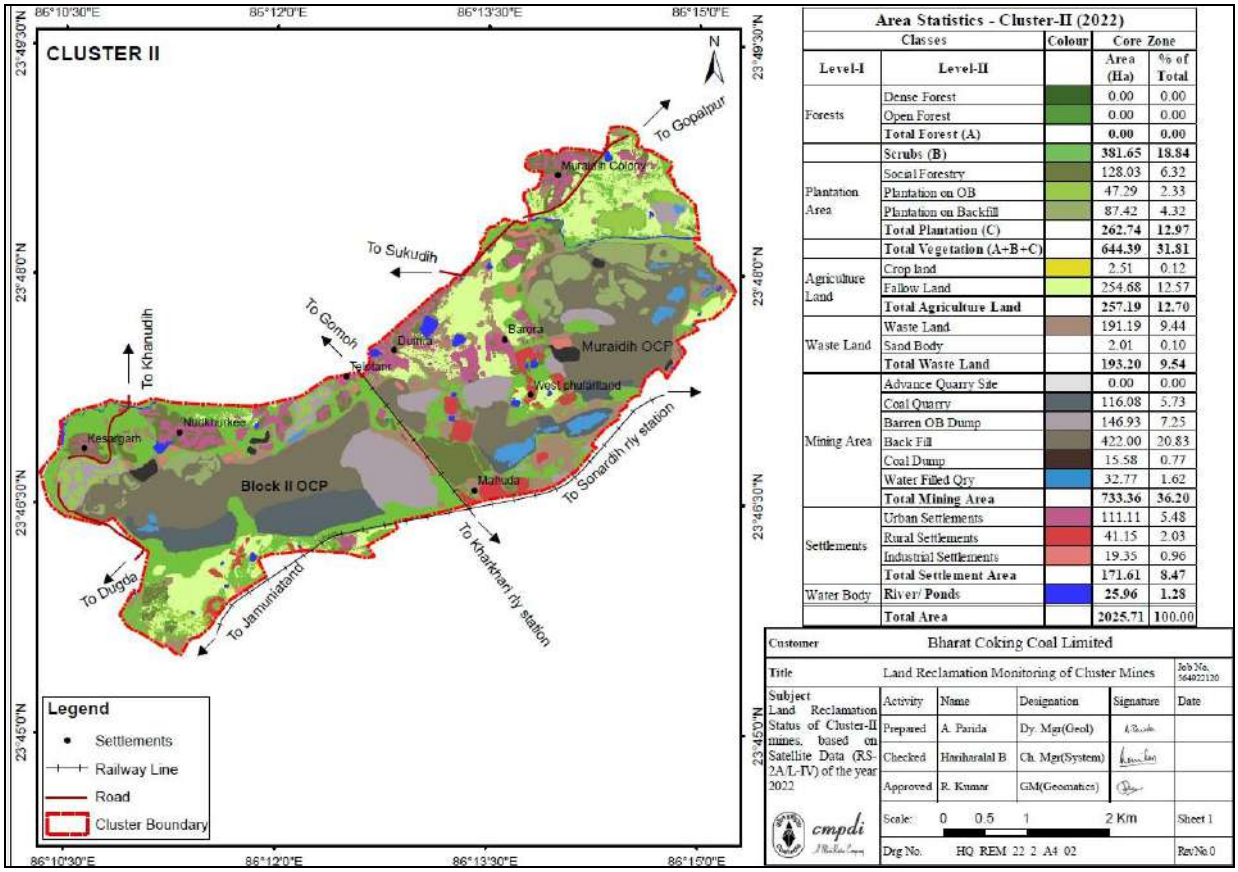
Monitoring stations (**B001, B059, B060 and B062**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has done in the months of May'25, August'25, and Nov'25 and January'26. The Ground water level data is presented in the table below:

Sl	Well	Location	Water level (bgl in meters)											
No.	No.		2025-26				2024-25				2023-24			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	B001	Muraidih	4.12	1.82	2.58	2.83	3.22	1.25	2.45	2.7	2.1	1.65	1.81	2.73
2	B059	Khodovaly	2.98	0.50	0.65	1.12	1.88	0.5	0.7	1.12	4.5	0.44	1.14	1.04
3	B060	Bahiyardih	9.10	2.70	5.77	9.04	10.73	5.31	5.73	9.51	10.53	1.08	5.8	9.38
4	B062	Sadiyardih	4.97	3.01	3.19	3.80	4.8	2.35	3.1	4	6.45	1.77	4.91	5.15
Average WL (bgl)			5.29	2.01	3.05	4.20	5.16	2.35	3	4.33	5.9	1.24	3.42	4.58

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 1.88m Max – 10.73 m
Post-monsoon GW Level (m): Min – 0.65 m Max – 5.80 m

LAND USE / LAND COVER MAP OF THE CLUSTER-II MINES, BCCL



Area Statistics - Cluster-II (2022)				
Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forests	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
	Scrubs (B)		**381.65**	**18.84**
Plantation Area	Social Forestry		128.03	6.32
	Plantation on OB		47.29	2.33
	Plantation on Backfill		87.42	4.32
	Total Plantation (C)		**262.74**	**12.97**
	Total Vegetation (A+B+C)		**644.39**	**31.81**
Agriculture Land	Crop land		2.51	0.12
	Fallow Land		254.68	12.57
	Total Agriculture Land		**257.19**	**12.70**
Waste Land	Waste Land		191.19	9.44
	Sand Body		2.01	0.10
	Total Waste Land		**193.20**	**9.54**
Mining Area	Advance Quarry Site		0.00	0.00
	Coal Quarry		116.08	5.73
	Barren OB Dump		146.93	7.25
	Back Fill		422.00	20.83
	Coal Dump		15.58	0.77
	Water Filled Qry		32.77	1.62
	Total Mining Area		**733.36**	**36.20**
Settlements	Urban Settlements		111.11	5.48
	Rural Settlements		41.15	2.03
	Industrial Settlements		19.35	0.96
	Total Settlement Area		**171.61**	**8.47**
Water Body	**River/ Ponds**		**25.96**	**1.28**
	Total Area		**2025.71**	**100.00**

Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of Cluster Mines				Job No. 564022120
Subject	Activity	Name	Designation	Signature	Date
Land Reclamation Status of Cluster-II mines, based on Satellite Data (RS-2A/L-IV) of the year 2022	Prepared	A. Panda	Dy. Mgr(Geol)		
	Checked	Hariharalal B	Ch. Mgr(System)		
	Approved	R. Kumar	GM(Geomatics)		
cmpdi	Scale: 0 0.5 1 2 K/m				Sheet 1
	Drg No. HQ REM 22 2 A4 02				Rev No.0

Sl no	Land Use Details	Existing (sq. meter)	Proposed (sq. meter)	Grand Total (sq. meter)
1	Green Belt Area	977.33×10^4	0.0	977.33×10^4
2	Open Land	1072.08×10^4	0.0	1072.08×10^4
3	Road/ Paved Area	140.32×10^4	0.0	140.32×10^4
4	Rooftop area of building/ sheds	70.81×10^4	0.0	70.81×10^4
5	Total	2260.54×10^4	0.0	2260.54×10^4

C. GROUND WATER LEVEL OF CLUSTER-III

Cluster-III consists of nine mines namely, Jogidih UG, Govindpur UG, Maheshpur UG, Kooridih/Block-IV Mixed Mine, New Akashkinaree Mixed Mine, South Govindpur UG (closed), and Teturiya UG (closed) mines. The life of the project has been worked out to be up to 60 years considering annual production target of 3.60 MTPA. This Cluster of mines is located in western part of Jharia Coalfield in Dhanbad district of Jharkhand (Toposheet no – 73 I/5).

The present leasehold area of Cluster-III is 1552.53 Ha. The area is plain with gentle undulation with RL varying from 160 m to 208.80 m AMSL. The general slope of the area is towards south. Khudia River, Baghdigi Jore, Katri River and its tributaries are controlling the drainage system of the area. The area comes under the watershed of Khudia River.

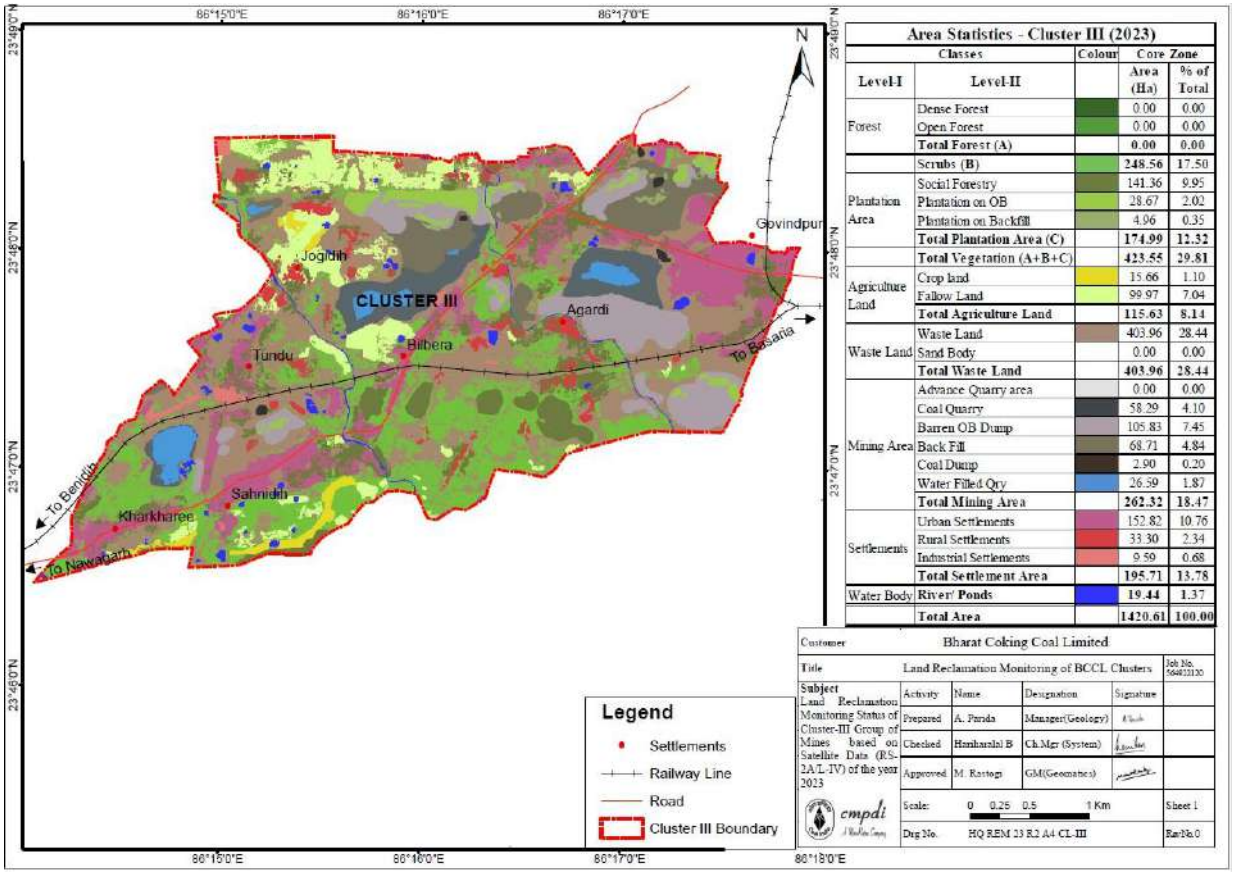
Monitoring stations (**A025, A029, B014 and B060**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'25, August'25, and Nov'25 and January'26. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2025-26				2024-25				2023-24			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	A025	Sinidih	4.85	1.39	2.65	2.98	2.93	1.09	2.6	2.7	3.31	1.33	2.08	2.51
2	A029	Dharmaband	3.06	1.01	2.80	2.88	5.6	2.1	3.2	4.08	4.6	1.2	1.15	1.12
3	B014	Mathadih	3.40	0.93	2.27	2.45	2.84	1.12	2.34	2.42	3.24	0.09	2.6	2.55
4	B060	Sonardih	9.10	2.70	5.77	9.04	10.73	5.31	5.73	9.51	10.53	1.08	5.8	9.38
Average WL (bgl)			5.10	1.51	3.37	4.34	5.53	2.41	3.47	4.68	5.42	0.93	2.91	3.89

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 2.84 m Max – 10.73 m
Post-monsoon GW Level (m): Min – 1.15 m Max – 5.80 m

LAND USE / LAND COVER MAP OF THE CLUSTER-III MINES, BCCL



Sl no	Land Use Details	Existing (sq. meter)	Proposed (sq. meter)	Grand Total (sq. meter)
1	Green Belt Area	580.21 x 10^4	0.0	580.21 x 10^4
2	Open Land	770.61 x 10^4	0.0	770.61 x 10^4
3	Road/ Paved Area	164.97 x 10^4	0.0	164.97 x 10^4
4	Rooftop area of building/ sheds	36.74 x 10^4	0.0	36.74 x 10^4
5	Total	1552.53 x 10^4	0.0	1552.53 x 10^4

D. GROUND WATER LEVEL OF CLUSTER-IV

Cluster-IV consists of six mines namely, Amalgamated Keshalpur & West Mudidih colliery, Amalgamated Angarpathra & Ramkanali colliery, Katras-Choitudih Colliery, Salanpur colliery and Gaslitand colliery of Katras area, BCCL. It is located in the north-central part of Jharia Coalfield in Dhanbad district of Jharkhand. The life of the project has been worked out to be more than 30 years considering annual target production of 9.55 MTPA (Toposheet no – 73 I/5).

The present leasehold area of Cluster-IV is 1123.79 Ha. The area has a general undulating topography, with an overall gentle south-west slope. The RL varies from 182 m to 216 m AMSL. Katri River, Kumari Jore and their tributaries are controlling the drainage pattern of the area. The area comes under the watershed of Katri River.

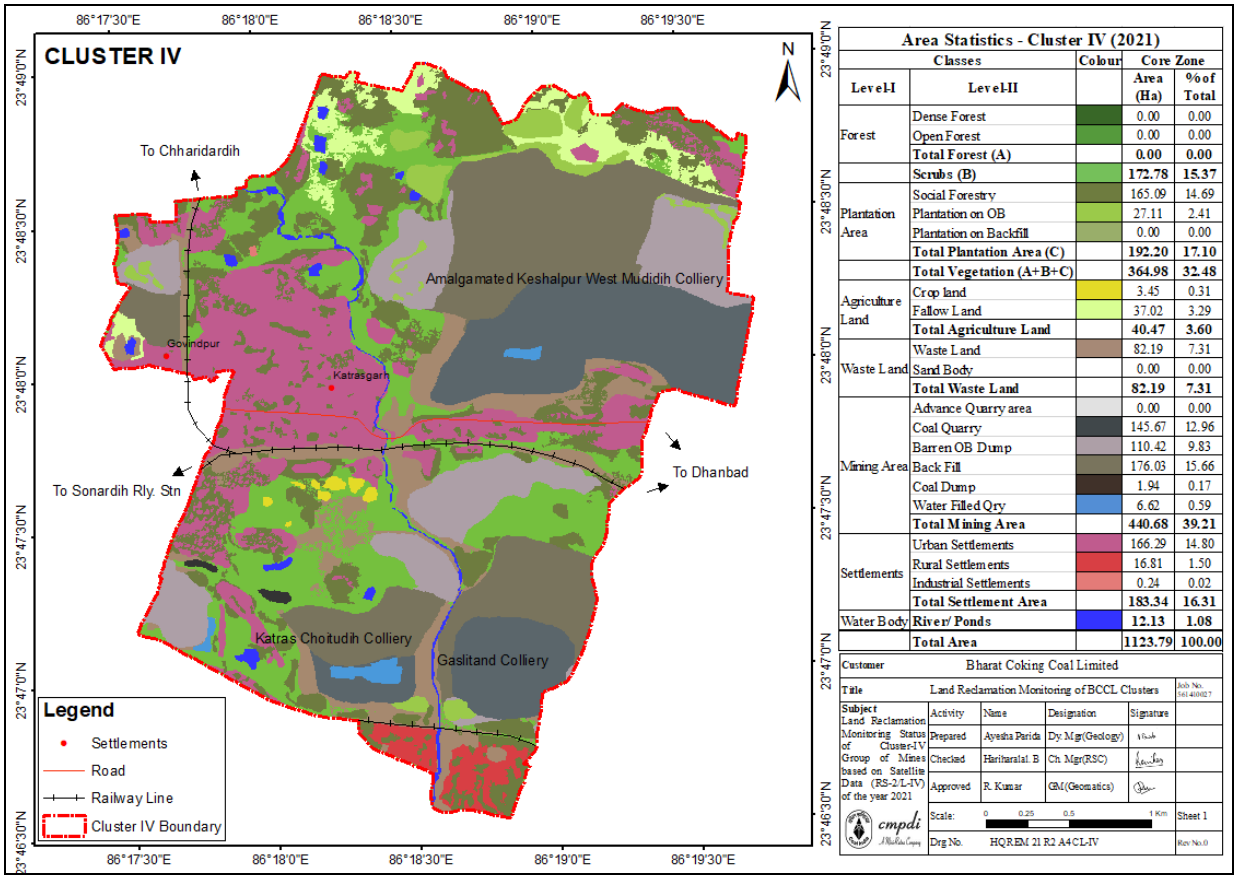
Monitoring stations (**A026, A028 and B065**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'25, August'25, and Nov'25 and January'26. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2025-26				2024-25				2023-24			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	A026	Malkhera	7.00	3.18	3.72	4.35	8.4	3.87	3.83	5.5	6.42	2.83	4.31	3.62
2	A028	Lakarka	4.30	3.30	3.49	3.78	3.45	3.13	3.35	3.4	4.23	2.85	3.3	3.57
3	B065	Jhinjipahari	10.60	2.22	2.45	4.01	8.45	1.95	2.35	4.93	7.45	0.5	2.27	3.45
Average WL (bgl)			7.30	2.90	3.22	4.05	6.77	2.98	3.18	4.61	6.03	2.06	3.29	3.55

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 3.45 m Max – 10.60 m
Post-monsoon GW Level (m): Min – 2.27 m Max – 4.31 m

LAND USE / LAND COVER MAP OF THE CLUSTER-IV MINES, BCCL



Sl no	Land Use Details	Existing (sq. meter)	Proposed (sq. meter)	Grand Total (sq. meter)
1	Green Belt Area	385.15 x 10^4	0.0	385.15 x 10^4
2	Open Land	555.43 x 10^4	0.0	555.43 x 10^4
3	Road/ Paved Area	160.59 x 10^4	0.0	160.59 x 10^4
4	Rooftop area of building/ sheds	22.63 x 10^4	0.0	22.63 x 10^4
5	Total	1123.79 x 10^4	0.0	1123.79 x 10^4

E. GROUND WATER LEVEL OF CLUSTER-V

Cluster-V consists of twelve mines namely; Tetulmari OC & UG mines, Mudidih OC & UG mines, Nichitpur OC mine, Sendra Bansjora OC & UG mines, Bansdeopur OCP (proposed) & UG Mines, Kankanee OC & UG mines and Loyabad UG mine (closed) of Sijua area, BCCL. This Cluster of mines is located in northern part of Jharia Coalfield in Dhanbad district of Jharkhand. The life of the project has been worked out to be more than 30 years considering annual production target of 6.311 MTPA (Toposheet no – 73 I/6).

The present leasehold area of Cluster-V is 1724.52 Ha. The area has a general undulating topography, with an overall gentle south-west slope. The RL varies from 210 m to 170 m AMSL. Jarian Nala, Nagri Jore, Ekra Jore and their tributaries are controlling the drainage pattern of the area. The area comes under the watershed of Jarian Nala and Ekra Jore.

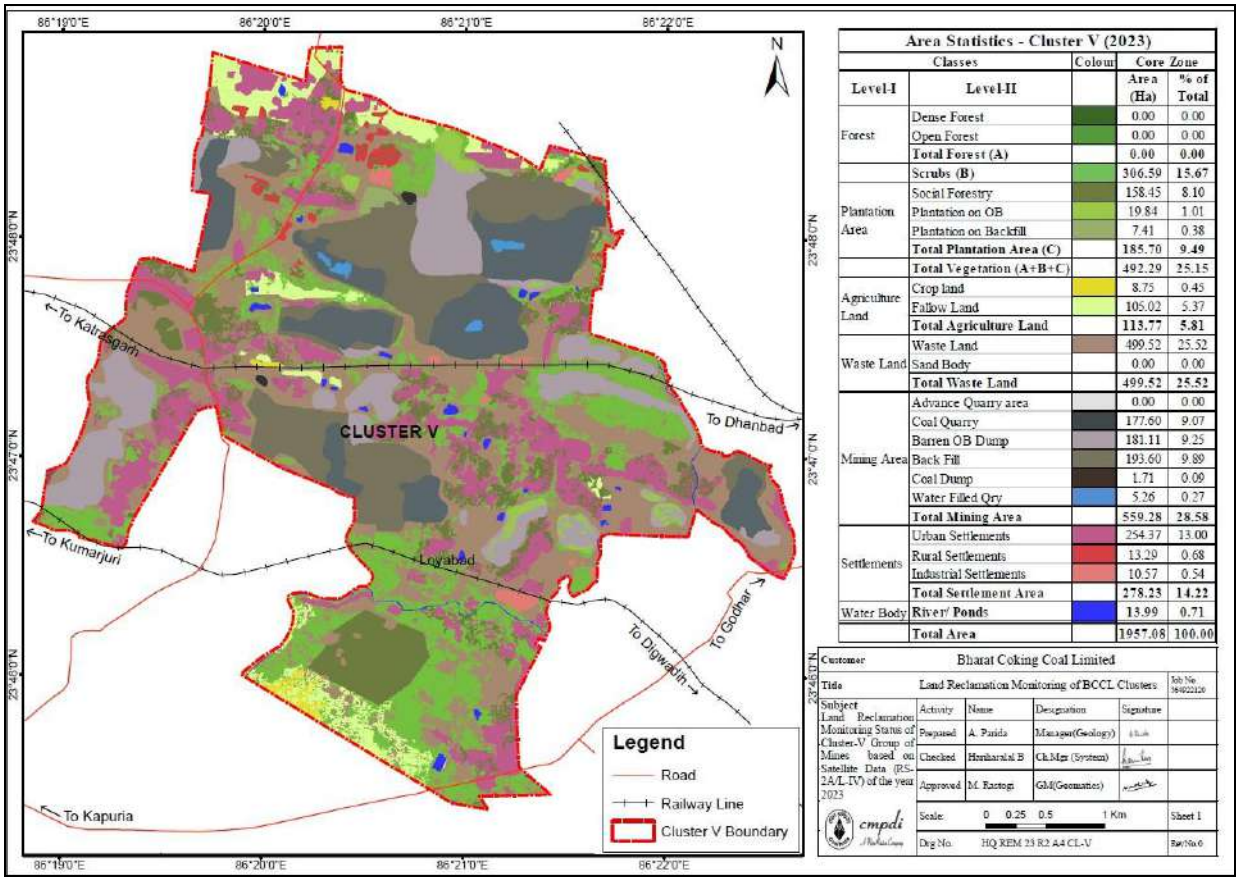
Monitoring stations (**A016 and A027**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'25, August'25, and Nov'25 and January'26. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2025-26				2024-25				2023-24			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	A016	Ekra	4.56	3.29	3.49	3.81	5.55	1.35	3.52	4.3	5.8	1.35	3.08	2.99
2	A027	Tetulmari	7.00	3.18	3.72	4.35	1.7	0.55	1.6	1.8	1.9	0.1	1.33	1.5
Average WL (bgl)			5.78	3.24	3.61	4.08	3.63	0.95	2.56	3.05	3.85	0.73	2.21	2.25

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 1.70 m Max – 7.00 m
Post-monsoon GW Level (m): Min – 1.33 m Max – 3.72 m

LAND USE / LAND COVER MAP OF THE CLUSTER-V MINES, BCCL



Area Statistics - Cluster V (2023)

Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forest	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
	Scrubs (B)		306.59	**15.67**
Plantation Area	Social Forestry		158.45	8.10
	Plantation on OB		19.84	1.01
	Plantation on Backfill		7.41	0.38
	Total Plantation Area (C)		**185.70**	**9.49**
	Total Vegetation (A+B+C)		492.29	25.15
Agriculture Land	Crop land		8.75	0.45
	Fallow Land		105.02	5.37
	Total Agriculture Land		**113.77**	**5.81**
Waste Land	Waste Land		499.52	25.52
	Sand Body		0.00	0.00
	Total Waste Land		499.52	**25.52**
Mining Area	Advance Quarry area		0.00	0.00
	Coal Quarry		177.60	9.07
	Barren OB Dump		181.11	9.25
	Back Fill		193.60	9.89
	Coal Dump		1.71	0.09
	Water Filled Qry		5.26	0.27
	Total Mining Area		559.28	**28.58**
Settlements	Urban Settlements		254.37	13.00
	Rural Settlements		13.29	0.68
	Industrial Settlements		10.57	0.54
	Total Settlement Area		**278.23**	**14.22**
Water Body	**River/ Ponds**		13.99	**0.71**
	Total Area		1957.08	100.00

Customer	Bharat Coking Coal Limited			
Title	Land Reclamation Monitoring of BCCL Clusters			Job No. 364022126
Subject: Land Reclamation Monitoring Status of Cluster-V Group of Mines based on Satellite Data (RS-2A/L-IV) of the year 2023	Activity	Name	Designation	Signature
	Prepared	A. Parida	Manager(Geology)	
	Checked	Hrushikesh B	Ch.Mgr (System)	
	Approved	M. Rastogi	GM(Geomatics)	
cmpdi	Scale:	0 0.25 0.5 1 Km		Sheet 1
	Drg No.	HQ/REM/23/R2/A4/CL-V		Rev No.0

Sl no	Land Use Details	Existing (sq. meter)	Proposed (sq. meter)	Grand Total (sq. meter)
1	Green Belt Area	527.26×10^4	0.0	527.26×10^4
2	Open Land	973.52×10^4	0.0	973.52×10^4
3	Road/ Paved Area	217.50×10^4	0.0	217.50×10^4
4	Rooftop area of building/ sheds	24.24×10^4	0.0	24.24×10^4
5	Total	1724.52×10^4	0.0	1724.52×10^4

F. GROUND WATER LEVEL OF CLUSTER-VI

Cluster–VI consists of four coal mines namely, East Bassuriya opencast (OC), Bassuriya underground (UG), Gondudih Khas-Kusunda OC and Godhur Mixed Mines (OC and UG) of BCCL. This Cluster of mines is located in central part of Jharia Coalfield in Dhanbad district of Jharkhand. The life of the project has been worked out to be more than 30 years considering annual production target of 7.631 MTPA (Toposheet no – 73 I/6).

The present leasehold area of Cluster-VI is 831.83 Ha. The area has a general undulating topography with general slope towards south. The RL varies from 180 m to 240 m AMSL. Ekra Jore, Kari Jore and their tributaries are controlling the drainage pattern of the area. The area comes under the watershed of Ekra Jore and Kari Jore.

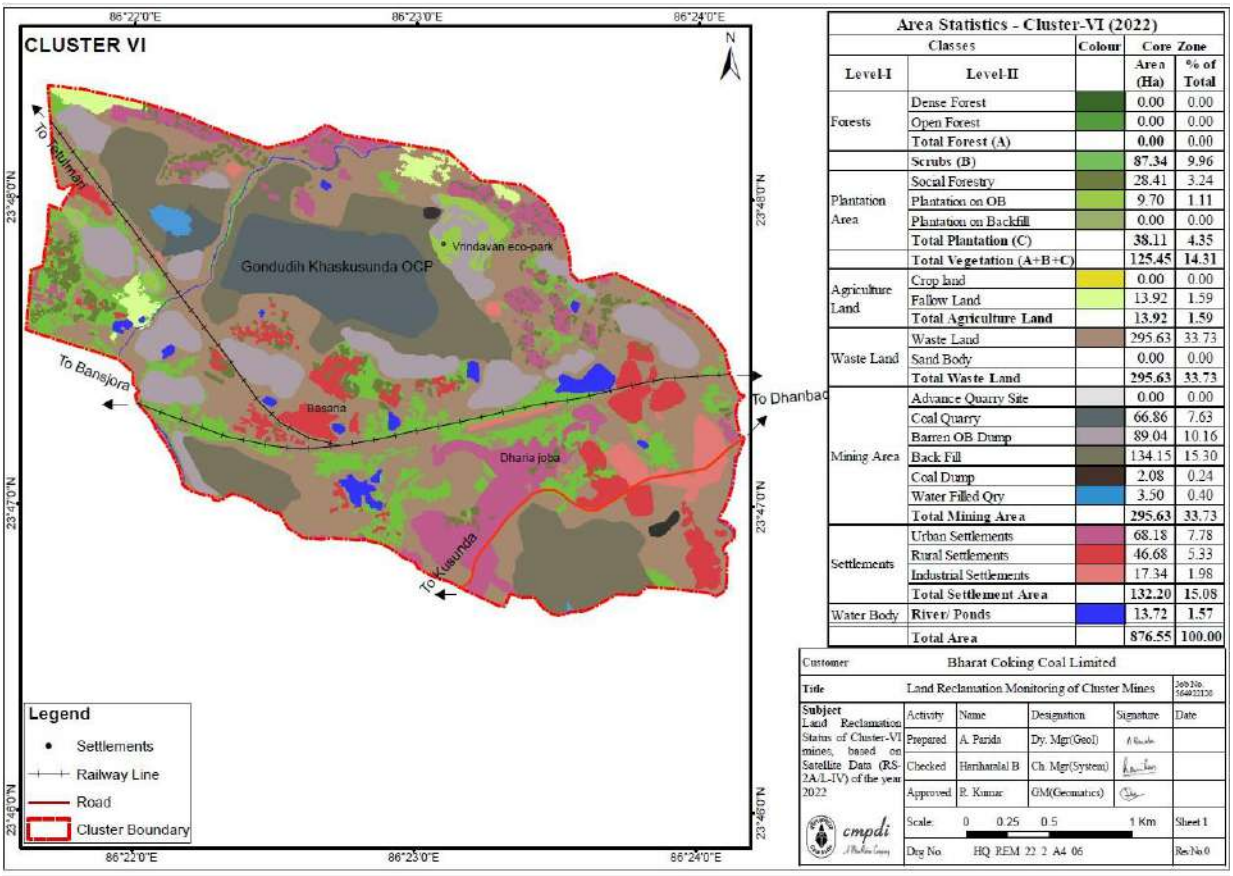
Monitoring stations (**D025, D030 and D034**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'25, August'25, and Nov'25 and January'26. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2025-26				2024-25				2023-24			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	D025	Godhur	6.33	3.24	3.47	5.20	4.40	1.80	3.40	4.20	11.90	2.58	4.70	5.30
2	D030	Borkiboa	4.12	1.39	2.28	2.88	4.08	2.10	2.20	3.44	4.37	1.80	2.29	4.15
3	D034	Kusunda	4.30	2.12	2.63	2.99	3.80	1.80	2.50	2.89	5.00	2.15	3.15	3.22
Average WL (bgl)			4.92	2.25	2.79	3.69	4.09	1.90	2.70	3.51	7.09	2.18	3.38	4.22

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 3.80 m Max – 11.90 m
Post-monsoon GW Level (m): Min – 2.20 m Max – 4.70 m

LAND USE / LAND COVER MAP OF THE CLUSTER-VI MINES, BCCL



Area Statistics - Cluster-VI (2022)				
Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forests	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	0.00
	Scrubs (B)		87.34	9.96
Plantation Area	Social Forestry		28.41	3.24
	Plantation on OB		9.70	1.11
	Plantation on Backfill		0.00	0.00
	Total Plantation (C)		**38.11**	4.35
	Total Vegetation (A+B+C)		**125.45**	14.31
Agriculture Land	Crop land		0.00	0.00
	Fallow Land		13.92	1.59
	Total Agriculture Land		**13.92**	1.59
Waste Land	Waste Land		295.63	33.73
	Sand Body		0.00	0.00
	Total Waste Land		**295.63**	33.73
Mining Area	Advance Quarry Site		0.00	0.00
	Coal Quarry		66.86	7.63
	Barren OB Dump		89.04	10.16
	Back Fill		134.15	15.30
	Coal Dump		2.08	0.24
	Water Filled Qry		3.50	0.40
	Total Mining Area		**295.63**	33.73
Settlements	Urban Settlements		68.18	7.78
	Rural Settlements		46.68	5.33
	Industrial Settlements		17.34	1.98
	Total Settlement Area		**132.20**	15.08
Water Body	River/ Ponds		13.72	1.57
	Total Area		**876.55**	100.00

Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of Cluster Mines				Job No 564022120
Subject: Land Reclamation Status of Cluster-VI mines, based on Satellite Data (RS-2A/L-IV) of the year 2022	Activity	Name	Designation	Signature	Date
	Prepared	A. Parida	Dy. Mgr(Geol)		
	Checked	Hariharilal B	Ch. Mgr(System)		
	Approved	R. Kumar	GM(Geomatics)		
cmpdi	Scale: 0 0.25 0.5 1 Km				Sheet 1
	Drg No. HQ REM 22 2 A4 06				Rev No 0

Sl no	Land Use Details	Existing (sq. meter)	Proposed (sq. meter)	Grand Total (sq. meter)
1	Green Belt Area	122.39 X 10^4	0.0	122.39 X 10^4
2	Open Land	581.14 X 10^4	0.0	581.14 X 10^4
3	Road/ Paved Area	68.81 X 10^4	0.0	68.81 X 10^4
4	Rooftop area of building/ sheds	59.49 X 10^4	0.0	59.49 X 10^4
5	Total	831.83 X 10^4	0.0	831.83 X 10^4

G. GROUND WATER LEVEL OF CLUSTER-VII

Cluster-VII consists of fourteen mines within Kusunda Area, Bastacolla Area and PB Area, B.C.C.L, Jharia Coalfield. Coal mines namely Dhansar UG, Dhansar OCP, Kusunda OCP and Viswakarma OCP (proposed) are under the administrative control of Kusunda Area and Industry UG (closed), Alkusa UG, Ena OCP, S.Jharia/Rajapur OCP, Burragarh UG, Simlabahal UG, Hurriladih UG, Bhutgoria UG (Re-opening), Kustore UG (closed) and E.Bhuggatdih UG (closed) are under Bastacolla and PB Area. This Cluster of mines is located in east central part of Jharia Coalfield in Dhanbad district of Jharkhand. The life of the project has been worked out to be more than 30 years considering annual production target of 8.226 MTPA (Toposheet no – 73 I/6).

The present leasehold area of Cluster-VII is 2127.70 Ha. The area has a general undulating topography with general slope towards south. The RL varies from 172 m to 221 m above M.S.L. Kari Jore, Chatkari Jore and their tributaries are controlling the drainage pattern of the area. The area comes under the watershed of Kari Jore and Chatkari Jore.

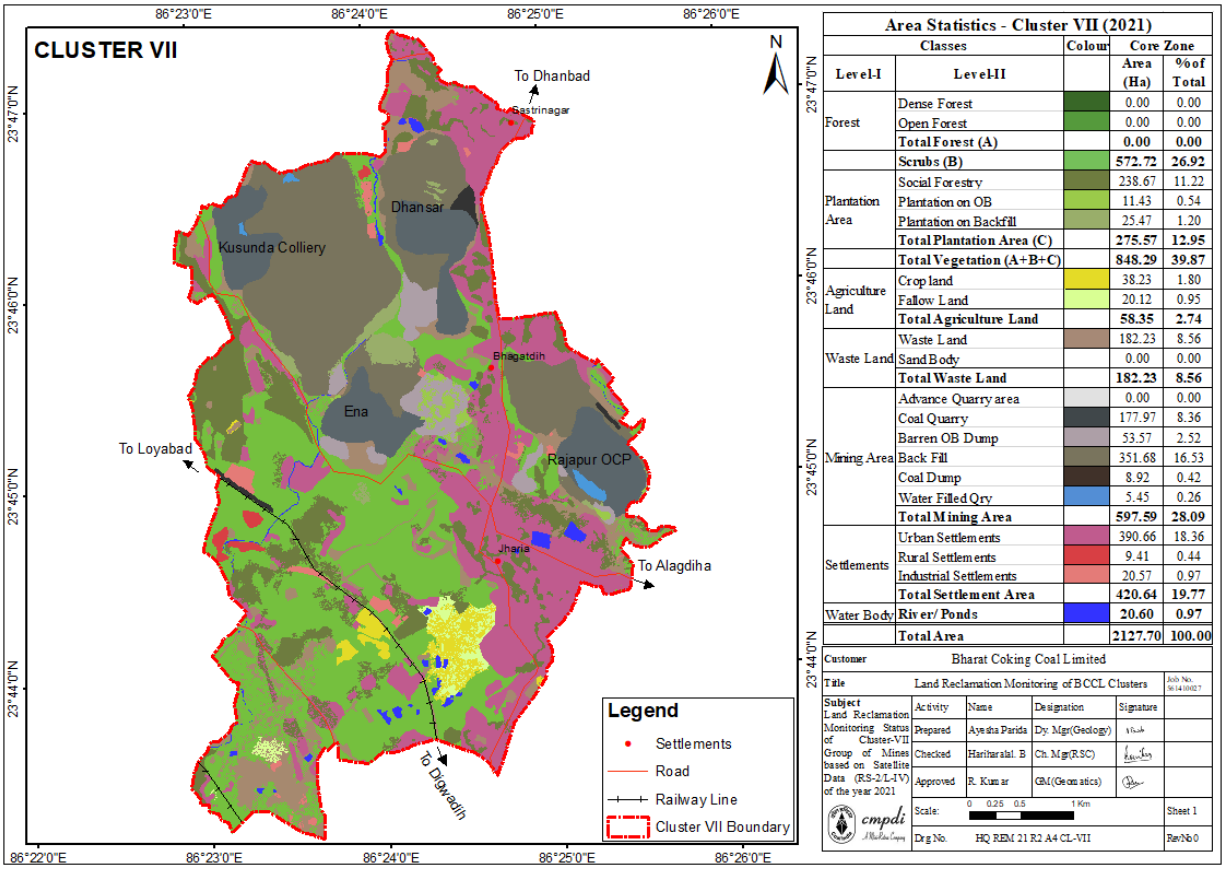
Monitoring stations (**D003, D034, D047 and D080**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'25, August'25, and Nov'25 and January'26. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2025-26				2024-25				2023-24			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	D003	Dhansar	1.95	0.87	1.71	1.88	3.15	1.22	1.85	2.28	5.96	0.55	1.32	1.34
2	D034	Kusunda	4.30	2.12	2.63	2.99	3.8	1.8	2.5	2.89	5	2.15	3.15	3.22
3	D047	Parastanr	4.32	2.14	3.38	3.65	4.45	2.57	3.27	3.85	6.55	5.32	5.85	11.4
4	D080	Bastacolla	3.66	2.14	2.55	2.71	4.75	1.75	2.6	3.42	3.3	2.4	3.08	1.8
Average WL (bgl)			3.56	1.82	2.57	2.81	4.04	1.84	2.56	3.11	5.2	2.61	3.35	4.44

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 1.95 m Max – 6.55 m
Post-monsoon GW Level (m): Min – 1.32 m Max – 5.85 m

LAND USE / LAND COVER MAP OF THE CLUSTER-VII MINES, BCCL



Area Statistics - Cluster VII (2021)

Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	%of Total
Forest	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
	Scrubs (B)		**572.72**	**26.92**
Plantation Area	Social Forestry		238.67	11.22
	Plantation on OB		11.43	0.54
	Plantation on Backfill		25.47	1.20
	Total Plantation Area (C)		**275.57**	**12.95**
	Total Vegetation (A+B+C)		**848.29**	**39.87**
Agriculture Land	Crop land		38.23	1.80
	Fallow Land		20.12	0.95
	Total Agriculture Land		**58.35**	**2.74**
Waste Land	Waste Land		182.23	8.56
	Sand Body		0.00	0.00
	Total Waste Land		**182.23**	**8.56**
Mining Area	Advance Quarry area		0.00	0.00
	Coal Quarry		177.97	8.36
	Barren OB Dump		53.57	2.52
	Back Fill		351.68	16.53
	Coal Dump		8.92	0.42
	Water Filled Qry		5.45	0.26
	Total Mining Area		**597.59**	**28.09**
Settlements	Urban Settlements		390.66	18.36
	Rural Settlements		9.41	0.44
	Industrial Settlements		20.57	0.97
	Total Settlement Area		**420.64**	**19.77**
Water Body	**River/ Ponds**		**20.60**	**0.97**
	Total Area		**2127.70**	**100.00**

Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of BCCL Clusters				Job No. 36/14/0027
Subject: Land Reclamation Monitoring Status of Cluster-VII Group of Mines based on Satellite Data (RS-2/L-IV) of the year 2021	Activity	Name	Designation	Signature	
	Prepared	Ayesha Parida	Dy. Mgr(Geology)		
	Checked	Hariharalal. B	Ch. Mgr(RSC)		
	Approved	R. Kumar	GM(Geomatics)		
cmpdi	Scale: 0 0.25 0.5 1 Km				Sheet 1
	Drg No. HQ REM 21 R2 A4 CL-VII				Rev No 0

Sl no	Land Use Details	Existing (sq. meter)	Proposed (sq. meter)	Grand Total (sq. meter)
1	Green Belt Area	968.53 x 10^4	0.0	968.53 x 10^4
2	Open Land	746.72 x 10^4	0.0	746.72 x 10^4
3	Road/ Paved Area	380.73 x 10^4	0.0	380.73 x 10^4
4	Rooftop area of building/ sheds	31.71 x 10^4	0.0	31.71 x 10^4
5	Total	2127.70 x 10^4	0.0	2127.70 x 10^4

H. GROUND WATER LEVEL OF CLUSTER-VIII

Cluster - VIII of B.C.C.L mines are under administrative control of Bastacolla Area, Jharia Coalfield. Cluster-VIII consists of ten mines namely Bastacolla mixed mines (OC & UG), Bera mixed mines (OC&UG), Dobari UG, Kuya mixed mines (OC&UG), Proposed Goluckdih (NC) OC mine, Ghanoodih OC mine and Kujama OC mine. This cluster is located in west part of Jharia Coalfield in Dhanbad district of Jharkhand. All the above mines are contiguous in nature and the environmental impact is overlapping in ambient environment due to cumulative effect of mining activities. The life of the project has been worked out to be up to 25 years considering annual production target of 6.383 MTPA (toposheet no. 73 I/5 and I/6).

The present leasehold area of Cluster-VIII is 1331.95 Ha. The area has a general undulating topography with general slope towards south and south-west. The ground elevation in the area ranges from 175 m to 221 m AMSL. Chatkari Jore, Tisra Jore and their tributaries are controlling the drainage pattern of the area. The area comes under the watershed of Chatkari Jore.

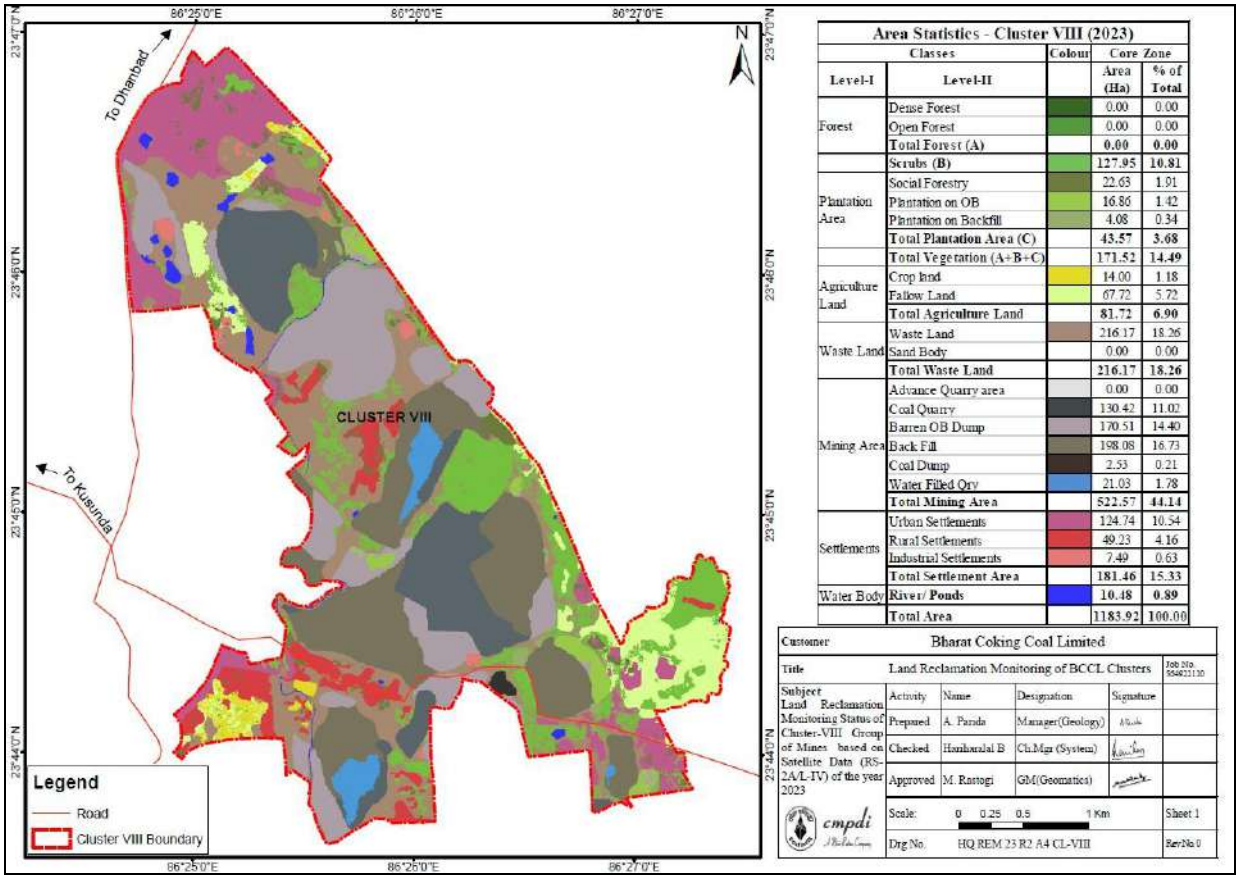
Monitoring stations (**D008 and D039**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'25, August'25, and Nov'25 and January'26. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2025-26				2024-25				2023-24			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	D008	Alokdiha	8.90	2.74	4.82	5.47	7.70	4.42	4.82	6.75	6.32	4.25	5.42	6.34
2	D039	Tilaboni	3.20	2.51	2.77	2.87	8.52	2.52	3.28	5.75	7.50	1.85	3.05	1.75
Average WL (bgl)			6.05	2.63	3.80	4.17	8.11	3.47	4.05	6.25	6.91	3.05	4.24	4.05

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 3.20 m Max – 8.90 m
Post-monsoon GW Level (m): Min – 2.77 m Max – 5.42 m

LAND USE / LAND COVER MAP OF THE CLUSTER-VIII MINES, BCCL



Area Statistics - Cluster VIII (2023)

Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forest	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
	Scrubs (B)		**127.95**	**10.81**
Plantation Area	Social Forestry		22.63	1.91
	Plantation on OB		16.86	1.42
	Plantation on Backfill		4.08	0.34
	Total Plantation Area (C)		**43.57**	**3.68**
	Total Vegetation (A+B+C)		**171.52**	**14.49**
Agriculture Land	Crop land		14.00	1.18
	Fallow Land		67.72	5.72
	Total Agriculture Land		**81.72**	**6.90**
Waste Land	Waste Land		216.17	18.26
	Sand Body		0.00	0.00
	Total Waste Land		**216.17**	**18.26**
Mining Area	Advance Quarry area		0.00	0.00
	Coal Quarry		130.42	11.02
	Barren OB Dump		170.51	14.40
	Back Fill		198.08	16.73
	Coal Dump		2.53	0.21
	Water Filled Qry		21.03	1.78
	Total Mining Area		**522.57**	**44.14**
Settlements	Urban Settlements		124.74	10.54
	Rural Settlements		49.23	4.16
	Industrial Settlements		7.49	0.63
	Total Settlement Area		**181.46**	**15.33**
Water Body	**River/ Ponds**		**10.48**	**0.89**
	Total Area		1183.92	100.00

Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of BCCL Clusters				Job No. 5540221130
Subject: Land Reclamation Monitoring Status of Cluster-VIII Group of Mines based on Satellite Data (RS-2A/L-IV) of the year 2023	Activity	Name	Designation	Signature	
	Prepared	A. Parida	Manager(Geology)		
	Checked	Hanhardal B	Ch.Mgr (System)		
	Approved	M. Rastogi	GM(Geomatics)		
cmpdi	Scale:	0 0.25 0.5 1 Km			Sheet 1
	Drg No.	HQ REM 23 R2 A4 CL-VIII			Rev No 0

Sl no	Land Use Details	Existing (sq. meter)	Proposed (sq. meter)	Grand Total (sq. meter)
1	Green Belt Area	279.69 x 10^4	0.0	279.69 x 10^4
2	Open Land	886.66 x 10^4	0.0	886.66 x 10^4
3	Road/ Paved Area	97.19 x 10^4	0.0	97.19 x 10^4
4	Rooftop area of building/ sheds	68.43 x 10^4	0.0	68.43 x 10^4
5	Total	1331.95 x 10^4	0.0	1331.95 x 10^4

I. GROUND WATER LEVEL OF CLUSTER-IX

Mines of cluster-IX are under administrative control of Lodna Area of B.C.C.L in western part of Jharia Coalfield which is located in Dhanbad district of Jharkhand. Cluster- IX consists of eight mines namely; North Tisra/South Tisra OCP, Jeenagora OCP, North Tisra UG, Lodna UG, Bagdigi UG, Bararee UG, Joyrampur UG and Jealgora UG (closed). Among them N. Tisra/S. Tisra OCP, Jeenagora OCP and N. Tisra UG mine will be amalgamated and will form North Tisra/South Tisra Expansion OCP. All above the mines are contiguous in nature and the environmental impact is overlapping in ambient environment due to cumulative effect of mining activities. The life of the project has been worked out to be up to 30 years considering annual production target of 8.513 MTPA (toposheet no. 73 I/6).

The present leasehold area of Cluster-IX is 1967.22 Ha. The topography of the area is undulating with gentle slope towards south. The RL varies from 221 m to 188.44 m AMSL. Chatkari Jore, Tisra Jore, Sulunga Jore and their tributaries are controlling the drainage pattern of the area. The area comes under the watershed of Chatkari Jore.

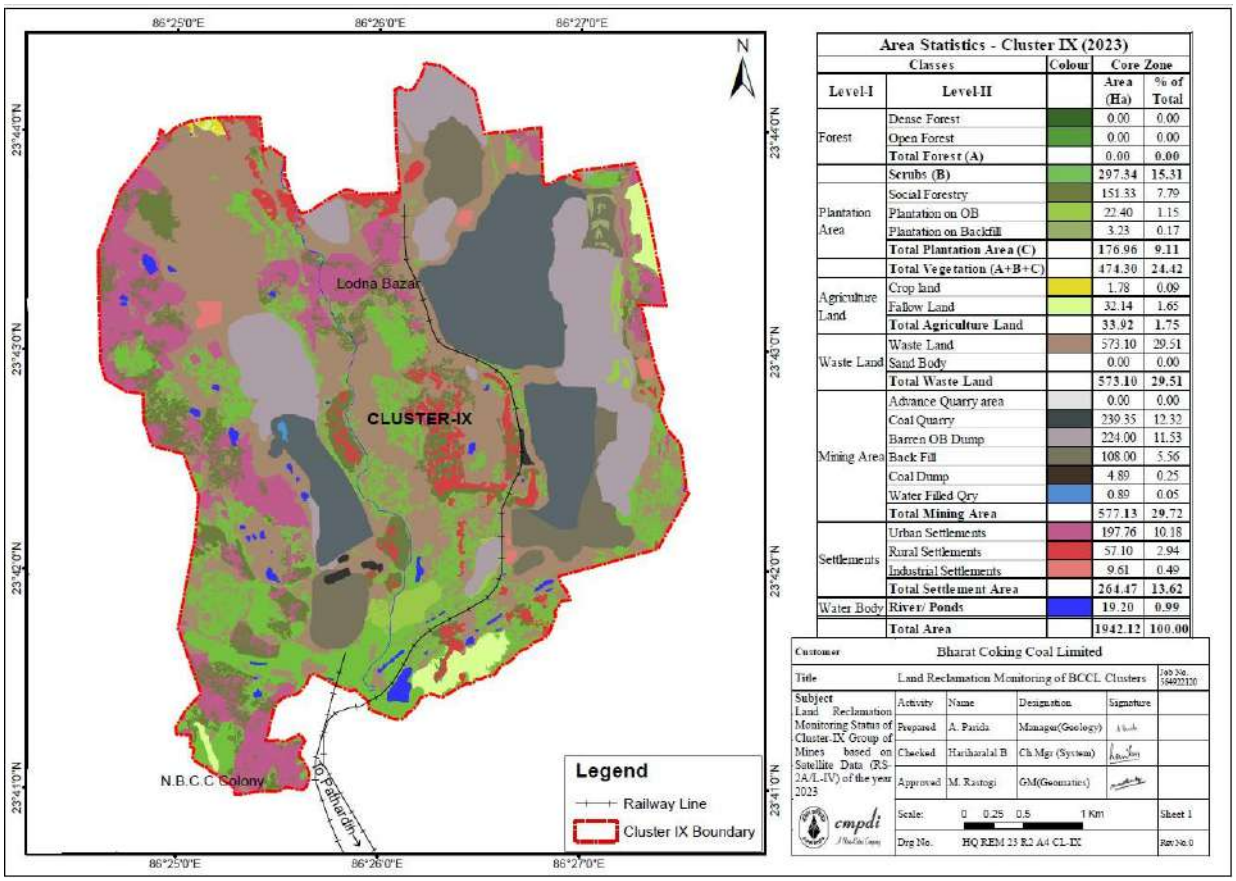
Monitoring stations (**D005, D007, D039 and D074**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'25, August'25, and Nov'25 and January'26. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2025-26				2024-25				2023-24			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	D005	Jiyalgora	8.70	4.53	6.02	7.35	8.20	4.08	5.90	6.54	8.40	3.36	7.01	8.95
2	D007	Golden Pahari	9.82	2.70	3.52	5.67	9.03	1.88	3.64	5.18	9.03	2.17	5.67	6.57
3	D039	Tilaboni	3.20	2.51	2.77	2.87	8.52	2.52	3.28	5.75	7.50	1.85	3.05	1.75
4	D074	BhulanBararee	4.74	2.65	3.73	3.89	4.57	3.10	3.54	4.09	6.17	3.20	5.77	7.90
Average WL (bgl)			6.62	3.10	4.01	4.95	7.58	2.90	4.09	5.39	7.78	2.65	5.38	6.29

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 3.20 m Max – 9.82 m
Post-monsoon GW Level (m): Min – 2.77 m Max – 7.01 m

LAND USE / LAND COVER MAP OF THE CLUSTER-IX MINES, BCCL



Area Statistics - Cluster IX (2023)

Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forest	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		0.00	0.00
Plantation Area	Scrubs (B)		297.34	15.31
	Social Forestry		151.33	7.79
	Plantation on OB		22.40	1.15
	Plantation on Backfill		3.23	0.17
	Total Plantation Area (C)		176.96	9.11
	Total Vegetation (A+B+C)		474.30	24.42
Agriculture Land	Crop land		1.78	0.09
	Fallow Land		32.14	1.65
	Total Agriculture Land		33.92	1.75
Waste Land	Waste Land		573.10	29.51
	Sand Body		0.00	0.00
	Total Waste Land		573.10	29.51
Mining Area	Advance Quarry area		0.00	0.00
	Coal Quarry		239.35	12.32
	Barren OB Dump		224.00	11.53
	Back Fill		108.00	5.56
	Coal Dump		4.89	0.25
	Water Filled Qry		0.89	0.05
	Total Mining Area		577.13	29.72
Settlements	Urban Settlements		197.76	10.18
	Rural Settlements		57.10	2.94
	Industrial Settlements		9.61	0.49
	Total Settlement Area		264.47	13.62
Water Body	**River/ Ponds**		19.20	0.99
	Total Area		1942.12	100.00

Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of BCCL Clusters				Job No. 164922120
Subject: Land Reclamation Monitoring Status of Cluster-IX Group of Mines based on Satellite Data (RS-2A/L-IV) of the year 2025	Activity	Name	Designation	Signature	
	Prepared	A. Parida	Manager(Geology)		
	Checked	Hariharalal B	Ch Mgr (System)		
	Approved	M. Rastogi	GM(Geomatics)		
cmpdi	Scale:	0 0.25 0.5 1 Km			Sheet 1
	Drg No.	HQ REM 23 R2 A4 CL-IX			Rev No.0

Sl no	Land Use Details	Existing (sq. meter)	Proposed (sq. meter)	Grand Total (sq. meter)
1	Green Belt Area	601.52 x 10^4	0.0	601.52 x 10^4
2	Open Land	1076.47 x 10^4	0.0	1076.47 x 10^4
3	Road/ Paved Area	232.31 x 10^4	0.0	232.31 x 10^4
4	Rooftop area of building/ sheds	56.92 x 10^4	0.0	56.92 x 10^4
5	Total	1967.22 x 10^4	0.0	1967.22 x 10^4

J. GROUND WATER LEVEL OF CLUSTER-X

Cluster-X consists of Bhowrah North OC & UG, Bhowrah South OC & UG, Amalgamated Sudamdih Patherdih, Sudamdih Shaft, Amlabad UG (Closed) and Sudamdih Coal Washery which comes under the administrative control of Eastern Jharia Area of Bharat Coking Coal Limited (B.C.C.L - A Subsidiary of Coal India Limited). This cluster of mines is located in eastern part of Jharia Coalfield in Dhanbad district of Jharkhand. The life of the project has been worked out to be more than 30 years considering annual production target of 2.289 MTY.

Cluster-X mine involves leasehold area of about 2057.47 Ha of land. It is covered in Survey of India toposheet no. 73 I/6. The area of Bhowrah North OC & UG, Bhowrah South OC & UG, Amalgamated Sudamdih Patherdih, Sudamdih Shaft, Amlabad UG (Closed) are 280.83 Ha, 571.58 Ha, 498.61 Ha, 391.50 Ha and 386.95 Ha respectively.

The present leasehold area of Cluster-X is 2057.47 Ha. The area has an undulating topography with gentle slope towards south and south-east. The RL varies from 185 m to 150.0 m AMSL. Gaurkuthi Nala and few seasonal streams are controlling the drainage pattern of the area. The area comes under the watershed of Damodar River.

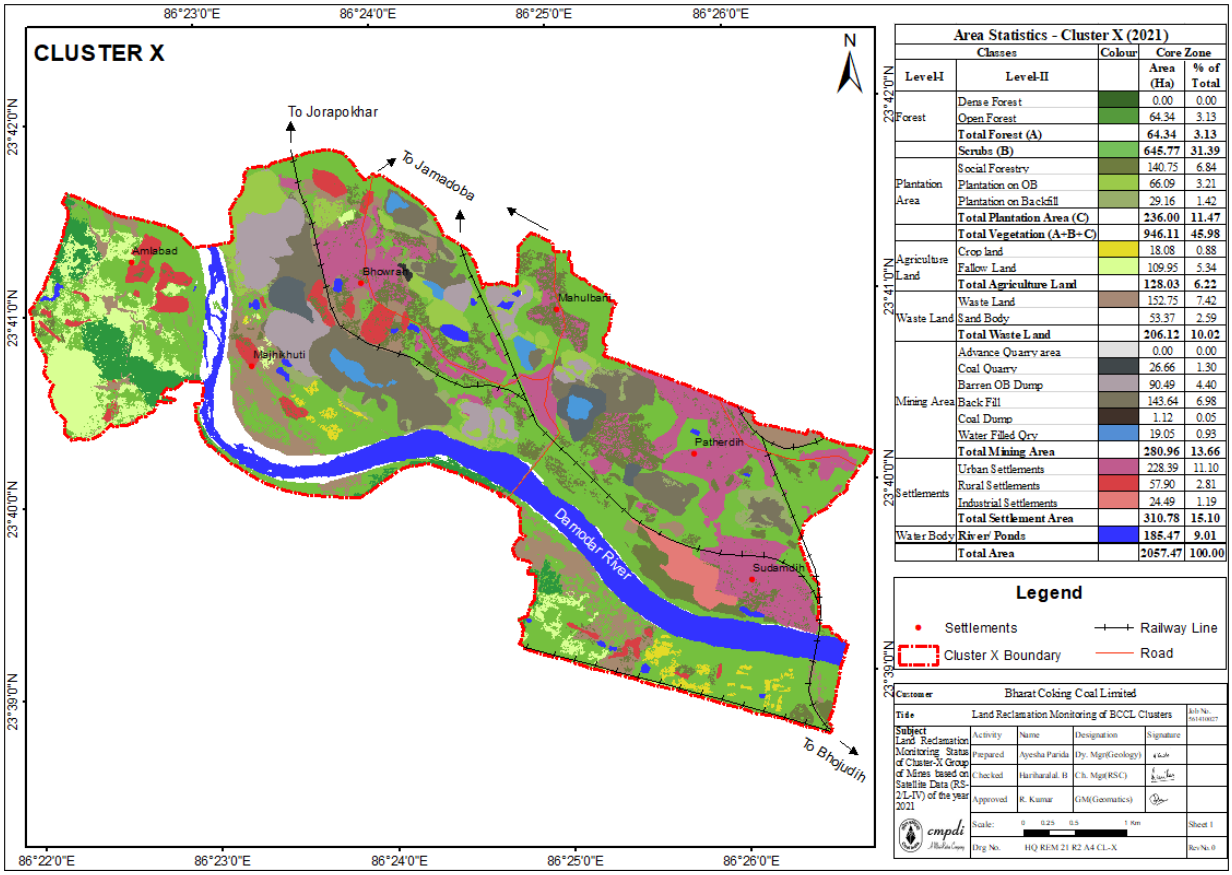
Monitoring stations (**A019, D035, D036 and D077**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'25, August'25, and Nov'25 and January'26, the Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2025-26				2024-25				2023-24			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	A019	Bhowrah	3.12	2.49	2.51	2.77	2.90	2.10	2.60	2.73	4.10	1.82	2.54	1.79
2	D035	Patherdih	5.16	3.28	4.10	4.70	5.23	3.45	3.90	4.10	6.10	3.70	4.68	5.50
3	D036	Sudamdih	2.64	0.45	0.74	1.13	1.85	0.50	0.60	1.00	3.25	0.15	0.60	1.44
4	D077	Amlabad	6.15	3.80	4.01	4.76	5.98	3.90	3.93	5.07	6.50	3.40	4.70	6.00
Average WL (bgl)			4.27	2.51	2.84	3.34	3.99	2.49	2.76	3.23	4.99	2.27	3.13	3.68

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 1.85 m Max – 6.50 m
Post-monsoon GW Level (m): Min – 0.60 m Max – 4.70 m

LAND USE / LAND COVER MAP OF THE CLUSTER-X MINES, BCCL



Level-I	Level-II	Colour	Core Zone Area (Ha)	Core Zone % of Total
Forest	Dense Forest		0.00	0.00
	Open Forest		64.34	3.13
	Total Forest (A)		**64.34**	**3.13**
	Scrubs (B)		**645.77**	**31.39**
Plantation Area	Social Forestry		140.75	6.84
	Plantation on OB		66.09	3.21
	Plantation on Backfill		29.16	1.42
	Total Plantation Area (C)		**236.00**	**11.47**
	Total Vegetation (A+B+C)		**946.11**	**45.98**
Agriculture Land	Crop land		18.08	0.88
	Fallow Land		109.95	5.34
	Total Agriculture Land		**128.03**	**6.22**
Waste Land	Waste Land		152.75	7.42
	Sand Body		53.37	2.59
	Total Waste Land		**206.12**	**10.02**
Mining Area	Advance Quarry area		0.00	0.00
	Coal Quarry		26.66	1.30
	Barren OB Dump		90.49	4.40
	Back Fill		143.64	6.98
	Coal Dump		1.12	0.05
	Water Filled Qry		19.05	0.93
	Total Mining Area		**280.96**	**13.66**
Settlements	Urban Settlements		228.39	11.10
	Rural Settlements		57.90	2.81
	Industrial Settlements		24.49	1.19
	Total Settlement Area		**310.78**	**15.10**
Water Body	River/ Ponds		185.47	9.01
	Total Area		**2057.47**	**100.00**

Sl no	Land Use Details	Existing (sq. meter)	Proposed (sq. meter)	Grand Total (sq. meter)
1	Green Belt Area	1085.72 x 10^4	0.0	1085.72 x 10^4
2	Open Land	661.04 x 10^4	0.0	661.04 x 10^4
3	Road/ Paved Area	228.39 x 10^4	0.0	228.39 x 10^4
4	Rooftop area of building/ sheds	82.32 x 10^4	0.0	82.32 x 10^4
5	Total	2057.47 x 10^4	0.0	2057.47 x 10^4

K. GROUND WATER LEVEL OF CLUSTER-XI

Cluster–XI consists of eight coal mines; Moonidih UG, Gopalichak UG Project, Kachi Balihari 10/12 Pit UG, Pootkee Balihari Project UG, Bhagaband UG, Kendwadih UG (closed), Pootkee UG (closed), Kachi Balihari 5/6 Pit UG (closed) which are under the administrative control of Western Jharia Area of Bharat Coking Coal Limited (B.C.C.L - A Subsidiary of Coal India Limited). The Cluster- XI is located in central part of Jharia Coalfield in Dhanbad district of Jharkhand. The life of the project has been worked out to be up to 50 years considering annual production target of 6.604 MTPA (toposheet no. no. 73 I/5 7 73 I/6).

The present leasehold area of Cluster-XI is 3527.58 Ha. The area has an undulating topography with gentle slope towards south. The RL varies from 201 m to 166 m AMSL. Katri River, Jarian Nala, Ekra Jore and Kari Jore are controlling the drainage of the area. The area comes under the watershed of Katri River and Kari Jore.

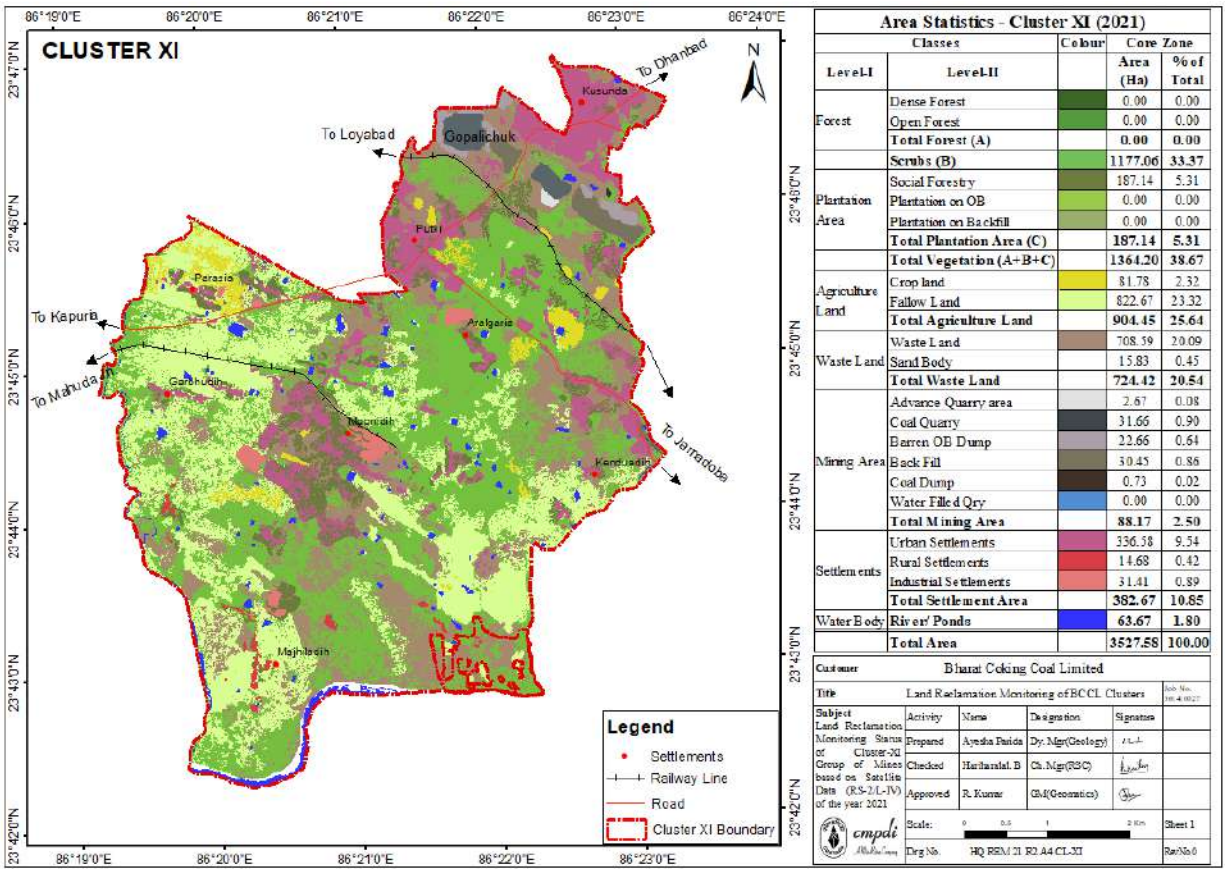
Monitoring stations (**A017, A020 and A032**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'25, August'25, and Nov'25 and January'26. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2025-26				2024-25				2023-24			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	A017	Kachi Balihari	3.18	2.11	2.26	2.51	2.41	1.78	2.19	2.57	2.62	2.06	2.59	2.64
2	A020	Gorbudih	7.90	4.15	4.30	5.10	8.02	4.05	4.20	7.27	5.59	3.18	3.54	5.27
3	A032	Baludih	3.51	1.59	1.72	2.15	3.83	0.95	1.60	2.09	2.25	0.65	1.75	2.79
Average WL (bgl)			4.86	2.62	2.76	3.25	4.75	2.26	2.66	3.98	3.49	1.96	2.63	3.57

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 2.25 m Max – 8.02 m
Post-monsoon GW Level (m): Min – 1.60 m Max – 4.30 m

LAND USE / LAND COVER MAP OF THE CLUSTER-XI MINES, BCCL



Area Statistics - Cluster XI (2021)

Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forest	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
	Scrubs (B)		**1177.06**	**33.37**
Plantation Area	Social Forestry		187.14	5.31
	Plantation on OB		0.00	0.00
	Plantation on Backfill		0.00	0.00
	Total Plantation Area (C)		**187.14**	**5.31**
	Total Vegetation (A+B+C)		**1364.20**	**38.67**
Agriculture Land	Crop land		81.78	2.32
	Fallow Land		822.67	23.32
	Total Agriculture Land		**904.45**	**25.64**
Waste Land	Waste Land		708.59	20.09
	Sand Body		15.83	0.45
	Total Waste Land		**724.42**	**20.54**
Mining Area	Advance Quarry area		2.67	0.08
	Coal Quarry		31.66	0.90
	Barren OB Dump		22.66	0.64
	Back Fill		30.45	0.86
	Coal Dump		0.73	0.02
	Water Filled Qry		0.00	0.00
	Total Mining Area		**88.17**	**2.50**
Settlements	Urban Settlements		336.58	9.54
	Rural Settlements		14.68	0.42
	Industrial Settlements		31.41	0.89
	Total Settlement Area		**382.67**	**10.85**
Water Body	River/ Ponds		**63.67**	**1.80**
	Total Area		**3527.58**	**100.00**

Customer	Bharat Coking Coal Limited			
Title	Land Reclamation Monitoring of BCCL Clusters			
Subject: Land Reclamation Monitoring Status of Cluster-XI Group of Mines based on Satellite Data (RS-2/L-IV) of the year 2021	Activity	Name	Designation	Signature
	Prepared	Ayesha Parida	Dy. Mgr(Geology)	
	Checked	Hariharalal. B	Ch.Mgr(RSC)	
	Approved	R. Kumar	GM(Geomatics)	
	Scale:	0 0.5 1 2 Km		Sheet 1
	Drg No.	HQ/RSM/21/R2/A4/CL-XI		Rev No.0

Sl no	Land Use Details	Existing (sq. meter)	Proposed (sq. meter)	Grand Total (sq. meter)
1	Green Belt Area	1060.61 x 10^4	0.0	1293.46 x 10^4
2	Open Land	1518.33 x 10^4	0.0	1509.06 x 10^4
3	Road/ Paved Area	171.08 x 10^4	0.0	171.08 x 10^4
4	Rooftop area of building/ sheds	777.56 x 10^4	0.0	563.06 x 10^4
5	Total	3527.58 x 10^4	0.0	3527.58 x 10^4

L. GROUND WATER LEVEL OF CLUSTER-XIII

Cluster-XIII, consists of one running mine (Murulidih 20/21 pit UG mine) and six abandoned mines i.e. Bhurungiya colliery, Muchraidih colliery, Hantoodih colliery, Padugora colliery, Murulidih colliery and Bhatdee colliery of Western Jharia area, BCCL which is located in the south-western part of Jharia coal field in Dhanbad district of Jharkhand. The area is covered under Survey of India toposheet no. 73 I/6. The life of the project has been worked out to be about 15 years considering annual production target of 0.234 MTPA.

The present leasehold area of Cluster-XIII is 1898.62 Ha. The area has an undulating topography with gentle slope towards south-east. The maximum RL is 224 m AMSL in the north-western part of the area whereas the minimum RL is 179 m AMSL at southern part. The area comes under the watershed area of Jamunia River and Katri River.

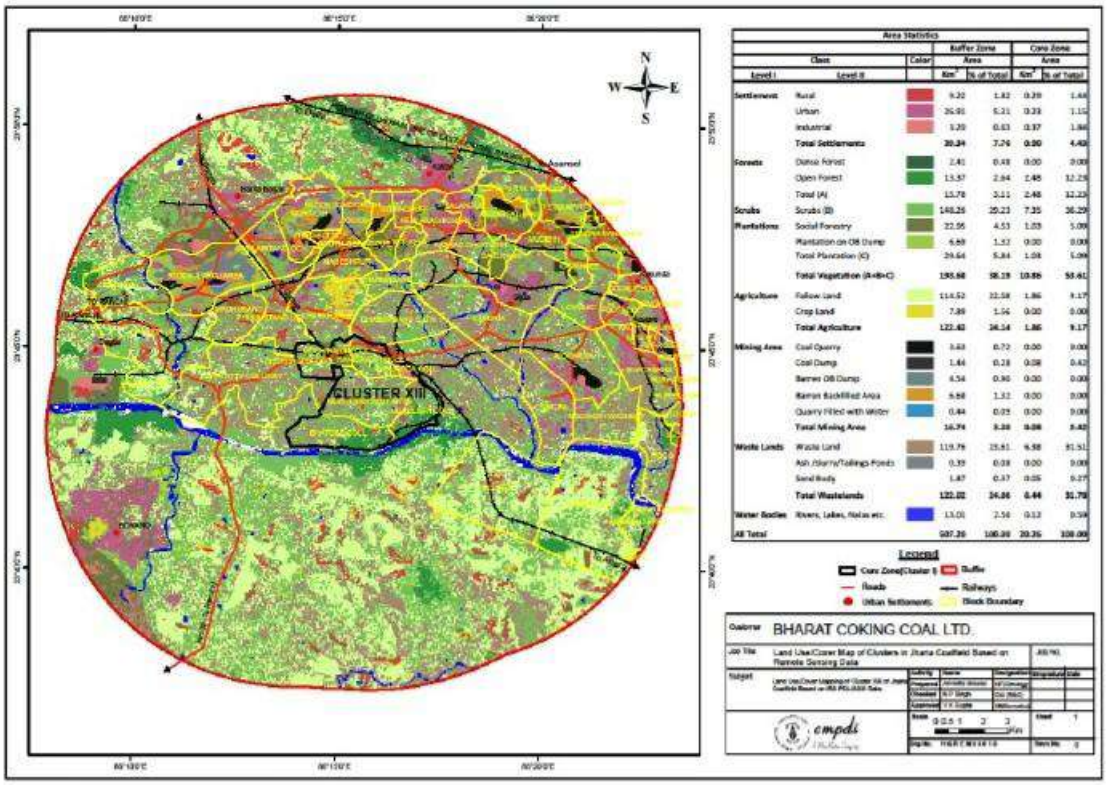
Monitoring stations (**A023, A034 and B048**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'25, August'25, Nov'25 and January'26. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2025-26				2024-25				2023-24			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	A023	Machhayara	10.44	2.72	5.72	6.95	9.00	5.10	5.71	7.90	7.97	1.14	4.79	6.67
2	A034	Mahuda vil.	6.54	1.82	3.90	4.92	6.54	2.98	4.01	4.85	8.20	3.65	6.35	6.95
3	B048	Mahuda	5.99	4.58	4.95	5.23	6.13	4.55	5.05	5.57	6.85	0.65	6.25	5.80
Average WL (bgl)			7.66	3.04	4.86	5.70	7.22	4.21	4.92	6.11	7.67	1.81	5.80	6.47

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 5.99 m Max – 10.44 m
Post-monsoon GW Level (m): Min – 3.90 m Max – 6.35 m

LAND USE / LAND COVER MAP OF THE CLUSTER-XIII MINES, BCCL



Sl no	Land Use Details	Existing (sq. meter)	Proposed (sq. meter)	Grand Total (sq. meter)
1	Green Belt Area	1484.41×10^4	0.0	1570.48×10^4
2	Open Land	183.28×10^4	0.0	97.22×10^4
3	Road/ Paved Area	71.84×10^4	0.0	71.83×10^4
4	Rooftop area of building/ sheds	159.09×10^4	0.0	159.09×10^4
5	Total	1898.62×10^4	0.0	1898.62×10^4

M. GROUND WATER LEVEL OF CLUSTER-XIV

Mines of Cluster-XIV are under administrative control of Western Jharia Area of B.C.C.L (Jharia Coalfield) which is located in Dhanbad district of Jharkhand. This cluster consists of Lohapatty UG and Lohapatty OC patch (proposed). The life of the project has been worked out to be up to 08 years considering annual production target of 0.526 MTPA. It is covered in Survey of India toposheet no. 73 I/2.

The present leasehold area of Cluster-XIV is 1418.25 Ha. The topography of the area is undulating with slope towards south west. The maximum RL is 224 m in the north-eastern part whereas the minimum RL is 170 m above mean sea level on the south-western part of the area. Jamunia River and its tributaries are controlling the drainage of the area. The area comes under the watershed area of Jamunia River.

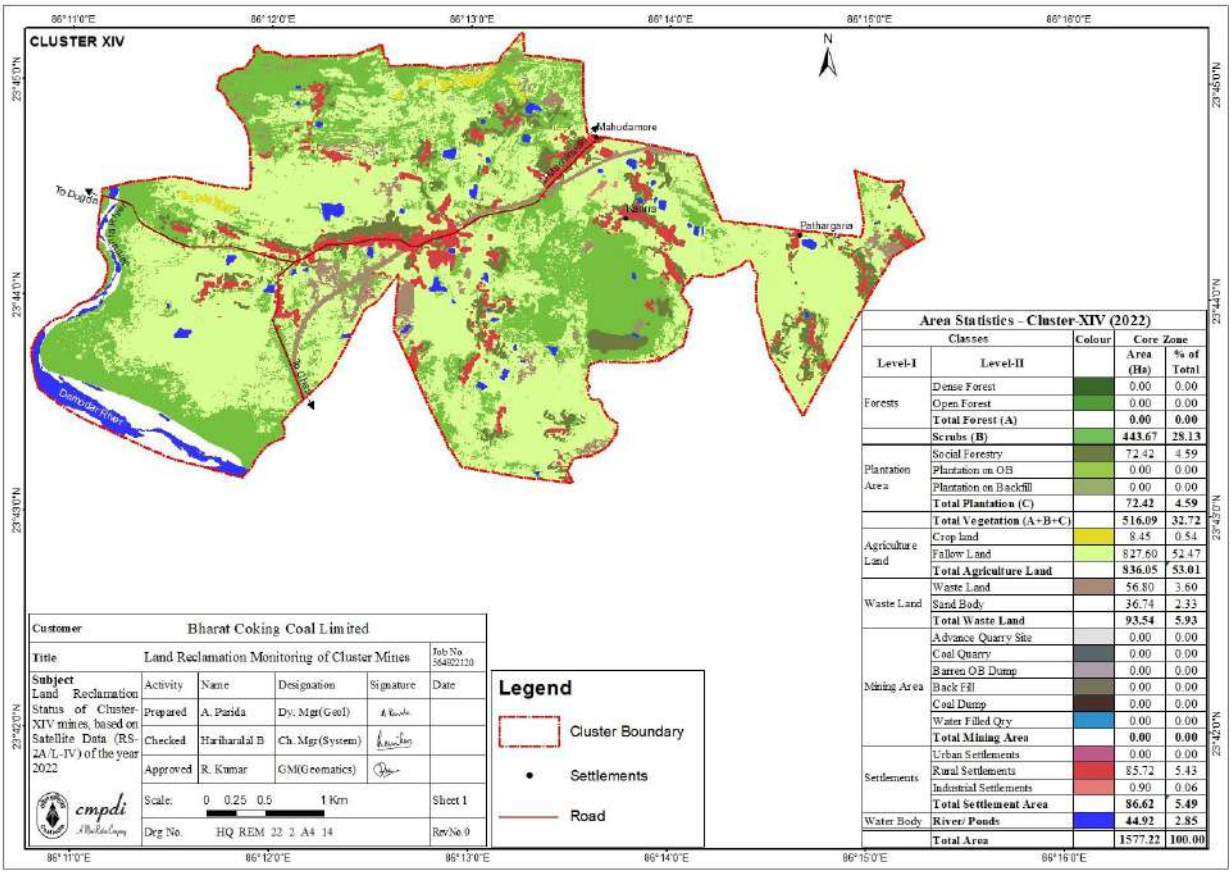
Monitoring stations (**B024 and B067**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'25, August'25, and Nov'25 and January'26. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2025-26				2024-25				2023-24			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	B024	Telmuchu	4.63	3.13	3.24	3.93	5.53	1.34	3.46	4.23	5.68	1.55	2.08	3.07
2	B067	Simatanr	8.05	3.85	5.32	6.27	8.50	3.55	6.30	7.35	8.95	2.45	2.95	3.65
Average WL (bgl)			6.34	3.49	4.28	5.1	7.02	2.45	4.88	5.79	7.32	2.00	2.52	3.36

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 4.63 m Max – 8.50 m
Post-monsoon GW Level (m): Min – 3.22 m Max – 6.30 m

LAND USE / LAND COVER MAP OF THE CLUSTER-XIV MINES, BCCL



Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forests	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
	Scrubs (B)		**443.67**	**28.13**
Plantation Area	Social Forestry		72.42	4.59
	Plantation on OB		0.00	0.00
	Plantation on Backfill		0.00	0.00
	Total Plantation (C)		**72.42**	**4.59**
	Total Vegetation (A+B+C)		**516.09**	**32.72**
Agriculture Land	Crop land		8.45	0.54
	Fallow Land		827.60	52.47
	Total Agriculture Land		**836.05**	**53.01**
Waste Land	Waste Land		56.80	3.60
	Sand Body		36.74	2.33
	Total Waste Land		**93.54**	**5.93**
Mining Area	Advance Quarry Site		0.00	0.00
	Coal Quarry		0.00	0.00
	Barren OB Dump		0.00	0.00
	Back Fill		0.00	0.00
	Coal Dump		0.00	0.00
	Water Filled Qry		0.00	0.00
	Total Mining Area		**0.00**	**0.00**
Settlements	Urban Settlements		0.00	0.00
	Rural Settlements		85.72	5.43
	Industrial Settlements		0.90	0.06
	Total Settlement Area		**86.62**	**5.49**
Water Body	**River/ Ponds**		**44.92**	**2.85**
	Total Area		**1577.22**	**100.00**

Sl no	Land Use Details	Existing (sq. meter)	Proposed (sq. meter)	Grand Total (sq. meter)
1	Green Belt Area	1251.76 x 10^4	0.0	1251.76 x 10^4
2	Open Land	79.76 x 10^4	0.0	79.76 x 10^4
3	Road/ Paved Area	85.83 x 10^4	0.0	85.83 x 10^4
4	Rooftop area of building/ sheds	0.90 x 10^4	0.0	0.90 x 10^4
5	Total	1418.25 x 10^4	0.0	1418.25 x 10^4

N. GROUND WATER LEVEL OF CLUSTER-XV

Mines o Cluster - XV comes under administrative control of Govindpur Area and Barora Area of B.C.C.L (Jharia Coalfield) which is located in Dhanbad district of Jharkhand. Cluster–XV consists of four coal mines; Kharkharee UG (underground mine) and Dharmaband UG which are under administrative control of Govindpur Area and Madhuband UG & Phularitand UG which are under the administrative control of Barora Area. The life of the project has been worked out to be up to 30 years considering annual production target of 0.423 MTPA. It is covered in Survey of India toposheet no. 73 I/1 and 73 I/5.

The present leasehold area of Cluster-XV is 1696.55 Ha. The topography of the area is undulating with slope towards south-west. The maximum RL is 235 m in the Kharkharee mine area whereas the minimum RL is 165 m AMSL on the eastern & western part of the Cluster. Jamunia River and Khudia River are controlling the drainage of the area. The area comes under the watershed area of both Jamunia River and Khudia River.

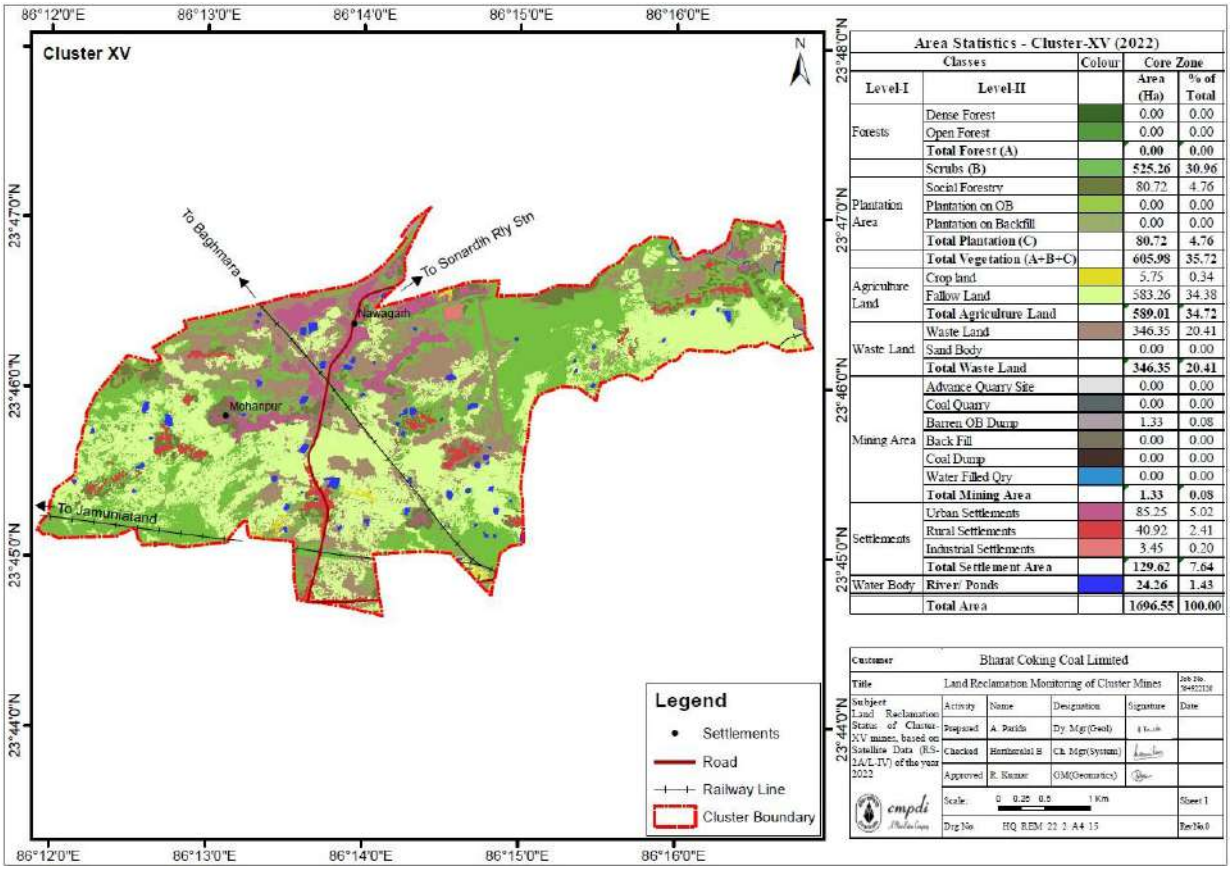
Monitoring stations (**A024, B032 and B062**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'25, August'25, and Nov'25 and January'26. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2025-26				2024-25				2023-24			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	A024	Pipratanr	5.43	3.71	3.96	4.12	5.38	3.60	3.90	5.00	7.28	2.55	4.33	5.32
2	B032	Madhuband	6.60	2.10	3.60	4.82	5.35	3.93	3.60	5.42	4.15	0.70	2.56	4.15
3	B062	Sadiyardih	4.97	3.01	3.19	3.80	4.80	2.35	3.10	4.00	6.45	1.77	4.91	5.15
Average WL (bgl)			5.67	2.94	3.58	4.25	5.18	3.29	3.53	4.81	5.96	1.67	3.93	4.87

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 4.15 m Max – 7.28 m
Post-monsoon GW Level (m): Min – 2.56 m Max – 4.91 m

LAND USE / LAND COVER MAP OF THE CLUSTER-XV MINES, BCCL



Area Statistics - Cluster-XV (2022)

Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forests	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
	Scrubs (B)		525.26	30.96
Plantation Area	Social Forestry		80.72	4.76
	Plantation on OB		0.00	0.00
	Plantation on Backfill		0.00	0.00
	Total Plantation (C)		**80.72**	**4.76**
	Total Vegetation (A+B+C)		**605.98**	**35.72**
Agriculture Land	Crop land		5.75	0.34
	Fallow Land		583.26	34.38
	Total Agriculture Land		**589.01**	**34.72**
Waste Land	Waste Land		346.35	20.41
	Sand Body		0.00	0.00
	Total Waste Land		**346.35**	**20.41**
Mining Area	Advance Quarry Site		0.00	0.00
	Coal Quarry		0.00	0.00
	Barren OB Dump		1.33	0.08
	Back Fill		0.00	0.00
	Coal Dump		0.00	0.00
	Water Filled Qry		0.00	0.00
	Total Mining Area		**1.33**	**0.08**
Settlements	Urban Settlements		85.25	5.02
	Rural Settlements		40.92	2.41
	Industrial Settlements		3.45	0.20
	Total Settlement Area		**129.62**	**7.64**
Water Body	River/ Ponds		24.26	1.43
	Total Area		**1696.55**	**100.00**

Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of Cluster Mines				Job No. 564922150
Subject	Activity	Name	Designation	Signature	Date
Land Reclamation Status of Cluster-XV mines, based on Satellite Data (RS-2A/L-IV) of the year 2022	Prepared	A. Parida	Dy. Mgr(Geol)		
	Checked	Hariharalal S	Ch. Mgr(System)		
	Approved	R. Kumar	GM(Geomatics)		
empdi	Scale:	0 0.25 0.5 1 Km			Sheet 1
	Drg No.	HQ REM/ 22/ 2/ A4/ 15			Rev No.0

Sl no	Land Use Details	Existing (sq. meter)	Proposed (sq. meter)	Grand Total (sq. meter)
1	Green Belt Area	365.18 x 10^4	0.0	957.34 x 10^4
2	Open Land	1130.53 x 10^4	0.0	538.37 x 10^4
3	Road/ Paved Area	101.67 x 10^4	0.0	101.67 x 10^4
4	Rooftop area of building/ sheds	99.17 x 10^4	0.0	99.17 x 10^4
5	Total	1696.55 x 10^4	0.0	1696.55 x 10^4

O. GROUND WATER LEVEL OF CLUSTER-XVI

Mines of Cluster - XVI (Dahibari-Basantimata Group of mines) are under administrative control of Chanch Victoria Area of B.C.C.L (western part of Raniganj Coalfield) which is located in Dhanbad district of Jharkhand. There are total five collieries within this Cluster- XVI (Dahibari-Basantimata OC, Basantimata UG, New Laikdih OC, Laikdih Deep UG and Chanch UG Colliery). All the above mines are contiguous in nature and the environmental impact is overlapping in ambient environment due to cumulative effect of mining activities. Life of the project has been worked out to be up to 24 years considering annual production target of 1.963 MTPA. It is covered in Survey of India toposheet no. 73 I/14.

The present leasehold area of Cluster-XVI is 2008.40 Ha. The topography of the area is undulating with slope towards south-west. The area is plain with gently undulating with elevation varying from 100 m to 140 m AMSL. The general slope of the area is towards southeast. Barakar River and Khudia River are controlling the drainage of the area. The area comes under the watershed area of Barakar River.

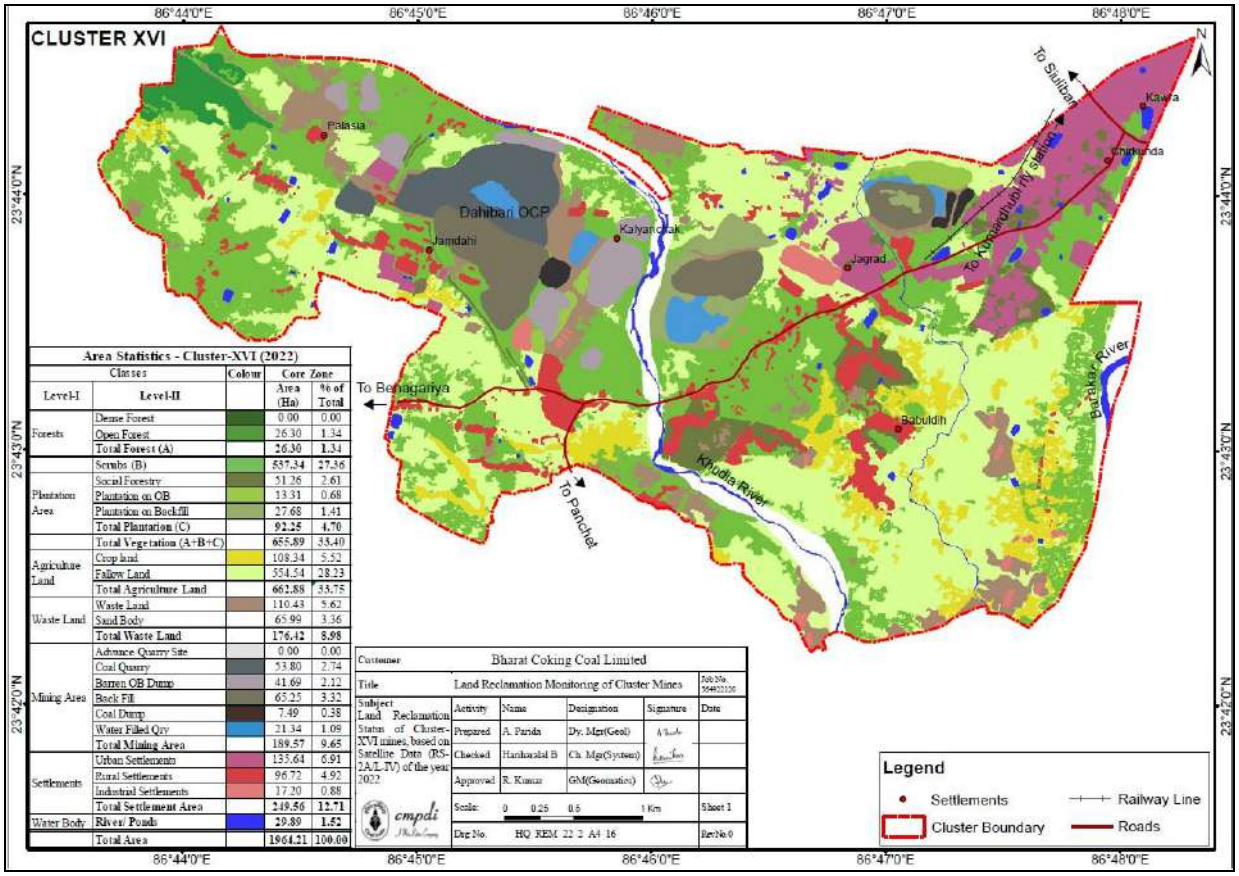
Monitoring stations (**DB022, DB023, DB024 & DB025**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of May'25, August'25, Nov'25 and January'26. The Ground water level data is presented in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2025-26				2024-25				2023-24			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	DB022	Dahibari, Basti	4.08	1.63	2.33	3.07	4.25	2.07	2.43	3.31	3.72	1.47	1.99	1.58
2	DB023	Dahibari OC	4.56	1.24	2.79	3.07	4.80	2.61	2.94	4.24	3.56	1.71	2.60	2.40
3	DB024	Dahibari	7.84	3.73	6.92	6.98	8.25	3.50	4.18	6.87	7.08		3.91	
Average WL (bgl)			5.49	2.20	4.02	4.37	5.77	2.73	3.18	4.81	4.79	1.59	2.83	1.99

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 3.56 m Max – 8.25 m
Post-monsoon GW Level (m): Min – 1.99 m Max – 6.92 m

LAND USE / LAND COVER MAP OF THE CLUSTER-XVI MINES, BCCL



Area Statistics - Cluster-XVI (2022)

Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forests	Dense Forest		0.00	0.00
	Open Forest		26.30	1.34
	Total Forest (A)		26.30	1.34
Plantation Area	Scrubs (B)		537.34	27.36
	Social Forestry		51.26	2.61
	Plantation on OB		13.31	0.68
	Plantation on Backfill		27.68	1.41
	Total Plantation (C)		92.25	4.70
	Total Vegetation (A+B+C)		655.89	33.40
Agriculture Land	Crop land		108.34	5.52
	Fallow Land		554.54	28.23
	Total Agriculture Land		662.88	33.75
Waste Land	Waste Land		110.43	5.62
	Sand Body		65.99	3.36
	Total Waste Land		176.42	8.98
Mining Area	Advance Quarry Site		0.00	0.00
	Coal Quarry		53.80	2.74
	Barren OB Dump		41.69	2.12
	Back Fill		65.25	3.32
	Coal Dump		7.49	0.38
	Water Filled Qry		21.34	1.09
	Total Mining Area		189.57	9.65
Settlements	Urban Settlements		135.64	6.91
	Rural Settlements		96.72	4.92
	Industrial Settlements		17.20	0.88
	Total Settlement Area		249.56	12.71
Water Body	River/ Ponds		29.89	1.52
	Total Area		1964.21	100.00

Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of Cluster Mines				Job No. 554022106
Subject	Activity	Name	Designation	Signature	Date
Land Reclamation Status of Cluster-XVI mines, based on Satellite Data (RS-2A/L-IV) of the year 2022	Prepared	A. Panda	Dy. Mgr(Geol)		
	Checked	Hanhumlal B	Ch. Mgr(System)		
	Approved	R. Kumar	GM(Geomatics)		
	Scale:	0 0.25 0.5 1 Km			Sheet 1
	Drg No.	HQ/REM/22/2/A4/16			Rev No 0

Sl no	Land Use Details	Existing (sq. meter)	Proposed (sq. meter)	Grand Total (sq. meter)
1	Green Belt Area	1349.29 x 10^4	0.0	1349.29 x 10^4
2	Open Land	401.55 x 10^4	0.0	401.55 x 10^4
3	Road/ Paved Area	142.41 x 10^4	0.0	142.41 x 10^4
4	Rooftop area of building/ sheds	115.15 x 10^4	0.0	115.15 x 10^4
5	Total	2008.40 x 10^4	0.0	2008.40 x 10^4

P. GROUND WATER LEVEL OF CLUSTER-XVII

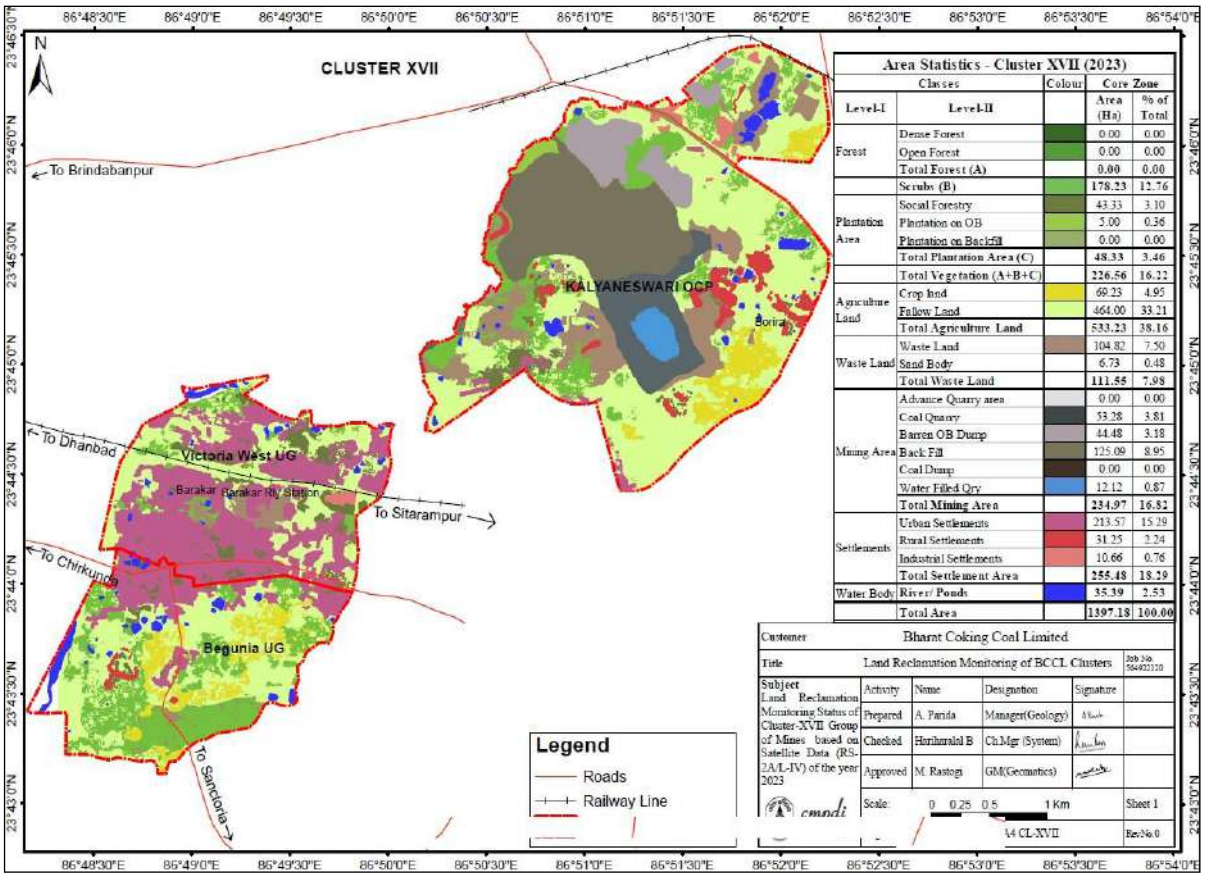
Cluster-XVII mines are under administrative control of Chanch Victoria Area, BCCL, located in western part of Raniganj coalfield in Dhanbad district of Jharkhand. Cluster–XVII consists of two closed Underground (UG) coal mines (Begunia Colliery and Victoria-West Colliery) and one opencast mines [Kalyaneshwari OCP]. The Leasehold area of the Cluster is located between latitude 23^0 43' 08" to 23^0 46' 26" N and longitude 86^0 47' 46" to 85^0 52' 11" E. All the above mines are contiguous in nature and the environmental impact is overlapping in the ambient due to cumulative effect of the mining activities. Leasehold area of the Cluster is 1397.18 ha and the capacity of the project is 4.0 MTPA using opencast method. Cluster-XVII mines is covered in Survey of India toposheet no. 73 I/13. The cluster is approachable both by rail and road. Salanpur and Kulti railway stations of Eastern Railways are at a distance of about 0.6 km from the eastern and southwestern boundary of the cluster respectively. The National Highway No.19 (NH-19) passes through the north eastern part of the cluster and the National Highway No.419 (NH-419) passes along the eastern boundary of the cluster while the Kulti and Barakar townships are about 2 km by road to the south east of the area.The study area has an undulating topography with gentle slope towards south and south west. The buffer zone is predominantly characterized by plain land, with highlands located in parts of the northwest, northeast, and southwest. The area comes under the watershed area of Barakar River.

Sl No.	Well No.	Location	Water level (bgl in meters)											
			2025-26				2024-25				2023-24			
			May	Aug	Nov	Jan	May	Aug	Nov	Jan	May	Aug	Nov	Jan
1	DB8	Chungei	5.40	3.06	4.10	4.76	4.50	2.55	3.42	3.97	4.67		2.86	
2	DB9	Barakar	10.26	6.42	7.34	8.93	9.50	4.17	5.18	6.47	9.68		4.85	
3	DB12	Sabanpur	5.60	2.07	2.37	3.27	5.44	2.01	2.30	3.17	4.56		1.89	
4	K26		2.14	1.36	1.53	1.58	2.10	1.33	1.50	1.55	1.93		1.29	
Average WL (bgl)			5.85	3.23	3.84	4.64	5.39	2.52	3.10	3.79	5.21		2.72	

LAST THREE-YEAR ASSESSMENT:

Pre-monsoon GW Level (m): Min – 1.93 m Max – 10.26 m
Post-monsoon GW Level (m): Min – 1.29 m Max – 7.34 m

LAND USE / LAND COVER MAP OF THE CLUSTER-XVII MINES, BCCL



Level-I	Level-II	Area (Ha)	% of Total
Forest	Dense Forest	0.00	0.00
	Open Forest	0.00	0.00
	Total Forest (A)	0.00	0.00
Plantation Area	Scrubs (B)	178.23	12.76
	Social Forestry	43.33	3.10
	Plantation on OB	5.00	0.36
	Plantation on Backfill	0.00	0.00
	Total Plantation Area (C)	48.33	3.46
	Total Vegetation (A+B+C)	226.56	16.22
Agriculture Land	Crop land	69.23	4.95
	Fallow Land	464.00	33.21
	Total Agriculture Land	533.23	38.16
Waste Land	Waste Land	104.82	7.50
	Sand Body	6.73	0.48
	Total Waste Land	111.55	7.98
Mining Area	Advance Quarry area	0.00	0.00
	Coal Quarry	53.28	3.81
	Barren OB Dump	44.48	3.18
	Back Fill	125.09	8.95
	Coal Dump	0.00	0.00
	Water Filled Qry	12.12	0.87
	Total Mining Area	234.97	16.82
Settlements	Urban Settlements	213.57	15.29
	Rural Settlements	31.25	2.24
	Industrial Settlements	10.66	0.76
	Total Settlement Area	255.48	18.29
Water Body	River/ Ponds	35.39	2.53
	Total Area	1397.18	100.00

Sl no	Land Use Details	Existing (sq. meter)	Proposed (sq. meter)	Grand Total (sq. meter)
1	Green Belt Area	336.55 x 10^4	0.0	336.5 x 10^4
2	Open Land	1008.81 x 10^4	0.0	1008.81 x 10^4
3	Road/ Paved Area	26.81 x 10^4	0.0	26.81 x 10^4
4	Rooftop area of building/ sheds	25.06 x 10^4	0.0	25.06 x 10^4
5	Total	1397.23 x 10^4	0.0	1397.23 x 10^4

4.0 GROUND WATER LEVEL SCENARIO

The summarized water level data of all clusters given in **Table – 7**.

Table –7: Groundwater level data (Cluster-wise)

Sl. No.	Cluster of BCCL	No. of Monitoring Wells	Water level Below ground level (May, Aug, Nov'25 & Jan'26)	Avg. Fluctuation (in meters) during 2025	Geological Formation
1	I	3 nos.	0.80 to 5.20 m	1.48 m	Barakar
2	II	4 nos.	0.50 to 10.73 m	2.16 m	Barakar
3	III	4 nos.	1.09 to 10.73 m	2.06m	Barakar
4	IV	3 nos.	1.95 to 8.45 m	3.59 m	Barakar
5	V	2 nos.	0.55 to 5.55 m	1.07 m	Barakar
6	VI	3 nos.	1.80 to 4.40 m	1.39 m	Barakar
7	VII	4 nos.	1.22 to 4.75 m	1.48 m	Barakar
8	VIII	2 nos.	2.52 to 8.52 m	4.06 m	Barakar
9	IX	4 nos.	1.88 to 9.03 m	3.49 m	Barakar
10	X	4 nos.	0.50 to 5.98 m	1.23 m	Barakar
11	XI	3 nos.	0.95 to 8.02 m	2.09 m	Barakar & Barren Measure
12	XIII	3 nos.	2.98 to 9.00 m	2.30 m	Raniganj
13	XIV	2 nos.	3.13 to 8.05 m	2.06 m	Raniganj
14	XV	3 nos.	2.35 to 5.42 m	1.64 m	Barakar & Barren Measure
15	XVI	3 nos.	2.07 to 8.25 m	2.50 m	Barakar

Depth to water level (in bgl) values describe that water level goes down to maximum 10.73 m during summer season and minimum up to 0.50 m during monsoon season of 2023. Un-confined aquifer is affected around 20 m to 30 m of maximum radius close to active opencast mining areas, showing steep gradient towards mine void. Other than that, there is no mining effect in the water level within JCF area and RCF area (part). Historical water level data and hydrograph of permanent observation stations from CGWB is shown in **Annexure–VI**. Water Table contour map and Depth to water level map both during pre & post-monsoon season is shown in **Plate-IV (A, B) & V (A, B)**.

Monitoring of groundwater (quantity & quality) to assess the present condition and resource has been done regularly in the coalfield area. Well hydrographs (**Annexure–VI**) are prepared and studied to identify

long-term trends. Hydrograph trend analysis of CGWB monitoring wells and observation wells reveals increasing groundwater level trends in most of the Cluster of mines. However, declining trends in both Pre and Post-monsoon GW level in Cluster-I, Cluster-V, Cluster-VI, Cluster-VIII and Cluster-XIII are recorded but no significant declining trend (>1.0 m/year) of water level is noticed in any particular area for the last 10 years within the coalfield area. Regarding quality monitoring, the water sample location map (**Plate–II**) with collection points details (dug wells) are given in **Annexure–V** and Quality is given in **Annexure–VII**.

5.0 DETAILS OF PIEZOMETERS

A piezometer network is useful for monitoring the impact of mining activity on groundwater regime. Total 23 nos. of Piezometers were constructed during 2025-26 within JCF and RCF to monitor GW level (**Plate-III**). The depth of piezometers varies from 30m to 300m below ground level.

Water level in the piezometers from May 25 to Dec 26 are furnished below in **Table-8** and the hydrographs are given in the Annexure VIB.

Table –8: Groundwater level data in Piezometers (Cluster-wise)

PZ ID	Cluster	Colliery	Lat.	Long.	Depth (m)	May 25	Aug 25	Dec 25
PZ1A	I	Damuda	23.7692	86.1754	40	11.70	11.35	11.60
PZ1B	I	Damuda	23.7692	86.1753	115	31.95	27.15	32.90
PZ2A	II	Benidih	23.7672	86.1890	87	29.10	24.95	27.65
PZ2B	II	Jogidih	23.7908	86.2470	77	4.40	4.46	3.54
PZ3A	III	Mahespur	23.8015	86.2824	172	25.00	24.85	31.60
PZ3B	III	E Katras	23.7798	86.2418	30			
PZ3C	III	E Katras	23.8016	86.2824	124	87.10	80.18	83.10
PZ4A	IV	Gaslitand	23.7764	86.3123	70	35.75	34.30	36.20
PZ4B	IV	Gaslitand	23.7765	86.3125	240	14.45 ??		18.00 ??
PZ5A	V	Loyabad	23.7817	86.3569	35	4.50	2.32	1.24
PZ5B	V	Nichitpur	23.7999	86.3619	94	88.40	89.20	89.10
PZ7A	VII	Amal Dhansar Ind	23.7701	86.4110	159	106.20	101.45	98.45
PZ7B	VII	Simlabahal	23.7400	86.3997	35	25.05	23.30	24.48

PZ7C	VII	N Tisra	23.7342	86.4433	105	77.90	67.82	71.93
PZ8A	VIII	Dobari	23.7556	86.4271	140			
PZ9A	IX	N Tisra	23.7305	86.4464	84			
PZ9B	IX	Bararee	23.6962	86.4159	100	71.30	65.30	71.30
PZ10A	X	Bhowrah N	23.6880	86.4051	134	6.45	4.70	5.70
PZ11A	XI	Singra	23.7264	86.3419	300	56.20	54.15	47.35
PZ13A	XII	Bhatdih	23.7138	86.2516	80	35.70	29.30	36.34
PZ14A	XIV	Lohapatti	23.7415	86.2139	30	12.50	4.20	8.70
PZ14B	XIV	Lohapatti	23.7415	86.2139	162	14.60	9.33	10.35
PZ16A	XVI	CV	23.7308	86.7605	90	34.00		

6.0 GROUND WATER QUALITY

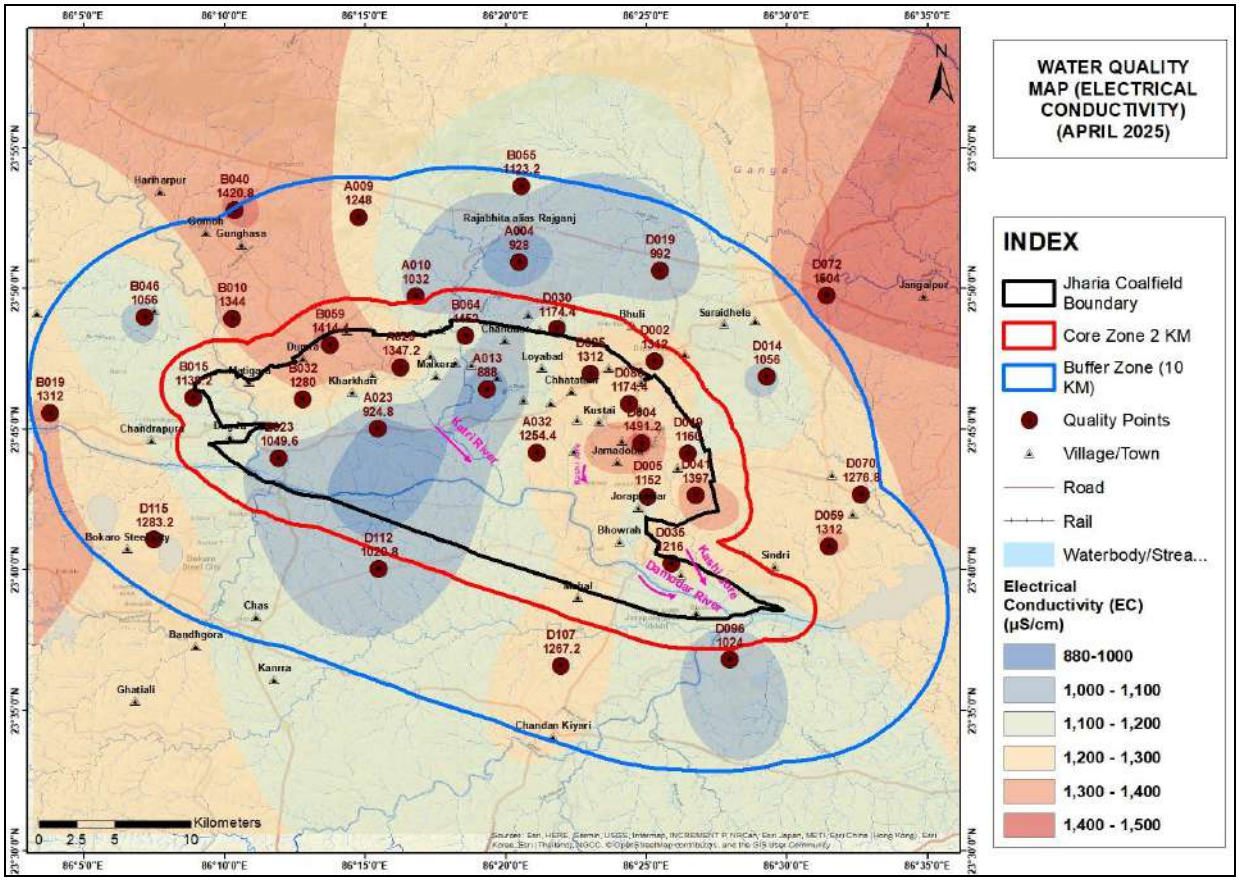
The ground water samples of the study area (16 nos. of Cluster of mines, BCCL) were collected from dug wells and analyzed. Thirty-five ground water samples were analyzed during the month of June'25 at CMPDI, RI-II, Dhanbad. The water sampling details is given in **Annexure–V** and Water sample locations are shown in **Plate-II**. The water quality data is presented in **Annexure–VII.**

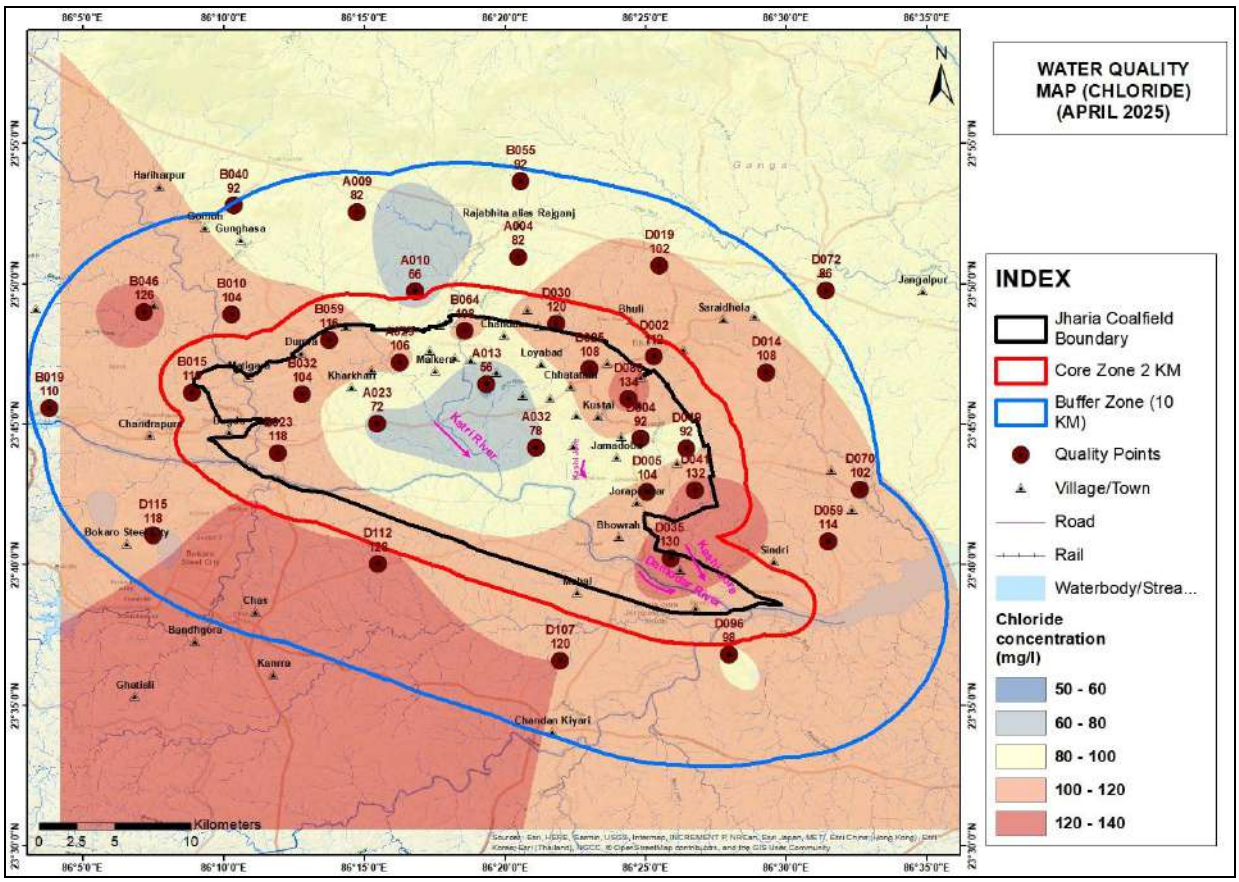
The study of the variations in water quality parameters is described below:

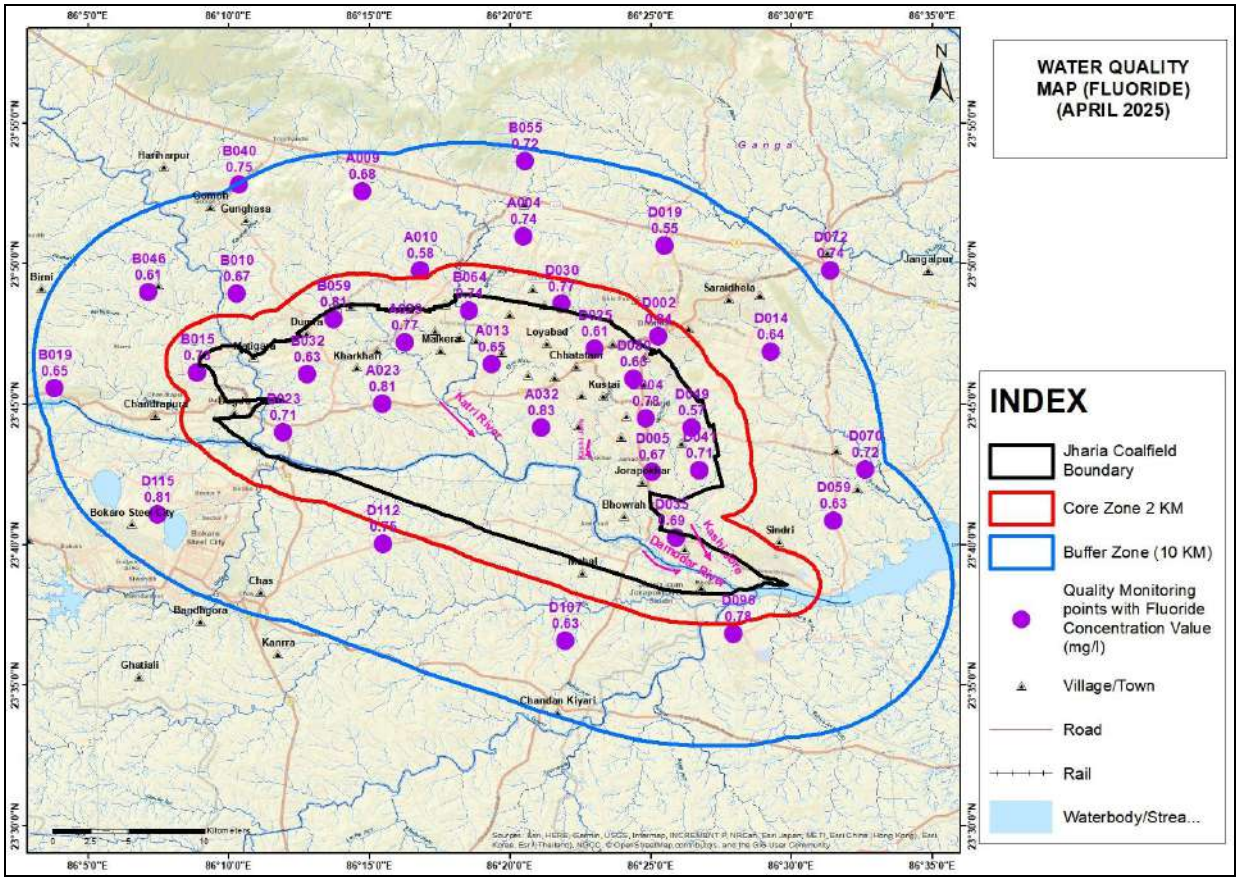
.

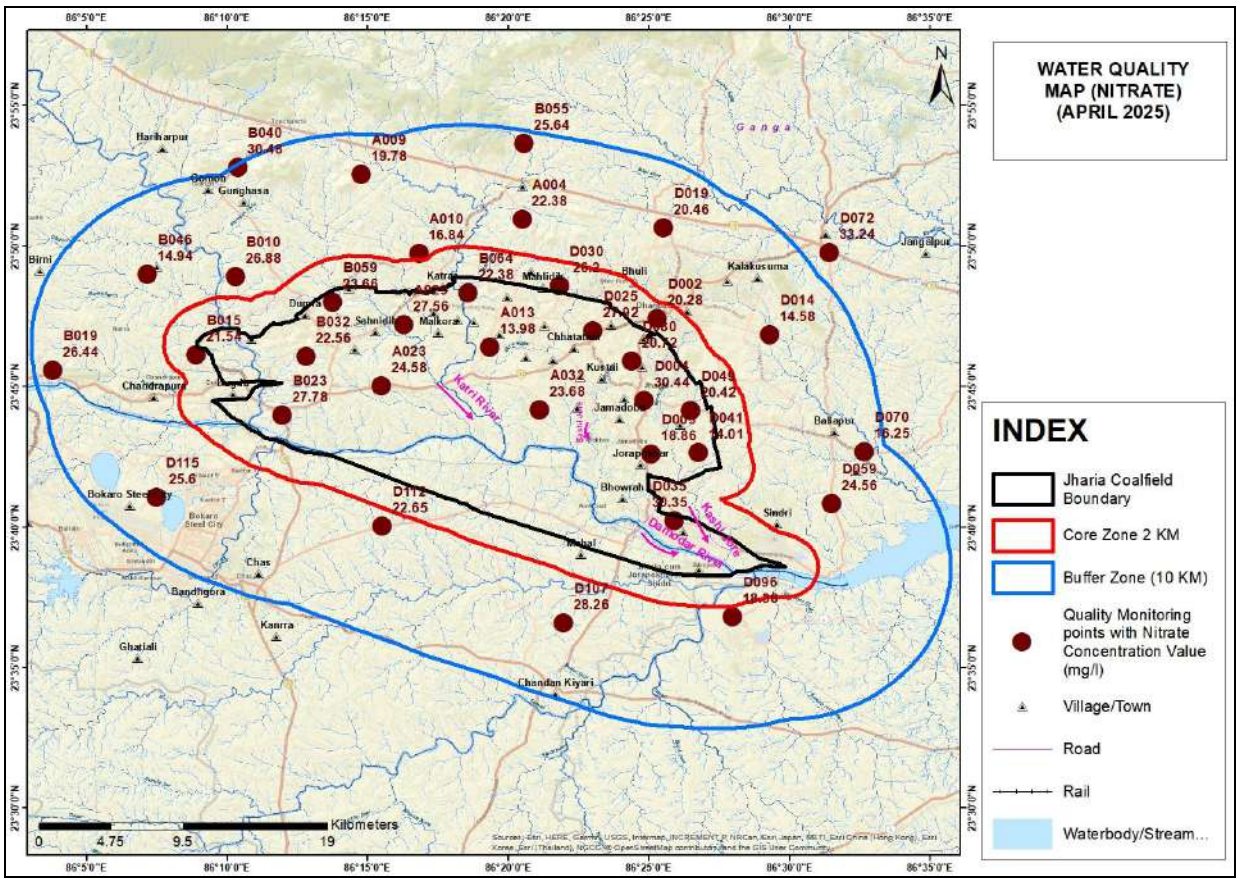
In wells of JCF concentration of magnesium in the water samples varies 103 (D-70) to 125 mg/l (D-4) and is above the permissible limit (100 mg/l) of drinking water standards. The total hardness mg/l ranges from 614 (A-09) to 824 mg/L (D-72) and is above the permissible limit of (600 mg/L) of drinking water standards The Iron, Manganese, Zinc and Chromium concentration in the water samples found to be below the upper IS 10500:2012 limits for drinking water.

In RCF part of BCCL Command area at a few locations, the total hardness value of the analyzed samples exceeds the permissible limit of 600 mg/L, specifically at DB2A (650 mg/L), DB4 (680 mg/L), DB30 (648 mg/L), DB38 (705 mg/L), and DB39 (602 mg/L). The rest of the groundwater quality data indicates that the values are well within the permissible limits as per the IS 10500:2012 drinking water standards.


WATER QUALITY MAP (ELECTRICAL CONDUCTIVITY) (APRIL 2025)
INDEX
Jharia Coalfield Boundary
Core Zone 2 KM
Buffer Zone (10 KM)
Quality Points
Village/Town
Road
Rail
Waterbody/Strea...
Electrical Conductivity (EC) (µS/cm)
880-1000
1,000 - 1,100
1,100 - 1,200
1,200 - 1,300
1,300 - 1,400
1,400 - 1,500
Kilometers
0 2.5 5 10
N


WATER QUALITY MAP (CHLORIDE) (APRIL 2025)
INDEX
Jharia Coalfield Boundary
Core Zone 2 KM
Buffer Zone (10 KM)
Quality Points
Village/Town
Road
Rail
Waterbody/Strea...
Chloride concentration (mg/l)
50 - 60
60 - 80
80 - 100
100 - 120
120 - 140
Kilometers
0 2.5 5 10
N


WATER QUALITY MAP (FLUORIDE) (APRIL 2025)
INDEX
Jharia Coalfield Boundary
Core Zone 2 KM
Buffer Zone (10 KM)
Quality Monitoring points with Fluoride Concentration Value (mg/l)
Village/Town
Road
Rail
Waterbody/Strea...
Ganga
Damodar River
Katri River
Kilometers


WATER QUALITY MAP (NITRATE) (APRIL 2025)
INDEX
Jharia Coalfield Boundary
Core Zone 2 KM
Buffer Zone (10 KM)
Quality Monitoring points with Nitrate Concentration Value (mg/l)
Village/Town
Road
Rail
Waterbody/Stream...
Ganga
Damodar River
Katri River
Kilometers

7.0 STAGE OF GROUNDWATER EXTRACTION

The groundwater is mainly utilized for domestic needs and irrigation purposes. The groundwater abstraction is mainly through dug wells and bore wells. The stage of groundwater development in Dhanbad District is 74.34% (as per GWRE 2023-24, INGRES Portal). The highest stage of development is in Baliapur Block (110.03%) & Dhanbad Urban Block (95.65%) and lowest stage of development is in Purbi Tundi Block (26.15%) and Chirkunda Block (34.53%) as per GWRA-2023-24 (Source: Ingres Portal). The Gondwana sandstones in general, known to constitute good aquifers at many places. However, the yield potential of the area adjoining to active mines in the coal belt is poor. The active mines often act as groundwater "sinks". In contrast, the water-logged abandoned mines and pits act as potential sources of groundwater. Block wise data of Dhanbad District given below:

Table–9A: Block wise Stage of Groundwater development

Sl No.	Administrative Unit			Category (GWRA-2023-24)
	State	District	Block	
1	Jharkhand	DHANBAD	BAGHMARA	Semi-Critical
2	Jharkhand	DHANBAD	BALIAPUR	**Over Exploited**
3	Jharkhand	DHANBAD	DHANBAD	Semi-Critical
4	Jharkhand	DHANBAD	DHANBAD URBAN	Critical
5	Jharkhand	DHANBAD	JHARIA	Hilly Area
6	Jharkhand	DHANBAD	TOPCHANCHI	Critical
7	Jharkhand	DHANBAD	TUNDI	Safe
8	Jharkhand	DHANBAD	PURBI TUNDI	Safe
9	Jharkhand	DHANBAD	CHIRKUNDA	Safe
10	Jharkhand	DHANBAD	GOBINDPUR	Semi-Critical
11	Jharkhand	BOKARO	CHANDRAPURA	Safe
12	W Bengal	P BARDHAMAN	SALANPUR	Safe

- **Dynamic Groundwater Resource Assessment, CGWB as per 2023-24.**

Table–9B: Cluster wise Groundwater development scenario

Cluster/ Area	Adminis-trative Blocks/Stage Of GW Extraction	Total Water demand (cum/day)				Avg. GW level (bgl in m) 2025-26		GW level declining trend 2005-2025		Remarks
		Mine Discharge + BH pumping	Surface Water Source	Total Use (Domestic + Industrial)	Excess Or other use	Pre-monsoon	Post-monsoon	Pre-monsoon	Post-monsoon	
Cluster-I	Chandrapura (SOD: Safe)	2601 (2493+108)	NIL	2380 (1700+680)	221	4.28	2.20	YES	YES	Recharge structure needed
Cluster-II	Baghmara (SOD: Semi Critical)	14465 (14660+5)	Jamunia river	9100 (6150+2950)	5365	5.29	3.05	NO	NO	Excess mine water needed to be utilized
Cluster-III		15285 (13485+1800)	NIL	9405 (8000+1405)	5730	5.10	3.37	YES	NO	
Cluster-IV		10212	MADA	5953 (2928+3025)	4259	7.30	3.22	YES	NO	
Cluster-V		19758 (19753+5)	MADA	8850 (6500+2350)	10238	5.78	3.61	YES	YES	
Cluster-VI	Dhanbad (SOD: Semi Critical)	6616	MADA	3310 (2155+1155)	3306	4.92	2.79	YES	NO	--
Cluster-VII		29218	MADA	18220 (15000+3220)	10998	3.56	2.57	YES	YES	Excess mine water needed to be utilized
Cluster-VIII		10501	MADA	9001 (7746+1255)	1550	6.05	3.80	YES	NO	
Cluster-IX		20192	MADA	9670 (6600+3070)	9767	6.62	4.01	NO	NO	
Cluster-X		15507	Damodar river	6519 (3437+3082)	8988	4.27	2.84	NO	NO	
Cluster-XI	Dhanbad (SOD: Critical)	34023	MADA & DVC	20325 (14015+6310)	13448	4.86	2.76	YES	NO	
Cluster-XIII	Baghmara (SOD: Critical)	445	Damodar river	445 (445+0)	0	7.66	4.86	NO	NO	--
Cluster-XIV		384	NA	384 (384+0)	0	6.34	4.28	NO	NO	--
Cluster-XV		6810	NA	5355 (4600+755)	1205	5.67	3.58	NO	NO	--
Cluster-XVI	Chirkunda (SOD: Safe)	5204	DVC (Barakar river)	1730 (1380+350)	3294	5.49	4.02	NO	NO	--
Cluster-XVII	Salanpur (SOD: Safe)	5091	DVC (Barakar river)	5091 (1470+1405)	2216	5.85	3.84	NO	NO	-

MADA – Mineral Area Development Authority, Jharkhand, Dhanbad (payment basis).

DVC – Damodar Valley Corporation, Maithon/Panchet, Jharkhand (payment basis).

8.0 IMPACT OF MINING ON GROUND WATER REGIME

8.1 GENERAL CONSEQUENCES OF COAL MINES ON AMBIENT HYDROGEOLOGICAL REGIME

Mining of coal either by opencast or underground method is bound to incise one or more water bearing strata (aquifers) which, in turn, may result in depletion or draw down in water levels and a corresponding inflow of water into the mine workings. The potential effects of coal mining operations on the hydrogeological regime are as under:

- Creates disruption in formation/aquifer
- Dewatering of aquifers
- Change in hydraulic gradient
- Modification in recharge of aquifers
- Change in groundwater flow pattern

The general need in mine planning from the hydrogeological point of view is the estimation of ground water seepage into the mine, its rate, the mine pumping capacity to meet the storm rainwater accumulation, extent of depression of water surface and management of mine effluent (mine water). It is also desirable that the consequences of mining operation on groundwater regime be determined in advance. However, the mine pumping in most of the cases are passive dewatering for the safety of the mine pit, active mine dewatering is done in few cases for very high potential aquifers.

8.2 POTENTIAL CONSEQUENCES OF OPENCAST AND UNDERGROUND COAL MINES ON HYDROGEOLOGICAL REGIME IN JHARIA COALFIELD

Generally, in the opencast and underground mines of Jharia Coalfield, alluvium and overlying weathered mantle are the first to be excavated, followed by upper Barakar Formation / Aquifer. Since these formations vary in thickness, compaction and their constituents over the area, their aquifer properties also vary.

The porosity and the compactness in the sandstone controls the discharge from these aquifers. The alluvium and weathered Formation wherever loose and fragile possess more porosity and this has high groundwater potential. Due to the mine cut, a depression in the water table is created. The initial discharges due to this depression is large in amount because of concentration of flow to that region. In the top zones, water table condition prevails and semi-confined conditions exist in the stratified section (Gondwana Sedimentary basin). With progress of mine operations, there is an increase in the depth of incision, as a result which, the semi-confined aquifers are also gets punctured.

During mining, the hydraulic gradients generally steep down near mine i.e. within the mine influence area. In the up-dip region, only un-confined aquifer is punctured through the mining process and thus only unconfined aquifer is affected whereas in the down-dip region both un-confined and semi-confined aquifers may be affected. The confined aquifers of lower Barakar Formation in the mining area are not punctured as it lies below the working coal seams and hence normally there is no noticeable effect in the aquifer related to this formation.

8.3 ESTIMATION OF RADIUS OF MINE INFLUENCE ZONE

Radius of Influence can be defined as the radial distance from the center of the borehole to the point where there is no lowering of groundwater table/potentiometric surface.

The radius of influence (R) for Opencast and UG Mines within Jharia CF is calculated by using Sichardt's formula based on present mining scenario.

$$R_0 = C*(H-h) * \sqrt{(K)}$$

Where, R_0- Radius of influence (m), C - Constant =3000,

(H-h)- Drawdown (m), K – Hydraulic conductivity (m/s).

Here, K for Barakar Formations is 0.05 m/d or 5.7 x 10^{-7} m/sec.

Here, it may be appropriate to mention that the presence of prominent boundaries/water bodies, faults or inter-fringing of sandstone and shale beds may restrict the propagation of drawdown cone. With the presence of low permeable beds such as clay/shale and younger coal seams in the formation, laying above the working seams the water level in the phreatic aquifer is not directly affected. Both, the phreatic and semi-confined aquifers, get affected during the working by board and pillar method as subsidence takes place while extracting total coal (depillaring). Surface vigilance and filling up subsided zone, if any, has to be constantly under observation. The effect on groundwater level for most of the coalmine in Jharia coalfield has been observed in the down-dip side, generally within a distance up to 500 m from active mine zone and becomes milder/ negligible thereafter.

9.0 CONSERVATION MEASURES & FUTURE STRATEGY

- BCCL has installed 25 Pressure Filter Plant of total capacity of 4.16 MGD to meet drinking water requirement in nearby area. At present 63 Water Treatment Plants are operational having

capacity of 16.16 MGD within Jharia Coalfield area. Further, installation of 28 more Pressure Filter Plants having capacity of 5.84 MGD are in progress.

- BCCL has participated in development of low cost technology for drinking water in a CSIR project along with CIMFR, Dhanbad and a pilot plant of 4000 Liters/hour is functional at PB Project site of BCCL. Similar plants have been proposed at other sites of BCCL.
- A scheme titled 'Scheme for multi-purpose utilization of surplus mine water of Barora Area, Block II and Govindpur Area of BCCL' was prepared with a view to harness the excess water discharge to take care of the persistence problem of water scarcity in the nearby villages. In the scheme, two water reservoirs of capacity 27 MG and 17 MG have been proposed in the non-coal bearing area for storage of 3250 GPM and 2000 GPM surplus mine water which will be fed by mine discharge at mines of Barora, Block-II and Govindpur Area through pipe line.
- Rooftop rainwater harvesting (RWH) has been taken up in the project areas using the administrative buildings. 138 no. of quarters having roof-top area of about 14950 sq. m. is ready to harvest rainwater and around 13150 cum/annum of water is going to recharge the nearby groundwater system through RWH structures. Proposal has already been made to facilitate this kind of RWH structure at suitable locations i.e., Lodna Area, Kusunda Area (Jawahar Nagar, Matkuria, Coal Board Colony), Sijua Area (Nichitpur and Tetulmari Colony) within Jharia Coalfield to augment groundwater recharge.
- After cessation of mining, with plenty of rainfall and abundant ground water recharge, the water levels will recoup and attain normalcy. Thus, the impact of mining on groundwater system may be considered as a temporary phenomenon. The abandoned mine workings (UG) behave as water pool and improves the resources availability in the coalfield area.
- Utilization of treated mine water discharge by both, industry and local people, in the mine influence area. The excess mine water can be used to recharge groundwater system by connecting pipelines to abandoned dug wells. Utilization of mine water for irrigation will also enhance the ground water recharge potential through artificial recharge in the area.
- Increase vegetative cover by plantation in the mine area under land amelioration measures. This will contain the surface run-off and increase the groundwater recharge.
- Imparting awareness among workers and local peoples about Rainwater harvesting and artificial recharge will have priority. This aspect is usually covered during the Environmental Week celebrated every year (5 to 12 June).

- Monitoring of water quality of mine water discharge, local River/nala and domestic water source (dug well/hand pump wells) will continue under routine monitoring (May, August, November & Jan).

10.0 EXISTING/PROPOSED RAINWATER HARVESTING STRUCTURES IN BCCL COAL MINES

Fig-3 to 4.

Proposed Rain Water Harvesting Site GVTC, Cluster-I, Barora Area

Proposed Rain Water Harvesting Site Nehru Balika Vidhalaya, Cluster-I, Barora Area

Fig-5 to 6.

Proposed Rain Water Harvesting Site Barora Area Guest House, Cluster-I, Barora Area

Proposed Rain Water Harvesting Site Regional Hospital Baghmara, Cluster-I, Barora Area

Fig-7 to 8.

Proposed Rain Water Harvesting Site – Barora Area Office, Cluster-I, Barora Area

RECHARGE POND / ABANDONDED IN THE JCF MINE AREA

Fig-9 to 10.

RECHARGE POND / ABANDONDED IN THE JCF MINE AREA

FILTER PLANT IN THE MINE AREA

Fig-11 to 12.

RECHARGE POND / ABANDONDED IN THE JCF MINE AREA

RECHARGE POND / ABANDONDED IN THE JCF MINE AREA

Fig-13 to 14.

RECHARGE POND / ABANDONDED IN THE JCF MINE AREA

Annexure – IV

25 Year Normal Rainfall Data (in mm) for Dhanbad District (Source: WRIS Grided Data)

Yearly Rainfall (25 Years Normal: 1998-2022)	
Year	**Rainfall (in mm)**
1998	1578
1999	1903
2000	1481
2001	1648
2002	1584
2003	1546
2004	1401
2005	1149
2006	1390
2007	1773
2008	1173
2009	1303
2010	1027
2011	1296
2012	1152
2013	1203
2014	1002
2015	996
2016	1398
2017	1385
2018	1144
2019	1357
2020	1116
2021	1745
2022	982

Monthly Rainfall (25 Years Normal: 1998-2022)	
Month	**Rainfall (in mm)**
January	8.2
February	15.1
March	19.8
April	32.1
May	77.6
June	204.6
July	329.6
August	285.8
September	259.9
October	105.5
November	6.4
December	4.5
Total	1349.1

Annexure – IV

Block wise Rainfall Data as per GWRE 2023-24 (Source: INGRES Portal)

State	District	Block	Category (GWRE 2023-24)	Rainfall in mm
Jharkhand	DHANBAD	BAGHMARA	SEMI-CRITICAL	1393.60
Jharkhand	DHANBAD	BALIAPUR	OVER EXPLOITED	1393.60
Jharkhand	DHANBAD	DHANBAD	SEMI-CRITICAL	1393.60
Jharkhand	DHANBAD	DHANBAD URBAN	CRITICAL	1393.60
Jharkhand	DHANBAD	JHARIA	HILLY AREA	0.00
Jharkhand	BOKARO	CHANDRAPURA	SAFE	1211.50
West Bengal	PASCHIM BARDHAMAN	SALANPUR	SAFE	1348.20

Annexure – IV

Rainfall Data (in mm) At Dhansar (Rescue station) Observatory Station
State Sec Deptt of Coord, BCCL

Year	January	February	March	April	May	June	July	August	Sep	Oct	Nov	Dec	Annual
2005	34.20	22.80	41.80	32.20	33.00	193.00	542.00	107.80	185.60	39.20	0.00	2.00	1233.60
2006	0.00	0.00	34.40	33.80	87.60	214.20	477.70	246.30	172.00	0.00	1.00	0.00	1267.00
2007	0.00	22.00	37.80	0.00	78.70	167.20	545.00	426.40	351.40	52.00	0.00	0.00	1680.50
2008	5.80	4.80	17.80	18.40	18.00	216.10	433.48	183.80	297.80	85.80	0.00	0.00	1281.78
2009	0.00	0.00	1.60	2.20	112.00	72.80	269.20	192.80	333.00	98.20	10.20	0.00	1092.00
2010	0.00	12.20	7.60	9.20	64.30	206.20	199.40	212.60	230.10	45.30	3.4	----	991.90
2011	7.60	0.00	18.0	11.40	121.60	344.20	163.40	452.0	374.0	41.80	0.00	0.00	1534.20
2012	17.6	13.4	1.0	9.0	6.60	52.0	328.20	315.10	367.70	11.60	61.60	18.0	1201.80
2013	0.0	32.0	3.0	33.90	190.40	244.20	192.80	364.40	304.70	233.60	0.0	0.0	1599.0
2014	12.40	36.80	21.80	2.60	79.80	217.60	305.30	315.60	178.0	6.40	0.0	0.0	1176.0
2015	23.80	0.0	6.20	76.20	35.80	122.10	407.60	244.40	145.20	25.60	0.0	6.20	1093.10
2016	3.0	20.60	5.50	0.0	99.40	181.60	248.80	456.70	443.60	50.40	0.0	0.0	1509.60
2017	8.80	0.0	3.80	17.90	33.20	120.0	533.40	284.70	247.40	207.70	3.40	0.0	1460.30
2018	0.0	0.0	0.0	102.90	76.30	270.60	382.30	338.80	159.50	38.90	2.40	37.90	1346.60
2019	0.0	49.60	10.20	54.20	132.0	188.0	319.10	343.60	403.10	156.40	3.20	10.80	1667.00
2020	22.0	7.60	77.80	76.80	86.20	214.10	296.80	351.40	214.0	92.0	0.0	0.0	1438.70
2021	0.00	0.00	21.8	12	157.4	295	382.2	130.2	451.8	285	54.4	43	1832.8
2022	12.8	85.8	0	0	61.8	130.2	104.6	350.1	172.2	64.4	0	3	984.9
2023	0.00	0.00	19.40	47.20	128.00	61.20	128.50	424.20	289.80	211.20	0.00	49.20	1358.7
2024	6.60	11.00	90.00	0.00	80.20	80.60	284.00	678.20	404.60	105.60	0.00	0.00	1740.8

Annexure – V

Location of Hydrograph Stations (Dug Wells)

Well No	Latitude	Longitude	Well No	Latitude	Longitude
A002	86.2586	23.8181	D029	86.3742	23.8208
A004	86.3417	23.8492	D030	86.3640	23.8096
A006	86.3149	23.8498	D034	86.3837	23.7733
A007	86.2982	23.8287	D035	86.4321	23.6705
A008	86.2635	23.8527	D036	86.4360	23.6564
A009	86.2462	23.8758	D039	86.4371	23.7195
A010	86.2805	23.8290	D046	86.5211	23.7377
A013	86.3226	23.7735	D047	86.4076	23.7539
A015	86.3425	23.8249	D052	86.4473	23.7538
A016	86.3598	23.7807	D054	86.3751	23.7222
A017	86.3672	23.7520	D056	86.4600	23.6590
A019	86.4004	23.6847	D057	86.4999	23.6467
A020	86.3272	23.7481	D059	86.5253	23.6806
A023	86.2581	23.7502	D062	86.4805	23.7029
A024	86.2275	23.7535	D063	86.4636	23.6760
A025	86.2540	23.7830	D065	86.4929	23.7442
A026	86.3005	23.7787	D068	86.4623	23.7054
A027	86.3402	23.8090	D070	86.5443	23.7112
A028	86.2979	23.7900	D071	86.5248	23.7922
A029	86.2713	23.7865	D072	86.5238	23.8293
A032	86.3521	23.7360	D074	86.4255	23.7015
A034	86.2537	23.7136	D075	86.3985	23.6509
B001	86.2402	23.8164	D077	86.3707	23.6802
B002	86.2091	23.7950	D080	86.4067	23.7650
B009	86.1797	23.8387	D088	86.3950	23.6230
B010	86.1718	23.8153	D089	86.3872	23.5968
B011	86.2063	23.8256	D090	86.4209	23.6058
B012	86.2049	23.8094	D091	86.4378	23.5621
B014	86.2704	23.8008	D096	86.4663	23.6135
B015	86.1484	23.7685	D105	86.3295	23.6436
B017	86.1194	23.7514	D109	86.1983	23.6554
B018	86.0918	23.7459	D112	```86.2586	23.6670
B024	86.2161	23.7410	D113	86.2785	23.6948
B027	86.3418	23.7562	D115	86.1250	23.6843
B029	86.2076	23.6992	D117	86.1787	23.7136
B032	86.2135	23.7676	DB001	86.7902	23.7303
B033	86.2053	23.8552	DB002	86.7794	23.75
B038	86.2135	23.8834	DB003	86.7638	23.6555
B040	86.1731	23.8799	DB004	86.8062	23.6541
B041	86.1611	23.9121	DB005	86.8216	23.6785
B043	86.2420	23.8949	DB008	86.81519	23.73067
B044	86.1276	23.8735	DB009	86.8135	23.7354
B046	86.1195	23.8163	DB010	86.8561	23.7085
B047	86.1233	23.7702	DB012	86.8713	23.7638
B048	86.2783	23.7259	DB013	86.8687	23.7814

B051	86.1521	23.7941	DB018	86.7915	23.7394
B053	86.1636	23.7683	DB019	86.7483	23.7194
B054	86.3639	23.8660	DB022	86.7571	23.7237
B055	86.3427	23.8940	DB023	86.7514	23.7291
B057	86.2860	23.8738	DB024	86.7509	23.7309
B059	86.2293	23.8000	DB025	86.7399	23.7337
B060	86.2541	23.8059	DB026	86.75	23.7194
B062	86.1929	23.7628	DB027	86.7232	23.7298
B065	86.3076	23.8083	DB028	86.6836	23.7472
B067	86.2325	23.7233	DB029	86.6548	23.7462
B068	86.0873	23.7225	DB030	86.6654	23.795
B071	86.0799	23.8088	DB033	86.8126	23.7645
D003	86.4149	23.7804	DB034	86.7877	23.7785
D005	86.4180	23.7098	DB036	86.7546	23.798
D007	86.4574	23.7220	DB038	86.7361	23.8346
D008	86.1915	23.8340	DB039	86.715	23.7996
D010	86.4947	23.7252	DB047	86.7509	23.7557
D012	86.4484	23.7771	K010	86.9157	23.7059
D014	86.4884	23.7808	K012	86.9277	23.7267
D018	86.4317	23.8189	K015	86.9103	23.8177
D019	86.4253	23.8440	K020	86.8824	23.8514
D020	86.4023	23.8527	K021	86.9277	23.7267
D022	86.4021	23.8015	K026	86.8808	23.7414
D025	86.3837	23.7828	K030	86.8472	23.7396
D028	86.4016	23.8223			

Annexure – VA

Details of Hydrograph Stations (Dug Wells)

Well No	Location	M.P. (agl) in m	Well Dia in m	Well Depth (m bmp)	Formation	Owner	Utility
A002	Beharekudur	0.63	3.00	12.93	Metamorphic	Nona Das	Domestic
A004	Daldoli	0.52	3.12	6.00	Metamorphic	Govt.	Domestic
A006	Barwadi,Kanko	0.75	3.15	9.10	Metamorphic	Govt.	Domestic
A007	Chaddriderdih	0.45	1.80	9.95	Metamorphic	Hazi	Domestic
A008	Siskari	0.60	1.95	12.50	Metamorphic	Govt.	Domestic
A009	Srirampur	0.43	2.10	9.80	Metamorphic	Mosque	Domestic
A010	Phulwar	0.63	1.90	10.90	Metamorphic	Govt.	Domestic
A013	Sijua	0.40	2.35	6.90	Barakar	Rajen	Domestic
A015	Tetulmari	0.90	1.85	9.00	Metamorphic	Dharmendar	Domestic
A016	Ekra, Kalali	0.45	3.10	6.50	Barakar	Govt.	Domestic
A017	Kachi Balihari	0.56	1.60	5.30	Barakar	Govt.	Domestic
A019	Bhaura	0.54	3.15	11.65	Barakar	Govt.	Domestic
A020	Gorbhudih	0.43	3.30	8.30	BM	Govt.	Domestic
A023	Machhyara	0.43	1.85	12.40	Raniganj	Govt	Domestic
A024	Pipra Tanr	0.22	1.80	19.55	Raniganj	Govt	Domestic
A025	Sinidih	0.22	2.00	11.30	Barakar	Govt	Domestic
A026	Pasitanr	0.32	1.80	9.65	Barakar	Govt	Domestic
A027	Chandor	0.60	2.50	5.50	Barakar	Govt	Domestic
A028	Lakarka 6 no.	0.65	1.30	5.25	Barakar	BCCL	Domestic
A029	Aambagan	0.10	2.60	9.15	Barakar	Govt	Domestic
A032	Baludih	0.55	2.30	6.85	BM	Govt	Domestic
A034	Bhatdih	0.55	3.50	24.50	Raniganj	BCCL	Domestic
B001	Muraidih	0.47	1.80	5.35	Talchir	Govt	Domestic
B002	Baghmara Tola	0.32	1.85	11.25	Metamorphic	Govt	Domestic
B009	Jari Tanr	0.60	2.57	9.00	Metamorphic	Hariram Majhi	Domestic
B010	Narayanpur	0.23	4.57	8.60	Metamorphic	Mukteswar	Domestic
B011	Nischitpur	0.60	2.08	11.30	Metamorphic	Babulal Das	Domestic
B012	Harina	0.37	2.20	10.87	Metamorphic	Ramayan	Domestic
B014	Mathadih	0.76	2.15	3.75	Barakar	Govt	Domestic
B015	Bera Basti	0.55	1.60	2.50	Talchir	Dhanu Roy	Domestic
B017	Chandrapura	0.40	1.85	11.40	Barakar	Govt	Domestic
B018	Khanoodih	0.66	2.30	13.25	Metamorphic	Govt	Domestic
B024	Telmuchu	0.67	4.35	10.83	Raniganj	Govt	Domestic
B027	Chirudih Basti	0.08	1.40	11.00	BM	Govt	Domestic
B029	Popanki	0.50	1.70	6.50	Metamorphic	Govt	Domestic
B032	Madhuband	0.80	4.30	8.60	Barakar	BCCL	Domestic
B033	Ramakunda	0.75	3.20	9.65	Metamorphic	Liluram Mahato	Domestic

B038	Tantri	0.4	1.80	11.3	Metamorphic	Panchayat	Domestic
B040	BhuiwarChita	0.4	1.80	9.15	Metamorphic	Govt	Domestic
B041	Pawapur	0.45	3.00	6.7	Metamorphic	Govt	Domestic
B043	Chatatanr	0.5	1.50	9.2	Metamorphic	Govt	Domestic
B044	Lachmipur	0.35	3.35	10.1	Metamorphic	Govt	Irrigation
B046	Telo	0.2	1.50	8.1	Metamorphic	Govt	Domestic
B047	Madanpur	0.7	1.80	10.8	Metamorphic	DVC	Domestic
B048	Mahuda	0.65	2.10	11.50	Raniganj	Mosque	Domestic
B051	Taranga	0.00	2.50	5.75	Metamorphic	Bisun	Irrigation
B053	Karmatanr	0.58	2.70	13.25	Barakar	Govt	Domestic
B054	Domanpur	0.45	3.30	9.55	Metamorphic	Govt	Domestic
B055	Rantanr	0.50	3.40	5.25	Metamorphic	Govt	Domestic
B057	Kotaldih	0.60	3.20	7.5	Metamorphic	Govt	Domestic
B059	Khodovaly	0.60	2.40	9.30	Barakar	BCCL	Domestic
B060	Bahiyardih	0.77	3.00	15.60	Barakar	BCCL	Domestic
B062	Sadariyadih	0.15	3.10	9.50	Barakar	Govt	Domestic
B065	Jhinjipahari	0.95	2.20	12.4	Metamorphic	Private	Domestic
B067	Simatanr	0.55	2.20	11.8	Raniganj	Govt	Domestic
B068	Sibutanr	0.4	2.20	6	Metamorphic	DVC	Domestic
B071	Bandiyo	0.55	3.50	7.1	Metamorphic	Govt	Irrigation
D003	Dhansar	0.6	1.70	8.7	Barakar	Govt	Domestic
D005	Jiyalgora PO	0.7	2.80	10.55	Metamorphic	Govt	Domestic
D007	Golden Pahari	0.67	2.85	10.05	Barakar	BCCL	Domestic
D008	Alokdiha	0.35	1.75	8.15	Metamorphic	Govt	Domestic
D010	Rakhisitpur	0.55	1.65	4.6	Metamorphic	Govt	Domestic
D012	Dhowatanr	0.75	1.85	13.2	Metamorphic	Govt	Domestic
D014	Karmatanr	0.48	1.90	11.55	Metamorphic	Nepal	Domestic
D018	Dhaiya	0.44	2.00	8.1	Metamorphic	Govt	Domestic
D019	Memko More	0.42	3.80	7.57	Metamorphic	Govt	Domestic
D020	Dhanbad	0.22	3.10	11.45	Metamorphic		Domestic
D022	Shyamnagar	0.35	1.70	6.3	Metamorphic	Govt	Domestic
D025	Godhar More	0.6	2.75	5.8	Barakar	Govt	Domestic
D028	Nawadih	0.46	2.00	10.6	Metamorphic	Gitarani Paul	Domestic
D029	Karamara	0.5	3.10	10.5	Metamorphic	Govt	Domestic
D030	Borkiboa	0.7	2.00	5.6	Metamorphic	Haru	Domestic
D034	Kusunda	0.6	1.50	3.45	Barakar	BCCL	Domestic
D035	Patherdih	0.4	2.00	11.2	Metamorphic	Govt	Domestic
D036	Sudamdih	0.9	2.00	6.2	Metamorphic	BCCL	Domestic
D039	Tilabani	0.85	2.00	20	Barakar	BCCL	Domestic
D046	Sindupur	0.74	3.00	8.75	Metamorphic	Govt	Domestic
D047	Ena colliery	0.45	3.20	23.8	Barakar	BCCL	Domestic
D052	Goluckdih	0.47	3.10	5	Metamorphic	Govt	Domestic
D054	Amtal	0.65	6.40	10.8	Barakar	Govt	Domestic
D056	Bhutgoria	0.5	1.80	12.75	Metamorphic	Govt	Domestic
D057	Kandra	0.37	2.10	6.55	Metamorphic	Govt	Domestic

D059	Belghutu Tola	0.5	3.60	9.3	Metamorphic	Govt	Domestic
D062	Bendachuna	0.65	2.80	12.1	Metamorphic	Saheb Ram	Domestic
D063	Chatabad	0.2	1.90	10.7	Metamorphic	Govt	Domestic
D065	Nischitpur	0.15	3.15	10.6	Metamorphic	Govt	Domestic
D068	Surunga	0.53	3.00	10.25	Metamorphic	Govt	Domestic
D070	Jaladih	0.7	1.80	9.5	Metamorphic	Govt	Domestic
D071	Domandih	0.65	2.00	13.5	Metamorphic	Govt	Domestic
D072	Gobindpur	0.4	1.70	6.7	Metamorphic	Govt	Domestic
D074	Bhulan-Barari	0.1	1.60	12.8	Barakar	Govt	Domestic
D075	Manpur	0.6	2.90	10.2	BM	Govt	Domestic
D077	Rohoniatanr	0.4	3.15	6.9	BM	Govt	Domestic
D080	Bastacolla	0.7	2.50	24.95	Barakar	Govt	Domestic
D088	Laghla more	0.35	2.00	7.75	Metamorphic	Govt	Domestic
D089	Machatanr	0.6	1.60	9.15	Metamorphic	Govt	Domestic
D090	Marradih	0.42	3.10	8.8	Metamorphic	Govt	Domestic
D091	Asurbandh	0.65	1.80	8.1	Metamorphic	Govt	Domestic
D096	Paradih	0.85	1.30	9.2	BM	Private	Domestic
D105	Bandhwatanr	0.55	3.00	9.15	Metamorphic	Dasarath Mahato	Domestic
D109	Domatanr	0.65	9.15	9	Metamorphic	Shiv Charan Mahato	Domestic
D112	Bansra	0.45	1.38	7.75	Metamorphic		Domestic
D113	Dumarda	0.7	3.00	11	Metamorphic	Govt	Domestic
D115	Mahuar	0.15	2.00	6.45	Metamorphic	Private	Domestic
D117	Bhatua	0.23	2.70	10	Metamorphic	Govt	Domestic
DB001	Laikadih	1	2.55	14.96	Barakar	BCCL	Domestic
DB010	Kulti College	0.6	1.8	13.88	BM	Govt	Domestic
DB012	Sabanpur	0.85	1.8	9.6	Barakar	Govt	Domestic
DB013	Dendua More	0.5	2	7.85	-	Govt	Domestic
DB018	Sarsapahari	0.75	1.6	7	Barakar	Govt	Domestic
DB019	Luchibad	0.73	1.8	6.45	Talchir	Govt	Domestic
DB002	Sulibari	0.42	1.8	9.63	Barakar	Govt	Domestic
DB022	Dahibari Majhi Basti	0.9	1.85	16.25	Barakar	Govt	Domestic
DB023	BCCL Substation,Dahibari	0.67	1.42	5.75	Barakar	Govt	Domestic
DB-24	Dahibari,LHS	0.58	2	12.8	Barakar	Govt	Domestic
DB026	Patlabari	0.7	4	9.8	Metamorphic	DVC	Domestic
DB027	Ledaharia Village	0.67	2.4	10.65	Metamorphic	Govt	Domestic
DB028	Patharkua	0.7	2.3	8	Barakar	BCCL	Domestic
DB029	Kelyasol	0.6	3.6	13.7	Barakar	BCCL	Domestic
DB003	Puapur	0.37	1.55	5.25	Raniganj	Govt	Domestic

DB030	Ramkanali Village	0.6	3.1	10.55	Metamorphic	Govt	Domestic
DB033	Barajor/Amkura	0.7	2	9.2	Talchir	Kajal Chatterjee	Domestic
DB034	Tetuldanga	0.6	3.6	11.6	Talchir	Govt	Domestic
DB036	Madanpur	0.55	2.4	8	Talchir	Chhotka Marandi	Domestic
DB038	Lukuidih	0.55	3.8	7.8	Metamorphic	Govt	Domestic
DB039	Pandra	0.65	3	6.9	Talchir	Forest Dept.	Domestic
DB004	Sarbari	0.62	2.22	8.98	Raniganj	DVC	Domestic
DB047	Mugma	0.65	3.2	8.3	Barakar	Govt	Irrigation
DB005	Parbelia	0.48	3.2	7.8	Raniganj	Govt	Domestic
DB008	Chungei	0.8	2.2	5.75	BM	Govt	Domestic
DB009	Begunia Temple	0.68	3	19.25	Barakar	Govt	Domestic
K010	Phatepur	0.8	2.02	28.3	Raniganj	Govt	Domestic
K012	Ethora	0.81	2	15.9	Raniganj	Govt	Domestic
K015	Kankurkunda	0.55	2.1	12.5	-	Govt	Domestic
K020	Majhladih	0.79	1.22	11.77	-	Govt	Domestic
K021	Pratappur	0.6	1.4	10.94	-	Govt	Domestic
K026	Bodra	0.9	2.1	10	BM	Govt	Domestic
K030	Kulti Station	0.31	0.75	4.25	BM	Govt	Domestic

MP: Measuring Point **R.L.: Reduced Level** **W.L.: Water Level m: Meter**
Abn.: Abandoned **b.g.l.: Below Ground Level** **a.g.l.: Above Ground Level**
G.L.: Ground Level **bmp: Below Measuring Point** **BM: Barren Measure**

Annexure – VB

Historical Water Level data of Hydrograph Stations

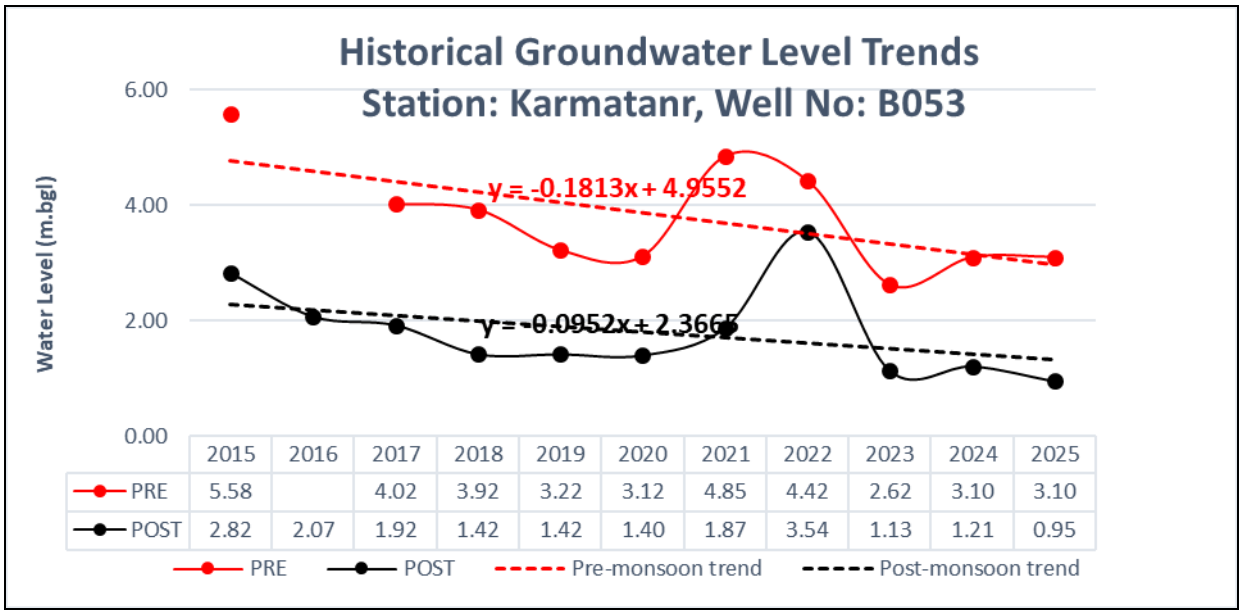
Well No	Water level below ground level (bgl) in meters																	
	May 15	Nov 15	May 16	Nov 16	May 17	Nov 17	May 18	Nov 18	May 19	Nov 19	May 20	Nov 20	May 21	Nov 21	May 22	Nov 22	May 23	Nov 23
JCF																		
A002	9.10	5.21	9.30	4.95	8.15	4.35	8.27	4.78	7.55	3.25	6.95	3.00	6.87	4.50	6.45	4.91	4.80	3.10
A004	4.56	1.78	5.20	1.48	3.48	0.91	4.48	1.73	3.38	1.78	4.63	2.28	3.51	1.83	4.40	1.80	3.51	1.90
A006	8.25	6.25	8.25	3.95	6.95	3.35	8.40	5.35	4.90	4.25	7.75	5.30	7.00	4.07	8.40	5.30	7.35	4.72
A007	7.79	4.57	9.45	5.27	7.55	2.55	7.40	3.75	9.45	4.10	7.35	3.70	6.63	3.66	7.40	3.75	8.15	5.65
A008		9.73	11.85	3.20	9.90	1.38			11.30				8.99	4.30	8.80	4.20	10.70	5.03
A009	6.70	5.47	7.23	4.44	7.77	2.42	6.42	5.22	8.87	5.07	6.12	4.62	7.42	4.55	6.30	5.05	7.42	4.76
A010	9.61	8.37		2.42	7.47	2.27	7.72	5.47	8.17	5.57	7.57	5.29	8.92	5.60	7.70	5.40	8.92	5.05
A013	3.60	5.30	5.20	3.85	4.40				5.10				4.63	2.60	4.60	2.50	4.63	2.31
A015	7.15	7.00	7.95	5.20	6.50	3.95			7.00				6.93	3.76	6.70	3.50	6.93	3.62
A016	5.55	4.17	5.85	3.15	3.65	2.20	4.30	3.65	5.45	1.95	7.15	1.75	3.45	2.00	5.80	3.08	5.55	3.52
A017	3.79	2.64	2.44	2.69	2.44	2.24	3.34	2.84	2.94	2.24	2.14	1.69	3.36	2.37	2.62	2.59	2.41	2.19
A019			7.81	4.11	6.38	2.46	5.55	2.45	4.86	3.44	6.06	3.26	3.31	1.91	4.10	2.54	2.90	2.60
A020	4.59	2.93	7.49	3.50	4.27	1.77	4.57	2.57	4.57	1.82	8.47	3.87	5.47	2.02	5.59	3.54	8.02	4.20
A023	11.37	9.37	11.87	8.13	11.87	6.97	11.15	7.17	11.97	3.77	8.92	5.62	9.52	2.82	7.97	4.79	9.00	5.71
A024	17.20	14.58	16.62	12.43	16.28	4.18	14.58	6.88	15.88	2.48	4.88	4.28	10.13	2.78	7.28	4.33	5.38	3.90
A025	7.78	5.85	7.43	4.58	6.38	2.88	6.63	3.13	6.08	1.93	2.98	1.83	5.78	2.43	3.31	2.08	2.93	2.60
A026	7.33	3.18	8.93	4.48	5.28	2.53	6.23	3.88	6.58	3.33	6.98	3.18	5.66	2.73	6.42	4.31	8.40	3.83
A027	4.40	3.99	4.85	1.80	2.90	1.25	2.90	1.00	2.40	0.92	2.40	1.10	1.67	0.90	1.90	1.33	1.70	1.60
A028	4.35	3.60	3.35	1.47	4.30	1.55	4.15	2.51	2.45	3.15	4.00	3.03	6.23	3.75	4.23	3.30	3.45	3.35
A029	4.55	4.60	5.92	6.96	4.40	1.30	6.45	2.10	4.85	3.40	6.20	3.20	6.49	5.90	4.60	1.15	5.60	3.20
A032	4.41	2.13	4.75	2.10	3.15	1.55	2.80	0.70	2.75	0.95	1.90	1.75	2.35	0.96	2.25	1.75	3.83	1.60
A034	8.40	4.81	4.75	4.45	12.45	4.45	5.90	3.70	6.35	3.95	8.35	3.45	5.20	3.55	8.20	6.35	6.54	4.01
B001	3.28	2.75	3.58	1.93	2.33	1.63	2.88	2.08	3.18	1.73	3.28	1.63	2.58	1.91	2.10	1.81	3.22	2.45
B002	-	-	10.93	6.99	10.9	6.8	-	-	10.88	6.58	-	-	10.13	6.5	9.8	6.4	10.55	4.47
B009	8.82	3.50	8.90	3.90	7.80	2.30	8.40	3.40	6.56	3.25	8.51	3.27	7.61	3.16	7.40	4.60	6.75	3.20
B010	7.12	3.63	6.77	4.69	7.97	4.42	6.97	2.79	8.02	2.77	6.92	2.80	7.12	3.35	6.80	2.70	7.47	4.42
B011	9.49	3.45	9.20	4.55	10.60	2.80	9.90	4.68	9.38	4.65	10.05	4.90	8.24	4.02	9.50	4.60	10.30	3.75
B012	8.78	7.31	7.17	8.63	9.03	5.33	8.37	4.83	8.98	8.63	8.63	5.66	8.68	6.99	6.4	4.7	8.88	5.63
B014	2.94	2.29	2.44	0.47	2.94	1.84	3.64	2.84	2.24	2.74	2.44	1.04	2.84	2.04	3.24	2.6	2.84	2.34
B015	1.5	0.45	1.85	0.55	1.85		1.85	0.85	1.9	0.95	3.7	1.47	1.46	0.35	3.67	1.02	3.2	1
B017	6.65	2.9	4.8	3.15	3	2.65	6.61	4.4	7.4	4.6	6.69	4.15	6.5	4.25	6.5	4.2	7.95	4.33
B018	9.01	6.16	6.39	5.19	6.24	1.99	8.56	3.39	8.34	3.34	8.54	3.52	7.84	3.62	8.5	3.2	7.36	3.9
B024	10.05	5.78	10.63	4.28	10.03	4.03	9.28	4.33	4.58	2.33	5.48	3.53	5.68	2.08	5.53	3.46	4.63	3.24
B027	9.87	5.47	6.07	4.22	8.12	3.87	9.97	5.67	7.52	5.42	8.87	5.47	8.89	4.73	10.1	4.8	8.89	4.16
B029	5.58	5.15	5.95	3.05	5.5				4.8	2.65			5.26	2.48	5.5	2.15	3.6	1.9
B032	7.55	3.32	6.95	3.07	6.95	2.8	6.75	3.9	5.55	1.7	3.3	2	5.6	1.7	4.15	2.56	7.3	3.54
B033	6.53	4.13	5.45	4.05	5.3	4.15	6.5	3.45	6.65	3.3	6.29	3.3	6.38	3.43	4.75	3.1	7.3	3.54
B038	10.65	7.95	10.82	4.2	7.6	4.5	10.3	5.1	10.8	4.85	9.17	4.85	9.34	4.18	8.1	5.2	8.17	5.2
B040	5.63	4.45	7.05	3.45	4.7	3.4	6.1	4.6	8.7	4.9	5.68	4.15	5.58	3.24	5.3	3.1	3.5	1.96
B041	5.9	2.85	5.25	3.75	5.35	2.9	5.25	2.05		1.95	5.37	2.25	5.36	2.4	5.05	3.6	6.45	4.02
B043	7.65	5.5	7.75	3.82	7.6	2.4	7.5	4.2		4.55	7.35	3.7	7.26	3.78	6.5	4.6	7.26	3.93
B044	9.15	5.54	7.7	4.79	6.6	2.75	9.68	5.05		4.6	8.58	4.73	7.51	3.83	9.1	6.3	9.35	7.63
B046	6.85	4.62	5.05	4.82	5.6	3.8	5.6	3.6			5.55	3.35	5.5	3.65	6.05	3.75	7.25	3.9
B047	9.33	8.6	8.85	6.7	10	4.37	8.2	5.3		5.1	8.02	4.66	7.15	4.73	8.75	5.6	7.8	4.95
B048	7.9	5.42	9.35	4.6	7.7	4.15	7.33	3.97	7.05	4.35	8.2	3.85	7.23	6.05	6.85	6.25	6.13	5.05
B051	4.65	3.4	4.9	3.18	4.98	2.55	5.02	2.42	5.1	2.7	5	2.1	5.7	1	5.06	4.57	5.2	4.45
B053	5.58	2.82		2.07	4.02	1.92	3.92	1.42	3.22	1.42	3.12	1.4	4.85	1.87	4.42	3.54	2.62	1.13

B054	7.62	4.56	9.25	5.55	7.2	4.1	7.55	3.65	9.05	3.55	7.7	3.87	7.4	3.43	7.3	4.75	7.65	5.8
B055	3.46	2.25	4.45	2.2	4.6	5.52	3.6	2.48		2.5	4.15	2.58	3.73	2.52	3.3	2	3.73	2.2
B057	6.18	3.35	6.9	3.45	5.9	3.6	6.2	3.1		2.95	6.4	3.05	5.36	2.92	6.1	3.5	5.36	3.26
B059	4.12	1.6	4.4	0.5	5.4	0.6	3.9	0.9	6.2	0.9	5.25	1.4	5.49	0.9	4.5	1.14	1.88	0.7
B060	9.21	5.28	10.33	5.03	13.23	3.18	13.68	4.23	8.13	3.23	10.33	3.21	11.26	2.23	10.53	5.8	10.73	5.73
B062	9.1	5.21	9.3	4.95	8.15	4.35	8.27	4.78	7.55	3.25	6.95	3	6.87	4.5	6.45	4.91	4.8	3.1
B065	7.82	5.87	7.15	2.68	9.05	1.25	10.03	2.4	11.05	0.95	9.25	2.3	9.03	1.42	7.45	2.27	8.45	2.35
B067	9.23	5.53	9.53	4.3	10	2.15	9.55	4	8.57	4.35	7.55	3.95	8.95	2.95	8.5	6.3	8.05	5.32
B068	5.05	3.42	5.25	2.8	4.35		5.2	3.85		3.65	5.1	3.44	4.18	3.76	5.5	4.6	7.92	4.6
B071	5.48	3.2	6.15				5.5	3.47		3.45			5.43	3.25	5.3	2.5	10.28	5.64
D003	4.25	2.25	2.35	1.9	2.15	2.3	3.43	2.45	1.75	1.3	5.4	1.38	3.41	0.85	5.96	1.32	3.15	1.85
D005	9.37	8.33	9.4	6.4	7.9	5.2	7.8	5.3	8.25	4.85	8.6	7.7	7.28	4	8.4	7.01	8.4	7.01
D007	8.25	5.61	7.53	4.03	7.33	2.88	7.53	2.83	8.23	3.28	7.33	5.13	6.08	2.63	9.03	5.67	9.03	3.64
D008	6.24	4.38	8	3.43	5.15	1.85	5.65	1.85	4.8	2.85	5.83	2.75	4.55	2.27	5.8	3.5	7.7	4.82
D010	3.77	2.9	3.77	1.6	3.65	1.6	3.95	2.6	3.5	2.73	3.78	2.45	3.55	1.47	3.5	1.9	5.4	2
D012	12.25	7.9	12.25	8.8	12.45	8.55	11.25	7.7	12.25	7.2	10.82	8.07	11.38	7.28	12	9.9	11.38	7.76
D014	11.02	9.47	10.77	8.12	10.22	7.47	10.52	7.42	10.32	7.07	9.47	5.65	9.57	7.02	10.3	7.1	9.57	6.18
D018	7.01	4.45	3.36	1.56	3.56	3.76	7.06	3.06		3.06			3.66	3.11	4.5	2.3	3.66	2.35
D019	8.43	5.12	8.33	5.5	7.76	4.65	7.53	4.83	7.45	4.85	7.21	4.25	7.47	4.4	7.05	4.4	7.68	5.48
D020	7.42	6.58	8.02	5.88	7.88	4.43	7.38	3.88	8.18	4.33	7.29	3.81	7.66	3.88	6.4	5.5	6.48	4.28
D022	5.78	2.67	5.45	4.75	4.15	1.15	5.8	1.75		2.5	5.75	1.7	3.8	0.5	4.6	1.7	3.8	1.36
D025	4.48	2.45	2.4	1.9	2.4	1.2	2.6	2.4	3.9	5.38	6.5	3.38	8.68	3.8	10.5	4.7	4.4	3.4
D028	9.38	7.22	9.27	3.57	8.64	2.79	9.04	5.74	8.52	5.59	7.44	4.62	8.75	5.51	7.9	5.6	8.75	4.87
D029	9.62	4.35	8.35	4.2	6.3	3.45	9.6	5.2	9.35	5	8.69	5	9.55	5.1	9.75	7.1	9.55	5.87
D030	4.55	3.15	4.45	3.2	4.4	1.25	4.58	1.1	4.6	0.75	4.5	1.35	4.23	0.84	4.37	2.29	4.08	2.2
D034	2.55	1.45	2.3	0.3	0.8	0.55	2.8	0.45	2.4	2	2.9	2.4	3.38	2.5	5	3.15	3.8	2.5
D035	9.8	7.9	9.52	6.45	8.8	3.6	8.4	4.45	8	3.8	8.2	5.4	6.6	2.9	6.1	4.68	5.23	3.9
D036	1.66	1.13	0.78	0.95	1.3	0.7	1.2	0.6	1.2	0.55	2.1	1	2.02	0.55	3.25	0.6	1.85	0.6
D039	5	2.61	2.18	2.65	5.05	4.75	4.95	4.35	4.95	5.6	9.05	5.7	10.35	4.75	7.5	3.05	8.52	3.28
D046	6.14	3.31	7.46	3.26	7.16	3.01	6.06	3.24	7.61	3.36	6.01	3.21			7.05	4.6	7.66	4.18
D047	9.6	3.6	3.18	2.95	3.15	2.85	5.33	2.55	4.55	4.35	9.45	5.45	4.05	2.45	2.2	1.5	4.45	3.27
D052			4.23	1.63	3.53	1.56	4.63	3.33	2.08	3.54	4.58	3.28			3.6	2	3.2	1.95
D054	8.78	6.7	9.5	3.55	8.65	5.35	8.85	3.45	9.35	3.15	7.33	2.88			9.5	6.9	8.03	6.3
D056	10.6	6.9	8.46	5.25	7.1	5	10.48	5.8	6.2	5.55	10	5.75	6.85	4.86	9.4	5.9	5.6	3.73
D057	5.94	5.33	6.1	5.41	5.23	3.43	6.03	4.63	5.23	4.43	6.13	3.98	5.42	3.5	5.2	4.05	5.18	3.65
D059	6.98	3.32	7.7	4.88	7.35	3.55			7.3				7.3	3.6	7.38	3.95	7.3	4.02
D062	7.43	4.12	6.33	3.5	7.76	3.65	7.35	4	7.45	3.85	7.21	3.85	7.47	3.4	7.75	4.4	7.47	3.74
D063	8.41	4.9	9.8	3.74	7.85	3.15	8.3	5.3	7.58	5.3	8.43	5.17	7.75	3.14	9.8	5.7	7.75	4.55
D065	7.48	4.36	8.85	2.35	6.95	4.95	7.45	3.9	8.35	3.85	7.68	3.85	7.41	4.83	7.9	5.7	6.4	4.65
D068	8.49	4.9	6.45	3.54	8.42	4.27	7.27	3.27		2.97	6.97	3.03	7.92	4.22	8.2	5.2	7.92	4.6
D070	7.1	4.25	7.55	3.08	6.5	4.28	7.2	5.1	5.1	4.8	7.12	4.8	6.13	3.78	7.5	5.05	8.6	4.63
D071	10.85	6.55	11.35	5.45	10.35	4.05	10.55	6.89	10.93	6.85	10.6	7	10.28	3.35	10.15	7.5	10.28	5.64
D072	4.62	2.6	3.41	2.3	2.5		5.65	3.6		3.75	6.92	3.86	4.36	2.69	3.3	2.2	5	2.9
D074	10.05	7.2	7.73	5	9.25	3.85	8.6	4.8	5.8	3.57	4.3	3.93	6.93	2.9	6.17	5.77	4.57	3.54
D075	7.42	4.5	5.75	1.4	3.2	1.3	7.4	3.4	5.25	4	7.45	3.27			5.8	2.3	5.75	2.8
D077	6.44	5.6	4.6	2.9	6.5	4.9	6.3	5.2	6.5	3.2	6.4	3.5	5.98	4.69	6.5	4.7	5.98	3.93
D080	10.97	3.35	6.55	4.15	8.65	3.7	9.35	4.2	5	3.05	4.3	4.9	7.1	2.55	6	3.3	4.75	2.6
D088	5.93	3.65		4.2	6.55	2.75	6.15	3.66		3.45	6.12	4.03	6.55	2.52	5.6	2.8	6.55	3.1
D089	5.2	3.22		4.7	6	2.7	5.3	3.7		3.6	5.45	3.63	4.41	2.55	5.7	4.2	4.41	3.55
D090	6.66	3.88		3.68	4.03	2.58	6.63	3.83		3.68	5.82	3.46	5.63	2.66	7	4.5	5.63	3.68
D091	6.85	4.95		4.15	5.65	2.65	6.85	3.15		3.4	6.4	3.4	5.18	3.02	5.2	3.1	5.18	3.2
D096	6.9	3.13		3.15	6		6.85	3.05					5.97	2.71	7.75	4.05	6.1	3.2
D105	7.57	3.1	8.15		7.95	4.3	4.1	4.2	7.7	4.48	6.7		8.2	6	7.05	4.92		
D109	8.15	6.55	5.8	4.15	7.51		7.78	3.5	6.35	3.85	7.9	3.22	7.33	3.1	5.2	3	7.33	2.88
D112	6.4	3.75	5.95	3.4	7.05	2.5	6.63	4.11	7.25	4.57	6.74	4.63	6.9	4.05	7.15	3.35	6.9	3.35

D113	6.6	3.85		3.95	7.28	2.35	6.85	3.3		3.5	6.1	3.45	6.8	2.99	7.3	4.3	5.75	3.48
D115		4.85		5.22	6.05	2.7	7.1	3.05		2.95	7.45	2.4	7.65	3.43	5.5	4.6	6.38	3.83
D117	7.86	5.34		5.67	8.8	4.37	7.92	5.02		5.02	7.52	4.79	7.87	5.11	8.7	5.5	7.27	5.25
RCF (Part)																		
DB001	5.4	4.08	4.17	3.7	4.5	3.8	4.35	4.2	4.85	4.3	5.08	4.08	4.88	3.88	4.73	3.76	3.94	2.77
DB002	3	1.8	3.2	1.98	3.42	2	3.19	2.02	3.6	2.62	3.97	2.43	3.30	2.31	3.20	2.24	2.9	2.25
DB003	4.8	3	5.3	3.22	5.32	2.42	5.6	3.1	5.67	3.12	4.72	3.37	4.53	3.20	4.40	3.11	4.55	2.98
DB004	7.5	4	7.32	3.12	6.59	3.42	6.8	4.1	5.8	3.55	5.17	3.01	4.96	2.98	4.81	2.89	6.1	4.80
DB005	6.88	3.26	6.48	3.8	5.48	3.8	4.98	3.13	5.08	2.78	5.1	3.26	4.90	3.10	4.75	3.00	5.52	3.50
DB008	4.6	2.8	4.57	3.02	4.17	2.13	4.17	2.89	4.27	3.07	5.01	3.1	4.81	2.95	4.67	2.86	4.5	3.42
DB009	9.45	4.5	10.5	5.26	11.5	6.26	9.26	5.22	11.01	6.26	10.4	6.44	9.98	5.00	9.68	4.85	9.5	5.18
DB010	5.68	4.07	4.75	3.75	4.4	2.5	4.8	2.9	4.55	2.95	5.28	3.07	5.07	2.92	4.92	2.83	4.6	3.12
DB012	6.5	2.05	6.76	2.78	6.3	2.73	5.18	2.55	5.08	2.73	4.9	2.05	4.70	1.95	4.56	1.89	5.44	2.30
DB013	3.55	6.5	3.25	5.8	3.72	5.5	3.1	5.3	2.92	5.4	3	4.5	4.88	2.98	4.73	2.89	4.5	2.70
DB018	5.48	3.65	4.6	3.2	4.2	3.3	4.2	2.99	4.6	2.55	3.8	2.9	3.65	2.76	3.54	2.67	4.25	2.61
DB019	5.26	3.02	5.5	3.93	5.53	3.18	4.98	3.03	5.33	3.98	4.9	3.02	4.70	2.87	4.56	2.78	4.8	2.96
DB022	4.87	3.1	4.63	2.23	4.83	2.53	3.16	1.83	3.8	2	3.99	2.16	3.83	2.05	3.72	1.99	4.25	2.43
DB023	4.05	2.82	4.17	2.97	3.9	2.57	4.4	2.17	4.67	2.27	3.82	2.82	3.67	2.68	3.56	2.60	4.8	2.94
DB024	9.47	6.3	9.48	4.08	7.38	4.3	8.88	4.98	8.93	4.46	7.6	3	7.30	2.85	7.08	3.91	8.25	4.18
DB025	8.1	3.5	7.73	3.63	6.88	3.23	6.68	2.65	6.4	2.78	5.25	3.05	5.04	2.90	4.89	2.81	5.15	2.90
DB026	5.9	3.77	6.14	3.53	6.6	3.52	7.3	4.86	7.6	4.6	6.93	3.77	6.65	3.58	6.45	3.47	6.9	3.66
DB027	6.26	3.2	5.77	2.92	6.02	3.35	5.97	3.69	5.57	3.37	6	3.59	5.76	3.41	5.59	3.31	6.85	3.63
DB028	3.08	3.74	1.9	4.1	2.1	3.9	1.88	4.3	2.6	3.8	1.9	3.35	3.80	2.03	3.69	1.97	4.2	2.39
DB029	9.1	4.8	8.6	4.6	8.1	3.98	7.6	4.1	7.1	4.25	6.9	4.3	6.62	4.09	6.43	3.96	8.5	4.67
DB030	7.02	3.6	7.6	3.8	6.8	3.98	7.1	3.8	6.85	3.5	6.01	4.25	5.77	4.04	5.60	3.92	7.5	3.89
DB031	7.84	3.78	7.44	3.6	6.8	3.8	5.45	3.8	5.55	3.55	4.91	3.78	4.71	3.59	4.57	3.48	5.7	2.98
DB033	6.05	4	6.85	3.95	5.07	3.65	5.55	2.9	5.6	3.15	4.69	3	4.50	2.85	4.37	2.76	5.6	3.10
DB034	9.2	4.02	7.93	3.3	6.95	3.88	6.4	3.3	5.9	3.18	5.33	3.8	6.12	3.61	5.94	3.50	5.5	3.08
DB036	6.48	4.15	8.1	4.8	6.75	3.98	7.85	3.9	8.4	4.25	6.46	3.8	6.20	3.61	6.02	3.50	5.04	3.24
DB038	4	2.95	4.2	2.05	3.8	2.8	3.95	2.43	3.55	2.31	3.68	2.95	3.53	2.80	3.43	2.72	3.73	2.66
DB039	5.45	3.31	6	3.6	5.8	3.8	5.62	3.47	5.1	3.5	5.74	3.31	5.51	3.14	5.35	3.05	6.67	3.90
DB047	7.62	4.8	8.77	3.27	6.77	3.62	8.97	3.63	9.07	3.77	6.56	3.8	6.30	3.61	6.11	3.50	7.02	4.30
K010	3.1	1.9	3.05	1.85	3	1.8	2.95	1.86	3.01	2.01	3.11	1.98	2.99	1.88	2.90	1.82	3.5	1.98
K012	4.16	1.98	4.8	2.5	3.9	1.75	4.05	1.9	3.75	1.8	3.65	1.95	3.50	1.85	3.40	1.80	3.7	2.00
K015	4.75	2.46	4.32	2.3	4	2.1	4.5	2.35	4.3	2.22	4.1	2.2	3.94	2.09	3.82	2.03	4.8	2.10
K020	7.25	2.85	7.1	2.7	6.5	2.8	6.75	2.98	6.3	2.5	6.2	2.4	5.95	2.28	5.77	2.21	5.44	2.50
K021	5.45	2.98	5.3	2.8	5.4	3.09	5.1	3	4.88	2.8	4.9	2.7	4.70	2.57	4.56	2.49	4.6	3.00
K026	2.2	1.46	2.7	1.8	2.1	1.6	2.08	1.65	2.1	1.55	2.07	1.4	1.99	1.33	1.93	1.29	2.1	1.50
K030	2.5	1.4	2.4	1.4	2.22	1.53	2.4	1.63	2.6	1.1	2.22	1.3	2.13	1.24	2.07	1.20	2.4	1.50

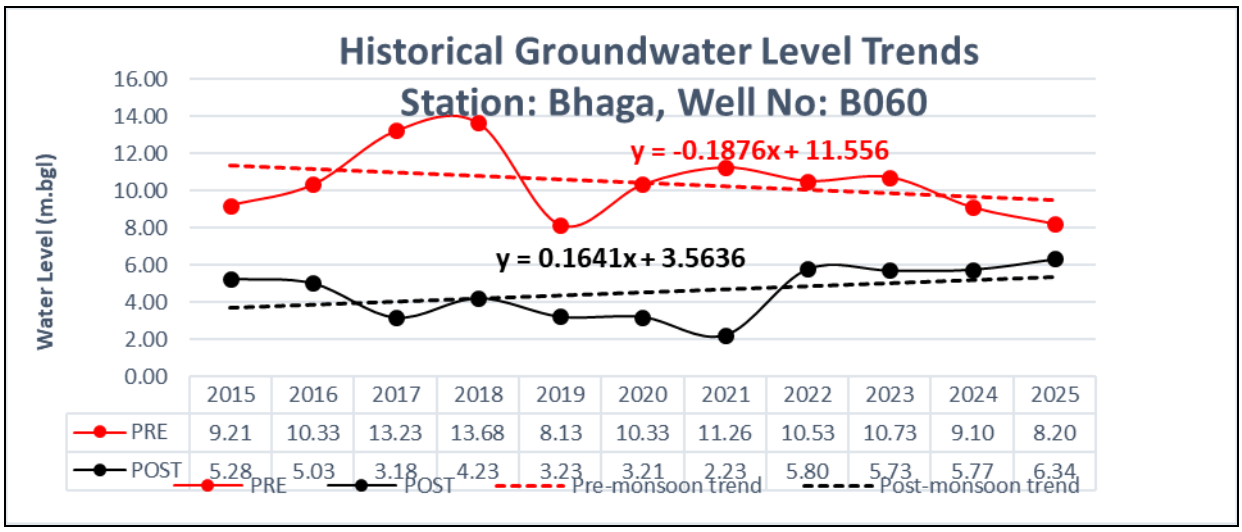
Annexure – VI

HYDROGRAPHS OF CLUSTER-I



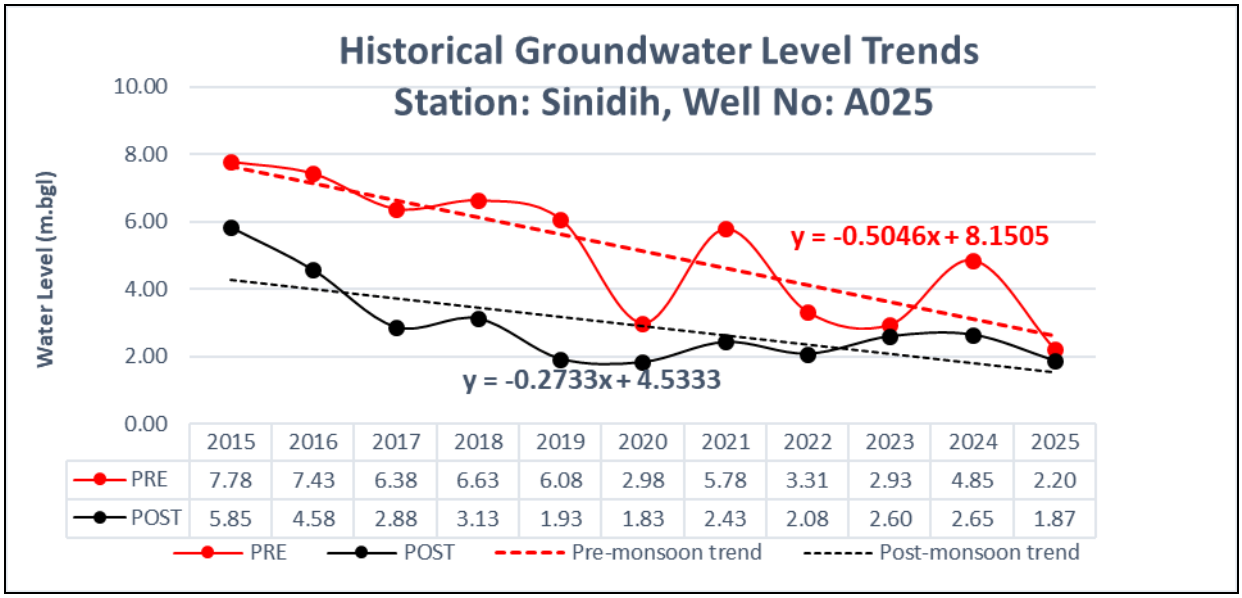
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
PRE	5.58		4.02	3.92	3.22	3.12	4.85	4.42	2.62	3.10	3.10
POST	2.82	2.07	1.92	1.42	1.42	1.40	1.87	3.54	1.13	1.21	0.95

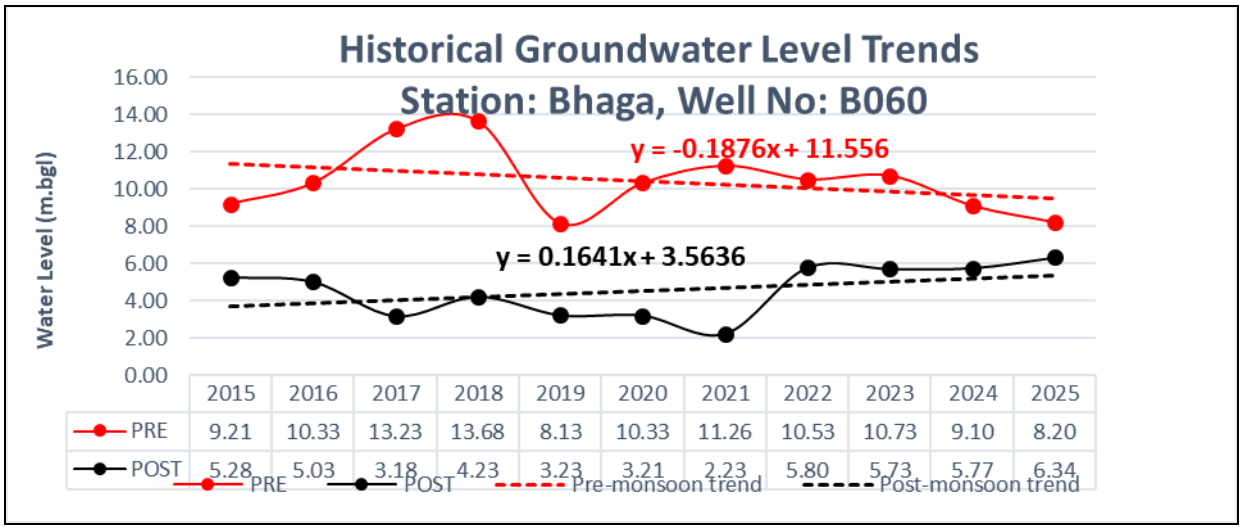
HYDROGRAPHS OF CLUSTER-II



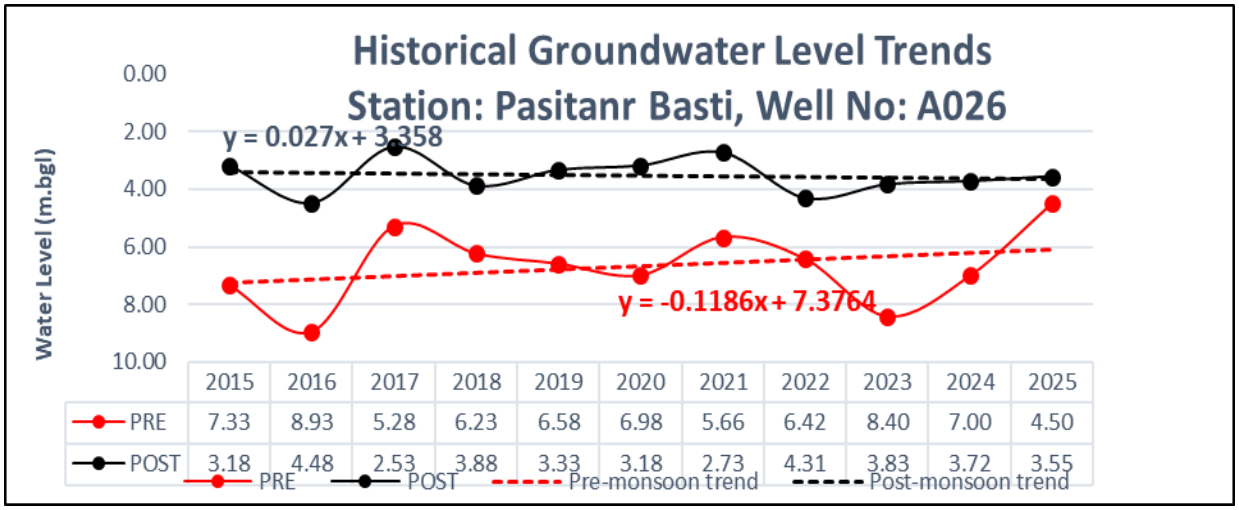
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
PRE	9.21	10.33	13.23	13.68	8.13	10.33	11.26	10.53	10.73	9.10	8.20
POST	5.28	5.03	3.18	4.23	3.23	3.21	2.23	5.80	5.73	5.77	6.34

HYDROGRAPHS OF CLUSTER-III

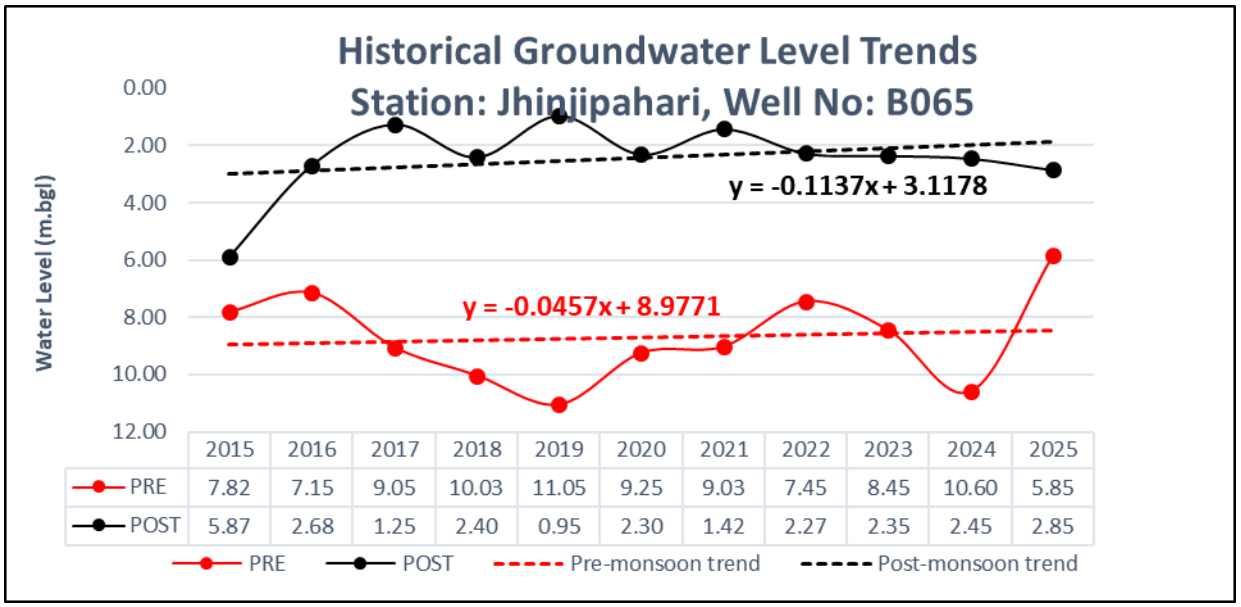




HYDROGRAPHS OF CLUSTER-IV

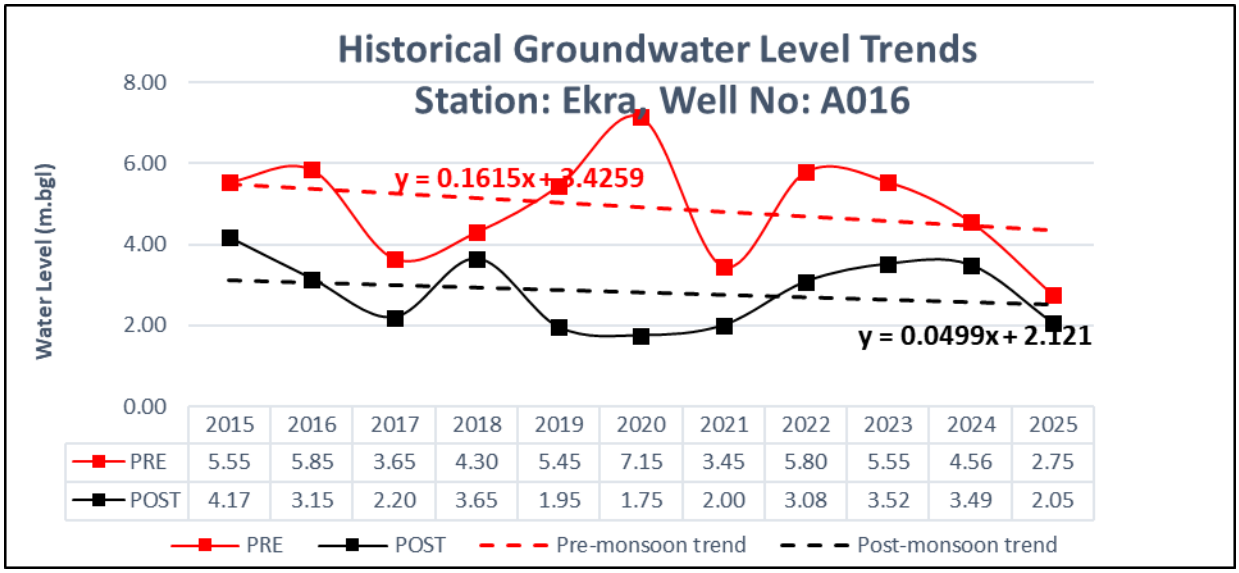


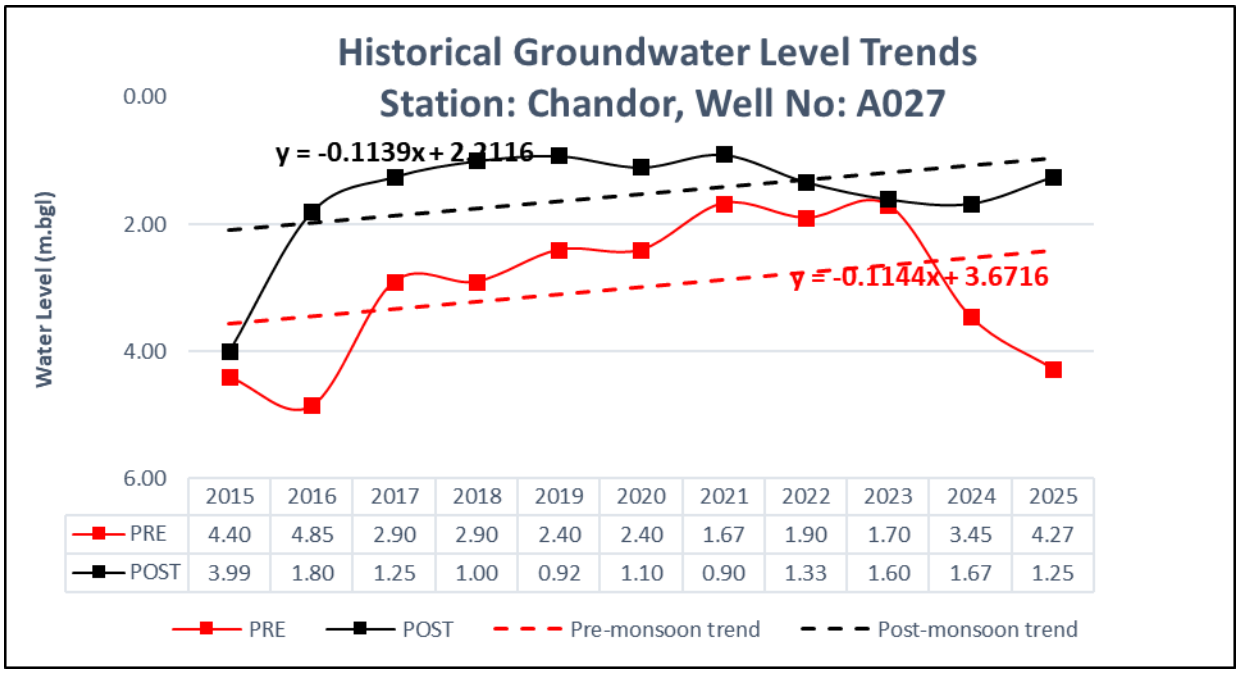
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
PRE	7.33	8.93	5.28	6.23	6.58	6.98	5.66	6.42	8.40	7.00	4.50
POST	3.18	4.48	2.53	3.88	3.33	3.18	2.73	4.31	3.83	3.72	3.55



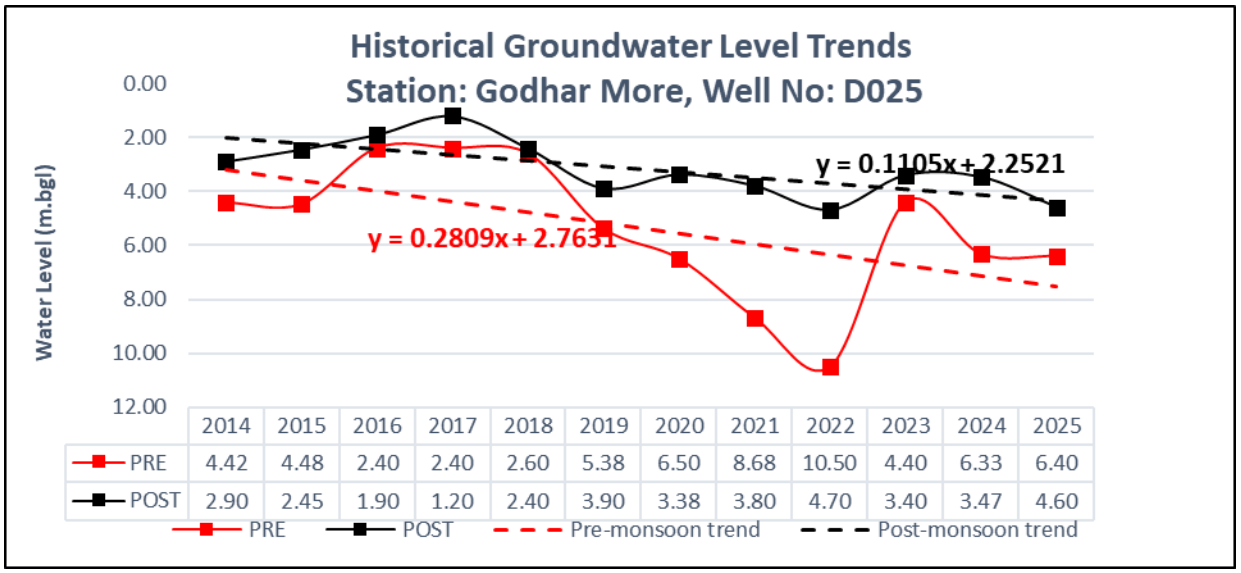
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
PRE	7.82	7.15	9.05	10.03	11.05	9.25	9.03	7.45	8.45	10.60	5.85
POST	5.87	2.68	1.25	2.40	0.95	2.30	1.42	2.27	2.35	2.45	2.85

HYDROGRAPHS OF CLUSTER-V

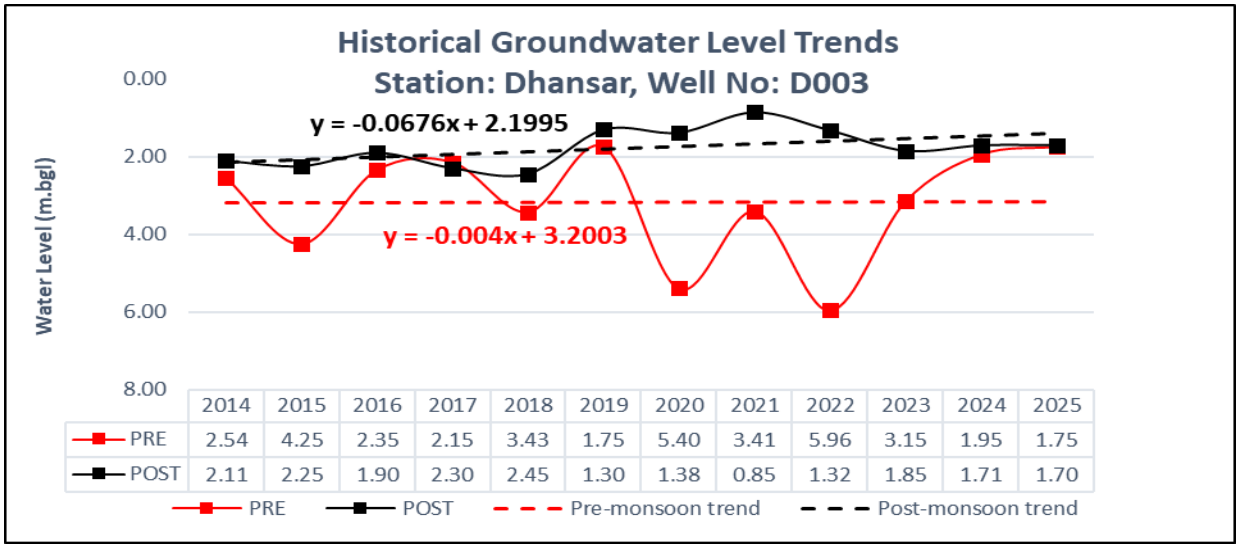


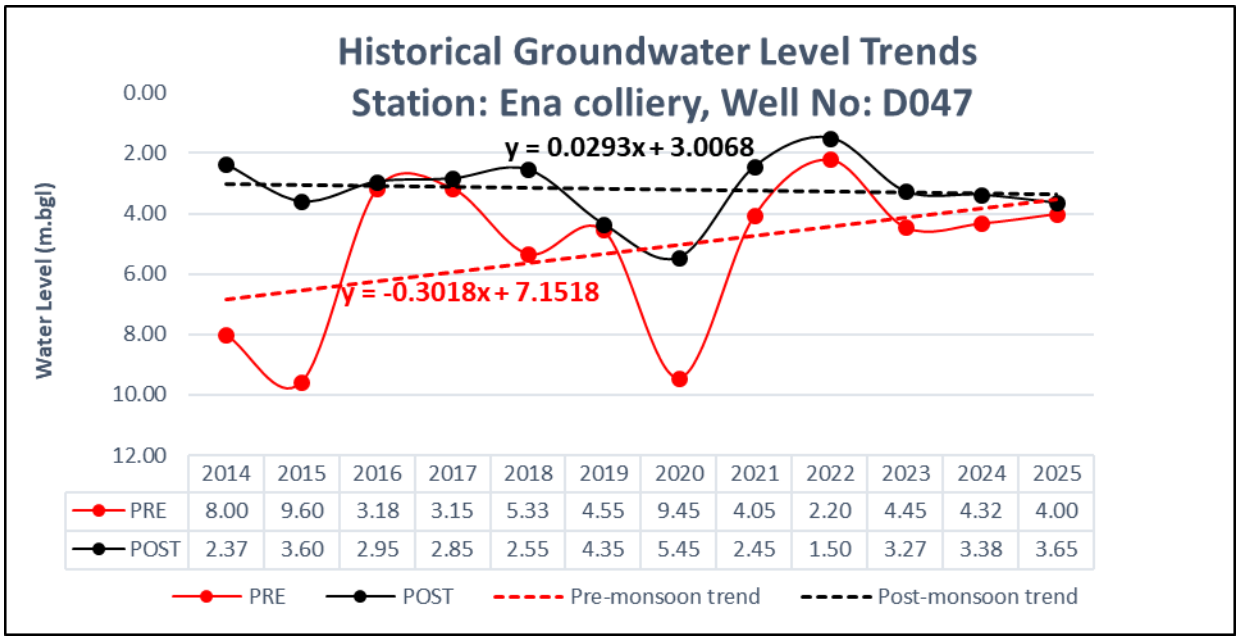


HYDROGRAPHS OF CLUSTER-VI

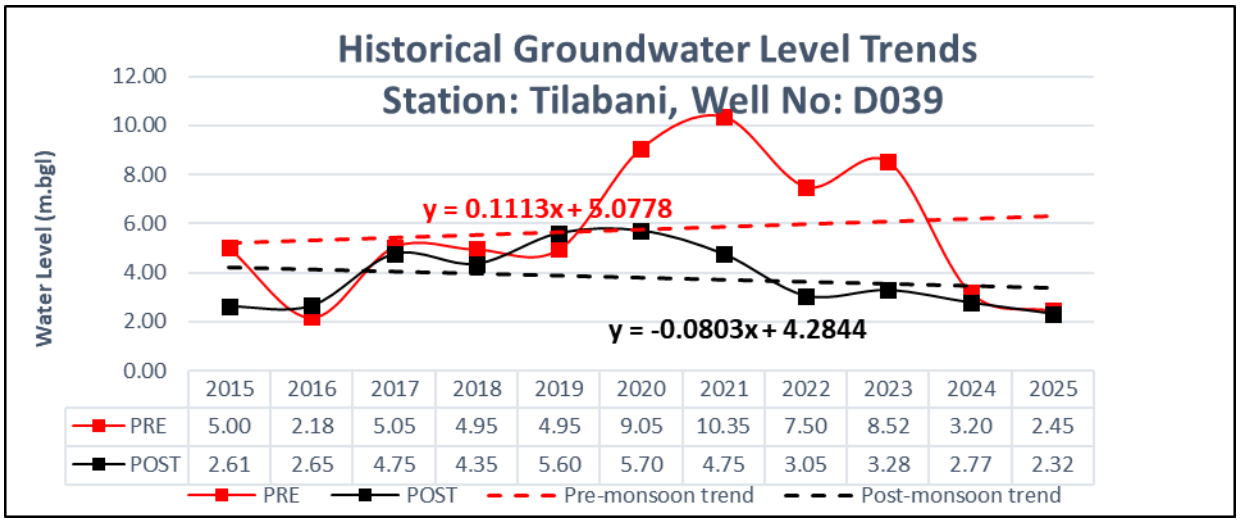


HYDROGRAPHS OF CLUSTER-VII

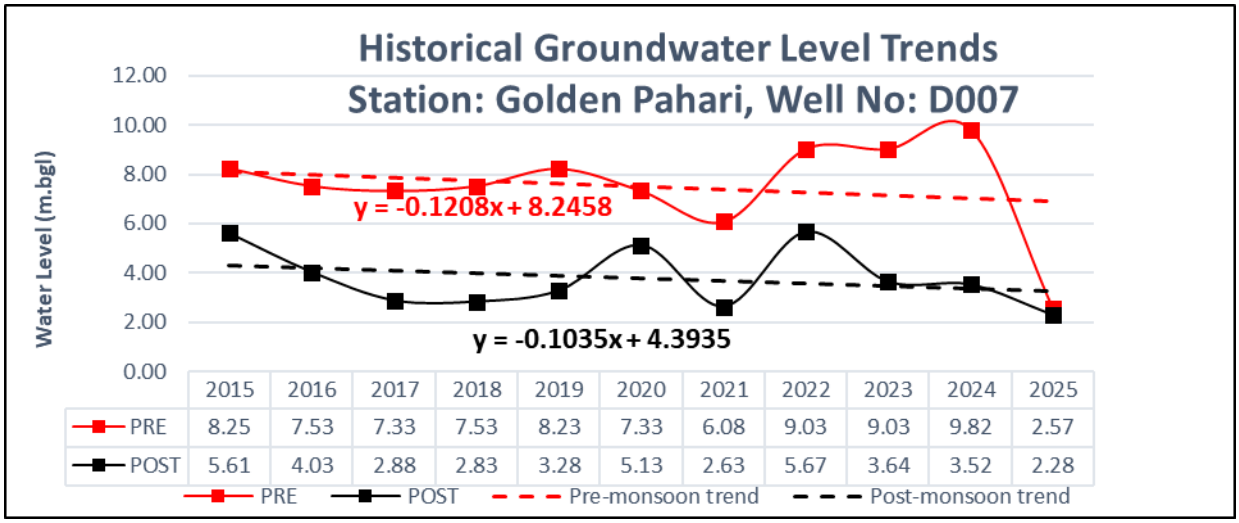




HYDROGRAPHS OF CLUSTER-VIII

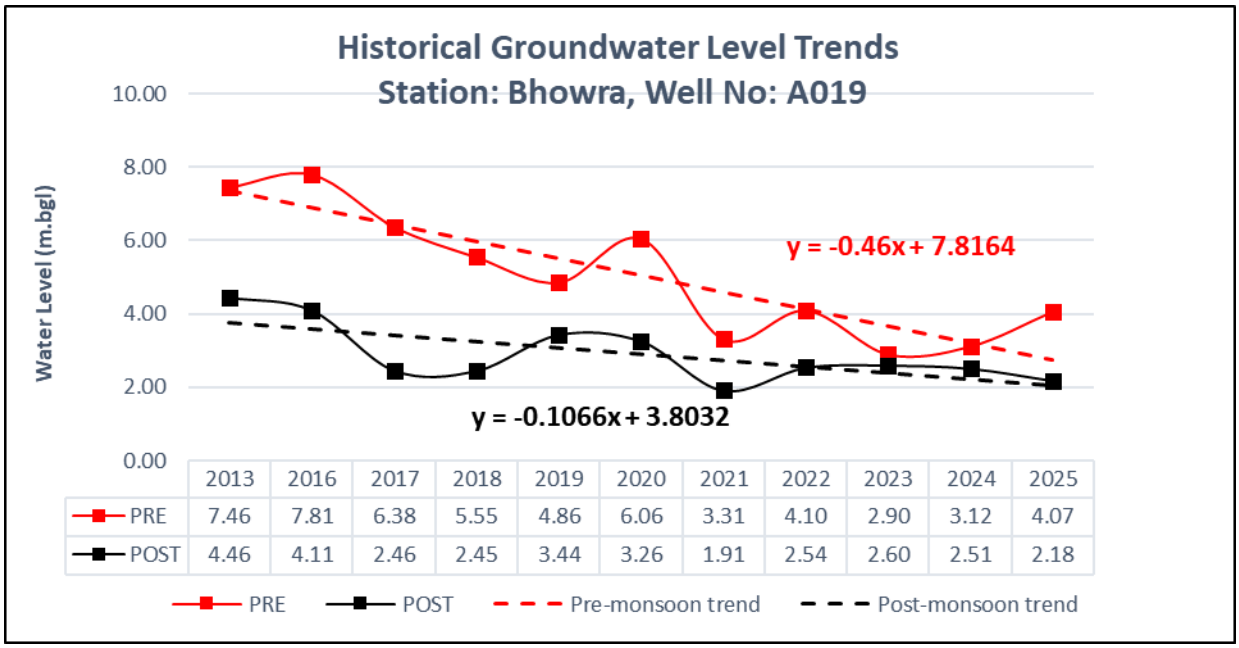


HYDROGRAPHS OF CLUSTER-IX



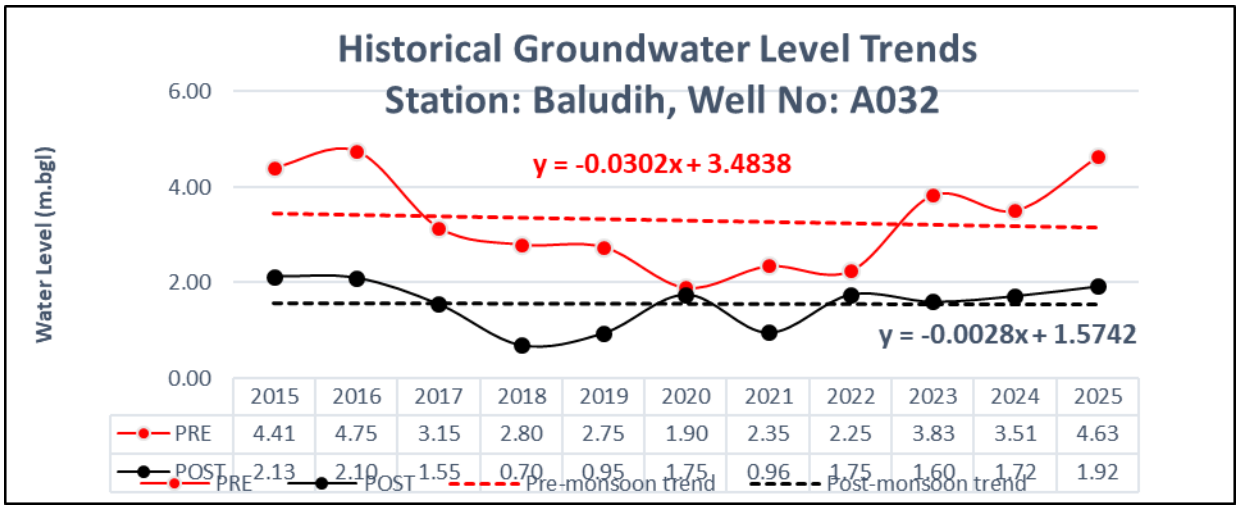
	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
PRE	8.25	7.53	7.33	7.53	8.23	7.33	6.08	9.03	9.03	9.82	2.57
POST	5.61	4.03	2.88	2.83	3.28	5.13	2.63	5.67	3.64	3.52	2.28

HYDROGRAPHS OF CLUSTER-X

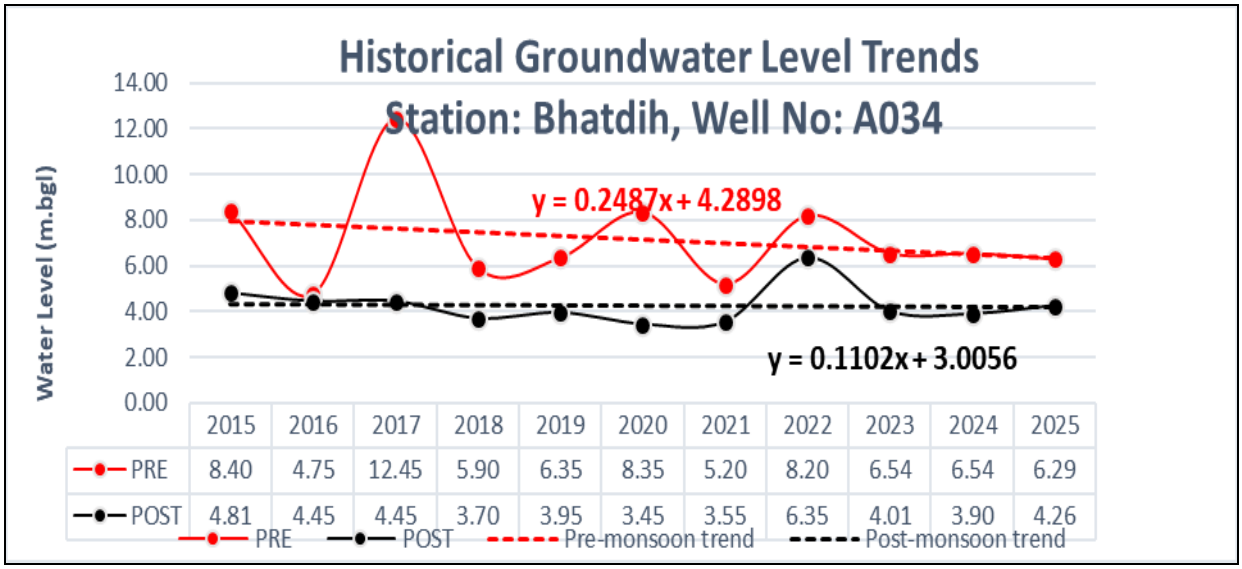


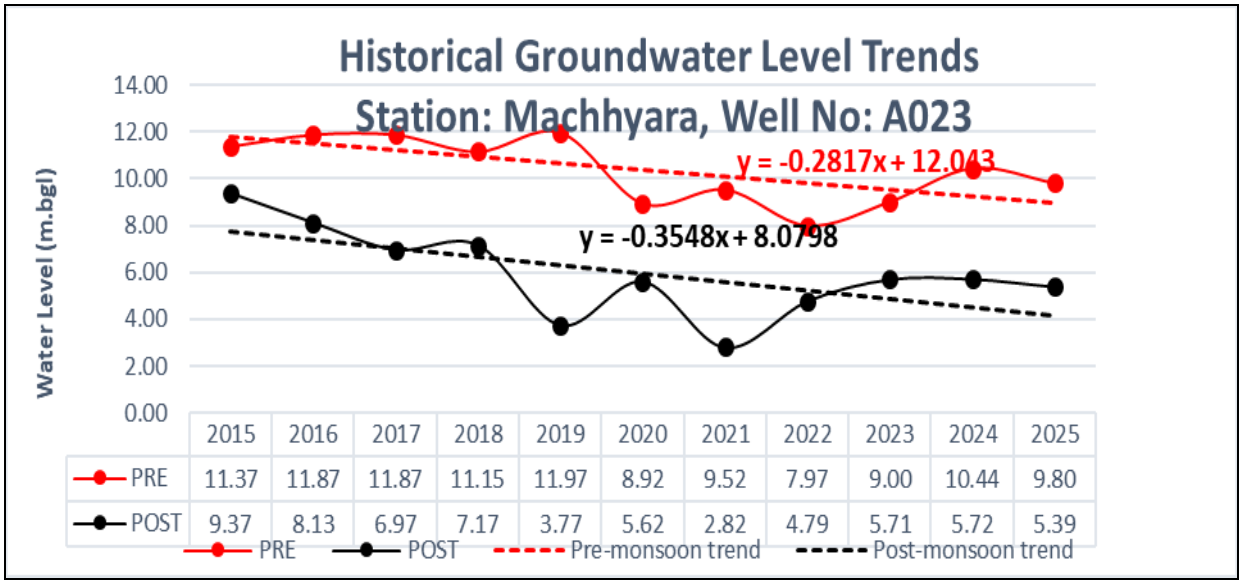
	2013	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
PRE	7.46	7.81	6.38	5.55	4.86	6.06	3.31	4.10	2.90	3.12	4.07
POST	4.46	4.11	2.46	2.45	3.44	3.26	1.91	2.54	2.60	2.51	2.18

HYDROGRAPHS OF CLUSTER-XI

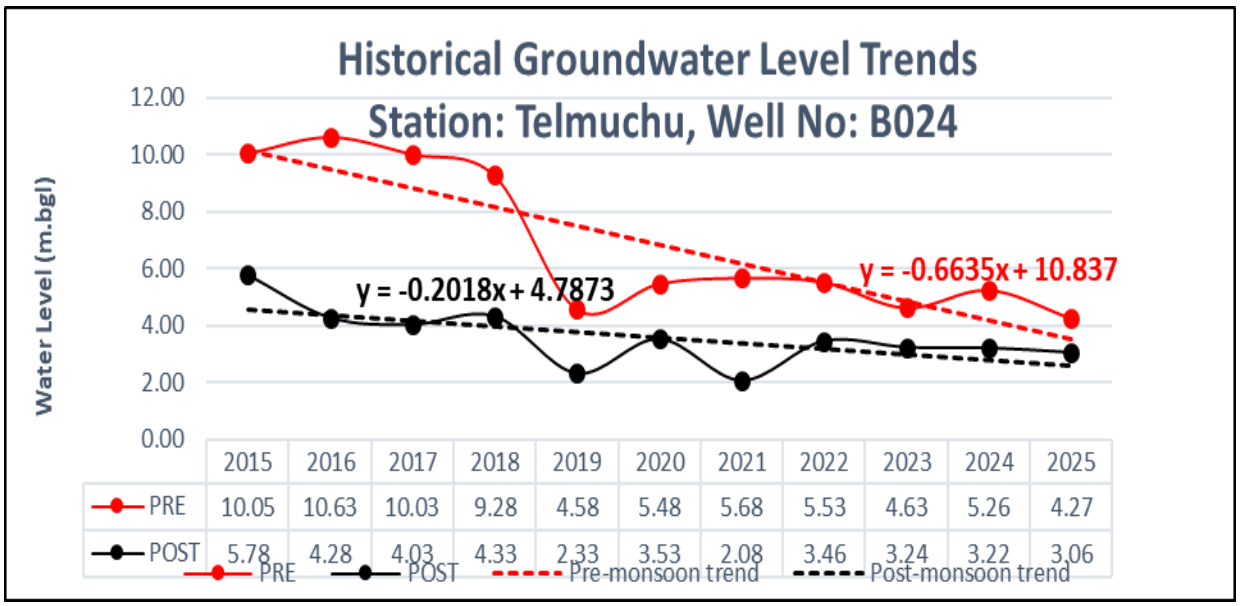


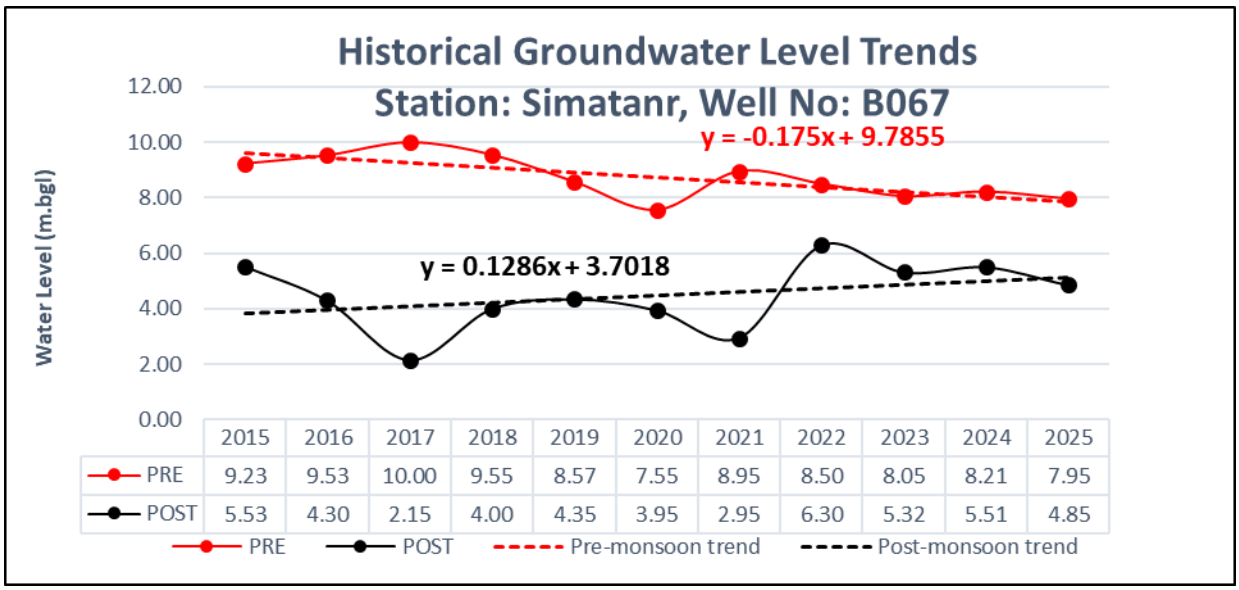
HYDROGRAPHS OF CLUSTER-XIII



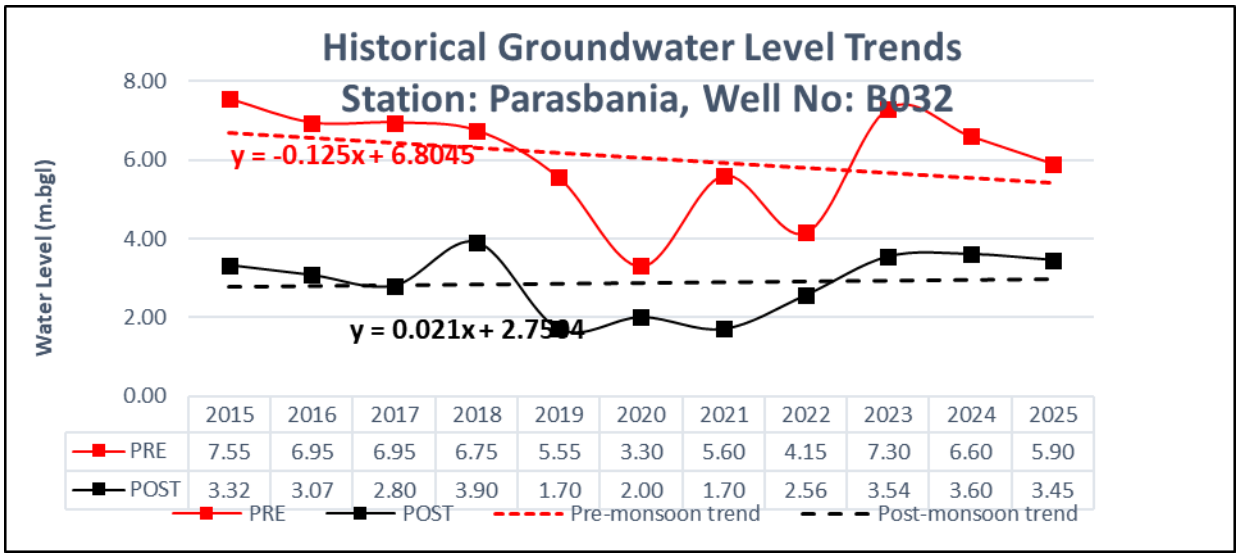


HYDROGRAPHS OF CLUSTER-XIV



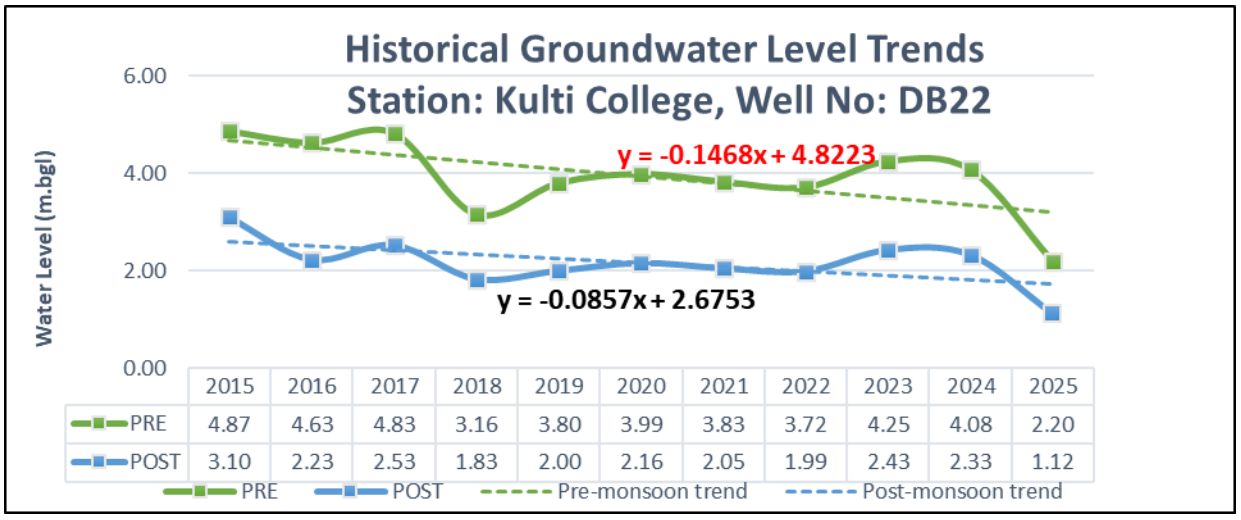


HYDROGRAPHS OF CLUSTER-XV

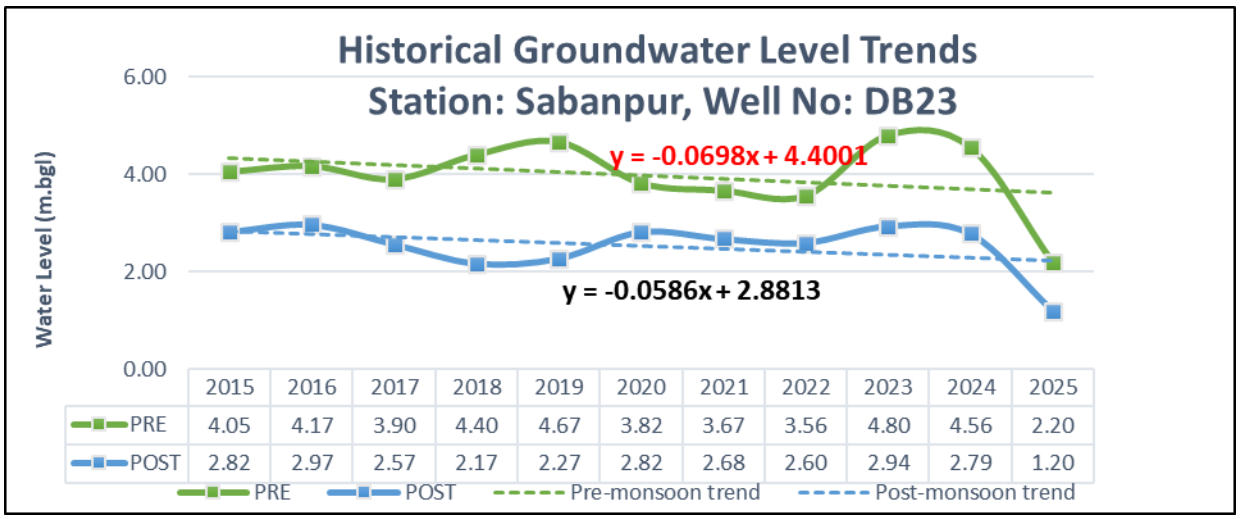


Annexure – VI

HYDROGRAPHS OF CLUSTER-XVI

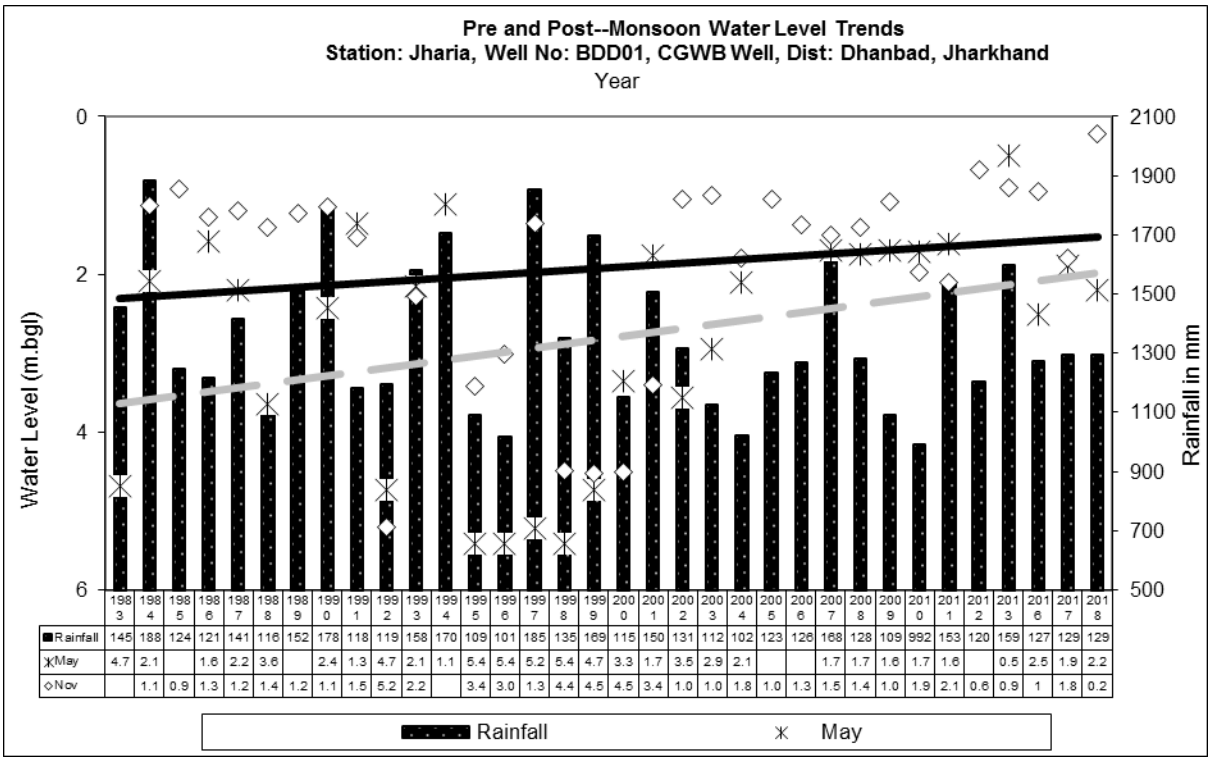


	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
PRE	4.87	4.63	4.83	3.16	3.80	3.99	3.83	3.72	4.25	4.08	2.20
POST	3.10	2.23	2.53	1.83	2.00	2.16	2.05	1.99	2.43	2.33	1.12

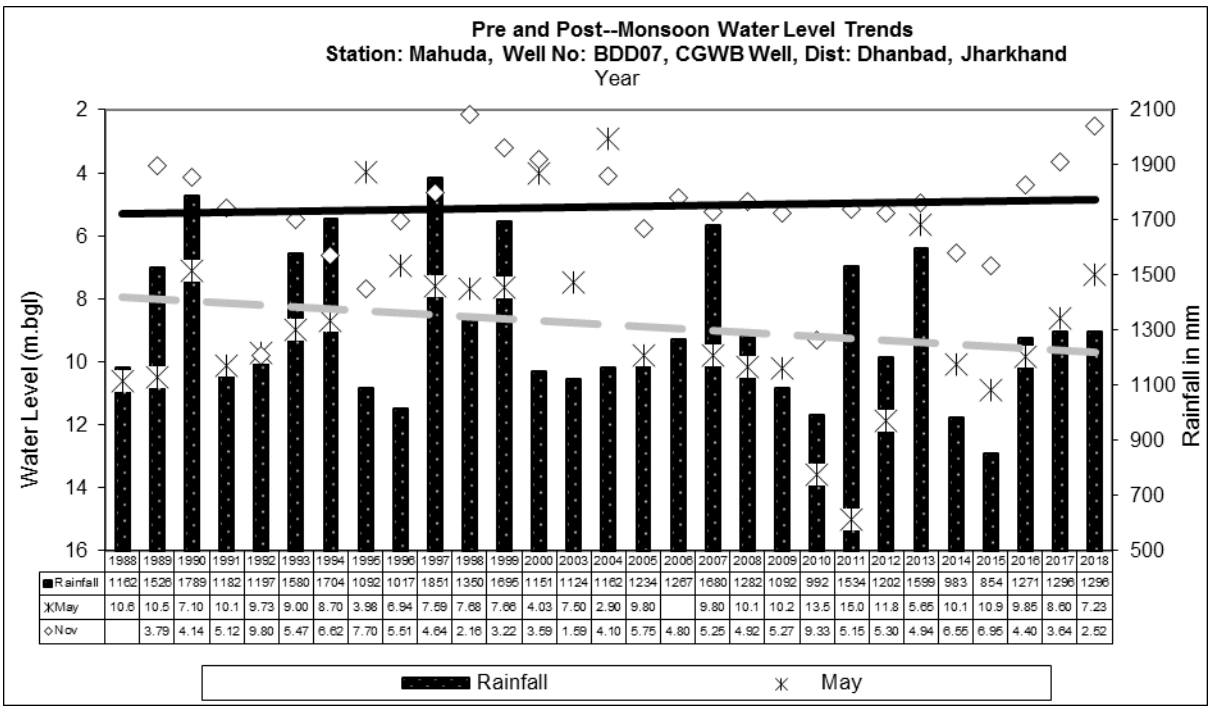


	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
PRE	4.05	4.17	3.90	4.40	4.67	3.82	3.67	3.56	4.80	4.56	2.20
POST	2.82	2.97	2.57	2.17	2.27	2.82	2.68	2.60	2.94	2.79	1.20

HYDROGRAPHS OF CGWB PERMANENT OBSERVATION STATIONS

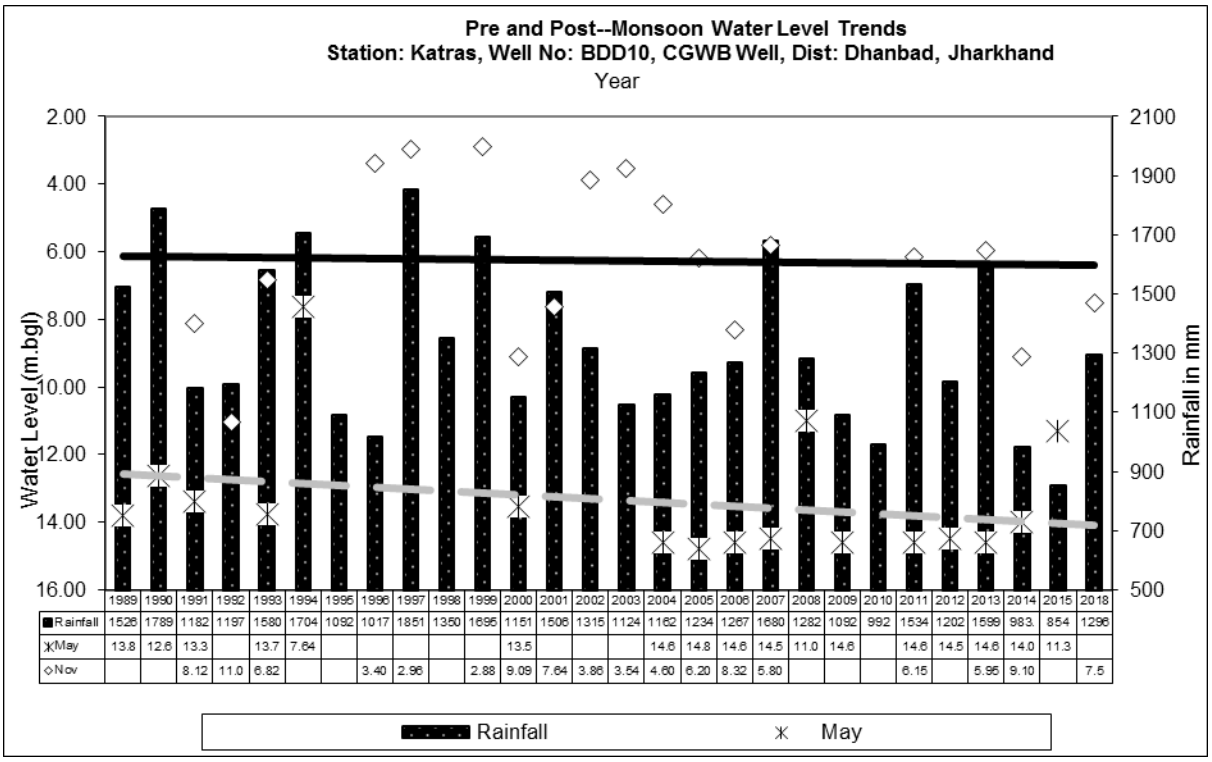


	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	145	188	124	121	141	116	152	178	118	119	158	170	109	101	185	135	169	115	150	131	112	102	123	126	168	128	109	992	153	120	159	127	129	129		
May	4.7	2.1		1.6	2.2	3.6		2.4	1.3	4.7	2.1	1.1	5.4	5.4	5.2	5.4	4.7	3.3	1.7	3.5	2.9	2.1			1.7	1.7	1.6	1.7	1.6		0.5	2.5	1.9	2.2		
Nov		1.1	0.9	1.3	1.2	1.4	1.2	1.1	1.5	5.2	2.2		3.4	3.0	1.3	4.4	4.5	4.5	3.4	1.0	1.0	1.8	1.0	1.3	1.5	1.4	1.0	1.9	2.1	0.6	0.9	1	1.8	0.2		

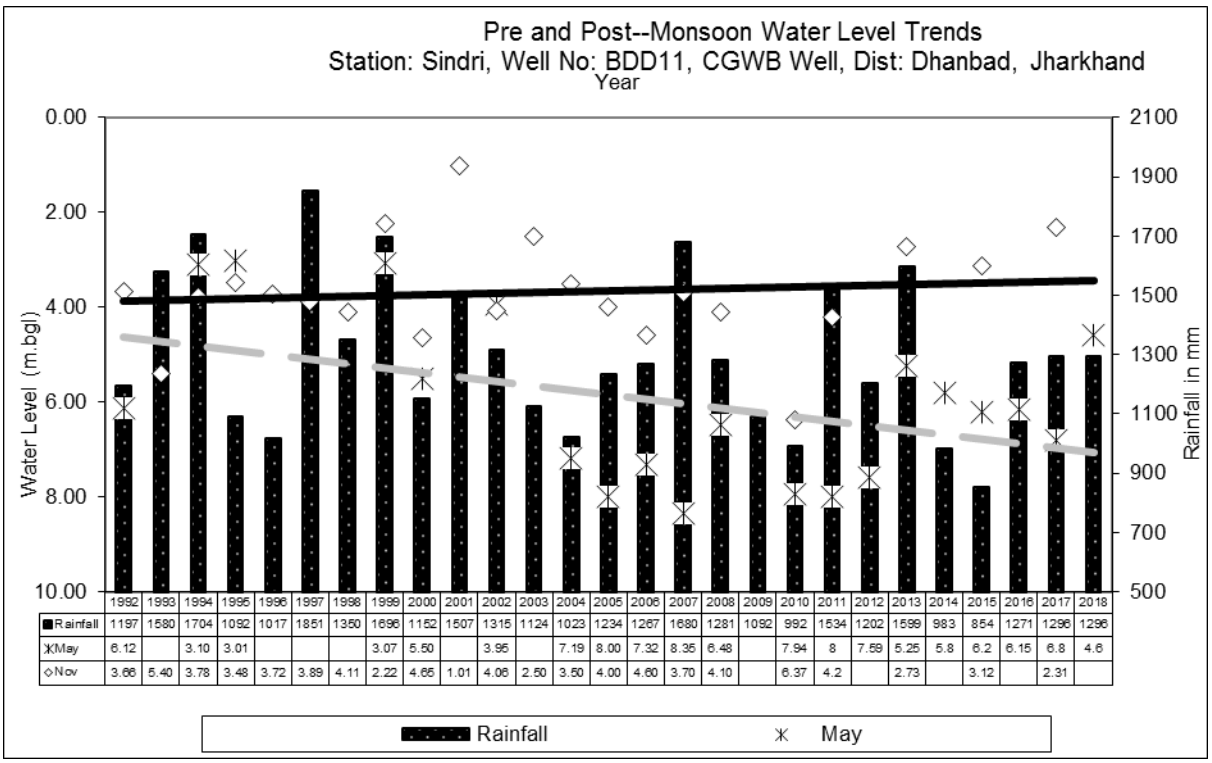


	1988	1989	1990	1991	1992	1993	1994	1996	1996	1997	1998	1999	2000	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	1162	1526	1789	1182	1197	1580	1704	1092	1017	1851	1350	1695	1151	1124	1162	1234	1267	1680	1282	1092	992	1534	1202	1599	983	854	1271	1296	1296
May	10.6	10.5	7.10	10.1	9.73	9.00	8.70	3.98	6.94	7.59	7.68	7.66	4.03	7.50	2.90	9.80		9.80	10.1	10.2	13.5	15.0	11.8	5.65	10.1	10.9	9.85	8.60	7.23
Nov		3.79	4.14	5.12	9.80	5.47	6.62	7.70	5.51	4.64	2.16	3.22	3.59	1.59	4.10	5.75	4.80	5.25	4.92	5.27	9.33	5.15	5.30	4.94	6.55	6.95	4.40	3.64	2.52

HYDROGRAPHS OF CGWB PERMANENT OBSERVATION STATIONS

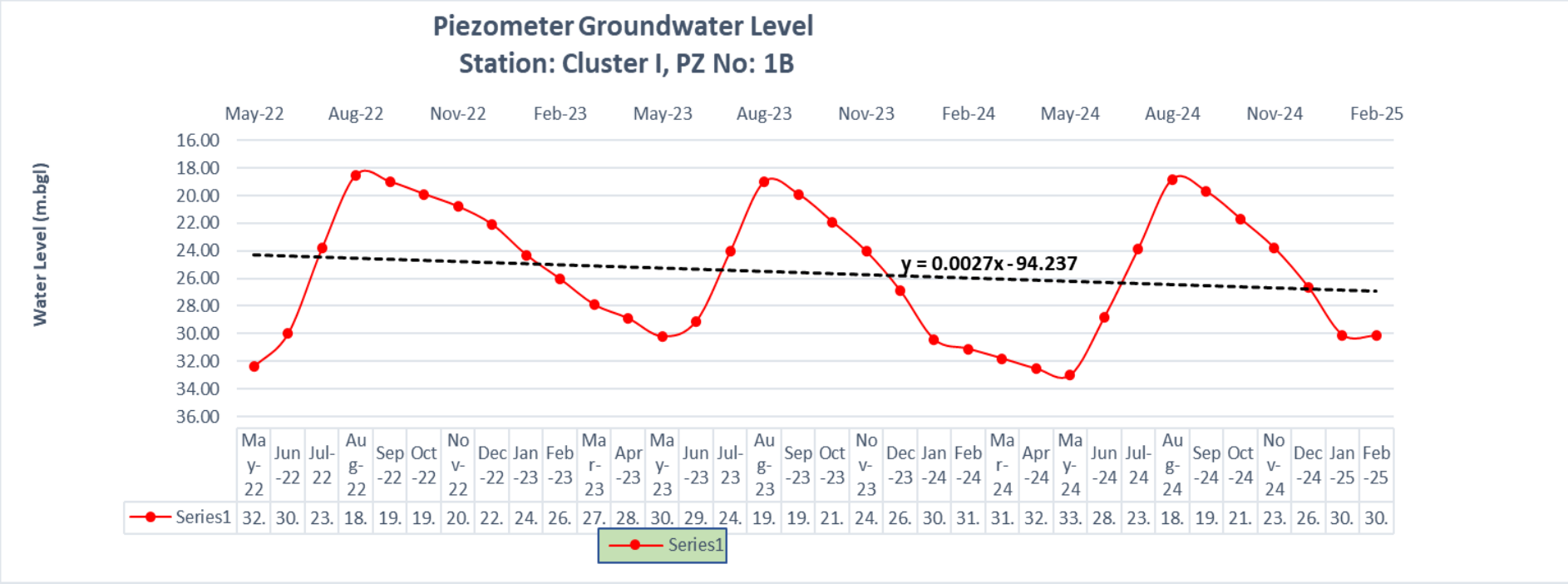


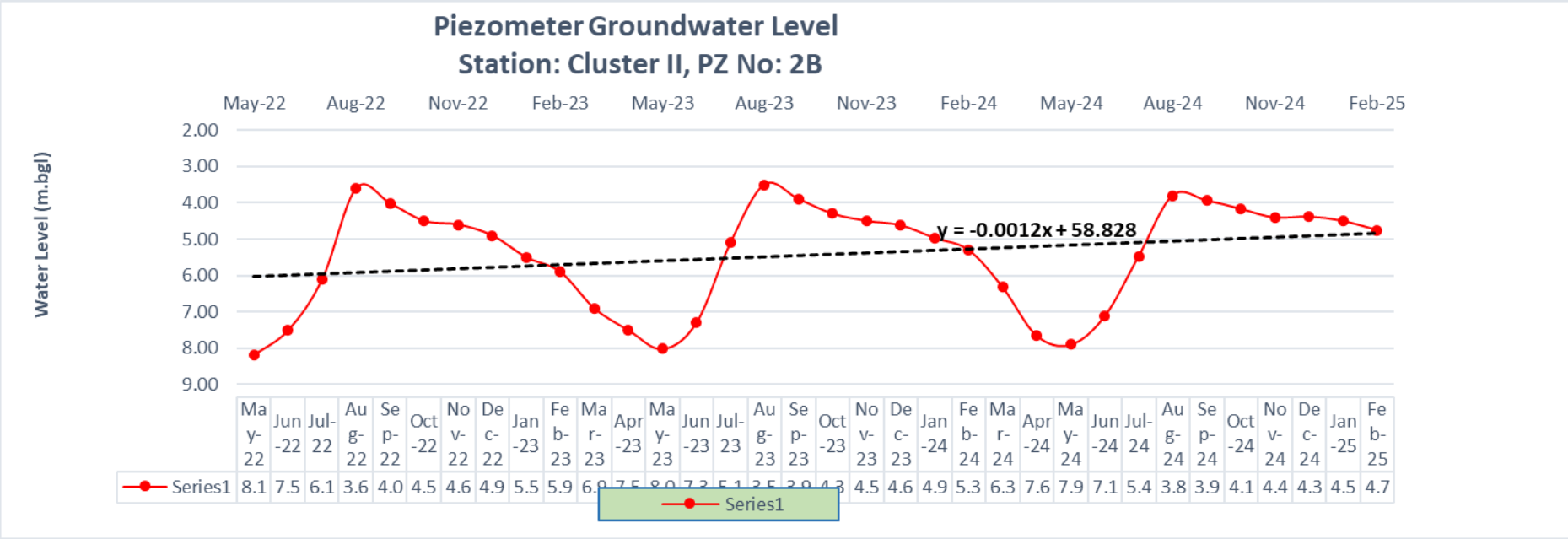
	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2018
Rainfall	1526	1789	1182	1197	1580	1704	1092	1017	1851	1350	1695	1151	1506	1315	1124	1162	1234	1267	1680	1282	1092	992	1534	1202	1599	983.	854	1296
May	13.8	12.6	13.3		13.7	7.64						13.5				14.6	14.8	14.6	14.5	11.0	14.6		14.6	14.5	14.6	14.0	11.3	
Nov			8.12	11.0	6.82			3.40	2.96		2.88	9.09	7.64	3.86	3.54	4.60	6.20	8.32	5.80				6.15		5.95	9.10		7.5



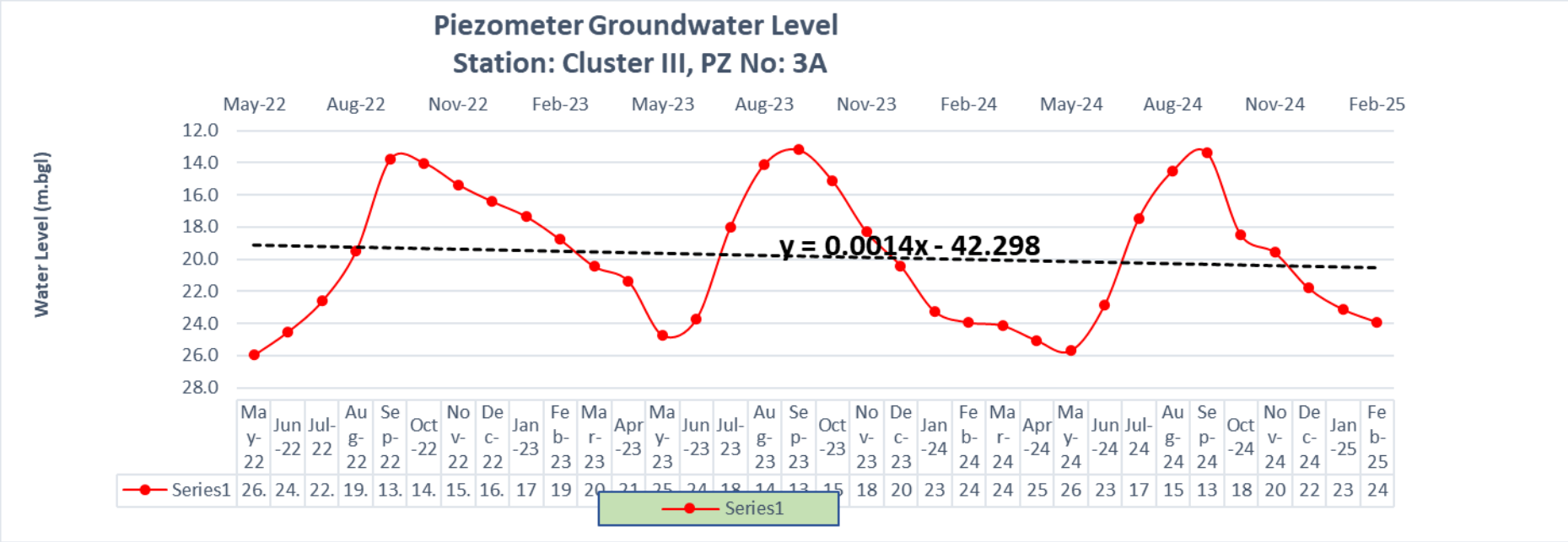
	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	1197	1580	1704	1092	1017	1851	1350	1696	1152	1507	1315	1124	1023	1234	1267	1680	1281	1092	992	1534	1202	1599	983	854	1271	1296	1296
May	6.12		3.10	3.01				3.07	5.50		3.95		7.19	8.00	7.32	8.35	6.48		7.94	8	7.59	5.25	5.8	6.2	6.15	6.8	4.6
Nov	3.66	5.40	3.78	3.48	3.72	3.89	4.11	2.22	4.65	1.01	4.06	2.50	3.50	4.00	4.60	3.70	4.10		6.37	4.2		2.73		3.12		2.31	

PIEZOMETER HYDROGRAPHS

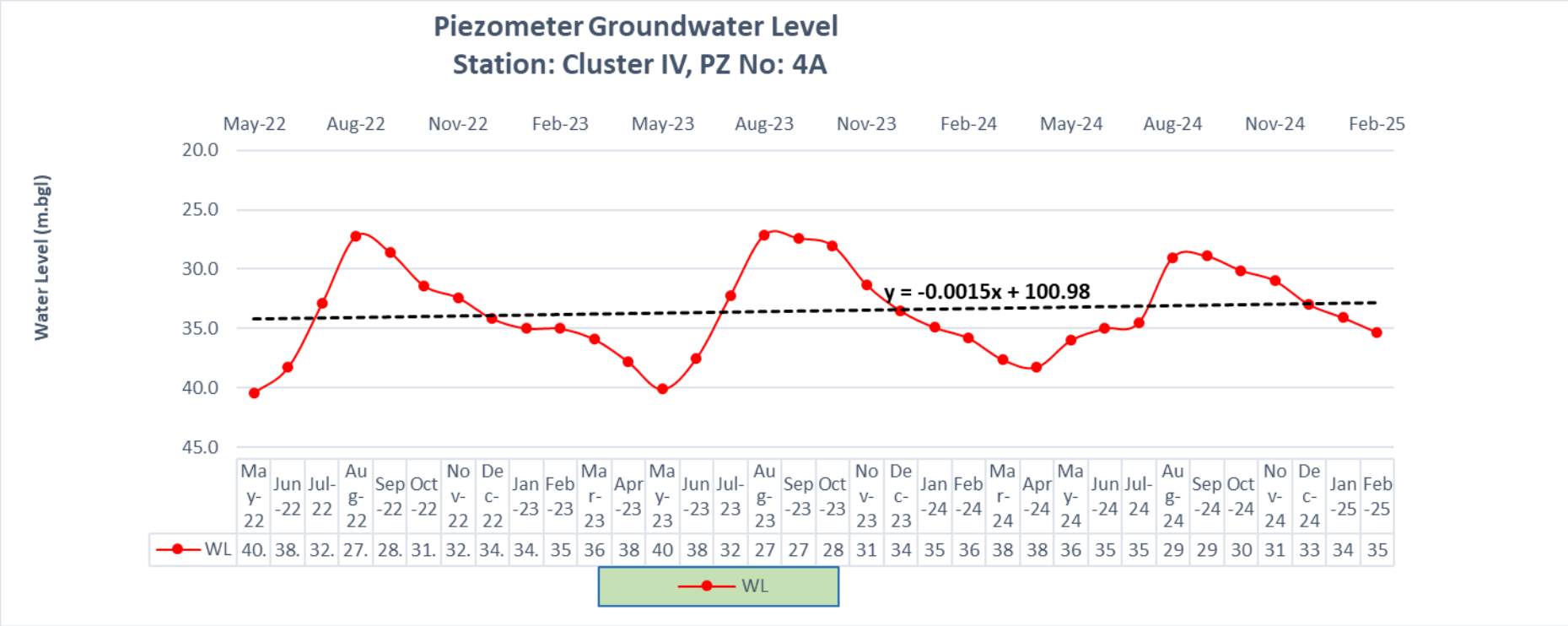




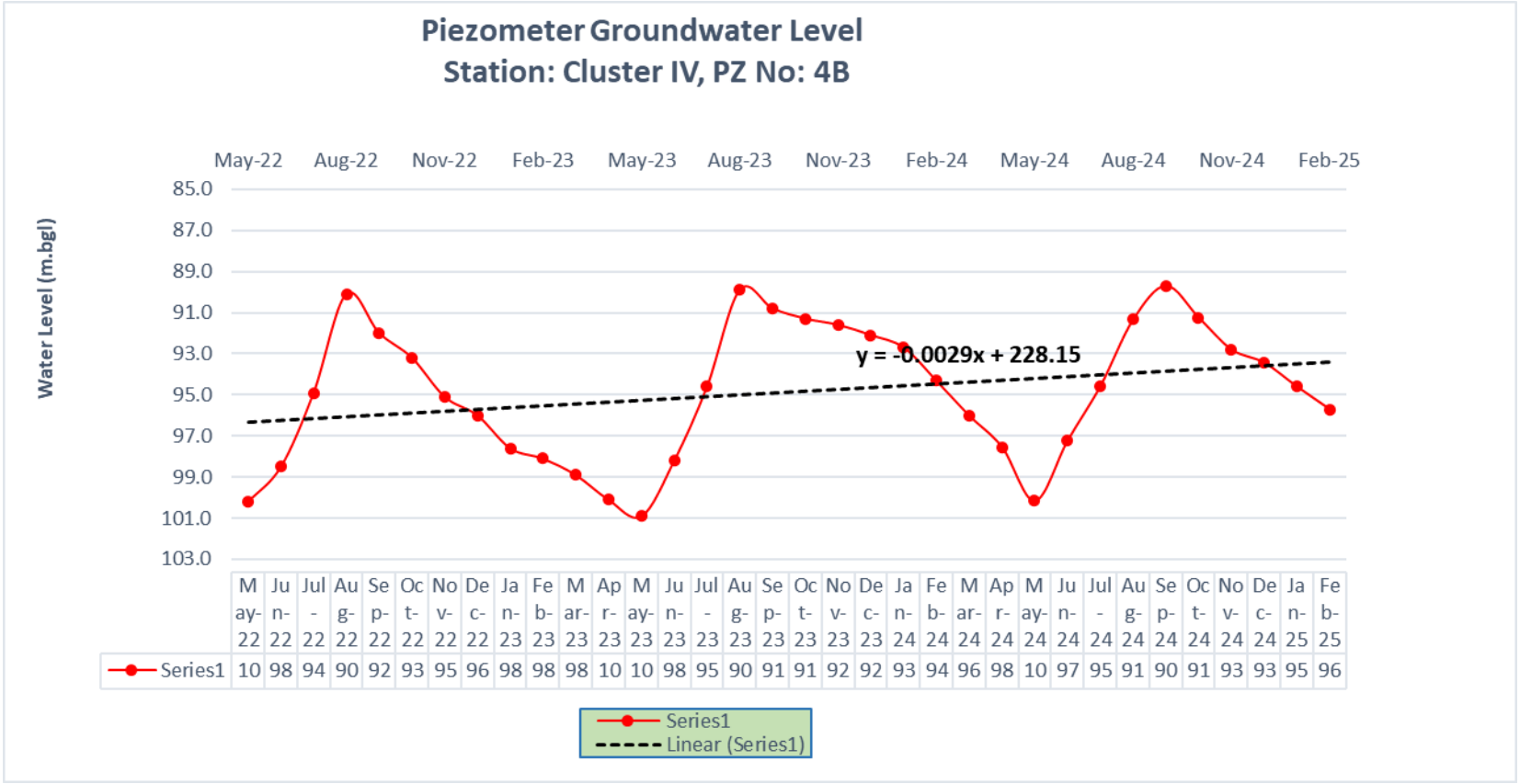
Annexure – VIA

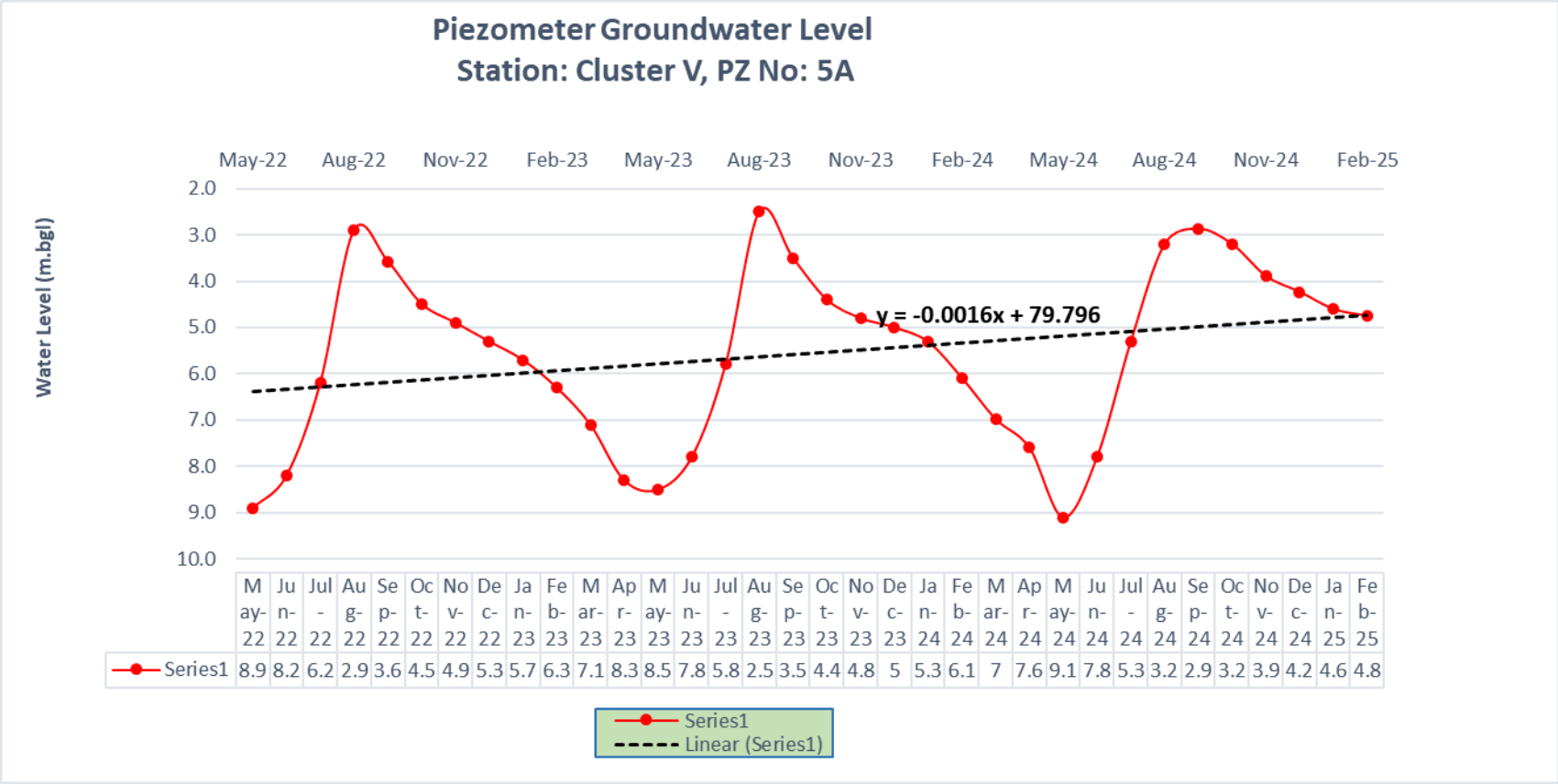


Annexure – VIA

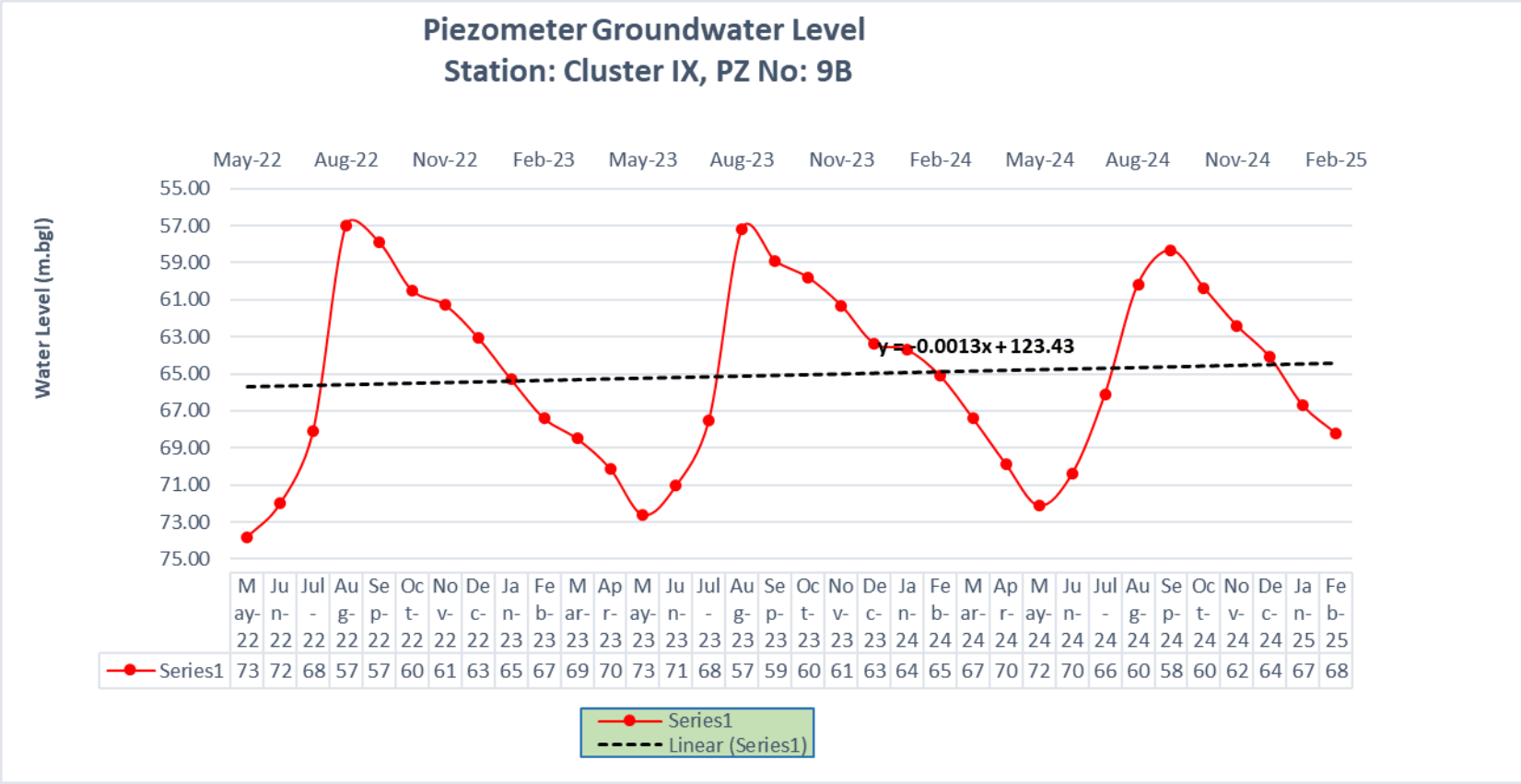


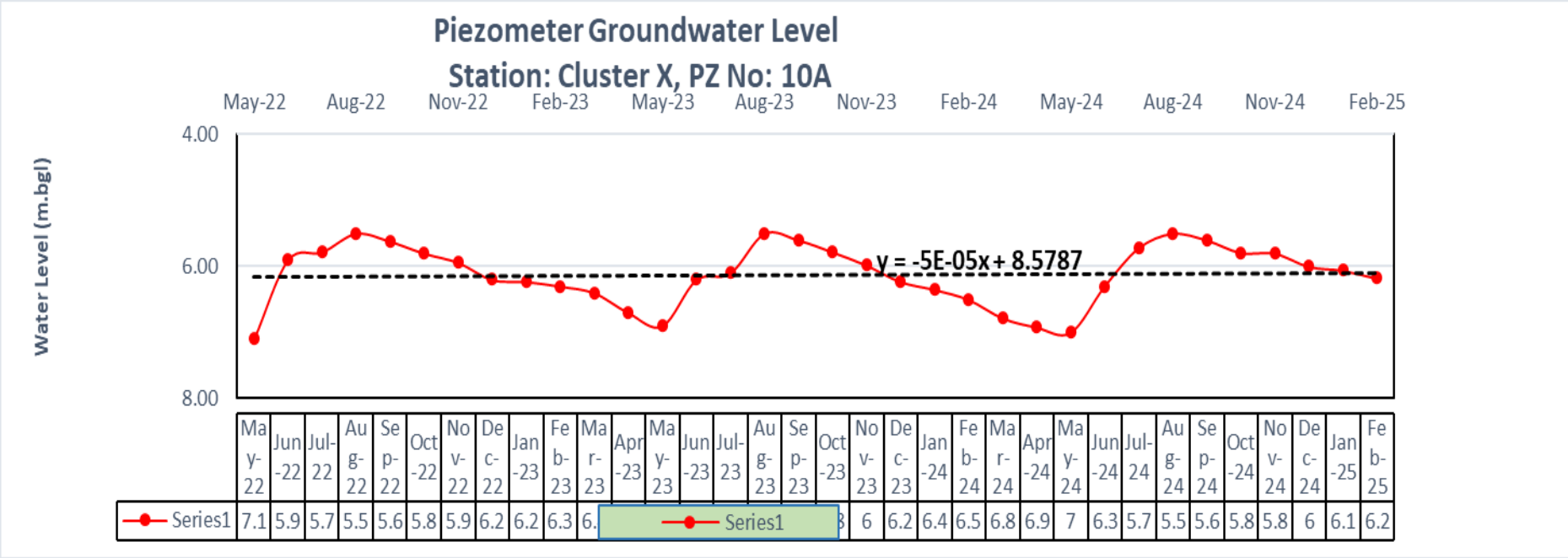
	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22	Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23	Jan-24	Feb-24	Mar-24	Apr-24	May-24	Jun-24	Jul-24	Aug-24	Sep-24	Oct-24	Nov-24	Dec-24	Jan-25	Feb-25
WL	40.	38.	32.	27.	28.	31.	32.	34.	34.	35	36	38	40	38	32	27	27	28	31	34	35	36	38	38	36	35	35	29	29	30	31	33	34	35

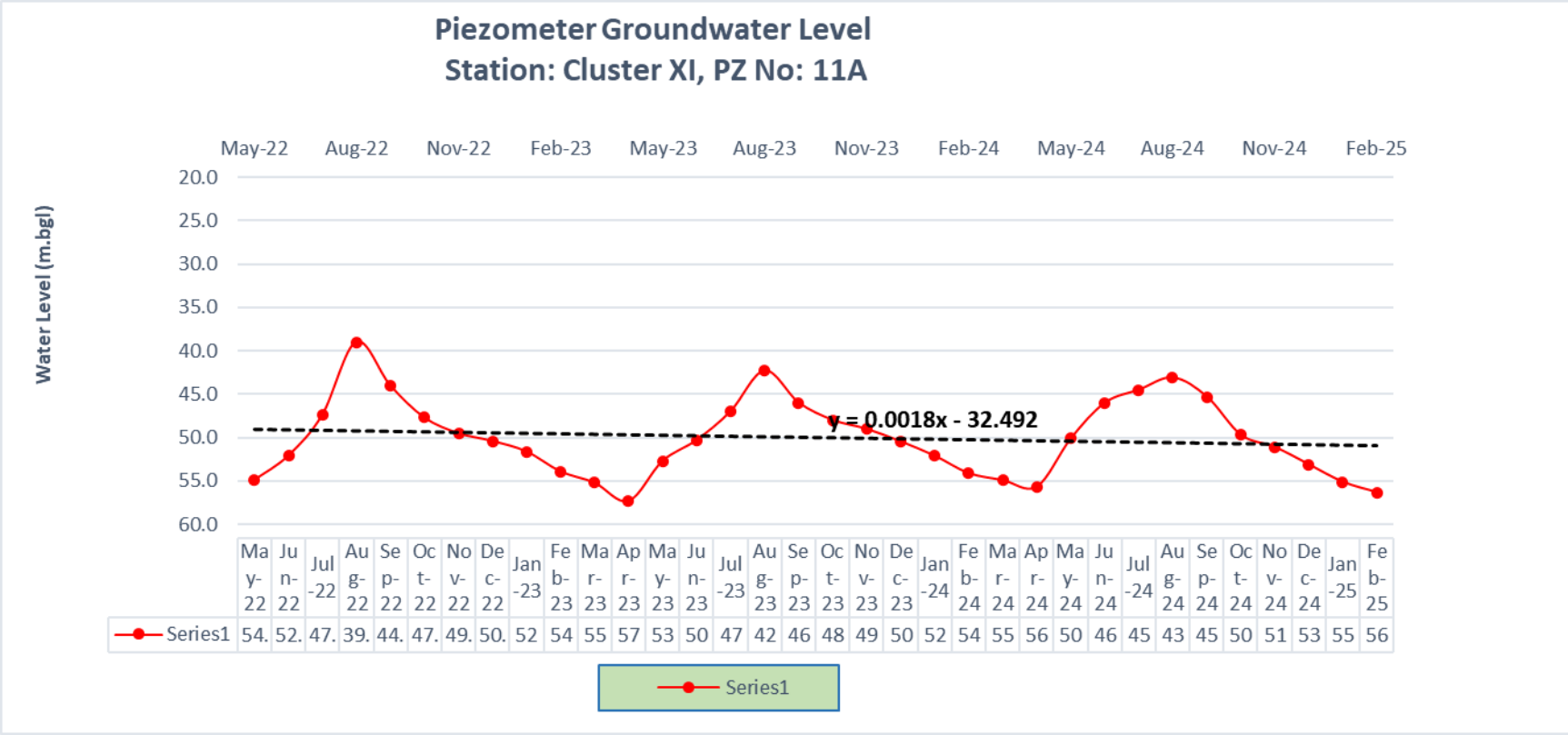

Piezometer Groundwater Level
Station: Cluster IV, PZ No: 4B
Water Level (m.bgl)
May-22 Aug-22 Nov-22 Feb-23 May-23 Aug-23 Nov-23 Feb-24 May-24 Aug-24 Nov-24 Feb-25
85.0
87.0
89.0
91.0
93.0
95.0
97.0
99.0
101.0
103.0
y = -0.0029x + 228.15
May-22 Jun-22 Jul-22 Aug-22 Sep-22 Oct-22 Nov-22 Dec-22 Jan-23 Feb-23 Mar-23 Apr-23 May-23 Jun-23 Jul-23 Aug-23 Sep-23 Oct-23 Nov-23 Dec-23 Jan-24 Feb-24 Mar-24 Apr-24 May-24 Jun-24 Jul-24 Aug-24 Sep-24 Oct-24 Nov-24 Dec-24 Jan-25 Feb-25
Series1 10 98 94 90 92 93 95 96 98 98 98 10 10 98 95 90 91 91 92 92 93 94 96 98 10 97 95 91 90 91 93 93 95 96
Series1
Linear (Series1)

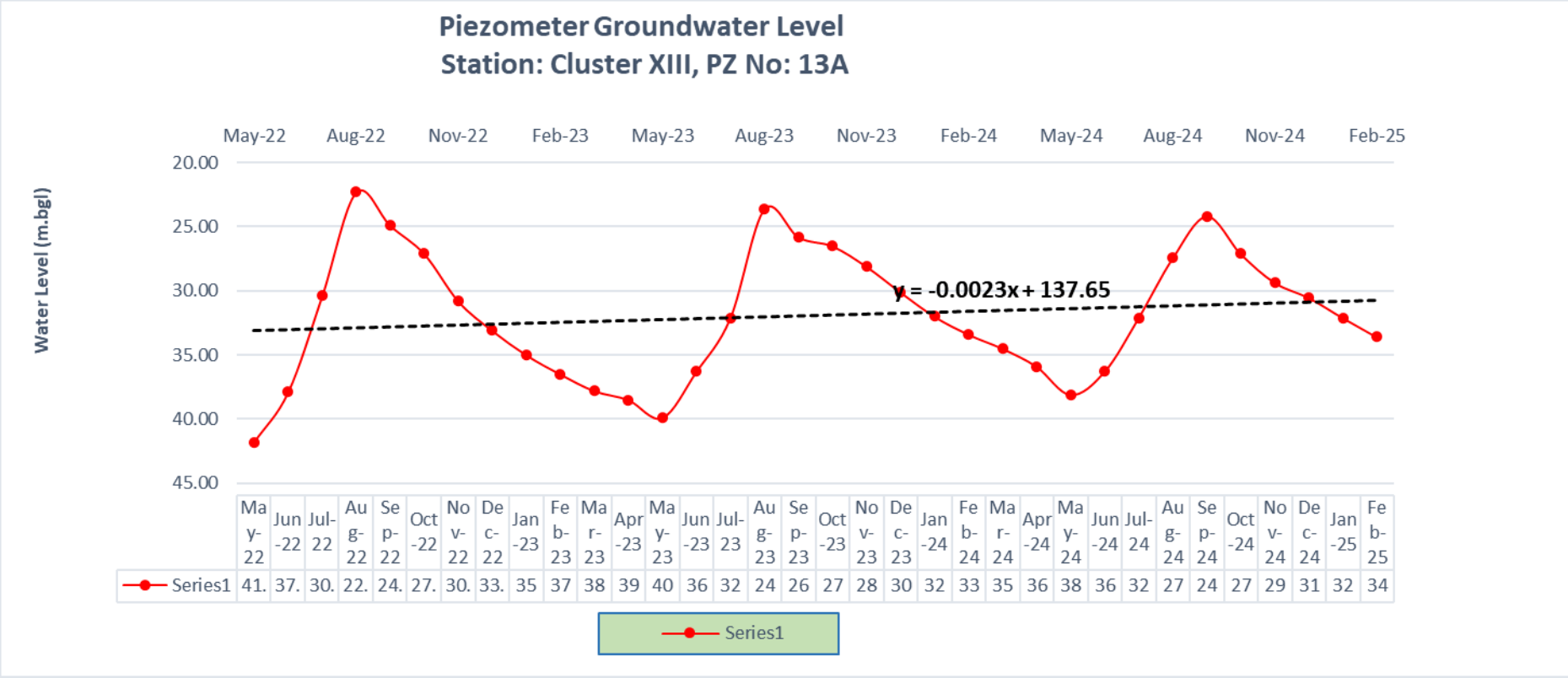


Annexure – VIA

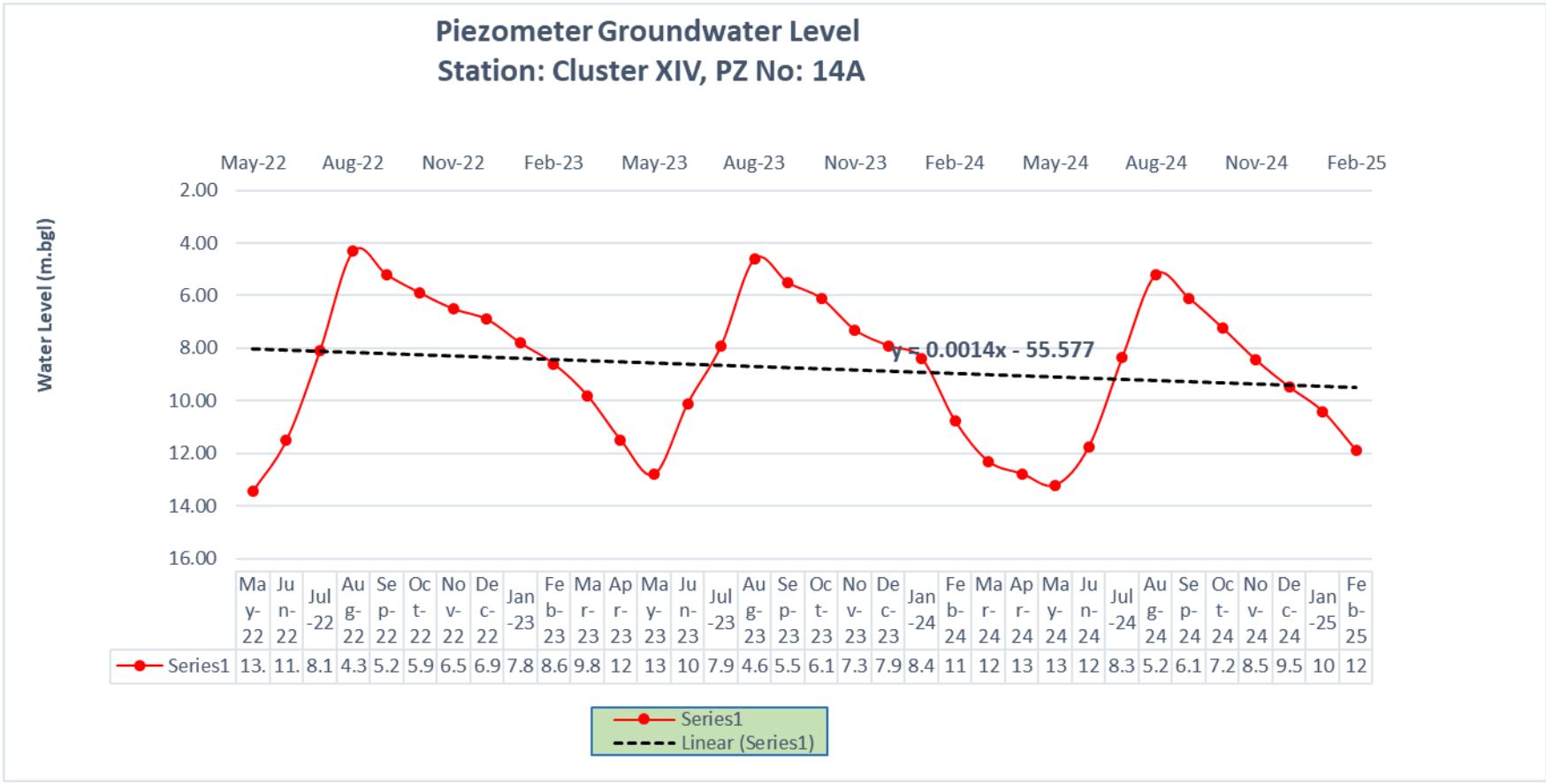

Piezometer Groundwater Level
Station: Cluster IX, PZ No: 9B
Water Level (m.bgl)
May-22
Aug-22
Nov-22
Feb-23
May-23
Aug-23
Nov-23
Feb-24
May-24
Aug-24
Nov-24
Feb-25
55.00
57.00
59.00
61.00
63.00
65.00
67.00
69.00
71.00
73.00
75.00
y = -0.0013x + 123.43
May-22 Jun-22 Jul-22 Aug-22 Sep-22 Oct-22 Nov-22 Dec-22 Jan-23 Feb-23 Mar-23 Apr-23 May-23 Jun-23 Jul-23 Aug-23 Sep-23 Oct-23 Nov-23 Dec-23 Jan-24 Feb-24 Mar-24 Apr-24 May-24 Jun-24 Jul-24 Aug-24 Sep-24 Oct-24 Nov-24 Dec-24 Jan-25 Feb-25
Series1 73 72 68 57 57 60 61 63 65 67 69 70 73 71 68 57 59 60 61 63 64 65 67 70 72 70 66 60 58 60 62 64 67 68
Series1
Linear (Series1)

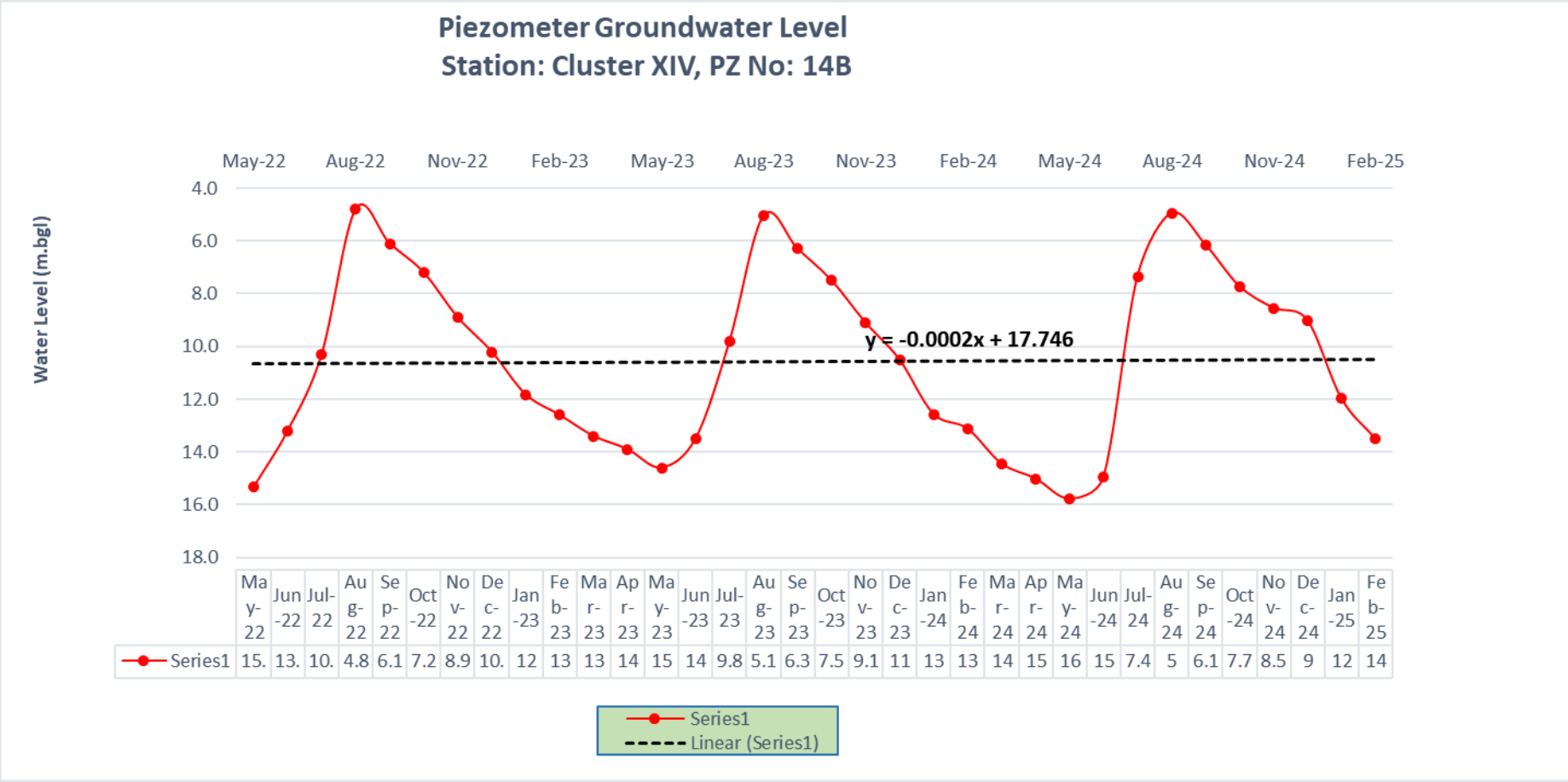

Piezometer Groundwater Level
Station: Cluster X, PZ No: 10A
Water Level (m.bgl)
May-22 Aug-22 Nov-22 Feb-23 May-23 Aug-23 Nov-23 Feb-24 May-24 Aug-24 Nov-24 Feb-25
4.00
6.00
8.00
y = -5E-05x + 8.5787
May-22 Jun-22 Jul-22 Aug-22 Sep-22 Oct-22 Nov-22 Dec-22 Jan-23 Feb-23 Mar-23 Apr-23 May-23 Jun-23 Jul-23 Aug-23 Sep-23 Oct-23 Nov-23 Dec-23 Jan-24 Feb-24 Mar-24 Apr-24 May-24 Jun-24 Jul-24 Aug-24 Sep-24 Oct-24 Nov-24 Dec-24 Jan-25 Feb-25
Series1 7.1 5.9 5.7 5.5 5.6 5.8 5.9 6.2 6.2 6.3 6. 6 6.2 6.4 6.5 6.8 6.9 7 6.3 5.7 5.5 5.6 5.8 5.8 6 6.1 6.2
Series1


Piezometer Groundwater Level
Station: Cluster XI, PZ No: 11A
Water Level (m.bgl)
May-22
Aug-22
Nov-22
Feb-23
May-23
Aug-23
Nov-23
Feb-24
May-24
Aug-24
Nov-24
Feb-25
20.0
25.0
30.0
35.0
40.0
45.0
50.0
55.0
60.0
y = 0.0018x - 32.492
May-22 Jun-22 Jul-22 Aug-22 Sep-22 Oct-22 Nov-22 Dec-22 Jan-23 Feb-23 Mar-23 Apr-23 May-23 Jun-23 Jul-23 Aug-23 Sep-23 Oct-23 Nov-23 Dec-23 Jan-24 Feb-24 Mar-24 Apr-24 May-24 Jun-24 Jul-24 Aug-24 Sep-24 Oct-24 Nov-24 Dec-24 Jan-25 Feb-25
Series1 54. 52. 47. 39. 44. 47. 49. 50. 52 54 55 57 53 50 47 42 46 48 49 50 52 54 55 56 50 46 45 43 45 50 51 53 55 56
Series1



Annexure – VIA


Piezometer Groundwater Level
Station: Cluster XIV, PZ No: 14A
Water Level (m.bgl)
May-22
Aug-22
Nov-22
Feb-23
May-23
Aug-23
Nov-23
Feb-24
May-24
Aug-24
Nov-24
Feb-25
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
y = 0.0014x - 55.577
May-22 Jun-22 Jul-22 Aug-22 Sep-22 Oct-22 Nov-22 Dec-22 Jan-23 Feb-23 Mar-23 Apr-23 May-23 Jun-23 Jul-23 Aug-23 Sep-23 Oct-23 Nov-23 Dec-23 Jan-24 Feb-24 Mar-24 Apr-24 May-24 Jun-24 Jul-24 Aug-24 Sep-24 Oct-24 Nov-24 Dec-24 Jan-25 Feb-25
Series1 13. 11. 8.1 4.3 5.2 5.9 6.5 6.9 7.8 8.6 9.8 12 13 10 7.9 4.6 5.5 6.1 7.3 7.9 8.4 11 12 13 13 12 8.3 5.2 6.1 7.2 8.5 9.5 10 12
Series1
Linear (Series1)


Piezometer Groundwater Level
Station: Cluster XIV, PZ No: 14B
Water Level (m.bgl)
May-22
Aug-22
Nov-22
Feb-23
May-23
Aug-23
Nov-23
Feb-24
May-24
Aug-24
Nov-24
Feb-25
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
y = -0.0002x + 17.746
May-22 Jun-22 Jul-22 Aug-22 Sep-22 Oct-22 Nov-22 Dec-22 Jan-23 Feb-23 Mar-23 Apr-23 May-23 Jun-23 Jul-23 Aug-23 Sep-23 Oct-23 Nov-23 Dec-23 Jan-24 Feb-24 Mar-24 Apr-24 May-24 Jun-24 Jul-24 Aug-24 Sep-24 Oct-24 Nov-24 Dec-24 Jan-25 Feb-25
Series1 15. 13. 10. 4.8 6.1 7.2 8.9 10. 12 13 13 14 15 14 9.8 5.1 6.3 7.5 9.1 11 13 13 14 15 16 15 7.4 5 6.1 7.7 8.5 9 12 14
Series1
Linear (Series1)

Annexure – VII

GROUNDWATER SAMPLE LOCATION DETAILS

Sampling month: June month of the assessment year of 2023-24

Sl No	Dug well (CMPDI)	Location	Sampling Date
			June'2024
Jharia Coalfield			
1	**A4**	DALDOLI	12.06.24
2	**A9**	SRIRAMPUR	12.06.24
3	**A10**	PHULWAR	12.06.24
4	**A13**	BHELATANR	11.06.24
5	**A23**	MACHHAYARA	05.06.24
6	**A29**	GOVINDPUR, AMBAGAN VILLAGE	06.06.24
7	**A32**	MOONIDIH BAZAR	05.06.24
8	**B10**	AMDIH NARAYANPUR	06.06.24
9	**B15**	BERA VILLAGE	07.06.24
10	**B19**	BHANDARIDAH	07.06.24
11	**B23**	LOHAPATTI VILLAGE	05.06.24
12	**B32**	MADHUBAND VILLAGE	06.06.24
13	**B40**	BHUIANCHITRO	07.06.24
14	**B46**	TELO	07.06.24
15	**B55**	RANTANR VILLAGE	12.06.24
16	**B59**	KHODOVALY VILLAGE	06.06.24
17	**B64**	KESHALPUR, BATIGHAR	06.06.24
18	**D2**	BIRSA MUNDA CHAWK, BANKMORE	03.06.24
19	**D4**	JHARIA THANA	03.06.24
20	**D5**	JIYALGORA (NEAR P.O.)	03.06.24
21	**D14**	KARMATANR	13.06.24
22	**D19**	MEMKO MORE	06.06.24
23	**D25**	GODHUR MORE	05.06.24
24	**D30**	BORKIBOA VILLAGE	06.06.24
25	**D35**	PATHERDIH RAILWAY COLONY	06.07.24
26	**D41**	JOYRAMPUR	03.06.24
27	**D49**	TISRA THANA	03.06.24
28	**D59**	SITALPUR	04.06.24
29	**D70**	JALADIH	04.06.24
30	**D72**	CHATI GOVINDPUR	07.06.24
31	**D80**	DHANSAR MINE RESCUE STATION	03.06.24
32	**D96**	BANSHRA	04.06.24
33	**D107**	BOGULA	04.06.24
34	**D112**	DEMUDI (DOMATANR)	05.06.24
35	**D115**	TELMUCHU	06.07.24

Sl No	Dug well (CMPDI)	Location	Sampling Date
			June'2024
Raniganj Coalfield			
1	DB-2A	Sulibari	13.06.24
2	DB-4	Sarbari	14.06.24
3	DB-8	Chungei	14.06.24
4	DB-10	Kulti	14.06.24
5	DB-12	Sabanpur	14.06.24
6	DB-13	Dendua More	14.06.24
7	DB-18	Luchibad	13.06.24
8	DB-26	Ledaharia	13.06.24
9	DB-27	Hodla	13.06.24
10	DB-29	Kelyasol	13.06.24
11	DB-30	Ramkanali	14.06.24
12	DB-38	Lukudih	14.06.24
13	DB-39	Pandra	14.06.24
14	K-12	Ethora	14.06.24
15	K-20	Majhladih	14.06.24

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. *Ground Water Sampling at Monitoring Station Code : - A04 DALDOLI ,*
   Date of Sampling at Station: April 2025

Month & Year	**April 2025**	**Dug Well No.**	**A4**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**Jharia Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/25-26/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**DALDOLI**	**Date of Sampling**	**05.04.2025**	**Sample Collected in 5 LtrJerricane ,Color as observed is transparent**	
			Period of Analysis	**05.04.2025**	**TO** **09.06.2025**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			A4	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24thd Edition ,Carmine,2023	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 24th Edition, , 4500-Cl- B. (Iodometric Method-I),2023	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th Edition IS-3025,part 56:2003, R-2019/, AAS-VGA,2023	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24thEdition, AAS-GTA,2023	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 :2003,R : 2019, AAS-Flame APHA, 24thEdition, AAS-GTA,2023	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	<0.02	0.02-10.0	0.02	0.1	0.3

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. *Ground Water Sampling at Monitoring Station Code: - A09, SRIRAMPUR*

Date of Sampling at Station: April 2025

Month & Year	**April 2025**	**Dug Well No.**	**A9**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**Jharia Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/25-26/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**SRIRAMPUR**	**Date of Sampling**	**04.04.2025**	**Sample Collected in 5 LtrJerricane ,Color as observed is transparent**	
			Period of Analysis	**04.04.2025**	**TO** **09.06.2025**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			A9	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 :2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	0.02	0.02-10.0	0.02	0.1	0.3

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. *Ground Water Sampling at Monitoring Station Code: - A10, PHULWAR*

Date of Sampling at Station: April 2025

Month & Year	**April 2025**	**Dug Well No.**	**A10**			
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**				**Date of Issue**	**16.06.2025**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/25-26/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**PHULWAR**	**Date of Sampling**	**05.04.2025**	**Sample Collected in 5 LtrJerricane ,Color as observed is transparent**		
			Period of Analysis	**05.04.2025**	**TO**	**09.06.2025**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			A10	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 :2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	<0.02	0.02-10.0	0.02	0.1	0.3

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. Ground Water Sampling at Monitoring Station Code: - A13, BHELATANR

Date of Sampling at Station: April 2025

Month & Year	**April 2025**	**Dug Well No.**	**A13**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**Jharia Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/25-26/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**BHELATANR**	**Date of Sampling**	**09.04.2025**	**Sample Collected in 5 LtrJerricane ,Color as observed is transparent**	

			Period of Analysis	**09.04.2025**	**TO**	**09.06.2025**	
Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			A13	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 :2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	<0.02	0.02-10.0	0.02	0.1	0.3

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. Ground Water Sampling at Monitoring Station Code : - A23 , Macchayara

Date of Sampling at Station: April 2025

Month & Year	**April 2025**	**Dug Well No.**	**A23**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**Jharia Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/25-26/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**MACHHAYARA**	**Date of Sampling**	**09.04.2025**	**Sample Collected in 5 LtrJerricane ,Color as observed is transparent**	
			Period of Analysis	**09.04.2025**	**TO** **09.06.2025**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			A23	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 :2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	IS 3025(Part 59) :2006,R:2019, AAS-Flame Method	0.05	0.02-10.0	0.02	0.1	0.3

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. Ground Water Sampling at Monitoring Station Code: - A29, Govindpur Ambagan

Date of Sampling at Station: April 2025

Month & Year	**April 2025**	**Dug Well No.**	**A29**				
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**16.06.2025**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/25-26/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**GOVINDPUR, AMABAGAN VILLAGE**	**Date of Sampling**	**05.04.2025**	**Sample Collected in 5 LtrJerricane ,Color as observed is transparent**			
			Period of Analysis	**05.04.2025**	**TO**	**09.06.2025**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			A29	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 :2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	<0.02	0.02-10.0	0.02	0.1	0.3

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. *Ground Water Sampling at Monitoring Station Code: - A32, Moonidih Bazar*

Date of Sampling at Station: April 2025

Month & Year	**April 2025**	**Dug Well No.**	**A32**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**Jharia Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/25-26/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**MOONIDIH BAZAR**	**Date of Sampling**	**09.04.2025**	**Sample Collected in 5 LtrJerricane ,Color as observed is transparent**	
			Period of Analysis	**09.04.2025**	**TO** **09.06.2025**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**				**IS 10500: 2012**
			A32	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 :2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	<0.02	0.02-10.0	0.02	0.1	0.3

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. Ground Water Sampling at Monitoring Station Code: - B10, AMDIH NARAYANPUR

Date of Sampling at Station: April 2025

Month & Year	**April 2025**	**Dug Well No.**	**B10**				
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**16.06.2025**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/25-26/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**AMDIH NARAYANPUR**	**Date of Sampling**	**10.04.2025**	**Sample Collected in 5 Ltr Jerricane ,Color as observed is transparent**			
			Period of Analysis		**10.04.2025**	**TO**	**09.06.2025**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			B10	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	3	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	128	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	104	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.67	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R :2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	84	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	26.88	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023Electrometric(pH Meter) Method	7.04	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500S , Turbidity Method	173	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_a co_3$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	236	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	840	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	666	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	1.8	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) :1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. Ground Water Sampling at Monitoring Station Code: - B15, BERA VILLAGE

Date of Sampling at Station: April 2025

Month & Year	**April 2025**	**Dug Well No.**	**B15**				
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**16.06.2025**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/25-26/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**BERA VILLAGE**	**Date of Sampling**	**10.04.2025**	**Sample Collected in 5 LtrJerricane ,Color as observed is transparent**			
			Period of Analysis	**10.04.2025**	**to**	**09.06.2025**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			B15	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	148	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	110	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.73	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R :2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	54	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	21.54	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023Electrometric(pH Meter) Method	6.55	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500S , Turbidity Method	154	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_a co_3$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	248	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	712	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	592	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.7	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) :1994,R:2019, AAS-Flame Method	0.1	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. Ground Water Sampling at Monitoring Station Code : - B19 , BHANDARIDIH

Date of Sampling at Station: April 2025

Month & Year	**April 2025**	**Dug Well No.**	**B19**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**16.06.2025**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**BHANDARIDAH**	**Date of Sampling**	**06.05.2024**	**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis			**to**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW10	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	136	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	112	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.51	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	90	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	17.17	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.31	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	140	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	242	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	834	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	712	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.3	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. Ground Water Sampling at Monitoring Station Code: - B23 , LOHAPATTI VILLAGE

Date of Sampling at Station: April 2025

Month & Year	**April 2025**	**Dug Well No.**	**B23**	**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**Jharia Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**LOHAPATTI VILLAGE**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis	**to**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW11	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	102	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	116	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.78	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	66	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	32.91	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.85	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	119	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	208	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	642	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	528	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.7	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.17	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. Ground Water Sampling at Monitoring Station Code : - B32, MADHUBANDAH

Date of Sampling at Station : April 2025

Month & Year	**April 2025**	**Dug Well No.**	**B32**	**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**Jharia Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**MADHUBNAD VILLAGE**	**Date of Sampling**			
		Period of Analysis		**to**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW12	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	122	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	96	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.67	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	80	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	18.55	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.41	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	151	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_ac_{03}), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	188	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	816	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	636	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.1	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.25	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. Ground Water Sampling at Monitoring Station Code : - B40 , BHUIANCHITRO

Date of Sampling at Station: April 2025

Month & Year	**April 2025**	**Dug Well No.**	**B40**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**16.06.2025**
Project	**Jharia Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**		**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**BHUIANCHITRO**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis			**to**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW13	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	1	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	144	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	104	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.81	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	92	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	28.13	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.38	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	181	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_ac_{O3}), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	256	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	946	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	738	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.5	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. Ground Water Sampling at Monitoring Station Code : - B46 , TELO

Date of Sampling at Station: April 2025

Month & Year	**April 2025**	**Dug Well No.**	**B46**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**16.06.2025**
Project	**Jharia Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**		**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**TELO**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis		**to**		

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW14	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	1	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	72	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	135	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.59	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	80	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	11.46	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.56	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	96	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_ac_{O3}), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	222	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	652	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	508	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.0	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.1	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. Ground Water Sampling at Monitoring Station Code : -B55 , RANTANR VILLAGE

Date of Sampling at Station: April 2025

Month & Year	**April 2025**	**Dug Well No.**	**B55**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**16.06.2025**
Project	**Jharia Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**		
Sampling Stations	**RANTANR VILLAGE**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis		**to**		

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW15	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	1	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	110	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	96	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.69	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	70	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	27.68	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.44	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	122	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_ac_{O3}), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	258	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	712	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	566	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.8	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. Ground Water Sampling at Monitoring Station Code : - B59, KHODOVALY VILLAGE

Date of Sampling at Station: April 2025

Month & Year	**April 2025**	**Dug Well No.**	**B59**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**16.06.2025**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**KHODOVALY**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis		**to**		

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW16	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	116	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	128	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.74	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	95	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	19.28	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.72	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	103	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	268	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	906	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	682	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	3.0	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

Ground Water Sampling at Monitoring Station Code : - B64 , KESHALPUR,BATIGHAR

Date of Sampling at Station: April 2025

Month & Year	**April 2025**	**Dug Well No.**	**B64**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**16.06.2025**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**KESHALPUR , BATIGHAR**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis		**to**		

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW17	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	3	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	96	2.0-800.0	2	75	200
4	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	118	2.0-1500.0	5	250	1000
5	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.68	0.2-2.00	0.2	1	1.5
6	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
7	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	83	6.0-700	6	30	100
8	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	17.88	0.5-45.0	0.5	45	No relaxation
9	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
10	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.63	1-14	0.1	6.5-8.5	No relaxation
11	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	109	10.0-400.0	10	200	400
12	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
13	Total Alkalinity (c_ac_{03}), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	244	4.0-2000.0	4	200	600
14	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	728	25.0-5000.0	25	500	2000
15	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	582	4.0-2000.0	4	200	600
16	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.8	1-800	0.1	1	5
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.19	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. Ground Water Sampling at Monitoring Station Code : - D107, BOGULA

Date of Sampling at Station: April 2025

Month & Year	**April 2025**	**Dug Well No.**	**D107**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**16.06.2025**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**BOGULA**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis		**to**		

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW33	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	4	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	112	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	128	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.61	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	88	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	39.28	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.72	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	178	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_ac_{O3}), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	275	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	808	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	642	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	3.0	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. Ground Water Sampling at Monitoring Station Code : - D112, DEMUDI(DOMATANR)

Date of Sampling at Station: April 2025

Month & Year	**April 2025**	**Dug Well No.**	**D112**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**16.06.2025**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**DEMUDI(DOMATANR)**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis			**to**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW34	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	86	2.0-800.0	2	75	200
4	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	136	2.0-1500.0	5	250	1000
5	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.82	0.2-2.00	0.2	1	1.5
6	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
7	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	69	6.0-700	6	30	100
8	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	27.88	0.5-45.0	0.5	45	No relaxation
9	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
10	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.63	1-14	0.1	6.5-8.5	No relaxation
11	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	119	10.0-400.0	10	200	400
12	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
13	Total Alkalinity (c_ac_{03}), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	210	4.0-2000.0	4	200	600
14	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	634	25.0-5000.0	25	500	2000
15	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	498	4.0-2000.0	4	200	600
16	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.8	1-800	0.1	1	5
17	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.1	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. Ground Water Sampling at Monitoring Station Code : - D115 , TELMUCHU

Date of Sampling at Station: April 2025

Month & Year	**April 2025**	**Dug Well No.**	**D115**		**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**				**Date of Issue**	**16.06.2025**
Project	**Jharia Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**TELMUCHU**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**		
			Period of Analysis		**TO**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW35	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
	Colour, Hazen unit	APHA, 24th Edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	3	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	106	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	124	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method,2023	0.73	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	0.26	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th Edition, 3500-Mg B: Calculation Method,2023	97	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th Edition, UV-Spectrophotometric Method,2023	29.58	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 24th Edition, , 2150-C,2023	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.56	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th Edition, 4500 S , Turbidity Method,2023	159	10.0-400.0	10	200	400
11	Taste	APHA,24th Edition, 2160-C , 2023	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_ac_{03}), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	236	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	837	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	665	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.1	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

*17***All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. Ground Water Sampling at Monitoring Station Code : - D14 , KARMATANR

Date of Sampling at Station: April 2025

Month & Year	**April 2025**	**Dug Well No.**	**D14**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**16.06.2025**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**KARMATANR**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis		**TO**		

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW21	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	128	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	122	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.59	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	58	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	11.95	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.38	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	114	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_ac_{O_3}$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	248	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	664	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	560	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.9	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. Ground Water Sampling at Monitoring Station Code : - D19, MEMKO MORE

Date of Sampling at Station: April 2025

Month & Year	**April 2025**	**Dug Well No.**	**D19**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**16.06.2025**
Project	**Jharia Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**		
Sampling Stations	**MEMKO MORE**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis		**TO**		

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW-22	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	3	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	88	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	94	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.67	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	0.46	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	51	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	17.50	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.52	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	91	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_ac_{O_3}$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	242	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	622	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	428	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.8	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

***All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. *Ground Water Sampling at Monitoring Station Code : - D2 , BIRSA MUNDA CHAWK,BANKMORE*

Date of Sampling at Station: April 2025

Month & Year	**April 2025**	**Dug Well No.**	**D2**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**16.06.2025**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**BIRSA MUNDA CHAWK , BANKMORE**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis			**TO**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW-18	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
	Colour, Hazen unit	APHA, 24th Edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	1	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	114	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	124	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method,2023	0.82	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th Edition, 3500-Mg B: Calculation Method,2023	92	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th Edition, UV-Spectrophotometric Method,2023	12.38	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 24th Edition, , 2150-C,2023	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.56	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th Edition, 4500 S , Turbidity Method,2023	95	10.0-400.0	10	200	400
11	Taste	APHA,24th Edition, 2160-C , 2023	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_ac_{o_3}$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	230	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	837	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	665	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	1.9	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

*17***All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. Ground Water Sampling at Monitoring Station Code : - D25 , GODHUR MORE

Date of Sampling at Station: April 2025

Month & Year	**April 2025**	**Dug Well No.**	**D25**	**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**Jharia Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**GODHUR MORE**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**TO**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW23	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	128	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	120	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.62	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	100	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	23.92	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.61	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	138	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_ac_{O3}), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	292	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	832	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	732	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.6	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.24	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

***All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

1. Ground Water Sampling at Monitoring Station Code : - D30 , BORKIBOA VILLAGE

Date of Sampling at Station: April 2025

Month & Year	**April 2025**	**Dug Well No.**	**D30**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**16.06.2025**
Project	**Jharia Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**		**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**BORKIBOA VILLAGE**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis		**TO**		

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW24	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	1	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	104	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	116	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.74	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	68	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	22.26	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.56	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	144	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_ac_{O_3}$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	232	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	742	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	540	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	1.8	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.1	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

Ground Water Sampling at Monitoring Station Code : - D35 , PATHERDIH RAILWAY COLONY

1.

Date of Sampling at Station: April 2025

Month & Year	**April 2025**	**Dug Well No.**	**D35**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**16.06.2025**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**PATHERDIH RAILWAY COLONY**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis			**TO**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW25	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	3	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	124	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	138	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.78	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	74	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	30.35	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.44	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	167	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_ac_{o_3}$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	264	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	772	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	615	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.5	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

Ground Water Sampling at Monitoring Station Code : - D4 , JHARIA THANA

1.

Date of Sampling at Station: April 2025

Month & Year	**April 2025**	**Dug Well No.**	**D4**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**16.06.2025**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**JHARIA THANA**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis			**TO**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW19	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	110	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	88	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.71	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	125	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	22.24	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.44	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	168	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_ac_{O_3}$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	296	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	942	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	790	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.5	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

Ground Water Sampling at Monitoring Station Code : - D41 , JOYRAMPUR

1.

Date of Sampling at Station: April 2025

Month & Year	**April 2025**	**Dug Well No.**	**D41**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**16.06.2025**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**JOYRAMPUR**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis		**to**		

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW26	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	1	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	164	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	132	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.71	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	51	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	8.49	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.52	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	67	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	265	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	838	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	620	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.3	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

Ground Water Sampling at Monitoring Station Code : - D49 , TISRA THANA

Date of Sampling at Station: April 2025

Month & Year	**April 2025**	**Dug Well No.**	**D49**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**16.06.2025**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**TISRA THANA**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis		**to**		

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW27	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	118	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	98	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.53	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	79	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	17.58	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.31	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	126	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_a co_3$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	229	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	736	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	620	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	1.9	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

Ground Water Sampling at Monitoring Station Code : - D5, JIYALGORA (NEAR P.O.)

Date of Sampling at Station: April 2025

Month & Year	**April 2025**	**Dug Well No.**	**D5**	**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**Jharia Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**JIYALGORA (NEAR P.O)**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**TO**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW 20	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	126	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	98	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.63	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	66	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	13.64	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.52	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	135	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_ac_{03}), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	265	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	738	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	586	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.9	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

Ground Water Sampling at Monitoring Station Code : - D59, SITALPUR

Date of Sampling at Station: April 2025

Month & Year	**April 2025**	**Dug Well No.**	**D59**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**16.06.2025**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**SITALPUR**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis		**to**		

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW28	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	118	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	122	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.83	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	81	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	22.91	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.85	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	134	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	282	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	829	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	630	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.9	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.1	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

Ground Water Sampling at Monitoring Station Code : - D70 JALADIH

Date of Sampling at Station: April 2025

Month & Year	**April 2025**	**Dug Well No.**	**D70**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**16.06.2025**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**JALADIH**	**Date of Sampling**					
			Period of Analysis		**to**		

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW29	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	1	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	92	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	112	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.69	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	0.21	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	103	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	18.55	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.41	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	111	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_ac_{o_3}$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	192	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	808	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	654	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.3	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.23	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

Ground Water Sampling at Monitoring Station Code : - D72, CHATI GOVINDPUR

Date of Sampling at Station: April 2025

Month & Year	**April 2025**	**Dug Well No.**	**D72**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**16.06.2025**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**CHATI GOVINDPUR**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis			**to**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW30	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	152	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	78	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.74	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	108	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	28.13	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.38	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	158	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_ac_{O_3}$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	278	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	966	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	824	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.5	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

Ground Water Sampling at Monitoring Station Code : - D80 DHANSAR MINE RESCUE STATION

Date of Sampling at Station: April 2025

Month & Year	**April 2025**	**Dug Well No.**	**D80**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**16.06.2025**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**DHANSAR MINE RESCUE STATION**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis			**to**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW31	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	1	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	116	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	138	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.61	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	63	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	21.46	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.56	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	133	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_a co_3$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	278	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	748	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	548	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.2	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.19	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

Ground Water Sampling at Monitoring Station Code : - D96 BANSHRA

Date of Sampling at Station: April 2025

Month & Year	**April 2025**	**Dug Well No.**	**D96**			**ULR No.**	
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**16.06.2025**
Project	**Jharia Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**BANSHRA**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis			**to**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW32	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	3	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	126	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	94	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.79	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	50	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	27.68	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.44	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	165	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_ac_{o_3}$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	232	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	637	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	522	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.6	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

PHYSICO-CHEMICAL CHARACTERISTICS OF GROUND WATER SAMPLES

(Wherever not specified, characteristics are expressed in mg/l, maximum)

Ground Water Sampling at Monitoring Station Code : - DB2A

Date of Sampling at Station: April 2025

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
GROUND WATER ANALYSIS TEST REPORT

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Month & Year	**April 2025**	**Dug Well No.**	**DB-2A**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Joyrampur Village**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**TO**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW36	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	3	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	98	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	88	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.61	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	98	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	24.31	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.94	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	162	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_a co_3$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	245	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	782	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	650	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	1.8	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

(Amit Raj Mishra)

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II

GROUND WATER ANALYSIS TEST REPORT

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Month & Year	**April 2025**	**Dug Well No.**	**DB-2A**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Joyrampur Village**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**TO**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW36	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	<0.02	0.02-10.0	0.02	0.1	0.3

****All units in mg/L unless specified otherwise*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

Page -2 of 2

---- End of Report ----

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II

GROUND WATER ANALYSIS TEST REPORT

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Month & Year	**April 2025**	**Dug Well No.**	**DB-4**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Sarbari**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**TO**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW37	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	1	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	116	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	76	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.48	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	95	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	30.19	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.86	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	95	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	265	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	974	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	680	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	1.9	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise.*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit.*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

GROUND WATER ANALYSIS TEST REPORT

Month & Year	**April 2025**	**Dug Well No.**	**DB-4**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Sarbari**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**TO**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW37	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	<0.02	0.02-10.0	0.02	0.1	0.3

****All units in mg/L unless specified otherwise*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

Page -2 of 2

---- End of Report ----

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

GROUND WATER ANALYSIS TEST REPORT

Month & Year	**April 2025**	**Dug Well No.**	**DB-8**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Chungei**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**TO**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW38	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	92	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	58	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.48	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	46	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	2.60	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	8.01	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	44	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	178	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	537	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	420	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.7	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise.*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit.*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

GROUND WATER ANALYSIS TEST REPORT

Month & Year	**April 2025**	**Dug Well No.**	**DB-8**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Chungei**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**TO**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW38	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	<0.02	0.02-10.0	0.02	0.1	0.3

****All units in mg/L unless specified otherwise*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit.*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

GROUND WATER ANALYSIS TEST REPORT

Month & Year	**April 2025**	**Dug Well No.**	**DB-10**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Kulti**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**TO**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW-39	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	3	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	74	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	80	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.54	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	50	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	27.35	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.91	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	114	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	172	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	533	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	390	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.2	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.14	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise.*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit.*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

GROUND WATER ANALYSIS TEST REPORT

Month & Year	**April 2025**	**Dug Well No.**	**DB-10**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Kulti**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**TO**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW39	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	IS 3025(Part 59) : 2006,R:2019, AAS-Flame Method	<0.02	0.02-10.0	0.02	0.1	0.3

****All units in mg/L unless specified otherwise*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

GROUND WATER ANALYSIS TEST REPORT

Month & Year	**April 2025**	**Dug Well No.**	**DB-12**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Sabanpur**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**TO**

Sl. No.	Parameter	Method of Analysis	Observed Values GW40	Range Of Testing	LDL	IS 10500: 2012 Acceptable Limit (Max)*	Permissible Limit in the Absence of Alternate Source (Max)
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	38	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	42	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.30	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	0.21	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	21	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	24.09	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	8.03	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	132	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	292	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	245	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	182	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.6	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.31	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise.*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit.*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

GROUND WATER ANALYSIS TEST REPORT

Month & Year	**April 2025**	**Dug Well No.**	**DB-12**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Sabanpur**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**TO**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW40	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	0.07	0.02-10.0	0.02	0.1	0.3

****All units in mg/L unless specified otherwise*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit.*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

GROUND WATER ANALYSIS TEST REPORT

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Month & Year	**April 2025**	**Dug Well No.**	**DB-13**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Dendua More**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**TO**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW41	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	3	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	58	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	40	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.49	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	33	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	34.4	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	8.02	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	108	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	158	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	350	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	280	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.6	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.1	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise.*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit.*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

GROUND WATER ANALYSIS TEST REPORT

Month & Year	**April 2025**	**Dug Well No.**	**DB-13**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**Hurriladih**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Dendua More**	**Date of Sampling**	**06.05.2024**	**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis	**TO**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW41	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	<0.02	0.02-10.0	0.02	0.1	0.3

****All units in mg/L unless specified otherwise.*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit.*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II

GROUND WATER ANALYSIS TEST REPORT

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Month & Year	**April 2025**	**Dug Well No.**	**DB-18**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**RCF**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Luchibad**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**TO**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW42	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	62	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	54	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.36	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	39	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	8.07	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	8.00	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	64	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	162	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	400	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	316	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	1.8	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

GROUND WATER ANALYSIS TEST REPORT

Month & Year	**April 2025**	**Dug Well No.**	**DB-18**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**RCF**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Luchibad**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
		Period of Analysis		**to**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW42	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.10-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	IS APHA, 24TH Edition:2023 AAS-GTA Method	<0.02	0.02-10.0	0.02	0.1	0.3

****All units in mg/L unless specified otherwise.*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit.*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

Page -2 of 2

---- End of Report ----

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

GROUND WATER ANALYSIS TEST REPORT

Month & Year	**April 2025**	**Dug Well No.**	**DB-26**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Ledaharia**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**to**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW43	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	1	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	64	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	42	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.82	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	39	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	29.30	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.75	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	166	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	155	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	393	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	320	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	3.0	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise.*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit.*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

GROUND WATER ANALYSIS TEST REPORT

Month & Year	**April 2025**	**Dug Well No.**	**DB-26**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Ledaharia**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
		Period of Analysis		**to**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW43	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	<0.02	0.02-10.0	0.02	0.1	0.3

****All units in mg/L unless specified otherwise.*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit.*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

Page -2 of 2

---- End of Report ----

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

GROUND WATER ANALYSIS TEST REPORT

Month & Year	**April 2025**	**Dug Well No.**	**DB-27**				
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**					**Date of Issue**	**16.06.2025**
Project	**Raniganj Coalfield**		**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**	
Sampling Stations	**Hodla**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**			
			Period of Analysis		**to**		

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW44	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	54	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	60	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.56	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	45	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	5.16	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.92	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	58	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	228	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	428	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	320	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.9	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

GROUND WATER ANALYSIS TEST REPORT

Month & Year	**April 2025**	**Dug Well No.**	**DB-27**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Hodla**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**to**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW44	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	<0.02	0.02-10.0	0.02	0.1	0.3

****All units in mg/L unless specified otherwise.*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit.*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

Page -2 of 2

---- End of Report ----

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

GROUND WATER ANALYSIS TEST REPORT

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Month & Year	**April 2025**	**Dug Well No.**	**DB-29**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**RCF**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Kelyasol**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**to**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW45	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	128	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	164	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.59	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	51	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	6.37	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.93	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	74	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	245	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	692	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	530	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.6	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.1	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise.*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit.*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

GROUND WATER ANALYSIS TEST REPORT

Month & Year	**April 2025**	**Dug Well No.**	**DB-29**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Keliyasol**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**to**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW45	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	<0.02	0.02-10.0	0.02	0.1	0.3

****All units in mg/L unless specified otherwise*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit.*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

Page -2 of 2

---- End of Report ----

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

GROUND WATER ANALYSIS TEST REPORT

Month & Year	**April 2025**	**Dug Well No.**	**DB-30**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Ramkanali**	**Date of Sampling**			
		Period of Analysis		**to**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW46	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	3	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	102	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	72	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.77	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	0.26	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	95	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	24.7	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.98	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	111	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	272	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	718	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	648	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.3	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.12	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise.*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit.*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II

GROUND WATER ANALYSIS TEST REPORT

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Month & Year	**April 2025**	**Dug Well No.**	**DB-30**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Ramkanali**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**to**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW46	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	0.02	0.02-10.0	0.02	0.1	0.3

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

GROUND WATER ANALYSIS TEST REPORT

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Month & Year	**April 2025**	**Dug Well No.**	**DB-38**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Lukudih**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis	**13.05.2024** to **07.08.2024**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW47	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	122	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	68	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.39	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	97	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	22.68	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	8.06	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	142	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	278	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	826	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	705	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.5	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise.*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit.*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

GROUND WATER ANALYSIS TEST REPORT

Month & Year	**April 2025**	**Dug Well No.**	**DB-38**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Lukudih**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis	**13.05.2024** to **07.08.2024**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW47	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	<0.02	0.02-10.0	0.02	0.1	0.3

****All units in mg/L unless specified otherwise*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit.*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II

GROUND WATER ANALYSIS TEST REPORT

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Month & Year	**April 2025**	**Dug Well No.**	**DB-39**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Pandra**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis	**06.05.2024** **to** **07.08.2024**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW48	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	3	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	120	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	84	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.86	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	73	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	9.54	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	8.09	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	71	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity (c_aco_3), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	264	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	748	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	602	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.2	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	0.18	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise.*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit.*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II
CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

GROUND WATER ANALYSIS TEST REPORT

Month & Year	**April 2025**	**Dug Well No.**	**DB-39**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Pandra**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis	**06.05.2024** **to**	**07.08.2024**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW48	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	<0.02	0.02-10.0	0.02	0.1	0.3

****All units in mg/L unless specified otherwise.*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit.*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED
Environment Laboratory, Regional Institute-II

GROUND WATER ANALYSIS TEST REPORT

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Month & Year	**April 2025**	**Dug Well No.**	**K-12**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Ethora**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis	**to**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW49	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	1	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	72	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	44	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.73	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	73	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	1.40	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	8.41	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	41	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_a co_3$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	210	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	591	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	480	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.8	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

GROUND WATER ANALYSIS TEST REPORT

Month & Year	**April 2025**	**Dug Well No.**	**K-12**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Ethora**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**to**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW49	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	<0.02	0.02-10.0	0.02	0.1	0.3

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

GROUND WATER ANALYSIS TEST REPORT

Month & Year	**April 2025**	**Dug Well No.**	**K-20**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**Raniganj Coalfield**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW/**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Majhladih**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis		**to**

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW50	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Colour, Hazen unit	APHA, 24th edition ,2120-c-Spectrophotometric Single Wavelength Method ,2023	2	1-500.0	1	5	15
2	Calcium, mg/l	IS 3025, (Part 40): 1991 R:2019,AAS-Flame Method & EDTA Method	62	2.0-800.0	2	75	200
3	Chlorides, mg/l	IS-3025(Part 32):1988, R-2019 , Argentometric Method	58	2.0-1500.0	5	250	1000
4	Fluoride, mg/l	APHA, 24th Edition, SPADNS Method	0.76	0.2-2.00	0.2	1	1.5
5	Iron, mg/l	IS 3025 (Part 53) : 2003, R : 2019 , AAS-Flame Method	<0.2	0.2-10	0.2	1	No relaxation
6	Magnesium	APHA 24th edition, 3500-Mg B: Calculation Method	40	6.0-700	6	30	100
7	Nitrate , mg/l	APHA, 24th edition, UV-Spectrophotometric Method	28.55	0.5-45.0	0.5	45	No relaxation
8	Odour	APHA, 23rd Edition, , 2150-C	Agreeable	Qualitative	Qualitative	Agreeable	Agreeable
9	pH value	IS 3025, Part 11 : 1983 R 2023 Electrometric(pH Meter) Method	7.64	1-14	0.1	6.5-8.5	No relaxation
10	Sulphate, mg/l	APHA –24th edition, 4500 S , Turbidity Method	103	10.0-400.0	10	200	400
11	Taste	APHA,24th edition, 2160-C	Acceptable	Qualitative	Qualitative	Acceptable	Agreeable
12	Total Alkalinity ($c_a co_3$), mg/l, Max	IS 3025, Part 23: 1986 R 2019 Titration Method	235	4.0-2000.0	4	200	600
13	Total Dissolved Solids, mg/l	IS 3025, Part 16: 1984 R 2023 Gravimetric method	438	25.0-5000.0	25	500	2000
14	Total Hardness, mg/l	IS 3025, (Part 21): 2019 EDTA Method	318	4.0-2000.0	4	200	600
15	Turbidity, NTU	IS 3025, (Part 10):1984, R-2023 Nephelometric/Turbiditimetric Method	2.9	1-800	0.1	1	5
16	Zinc, mg/l	IS 3025(Part 49) : 1994,R:2019, AAS-Flame Method	<0.1	0.10 – 10.0	0.1	5	15

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

CENTRAL MINE PLANNING AND DESIGN INSTITUTE LIMITED

Environment Laboratory, Regional Institute-II

GROUND WATER ANALYSIS TEST REPORT

CMPDIL, RI-II
KOYLA BHAWAN COMPLEX
DHANBAD. -826005
Phone:0326-223-850
email: rdri2cmpdi@coalindia.in

Month & Year	**April 2025**	**Dug Well No.**	**K-20**		
Customer	**Environment Department, Bharat Coking Coal Limited (BCCL), Koyla Bhawan, Dhanbad (E-mail: gmenv.bccl@coalindia.in)**			**Date of Issue**	**16.06.2025**
Project	**RCF**	**Sample Ref. No.**	**RI-II/HYDROGEOLOGY/24-25/GW**	**Sampling Method**	**CMPDI/RI-II/LPM 13,(IS 3025:Part -1)**
Sampling Stations	**Majhladih**	**Date of Sampling**		**Sample Collected in 5 Ltr Jerricane , Color as observed is transparent**	
			Period of Analysis	**13.05.2024** to **07.08.2024**	

Sl. No.	**Parameter**	**Method of Analysis**	**Observed Values**			**IS 10500: 2012**	
			GW50	**Range Of Testing**	**LDL**	**Acceptable Limit (Max)***	**Permissible Limit in the Absence of Alternate Source (Max)**
1	Boron (as B), mg/l, Max	APHA, 24th edition ,Carmine	<0.2	0.2-10	0.2	0.5	1
2	Copper (as Cu), mg/l, Max	IS 3025 Part 42 : 1992 R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	1.5
3	Free Residual Chlorine, mg/l, Min	APHA, 23rd Edition, , 4500-Cl-B. (Iodometric Method-I)	<0.04	0.04-5	0.04	0.2	1
4	Lead (as Pb), mg/l, Max	IS:3025(Part 47):1994 (Reaffirmed 2019) APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.01	No relaxation
5	Phenolic compounds (as C6H5OH), mg/l, Max	APHA, 24th Edition,4-Amino Autipyrine	<0.001	0.001-10	0.001	0.002	0.002
6	Selenium, mg/l, Max	APHA 24th edition IS-3025,part 56:2003, R-2019/, AAS-VGA	<0.007	0.007-10	0.007	0.01	No relaxation
7	Total Arsenic (as As), mg/l, Max	IS-3025,part 37:1988, R-2019/ APHA 24th edition AAS-VGA	<0.006	0.006-10	0.006	0.01	0.05
8	Total Chromium (as Cr), mg/l, Max	IS-3025 Part 52:2003, R:2019,AAS-Flame APHA, 24th edition, AAS-GTA	<0.01	0.01-10.0	0.01	0.05	No relaxation
9	Nickel as Ni, mg/l Max	IS 3025 Part 54 : 2003,R : 2019, AAS-Flame APHA, 24th edition, AAS-GTA	<0.005	0.005-10	0.005	0.02	No relaxation
10	Manganese as Mn, mg/l, Max	APHA, 24TH Edition:2023 AAS-GTA Method	<0.02	0.02-10.0	0.02	0.1	0.3

****All units in mg/L unless specified otherwise,*

***Grab sampling carried out for water samples. *LDL indicates Lower Detection Limit & BDL indicates Below Detection Limit,*

ANALYSED BY

(Kumar Vaibhav)
REVIEWED BY

(Amit Raj Mishra)
Authorised Signatory

Note: The results above relate to the samples tested as received. This report can not be reproduced in part or full without the written permission of the HOD(Env) , CMPDI, RI-II.

---- End of Report ----

Abbreviations

Abn.: Abandoned
AMSL: Above mean sea level
Avg.: Average
APT: Aquifer Pumping Test
BCCL: Bharat Coking Coal Ltd.
bgl: Below Ground Level
Buffer zone: periphery of the 10 km radius from the project boundary
Core zone: Project / mine / colliery boundary (leasehold area)
CMPDI: Central Mine Plan & Design Institute
DVC: Damodar Valley Corporation
DTW: Depth to water level
GW: Groundwater
IMD: Indian Meteorological Division
JCF: Jharia Coalfield
RCF: Raniganj Coalfield
MADA: Mineral Area Development Authority
MCM: Million Cubic Meter
MGD: Million Gallon per day
NTU: Nephlometric Turbidity unit
OC / UG: Opencast / Underground
OCP / UGP: Opencast Project / Underground Project
RL: Reduced Level
RWH: Rainwater Harvesting
FF: Fire Fighting

PLATES

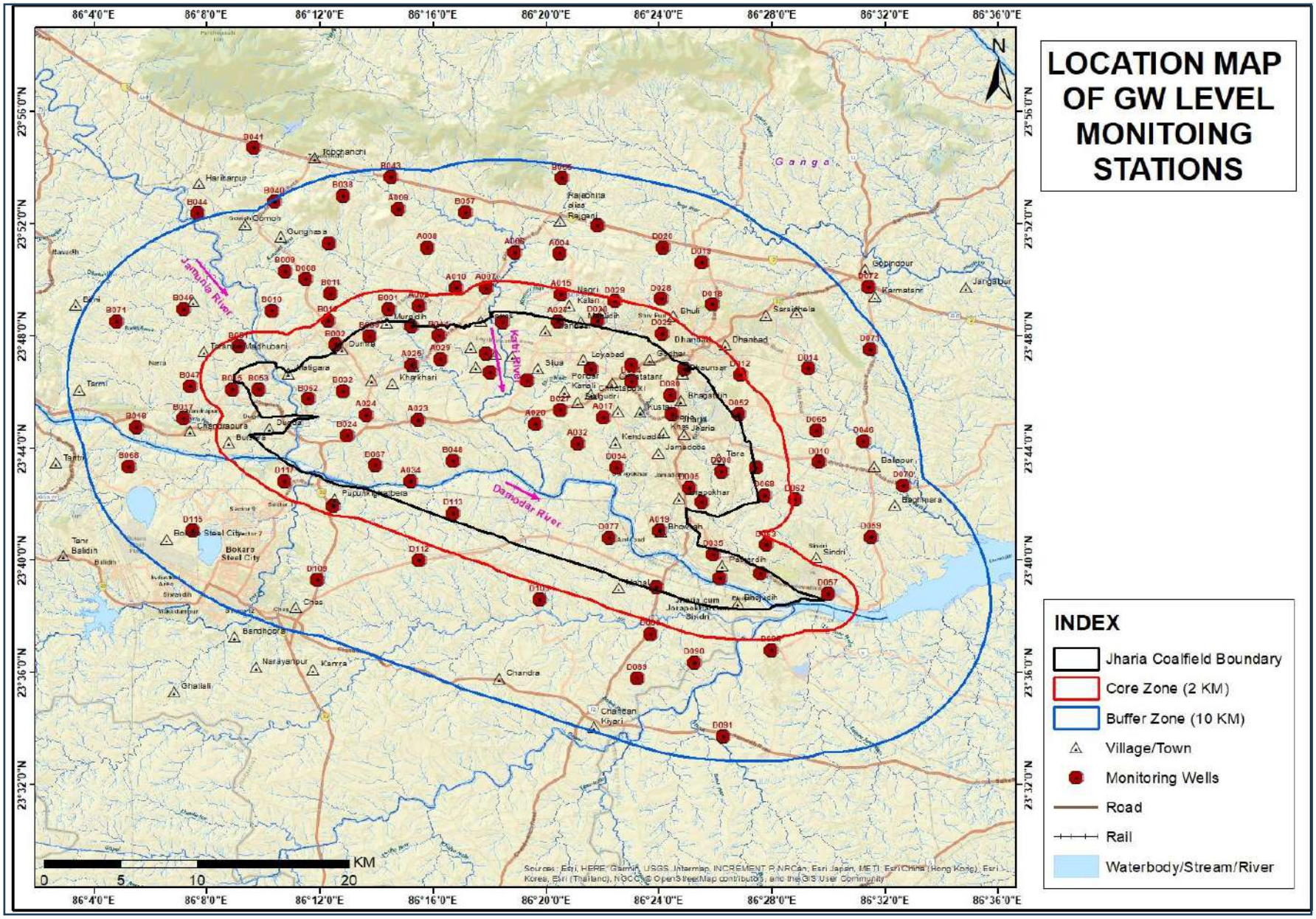


Plate- I: Location Map of Groundwater Level Monitoring stations (Dug wells)

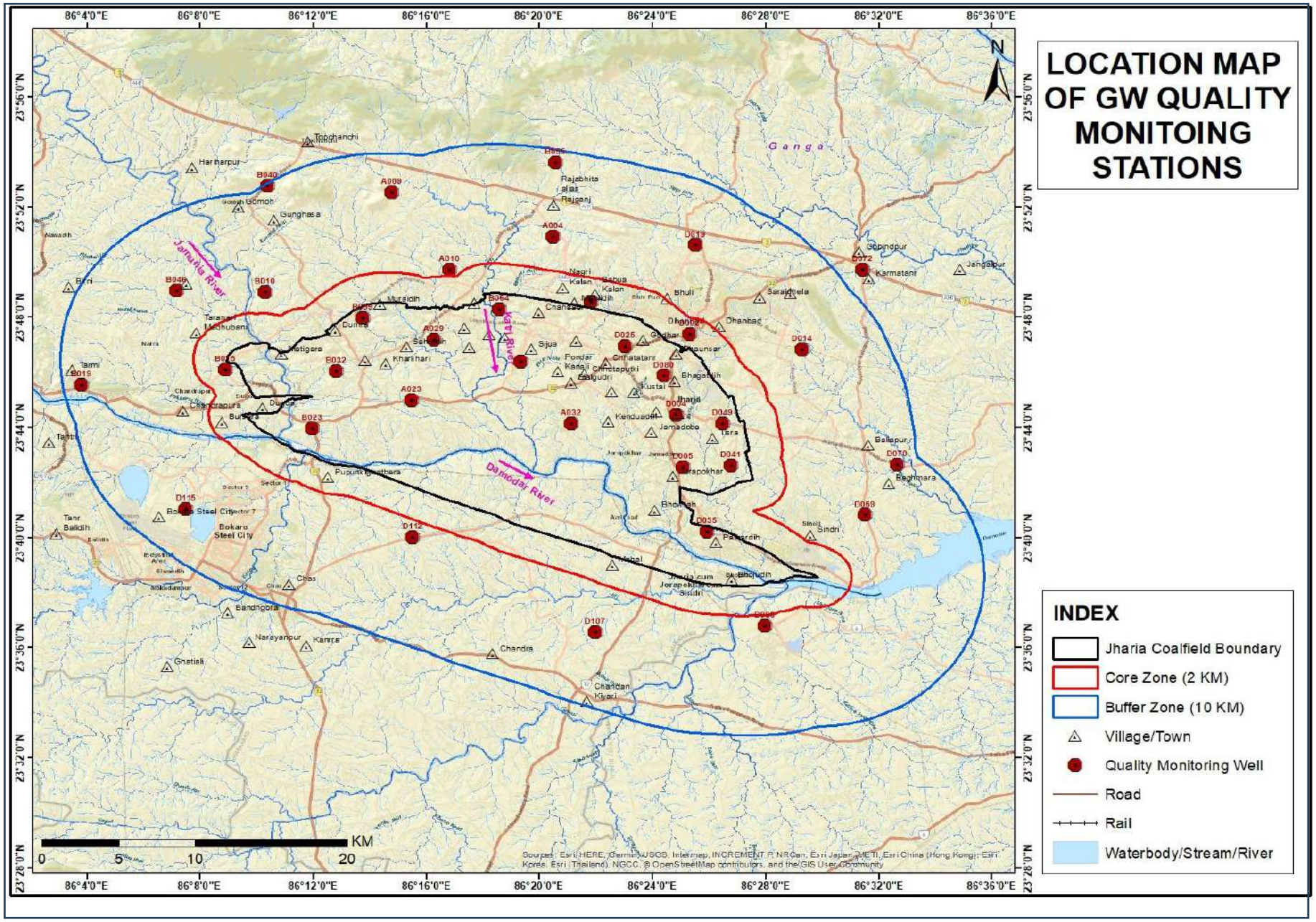


Plate- II: Location Map of Groundwater Quality Monitoring stations

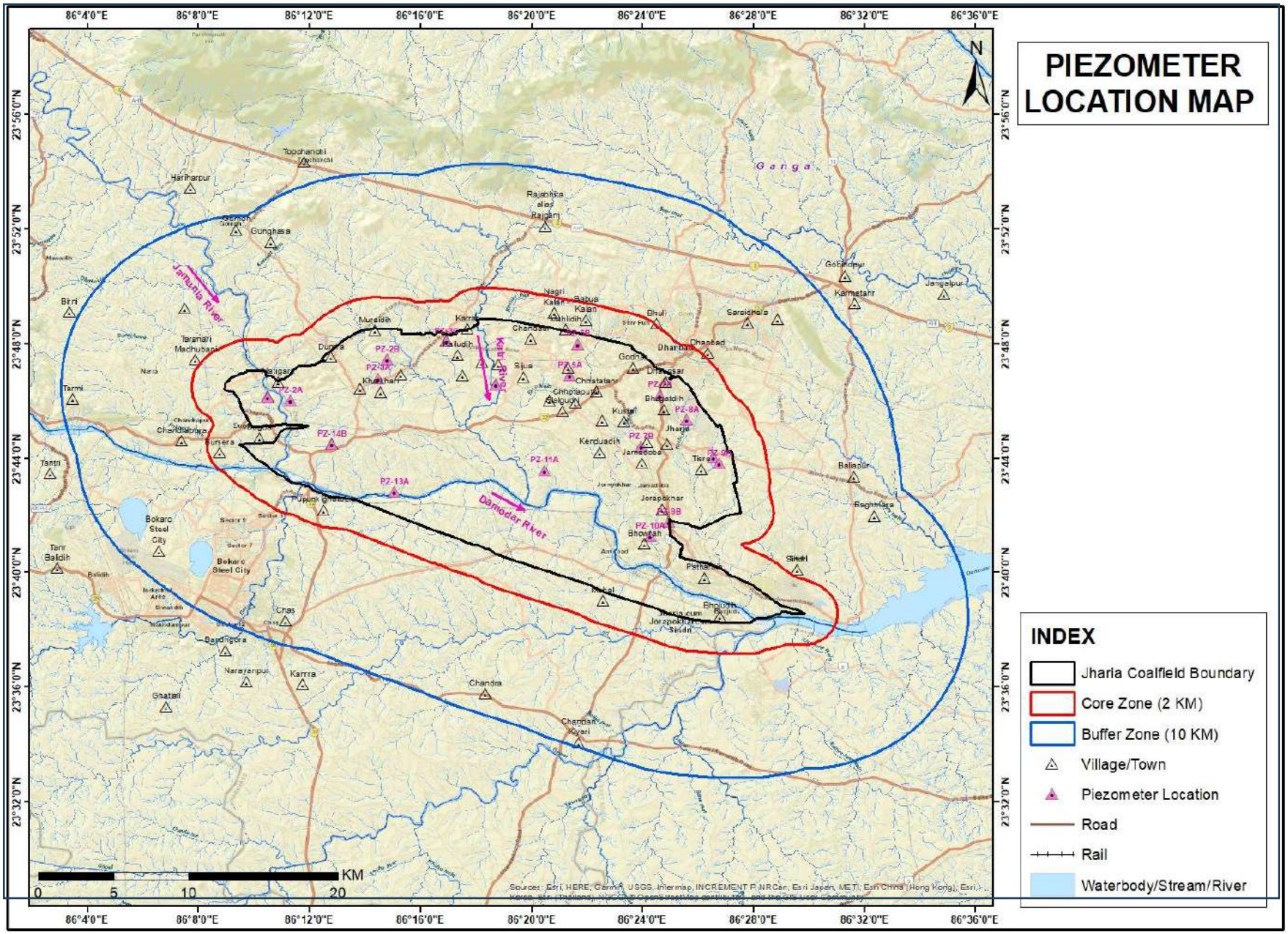


Plate- III: Location Map of Piezometers

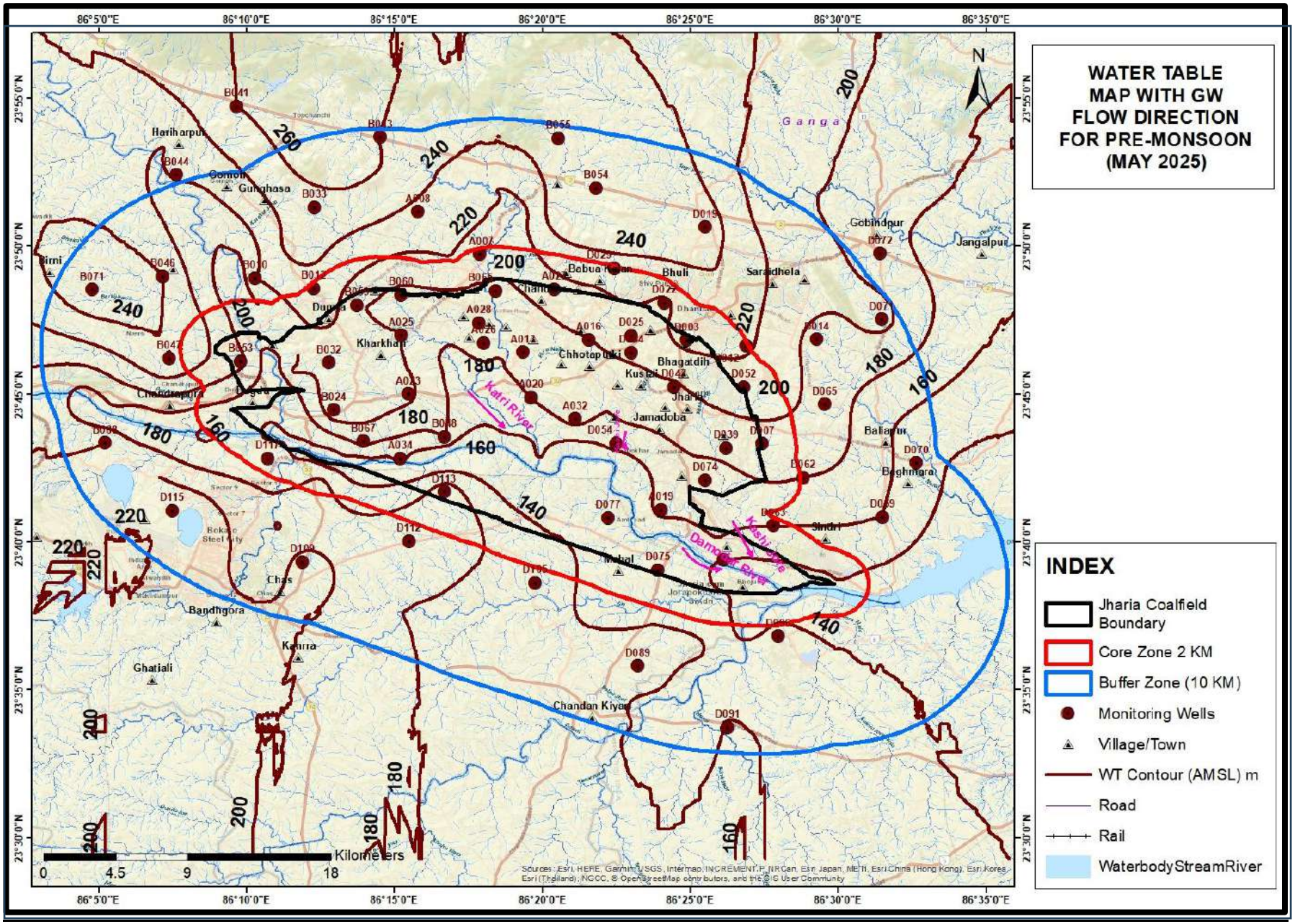


Plate- IVA: Water table Contour Map of JCF, Pre Monsoon (May'25)

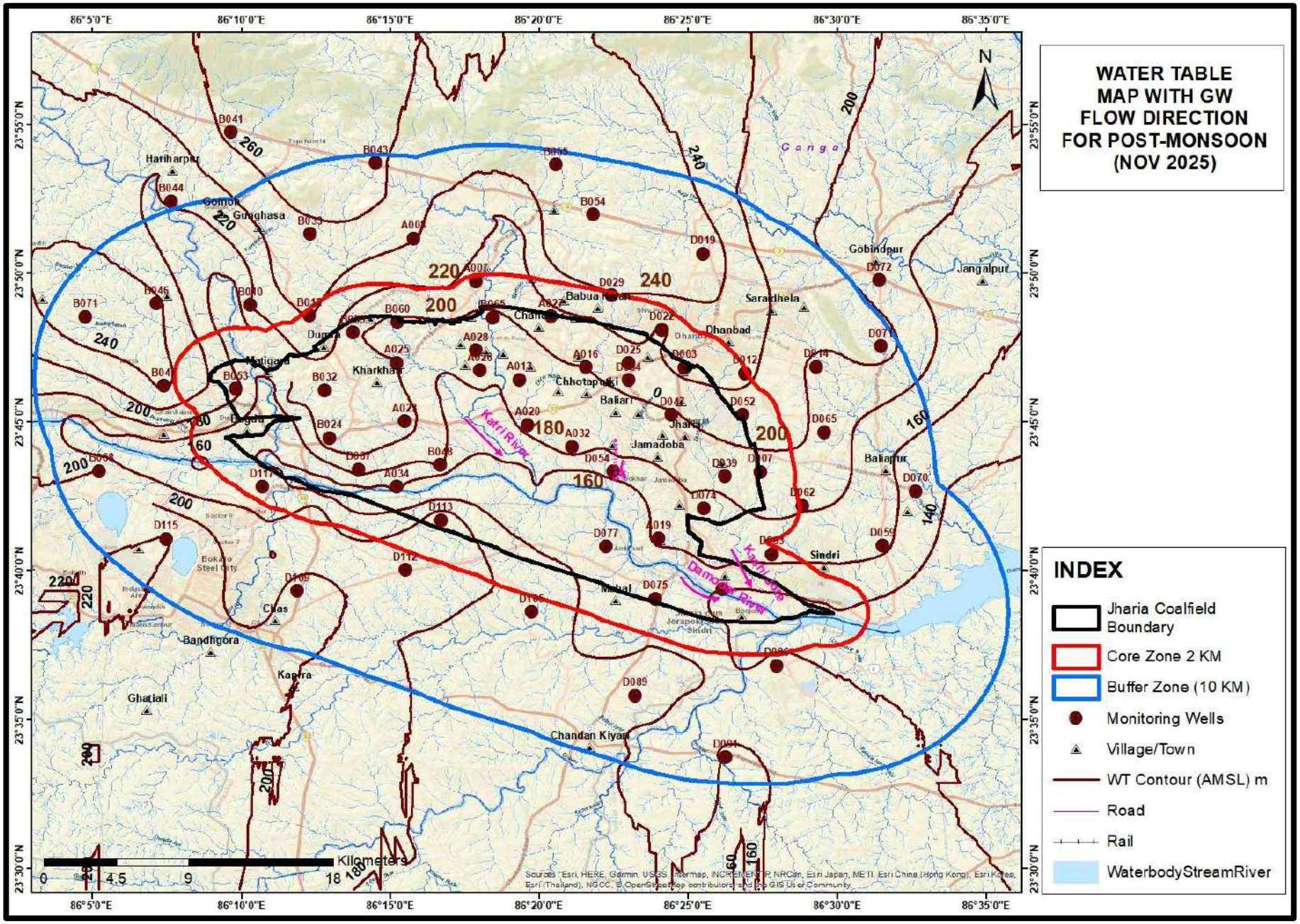


Plate- IVB: Water table Contour Map of JCF, Post Monsoon (Nov'25)

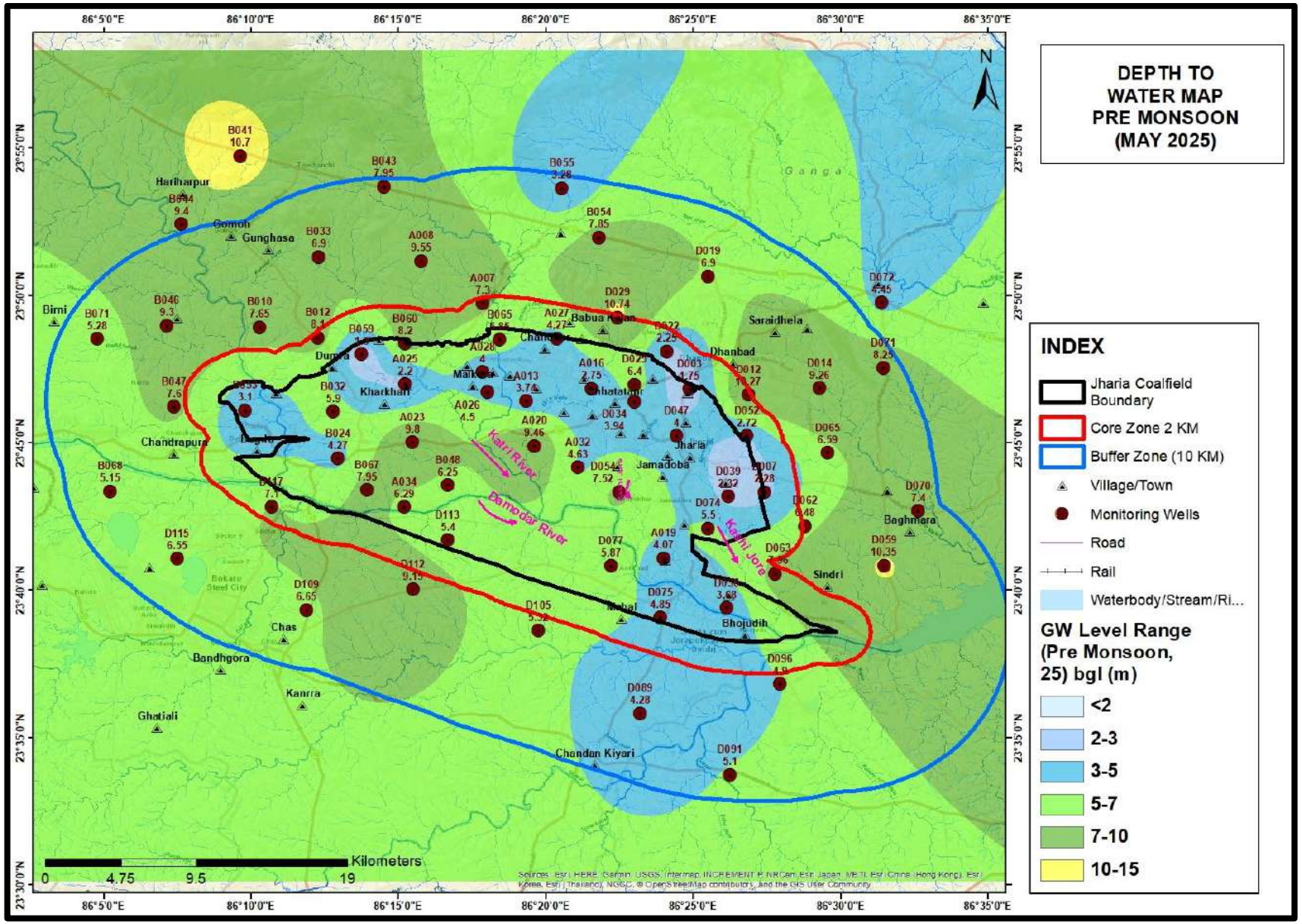


Plate- VA: Depth to Groundwater Level map of JCF, Pre Monsoon (May'25)

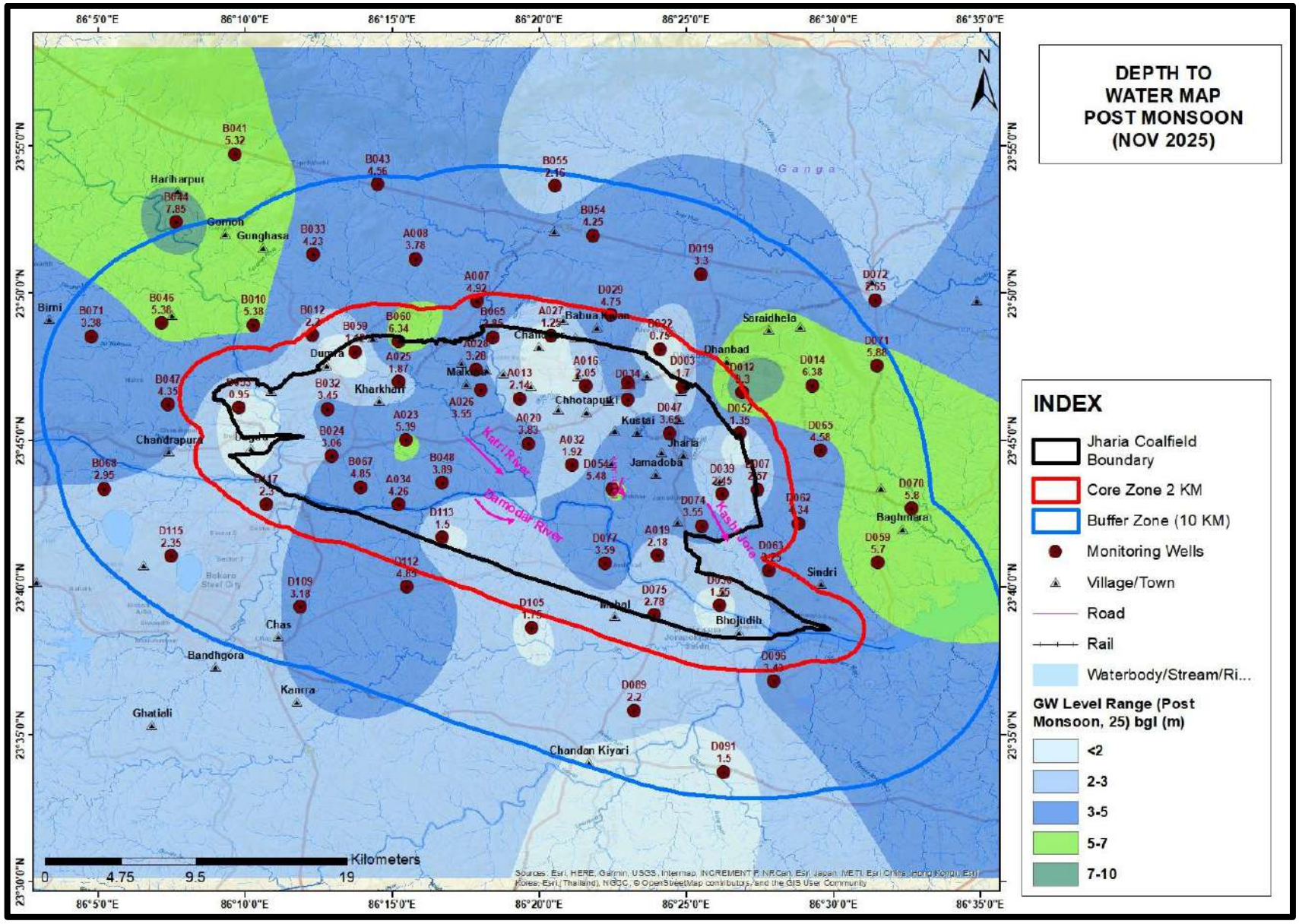


Plate- VB: Depth to Groundwater Level map of JCF, Post Monsoon (Nov'25)

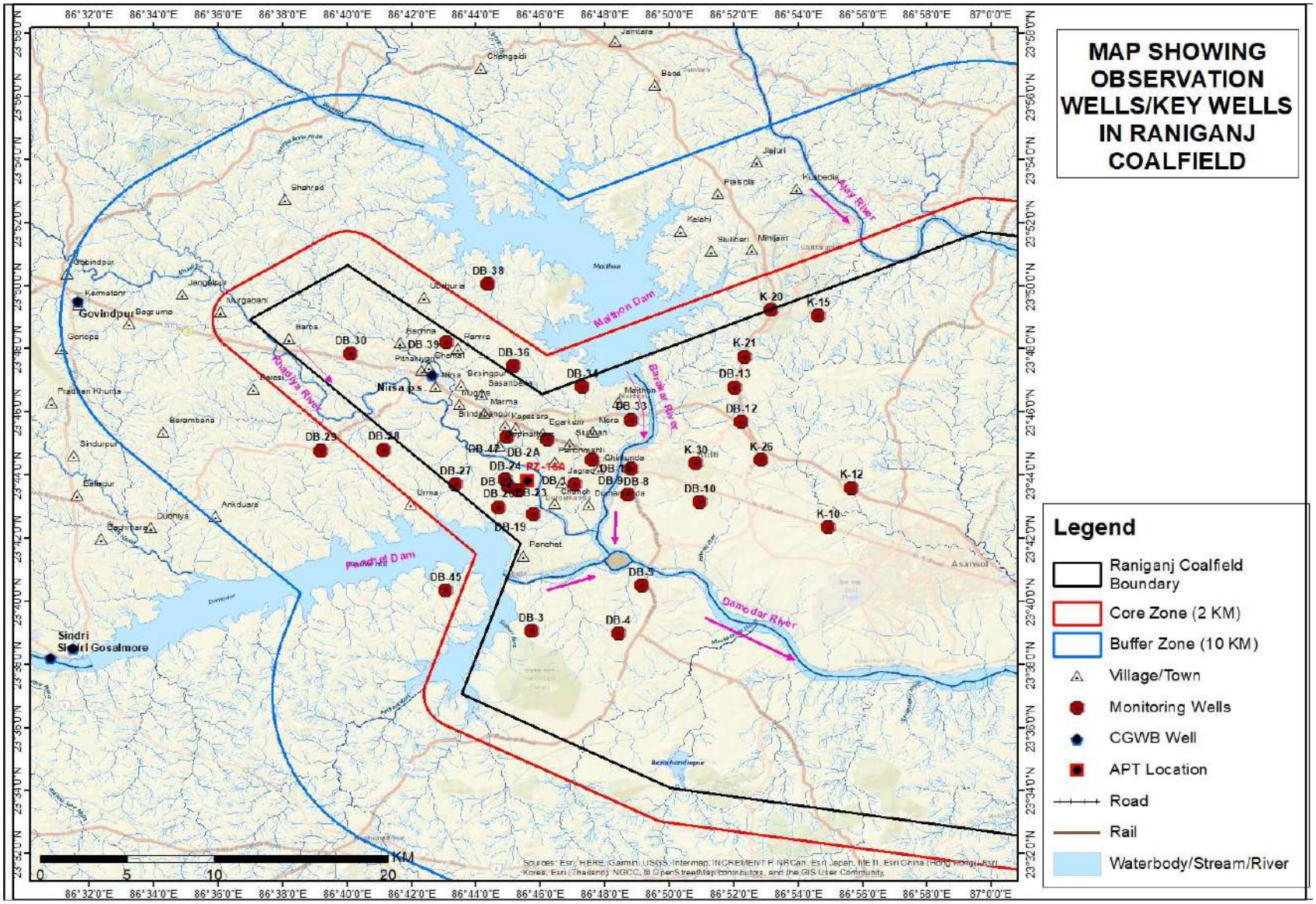


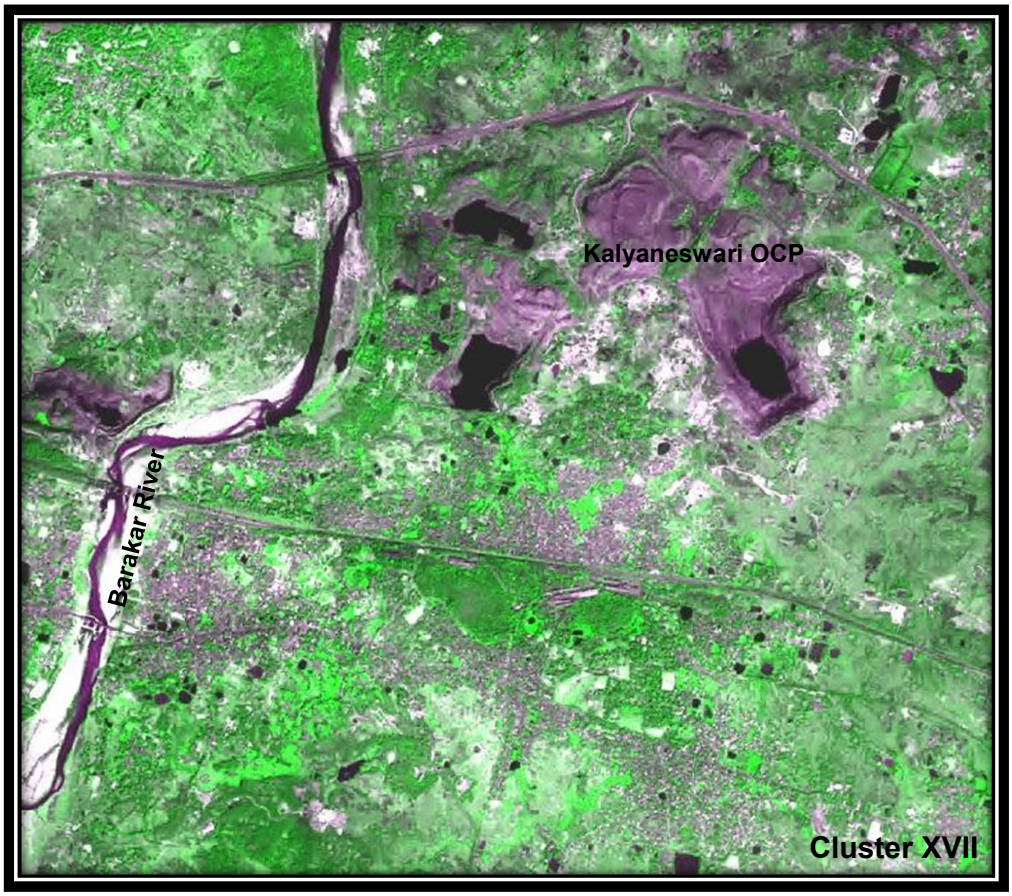
Plate- VI: Drainage Map (Part of RCF Coalfield under BCCL Command Area)

GPS Map Camera
Katras, Jharkhand, भारत
Q7XF+Q33, Main Rd Barora, Katras, Jharkhand 828125, भारत
Lat 23.800154°
Long 86.272343°
27/05/24 08:23 AM GMT +02:00
Google

Embankment along water body

भारत कोकिंग कोल लिमिटेड के ५ मिलियन घन मीटर (कोल+अधिभार) से कम उत्पादन क्षमतावाले ०५ क्लस्टर (खुली + भूमिगत खदानों के समूह) का भूमि पुनरुद्धार हेतु वर्ष २०२३ के उपग्रह डाटा के आधार पर निगरानी का प्रतिवेदन

Land Reclamation/ Restoration Monitoring of five Clusters of (Opencast + Underground) Coal Mines of Bharat Coking Coal Limited based on Satellite Data of the Year 2023



Submitted to

Bharat Coking Coal Limited

भारत कोकिंग कोल लिमिटेड के ५ मिलियन घन मीटर (कोल+अधिभार) से कम उत्पादन क्षमतावाले ०५ क्लस्टर (खुली + भूमिगत खदानों के समूह) का भूमि पुनरुद्धार हेतु वर्ष २०२३ के उपग्रह डाटा के आधार पर निगरानी का प्रतिवेदन

Land Reclamation/ Restoration Monitoring of five Clusters of (Opencast + Underground) Coal Mines of Bharat Coking Coal Limited based on Satellite Data of the Year 2023

March - 2024

Remote Sensing Cell
Geomatics Division
CMPDI, Ranchi

CONTENTS

कार्यकारी सारांश iii
Executive Summary v

1 Background 1
2 Objective 2
3 Methodology 3
4 Land Reclamation Status in Bharat Coking Coal Ltd. 6

List of Tables

Table -1 Cluster wise Land Reclamation Status vii
Table -2 Area Statistics of Land Use Classes in Clusters 10

List of Figures

Figure-1 Cluster wise Land Reclamation Status-2023 (BCCL) viii
Figure-2 Methodology of Land Reclamation Monitoring 3
Figure-3 Bar-chart of Land Reclamation Status of Cluster III 16
Figure-4 Bar-chart of Land Reclamation Status of Cluster V 16
Figure-5 Bar-chart of Land Reclamation Status of Cluster VIII 17
Figure-6 Bar-chart of Land Reclamation Status of Cluster IX 17
Figure-7 Bar-chart of Land Reclamation Status of Cluster XVII 18

List of Plates

Plate -1: Land Use Map of Cluster III 11
Plate -2: Land Use Map of Cluster V 12
Plate -3: Land Use Map of Cluster VIII 13
Plate -4: Land Use Map of Cluster IX 14
Plate -5: Land Use Map of Cluster XVII 15

List of Photographs

Photo-1: Plantation on OB Dump, Cluster XVII 18
Photo-2: Plantation on OB Dump, Cluster III 19
Photo-3: Plantation on OB Dump, Cluster III 19
Photo-4: Plantation on OB Dump, Cluster V 20
Photo-5: Plantation on OB Dump, Cluster V 20
Photo-6: Govardhan Eco Restoration Park - Bera, Cluster VIII 21
Photo-7: Plantation on OB Dump, Cluster VIII 21
Photo-8: Plantation on OB Dump, Cluster VIII 22
Photo-9: Ashok Vatika, Cluster VIII 22
Photo-10: Plantation on OB Dump, Cluster IX 23
Photo-11: Plantation on OB Dump, Cluster IX 23

शब्द-कोष 24
Abbreviations 26
Glossary 27

कार्यकारी सारांश

१.० परियोजना भारत कोकिंग कोल लिमिटेड के ५ मिलियन घन मीटर (कोल + अधिभार) से कम उत्पादन क्षमतावाले ०५ क्लस्टर अर्थात (भूमिगत + खुली) खदानों के समूह के पुनरुद्धार हेतु वर्ष २०२३ के उपग्रह डाटा पर आधारित तीन साल के अन्तराल पर नियमित निगरानी।

२.० उद्देश्य भूमि पुनरुद्धार (लैंड रिक्लेमेशन) का उद्देश्य कुल पट्टाक्षेत्र में बैकफील, वृक्षारोपण, सामाजिक वानिकी, सक्रिय खनन क्षेत्र, जल निकाय (वाटर ड्रेनेज) बंजर भूमि, कृषि भूमि और जंगल के विभिन्न प्रकार के वितरण प्रणाली के क्षेत्र का आकलन करने के लिए है। यह अध्ययन उपरोक्त सभी क्लस्टरों के भूमि पुनरुद्धार (लैंड रिक्लेमेशन) का निगरानी के प्रगति का आकलन करने में मदद करेगा तथा इसके अतिरिक्त पर्यावरण संरक्षण के लिए आवश्यक उपचारात्मक उपायों को क्रियान्वित करने में भी सहायता करेगा।

३.० मुख्य निष्कर्ष

- वर्ष २०२३-२४ में भूमि पुनरुद्धार (लैंड रिक्लेमेशन) हेतु चयन किये गए कुल ०५ क्लस्टरों का कुल पट्टाक्षेत्र अथवा माइन लीज होल्ड एरिया ७९००.९१ हेक्टेयर है, जिसमें १४३७.९९ हेक्टेयर उत्खनन क्षेत्र के अंतर्गत है तथा इस उत्खनन क्षेत्र में से १९.६८ हेक्टेयर (१.३७%) क्षेत्र में जैविक पुनरुद्धार (बैकफील पर बृक्ष।रोपण) किया गया है तथा ६९३.४८ हेक्टेयर (४८.२३%) क्षेत्र में तकनीकी पुनरुद्धार (बैकफीलिंग) का कार्य प्रगति पर है और शेष ७२४.८३ हेक्टेयर (५०.४१%) क्षेत्र सक्रिय खनन के अन्तर्गत है। क्लस्टरवार भूमि पुनरुद्धार (लैंड रिक्लेमेशन) के निगरानी का वर्णन विस्तार रूप से तालिका संख्या ०१ में दर्शाया गया है ।

- वर्ष २०२३ के उपग्रह डाटा के विश्लेषण से यह देखा गया है कि तकनीकी पुनरुद्धार (बैकफ़िलिंग) के तहत क्षेत्र ६५७.४९ हेक्टेयर (वर्ष २०२०) से बढ़कर ६९३.४८ हेक्टेयर (वर्ष २०२३) हो गया है जो वर्ष २०२० के संबंध में ३५.९९ हेक्टेयर की वृद्धि दर्शाता है।

- जैविक पुनरुद्धार (बैकफील पर बृक्ष।रोपण) के तहत क्षेत्र २७.८१ हेक्टेयर (वर्ष २०२०) से घटकर १९.६८ हेक्टेयर (वर्ष २०२३) हो गया है जो वर्ष २०२० के संबंध में ८.१३ हेक्टेयर की कमी दर्शाता है।

- अधिभार पर किए गए वृक्षारोपण के तहत क्षेत्र ११३.७२ हेक्टेयर (वर्ष २०२०) से घटकर ९२.७७ हेक्टेयर (वर्ष २०२३) हो गया है जो वर्ष २०२० के संबंध में २०.९५ हेक्टेयर की कमी दर्शाता है।

- सामाजिक वानिकी के अंतर्गत वृक्षारोपण के तहत क्षेत्र ५०४.२३ हेक्टेयर (वर्ष २०२०) से बढ़कर ५१७.१० हेक्टेयर (वर्ष २०२३) हो गया है जो वर्ष २०२० के संबंध में १२.८७ हेक्टेयर की वृद्धि दर्शाता है।

- सक्रिय खनन के अंतर्गत क्षेत्र ६१५.४४ हेक्टेयर (वर्ष २०२०) से बढ़कर ७२४.८३ हेक्टेयर (वर्ष २०२३) हो गया है जो वर्ष २०२० के संबंध में १०९.३९ हेक्टेयर की वृद्धि दर्शाता है।

- कुल उत्खनन क्षेत्र १३००.७४ हेक्टेयर (वर्ष २०२०) से बढ़कर १४३७.९९ हेक्टेयर (वर्ष २०२३) हो गया है जो वर्ष २०२० के संबंध में १३७.२५ हेक्टेयर की वृद्धि दर्शाता है।

- कुल वृक्षारोपण अथवा हरित आवरण के तहत कुल क्षेत्र ६४५.७६ हेक्टेयर (वर्ष २०२०) से घटकर ६२९.५५ हेक्टेयर (वर्ष २०२३) हो गया है जो वर्ष २०२० के संबंध में १६.२१ हेक्टेयर की कमी दर्शाता है।

- निगरानी के लिए बनाई गई तालिका-१ में उल्लिखित बिसीसीएल की विभिन्न क्लस्टरों में वर्ष २०२३ के लिए भूमि पुनरुद्धार की स्थिति की तुलना वर्ष २०२० से करने पर, विश्लेषण से यह स्पष्ट है कि भूमि पुनरुद्धार के तहत क्षेत्र ६८५.३० हेक्टेयर (वर्ष २०२०) से बढ़कर ७१३.१६ हेक्टेयर (वर्ष २०२३) हो गया है।

- इस रिपोर्ट और निष्कर्षों को आगे की निगरानी और सुधार संबंधी गतिविधियों के लिए आधार माना जाएगा।

Executive Summary

1. **Project** — Land reclamation/ restoration monitoring of five clusters of (Opencast + Underground) coal mines of Bharat Coking Coal Ltd. (BCCL), based on satellite data on every three-year basis.

2. **Objective** — Objective of land reclamation/ restoration monitoring is to assess the area of backfilled, plantation, social forestry, active mining area, water bodies, distribution of wasteland, agricultural land and forest in the leasehold area of the project. This will help in assessing the progressive status of mined land reclamation and to take up remedial measures, if any, required for environmental protection.

3. **Salient Findings**

- Out of the total mine leasehold area of 7900.91 Ha. of the 05 clusters producing less than 5mcm (Coal+OB) annually considered for monitoring during the year 2023-24; total excavated area is 1437.99 Ha. out of which 19.68 Ha. area (1.37%) has been planted on backfill (Biological Reclamation) and 693.48 Ha. area (48.23%) is under backfilling (Technical Reclamation) and 724.83 Ha. area (50.41%) under active mining. Cluster wise details of land reclamation of the above Clusters is given in Table-1.

- It has been observed from the analysis of Satellite Data of the year 2023 that area under technical reclamation (backfilling) has increased from 657.49 Ha. (Yr.2020) to 693.48 Ha. (Yr.2023) which indicates an increase of 35.99 Ha. with respect to the year 2020.

- Area under biological reclamation has decreased from 27.81 Ha. (Yr.2020) to 19.68 Ha. (Yr.2023) which indicates a decrease of 8.13 Ha. with respect to the year 2020.

- Plantation on OB dump has decreased from 113.72 Ha. (Yr.2020) to 92.77 Ha. (Yr.2023) which indicates a decrease of 20.95 Ha. with respect to the year 2020.

- Plantation under social forestry has increased from 504.23 Ha. (Yr.2020) to 517.10 Ha. (Yr.2023) which indicates an increase of 12.87 Ha. with respect to the year 2020.

- Area under active mining has increased from 615.44 Ha. (Yr.2020) to 724.83 Ha. (Yr.2023) which indicates an increase of 109.39 Ha. with respect to the year 2020.

- Total excavated area has increased from 1300.74 Ha. (Yr.2020) to 1437.99 Ha. (Yr.2023) which indicates an increase of 137.25 Ha. with respect to the year 2020.

- Total area under plantation (green cover) has decreased from 645.76 Ha. (Yr.2020) to 629.55 Ha. (Yr.2023) which indicates a decrease of 16.21 Ha. with respect to the year 2020.

- On comparing the status of land reclamation for the year 2023 with respect to the year 2020 in different Clusters of BCCL mentioned in Table 1, undertaken for monitoring, it is evident from the analysis that area under land reclamation has increased from 685.30 Ha. (Yr.2020) to 713.16 Ha. (Yr.2023).

- This report and the findings will be considered as basis for further monitoring and reclamation related activities.

Table 1

Land Reclamation Status in five Clusters (Underground + Opencast Mines) of BCCL based on Satellite Data of the Year 2023

(Area in Hectare)

Sl. No.	Cluster No.	Total Leasehold Area		Technical Reclamation		Plantation						Area under Active Mining		Total Excavated Area		Total Area under Plantation (% Green Cover Generated in Leasehold)		Total Area under Reclamation	
						Biological		Other Plantations											
				Area under Backfilling		Plantation on Excavated / Backfilled Area		Plantation on External OB Dumps		Social Forestry, Avanue Plantation Etc.									
1	*2*	*3*		*4*		*5*		*6*		*7*		*8*		*9 (=4+5+8)*		*10 (=5+6+7)*		*11(=4+5)*	
		2020	2023	2020	2023	2020	2023	2020	2023	2020	2023	2020	2023	2020	2023	2020	2023	2020	2023
1	Cluster III	1552.53	1420.61	60.37	68.71	3.89	4.96	21.11	28.67	162.33	141.36	104.79	84.88	169.05	158.55	187.33	174.99	64.26	73.67
				35.71%	43.34%	2.30%	3.13%					61.99%	53.54%			12.07%	12.32%	38.01%	46.46%
2	Cluster V	1724.52	1957.08	187.59	193.60	7.19	7.41	23.85	19.84	105.29	158.45	103.52	182.86	298.30	383.87	136.33	185.70	194.78	201.01
				62.89%	50.43%	2.41%	1.93%					34.70%	47.64%			7.91%	9.49%	65.30%	52.36%
3	Cluster VIII	1331.95	1183.92	206.91	198.08	9.93	4.08	21.97	16.86	24.70	22.63	124.49	151.45	341.33	353.61	56.60	43.57	216.84	202.16
				60.62%	56.02%	2.91%	1.15%					36.47%	42.83%			4.25%	3.68%	63.53%	57.17%
4	Cluster IX	1967.22	1942.12	77.53	108.00	6.80	3.23	41.79	22.40	168.58	151.33	217.24	240.24	301.57	351.47	217.17	176.96	84.33	111.23
				25.71%	30.73%	2.25%	0.92%					72.04%	68.35%			11.04%	9.11%	27.96%	31.65%
5	Cluster XVII	1412.00	1397.18	125.09	125.09	0.00	0.00	5.00	5.00	43.33	43.33	65.40	65.40	190.49	190.49	48.33	48.33	125.09	125.09
				65.67%	65.67%	0.00%	0.00%					34.33%	34.33%			3.42%	3.46%	65.67%	65.67%
	TOTAL	**7988.22**	**7900.91**	**657.49**	**693.48**	**27.81**	**19.68**	**113.72**	**92.77**	**504.23**	**517.10**	**615.44**	**724.83**	**1300.74**	**1437.99**	**645.76**	**629.55**	**685.30**	**713.16**
				50.55%	**48.23%**	**2.14%**	**1.37%**					**47.31%**	**50.41%**			**8.08%**	**7.97%**	**52.69%**	**49.59%**

(% is calculated with respect to Excavated Area as applicable)

Note: In reference of the above Table, different parameters are classified as follows:

1. Area under Biological Reclamation includes Areas under Plantation done on Backfilled Area Only.
2. Area under Technical Reclamation includes Area under Barren Backfilling only.
3. Area under Active Mining Includes Coal Quarry, Advance Quarry Site and Quarry filled with water etc., if any.
4. Social Forestry and Plantation on External OB Dumps are not included in Biological Reclamation and are put under separate categories as shown in the above Table.
5. (%) calculated in the above Table is in respect to Total Excavated Area except for "Total Area under Plantation" where % is in terms of "Leasehold Area".
6. Leasehold Boundaries of the above 5 clusters are updated as per EC.

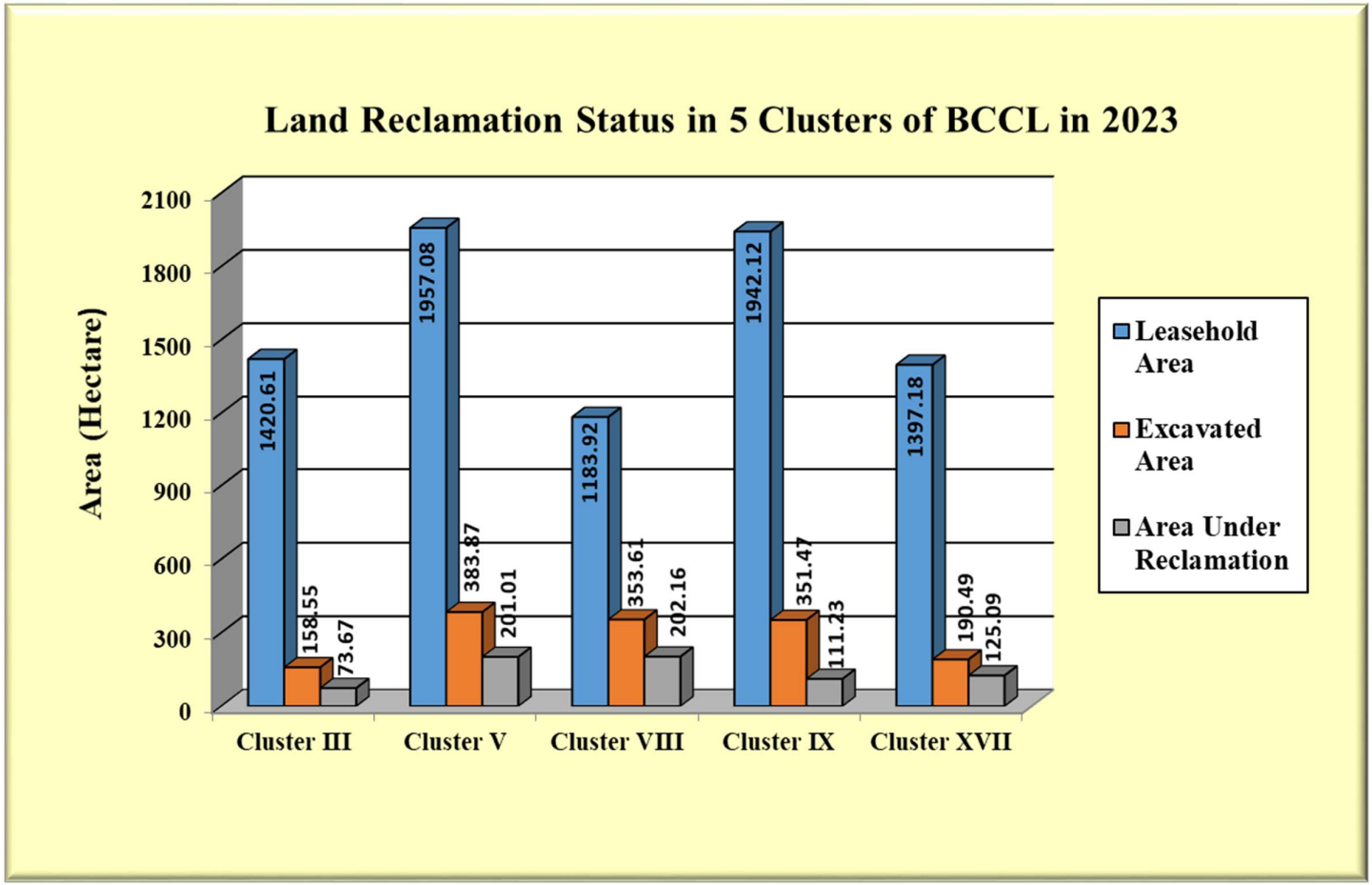


Fig. 1: Cluster wise Land Reclamation Status in five Clusters - 2023 (BCCL)

1.0 Background

1.1 Land is the most important natural resource which embodies soil, water, flora, fauna and total ecosystem. All human activities are based on the land which is the scarcest natural resource in our country. Mining is a site specific industry and it could not be shifted anywhere else from the location where mineral occurs. It is a fact that surface mining activities do affect the land environment due to ground breaking. Therefore, there is an urgent need to reclaim and restore the mined out land for its productive use for sustainable development of mining. This will not only mitigate environmental degradation, but would also help in creating a more congenial environment for land acquisition by coal companies in future.

1.2 Keeping above in view, Coal India Ltd. (CIL) issued a work order vide letter no. CIL/WBP/ENV/2017/DP/8391 dated 22.06.2017 to Central Mine Planning & Design Institute (CMPDI), Ranchi, for monitoring of clusters with coal mines (both underground and open cast projects) having less than 5 million m^3 per annum capacity (Coal +OB) at an interval of three years based on remote sensing satellite data for sustainable development of mining. Earlier, CMPDI used to carry out land reclamation monitoring for individual projects of less than 5 million capacities, but from 2017 the same was carried out cluster wise for mines of BCCL. For operational reasons and convenience, underground and opencast mines (often with multiple overlapping seams), have now been clustered together. Further, a revised work order was issued vide letter no. CIL/ENVT/2022-23/W.O/10899 dated 06.07.2022 from Coal India Limited for the period 2022-23 to 2023-24. According to this work order, 76 OC projects having more than 5 million cu. m (coal +OB) per annum capacity shall be monitored every year and also land reclamation monitoring of 47 OCPs having less than 5 million cu. m (coal +OB) per annum capacity, totaling 123 OC mines will be monitored in

2023-24 covering all the subsidiaries of Coal India Ltd. The result of land reclamation status of all such mines are hosted on the website of CIL, (www.coalindia.in), CMPDI (www.cmpdi.co.in) and the concerned coal companies in public domain. Detailed report is submitted to Coal India and respective subsidiaries.

1.3 Land reclamation monitoring of all clusters of coal mining projects would also comply the statutory requirements of Ministry of Environment, Forest & Climate Change (**MoEF & CC**). Such monitoring would not only facilitate in taking timely mitigation measures against environmental degradation, but would also enable coal companies to utilize the reclaimed land for larger socio-economic benefits in a planned way.

1.4 Present report is embodying the finding of the study based on satellite data of the year 2023 carried out for five clusters of mines comprising both underground and opencast projects of Bharat Coking Coal Ltd.

2.0 Objective

Objective of the land reclamation/restoration monitoring is to assess the area under backfilling, plantation, OB dumps, social forestry, active mining area, settlements, water bodies, distribution of wasteland, agricultural land and forest land in the leasehold area of the project. This is an important step taken up for assessing the progressive status of mined land reclamation and for taking up remedial measures, if any, required for environmental protection.

3.0 Methodology

There are number of steps involved between raw satellite data procurement and preparation of final map. National Remote Sensing Centre (NRSC) Hyderabad, being the nodal agency for satellite data supply in India, provides only raw digital satellite data, which needs further digital image processing for extracting the information and map preparation before uploading the same in the website. Methodology for land reclamation monitoring is given in fig 2. Following steps are involved in land reclamation/ restoration monitoring:

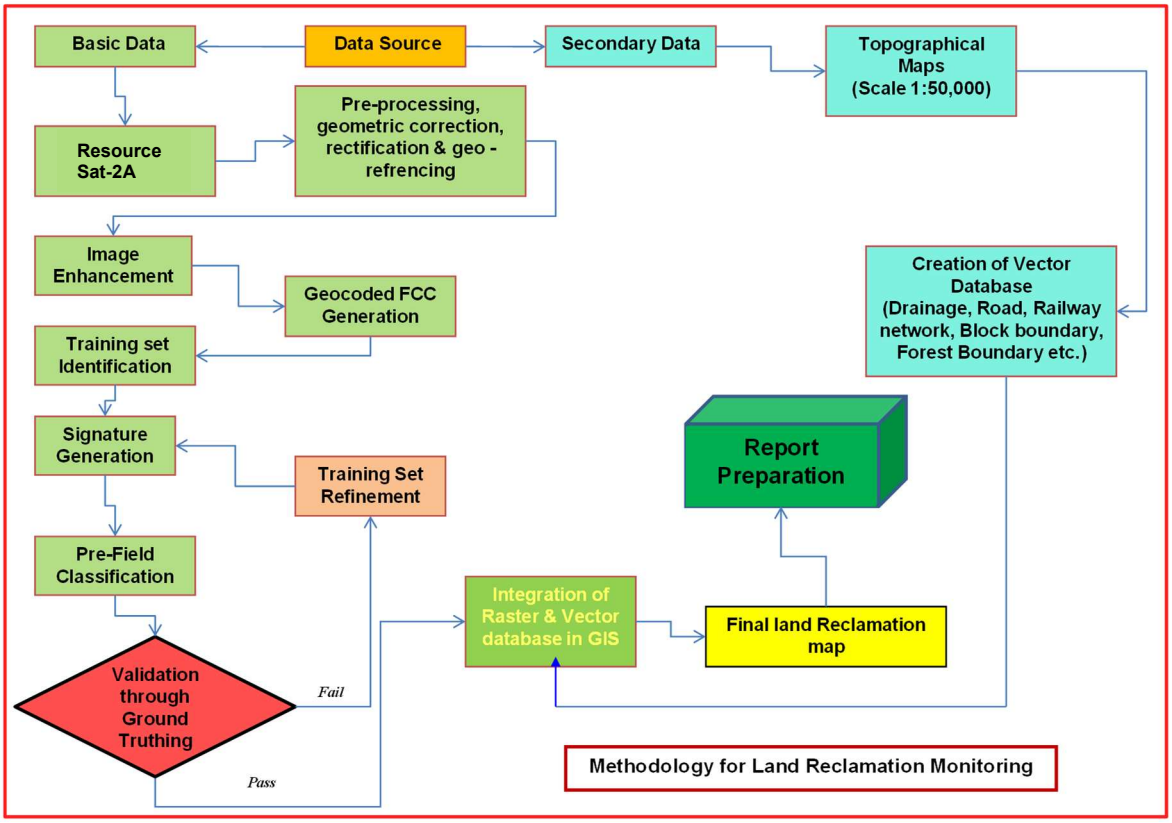


Fig. 2: Methodology of Land Reclamation Monitoring

3.1 Data Procurement: After browsing the data quality and date of pass on internet, supply order for data is placed to NRSC. Secondary data like leasehold boundary, toposheet are procured for creation of vector database.

3.2 **Satellite Data Processing:** Satellite data are processed using ERDAS IMAGINE digital image processing s/w. Methodology involves the following major steps:

- **Rectification & Geo-referencing:** Inaccuracies in digital imagery may occur due to 'systematic errors' attributed to earth curvature and rotation as well as 'non-systematic errors' attributed to satellite receiving station itself. Raw digital images may contain geometric distortions, which make them unusable as maps. Therefore, geo-referencing is required for correction of image data using ground control points (GCP) to make it compatible with the new series WGS-84 compatible SoI toposheet.

- **Image enhancement:**

  To improve the interpretability of the raw data, image enhancement is necessary. Local operations modify the value of each pixel based on brightness value of neighbouring pixels using ERDAS IMAGINE 2022 s/w. and enhance the image quality for interpretation.

- **Training set selection**

  Training set requires to be selected, so that software can classify the image data accurately. The image data are analysed based on the interpretation keys. These keys are evolved from certain fundamental image-elements such as tone/colour, size, shape, texture, pattern, location, association and shadow. Based on the image-elements and other geo-technical elements like land form, drainage pattern and physiography; training sets were selected/identified for each land use/cover class. Field survey was carried out by taking selective traverses in order to collect the ground information (or reference data) so that training sets are selected accurately in the image. This was intended to serve as an aid for classification.

- **Classification and Accuracy assessment**

  Image classification is carried out using the maximum likelihood algorithm. The classification proceeds through the following steps: (a) calculation of statistics [i.e. signature generation] for the identified training areas, and (b) the decision boundary of maximum probability based on the mean vector, variance, covariance and correlation matrix of the pixels. After evaluating the statistical parameters of the training sets, reliability test of training sets is conducted by measuring the statistical separation between the classes that resulted from computing divergence matrix. The overall accuracy of the classification was finally assessed with reference to ground truth data.

- **Area calculation**

  The area of each land use class in the leasehold is determined using ERDAS IMAGINE v. 2022 s/w.

- **Overlay of Vector data base**

  Vector data base is created based on secondary data. Vector layer like drainage, railway line, leasehold boundary, forest boundary etc. are superimposed on the image as vector layer in the Arc GIS database.

- **Pre-field map preparation**

  Pre-field map is prepared for validation of the classification result.

3.3 Ground Truthing:

Selective ground verification of the land use classes is carried out in the field and necessary corrections if required, are incorporated before map finalization.

3.4 Land reclamation database on GIS:

Land reclamation database is created on GIS platform to identify the temporal changes identified from satellite data of different cut - of dates. The database boundary shape files (.shp), kml files and the maps thus prepared confirm to the WGS-84 datum and UTM projected co-ordinate system.

4.0 Land Reclamation Status in Bharat Coking Coal Ltd.

4.1 Following 5 clusters of mines comprising both opencast and underground projects of Bharat Coking Coal Ltd. have been taken up for land reclamation monitoring during the year 2023-24:

- **Cluster III** (Jogidih Colliery, Maheshpur Colliery, South Govindpur Colliery, Teturiya Colliery, Govindpur Colliery, New Akashkinaree Mine, Block-IV/Kooridih Mixed Mine)
- **Cluster V** (Nichitpur OCP, Tetulmari OCP & UG section, Mudidih OCP & UG section, Sendra Bansjora OCP & UG section, Kankanee OCP & UG section, Bansdeopur OCP & UG section, Loyabad UG)
- **Cluster VIII** (Bastacolla Colliery OC & UG, Bera Colliery OC & UG, Dobari Colliery UG, Ghanoodih Colliery OC, Kuya Colliery OC & UG, Goluckdih OC, Kujama Colliery OC)
- **Cluster IX** (Lodna UG, Bagdigi UG, Joyrampur UG, Bararee UG, Jealgora UG, NTST Expn. OCP)
- **Cluster XVII** (Begunia UG, Victoria West UG, Kalyaneswari OCP)

4.2 Cluster wise Land Reclamation status of above mentioned clusters in BCCL is given in Table 1 and also shown graphically in Fig 1. Area statistics of different land use classes present in the mine leasehold of the above clusters for the year 2023 are shown in Table 2. Land use maps derived from the satellite data are shown in Plate 1 - 5. Different land use classes based on satellite data are depicted in bar charts in Fig. 3 - 7.

4.3 Study reveals that out of total mine leasehold area of 7900.91 ha. of the 5 clusters of mines (Opencast + Underground) of BCCL mentioned above taken for this study in 2023-24, total excavated area is 1437.99 ha. out of which 19.68 ha. (1.37%) has been planted (*Biologically Reclaimed*), 693.48

ha. (48.23%) is under backfilling (*Technically Reclaimed*) and balance 724.83 ha. (50.41%) is under active mining.

4.4 The leasehold boundaries of the above mentioned 5 clusters are updated as per EC.

4.5 It is seen that technical reclamation in the above 5 Clusters has increased from 657.49 ha. (Year 2020) to 693.48 ha. (Year 2023).

4.6 Study indicates that Cluster III and Cluster V of BCCL considered for this study in the year 2023-24 indicate increasing trend in Biological Reclamation (plantation on backfill) with respect to the year 2020. Area under plantation on backfill has increased from 3.89 ha. (Year 2020) to 4.96 ha. (Year 2023) in Cluster III and from 7.19 ha. (Year 2020) to 7.41 ha. (Year 2023) in Cluster V respectively. Whereas in Cluster VIII plantation on backfill has decreased from 9.93 ha. (Year 2020) to 4.08 ha. (Year 2023) due to rehandling of backfill. In Cluster IX, biological reclamation has decreased from 6.80 ha. (Year 2020) to 3.23 ha. (Year 2023) due to the effect of underground fire. In Cluster XVII biological reclamation has not been started yet.

4.7 On comparing the status of plantation on OB dumps for the year 2023 with respect to the year 2020 in the above Cluster of mines of BCCL, it is evident from the analysis that area under plantation on OB dumps has increased from 21.11 ha. (Year 2020) to 28.67 ha. (Year 2023) in Cluster III. This increase in span of three years is due to the sincere effort made by BCCL towards environmental protection in these Clusters. Plantation on OB has decreased from 23.85 ha. (Year 2020) to 19.84 ha. (Year 2023) in Cluster V. In Cluster VIII it has decreased from 21.97 ha. (Year 2020) to 16.86 ha. (Year 2023) and in Cluster IX, it has decreased from 41.79 ha. (Year 2020) to 22.40 ha. (Year 2023) due to rehandling of OB dumps. But in the above

Clusters where plantation on OB dumps has decreased, new plantations on OB dumps and their slopes has been started by BCCL but their height and canopy cover are not enough to be captured in satellite imagery. In Cluster XVII there is no change or plantation on OB dumps is static during the last three-year duration.

4.8 It is seen that total plantation under social forestry has increased from 504.23 ha. (Year 2020) to 517.10 ha. (Year 2023). Plantation under social forestry has decreased from 162.33 ha. (Year 2020) to 141.36 ha. (Year 2023) in Cluster III. In Cluster VIII it has decreased from 24.70 ha. (Year 2020) to 22.63 ha. (Year 2023) and in Cluster IX it has decreased from 168.58 ha. (Year 2020) to 151.33 ha. (Year 2023). This decrease of 20.97 ha. area in Cluster III, 2.07 ha. in Cluster VIII and 17.25 ha. in Cluster IX is due to change in shape and area of these clusters. In Cluster V plantation under social forestry has increased from 105.29 ha. (Year 2020) to 158.45 ha. (Year 2023). Ongoing projects like road side plantations and river side plantations in this cluster is under progress. In Cluster XVII there is no change or plantation under social forestry is static during the last three-year duration.

4.9 In Cluster III, it is seen that total excavated area has decreased from 169.05 ha. (Year 2020) to 158.55 ha. (Year 2023). This decrease of 10.50 ha. area is due to reduction in area under mining which has happened due to change in shape and area of this cluster. The Cluster boundary is updated as per EC.

4.10 After analyzing the satellite data of the year 2020 vs 2023, it reveals that area under total plantation (Green cover) carried out on backfilled area, OB dumps as well as under social forestry in the above clusters of BCCL has decreased from 645.76 ha. (8.08%) to 629.55 ha. (7.97%) in span of last

three years. The reason for this reduction in area under green cover has been described separately earlier in point no. 4.6, 4.7 and 4.8.

4.11 On comparing the status of land reclamation for the year 2023 with respect to the year 2020 it is evident from the analysis that total area under land reclamation has increased from 685.30 ha. (Year 2020) to 713.16 ha. (Year 2023). This increase of 27.86 ha. area under land reclamation is due to increase in reclamation activities in Cluster III, Cluster V & Cluster IX. In Cluster VIII, it is seen that total area under reclamation has decreased from 216.84 ha. (Year 2020) to 202.16 ha. (Year 2023). This decrease of 14.68 ha. area is due to reduction in area under backfilling which is due to change in shape and reduction of leasehold area of this cluster. The cluster boundary is updated as per EC.

4.12 The area under total plantation (Green Cover) is maximum in Cluster III (12.32%) followed by Cluster V with (9.49%), Cluster IX with (9.11%), Cluster VIII with (3.68%) and Cluster XVII with (3.46%).

4.13 Out of the 5 Clusters in BCCL considered for satellite data based land reclamation monitoring in 2023-24, Cluster XVII tops with 65.67% reclamation followed by Cluster VIII with 57.17%, Cluster V with 52.36%, Cluster III with 46.46% and Cluster IX with 31.65%.

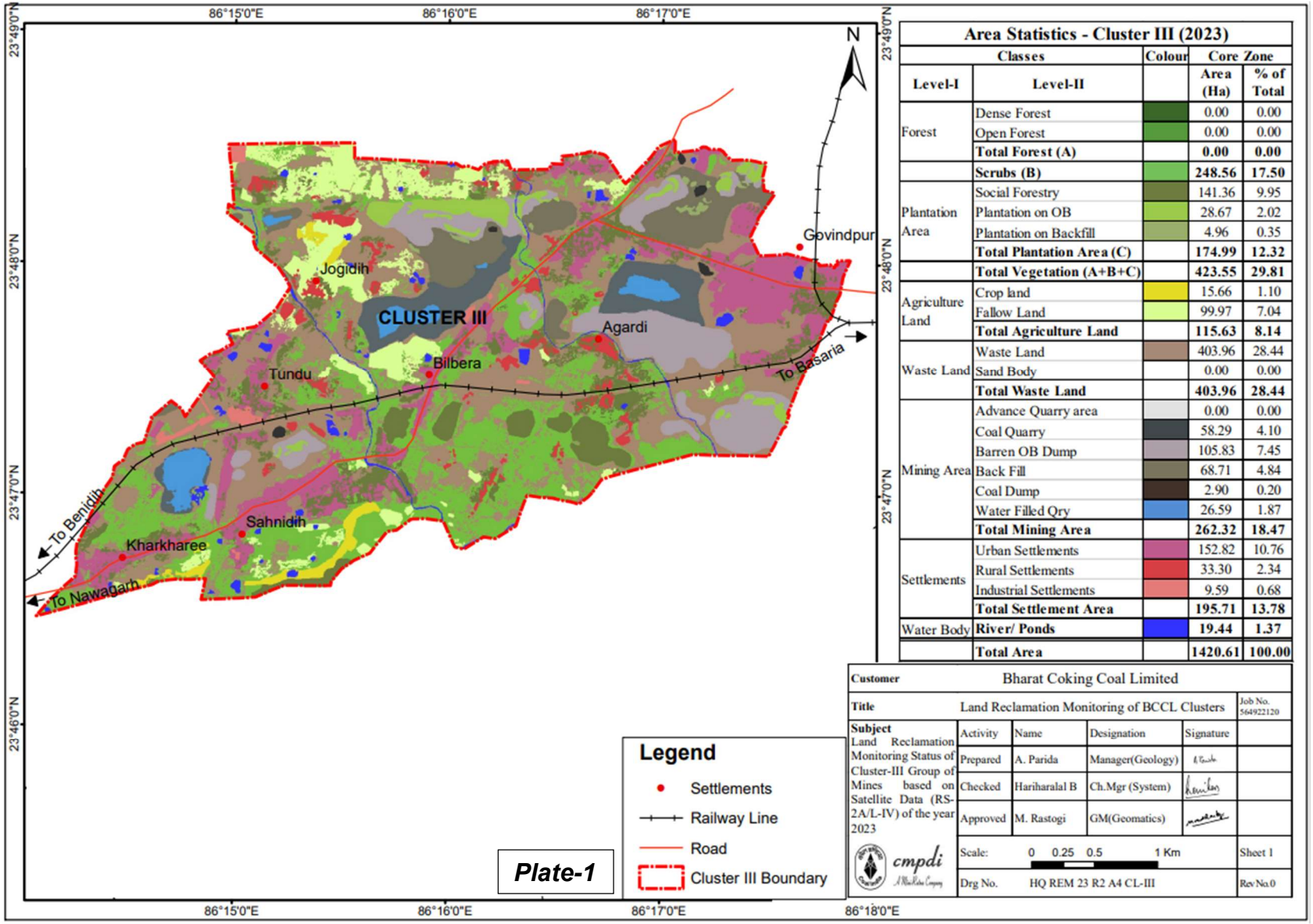
Table 2

Cluster wise Area Statistics of Land Use/ Cover classes in five Clusters of (OC+UG) mines of BCCL based on Satellite Data of the year 2023

Status of Land Reclamation in 5 Clusters of (UG+OC) mines of Bharat Coking Coal Ltd. based on Satellite data of the Year 2023

(Area in Hectare)

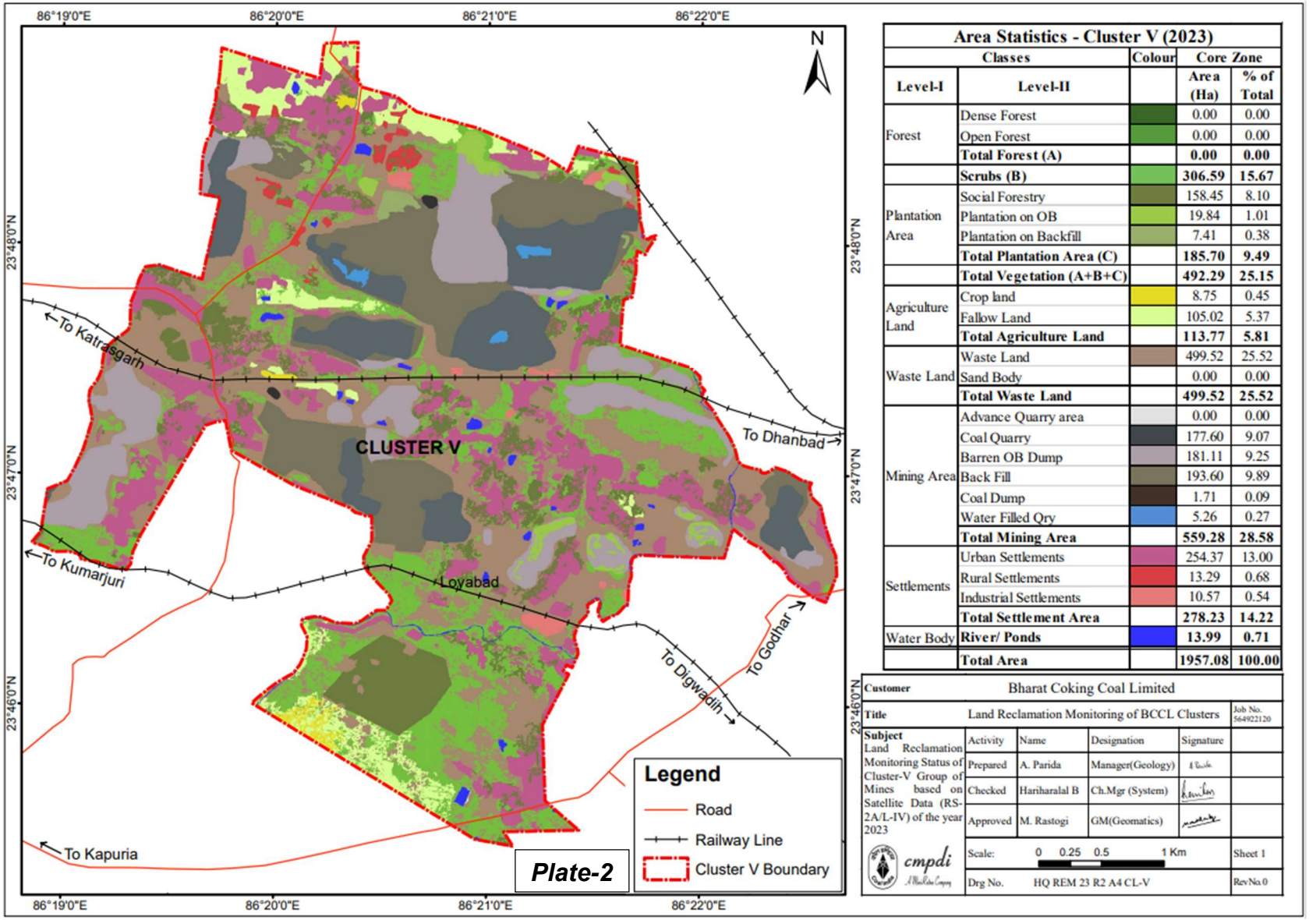
		CLUSTER III		CLUSTER V		CLUSTER VIII		CLUSTER IX		CLUSTER XVII		TOTAL	
		Area	%	Area	%	Area	%	Area	%	Area	%	Area	%
FOREST'S	Dense Forest	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Open Forest	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total Forest (A)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SCRUBS	**Scrubs (B)**	248.56	17.50	306.59	15.67	127.95	10.81	297.34	15.31	178.23	12.76	1158.67	14.67
PLANTATION	Social Forestry/Avenue Plantation	141.36	9.95	158.45	8.10	22.63	1.91	151.33	7.79	43.33	3.10	517.10	6.54
	Plantation on OB Dump	28.67	2.02	19.84	1.01	16.86	1.42	22.40	1.15	5.00	0.36	92.77	1.17
	Plantation on Backfill (Biological Reclamation)	4.96	0.35	7.41	0.38	4.08	0.34	3.23	0.17	0.00	0.00	19.68	0.25
	Total Plantation (C)	174.99	12.32	185.70	9.49	43.57	3.68	176.96	9.11	48.33	3.46	629.55	7.97
	Total Vegetation (A+B+C)	**423.55**	**29.81**	**492.29**	**25.15**	**171.52**	**14.49**	**474.30**	**24.42**	**226.56**	**16.22**	**1788.22**	**22.63**
	Coal Dump	2.90	0.20	1.71	0.09	2.53	0.21	4.89	0.25	0.00	0.00	12.03	0.15
ACTIVE MINING	Coal Quarry	58.29	4.10	177.60	9.07	130.42	11.02	239.35	12.32	53.28	3.81	658.94	8.34
	Advance Quarry Site	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Quarry Filled With Water	26.59	1.87	5.26	0.27	21.03	1.78	0.89	0.05	12.12	0.87	65.89	0.83
	Total Area under *Active Mining*	**84.88**	**5.97**	**182.86**	**9.34**	**151.45**	**12.79**	**240.24**	**12.37**	**65.40**	**4.68**	**724.83**	**9.17**
	Barren OB Dump	105.83	7.45	181.11	9.25	170.51	14.40	224.00	11.53	44.48	3.18	725.93	9.19
RECLAIMED	Area Under Backfilling (Technical Reclamation)	68.71	4.84	193.60	9.89	198.08	16.73	108.00	5.56	125.09	8.95	693.48	8.78
	Total Area under Mine Operation	**262.32**	**18.47**	**559.28**	**28.58**	**522.57**	**44.14**	**577.13**	**29.72**	**234.97**	**16.82**	**2156.27**	**27.29**
WASTELAND	Waste Lands	403.96	28.44	499.52	25.52	216.17	18.26	573.10	29.51	104.82	7.50	1797.57	22.75
	Fly Ash Pond / Sand Body	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.73	0.48	6.73	0.09
	Total Wasteland	**403.96**	**28.44**	**499.52**	**25.52**	**216.17**	**18.26**	**573.10**	**29.51**	**111.55**	**7.98**	**1804.30**	**22.84**
WATERBODIES	Reservoir, Nallah, Ponds	19.44	1.37	13.99	0.71	10.48	0.89	19.20	0.99	35.39	2.53	98.50	1.25
	Total Waterbodies	**19.44**	**1.37**	**13.99**	**0.71**	**10.48**	**0.89**	**19.20**	**0.99**	**35.39**	**2.53**	**98.50**	**1.25**
AGRICULTURE	Crop Lands	15.66	1.10	8.75	0.45	14.00	1.18	1.78	0.09	69.23	4.95	109.42	1.38
	Fallow Lands	99.97	7.04	105.02	5.37	67.72	5.72	32.14	1.65	464.00	33.21	768.85	9.73
	Total Agriculture	**115.63**	**8.14**	**113.77**	**5.81**	**81.72**	**6.90**	**33.92**	**1.75**	**533.23**	**38.16**	**878.27**	**11.12**
SETTLEMENTS	Urban Settlement	152.82	10.76	254.37	13.00	124.74	10.54	197.76	10.18	213.57	15.29	943.26	11.94
	Rural Settlement	33.30	2.34	13.29	0.68	49.23	4.16	57.10	2.94	31.25	2.24	184.17	2.33
	Industrial Settlement	9.59	0.68	10.57	0.54	7.49	0.63	9.61	0.49	10.66	0.76	47.92	0.61
	Total Settlements	**195.71**	**13.78**	**278.23**	**14.22**	**181.46**	**15.33**	**264.47**	**13.62**	**255.48**	**18.29**	**1175.35**	**14.88**
	Grand Total	**1420.61**	**100.00**	**1957.08**	**100.00**	**1183.92**	**100.00**	**1942.12**	**100.00**	**1397.18**	**100.00**	**7900.91**	**100.00**



Area Statistics - Cluster III (2023)

Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forest	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
	Scrubs (B)		**248.56**	**17.50**
Plantation Area	Social Forestry		141.36	9.95
	Plantation on OB		28.67	2.02
	Plantation on Backfill		4.96	0.35
	Total Plantation Area (C)		**174.99**	**12.32**
	Total Vegetation (A+B+C)		**423.55**	**29.81**
Agriculture Land	Crop land		15.66	1.10
	Fallow Land		99.97	7.04
	Total Agriculture Land		**115.63**	**8.14**
Waste Land	Waste Land		403.96	28.44
	Sand Body		0.00	0.00
	Total Waste Land		**403.96**	**28.44**
Mining Area	Advance Quarry area		0.00	0.00
	Coal Quarry		58.29	4.10
	Barren OB Dump		105.83	7.45
	Back Fill		68.71	4.84
	Coal Dump		2.90	0.20
	Water Filled Qry		26.59	1.87
	Total Mining Area		**262.32**	**18.47**
Settlements	Urban Settlements		152.82	10.76
	Rural Settlements		33.30	2.34
	Industrial Settlements		9.59	0.68
	Total Settlement Area		**195.71**	**13.78**
Water Body	**River/ Ponds**		**19.44**	**1.37**
	Total Area		**1420.61**	**100.00**

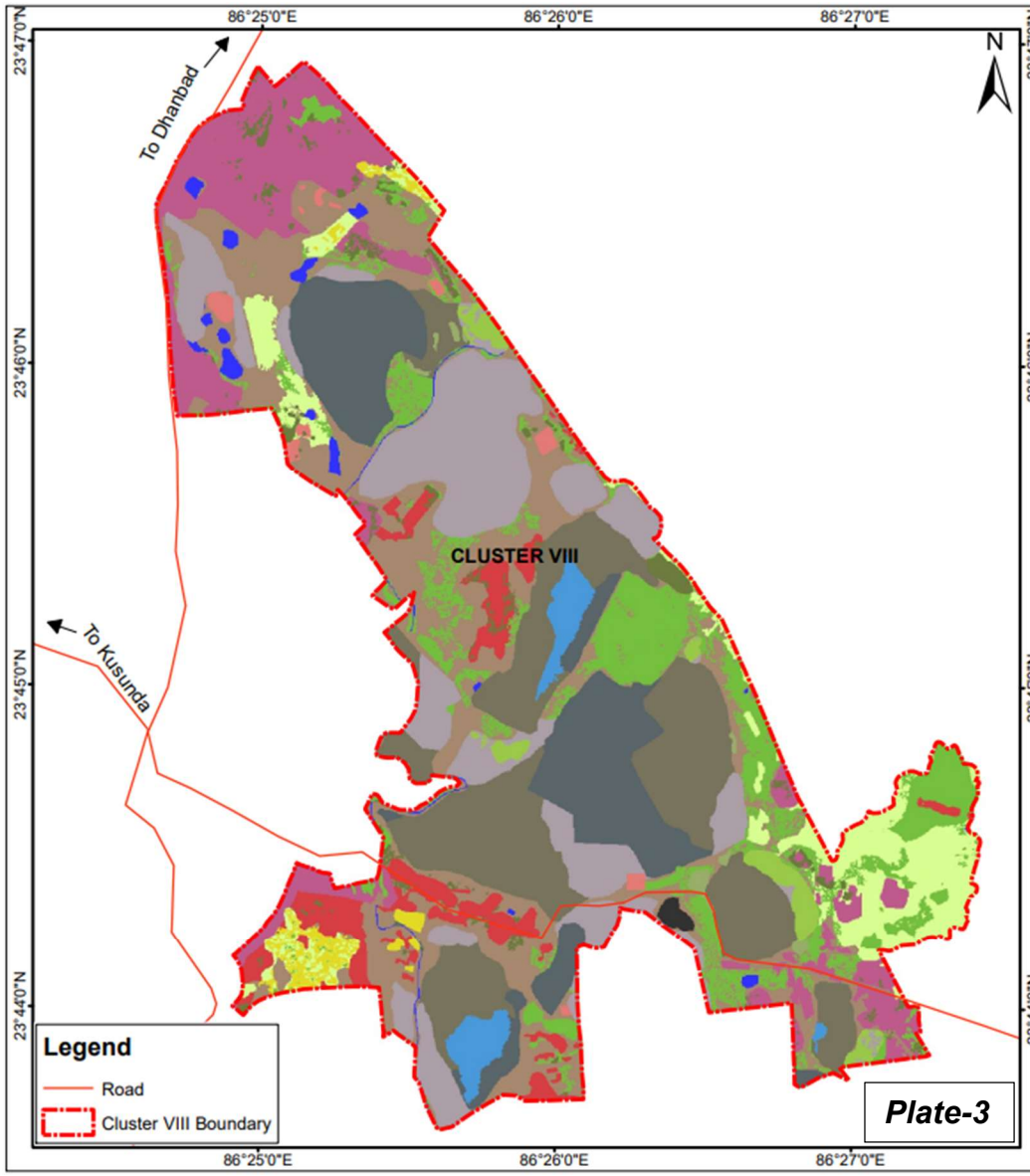
Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of BCCL Clusters				Job No. 564922120
Subject Land Reclamation Monitoring Status of Cluster-III Group of Mines based on Satellite Data (RS-2A/L-IV) of the year 2023	Activity	Name	Designation	Signature	
	Prepared	A. Parida	Manager(Geology)		
	Checked	Hariharalal B	Ch.Mgr (System)		
	Approved	M. Rastogi	GM(Geomatics)		
cmpdi	Scale: 0 0.25 0.5 1 Km				Sheet 1
	Drg No. HQ REM 23 R2 A4 CL-III				Rev No.0



Area Statistics - Cluster V (2023)

Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forest	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
	Scrubs (B)		**306.59**	**15.67**
Plantation Area	Social Forestry		158.45	8.10
	Plantation on OB		19.84	1.01
	Plantation on Backfill		7.41	0.38
	Total Plantation Area (C)		**185.70**	**9.49**
	Total Vegetation (A+B+C)		**492.29**	**25.15**
Agriculture Land	Crop land		8.75	0.45
	Fallow Land		105.02	5.37
	Total Agriculture Land		**113.77**	**5.81**
Waste Land	Waste Land		499.52	25.52
	Sand Body		0.00	0.00
	Total Waste Land		**499.52**	**25.52**
Mining Area	Advance Quarry area		0.00	0.00
	Coal Quarry		177.60	9.07
	Barren OB Dump		181.11	9.25
	Back Fill		193.60	9.89
	Coal Dump		1.71	0.09
	Water Filled Qry		5.26	0.27
	Total Mining Area		**559.28**	**28.58**
Settlements	Urban Settlements		254.37	13.00
	Rural Settlements		13.29	0.68
	Industrial Settlements		10.57	0.54
	Total Settlement Area		**278.23**	**14.22**
Water Body	**River/ Ponds**		**13.99**	**0.71**
	Total Area		**1957.08**	**100.00**

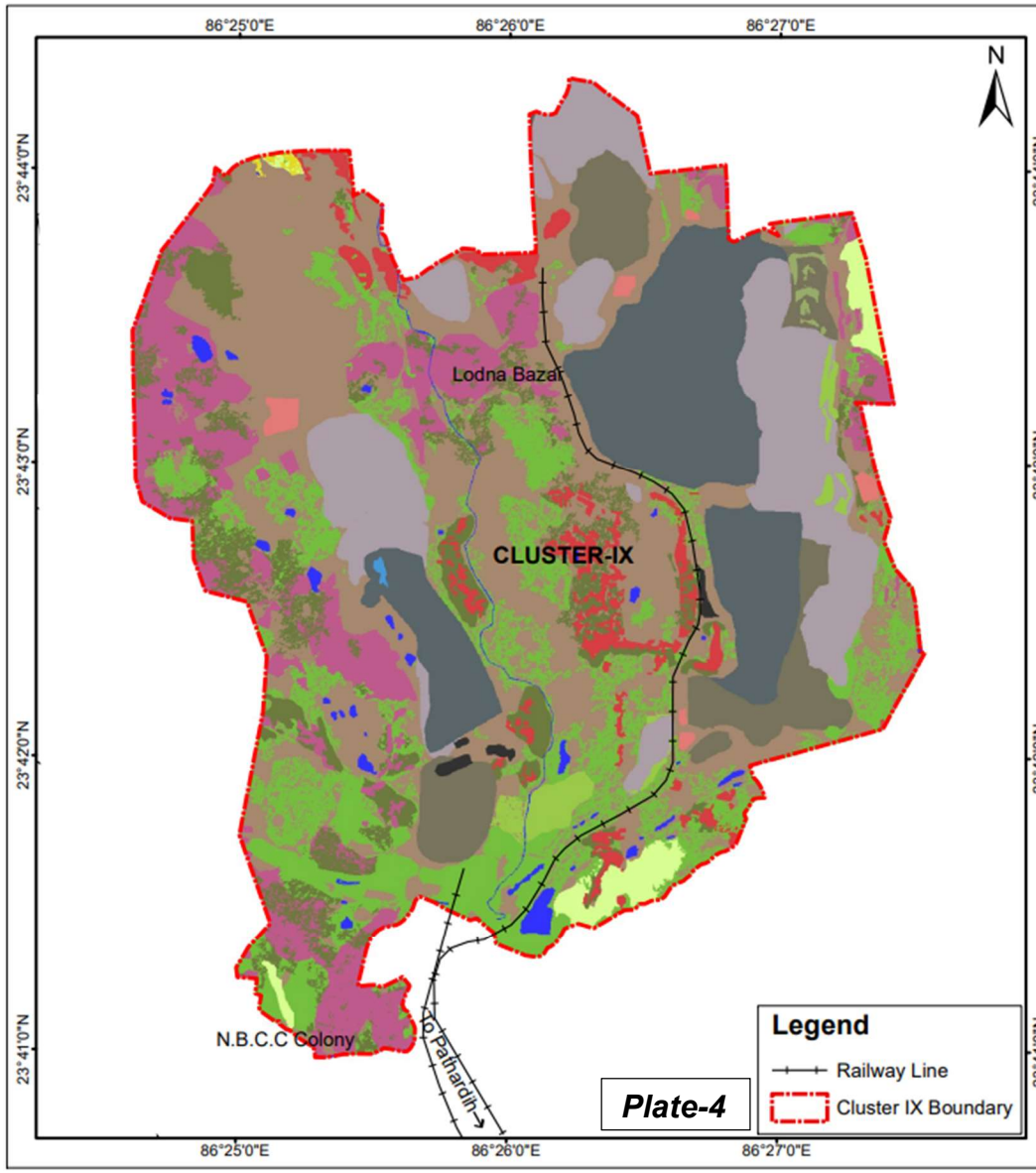
Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of BCCL Clusters				Job No. 564922120
Subject: Land Reclamation Monitoring Status of Cluster-V Group of Mines based on Satellite Data (RS-2A/L-IV) of the year 2023	Activity	Name	Designation	Signature	
	Prepared	A. Parida	Manager(Geology)		
	Checked	Hariharalal B	Ch.Mgr (System)		
	Approved	M. Rastogi	GM(Geomatics)		
cmpdi	Scale:	0 0.25 0.5 1 Km			Sheet 1
	Drg No.	HQ REM 23 R2 A4 CL-V			RevNo.0



Area Statistics - Cluster VIII (2023)

Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forest	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
	Scrubs (B)		**127.95**	**10.81**
Plantation Area	Social Forestry		22.63	1.91
	Plantation on OB		16.86	1.42
	Plantation on Backfill		4.08	0.34
	Total Plantation Area (C)		**43.57**	**3.68**
	Total Vegetation (A+B+C)		**171.52**	**14.49**
Agriculture Land	Crop land		14.00	1.18
	Fallow Land		67.72	5.72
	Total Agriculture Land		**81.72**	**6.90**
Waste Land	Waste Land		216.17	18.26
	Sand Body		0.00	0.00
	Total Waste Land		**216.17**	**18.26**
Mining Area	Advance Quarry area		0.00	0.00
	Coal Quarry		130.42	11.02
	Barren OB Dump		170.51	14.40
	Back Fill		198.08	16.73
	Coal Dump		2.53	0.21
	Water Filled Qry		21.03	1.78
	Total Mining Area		**522.57**	**44.14**
Settlements	Urban Settlements		124.74	10.54
	Rural Settlements		49.23	4.16
	Industrial Settlements		7.49	0.63
	Total Settlement Area		**181.46**	**15.33**
Water Body	**River/ Ponds**		**10.48**	**0.89**
	Total Area		**1183.92**	**100.00**

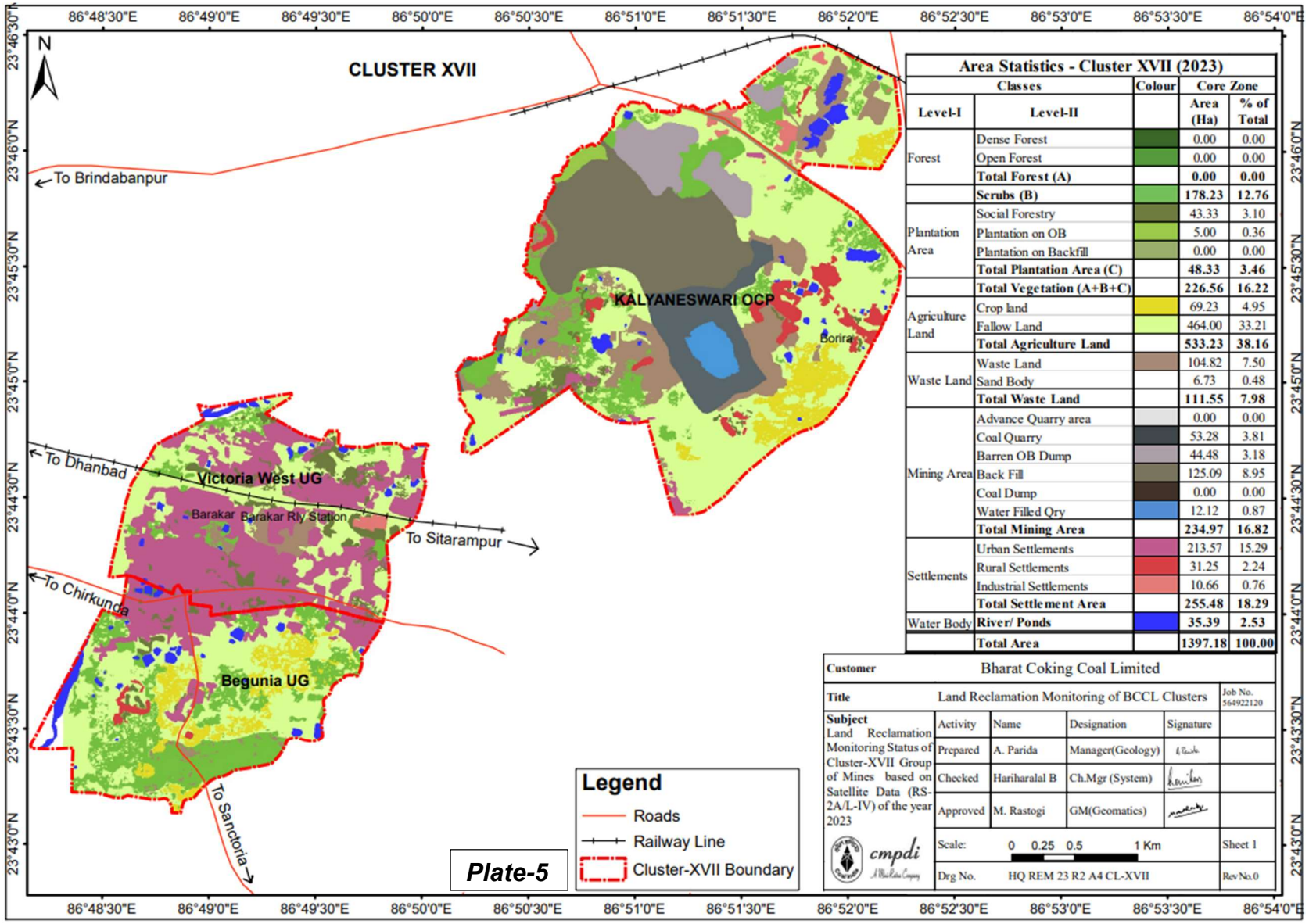
Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of BCCL Clusters				Job No. 564922120
Subject Land Reclamation Monitoring Status of Cluster-VIII Group of Mines based on Satellite Data (RS-2A/L-IV) of the year 2023	Activity	Name	Designation	Signature	
	Prepared	A. Parida	Manager(Geology)		
	Checked	Hariharalal B	Ch.Mgr (System)		
	Approved	M. Rastogi	GM(Geomatics)		
	Scale: 0 0.25 0.5 1 Km				Sheet 1
	Drg No. HQ REM 23 R2 A4 CL-VIII				Rev No.0



Area Statistics - Cluster IX (2023)

Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forest	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
	Scrubs (B)		**297.34**	**15.31**
Plantation Area	Social Forestry		151.33	7.79
	Plantation on OB		22.40	1.15
	Plantation on Backfill		3.23	0.17
	Total Plantation Area (C)		**176.96**	**9.11**
	Total Vegetation (A+B+C)		**474.30**	**24.42**
Agriculture Land	Crop land		1.78	0.09
	Fallow Land		32.14	1.65
	Total Agriculture Land		**33.92**	**1.75**
Waste Land	Waste Land		573.10	29.51
	Sand Body		0.00	0.00
	Total Waste Land		**573.10**	**29.51**
Mining Area	Advance Quarry area		0.00	0.00
	Coal Quarry		239.35	12.32
	Barren OB Dump		224.00	11.53
	Back Fill		108.00	5.56
	Coal Dump		4.89	0.25
	Water Filled Qry		0.89	0.05
	Total Mining Area		**577.13**	**29.72**
Settlements	Urban Settlements		197.76	10.18
	Rural Settlements		57.10	2.94
	Industrial Settlements		9.61	0.49
	Total Settlement Area		**264.47**	**13.62**
Water Body	**River/ Ponds**		**19.20**	**0.99**
	Total Area		**1942.12**	**100.00**

Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of BCCL Clusters				Job No. 564922120
Subject Land Reclamation Monitoring Status of Cluster-IX Group of Mines based on Satellite Data (RS-2A/L-IV) of the year 2023	Activity	Name	Designation	Signature	
	Prepared	A. Parida	Manager(Geology)		
	Checked	Hariharalal B	Ch.Mgr (System)		
	Approved	M. Rastogi	GM(Geomatics)		
cmpdi	Scale:	0 0.25 0.5 1 Km			Sheet 1
	Drg No.	HQ REM 23 R2 A4 CL-IX			Rev No.0



Area Statistics - Cluster XVII (2023)

Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forest	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
	Scrubs (B)		**178.23**	**12.76**
Plantation Area	Social Forestry		43.33	3.10
	Plantation on OB		5.00	0.36
	Plantation on Backfill		0.00	0.00
	Total Plantation Area (C)		**48.33**	**3.46**
	Total Vegetation (A+B+C)		**226.56**	**16.22**
Agriculture Land	Crop land		69.23	4.95
	Fallow Land		464.00	33.21
	Total Agriculture Land		**533.23**	**38.16**
Waste Land	Waste Land		104.82	7.50
	Sand Body		6.73	0.48
	Total Waste Land		**111.55**	**7.98**
Mining Area	Advance Quarry area		0.00	0.00
	Coal Quarry		53.28	3.81
	Barren OB Dump		44.48	3.18
	Back Fill		125.09	8.95
	Coal Dump		0.00	0.00
	Water Filled Qry		12.12	0.87
	Total Mining Area		**234.97**	**16.82**
Settlements	Urban Settlements		213.57	15.29
	Rural Settlements		31.25	2.24
	Industrial Settlements		10.66	0.76
	Total Settlement Area		**255.48**	**18.29**
Water Body	**River/ Ponds**		**35.39**	**2.53**
	Total Area		**1397.18**	**100.00**

Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of BCCL Clusters				Job No. 564922120
Subject Land Reclamation Monitoring Status of Cluster-XVII Group of Mines based on Satellite Data (RS-2A/L-IV) of the year 2023	Activity	Name	Designation	Signature	
	Prepared	A. Parida	Manager(Geology)		
	Checked	Hariharalal B	Ch.Mgr (System)		
	Approved	M. Rastogi	GM(Geomatics)		
	Scale:	0 0.25 0.5 1 Km			Sheet 1
	Drg No.	HQ REM 23 R2 A4 CL-XVII			Rev No.0

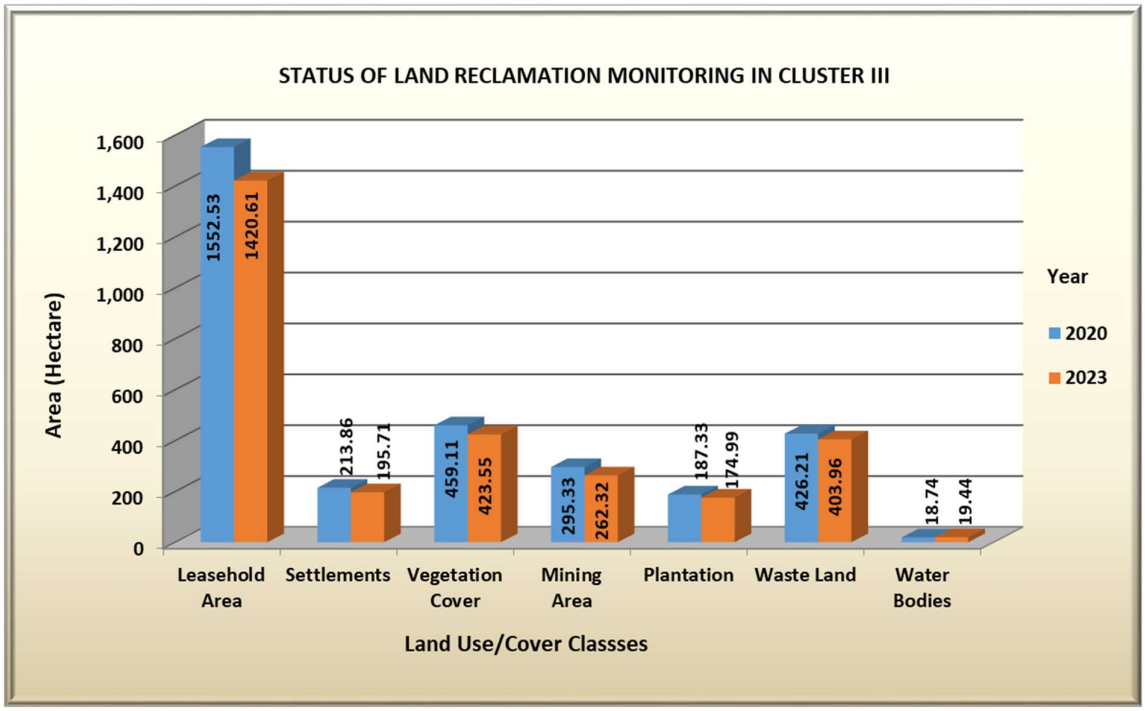


Fig. 3: Land Reclamation Status of Cluster III

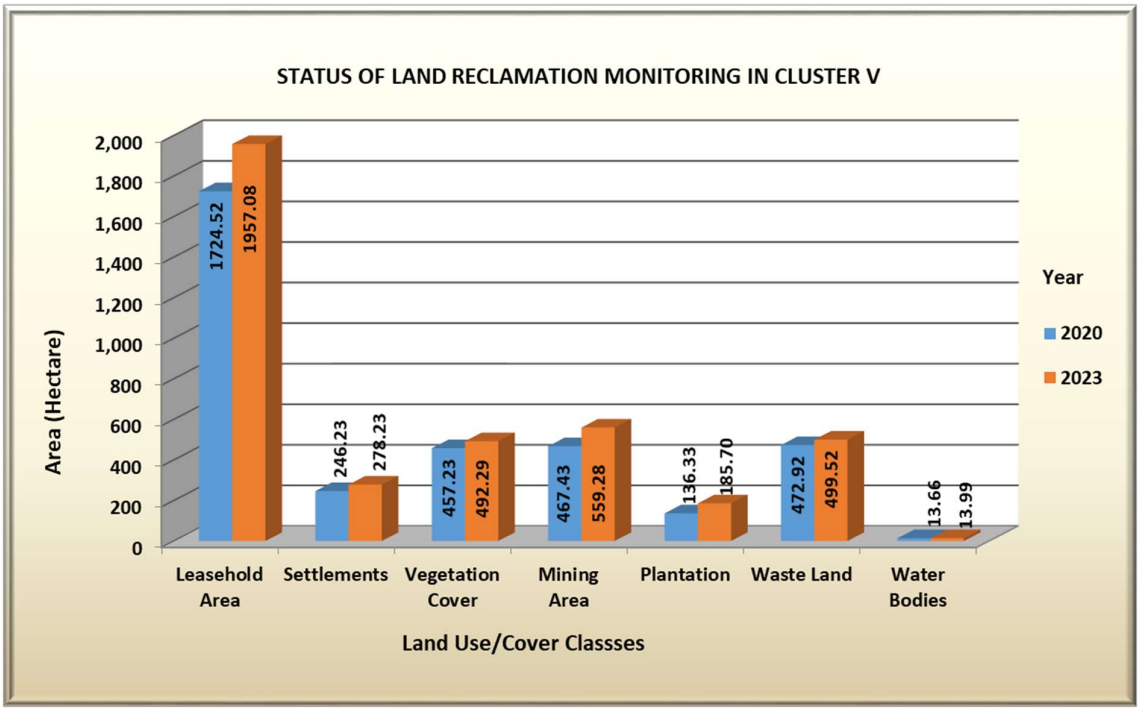


Fig. 4: Land Reclamation Status of Cluster V

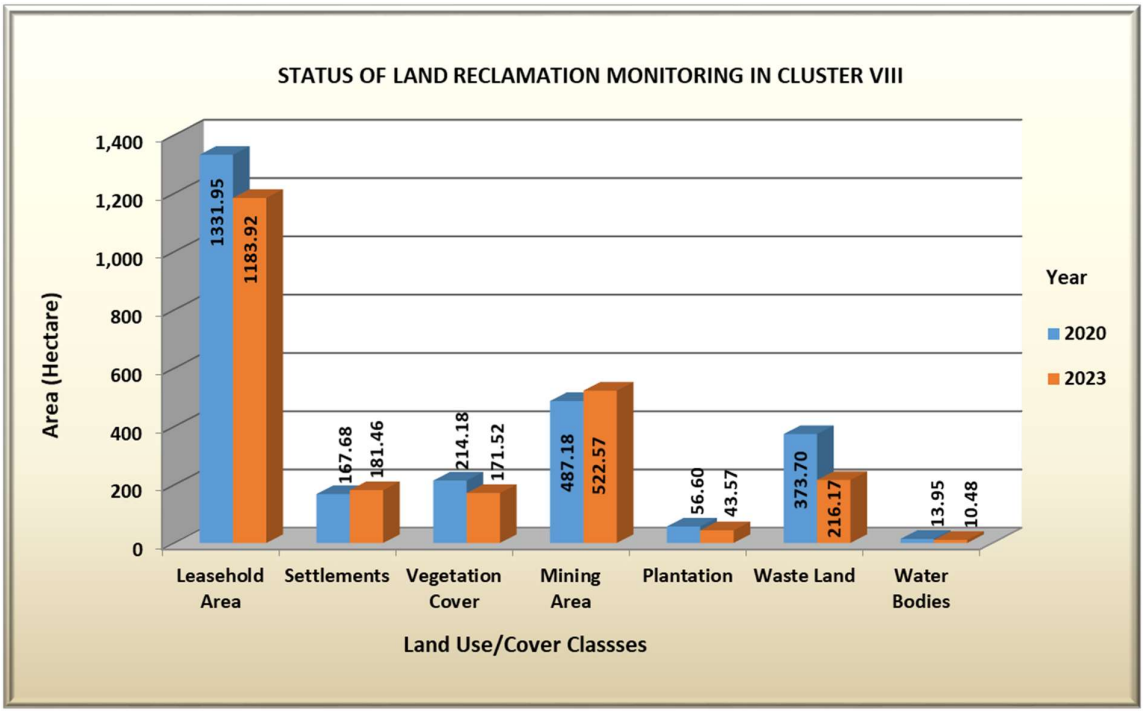


Fig. 5: Land Reclamation Status of Cluster VIII

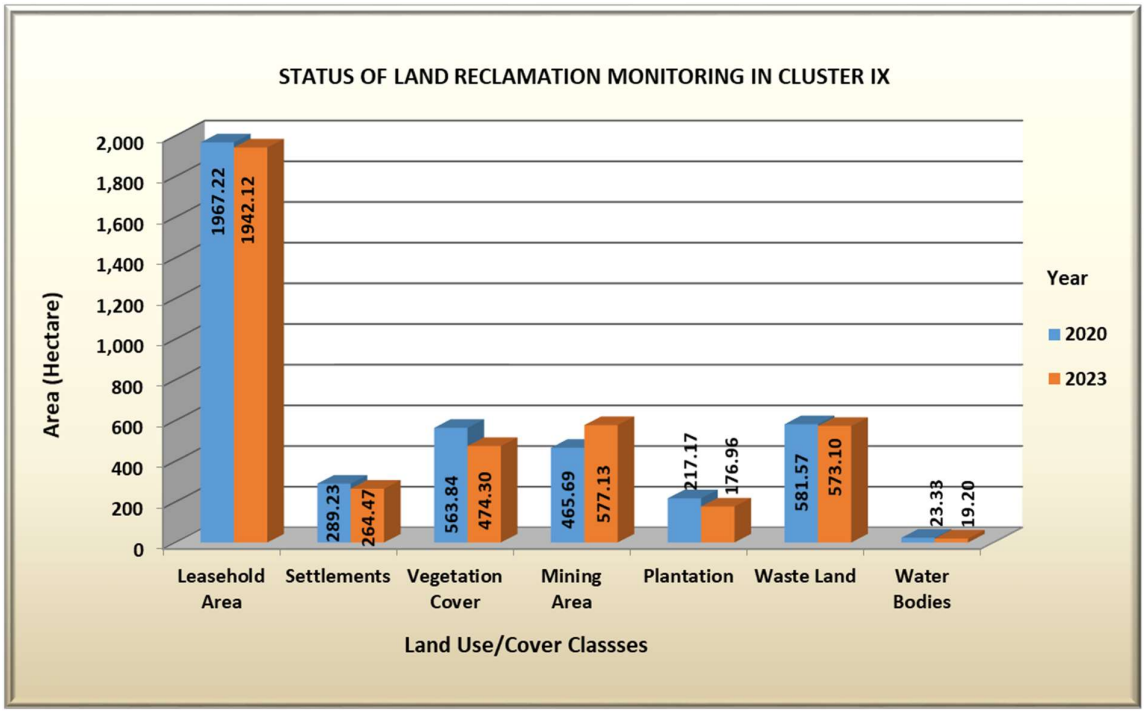


Fig. 6: Land Reclamation Status of Cluster IX

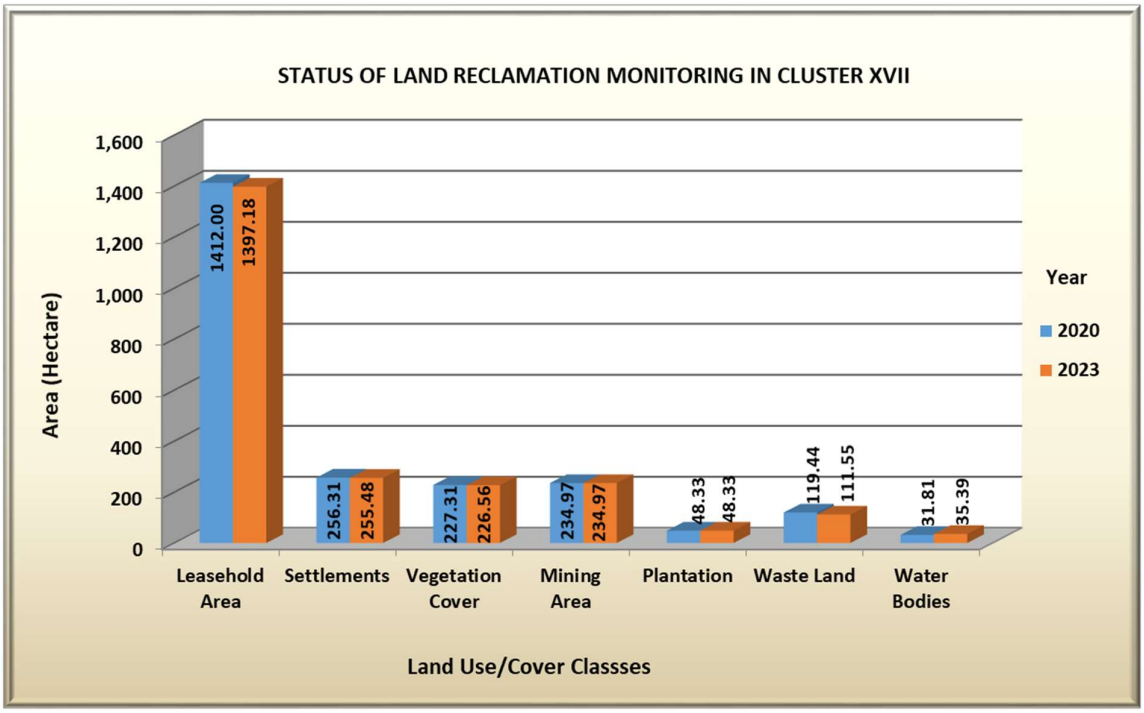


Fig. 7: Land Reclamation Status of Cluster XVII

Photo 1: Plantation on OB dump, Cluster XVII

Photo 2: Plantation on OB dump, Cluster III

Photo 3: Plantation on OB dump, Cluster III

Photo 4: Plantation on OB Dump, Cluster V

Photo 5: Plantation on OB Dump, Cluster V

Photo 6: Govardhan Eco Restoration Park - Bera, Cluster VIII

Photo 7: Plantation on OB Dump, Cluster VIII

Photo 8: Plantation on OB Dump, Cluster VIII

Photo 9: Ashok Vatika, Cluster VIII

Photo 10: Plantation on OB Dump, Cluster IX

Photo 11: Plantation on OB Dump, Cluster IX

शब्द-कोष

1	Land Reclamation	भूमि पुनरुद्धार
2	Over Burden	अधिभार
3	Monitoring	निगरानी
4	Report	प्रतिवेदन
5	Executive Summary	कार्यकारी सारांश
6	Opencast Mine	खुली खदान
7	Objective	उद्देश्य
8	Methodology	कार्य प्रणाली अथवा प्रक्रिया
9	Table	तालिका
10	List of Tables	तालिकाओं की सूची
11	Map	मानचित्र
12	Social Forestry	सामाजिक वानिकी
13	Plantation	पौधारोपण
14	Million	घनमीटर
15	Background	पृष्टभूमि
16	Planning	योजनाबद्ध
17	Asses	आकलन
18	Status	स्थिति
19	Regularly	निरंतर
20	Satellite	उपग्रह
21	Subsidiary	अनुषांगिक
22	Production	उत्पादन
23	Biological Reclamation	जैविक पुनरुद्धार
24	Technical Reclamation	तकनिकी पुनरुधार
25	Leasehold Area	पट्टाक्षेत्र
26	Excavated Area	उत्खनन क्षेत्र
27	Active mining	सक्रिय खनन
28	Environmental Protection	पर्यावरण संरक्षण
29	Remedial Measure	उपचारात्मक उपाय
30	Interval	अंतराल
31	Systematic Error	व्यवस्थित त्रुटियँ।
32	Error	अशुद्धियाँ
33	Curvature	वक्रता
34	Geometric	ज्यामितिक
35	Distortion	विरुपण
36	Plantation	पौधारोपण

37	Capacity	क्षमता
38	Software	सॉफ्टवेयर
39	Class	वर्ग
40	Accuracy	सटीकता
41	Statistical Separation	सांख्यिकीय पृथक्करण
42	Cubic meter	घनमीटर
43	Depicted	दर्शाया गया
44	Percentage	प्रतिशत
45	Salient Findings	मुख्य निष्कर्ष
46	Methodology	पद्धति
47	Data Procurement	डाटाक्रय
48	Satellite data Processing	उपग्रह डाटा प्रसंस्करण
49	Rectification and geo-referencing	सुधार और भूसन्दर्भ-
50	Image enhancement	छवि गुण वृद्धि
51	Training set selection	प्रशिक्षण सेट का चयन
52	Classification and Accuracy assessment	वर्गीकरण और मूल्यांकन की सटीकता
53	Area calculation	क्षेत्र गणना
54	Temporal	लौकिक
55	Processing	प्रसंस्करण
56	Overlay of Vector data base	वेक्टर डाटाबेस का अरोपन
57	Pre-field map preparation	क्षेत्र जाने के पहले नक्शे की त्तैयारी
58	Ground Truthing	भू-सत्यापन
59	Ground Information	भू- सुचना
60	Interpretation	व्याख्या
61	Eco-system	पारिस्थितिकी तंत्र
62	Minor	मामुली
63	Water Drainage	जलनिकाय
64	Interval	अंतराल
65	Maximum	अधिकतम
66	Coal field	कोयला क्षेत्र
67	Design	परिकल्पना
68	Superimpose	आरोपित
69	Update	अद्यतनीकरण/नवीनीकरण
70	Cumulative	संचयित
71	Embankment	तटबंध
72	Cluster	खुली तथा भूमिगत खदानों के समूह

ABBREVIATIONS

SoI	Survey of India
MoEF & CC	Ministry of Environment, Forest & Climate Change
CIL	Coal India Limited
ECL	Eastern Coalfields Limited
BCCL	Bharat Coking Coal Limited
CCL	Central Coalfields Limited
WCL	Western Coalfields Limited
SECL	South Eastern Coalfields Limited
NCL	Northern Coalfields Limited
MCL	Mahanadi Coalfields Limited
NEC	North Eastern Coalfields
CMPDIL	Central Mine Planning & Design Institute Ltd
NRSC	National Remote Sensing Centre
R2/ R2A	Resource Sat Satellites
LISS - 4	Linear Imaging and Self Scanning Sensor
FCC	False Color Composite
OCP	Opencast Project
UGP	Underground Project
OB	Over Burden
GCP	Ground Control points
GIS	Geographic Information System
WGS-84	World Geodetic System
UTM	Universal Transverse Mercator

GLOSSARY

Sl.	Term	Definition
1.	Land Reclamation	To manage, reclaim and restore mined out/ degraded land as close as possible to its original stage.
2.	Over Burden	The material that lies above the coal seam/ deposit
3.	Monitoring	A process of evaluation to check or keep record for a period of time.
4.	Opencast Coal Mine	Open-pit mining, also known as opencast mining, is a surface mining technique that extracts minerals from an open pit in the ground.
5.	Social Forestry	Social forestry is the management and protection of forests and afforestation of barren and deforested lands with the purpose of helping environmental, social and rural development. Plantation (Social/ Avenue or other) carried out outside mining area.
6.	Biological Reclamation	Plantation on Backfilled areas (Stabilized Internal Dumps)
7.	Technical Reclamation	Area under backfilling (Over burden dumped inside the mine voids) in mining area.
8.	Green Cover Generated	Total Plantation carried out in the lease area of Project. This includes Plantation on Backfill, Plantation on OB and Social Forestry.
9.	Leasehold Area	The area, for which lease is granted for the purpose of undertaking mining and allied operations.
10.	Excavated area	Mined out area which includes active mining, area under backfilling and plantation on backfilled areas
11.	Active Mining	Mining areas which include Coal Quarry, Advance Quarry, Quarry Filled with Water etc.
12.	Environmental Protection	It is the practice of protecting the natural environment by individuals, organizations and governments. Its objectives are to conserve natural resources and the existing natural environment and, where possible, to mitigate damage and reverse trends.
13.	Remedial Measure	Any measure or action required or undertaken to investigate, monitor, clean up, remove, treat, prevent, contain or otherwise remediate the presence or release of any hazardous substance or activity.
14.	Systematic Error	Every measurement differing from the true measurement in the same direction, and even by the same amount in some cases.

15.	Geometric Distortion	It refers to the improper positioning of any image with respect to their true geographic position when viewed in a properly scaled common image display plane.
16.	Land Use/ Cover Class	Land cover is what covers the surface of the earth and land use describes how the land is used.
17.	Accuracy	The closeness of agreement between a measured quantity value and a true quantity value.
18.	Environmental Clearance	Environmental Clearance (EC) for any developmental projects like coal mining projects etc. has been made mandatory by the Ministry of Environment, Forests and Climate Change (MoEF & CC) through its Notification issued on 27.01.1994 under the provisions of Environment (Protection) Act, 1986.
19.	Rectification and Geo-referencing	Geo-referencing is the assigning of absolute location of a data point or data points. Geo-rectification refers to the removal of geometric distortions between sets of data points, most often the removal of terrain, platform, and sensor induced distortions from remote sensing imagery.
20.	Image Enhancement	It is the process of modifying digital images so that the results are more suitable for processing or further image analysis.
21.	Training set selection	It is a portion of a data set used to fit or train a model for prediction or classification of values that are known in the training set, but unknown in other (future) data.
22.	Image Classification	It refers to the task of extracting information classes from a multiband raster image. The resulting raster from image classification can be used to create thematic maps.
23.	Temporal Changes	The 'temporal change' means the change in any entity with a period of time.
24.	Ground Truthing	Collection of primary/ basic information from ground realities for satellite image interpretation and thematic mapping.
25.	Cluster	Group of opencast and/ or underground mines clubbed together for administrative purposes.
26.	Arc GIS	GIS Software used for Map preparation
27.	ERDAS IMAGINE	Satellite Image Data Classification Software

Central Mine Planning & Design Institute Ltd.
(A Subsidiary of Coal India Ltd.)
Gondwana Place, Kanke Road, Ranchi 834031, Jharkhand
Phone : (+91) 651 2230001, 2230002, 2230483, FAX (+91) 651 2231447, 2231851
Website : www.cmpdi.co.in, Email : cmpdihq@cmpdi.co.in

Annexure-XI

बीसीसीएल
BCCL
Coal India
भारत कोकिंग कोल लिमिटेड
(कोल इण्डिया लिमिटेड की एक अनुषंगी कंपनी)
Bharat Coking Coal Limited
(A Subsidiary of Coal India Limited)
(एक मिनीरत्न कंपनी - A Miniratna Company)
(भारत सरकार का उपक्रम - A Government of India Undertaking)
G20 भारत 2023 INDIA
वसुधैव कुटुम्बकम्
ONE EARTH • ONE FAMILY • ONE FUTURE

Ref: BCCL/AR.III/GM/2025/282

Date: 07.05.2025

Office-Order

Following committee is hereby constituted for regular monitoring of subsidence and its mitigation measures in Cluster-III coal mining project:

1. Addl. GM, Govindpur Area- Chairman
2. Area Manager (Survey)
3. Area Manager (Safety)
4. All Project Officers/their representative
5. All Colliery Surveyor

The above-mentioned committee shall hold review meeting regularly i.e., once in a month and submit the inspection report/mitigation measures report to the undersigned.

This shall come into force with immediate effect.

General Manager
Govindpur Area (Cluster-III)

Distribution:

1. All Concerned
2. Office Copy

THE TIMES OF INDIA, RANCHI
TUESDAY, MARCH 11, 2025

Bharat Coking Coal Limited

A Mini Ratna Company
(A Subsidiary of Coal India Limited)
www.bcclweb.in

ADVERTISEMENT

This is to bring to notice of all concerned that the Amendment in Environmental Clearance to Cluster-III group of mines of Bharat Coking Coal Limited, located at Dhanbad District, Jharkhand has been amended as following by Ministry of Environmental, Forests and Climate Change. Details are following:

Name & details of Cluster	Sanction order number & date
Environment clearance of Cluster III of BCCL dated 06.02.2013 with a rated capacity of 3.6 MTPA in an area of 1420.61 ha, located in the Jharia Coalfield in Dhanbad district of Jharkhand state has been amended by Ministry of Environmental, Forests and Climate by amalgamating seven mines in to single mine to enable mining with OC cum UG with Highwall Mining Method without no change in lease area and production capacity .	**J-11015/213/ 2010-IA.II(M)** dated 03 March, 2025

Copy of the clearance letter may be seen at the website of the Ministry of Environment, Forests and Climate Change at **https://parivesh.nic.in/certificates/BHARAT_COKING_COAL_LIMITED/37/114181011/ec_mining_amendmentIA_JH_CMIN_513800_2024_114181461_-signed.pdf** and also on Bharat Coking Coal Limited official website **www.bcclweb.in**

Sd/- General Manager (Environment)

This information is also available on BCCL website www.bcclweb.in

बीसीसीएल
BCCL

भारत कोकिंग कोल लिमिटेड

'एक मिनीरत्न कम्पनी'

(कोल इण्डिया लिमिटेड का एक अंग)

सभी सम्बंधित व्यक्तियो को सूचित किया जाता है कि भारत कोकिंग कोल लिमिटेड के क्लस्टर-3 को पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय के द्वारा पर्यावरणीय स्वीकृति में बदलाव कीमंजूरी प्राप्त हुई है। विवरण निम्न है :

ख़ान का नाम	स्वीकृति आदेश संख्या एवं तिथि
झारखंड राज्य के धनबाद जिले के झरिया कोयला क्षेत्र में स्थित क्लस्टर ~~क~~ (1420.61 हेक्टेयर क्षेत्र में 3.6 एमटीपीए की क्षमता) के पर्यावरण मंजूरी 9 दिनांक 06.02.2013) को पर्यावरण, वन और जलवायु मंत्रालय द्वारा संशोधित किया गया है एवं सात खदानों को एक खदान में मिलाकर (पट्टा क्षेत्र एवं क्षमता में कोई बदलाव किए बिना) हाईवॉल खनन विधि के साथ ओसी सह यूजी के साथ खनन उत्पादन करने की अनुमति प्राप्त हुई है।	J-11015/213/2010-IA.II(M) dated 03 March, 2025.

प्रतिलिपि पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय की आधिकारिक वेबसाईड https://parivesh.nic.in/certificates/BHARAT COKING COAL LIMITED/37/114181011/ec mining am endmentIA JH CMIN 513800 2024 114181461-signed.pdf और भारत कोकिंग कोल लिमिटेड के आधिकारिक वेबसाईड www.bcclweb.in पर उपलब्ध है।

महाप्रंधक (पर्यावरण)
भारत कोकिंग कोल लिमिटेड

यह सूचना बीसीसीएल की वैबसाइट www.bcclweb.in पर भी उपलब्ध है।

हिन्दुस्तान, धनबाद - 11.03.2025

Annexure-XIII

Email **Vivek Sharma**

Submission of Copy of Amended EC granted by MoEF&CC, New Delhi to Cluster-III, BCCL dated 03.03.2025

From : Ganesh Chandra Saha <gmgovindpur.bccl@coalindia.in> Thu, Mar 13, 2025 11:13 AM

Subject : Submission of Copy of Amended EC granted by MoEF&CC, New Delhi to Cluster-III, BCCL dated 03.03.2025 1 attachment

To : dc-dhn@nic.in

Cc : Vivek Sharma <amenv.govindpur.bccl@coalindia.in>

Respected Madam

This is to bring to your kind attention that amendment in Environment Clearance (EC) has been granted to Cluster-III, BCCL by MoEF&CC, New Delhi dated 03.03.2025 and copy of the same is enclosed herewith.

Further, Copy of the amended EC is also available on PARIVESH Portal (https://parivesh.nic.in/certificates/BHARAT_COKING_COAL_LIMITED/37/114181011/ec_mining_amendmentIA_JH_CMIN_513800_2024_114181461_-signed.pdf) and BCCL website (bcclweb.in)

This is for compliance of condition enforced in amended EC.

Warm regards

Ganesh Chandra Saha
General Manager
Govindpur Area-III

Cluster-III ec_mining_amendmentIA_JH_CMIN_513800_2024_114181461_-signed.pdf
354 KB

Email **Vivek Sharma**

Fwd: Submission of Copy of Amended EC granted by MoEF&CC, New Delhi to Cluster-III, BCCL dated 03.03.2025

From : Vivek Sharma <amenv.govindpur.bccl@coalindia.in> Wed, Mar 12, 2025 12:44 PM
Subject : Fwd: Submission of Copy of Amended EC granted by MoEF&CC, New Delhi to Cluster-III, BCCL dated 03.03.2025 1 attachment
To : Dhanbad Municipal Corporation <admin.dmc@gov.in>
Cc : Ganesh Chandra Saha <gmgovindpur.bccl@coalindia.in>

Respected Sir

Please refer to the trailing mail.

This is to bring to your kind attention that amendment in Environment Clearance (EC) has been granted to Cluster-III, BCCL by MoEF&CC, New Delhi dated 03.03.2025 and copy of the same is enclosed herewith.

Copy of the amended EC is also available on PARIVESH Portal (https://parivesh.nic.in/certificates/BHARAT_COKING_COAL_LIMITED/37/114181011/ec_mining_amendmentIA_JH_CMIN_513800_2024_114181461_-signed.pdf) and BCCL website (bcclweb.in)

This is for your kind information and further display of the same at your office, please.

With Regards

Vivek Sharma
Area Manager (Environment)
Govindpur Area, BCCL
Mob: 6287696312

From: "Vivek Sharma" <amenv.govindpur.bccl@coalindia.in>
To: dhanbadmunicipalcorporationadm@gmail.com
Cc: "Ganesh Chandra Saha" <gmgovindpur.bccl@coalindia.in>
Sent: Wednesday, March 12, 2025 12:27:13 PM
Subject: Submission of Copy of Amended EC granted by MoEF&CC, New Delhi to Cluster-III, BCCL dated 03.03.2025

Dear Sir

This is to bring to your kind attention that amendment in Environment Clearance (EC) has been granted to Cluster-III, BCCL by MoEF&CC, New Delhi dated 03.03.2025 and copy of the same is enclosed herewith.

Copy of the amended EC is also available on PARIVESH Portal (https://parivesh.nic.in/certificates/BHARAT_COKING_COAL_LIMITED/37/114181011/ec_mining_amendmentIA_JH_CMIN_513800_2024_114181461_-signed.pdf) and BCCL website (bcclweb.in)

This is for your kind information and further display of the same at your office, please.

With Regards

Vivek Sharma
Area Manager (Environment)
Govindpur Area, BCCL
Mob: 6287696312

Cluster-III ec_mining_amendmentIA_JH_CMIN_513800_2024_114181461_-signed.pdf
354 KB

Email **Vivek Sharma**

Submission of Copy of Amended EC granted by MoEF&CC, New Delhi to Cluster-III, BCCL dated 03.03.2025

From : Vivek Sharma <amenv.govindpur.bccl@coalindia.in> Wed, Mar 12, 2025 12:22 PM

Subject : Submission of Copy of Amended EC granted by MoEF&CC, New Delhi to Cluster-III, BCCL dated 03.03.2025

1 attachment

To : dhanbadjspcb@gmail.com, ro dhanbad <ro_dhanbad@jharkhandspcb.in>

Cc : Ganesh Chandra Saha <gmgovindpur.bccl@coalindia.in>

Dear Sir

This is to bring to your kind attention that amendment in Environment Clearance (EC) has been granted to Cluster-III, BCCL by MoEF&CC, New Delhi dated 03.03.2025 and is enclosed herewith.

Copy of the amended EC is also available on PARIVESH Portal (https://parivesh.nic.in/certificates/BHARAT_COKING_COAL_LIMITED/37/114181011/ec_mining_amendmentIA_JH_CMIN_513800_2024_114181461_-signed.pdf) and BCCL website (bcclweb.in)

This is for your kind information and further display of the same at your office, please.

With Regards

Vivek Sharma
Area Manager (Environment)
Govindpur Area, BCCL
Mob: 6287696312

Cluster-III ec_mining_amendmentIA_JH_CMIN_513800_2024_114181461_-signed.pdf
354 KB

OFFICE OF THE GENERAL MANAGER, GOVINDPUR AREA
ENVIRONMENT DEPARTMENT

Ref: BCCL/AR.III/ENVT/2026-27/25

Date: 11.05.2026

Annexure-XIV

To
The Regional Officer,
Jharkhand State Pollution Control Board,
Sardar Patel Nagar, Dhanbad.

Subject: Submission of Environment Statement along with Ambient Air & Water Analysis Report (in photocopies) in Form –V and IV of Cluster-III Mine under Govindpur Area for the financial year 2025-26.

Dear Sir,

Enclosed please find herewith the environment statement for the financial year 22025-26 of Cluster-III Mine under Govindpur Area of M/s BCCL.

Enclosure: -

1. Copy of Water Analysis Report& Ambient Air Report.
2. Form-V and IV.

Received
11.05.2026
JHARKHAND STATE POLLUTION CONTROL BOARD
JSPCB
DHANBAD

Yours faithfully

11-05-2026

Area Manager (Env.)
Govindpur Area
Area Manager (Environment)
Govindpur Area BCCL
क्षेत्रीय प्रबंधक (पर्यावरण)
गोविन्दपुर क्षेत्र, बी.सी.सी.एल

FORM – V

(See rule-14)

Environmental statement for the financial year ending the 31st March 2026

PART – A

1. Name of the address of the owner of the industry operation or process : BCCL, Nominated owner
   Shri Rajeev Kumar Sinha, DT (P&P),
   Koyla Bhawan, Koyla Nagar, Dhanbad
   (Jharkhand).
2. Industry category : Large Scale
   Primary (STC code)
   Secondary (SIC code)
3. Production capacity (units) : 3.6 MTPA
4. Year of establishment : 1972
5. Date of the last environmental statement submitted : 27.09.2023

PART – B

1. Water & river material consumption
   Water consumption m^3 /d : 9400 KL/day
   Process : 1350 KL/day
   Domestic : 8050 KL/day

Name of the products	Process water consumption per unit of product output	
	During the previous financial year	During the current financial year
1	0.0079KL/Te	0.076 KL/Te

2. Raw material consumption

Name of the raw material	Name of the product	Consumption of raw material per unit of out put	
		During the previous financial year	During the current financial year
Explosive	Coal	0.0015 Te/Te of Coal	0.0016 Te/Te of coal

Industry may use cades if disclosing details of raw material would violate contractual obligations, otherwise all industries have to name the raw materials uses.

PART-C

Pollution discharged to environment/unit of output (parameter as specified in the consent issued)

Pollutants	Quantity of pollutions discharged (mass/day)	Concentration of pollutions discharged (mass/day)	Percentage of variation from prescribed standards with reasons
a) Water (As on 12.01.2026)	Total suspended solids -31 PH – 7.89 Oil &grease < 2.0 COD - 28		
b) Air (As on 27.01.2026)	SPM PM 10 – 97 PM 2.5 - 52		
	SO_2: 10		
	NOx : 26		

Monitoring Reports Attached

PART-D

Hazardous Wastes
(as specified under hazardous management and Handling Rules 1989)

Hazardous Wastes	Total quantity (Kg/KL)	
	During the previous financial year	During the current financial year
a) From process	10	11.5
b) From pollution control facilities	NA	NA

PART-E

Solid Wastes

	Total quantity (Kg)	
	During the previous financial year	During the current financial year
a) From process	73 Lakh cum	88.42 Lakh Cum
b) From pollution control facilities	Nil	Nil
c) 1. Quantity recycled or reutilized within the unit. 2.Sold 3.Disposed	1. 73 Lakh cum (backfilled)	1. 88.42 Lakh Cum (backfilled)

PART-F

Please specify the characterizations (in terms of composition of quantum) of hazards as well as solid wastes and indicate disposal practice adopted for both these categories of wastes.

For underground mines : NA
For OCP : Burnt Oil and Over Burden Material.

PART-G

Impact of the pollution abatement measures taken on conservation of natural resources and on the cost of production.

The abatement measures are undertaken and practiced by which the impact on the atmosphere has been become positive. Due care is taken to conserve the natural resources and protect the environment and all its components.

PART-H

Additional measures/investment proposal for environmental protection including abatement of pollution, prevention of pollution.

1. Water sprinkling: - Regular Water sprinkling is carried out through mist type sprinkler in all haul roads, siding, and coal transportation route. Also, 03 nos. fog cannons have been installed in SLG railway siding for abating the pollution. Road maintenance: - Regular maintenance of roads is carried out.
2. Exhaust of vehicle control: - Coal transport vehicle with valid PUC.

PART-I

Any other particulars for improving the quality of the environment.

1. Tree plantation- 2366 nos. bamboo gabion plantation have been carried out along coal transportation route, and public roads.
2. 150 nos. bamboo gabion plantation have been done in SLG railway siding.
3. Ambient air & water monitoring is carried out through CMPDIL.
4. Online PM10 analyzer has been installed for regular monitoring of air quality.
5. 02 nos. of Digital Water Level Recorder have been installed for monitoring the ground water level.
6. 01 no. truck mounted fog cannon has been procured for water sprinkling within mine premises

11-05-26

Area Manager (Env.)
Govindpur Area
Area Manager (Environment)
Govindpur Area, BCCL
क्षेत्रीय प्रबंधक (पर्यावरण)
गोविन्दपुर क्षेत्र बी.सी.सी.एल

FORM – 4

[See rules 5(6) and 22(2)]

FORM FOR FILING ANNUAL RETURNS BY THE OCCUPIER OR OPERATOR OF A FACILITY

[To be submitted by occupier/operator of disposal facility to State Pollution Control Board/Pollution Control Committee by 30th June of every year for the preceding period April'24 to March'25]

1.	**Name and address of the generator/operator of facility**	:	M/s Cluster-III Mine with Railay Siding, RLS(SILO) , BCCL PO: Sonardih, Dist: Dhanbad, 828125
2.	**Name of the authorized person and full address with telephone number and fax**	:	Shri V. Vijay Kumar Office of the General Manager, Govindpur Area(III), BCCL PO: Sonardih, Dist: Dhanbad, 828125
3.	**Description of hazardous waste**	:	**Physical form with description**: Burnt Oil (Liquid); **Chemical Formula**: HFD4-68
4.	**Consented quantity of product/others**	:	Coal: 3.6 MTPA
5.	**Manufactured quantity of product/others**	:	Coal: **1.20** MTe
6.	**Quantity of hazardous wastes (~~in KL~~)** → **Note: If the space is not sufficient enclose annexure**	:	**Type of hazardous waste as per Authorization** / **Quantity (in KL)** → **Generated** (a) Burnt Oil — 11.5
7.	**Description of Storage**	:	Stored in properly covered plastic drums
8.	**Description of Treatment**	:	1. E-auction to certified recyclers. 2. Reused as lubricant oil. Quantity of Reused burnt oil is 2 KL
9.	**Details of transportation**	:	**Name & address of consignee** / **Mode of packing** / **Mode of transportation** / **Transportation: Date** / **Quantity** NA
10.	**Details of disposal of hazardous waste**	:	**Name & address of consignee** / **Mode of packing** / **Mode of transportation** / **Transportation: Date** / **Quantity** 1. E-auction to certified recyclers. 2. Reused as lubricant oil. Quantity of Reused burnt oil is 2 KL
11.	**Quantity of useful materials sent back to the manufacturers* and others#**	:	**Name and type of material sent back to manufacturers* and others#** : NA; **Quantity in Tones/KL:** NIL

*delete whichever is not applicable #enclose list of other agencies

Note: The Quantity shall be match with Form-5, Environmental Audit.

Date:

Place:

Signature: 11-05-26

Designation: Area Manager (Env)
Govindpur Area

Area Manager (Environment)
Govindpur Area, BCCL
क्षेत्रीय प्रबंधक (पर्यावरण)
गोविन्दपुर क्षेत्र बी.सी.सी.एल

STATUS OF CGWA NOC

भारत सरकार
जल शक्ति मंत्रालय
जल संसाधन, नदी विकास
और गंगा संरक्षण विभाग
केन्द्रीय भूमि जल प्राधिकरण
Government of India
Ministry of Jal Shakti
Department of Water Resources,
River Development & Ganga Rejuvenation
Central Ground Water Authority

(भूजल निकासी हेतु अनापत्ति प्रमाण पत्र)
NO OBJECTION CERTIFICATE (NOC) FOR GROUND WATER ABSTRACTION

Project Name:	Cluster Iii Mines Of Bccl		
Project Address:	Office Of General Manager, Govindpur Area, M/s Bccl, Po- Sonardih		
Village:	Sonardih	Block:	Baghmara
District:	Dhanbad	State:	Jharkhand
Pin Code:			
Communication Address:	Office Of The General Manager, Govindpur Area.iii Bccl, Po. Sonardih, Baghmara, Dhanbad, Jharkhand - 828125		
Address of CGWB Regional Office :	Central Ground Water Board Mid Eastern Region, 6th & 7th Floor, Lok Nayak Jai Prakash Bhawan, Frazer Road Dak Banglow, Patna, Bihar - 800011		

1.	**NOC No.:**	CGWA/NOC/MIN/REN/1/2025/10882	2.	**Date of Issuence**	21/02/2025
3.	Application No.:	21-4/277/JH/MIN/2018	4.	Category: (GWRE 2024)	Semi Critical
5.	Project Status:	Existing With Additional Ground Water Requirment	6.	NOC Type:	Renewal
7.	**Valid from:**	03/12/2023	8.	**Valid up to:**	02/12/2025

9. Ground Water Abstraction Permitted:

Fresh Water		Saline Water		Dewatering		Total	
m³/day	m³/year	m³/day	m³/year	m³/day	m³/year	m³/day	m³/year
1800.00	657000.00			15677.00	5722105.00	17477.00	6379105.00

10. Details of ground water abstraction /Dewatering structures

	Total Existing No						Total Proposed No					
	DW	DCB	BW	TW	MP	MPu	DW	DCB	BW	TW	MP	MPu
Abstraction Structure*	0	0	0	0	1	7	0	0	0	0	0	0
Dewatering Structure*	0	0	7	0	0	0	0	0	0	0	0	0

*DW- Dug Well; DCB-Dug-cum-Bore Well; BW-Bore Well; TW-Tube Well; MP-Mine Pit;MPu-Mine Pumps

11.	Ground Water Abstraction/Restoration Charges paid (Rs.):	72688350.00
12.	Environment Compensation (if applicable) paid (Rs.):	0.00

13.	Number of Piezometers(Observation wells) to be constructed/ monitored & Monitoring mechanism.	No. of Piezometers	Monitoring Mechanism		
			Manual	DWLR**	DWLR With Telemetry
	**DWLR - Digital Water Level Recorder	2	0	1	1

CENTRAL GROUND WATER AUTHORITY

CENTRAL GROUND WATER AUTHORITY

18/11, जामनगर हाउस, मानसिंह रोड, नई दिल्ली - 110011 / 18/11, Jamnagar House, Mansingh Road, New Delhi-110011
Phone: (011) 23383561 Fax: 23382051, 23386743
Website: cgwa-noc.gov.in

(Compliance Conditions given overleaf)

This is an auto generated document & need not to be signed.

CENTRAL GROUND WATER AUTHORITY

18/11, जामनगर हाउस, मानसिंह रोड, नई दिल्ली - 110011 / 18/11, Jamnagar House, Mansingh Road, New Delhi-110011
Phone: (011) 23383561 Fax: 23382051, 23386743
Website: cgwa-noc.gov.in

Validity of this NOC shall be subject to compliance of the following conditions:

Mandatory conditions:

1) Installation of tamper proof digital water flow meter with telemetry on all the abstraction structure(s) shall be mandatory for all users seeking No Objection Certificate and intimation regarding their installation shall be communicated to the CGWA within 30 days of grant of No Objection Certificate.

2) Proponents shall mandatorily get water flow meter calibrated from an authorized agency once in a year.

3) Construction of purpose-built observation wells (piezometers) for ground water level monitoring shall be mandatory as per Section 14 of Guidelines. Water level data shall be made available to CGWA through web portal. Detailed guidelines for construction of piezometers are given in Annexure-II of the guidelines.

4) Proponents shall monitor quality of ground water from the abstraction structure(s) once in a year. Water samples from bore wells/ tube wells / dug wells shall be collected during April/May every year and analysed in NABL accredited laboratories for basic parameters (cations and anions), heavy metals, pesticides/ organic compounds etc. Water quality data shall be made available to CGWA through the web portal.

5) In case of mining projects, additional key wells shall be established in consultation with the Regional Director, CGWB for ground water level monitoring four (4) times a year (January, May, August and November) in core as well as buffer zones of the mine.

6) In case of mining project the firm shall submit water quality report of mine discharge/ seepage from Govt. approved/ NABL accredited lab.

7) The firm shall report compliance of the NOC conditions online in the website (www.cgwa-noc.gov.in) within one year from the date of issue of this NOC.

8) Industries abstracting ground water in excess of 100 m 3 /d shall undertake annual water audit through certified auditors and submit audit reports within three months of completion of the same to CGWA. All such industries shall be required to reduce their ground water use by at least 20% over the next three years through appropriate means.

9) Application for renewal can be submitted online from 90 days before the expiry of NOC. Ground water withdrawal, if any, after expiry of NOC shall be illegal & liable for legal action as per provisions of Environment (Protection) Act, 1986.

10) This NOC is subject to prevailing Central/State Government rules/laws/norms or Court orders related to construction of tube well/ground water abstraction structure / recharge or conservation structure/discharge of effluents or any such matter as applicable.

General conditions:

11) No additional ground water abstraction and/or de-watering structures shall be constructed for this purpose without prior approval of the Central Ground Water Authority (CGWA).

12) The proponent shall seek prior permission from CGWA for any increase in quantum of groundwater abstraction (more than that permitted in NOC for specific period).

13) Proponents shall install roof top rain water harvesting in the premise as per the existing building bye laws in the premise.

14) The project proponent shall take all necessary measures to prevent contamination of ground water in the premises failing which the firm shall be responsible for any consequences arising thereupon.

15) In case of industries that are likely to contaminate the ground water, no recharge measures shall be taken up by the firm inside the plant premises. The runoff generated from the rooftop shall be stored and put to beneficial use by the firm.

16) Wherever feasible, requirement of water for greenbelt (horticulture) shall be met from recycled / treated waste water.

17) Wherever the NOC is for abstraction of saline water and the existing wells (s) is /are yielding fresh water, the same shall be sealed and new tubewell(s) tapping saline water zone shall be constructed within 3 months of the issuance of NOC. The firm shall also ensure safe disposal of saline residue, if any.

18) Unexpected variations in inflow of ground water into the mine pit, if any, shall be reported to the concerned Regional Director, Central Ground Water Board.

19) In case of violation of any NOC conditions, the applicant shall be liable to pay the penalties as per Section 16 of Guidelines.

20) This NOC does not absolve the proponents of their obligation / requirement to obtain other statutory and administrative clearances from appropriate authorities.

21) The issue of this NOC does not imply that other statutory / administrative clearances shall be granted to the project by the concerned authorities. Such authorities would consider the project on merits and take decisions independently of the NOC.

22) In case of change of ownership, new owner of the industry will have to apply for incorporation of necessary changes in the No Objection Certificate with documentary proof within 60 days of taking over possession of the premises.

23) This NOC is being issued without any prejudice to the directions of the Hon'ble NGT/court orders in cases related to ground water or any other related matters.

24) Proponents, who have installed/constructed artificial recharge structures in compliance of the NOC granted to them previously and have availed rebate of upto 50% (fifty percent) in the ground water abstraction charges/ground water restoration charges, shall continue to regularly maintain artificial recharge structures.

25) Industries which are likely to cause ground water pollution e.g. Tanning, Slaughter Houses, Dye, Chemical/ Petrochemical, Coal washeries, pharmaceutical, other hazardous units etc. (as per CPCB list) need to undertake necessary well head protection measures to ensure prevention of ground water pollution as per Annexure III of the guidelines.

26) In case of new infrastructure projects having ground water abstraction of more than 20 m3/day, the firm/entity shall ensure implementation of dual water supply system in the projects.

27) In case of infrastructure projects, paved/parking area must be covered with interlocking/perforated tiles or other suitable measures to ensure groundwater infiltration/harvesting.

28) In case of coal and other base metal mining projects, the project proponent shall use the advance dewatering technology (by construction of series of dewatering abstraction structures) to avoid contamination of surface water.

29) The NOC issued is conditional subject to the conditions mentioned in the Public notice dated 27.01.2021 failing which penalty/EC/cancellation of NOC shall be imposed as the case may be.
30) This NOC is issued subject to the clearance of Expert Appraisal Committee (EAC) (if applicable).
31) In the self-compliance report, the PP shall submit details of Drilling Agency/ Agencies, which has/ have constructed BW(s)/ TW(s) along with undertaking to the effect that all necessary measures have been taken as per directions of Hon'ble Supreme Court provided in Annexure-VII of guidelines dated 24.09.2020 in respect of abandoned/ failed BW(s)/ TW(s)/Piezometer(s), if any. The PP is advised to engage registered drilling agency/ agencies. In the event of any mishap/ unfortunate incident due to negligence in taking measures for prevention of accident due to falling in Bore Well, both PP and concerned drilling agency shall jointly be held responsible and penal action as per extant Government rules shall be taken.

(Non-compliance of the conditions mentioned above is likely to result in the cancellation of NOC and legal action against the proponent.)

CENTRAL GROUND WATER AUTHORITY

CENTRAL GROUND WATER AUTHORITY

Department of Water Resources, River Development and Ganga Rejuvenation
Ministry of Jal Shakti, Govt. of India

Receipt

(As per the guideline Gazette Notification S.O. 3281(E) regarding the New Guidelines dated 24.09.2020 of CGWA, MoJS, Govt. of India)
https://cgwa-noc.gov.in

Application No,:	21-4/277/JH/MIN/2018	Date of Issuence:21/02/2025
Name of Firm:	CLUSTER III MINES OF BCCL	
AppType Category:	*Coal*	
Application Type:	*Mining*	
PAN/GSTIN No. of Firm/Individual:	/	

SN	Description	Amount (Rs.)
1.	Application Processing Fee	5000.00
2.	Ground Water Abstraction charges	72688350.00
3.	Ground Water Restoration charges	0
4.	Environmental Compensation Charges (ECRGW) *(Date From to) Days-*	
5.	Penalty for non-Compliance of NOC conditions *Condition to be mentioned*	
6.	Adjustment Charges	
7.	Rebate	
8.	Charges for correction/modification in the existing issued No Objection Certificate	

S.No.	Description	Rate
(i)	Change in User ID	Rs. 1000
(ii)	Change in firm Name	Rs. 5000
(iii)	Extension of No Objection Certificate	Rs. 5000
(iv)	Issuance of duplicate No Objection Certificate	Rs. 5000
(v)	Issuance of corrigendum to No Objection Certificate	Rs. 5000
(vi)	Any other items/correction etc.	Rs. 500

Rs. Rupees Seven Crore Twenty Six Lakh Ninty Three Thousand Three Hundred Fifty Only	**72693350.00**

This is an system generated invoice, hence, does not require ink signed.

CENTRAL GROUND WATER AUTHORITY

18/11, जामनगर हाउस, मानसिंह रोड, नई दिल्ली - 110011 / 18/11, Jamnagar House, Mansingh Road, New Delhi-110011
Phone: (011) 23383561 Fax: 23382051, 23386743
Website: cgwa-noc.gov.in

पानी बचाये – जीवन बचाये
SAVE WATER - SAVE LIFE

Term and conditions:

i. All disputes are subject to Delhi Jurisdiction.
ii. Any complaint in regard to the rates will not be entertained.

Member-Secretary
CGWA, New Delhi

CENTRAL GROUND WATER AUTHORITY

Kind Attention: Any document shared via mail will not be accepted for application processing. Kindly upload all the documents required or enquired by CGWA sl

Application for Issue of NOC to Abstract Ground Water

Government of India

Ministry of Jal Shakti

Department of Water Resources, River Development and Ganga Rejuvenation

Central Ground Water Authority (CGWA)

Application Number : MIN/JH/2025/13898/R-2

APPLICATION BASIC DETAILS		
PREVIOUS NOC NUMBER: **CGWA/NOC/MIN/REN/1/2025/10882**	PREVIOUS NOC VALID FROM: **03/12/2023**	PREVIOUS NOC VALID TO: **02/12/2025**
APPLICATION TYPE: **Mining**	APPLICATION SUB TYPE: **Open Cast cum Underground Mine**	PROJECT TYPE: **Coal**
WATER QUALITY TYPE: **Fresh Water**	WHETHER INDUSTRY IS MSME: **No**	Renewal Applied For: **INCREASE IN QUANTUM**
CommercialUse: ✓ Drinking Domestic Use: ✓ Dewatering: ✓		

© 2026 , Design & Developed by NIC National Informatics Centre

	PREVIOUS NOC QUANTUM (A)	CHANGE IN QUANTUM (B)	FINAL QUANTUM APPLIED [C = A-B]
KLD	17477.00	605.00	18082.00
KLY	6379105.00	220825.00	6599930.00

PROJECT DETAILS		
PROJECT NAME: **CLUSTER III MINES OF BCCL**	STATE: **JHARKHAND**	DISTRICT: **DHANBAD**
ASSESSMENT UNIT(BLOCK/TEHSIL): **BAGHMARA (Status - SEMI CRITICAL) (Status: Semi Critical)**	ADDRESS: **OFFICE OF GENERAL MANAGER, GOVINDPUR AREA, M/S BCCL PO- SONARDIH**	PINCODE: **828125**
LATITUDE: **23.780000**	LONGITUDE: **86.240000**	Geology: **NON-ALLUVIUM (HARD ROCK)**
WATER REQUIRED FOR GREEN BELT: **Yes**	GREEN BELT AREA(SQ METER): **3628600.00**	PROJECTS FALL WITH IN 500M IN THE PERIPHERY OF WETLAND AREAS: **No**

COMPANY DETAILS		
COMPANY NAME: **Cluster-III Mines of BCCL**	COMPANY PHONE NUMBER: **7903791208**	COMPANY GST NO.:
COMPANY PAN CARD NO.: **AHGPS4547P**	COMPANY EMAIL: **envgovindpur.bccl@gmail.com**	COMPANY POSTAL ADDRESS: **Office of the General Manager, Govindpur Area BCCL**
COMPANY STATE: **JHARKHAND**	COMPANY DISTRICT: **DHANBAD**	COMPANY PIN CODE: **828125**

© 2026 , Design & Developed by NIC एनआईसी National Informatics Centre

DRINKING DOMESTIC USE

NBC RESIDENTIAL APPLICATION DETAIL

TYPE OF UNITS	TYPE OF ACCOMMODATION	UNIT POPULATION	NO. OF UNITS	TOTAL POPULATION	FRESH WATER: PERMISSIBLE LIMIT	TREATED WATER: PERMISSIBLE LIMIT	FRESH DEMAND (LPHD)	TREATED DEMAND (LPHD)	TOTAL FRESH WATER REQUIREMENT (KLD)	TOTAL TREATED WATER AVAILABLE (KLD)
N.A.	1 BHK	4	2863	11452.00	100	45	100.00	0.00	1145.20	0.00
LIG	2 BHK	5	1058	5290.00	100	45	100.00	0.00	529.00	0.00
MIG	3 BHK	6	17	102.00	100	45	100.00	0.00	10.20	0.00
HIG	4 BHK & above	7	1	7.00	100	45	100.00	0.00	0.70	0.00

© 2026 , Design & Developed by NIC एनआईसी National Informatics Centre

BREAKUP OF WATER REQUIREMENT, AVAILABILITY AND USAGE

#	ACTIVITY	NO. OF OPERATIONAL Days in a Year	EXSITING QUANTUM (m^3 /DAY)	EXSITING QUANTUM (m^3 /YEAR)	CHANGE IN QUANTUM	PROPOSED QUANTUM (m^3 /DAY)	PROPOSED QUANTUM (m^3 /YEAR)	TOTAL QUANTUI (m^3 /DAY)
			Total Water Requirement (A1)					
1	Drinking And Domestic Use	365	8160.00	2978400.00	Decrease	6474.90	2363338.50	1685.10
			Gainful Utilization of Mine Dewater (A2)					
2	Water Supply to Villages	0	0.00	0.00		0.00	0.00	0.00
3	Irrigation use	0	0.00	0.00		0.00	0.00	0.00
4	Green Belt Development	365	175.00	63875.00	Increase	2495.00	910675.00	2670.00
5	Suppression of Dust	365	200.00	73000.00		0.00	0.00	200.00
6	Recharge/ Water Conservation	365	150.00	54750.00		0.00	0.00	150.00
7	Others	365	1030.00	375950.00	Decrease	479.00	174835.00	551.00
8	Remaining Water Left	365	7762.00	2833130.00	Increase	5063.90	1848323.50	12825.90
	TOTAL (USAGE)		**17477.00**	**6379105.00**	**14512.80**	**5297172.00**	**18082.00**	**6599930**

© 2026 , Design & Developed by NIC National Informatics Centre

BREAKUP OF WATER REQUIREMENT, AVAILABILITY AND USAGE

Water Availability from other Sources other than Ground Water (B)

1	Surface Water Availability	0	0.00	0.00		0.00	0.00	0.00
2	Water Supply from Other Agencies	0	0.00	0.00		0.00	0.00	0.00
3	Recycled Water Generated / Used	0	0.00	0.00		0.00	0.00	0.00
	TOTAL (AVAILABILITY)		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Net Ground Water Requirement (C)

1	Ground Water Required through Abstraction Structure	0	1800.00	657000.00	Decrease	114.90	41938.50	1685.10
2	Rainfall Component of Dewatering	0	4314.00	1574610.00	Decrease	639.00	233235.00	3675.00
3	Ground Water Seepage	0	11363.00	4147495.00	Increase	1358.90	495998.50	12721.90

© 2026 , Design & Developed by NIC National Informatics Centre

BREAKUP OF WATER REQUIREMENT, AVAILABILITY AND USAGE

	TOTAL (GROUND WATER REQUIREMENT)		**17477.00**	**6379105.00**	**2112.80**	**771172.00**	**18082.00**	**6599930**

GROUNDWATER STRUCTURE EXISTING

S.No.	TYPE OF STRUCTURE	YEAR OF CONSTRUCTION	DEPTH (METER)	WHETHER FITTED WITH WATER METER
1	Borewell	2023	50.00	YES
2	Borewell	2023	120.00	YES
3	Borewell	2023	120.00	YES
4	Borewell	2023	150.00	YES
5	Borewell	2023	150.00	YES
6	Borewell	2023	150.00	YES
7	Borewell	2023	50.00	YES
8	Pump/Mine Pump	2023	150.00	YES
9	Pump/Mine Pump	2023	150.00	YES
10	Pump/Mine Pump	2023	150.00	YES
11	Pump/Mine Pump	2023	150.00	YES

© 2026 , Design & Developed by NIC एनआईसी National Informatics Centre

GROUNDWATER STRUCTURE EXISTING				
13	Pump/Mine Pump	2023	150.00	YES
14	Pump/Mine Pump	2023	150.00	YES
15	Pump/Mine Pump	2023	150.00	YES

GROUNDWATER STRUCTURE PROPOSED

S.No.	TYPE OF STRUCTURE	No. OF STRUCTURE COUNT
1	Pump/Mine Pump	2

DEWATERING DETAILS

WHETHER THE GROUNDWATER TABLE WILL BE INTERSECTING MINE DEPTH:	**YES**	DEPTH TO WATER LEVEL(M BGL):	**13.00**
DEPTH UPTO WHICH MINING IS PROPOSED (M BGL):	**300.00**	PROVIDE DETAILS OF GAINFUL UTILIZATION MENTIONED IN OTHERS (ITEM NO 7 OF A2 IN BREAKUP OF WATER REQUIREMENT):	**Discharged to natural drainage to maintain the e-flow**

NO OF MINE PITS EXISTING:	1	NO OF MINE PITS PROPOSED:	0	TOTAL AREA OF PITS (SQ METER):	9660700.00

© 2026 , Design & Developed by NIC एनआईसी National Informatics Centre

ATTACHMENTS

NAME	Remark	File
Latest Mine Plan with approved increase in quantum		PDF
Approved Mine Plan as per approving authority		PDF
Any other document	additional key well details are enclosed herewith as it could not be uploaded on the main page.	PDF
Comprehensive Hydrogeological report and Modelling by Accredited Consultant		PDF
Copy of Rain Water Harvesting Plan		PDF
Notarised affidavit as proof for justifying the increase of quantum of GW abstraction		PDF

PAYMENT DETAILS

Total Charges(Rs)	2,85,02,178.00

Ground Water Charges

S.NO.	DETAILS OF CHARGES	AMO

© 2026 , Design & Developed by NIC National Informatics Centre

S.NO.	DETAILS OF CHARGES									AMO
S.No.	Details of Charges									Am (Rs)
A	Application Processing Fee									500
B	Late Penalty									0.00
C	Non Compliance Penalty									0.00
D	Environmental Compensation Charges									0.00
D(a)	Environmental Compensation Charges on Excess Withdrawal								0.00	
D(b)	Environmental Compensation Charges on Withdrawal with Expired NOC								0.00	
E	Arrears on Excess Withdrawal									0.00
F	Ground Water Abstraction Charges									284
	Start Date	End Date	Category of Assessment Unit (GWRE Year)	Rates (Rs. per m3)	Quantum (m3/day)	Period in days (Period in years)	Quantum (m3/year)	Charges (Rs)		
	2025-12-03	2025-12-31	Semi Critical (2024)	4.00	18082.00	29 (0.07945)	6599930.00	209457.75		
	2026-01-01	2026-12-31	Semi Critical (2024)	4.00	18082.00	365 (1.00000)	6599930.00	26399720.00		
										285

© 2026 , Design & Developed by NIC एनआईसी National Informatics Centre

Two Crore Eighty Five Lakh Two Thousand One Hundred Seventy Eight Rupees Only.

Rs. 2,85,02,178.00 /-

Final Amount to be Paid

PAYMENT HEAD	TOTAL AMOUNT (RS A)	ADJUST AMOUNT (RS B)	REF INVOICE NO	BALANCE AMOUNT (RS C= A-B)	FINAL AMOUNT (RS C OR 0)
Application Fee/Renewal Fee/ Revival Fee	**5000.00**	0.00	0	0.00	5000.00
Ground Water Abstraction Charges	**28497178.00**	0.00	0	28497178.00	28497178.00

* Any excess amount paid will be adjusted in next billing cycle

Consolidated Guidelines to regulate and control ground water extraction in India (24-Sep-2020 with Amendment Notification dated 29.03.2023)

Application Submission

Prev

Note: If you want to submit the request for revision of the charges, please submit the application by using Application submission button

© 2026 , Design & Developed by NIC एनआईसी National Informatics Centre

JHARKHAND STATE POLLUTION CONTROL BOARD

TOWNSHIP ADMINISTRATION BUILDING, HEC COMPLEX, DHURWA, RANCHI 834004
Telephone: 0651-2400850 (Fax)/ 2400851/2400852/2401847/2400979/2400139

Ref No.: JSPCB/HO/RNC/CTE-22087555/2025/365 Dated : 2025-06-05

Consent to Establish (CTE) under section 25 /26 of the Water (Prevention & Control of Pollution) Act, 1974 and under section 21 of the Air (Prevention & Control of Pollution) Act, 1981

1. Reference: Application (s) No.- 22087555 / dated : 14/05/2025 of Cluster-III Mine with Railway siding, RLS (SILO), Bharat Coking Coal Limited, Ganesh Chandra Saha for consent under section 25 /26 of the Water (Prevention & Control of Pollution) Act, 1974 and under section 21 of the Air (Prevention & Control of Pollution) Act, 1981

2. Documents Relied Upon:

(i) The content of Environmental Clearance (EC), vide File No.- J-11015/213/2010-IA.II(M), dated 03.03.2025 issued by MoEF and CC, New Delhi.

(ii) The content of opinion Sri Kaushik Chanda, Additional solicitor General for India on the issue of Renewal of Mining Lease which had been in the control of Coal India subsidiaries by virtue of the Coal Mines Nationalization Acts, 1972/1973.

(iii) The content of letter of PESO vide dated 02.08.2023.

(iv) The content of Inspection Report (IR), vide ref. no. 359, dated 29.03.2025 issued by Regional Officer, Regional Office, JSPCB, Dhanbad.

3. The consent is granted under section 25 / 26 of the Water (Prevention & Control of Pollution) Act, 1974 and under section 21 of the Air (Prevention & Control of Pollution) Act, 1981 to establish the project in Mauza- Jogidih akashkinaree, P S -, District-DHANBAD as follows:

Project	Site-Area		Investment (Rs)/ Year	Product & Capacity	Period of CTE
	Plot Nos.	Area			
Before Expansion	As per EC	As per EC	249.11 Crore [capital investment of cluster-III mine with railway siding]	Coal- 3.6 MTPA	As per EC

(A) Specific Conditions:

1. That, the occupier shall submit sustainability report of the stack to which ovens would be linked for stack emission point of view at regular intervals.

2. That, the occupier shall inform to Regional Office, Dhanbad and Head Office, JSPC Board, at Ranchi within 24 hrs from the time of closure or opening of the plant.

3. That, the occupier shall carry out transportation in covered vehicle with tarpaulin.

4. That, the occupier shall obtain raw material from valid sources.

5. That, the occupier shall ensure water used for scrubbing must be re-circulated and reused after proper settling and treatment and in no case it shall be discharged out of premises.

6. That, the occupier shall submit documents related to the size of ovens and installed capacity of the plant prepared by CIMFR or institution recognized by Govt. of India / State Govt. or their public undertakings at new site when the proposed unit will be established at the time of Consent to operate; the production capacity of ovens assessed shall be considered final and Consent to operate (CTO) shall be issued for the same assessed capacity; and is mandatory.

7. That, the occupier shall store the surface runoff in concrete settling tank with proper lining of adequate capacity and in no case shall allow the percolation to underground; submit the photographic view of structure of Rain water harvesting plan with settling tanks, failing which consent order shall be revoked.

8. That, the occupier shall make Work area and transport roads and approach road off the main road concrete/ black top.

9. That, the occupier shall obtain raw material only from valid source and shall maintain record of it and shall show the record to the Inspecting Officer during inspection.

10. That, the occupier shall install fixed type water sprinklers to cover all dusty places in the premises to impart water spraying intermittently and during loading, unloading of raw materials/products and wastes.

11. That, the occupier shall submit compliance of this CTO conditions every year before 120 days of the expiry date of this CTO alongwith the recent analysis reports successively.

12. That, the occupier shall operate and maintain the Air Pollution Control Devices (i.e. Double Tunnel System) and bag filters.

13. That, the occupier shall submit applications for renewal of consent under section 25 / 26 of the Water (Prevention & Control of Pollution) Act, 1974 and under section 21 of the Air (Prevention & Control of Pollution) Act, 1981 again 120 days rior to the date of expiry of this consent with documents showing compliance of all of the above conditions.

(B) General Conditions :

(1) That, the occupier shall construct pucca (i) minimum ten feet high boundary wall and (ii) approach road and internal roads and shall keep the premises neat and clean and tidy.

(2) That, the occupier shall install comprehensive enclosure (s) to cover the places of unloading of raw materials, the equipments of their processing & transferring, the places of loading of products, by products and wastes for prevention of fugitive emission and shall install such automatic inbuilt system(s) that in house dust/ gases collect(s) and undergo (es) cleaning and clean air goes out.

(3) That, the occupier shall install such automatic inbuilt system(s) that process flue gas(es) / process gas(es) and undergo(es) cleaning and clean air go(es) out through the chimney(s), having height(s) as per Central Pollution Control Board norm.

(4) That, the occupier shall have D G Set(s) of the standard as laid in the Environment (protection) Rules, 1986 and shall install it (them) within acoustic enclosure (s) and shall keep the height(s) of exhaust pipe(s) as per Central Pollution Control Board norm .

(5) That, the occupier shall impart treatment as per Central Pollution Control Board text to wastewater and shall keep process effluent in close-circuit and effluent from other sources in conformity with the standard (s).

(6) That, the occupier shall install Central Ground Water Board/ State Ground Water Directorate approved system of rain water harvesting-cum-ground water recharge.

(7) That, the occupier shall create new water body (ies) / remove deposit(s) of existing water body(ies) and nearby stream(s) and pond(s) and shall maintain the wholesomeness of water.

(8) That, the occupier shall grow greenery in the periphery and other available spaces and shall continue enhancing its plant density and biodiversity.

(9) That, this CTE is valid subjected to the validity of mining Lease / Mining Plan / Ecofriendly / Environmental Clearance, if applicable. In case of no renewal of Mining Lease/Mining Plan, this consent shall be treated as revoked automatically.

(10) That, this CTE is issued from the environmental angle only and does not absolve the occupier from other statutory obligations prescribed under any other law or any other instrument in force. The sole and complete responsibility to comply with these conditions laid down in all other laws for the time being in force, rests with the industry/ unit/ occupier.

(11) That, this CTE shall not in any way, adversely affect or jeopardize the legal proceeding , if any, instituted in the past or that could be , instituted against you by the State Board for violation of the provisions of the Act or the Rules made there under.

(12) That, the occupier shall comply with all applicable provisions of the Water (Prevention & Control of Pollution) Act, 1974; the Water (Prevention & Control of Pollution) Cess Act, 1977; the Air (Prevention & Control of Pollution) Act, 1981; and the Environment (Protection) Act, 1986 and Rules there under.

4. That, this CTE shall not absolve the occupier from making compliance of other statutory prescribed under any law or direction of courts or any other instrument for the time being in force.

5. **That, this CTE is being issued on the basis of information/ documents/ certificate submitted by the unit. This CTE will be revoked if any of the information/ documents/ certificates/ undertaking given by the occupier is found false/fictitious/forged in future.**

6. **This order shall be valid subject to compliance of all other legal requirements applicable to the unit.**

7. **The State Board reserves the right to revoke, withdraw or make any reasonable variation / change / alteration in condition of this consent.**

This is issued with the approval of the competent authority

Rajeev Lochan Bakshi
Digitally signed by Rajeev Lochan Bakshi
Date: 2025.06.05 09:35:01 +05'30'

[R. L. Bakshi]
Member Secretary

Memo No. : JSPCB/HO/RNC/CTE-22087555/2025/365

Dated : 2025-06-05

Copy to : Cluster-III Mine with Railway siding, RLS (SILO), Bharat Coking Coal Limited, Address:: Office of the GM, Govindpur Area, Dhanbad/Director of Industry, Government of Jharkhand, Ranchi/ Deputy Commissioner, Dhanbad/ Director of Mines, Government of Jharkhand, Ranchi/ Chief Inspector of Factories, Ranchi/ DFO, Dhanbad/ R O, JSPCB, Dhanbad/ DMO, Dhanbad for information & ensuring compliance of the above.

Rajeev Lochan Bakshi
Digitally signed by Rajeev Lochan Bakshi
Date: 2025.06.05 09:35:36 +05'30'

[R. L. Bakshi]
Member Secretary

JHARKHAND STATE POLLUTION CONTROL BOARD

TOWNSHIP ADMINISTRATION BUILDING, HEC COMPLEX, DHURWA, RANCHI 834004
Telephone: 0651-2400850 (Fax)/ 2400851/2400852/2401847/2400979/2400139

Ref No. JSPCB/HO/RNC/CTO-21538155/2025/1708 Dated : 2025-06-24

Consent to operate (CTO) under section 25 /26 of the Water (Prevention & Control of Pollution) Act, 1974 and under section 21 of the Air (Prevention & Control of Pollution) Act, 1981

1. Application (s) dated 2025-05-13 of Cluster-III Mine with Railway siding, RLS (SILO), Occupier Name :Sri GC Saha for consent under section 25 (1)(b)/25 (1) (c)/26 of the Water (Prevention & Control of Pollution) Act, 1974 and under section 21(1) of the Air (Prevention & Control of Pollution) Act,1981..

2. Documents Relied Upon:

(a) The content of Copy of Environmental Clearance issued vide J-11015/67/2013/2010-IA.II (M) dated 06.02.2013 for Cluster III (7 mines of a peak production of 3.6 MTPA in a combined ML area of 1420.61 ha) of M/s Bharat Coking Coal Ltd., located in Jharia Coalfields, Dist. Dhanbad, Jharkhand (EC based on TOR granted on 04.11.2010) -Environment Clearance.

(b) The content of Consent to Establish (CTE), vide ref. no. JSPCB/HO/RNC/CTE-22087555/2025/365, dated 05.06.2025 for the Coal- 3.6 MTPA.

(c) The content of copy of Consent to Operate (CTO) issued vide Ref No. JSPCB/HO/RNC/CTO-13958408/2022/1632, Dated 23.11.2022 valid for 30.06.2025 for Coal- Peak production of 3.6 MTPA, Unloading, Loading and Dispatch of Coal through Railway Siding - 3.6 MTPA (As per cluster III E.C) with Rapid Loading System (SILO)- 5 MTPA.

(d) The content of inspection report (I/R) vide Ref. No. 359, dated 29.03.2025 of R.O. Dhanbad, JSPCB, Dhanbad.

(e) The content of copy of the opinion of Sri Kaushik Chanda, Additional Solicitor General for India on the issue of Renewal of Mining Leases which has been in the control of Coal India subsidiaries by virtue of the Coal Mines Nationalization Acts 1972/1973.

(f) The content of Self-Deceleration for no expansion in Cluster- III leasehold area and no modernization in the Cluster- III group of mines.

(g) The content of copy of the HWM Authorization granted by the Board vide ref. no. JSPCB/HO/RNC/HWM-10502533/2021/45 dated 20.09.2021 valid till 31.12.2025.

3. The consent is granted under section 25 / 26 of the Water (Prevention & Control of Pollution) Act, 1974 and under section 21 of the Air (Prevention & Control of Pollution) Act, 1981 to operate the project in Mauza -Bhatmurna,Katras, etc , P S -Sonardih , District -DHANBAD , as follows:

Project	Site-Area		Investment (Rs)	Product & Capacity	Period of CTO
	Plot Nos.	Area			Date of issue To

Before Expansion	As per EC	As per EC	475.69 Crores	Coal- Peak production of 3.6 MTPA, Unloading, Loading and Dispatch of Coal through Railway Siding - 3.6 MTPA (As per cluster III E.C) with Rapid Loading System (SILO)- 5 MTPA	30/06/2030

(A) Specific Conditions:

1. That, the occupier shall do Over Burden management properly as per the prescribed guidelines.

2. That, the occupier shall reclaim mined out areas with OB and shall plant trees on them.

3. That, the occupier shall operate & maintain ETP with workshop of heavy vehicles.

4. That, the occupier shall not exceed the production as mentioned in CTO.

5. That, the occupier shall inform to Regional Office-Cum- Lab, Dhanbad and Head Office, JSPC Board, at Ranchi within 24 hrs from the time of closure or opening of the plant.

6. That, the occupier shall if be found violating the Consent to Operate at any point of time during inspection of the plant by the competent authority, the Consent to Operate shall be revoked as per provision of the acts.

7. That, the occupier shall operate crushers at CHP with high efficiency bag filters, water sprinkling system to check fugitive emission.

8. That, the occupier shall if be found violating the Consent to Operate at any point of time during inspection of the plant by the competent authority, the Consent to Operate shall be revoked as per provision of the acts.

9. That, occupier shall maintain proper housekeeping within the premises.

10. That, the occupier shall construct catch drain, siltation pond retaining wall of appropriate size to arrest silt & sediment flows from soil, OB dump and mineral dump.

11. That, the occupier shall carry out transportation of coal in wet conditions i.e. wet transportation must be carried out and submit the photographs to the Board.

12. That, he (they) shall in no case discharge runoff water or waste water of premises outside the railway siding.

13. That, the occupier shall allow transportation of materials either in lumps or in fines only through covered and
leak proof dumpers/trucks within the railway siding area.

14. That, the occupier shall allow transport of materials through the railway siding of such mines/plants which have valid consent to operate order of the State Pollution Control Board and also keep a record thereof and shall make available to the officer (s) concerned during his (their) visits of the site.

15. That, the occupier shall construct permanent boundary/wind breaking wall of at least 20 ft. height all along the railway siding.

16. That, the occupier shall develop three tier plantation all along the boundary wall with de-silting pit within three months and submit the report to the Board.

17. That, the occupier shall install fixed type water sprinklers/foggers on all roads and sidings to control fugitive emission within four months from the issuance of CTO and submit the report to the Board.

18. That, the occupier shall ensure that vehicle used for transportation must be covered with tarpulin sheets.

19. That, the occupier shall operate and maintain the PM 10 analyzer and also ensure data transmission to JSPCB server uninterruptedly.

20. The occupier shall operate and maintain the CAAQMS and ensure data transmission to CPCB and JSPCB server.

21. That, the occupier shall submit compliance of EC and this CTO conditions on six monthly basis alongwith the analysis reports to the Board and other concerned organizations.

22. That, the occupier shall submit application for renewal of consent under section 25/26 of the Water (prevention & Control of Pollution) Act, 1974 and under section 21 of the Air (prevention & Control of Pollution) Act, 1981 again 120 days prior to the date of expiry of this consent with documents showing compliance of all of the above conditions.

23. That, the occupier shall comply with all the conditions prescribed for siding vide JSPCB letter memo no B-387 dated. 11.04.2019 and the conditions prescribed by concerned authorities for railway siding.

24. That, the occupier shall submit application for renewal of consent under section 25/26 of the Water (prevention & Control of Pollution) Act, 1974 and under section 21 of the Air (prevention & Control of Pollution) Act, 1981 again 120 days prior to the date of expiry of this consent with documents showing compliance of all of the above conditions.

25. That, this CTO supersedes the CTO granted vide ref. no. JSPCB/HO/RNC/CTO-13958408/2022/1632, dated 23.11.2022.

(B) General Conditions :

(1) That, the occupier shall maintain the **National Ambient Air Quality Standard** given below:

S N	Pollutant	Time Weighted Average	Concentration in Ambient Air	
			Industrial, Residential, Rural and Other Area	Ecologically Sensitive Area (notified by Central Govt.)
(1)	(2)	(3)	(4)	(5)
1.	Sulphur Dioxide (SO2), µg/m3	Annual 24 hours	50 80	20 80
2.	Nitrogen Dioxide (NO2), µg/m3	Annual 24 hours	40 80	30 80
3.	Particulate Matter (size less than 10 µm) or PM10, µg/m3	Annual 24 hours	60 100	60 100
4.	Particulate Matter (size less than 2.5 µm) or PM2.5, µg/m3	Annual 24 hours	40 60	40 60
5.	Ozone(O3), µg/m3	8 hours 1 hour	100 180	100 180
6.	Lead (Pb) µg/m3	Annual 24 hours	0.50 1.0	0.50 1.0
7.	Carbon Monoxide (CO) mg/m3	8 hours 1 hour	02 04	02 04
8.	Ammonia (NH3) µg/m3	Annual 24 hours	100 400	100 400
9.	Benzene (C6H6) µg/m3	Annual	05	05
10.	Benzo(a) Pyrene(BaP) Particulate Phase only ng/m3	Annual	01	01
11.	Arsenic (As) ng/m3	Annual	06	06
12.	Nickel (Ni) ng/m3	Annual	20	20

Note : Serial no. 1 to 4 – Mandatory
Serial no. 5 to 12 As applicable for specific type of industry.

(2) That, the occupier shall maintain the emission quality within the standard and the quantity, as follows:

S N	Parameter	Standard
1	Particulate Matter	150 mg/Nm3

(3) That, the occupier shall keep process effluent in close-circuit and the quality of effluent from other sources in conformity with the standard (s) and the discharge quantity as below:

S N	Parameter	Standard
1	Total Suspended Solids	100 mg/L
2	BOD	30 mg/L
3	COD	250 mg/L
4	Oil & Grease	10 mg/L

(4) That, the occupier shall dispose of solid wastes as follows:

S N	Waste Type	Mode of Disposal
1	Hazardous Carbonaceous Wastes	In co-processing in high temperature furnaces or kilns
2	Hazardous Non-Carbonaceous Wastes	In TSDF
3	Non-Carbonaceous Non-Hazardous solid wastes/ Mine Over Burden	As a substitute of Soil or Mineral

(5) That, the occupier shall keep D G Set(s) within acoustic enclosure and shall keep the height(s) of exhaust pipe(s) as per Central Pollution Control Board norm.

(6) That, the occupier shall install and maintain Central Ground Water Board/ State Ground Water Directorate approved system of rain water harvesting-cum-ground water recharge and submit the photographic view of the structures within a month.

(7) That, the occupier shall grow and maintain greenery of the project in the periphery and other available spaces and shall continue enhancing its plant density and biodiversity.

(8) That, the occupier shall submit environmental statement with supporting stoichiometric calculations analyses reports, every year latest by 30th September of the next financial year.

(9) That, the occupier shall submit report(s) duly monitored and issued by an NABL accredited / ISO 9001:2008 and OHSAS 18001:2007 certified laboratory in compliance sub-para (2), (3), (4) and (5) of paragraph 3 of this CTO yearly at required periodicity.

(10) That, this CTO is valid subjected to the validity of mining Lease/Mining Plan/Ecofriendly/Environmental Clearance, if applicable. In case of no renewal of Mining Lease/Mining Plan, this consent shall be treated as revoked automatically.

(11) That, this CTO is issued from the environmental angle only and does not absolve the occupier from other statutory obligations prescribed under any other law or any other instrument in force. The sole and complete responsibility to comply with these conditions laid down in all other laws for the time-being in force, rests with the industry/ unit/ occupier.

(12) That, this CTO shall not in any way, adversely affect or jeopardize the legal proceeding , if any, instituted in the past or that could be , instituted against you by the State Board for violation of the provisions of the Act or the Rules made there under.

(13) That, the occupier shall comply with all applicable provisions of the Water (Prevention & Control of Pollution) Act, 1974; the Water (Prevention & Control of Pollution) Cess Act, 1977; the Air (Prevention & Control of Pollution) Act, 1981; and the Environment (Protection) Act, 1986 and Rules made there under.

4. That, this CTO shall not absolve the occupier from making compliance of other statutory prescribed under any law or direction of courts or any other instrument for the time being in force.

5. That, this CTO is being issued on the basis of information/ documents/ certificate submitted by the unit. This CTO will be revoked if any of the information/documents/certificates/undertaking given by the occupier is found false/fictitious/forged in future.

6. The Order shall be valid subject to compliance of all other legal requirements applicable to the unit.

7. The State Board reserve the right to revoke, withdraw or make any reasonable variation / change / alteration in conditions of this consent.

This is issued with the approval of the Competent authority

Rajeev Lochan Bakshi
Digitally signed by Rajeev Lochan Bakshi
Date: 2025.06.24 08:36:13 +05'30'

[R. L. Bakshi]
Member Secretary

Memo No. : JSPCB/HO/RNC/CTO-21538155/2025/1708

Dated : 2025-06-24

Copy to: M/S Cluster-III Mines with Railway siding, RLS (SILO), At- BCCL, Koyla Bhawan, Koyla Nagar Dhanbad 826005/Director of Industry, Government of Jharkhand, Ranchi/ Deputy Commissioner, Dhanbad/ Chief Inspector of Factories, Government of Jharkhand, Ranchi/ D.F.O., Dhanbad/ Regional Officer, J.S.P.C.B., Dhanbad for information & necessary action.

Rajeev Lochan Bakshi
Digitally signed by Rajeev Lochan Bakshi
Date: 2025.06.24 08:36:39 +05'30'

[R. L. Bakshi]
Member Secretary

CAAQMS PHOTOS

CAAQMS-1 at CISF Camp, NAKC

CAAQMS-2 at Jogidih Colliery

CAAQMS-3 at Regional Store, Maheshpur

CAAQMS-4 at Kharkharee (Buffer zone)