भारत कोकिंग कोल लिमिटेड
(एक मिनिरत्न कम्पनी)
(कोल इन्डिया लिमिटेड का एक अंग)
महाप्रबन्धक का कार्यालय
कुसुन्डा क्षेत्र, पो: कुसुन्डा, धनबाद, झारखन्ड

Ref No. BCCL/KA-6/Env./2019/

Date: 30-11-2019

To,
The Director(s)
Ministry of Environment, Forest and Climate Change (MoEFCC),
(Govt. of India)
Regional Office (ECZ),
Bungalow No. A-2,
Shyamali Colony,
Ranchi - 834002

Sub : Six monthly compliance report on Environmental Clearance Conditions for the period from Oct '2018 to March '2019 in respect of Cluster-VI Group of mines, EC order no.: EC order no.: J-11015/183/2011-1A.II (M), dated 26-08-2013

Dear Sir,

Enclosed please find herewith six monthly compliance report on environmental clearance conditions for the period from Oct '2018 to March '2019 in respect of Cluster-VI Group of mines, EC order no.: J-11015/183/2011-1A.II (M), dated 26-08-2013 for your kind perusal.

With regards,

General Manager
Kusunda Area, BCCL

COMPLIANCE OF EC CONDITIONS of CLUSTER-VI

EC order no.: J-11015/183/2011-1A.II (M), dated 26-08-2013

(March '19 to Sept'19)

Sl. no.	A. Specific Conditions by MOEF:	Compliance
i	**The maximum production from the two opencast section in the cluster shall not exceed beyond that for which environmental clearance has been granted.**	The approved peak production capacity for whole cluster consisting of East Bassuriya Colliery, Bassuriya Colliery, Gondudih Khas Kusunda Colliery and Godhur Colliery, 7.631 MTPA. Total production from the cluster for the year 2018-19 is 0.662 MTPA **which is well within the limit.** The colliery wise production is attached in annexure A1
ii	**The two nallahs passing through the mines should be preserved and made functional to drain the water.**	Complied. In every year, before monsoon the nallahs are made clear of any obstacles to ensure proper drainage of water.
iii	**The coal transport to the siding will continue by road to the siding within 2 km with pay loader loading into Rly. Wagons for a period of 5 years by which time the proposed silo in Rly. Siding not being affected in the Jharia Action Plan will be constructed for RLS loading into railway wagons.**	In order to install silo for RLS the study can be carried out only after liquidation of coal mine fire, rehabilitation of 595 unstable sites road alignment and relocation of railway siding of BCCL and final report of RITES in regard with realignment of railway lines. The consultant document in this regard is attached in annexure B
iv	**As subsidence is on higher side in Godhur colliery, special attention should be given for control and monitoring of subsidence.**	For control and monitoring of threat of subsidence at fire affected area within Godhur lease hold special attention has been made by mine management. JRDA has completed survey the basties at fire affected area for evacuation & rehabilitation of the inhabitants under Jharia Master Plan and partially distributed Identity Cards, but evacuation of non-BCCL persons have not yet been done by JRDA. Colliery Management have allotted quarters at other safe place to employees residing at/near fire affected area for their early evacuation and accordingly shifting of employees is going on at the allotted quarters at newly constructed colonies at East Bassuriya and Jagjivan Nagar. Besides, Safety Committee team is there at the Colliery for inspection/supervision of Godhur for early detection of any pot hole, fume and report to mine management for early action. Pot holes detected near Muchi Basti have been filled up by

		incombustible materials (sand & quarry OB). Fiery coal is being dugged out by OC method to control fire as well as environmental pollution.
v	**All old dumps will be filled back in mine voids. At the end of mining there should not be any OBD and should be only one void which shall not exceed 30 m deep.**	It shall be complied. Action is being taken as specified in EMP.
vi	**An increase in the CSR**	BCCL is taking up activities from the HQ level and through its administrative areas for the implementation of CSR activities. For this purpose A CSR cell is functioning which is headed by General Manger (CSR) under the direct control of Director (Personnel) of the company. A details of CSR and welfare activities at Kusunda Area is enclosed Annexure-A 3.
vii	**Dhanbad Action Plan, as CEPI, be implanted where ever is applicable.**	Dhanbad Action Plan has been prepared in consultation with Jharkhand State Pollution Control Board for entire BCCL and not cluster wise. It is being implemented comprehensively for all the mines of BCCL including mines of Kusunda Area. Some of the salient actions of this cluster are enclosed as Annexure-F.
viii	**Since the cluster is situated close to Dhanbad, thick green belt and residential areas should be done along the periphery of ML area. Avenue-plantation should be done along the roads which are used for coal transport and measures to arrest coal dust while transporting by covering the trucks and water sprinkling measures etc.**	It is being complied. Plantation at de-coaled OB dump area is already being executed for development of green belts as per EC. Adequate water sprinkling is being done at coal transportation road regularly by mobile water sprinklers, and coal transportation is being done by covering trucks by tarpaulin as measures to control dust pollution. At degraded OB dumps at Gondudih eco-restoration work are in successful progress. Details of plantation done and programme of eco-restoration are enclosed as Annexure-B.
ix	**Whereas laudable efforts have been made in drawing skill development programmes along with Planning Commission of GoI , all out efforts should be made to ensure that they are suitably employed either with the PP or elsewhere.**	Training programmes for all employees are conducted regularly at mine Vocational Training Centre as per Mine VT Rule and also through NSDC (National Skill Development Corporation), and special training are being conducted at mine VT Centre, at HRD Dept. of BCCL HQ and outside of Company for development of their skill. The required details are given in Annexure-G.

x	**The measure to identify in the Environmental Plan for Cluster- VI groups of mine and the conditions given in this environmental clearance letter shall be dovetailed to the implementation of the Jharia Action Plan.**	Master Plan activities are dovetailed with compliance of environmental clearance conditions. The master plan deals with fire control and rehabilitation activities of fire affected areas in the leasehold of BCCL. By implementing complete digging out of fiery seams with water spraying in force as fire control measures air pollution and emission of Green House Gases (GHGs) from the fire affected areas are being prevented. Further rehabilitation of the families from the fire endangered area to the safe places is being taken-up with the help of State Govt. of Jharkhand. The Master plan is being implemented for BCCL as per the prioritization of fire and rehabilitation activities in approved Master Plan. The brief status of Rehabilitation and Fire control measures are enclosed **(Annexure-E)**
xi	**The proponent shall prepare time -series maps of the Jharia Coalfields through NRSA to monitor and prevent fire problems in the Jharia Coalfields by Isothermal mapping /imaging and monitoring temperatures of the coal seams (whether they are close to spontaneous ignition temperatures) and based on which, areas with potential fire problems shall be identified. Measures to prevent ingress of air (Ventilation) in such areas, to prevent restart fresh/spread fires in other areas including in mines of cluster VI shall be undertaken. Expertise available internationally could also be utilized for control of fire in Jharia Coalfields and for their reclamation and to further minimize time for fire and subsidence control. Isothermal mapping using thermal imaging has been got done by NRSA. Measures would be taken to prevent ingress of air (ventilation) in such areas, which may re-start fresh fires**	NRSC had conducted survey of fires of Jharia coalfield by remote sensing methods using thermal infra-red data and land subsidence mapping of Jharia coalfield using Inter-ferometic SAR data. Total fire affected area in Jharia Coalfield has been reduced. The latest report as submitted by NRSC in this regard is attached below. For control and monitoring of threat of subsidence at fire affected area within Godhur lease hold special attention has been made by mine management. JRDA has nearly completed survey the basties at fire affected area for evacuation & rehabilitation of the inhabitants under Jharia Master Plan and partially distributed Identity Cards, but evacuation of non-BCCL persons have not yet been done by JRDA. Colliery Management have allotted quarters at other safe place to employees residing at/near fire affected area for their early evacuation and accordingly shifting of employees is going on at the allotted quarters at newly constructed colonies at East Bassuriya and Jagjivan Nagar and Karmik Nagar. Besides, one special team headed by senior mine official has been made at Colliery for

		inspection/supervision of the lease hold area of Godhur for early detection of any pot hole, fume and report to mine management for early action. Under Jharia Master Plan, fire patch of V/VI/VII/VIII seam at Gareria Section of East Bassuriya, Kusunda Area about 1,70,000 m^3 have been filled by mitti/incombustible OB, rest void will be filled up by quarry OB of East Bassuriya OC.
xii	**Underground mining should be taken up after completion of reclamation of Opencast mine area.**	It shall be complied.
xiii	**The OB material should be crushed like sand and be used for stowing in underground mines.**	At present no underground mining work is going on in the mines of Kusunda Area.
xiv	**A detailed calendar plan of production with plan for OB dumping and backfilling (for OC mines) and reclamation and final mine closure plan for each mine of cluster-VI shall be drawn up and implemented. The schedule of backfilling should be clearly brought out and submit the same to MoEF.**	Calendar plan has been prepared and enclosed as annexure –A 1, 2. Mine closure plan as per the guidelines of Ministry of Coal has been prepared by Regional Institute –II, Central Mine planning and Design Institute (CMPDI), Dhanbad. The financial provisions required for the implementation of mine closure plan are being kept in accounts, and accordingly action are being taken.
xv	**The embankment constructed along the river boundary shall be of suitable dimensions and critical patches shall be strengthened by stone pitching on the river front side and stabilized with plantation so as to withstand the peak water flow and prevent mine inundation**	It is being followed. Embankments have been constructed and maintained as specified in EC **(Figure 1).**
xvi	**No mining shall be undertaken where underground fires continue. Measure shall be taken to prevent/check such fire including in old OB dump areas where the fire could start due to presence of coal/shale with sufficient carbon content.**	It is being complied. Action is being taken to control, mine fires as specified in Jharia Master Plan and the mining is being done as per the guidelines and permissions of Directorate General of Mines Safety (DGMS).
xvii	**There shall be no internal OB dumps. There will be 8 external OB Dumps covering an area of 32.84 Ha. The height of the dumps shall be 16 m and the total quantity shall be of 5.247 Mm3. The final mine voids will have an area of 66.76 ha (Filled up with water). With depth of 25 m bgl. The entire mined out area shall be re-**	It is being complied. Action is being taken as specified in EMP. Backfilling of OB is going on concurrent with mining and at the end of mining activity the area will be re-vegetated and reclaimed as per EMP. Plantation work have already been done with the help of DFO, Dhanbad. At degraded OB dump areas eco-restoration work is in successful progress.

	vegetated. Areas where opencast mining was carried out and completed shall be reclaimed immediately thereafter. It was observed that most of the OB are reclaimed total area 441.24 ha at the end of mining where reclaimed external OB dump 32.84 ha and internal OB Dump 120.34 ha. Green Belt over an area of 66.12 ha. Density of tree plantation 2500 trees/ ha of plants which of and abandoned. The proponent should dump all the OB material in abandoned mines.	**(Annexure-C)**
xviii	**Mining shall be carried out as per statuette from the streams/nalas flowing within the lease and maintaining a safe distance from the nalas flowing along the lease boundary. A safety barrier of a minimum 60m width shall be maintained along the nalas/water bodies. The small water bodies in OC shall be protected to the extent feasible and the embankment proposed along water body shall be strengthened with stone pitching.**	It is being followed. Embankments have been constructed as specified in EC
xix	**Active OB dumps near water bodies and rivers should be rehandled for backfilling abandoned mine voids. However, those which have been biologically reclaimed need not be disturbed.**	No OB is being dumped near any water bodies.
xx	**Thick green belt shall be developed along undisturbed areas, mine boundary and in mine reclamation.**	It is being complied. Yearly plantation is being done. For plantation / eco-restoration programme is enclosed in Annexure-C.
xxi	**Specific mitigative measures identified for the Jharia Coalfields in the Environmental Action Plan prepared for Dhanbad as a critically polluted area and relevant for Cluster VI shall be implemented.**	Dhanbad Action Plan has been prepared in consultation with Jharkhand Pollution Control Board for entire BCCL and not cluster wise. It is being implemented comprehensively for all the mines of BCCL. Some of the salient actions of this cluster are enclosed in Annexure-F.
xxii	**The locations of monitoring stations in the Jharia Coalfields should be finalized in consultation with the Jharkhand State Pollution Control Board.**	The locations of monitoring stations has been finalized in consultation with JSPCB and the Environmental monitoring of mines/units of BCCL as per the requirement of environmental Acts, Laws, Environmental Clearance conditions, etc . The work is now being carried out by CMPDI.

xxiii	**The Committee stated that smoke/dust emission vary from source to source (fuel wood, coal ,fly ash from TPPs, silica from natural dust, etc) and a Source Apportionment Study should be got carried out for the entire Jharia Coalfields. Mineralogical composition study should be undertaken on the composition of the suspended particulate matter (PM10 and PM2.5) in Jharia Coalfields and also quantified. These studies would help ascertain source and extent of the air pollution, based on which appropriate mitigative measures could be taken.**	Work for source apportionment study has already been started and the summer data has been collected. The progress report of the same is attached below.
xxiv	**The Plan for conveyor-cum—rail for Cluster-VI should be dovetailed with Jharia Action Plan. The Committee desired that road transportation of coal during Phase—I should be by mechanically covered trucks, which should be introduced at the earliest. Coal dispatch shall be diverted from the present rail sidings to Rapid Loading System (RLS) soon after the construction and commissioning of the RLS at Maheshpur is completed. The railway siding order issued and same would come in 3 years. The details of same should be provided to ministry. The mode of transportation of coal by truck till Railway Siding should be by mechanically covered trucks.**	CMPDIL, RI-II has been requested to conduct study and prepare the plan in this regard and the status is attached in annexure B. By that time transportation is being done by covering vehicle with tarpaulin cover.
xxv	**1387 no. of PAF's should be rehabilitated at cost of Rs 10,768.17 Lakhs as per the approved Jharia Action Plan.**	It is being complied.
xvi	**Regular monitoring of subsidence movement on the surface over and around the working area and 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 movement, appropriate effective corrective measures shall be taken to avoid loss of life and material. Cracks shall be effectively plugged with ballast and clayey soil/suitable material.**	No underground mining work is going on at present in this Area. For control and monitoring of threat of subsidence at fire affected area within Godhur lease hold special attention has been made by mine management. JRDA has completed survey the basties at fire affected area for evacuation & rehabilitation of the inhabitants under Jharia Master Plan and partially distributed Identity Cards, but evacuation of non-BCCL persons have not yet been done by JRDA. Colliery Management have allotted quarters at other safe place to employees residing

		at/near fire affected area for their early evacuation and accordingly shifting of employees is going on at the allotted quarters at newly constructed colonies at East Bassuriya and Jagjivan Nagar. Besides, one special team headed by senior mine official has been made at Colliery for inspection/supervision of the lease hold area of Godhur for early detection of any pot hole, fume and report to mine management for early action.
xxvii	**Sufficient coal pillars shall be left un extracted around the air shaft (within the subsidence influence area) to protect from any damage from subsidence, if any.**	It shall be complied. Action is being taken as specified in EMP.
xxviii	**High root density tree species shall be selected and planted over areas likely to be affected by subsidence.**	It will be complied, if required certificate for high root density plant is attached below by FRI, Dehradun in Annexure H
xxix	**Depression due to subsidence resulting in water accumulating within the low lying areas shall be filled up or drained out by cutting drains.**	It will be complied, if required
xxx	**Solid barriers shall be left below the roads falling within the blocks to avoid any damage to the roads.**	It has been complied and maintained
xxxi	**No depillaring operation shall be carried out below the township/colony.**	It will be complied,
xxxii	**A detailed CSR Action Plan shall be prepared for Cluster VI croup of mines. As stated by the Proponent, it is formulating a detailed Corporate Social Responsibility (CSR) Action Plan through Tata Institute of Social Sciences (TISS), Mumbai which will consist of need-based base-lit e survey, CSR Action Plan, CSR Auditing and monitoring mechanism etc. Director (Per.), BCCL. along with a team visited TISS/ National CSR Hub, Mumbai on 18th Jun, 2012 for finalizing the MoU with TISS and National CSR Hub for conducting base-line survey, empanelment of NGOs and formulating the project specific CSR action plan for BCCL. The Action Plan for Corporate Social Responsibility will include 5% of the retained earnings of the previous year subject o minimum of Rs. 5 per tonne of coal**	CSR activities have been taken up on priority basis. The details of activities is enclosed in Annexure-A3.

	production of the previous year will be provided for Corporate Social Responsibility (CSR), an amount of Rs. 381.55 lakhs/year has been year marked for the CSR activities.	
xxxiii	**The area within Cluster VI ML existing as waste land and not being acquired shall be put for productive use under CSR and developed with fruit bearing and other useful species for the local communities. A third party evaluation shall be carried out regularly for the proper implementation of activities undertaken in the project area under CSR. Issue raised in the Public Hearing shall also be integrated with activities being taken up under CSR. The details of CSR undertaken along with budgetary provisions for the village-wise various activities and expenditures there on shall be uploaded on the company website every year. The company must give priority to capacity building both within the company and to the local youth, who are motivated to carry out the work in future. The gap/space available between the entire mine area should he suitably planted with native species. Plantation should also be made in vacant area and along the road side so as to reduce dust pollution.**	CSR and other welfare activities have been taken up on priority basis. The details of activities are enclosed. Plantation at degraded area and office/colonies premises has been done for development of green belts as per EC. Eco-restoration work are in successful progress at degraded at OB dump areas. Details of plantation to be done and programme of eco-restoration are enclosed in **Annexure- C.**
xxxiv	**The mine water should be treated properly before supply to the villager**.	Mine water is treated by water filter plant before supply to villagers.
Xxxv	**Details of transportation, CSR, R&R. and implementation of environmental action plan for each of the clusters-VI should be brought out in a booklet form within a year and regularly updated.**	It is being complied.
xxxvi	**Central recreation park with herbal garden should be developed for use of all inhabitants.**	It shall be complied. The Eco-restoration park at GKKC has been developed and dedicated to citizens of the city.
xxxvii	**Mine discharge water shall be treated to meet standards prescribed standards before discharge into natural water courses/agriculture. The quality of the water discharged shall be monitored at the outlet**	Being complied. The work of monitoring of ambient air and water is being carried out by CMPDI.

	points and proper records maintained thereof and uploaded regularly on the company website.	
xxxviii	**No groundwater shall be used for the mining activities. Additional water required, if any shall be met from mine water or by recycling/reuse of the water from the existing activities and from rainwater harvesting measures. The project authorities shall meet water requirement of nearby village(s) in case the village wells go dry to dewatering of mine.**	No ground water is being utilized for the purpose of industrial use. Mine water has been channelized through pipelines and through delivery for its use for the community purposes after filtration. Drinking water is being purchased from the Mineral Area Development Authority (MADA). Further for the utilization of mine water following actions has been taken by the company **Rain water Harvesting:** to catch run-off water in colonies Rain water Harvesting is being done. BCCL has already developed rain water harvesting at Koylanagar Township In Kusunda Area, proposal for rain water harvesting at colonies is under process from Civil Deptt.
xxxix.	**The void shall be converted into a water reservoir of a maximum depth of 15-20 m and shall be gently sloped and the upper benches of the reservoir shall be stabilized with plantation and the periphery of the reservoir fenced. The abandoned pits and voids should be backfilled with OB and reclaimed with plantation and or may he used for pisciculture.**	It shall be complied.
xl	**Regular monitoring of groundwater level and quality of the study area shall be carried out by establishing a network of existing wells and construction of new piezometers. The monitoring for quantity shall be done four times a year in pre-monsoon(May), monsoon(August), post-monsoon(Novemer) and winter(January) seasons and for quality including Arsenic and Fluoride during the month of May. Data thus collected shall be submitted to the Ministry of Environment & Forest and to the Central Pollution Control Board/SPCB quarterly within one month of monitoring. Rainwater harvesting measures shall be undertaken in case monitoring of water table indicates a declining trend.**	Tender has been cancelled thrice. The estimate is being revised in association with CMPDI for re-tendering
xli	**ETP shall also be provided for workshop, and**	It shall be complied.

	CHP, if any. Effluents shall be treated to confirm to prescribe standards in case discharge into the natural water course.	
xlii	**For monitoring land use pattern and for post mining land use, a time series of land use maps, based on satellite imagery (on a scale of 1:5000) of the core zone and buffer zone, from the start of the project until end of mine life shall be prepared once in 3 years(for any one particular season which is consistent in the time series), and the report submitted to MOEF and its Regional office at Bhubaneswar.**	Presently a time series map of vegetation cover in the Jharia Coal Field is being carried out through CMPDI Ranchi using satellite imagery for every 3 years. CMPDI has started to prepare "Time series of land use maps based on satellite imagery of the core zone and buffer zone.
xliii	**A Final Mine Closure Plan along with details of Corpus Fund shall be submitted to the Ministry of Environment & Forests five year before mine closure for approval. Habitat Restoration Plan of the mine area shall be carried out using a mix of native species found in the original eco system which were conserved in-situ and ex-situ in an identified area within the lease for reintroduction in the mine during mine reclamation and at the post mining stage for habitat restoration, the mining plan and post-mining plan, closure plan should be prepared and submitted to the Ministry;**	CMPDI has prepared Mine Closure Plan for progressive mine closure activities which are being implemented at mines. Final Mine Closure Plan will be prepared in time. The study for Cluster VI is under process.
xliv	**A separate management structure for implementing environment policy and socio-economic issues and the capacity building required in this regard.**	A full-fledged Environment Department, headed by a HoD (Environment) along with a suitable qualified multidisciplinary team of executives has been established in Headquarters. They are also trained in ecological restoration, sustainable development, rainwater harvesting methods etc. At the Area level, one Executive in each area has also been nominated as Nodal Officer (Environment) under General Manager of Area and at Project level, concerned Safety Officer under Project Officer is looking after the environment related jobs and also entrusted with the responsibility of compliance and observance of the environmental Acts/ Laws including environment protection measures .The activities are monitored on regular basis at Area and at Head quarters levels. HoD (Environment) at head quarter level, co-ordinates with all the Areas and

		reports to the Director (Technical) and in turn he reports to the CMD of the company. The team is multidisciplinary and very much motivated under the guidance of company's CMD and Director (Technical) . Further capacity building at both corporate and operating level is being done.
Xlv	**Corporate Environment Responsibility.**	
(a.)	**The Company shall have a well laid down Environment Policy approved by the Board of Directors.**	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.
(b.)	**The Environment Policy shall prescribe for standard operating process/procedures to bring into focus any infringements/deviation/violation of the environmental or forest norms/conditions.**	Complied.
(c.)	**The hierarchical system or Administrative Order of the company to deal with environmental issues and for ensuring compliance with the environmental clearance conditions shall be furnished.**	A hierarchical system of the company to deal with environmental issues from corporate level to mine level already exists.
(d.)	**To have proper checks and balances, the company shall have a well laid down system of reporting of non-compliances/violations of environmental norms to the Board of Directors of the company and/or shareholders or stakeholders at large.**	Being complied.
B.	**<u>General Conditions</u>**	
i	**No change in mining technology and scope of working shall be made without 'prior approval of the Ministry of Environment and Forests.**	Being followed.
ii	**No change in the calendar plan of production for quantum of mineral coal shall be made.**	Being followed. Production of clusters are well within the production capacity as per EC.
iii	**Four ambient air quality monitoring stations shall be established in the core zone as well as**	Air quality monitoring stations and monitoring of ambient environment has been established after

	in the buffer zone for PM10, PM2.5, SO2 and NOx monitoring. Location of the stations shall be decided based on the meteorological data, topographical features and environmentally and ecologically sensitive targets in consultation with the State Pollution Control Board. Monitoring of heavy metals such as Hg, As, Ni, Cd, Cr, etc. carried out at least once in six months.	consultation with State Pollution Control Board. CMPDIL is presently doing the monitoring work .Results of monitoring is enclosed as Annexure-C.
iv	**Data on ambient air quality (PM10, PM 2.5, SO2 and NOX) and heavy metals such as Hg, As Ni, Cd, Cr and other monitoring data shall be regularly submitted to the Ministry including its Regional Office at Bhubaneswar and to the State Pollution Control Board and the Central Pollution Control Board once in six months. Random verification of samples through analysis from independent laboratories recognized under the EPA rules, 1986 shall be furnished as part of compliance report.**	It is being complied.
v	**Adequate measures shall be taken for control of noise levels below 85 dB(A) in the work environment. Workers engaged in blasting and drilling operations, operation of HEMM, etc shall be provided with ear plugs/muffs.**	Being complied
vi	**Industrial wastewater (workshop and waste water from the mine) shall be properly collected, treated so as to conform to the standards prescribed under GSR 422 (E) dated 19th May 1993 and 31st December1993 or as amended from time to time before discharge. Oil and grease trap shall be installed before discharge of workshop effluents.**	It shall be complied.
vii	**Vehicular emissions shall be kept under control and regularly monitored. Vehicles used for transporting the mineral shall be covered with tarpaulins and optimally loaded.**	It is being complied. As part of DAP condition, actions are being taken for its implementation.

viii	**Monitoring of environmental quality parameters shall be carried out through establishment of adequate number and type of pollution monitoring and analysis equipment in consultation with the State Pollution Control Board and data got analyzed through a laboratory recognized under EPA Rules, 1986.**	Air quality monitoring stations and monitoring of ambient environment has been established after consultation with State Pollution Control Board. The monitoring work is being carried out by CMPDIL.
ix	**Personnel working in dusty areas shall wear protective respiratory devices and they shall also be provided with adequate training and information on safety and health aspects.**	Being Complied. A separate full-fledged Human Resource Development Deptt. is conducting regular training programme on these issues. Apart from this Vocational Training Centers are existing in the Area which provides periodical training on the safety and occupational health issue to each of the workers working in the mines.
x	**Occupational health surveillance programme of the workers shall be undertaken periodically to observe any contractions due to exposure to dust and to take corrective measures, if needed an records maintained thereof. The quality of environment due to outsourcing and he health and safety issues of the outsourced manpower should be addressed by the company white outsourcing.**	Initial Medical Examination (IME) and Periodical Medical Examination (PME) of all the personnel of the Area is carried out at Bhuli PME Centre, Bhuli, Dhanbad as per the Statutes and guidelines of Director General of Mines Safety (DGMS). Data enclosed as Annexure-G
xi	**A separate environmental management cell with suitable qualified personnel shall be set up under the control of a Senior Executive, who will report directly to the Head of the company.**	A full-fledged Environment Department, headed by HoD (Environment) along with a suitable qualified multidisciplinary team of executives has been established in Headquarters. They are also trained in ecological restoration, sustainable development, rainwater harvesting methods etc. At the Area level, atleast one Executive in each area has also been nominated as Nodal Officer (Environment) under General Manager of Area and at Project level, concerned Safety Officer under Project Officer is looking after the environment related jobs and also entrusted with the responsibility of compliance and observance of the environmental Acts/ Laws including environment protection measures .The activities are monitored on regular basis at Area and at Headquarters levels. HoD (Environment) at head quarter level, co-ordinates with all the Areas and

		reports to the Director (Technical) and in turn he reports to the CMD of the company.
xii	**The funds earmarked for environmental protection measures shall be kept in separate account and shall not be diverted for other purpose. Year-wise expenditure shall be reported to this Ministry and its Regional Office at Bhubaneswar**	Being complied
xiii	**The Project authorities shall advertise at least in two local newspapers widely circulated around the project, one of which shall be in the vernacular language of the locality concerned within seven days of the clearance letter informing that the project has been accorded environmental clearance and a copy of the clearance letter is available with the State Pollution control Board and may also be seen at the website of the ministry of Environment & Forests at www.envfor.nic.in.**	It has been complied.
xiv	**A copy of the environmental clearance letter shall be marked to concern Panchayat /Zila Parishad, Municipal Corporation or Urban local body and local NGO, if any, from whom any suggestion/representation has been received while processing the proposal. A copy of the clearance letter shall also be displayed on company's website.**	Complied.
xv	**A copy of the environmental clearance letter shall also be displayed on the website of the concerned State Pollution Control Board.** **The EC letter shall also be displayed at the Regional Office, District Industry Sector and Collector's Office/Tehsildar's Office for 30 days.**	Complied.
xvi	**The clearance letter shall be uploaded on the company's website. The compliance status of the stipulated environmental clearance conditions shall also be uploaded by the project, authorities on their website and updated at least once every six months so as to bring the same in public domain. The monitoring data of environmental quality parameter (air, water, noise, and soil) and**	Complied.

	critical pollutant such as PM10, PM2.5, SO2 and NO„ (ambient) and critical sectoral parameters shall also be displayed at the entrance of the project premises and mine office and in corporate office and on company's website.	
xvii	**The project proponent shall submit six monthly compliance reports on status of compliance the stipulated environmental clearance conditions (both in hard copy and in e-mail) to view respective Regional Office of the Ministry, respective Zonal Office s of CPCB and the SPCB.**	Being complied in time.
xviii	**The Regional Office of this Ministry located at Bhubaneswar shall monitor compliance of the stipulated conditions. The Project authorities shall extend full cooperation to the office) s) of the Regional Office by furnishing the requisite data/ information/monitoring reports.**	Shall be complied.
xix	**The Environmental statement for each financial year ending 31 March in Form —V is mandated to be submitted by the project proponent for the concerned State Pollution Control Board as prescribed under the Environment (Protection) Rules, 1986, as amended subsequently, shall also be uploaded on the company's website along with the status of compliance of EC conditions and shall be sent to the respective Regional Offices of the MoEF by E-mail.**	Being complied.
6.	**The proponent shall abide by all the commitments and recommendations made in the EIA/EMP report so also during their presentation to the EAC.**	Agreed
7.	**The proponent is required to obtain all necessary clearances/approvals that may be required before the start of the project.**	Agreed
8.	**The Ministry or any other competent authority may stipulate any further condition for environmental protection.**	Agreed

	e to comply with any of the conditions ntioned above may result in the withdrawal of this clearance and attract the provisions of the Environment (Protection) Act, 1986.	Agreed
10.	The above conditions will 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 and the Public Liability insurance Act, along with their amendments and Rules. The proponent shall ensure to undertake and provide for the costs incurred for taking up remedial measures in case of soil contamination. Contamination of groundwater and surface water, and occupational and other diseases due to the minting operations.	It is being complied
11.	The Environmental Clearance is subject to the outcome of the Writ Petition filed b. M/S Bharat Coking Coal Limited (BCCL) in response to the closure orders issued by the Jharkhand State Pollution Control Board which is pending in the Jharkhand High Court.	Agreed

04/12/19
Project Officer
East Bassuriya Colliery

04/12/19
Project Officer
Bassuriya Colliery

04/12/19
Project Officer
Gondudih Khas Kusunda Colliery

4/12/19
Project Officer
Godhur Colliery

Annexure-A

1. **Coal Production of the Cluster mine wise is hereby mentioned**

Name of the mine	EC Limit (MTPA)	Actual Production (MTPA)
Godhur(NGKC)	2.6	0.523
East Bassuriya	1.95	0.139
GKKC	2.6	0
Bassuriya	0	0

2. **OB BACKFILLING PROGRAMME**

At Godhur OC- After progressive extraction of coal up to V/VI/VII/VIII combined seam back filling of OB is going on.

At GKKC- progressive back filling of OB is going on after progressive extraction of total coal of all seams.

At East Bassuriya Colliery- Back filling will be done in continuous succession of total coal extraction.

3. CSR and other welfare activities of BCCL

Bharat Coking Coal Limited (BCCL) is committed to good corporate citizenship and makes constant efforts to build and nurture long lasting relationships with members of the society in general and it's peripheral communities in particular.
BCCL is taking up activities from the HQ level and through its administrative areas for the implementation of CSR activities. For this purpose a CSR cell is functioning which is headed by General Manger(CSR) under the direct control of Director(Personnel) of the company.

The CSR activities presently being done by BCCL

- To meet the acute shortage of drinking water in peripheral villages' drinking Water is provided through deep borewells, tubewells, pumps/motors, in the peripheral villages of BCCL. Water supply through pipeline, through water tanker is provided also to the villages. Mine water is supplied after proper filtration in Filter Plants.
- **Education**: BCCL adopts a multi-pronged approach to promote quality education in backward areas. The measures taken by BCCL comprise Construction, Extension, and Renovation of school buildings etc are done to promote quality education in the nearby villages. BCCL is Extending financial aid for educational facilities to 83 nos. Private Committee Managed schools. Measures are taken to promote women literacy and carrier development.
- **Health Care**: BCCL Conducts medical/health camps for dwellers of peripheral villages for rendering free medical consultancy. CSR Clinics, wellness clinics, artificial limbs centers are organized for the benefit of the needy section of the society.. Mobile medical vans are deployed as special arrangement for medical services. AIDS awareness camps are organized as special drive to develop awareness and to render free consultancy. In Kusunda Area many medical /health camps in peripheral villages and in collieries and various awareness programmes have already been conducted, and is being conducted regularly by Area Medical Team.
- **Occupational health**: awareness programme are organized.
- **Other Welfare Activities**: this includes Construction / renovation of Community Halls, construction / repair of roads, construction of Health-sub centres, construction of drain, construction of Chhat Ghat in the ponds, Construction of Boundary wall, providing Choupal for community gatherings, etc.
- **Mashla Chakki centres :** Mashla Chakki centres has been established with machines to promote self employment.
- **Sports & Cultural**: Various activities are organized to propagate sports and cultures. Sports/games items and instruments are also provided with play ground.
- **Village adoption**: Lahbera – A SC/ST village nearby Dhansar Mine has been adopted for its all round development and a number of development activities have been carried out including school, health care and Ambulance facility, Mashla Chakki Centre, Community Centre, Play ground, etc.

IN KUSUNDA AREA :

A lot of CSR activities have been done in the peripheral villages in the field of medical and civil and welfare.

Health Campaigning at surrounding villages by MMV (Mobile Medical Van) :

Year	No. of MMV camps	Beneficiaries
2013-'14	298	11,171 patients
2014-'15	306	11,884 patients
2015-'16	380	11,013 patients

Village Health Camps-	No. of camps	Beneficiaries
2017-'18	109	2556

Special Health Camps in

2015-'16	5	354 patients
2016-'17	2	62 children
2017-'18	1	46 patients
2018-19	5	946 patients
2019-20	4	517 patients

CSR Clinic :

2015-'16	5842 patients
2016-'17	1387 patients
2017-18	1069 patients

Welness Clinic

2015-'16	6244 patients
2016-'17	3922 patients
2017-18	2194 patients

In 2013-'14 & 2014-'15 and 2015-16 following civil work have been completed under CSR Activity

- **Construction of compound wall for Lahbera School at Dhansar -- work completed**
- **Deeping of Pond at Lahbera Basti at Dhansar -- work completed**
- **Constr. of pcc road from Dom tola to Kali Mandir at Barki Bowa Village -- work completed**
- **Constr. of pcc road from near house of Vikash Rajak to main road at Satitand Village -- work completed**
- **Constr. of pcc road from Parduman Singh Chowk to near house of Sri Kishore Pandey at Ranguni Panchayat -- work completed**
- **Constr. of Yatri shed at Dutta Tola near Hanuman Mandir Ranguni Panchayat -- work completed of**
- **Constr. of boundary wall , Chabutra and a shed near Gram Dewata at Dhansar -- work completed**
- **Construction of PCC road in Lahbera Basti at Dhansar -- work completed**
- **Construction of 318 toilets in 179 schools in Chaibasa has been undertaken by Kusunda Area under the Pradhan Mantri Swatchh Vidyalaya Yojana . Construction of toilets in 25 boys' school, 15 girls' schools and 139 Co-education School have been undertaken. -- Out of 318, 236 toilets have been completed.**

Financial grants given to various privately managed schools is Rs 21,54,000.00 for the period of 1.04.2018 to 31.03.2019

Annexure-B

सेंट्रल माइन प्लानिंग एण्ड डिज़ाइन इंस्टीच्यूट लिमिटेड
(कोल इंडिया लिमिटेड की अनुषंगी कम्पनी / भारत सरकार की एक लोक उपक्रम)
पंजीकृत कार्यालय : गोन्दवाना प्लेस , कांके रोड , राँची - 834031 (झारखण्ड) भारत
क्षेत्रीय संस्थान-2, पत्रा. बीसीसीएल टाउनशीप, कोयला नगर, धनबाद 826005 (झारखण्ड) भारत
Central Mine Planning & Design Institute Limited
(A Subsidiary of Coal India Limited / Govt. of India Public Sector Undertaking)
Registered Office : Gondwana Place, Kanke Road, Ranchi –834031(Jharkhand)
Regional Institute-II, P.O. BCCL Township, Koylanagar, Dhanbad 826005(Jharkhand) India
Corporate Identity No. U14292JH1975GOI001223

cmpdi
A Mini Ratna Company

Coal India

पत्रांक: आर.आई.-2/पर्यावरण/एम-30/1967-69 दिनांक: 02.08.2016
03.

सेवा में,
विभागाध्यक्ष (पर्यावरण)
बी. सी. सी. एल.
कोयला भवन
धनबाद

633/M
03/08/16

विषय: Study of Installation of Rail-cum-Conveyor System in BCCL for transportation of coal.

संदर्भ: पत्र संख्या:
1. सी.एम.पी.डी.आई./पर्यावरण /2016/663, दिनंक: 14.07.2016,
2. BCCL/Dy.GM (Env)/F-EMP/16/1314-15 (M), Dated: 23.06.2016,
3. आर.आई.- 2/पर्यावरन / एम-30/1150, दिनांक : 20.06.2015.
4. E-17719

महोदय,

In reference to your letter no. BCCL/Dy.GM (Env)/F-EMP/16/1314-15 (M), Dated: 23.06.2016, to GM (Env), CMPDI-HQ, it has already been indicated in letter no.आर.आई.-2/पर्यावरन / एम-30/1150, दिनांक : 20.06.2015 that study for installation of Rail-cum-Conveyor System in BCCL for transportation of coal can be started only after the liquidation of coal mine fire, rehabilitation of 595 unstable sites, road realignment and relocation of railway sidings of BCCL and final report of RITES in regard to realignment of railway lines.

This is for your kind information.

भवदीय

(वि.कु. सिन्हा) 5/8/16
क्षेत्रीय निदेशक

Dr. Amalendu Asst Mgr (Env), for record.
4.8.16.

प्रतिलिपि:
1. महाप्रबंधक (पर्यावरण) सी.एम.पी.डी.आई (मुख्यालय), राँची
2. विभागाध्यक्ष (खनन), आर.आई- II, धनबाद

फोन : (+91) 0326-2230850 फैक्स / Fax : (+91) 0326-2230500
वेब साइट / Website : www.cmpdi.co.in
ईमेल / Email : ri2@cmpdi.co.in

Annexure-C

- **Plantation- At Gondudih- Khas Kusunda Colliery about 500 no. bamboo-gabion plantation have already been done.**
- **At 1st Ecological restoration site a total of about 6402 no. plants and plenty of grass-seeds in an area of 2.0 Ha have been planted successfully with encouraging results, and natural eco-system is being established there with increasing flora & fauna (Fig.2).**
- **At 2nd. eco-restoration site (about 1.79 Ha OB dump- area) about 2400 plants along with seeds of grass and shrubs have spread over since 2015-'16 successfully.**
- **And at 3rd. site, (about 3.0 Ha OB dump area) about 5322 plants and plenty of grass seeds have been planted**
- **A 4th site of area about 4.99 Ha has been taken up in the year 2018-19. Till March, 2019 a total of 12,482 saplings have been planted.**
- **At all four sites more 4465 plant has been planted and 5000 seed ball broadcasted till September and 983 plants have been planted in lease hold of mines under Kusunda Area.**

PLANTATION/ECOLOGICAL-RESTORATION PROGRAMME

Plantation/Ecological Restoration Programme (Cluster-VI & part of Cluster-VII mines of Kusunda Area) :

YEAR	CLUSTER VI & CLUSTER VII(Part under Kusunda Area)	No.of saplings/plants
2019-20	More Planation in Existing Eco Restoration	5000
2020-21	At various location being surveyed	5000
2021-22	At various location being surveyed	5000

Annexure-D

ENVIRONMENTAL MONITORING REPORT OF

CLUSTER – VI

(FOR THE Q.E. March, 2019)

Action taken :

(1) regular and sufficient water spraying by mobile tankers and through pipe lines is done at roads(haul roads, transportation roads, etc.), at all strategic dust generating points such as loading, un-loading,transfer points etc.

(2) covered coal transportation by trucks is already implemented

(3) plantation/eco-restoration at non-coal bearing/decoaled OB dump site is being done.

(4) making transportation road pucca and its regular maintenance

(5) use of dust extractors at drill m/c.

etc.

Note: Pollution inventory of different sources within the area apart from the coal mining is required to be carried out for actual assessment of pollution load by mining and other sources.

ANNEXURE--- E

STATUS OF JHARIA MASTER PLAN DOVETAILED WITH ENVIRONMENT CLEARANCE CONDITIONS

Rehabilitation and Fire control measures

Socio-economic Survey :

Survey of fire affected families (non-BCCL) at Kusunda Area has been nearly completed by JRDA and distribution of ID Card has been partially done by JRDA.

Accommodation provided in Satellite Township:

- Till about 1417 quarters out of 1688 total newly quarters constructed in colonies at East Bassuriya and at Jagjivan Nagar and Karmik Nagar have been allotted to the employees residing at coal bearing/fire affected areas in different collieries under Kusunda Area and out of which 767 employees have been shifted. More quarters are under construction for phase wise shifting of employees.
- In temporary rehabilitation site at decoaled zone of East Bassuriya about 28 PAF/encroachers have been shifted.
- Non-BCCL families will be shifted by JRDA. The survey work has been under process.

Status of fire dealing :

Under Master Plan, many Fire schemes have been formulated / prepared /implemented for dealing fires sites spread in collieries of BCCL. Further for expediting the fire dealing process, excavation methods has been resorted to by deploying Hired HEMM at various mines of BCCL. Total digging out of fiery coal has been adopted for dealing of fire.
In fire patch of V/VI/VII/VIII seam of Gareria Secn. at East Bassuriya, about 1,70,000 cu.m. mitti and non-combustible material has been filled, rest will be filled by quarry OB .

At Kusunda Colliery total firey coal are being dug out as a measure of fire dealing with the deployment of hired HEMM, and at Ena OC, after restart, total firey coal will be dug out . The underground workings of Alkusa Colliery has been sealed due to fire threats after taking measures to control UG fire as per CMR'57 DGMS guidelines. The coal reserve of Alkusa Colliery will be extracted from Kusunda OC side. For control and monitoring of threat of subsidence at fire affected area within Godhur lease hold special attention has been made by mine management.

Details of priority of sites for fire mitigation under Master Plan of Kusunda Area-VI

		Site No/Code	Site Name	Total no of encroachers/Non LTH	Total no of LTH	To be Extracted Upto Seam	Left Seam	Coal Locked To be Extracted Upto Seam	Urban/Rural	Colliery
Phase-I	1	2/176	Keska Basti Qtrs	0	3	Comb. Seam	IV Seam & Below	59 LMT	Urban	Kusunda
	2	2/215	4 pit Ghansadih Colliery Qtrs/20 & Ghansadih Kumartola Bhuiyan Bastee	425	0					Godhur(Jendu adih)
	3	1/153	West Ena 1 & 2 Pit/01	756	0	Extracted Upto Zero Seam	Nil	70 LMT		Industry
	4	1/133	No 2 Colony/04	289	0					Ena
	5	1/134	Officer Colony & B.UP Area/05		0					Ena
	6	2/163	Lahabera Bastee/03	59	0	Comb. Seam	IV Seam & Below	10 LMT		Industry
	7	2/165	KOCP Office and Colony qtrs.	61	0					Industry
	8	2/166	Bse Bhagatdih Colony/06	294	0					Industry
Total				1884	3			139 LMT		
Phase-II	1	1/150	No 1 Bastee/01	120	1	Extracted Upto Zero Seam	Nil	59 LMT	Urban	Basseriya
	2	1/154	Office Complex & companies Qtrs/10	84	0					Khas Kusunda
	3	2/167	B Panel Area/07	125	0					KKC
	4	2/168	Colony near KG Section School/11	4	0					KKC
	5	2/169	Company Qtr west of Bhuli Road/12	6	1					KKC
	6	2/172	Harijan Bastee/05	49	51					KKC
	7	2/173	Hospital Bastee/08	101	25					KKC
	8	2/174	Kharkabad Bastee/09	63	87					KKC
	9	2/175	Kusunda Station Village/06	66	4					KKC
	10	2/170	Dhana Joba Village/04	54	13			80 LMT		KKC
	11	2/171	Gondudih Bastee/03	35	26					KKC
	12	1/149	Gwala Patti/01	287	50					Basseriya
Total				994	258			139 LMT		
Phase-III	1	1/132	Colliery Qtrs/03	228	639	Upto Zero Seam	Nil	15 LMT	Urban	Ena
	2	1/135	Parsatand Bastee/02	199	71					Ena
	3	2/159	Gareria Bastee/01	185	78	Comb. Seam	IV Seam & Below	22 LMT		East basseriya
	4	1/151	Rpwani Bastee	134	7			30 LMT		Godhur
	5	2/160	3 Pit Area/03	111	0					Godhur
	6	2/161	Bekkar Bastee (Unsurveyed because of heavy resistance from bastee people. However head count was done by distric administration team as per DC dhanbad Order during review meeting)	130	650					Godhur
	7	1/155	Kusunda Village/01	80	3			20 LMT		Kusunda
	8	1/156	workshop Office and Qtrs (PK1 & 2 Pit Area)/04	187	0					Kusunda
	9	1/129	Officers qtrs near Thana/01	37	0			30 LMT		Alkusa
	10	1/121	DAV school & G camp/02	63	0					Alkusa
	11	1/122	Hutment Near Durga mandir/05	44	0			25 LMT		Alkusa
	12	2/124	GM bunglows & qtrs/04	122	0					Alkusa
	13	2/125	Qtrs near 6/7 Pit /03	272	0			10 LMT		Alkusa
	14	2/150	Bright Kusunda Colony/02	233	0			NIL		Dhansar
	15	2/158	New Delhi Colony/03	591	0	III seam & below	NIL	8 LMT		Dhansar
	16	2/157	East Godhur Colony/01	221	0	Zero Seam	NIL	NIL		Kusunda Area
Total				2859	1448			160 LMT		
Vacated	1	2/164	Huchuktand Bastee/02	0	0	Comb. Seam	IV Seam & Below		Urban	evacuation through dept. patch (Industry)
	2	1/152	Surender Colony(East Loyabad)	0	0	Excavated upto Zero Seam	NIL			Gondudih
	3	2/162	10 no Dhowra/08	0	0	Zero Seam	Nil			Excavation will be done through patch 4 (Gondudih)
Total				0	0					

DETAILS OF SHIFTING OF QUARTERS FROM COAL BEARING AREA TO NON-COAL BEARING AREA , AS ON 18/10/19

SL.NO	Quarters situated at	Tot.No.of Qtrs	Allotted	Shifted	Vacant	Remarks
1	Jagjiwan nagar	480	434	335	99	Block No.06 handed over to CHD No.22 (only four qtrs Const) & 23 not Constructed Tot.Block No.04 to 40 to Kusunda Area 08 Nos block allotted to Sijua Area Block No.33,34,35,36,39 fully unauthorised Block NO 37 Qtr No 01 to 08 authorised rest unauthorise Block No.38 Qtr No.06 authorised rest unauthorisd
2	East Basseriya Sector-01	72	68	39	29	04 Nos allotted to Sijua Area
3	East Basseriya,Sector -02	288	222	191	31	66 Nos allotted to Sijua Area
4	East Basseriya Sector-03	240	192	0	192	48 Nos allotted to Sijua Area
5	Karmik Nagar	620	548	255	293	Block No.49 & 50 allotted to Fire etfected Village people at Kurmidih Basti & Block 39 is used as Office & 12 No of Qtrs used by Civil Contractor as godown
6	Koyla Nagar "B"type	114	15	0	15	
7	Koyla Nagar "C"type	20	0	0	0	
8	Koyla Nagar "D" Type	4	0	0	0	

ANNEXURE-F

COMPLIANCE OF DHANBAD ACTION PLAN

(1) Covering of loaded transport vehicles

It has been complied. The clause of covering of loaded coal transport vehicle has also been incorporated in the transport agreement/ contract.

(2) Coal transport roads shall be made pucca

In 2015-16 about 80 m pucca road near Kusunda Office has been constructed.
In 2016-17:

- **Repair & maintenance of PCC Rd. from NH-32 to Kali Mandir for coal transportation at Godhur Colliery- - 200 mtr. Lenth completed**
- **Repair & maintenance of road by locking pre-cast cement concrete block from NH-32 to Sub-station at Godhur Colliery - - 60 mtr. Length – proposal in progress**
- **Repair & maintenance of 15 nos. road NH-32 to Godhur Weigh Bridge - - 120 mtr. Length – proposal in progress.**

(3) All drillings to be done with dust containment and suppression systems. Sprinklers will be installed including at all coal stock & sidings

DUST EXTRACTOR: Regarding drilling it has already been complied in all OC mines. Drill machines are having OEM fitted DUST EXTRACTION system.

Complied. Water sprinkling at all coal stock and sidings is being done by mobile water tankers and through pipe lines. Proposal for installation of fixed sprinklers at siding is under process.

(4) MOBILE SPRINLKLERS

Sl. no.	Mine	Haul road length in Km	No. of mobile sprinklers	Total Capacity(KL)	Trips per day
1	Kusunda OC + Godhur mixed	6.5-7.0	9	4-20 KL each,1-12KL ,2-2KL, 1-3KL, 1-5KLeach	35 trips/day
2	Dhansar/Industry	7.0-8.0	2	1-16KL, 1 -28KL	40 trips/day
3	Gondudih KKC	(mine not running currently)			
4	Ena	5.0	3	2-16KL,2-12KL	Presently used for water supply at colonies.
5.	East Bassuriya	2.5-3.0	3	3-12KL	9 trips each/day

(5) The direction of surface run-off of the premises of collieries shall be diverted to created water bodies.
Creation of water bodies in coal bearing area will pose safety threats to nearby mine and it will be violation of mines act. This will also create grave danger of inundation of the adjacent mines since the mines are 100 years old and interconnected with each other. So this action cannot be complied**.**

However to catch run-off water in colonies proposal for Rain water Harvesting in colonies is under process

(6) Dealing of mine fires

A Master plan for Dealing with fires and subsidence and rehabilitation in the Leasehold of BCCL has been approved by Govt. of India vide letter no- 22020/1/2005-CRC dated 12 08 09. In fire patch of V/VI/VII/VIII seam of Gareria Secn. At East Bassuriya about 1, 70,000 cu.m. mitti and non-combustible material has been filled, rest will be filled by quarry OB .

In Kusunda OC, fiery coal patches are being dug out for the purpose of dealing with fire and combustible materials are extracted out to save the coal from burning and to stop further spread of the fire. Once the total fiery coal is dug-out/excavated there will be no more chance of re-starting of fresh/ spreading of fire into other areas.

At Alkusa mine, measures have been taken as per CMR'57 and DGMS Guidelines to control ug fire and entrances have been filled/sealed to stop ingress of air into fire affected area.

(7) The waste water shall be passed through oil separator-cum-filtration system

-- It shall be complied

(8) The removed OBs shall be utilized for low land filling or for making roads.

Complied. Removed OB is used for low land filling and for making roads as and when required**.**

(9) Tree plantation on the dumps

Complied. 500 no. bamboo-gabion plantation have already been done. At about 2.0 Ha Ecological restoration site total about 6402 no. plants and plenty of grass-seeds have been planted successfully with encouraging results, and natural eco-system is being established there with increasing flora & fauna. At 2nd. eco-restoration site (about 1.79 Ha OB dump- area) about 2400 plants along with seeds of grass and shrubs have spread over since 2015-'16 successfully. And at 3rd. site, (about 3.0 Ha OB dump area) about 5322 plants and plenty of grass seeds have been planted and spreaded over during this monsoon successfully.A fourth site of 4.99 ha area has been taken up in the year 2017-18 and about 12,482

(10) All hazardous wastes shall be disposed off

Complied.

1. All units have applied for authorization as per Hazardous Wastes (Management, Handling and Trans boundary Movement) Rules.
2. Burnt/used oil is disposed off as per rule.
3. Disposal of Hazardous waste, burnt Oil / batteries is being done through E-auctioning to authorized recycler/ re-processor having valid authorization from CPCB/ SPCB. Return are also being filed.

(11) Monitoring and Reporting six monthly

Monitoring work has been done by CMPDI, Dhanbad as per work order issued by BCCL HQ.

(12) Introduction of GIS/ GPS

CMPDI, HQ has been given the job of satellite surveillance of the Jharia coal field through NRSA Hyderabad and the information is being uploaded in the website.

Status of Compliance Action Plan, Kusunda Area as on date 21-09-2019

1. Proposal has been initiated for construction of transporting road from 26 no. kali mandir at Godhur to railway phatak KDS Siding. Coal net tracking number KusundaArea/Transportingroa/2018-19/864.
2. Proposal for construction Haulage road main gate Dhansar diesel dispensing unit under estimation process.
3. Proposal for construction transporting road from GKKC office to weigh bridge is under process.
4. Water tank has been installed at siding to store water for sprinkling at KDS K siding. Earlier Fixed Water Sprinklers proposal in process (not tracked).
5. Proposal for construction of boundary wall at ADIC (between ADIC coal dump & public road) has been initiated vide ref. No. BCCL/KA6/ADIC/2019/497 dated 24.07.2019 and is with Civil deptt., Kusunda Area for estimate preparation.
6. Site has been finalised at exit of Godhur colliery and initial survey has been conducted by the officials of Civil Department and colliery engineers for construction of Overhead sprinklers & wheel washing ditch. Platform constructed for Overhead Sprinklers & Wheel Washing ditch. Overhead sprinkler is to be installed. Note-sheet for pipeline for water supply is in process
7. The direction has been issued regarding maintaining log book for no. of trips of mobile sprinkler.
8. Seed balls has been broadcasted at Side slope of OB dump at GKKC (11.78 Ha along the slopes of 11.78 Ha dump) & 3 Ha ADIC along Karijore.
9. There are 5458 saplings have been planted at various location under Kusunda Area.
10. Perforated green cloths will be used to surround the siding boundaries - Proposal is with Area Civil Engineer for surveying and feasibility of covering with jute clothes with bamboo/ iron rods.
11. GM excavation confirmed in a letter regarding Wet drilling in departmental patches.
12. The direction has been issued by GM, Kusunda Area in EC monitoring committee meeting at area dated 21-08-2019 for PUC certificate
13. O&G trap proposal initiated vide ref. no. Civil dept./kusunda area6/53 dated 24.07.2019. Proposal is with Area Civil Deptt. for some additional documents required by GM Civil, HQ.
14. COAQMS proposal initiated vide ref. no. BCCL/KA6/Env/2019/22 dated 19.09.2019 in the boundary of Cluster VI & Cluster VII, JSPCB guideline 25.07.2019 JSPCB, Ranchi.
15. Proposal for procurement of Road sweeper machine (to be mounted at tractors rear side with three point linkage system) with dust collecting system initiated vide ref. No. BCCL/KA6/NGKC/PO/2019/3411 dated 30.03.2019

ANNEXURE-G

KUSUNDA AREA

Status of Periodical Medical Examination & Training

Mines under Cluster-VI	Total PME done for the period March'19 to Nov'19	Vocational Training done for the period April'18 to March'19
Bassuriya, East Bassuriya, Godhur and Gondudih Khas Kusunda	609	55

Annexure H

Certificate of high root density plant for controlling subsidence

This is to certify that BCCL has been doing plantation/ecological restoration under the guidelines of Forest Research Institute. The various species selected for the restoration are having a tap root system with branches which serve the purpose. These species have high root density and are already being planted at all the ecorestoration/plantation sites of BCCL. The various species having tap root system are given below.

S.No.	Species	Common name
1.	*Acacia nilotica*	Kikkar
2.	*Albizia odoratissima*	Kala siris
3.	*Bauhinia variegata*	Kachnar
4.	*Cassia fistula*	Amaltas
5.	*Ficus benghalensis*	Baniyan /bargad
6.	*Ficus racemosa*	Gular
7.	*Ficus religiosa*	Pipal
8.	*Gmelina arborea*	Ghamar
9.	*Lagerstroemea parviflora*	Jarul
10.	*Lannea coromandelica*	Zhingan
11.	*Madhuca latifolia*	Mahua
12.	*Mangifera indica*	Aam
13.	*Morus alba*	Shahtoot
14.	*Phyllanthus emblica*	Aonla
15.	*Pithecellobium dulce*	Jangal jalebi
16.	*Pongamia pinnata*	Karanj
17.	*Tamarindus indica*	Imli
18.	*Trema orientalis*	Tree
19.	*Terminalia arjuna*	Arjun
20.	*Terminalia bellerica*	Bahera
21.	*Dalbergia sissoo*	Shisham
22.	*Syzygium cumini*	Jamun
23.	*Azadirachta indica*	Neem
24.	*Holoptelea integrifolia*	Indian elm
25.	*Butea monosperma*	Palash /dhak

Figure 1 *Stone Pitching/embankment at Kari Jore near Godhur Colliery.*

Fig. 2 : Eco-restoration at OB Dump at Gondudih Khas Kusunda 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.

GROUNDWATER LEVEL & QUALITY REPORT

FOR CLUSTER OF MINES, BCCL

(Assessment year - 2017)

[CLUSTER – I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XIII, XIV, XV & XVI of Mines, BCCL]

JHARIA COALFIELD AND RANIGANJ COALFIELD (PART)

For

(BHARAT COKING COAL LIMITED)

(A Subsidiary of Coal India Limited)

KOYLA BHAWAN (DHANBAD)

MARCH – 2018

3.3 F Monitoring of Ground Water Levels of Cluster-VI

Cluster–VI consists of four coal mines; East Bassuriya OC, Bassuriya UG, Gondudih Khas-Kusunda OC, Godhur Mixed Mines (OC and UG) are under the administrative control of Kusunda Area of BCCL. This Cluster of mines is located in central part of Jharia Coalfield in Dhanbad district of Jharkhand.

The present leasehold area of Cluster-VI is 876.55 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.

2 hydrograph stations (**D-25 and D-30**) are located in the core zone of the mine area. Water level monitoring in these monitoring stations has been done in the months of February, April, August & November'2018 and the Ground water level data is enclosed in the table below:

Sl No.	Well No.	Location	Water level (bgl in meters)			
			Feb'18	Apr'18	Aug'18	Nov'18
1	D-25	Godhur	0.50	2.60	0.60	2.40
2	D-30	Borkiboa	2.60	4.58	1.00	1.10
Average WL (bgl)			***1.55***	***3.59***	***0.80***	***1.75***

ENVIRONMENTAL MONITORING REPORT OF BHARAT COKING COAL LIMITED, CLUSTER – VI

(FOR THE MONTH AUGUST, 2019)

E. C. no. J-11015/183/2011-IA.II (M) dated 26.08.2013.

CMPDI
ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

CONTENTS

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 analyzed 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 analyzed for four parameters on fortnightly basis. Thereafter the samples were preserved and analyzed 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&CCGazette Notification No. GSR 742(E) dt.25.09.2000 Standards for Coal Mines were 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

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 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.

1.1 The Cluster-VI is situated in the Northern part of the Jharia coalfield. It includes a group of 4 Mines (viz. East Basseriya Colliery , Gondudih Khas Kusunda colliery and Godhur Colliery. The Cluster – VI is situated about 25 - 30 kms from Dhanbad Railway Station. The mines of this Cluster–VI 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 Sendra and Ekra nalas.

1.2 The Cluster-VI is designed to produce 5.87 MTPA (normative) and 7.631 MTPA(peak) capacity of coal. The average grade of coal W – III & W- IV.

The Project has Environmental Clearance from Ministry of Environment, Forest and Climate Change (MoEF&CC) for a rated capacity 5.87 MTPA (normative) and 7.631 MTPA (peak) capacity of coal production vide letter no. J-11015/183/2011-IA.II (M) dated 26thAugust, 2013.

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

I. CORE ZONE Monitoring Location

i) Basseriya Managers Office (A9): Industrial Area

The location of the sampling station is 23^0 48'11.53" N & 86^0 22'17.50" E. The sampler was placed at 1.5 m above the ground level of Safety Office.

II. BUFFER ZONE Monitoring Location

i) Nichitpur (A8) : Industrial Area

The location of the sampling station is 23^0 48'18.59" N $86^0$21'30.93" E. The sampler was placed at 1.5 m above the ground level at Safety office of Nichitpur colliery.

ii) Kusunda OCP (A10) : Industrial Area

The location of the sampling station is 23^0 46' 49.07'' N & 86^0 24' 15.71'' E. The sampler was placed at 1.5 m above the ground level of Safety Office.

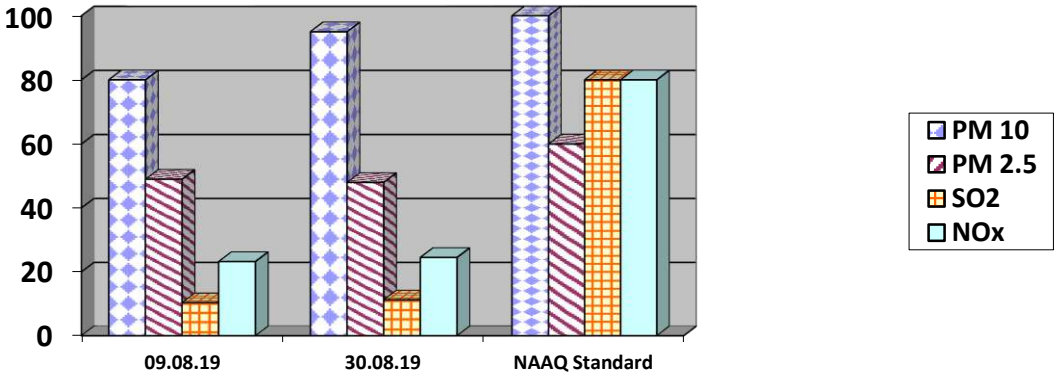
Iii) Pootki Balihari Office (A16): Industrial Area

The location of the sampling station is 23º45.17.23' N 86º21.46.27'E, The sampler was placed at 1.5 m above the ground level of Colliery Office.

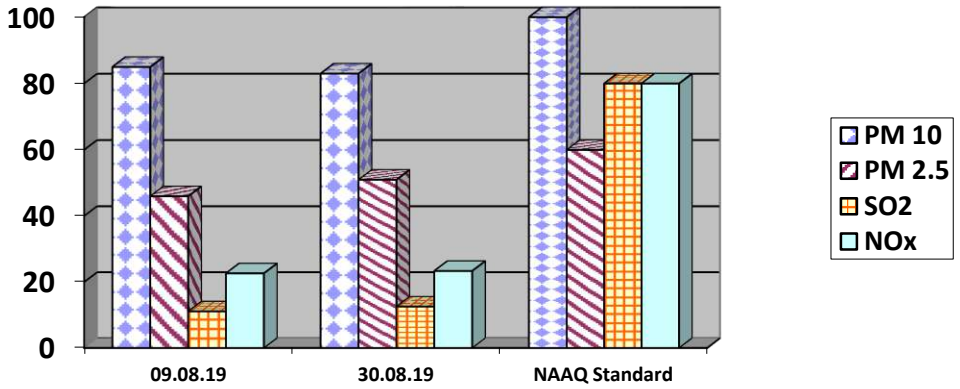
AMBIENT AIR QUALITY DATA

Cluster – VI, Bharat Coking Coal limited Month: **AUG. 2019** Year: **2019-20.**

Station Name: A9 – Basseriya Managers Office		Zone: Core		Category: Industrial	
Sl. No.	**Dates of sampling**	**PM 10**	**PM 2.5**	**SO_2**	**NO_X**
1	09.08.19	80	49	10.33	23.22
2	30.08.19	95	48	11.21	24.49
	NAAQ Standard	100	60	80	80



Station Name: A8 – Nichitpur		Zone: Buffer		Category: Industrial	
Sl. No.	**Dates of sampling**	**PM 10**	**PM 2.5**	**SO_2**	**NO_X**
1	09.08.19	85	46	11.10	22.62
2	30.08.19	83	51	12.55	23.34
	NAAQ Standard	100	60	80	80

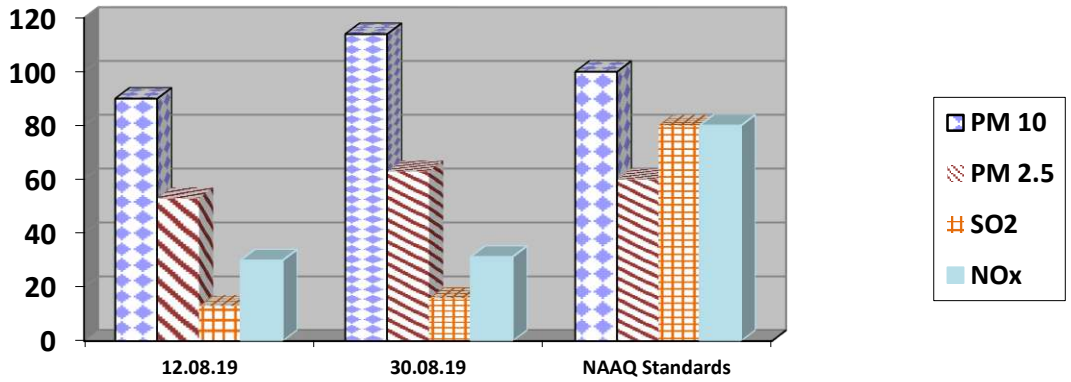


Analysed By
JSA/SA/SSA

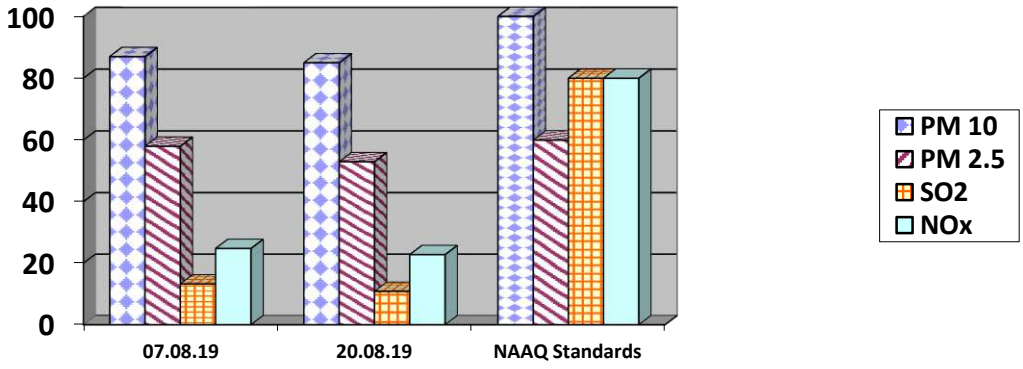
Checked By
Lab In Charge
RI-2, CMPDI, Dhanbad

Approved By
HOD(Mining/Environment)
RI-2, CMPDI, Dhanbad

Station Name: A10 – Kusunda OCP		Zone: Buffer		Category: Industrial	
Sl. No.	Dates of sampling	PM 10	PM 2.5	SO2	NOx
1	12.08.19	90	53	13.04	29.93
2	30.08.19	114	63	15.92	31.23
	NAAQ Standards	100	60	80	80



Station Name: A16 Pootki Balihari Office		Zone: Buffer		Category: Industrial	
Sl. No.	Dates of sampling	PM 10	PM 2.5	SO2	NOx
1	07.08.19	87	58	13.25	24.78
2	20.08.19	85	53	10.84	22.79
	NAAQ Standards	100	60	80	80



- *All values are expressed in microgram per cubic meter.*
- *24 hours duration*

Analysed By
JSA/SA/SSA

Checked By
Lab In Charge
RI-2, CMPDI, Dhanbad

Approved By
HOD(Mining/Environment)
RI-2, CMPDI, Dhanbad

WATER QUALITY MONITORING

3.1 Location of sampling sites

(Refer **Plate No. – II**)

Mine Discharge of East Basseriya (MW6)

A sampling point is fixed to assess the effluent quality of Mine discharge. This location is selected to monitor effluent discharge in to Ekra Nala.

3.2 Methodology of sampling and analysis

Water samples were collected as per standard practice. The effluent samples were collected and analyzed 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.

WATER QUALITY DATA

(EFFLUENT WATER- FOUR PARAMETERS)

Name of the Cluster: **Cluster -VI**		Month: **AUG. 2019**	Name of the Station: **Mine Discharge of East Basseriya**	
Sl. No.	**Parameters**	**MW6** First Fortnight 16.08.2019	**MW6** Second Fortnight 30.08.2019	**As per MOEF General Standards for schedule VI**
1	Total Suspended Solids	51	64	*100 (Max)*
2	pH	7.7	7.82	*5.5 - 9.0*
3	Oil & Grease	<2.0	<2.0	*10 (Max)*
4	COD	28	40	*250 (Max)*

All values are expressed in mg/lit except pH.

Analysed By
JSA/SA/SSA

Checked By
Lab In Charge
RI-2, CMPDI, Dhanbad

Approved By
HOD(Mining/Environment)
RI-2, CMPDI, Dhanbad

NOISE LEVEL QUALITY MONITORING

4.1Location of sampling sites

i) **Basseriya Managers Office (N9)**
ii) **Nichitpur (N8)**
iii) **Kusunda OCP (N10)**
iv) **Pootki Balihari Office (N16)**

4.2 Methodology of sampling and analysis

Noise level measurements in form of 'L_{EQ}' were taken using Integrated Data Logging Sound Level Meter (NL-52 OF RION CO. Ltd. Make) during day time. Noise levels were measured for about one hour time in day time. Noise levels were measured in Decibels, 'A' weighted average, i.e. dB (A).

4.3 Results & Interpretations

Ambient noise levels were recorded during day time and the observed values were compared with standards prescribed by MoEF&CC. The results of Noise levels recorded during day 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.

NOISE LEVEL DATA

Name of the Project: **Cluster -VI**			Month: **AUG. 2019**		
Sl. No.	**Station Name/Code**	**Category of area**	**Date**	**Noise level dB(A)LEQ**	***Permissible Limit of Noise level in dB(A)***
1	**Nichitpur (N8)**	**Industrial area**	09.08.19	60.2	*75*
2	**Nichitpur (N8)**	**Industrial area**	30.08.19	60.2	*75*
3	**Basseriya Managers Office (N9)**	**Industrial area**	09.08.19	63.5	*75*
4	**Basseriya Managers Office (N9)**	**Industrial area**	30.08.19	62.9	*75*
5	**Kusunda OCP (N10)**	**Industrial area**	12.08.19	57.2	*75*
6	**Kusunda OCP (N10)**	**Industrial area**	30.08.19	61.6	*75*
7	**Pootki Balihari Office (N16)**	**Industrial area**	07.08.19	70.1	*75*
8	**Pootki Balihari Office (N16)**	**Industrial area**	20.08.19	68.2	*75*

Permissible limits of Noise Level as per MOEF Gazette Notification No. GSR 742(E) dt. 25.09.2000 Standards for Coal Mines and Noise Pollution (Regulation and Control) Rules, 2000.
*** Day Time: 6.00 AM to 10.00 PM,**

Analysed By
JSA/SA/SSA

Checked By
Lab In Charge
RI-2, CMPDI, Dhanbad

Approved By
HOD(Mining/Environment)
RI-2, CMPDI, Dhanbad

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/8hourlyvaluesshallbemet92%ofthetimeinayear.However,8% of the time it may exceed but not on two consecutivedays.

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 October 1998, the Central Pollution Control Board hereby notify the National Ambient Air Quality Standards with immediate effect.

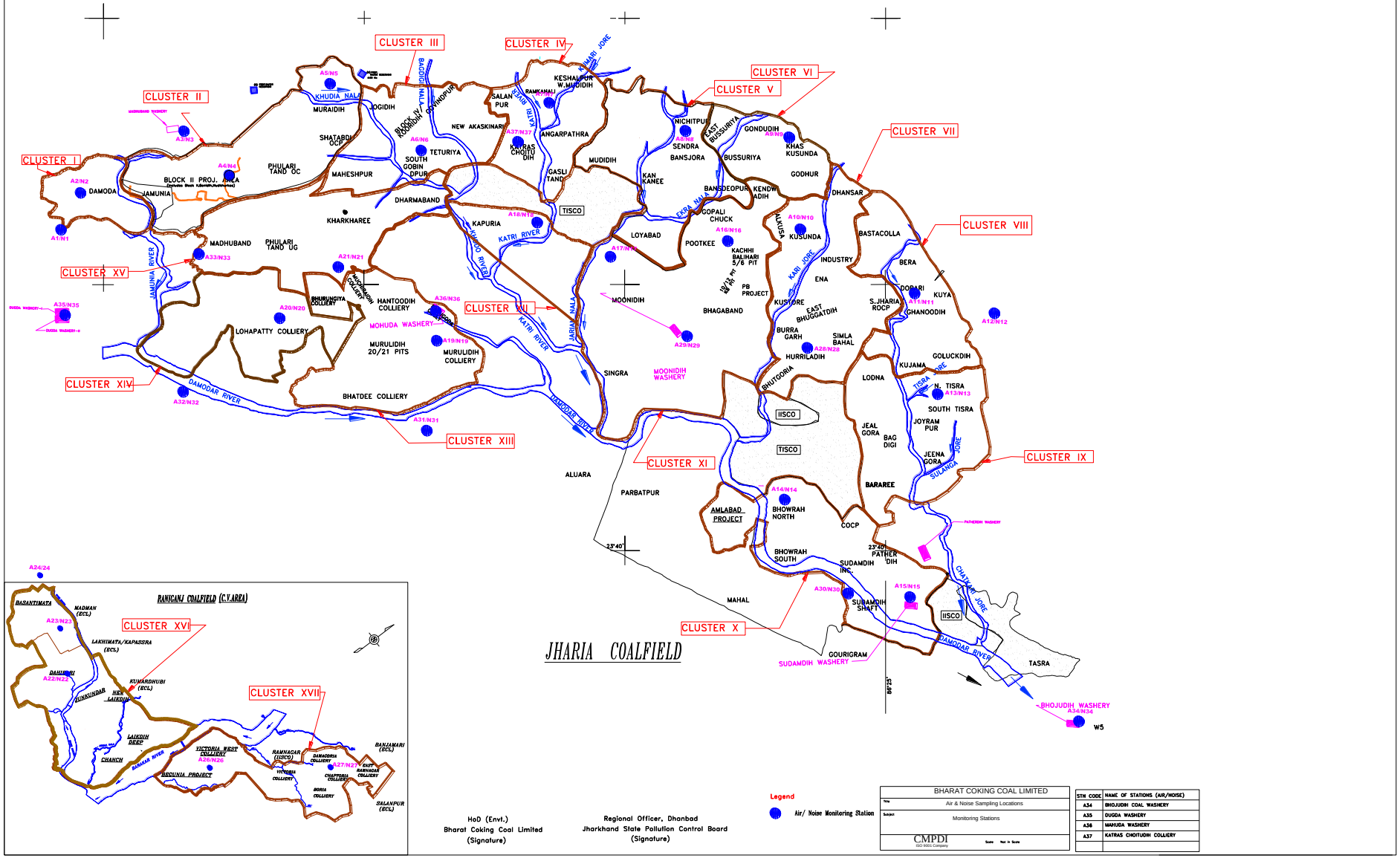
Pollutant	Time Weighted Average	Concentration in Ambient Air		Methods of Measurement
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)	
Sulphur Dioxide (SO_2), µg/m³	Annual * 24 Hours **	50 80	20 80	-Improved West and Gaeke Method -Ultraviolet 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.

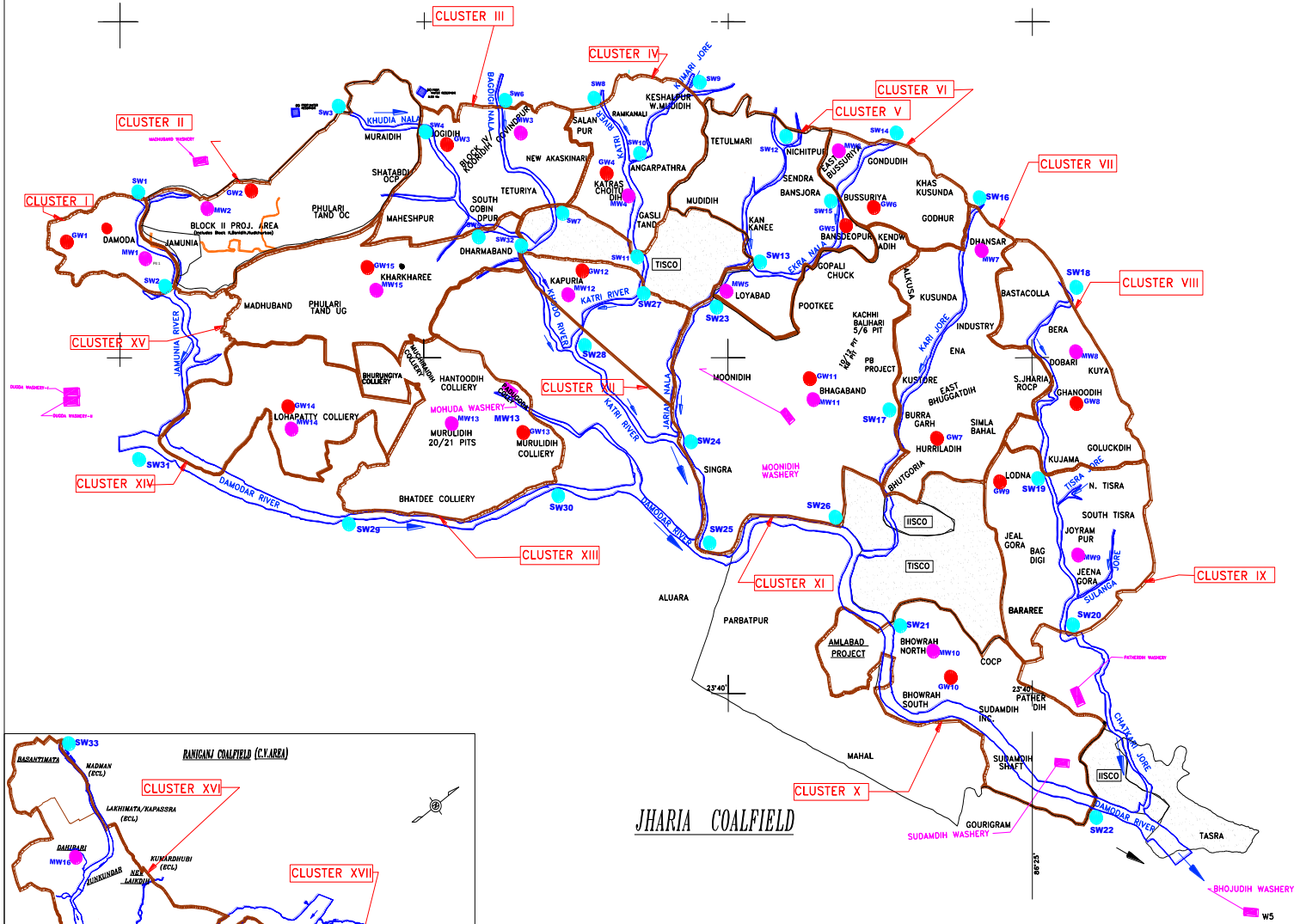
** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

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

WATER QUALITY REPORT
OF
BHARAT COKING COAL LIMITED,
CLUSTER – VI

(FOR THE Q.E. DECEMBER, 2018)

E. C. no. J-11015/183/2011-IA.II (M) dated 26.08.2013.

CMPDI
ISO 9001 Company
Regional Institute-II
Dhanbad, Jharkhand

CLUSTER - VI

(FOR THE Q.E. December, 2018)

CONTENTS

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WATER QUALITY REPORT
OF
BHARAT COKING COAL LIMITED
CLUSTER – VI

(FOR THE Q.E. DECEMBER, 2018)

E. C. no. J-11015/183/2011-IA.II (M) dated 26.08.2013.

CMPDI

ISO 9001 Company

Regional Institute-II
Dhanbad, Jharkhand

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 MoEFCC 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 Water sampling stations

The Water sampling stations were selected for mine effluent water, drinking water supply, well/ Hand pump water and also surface water samples.

2.2 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 Water quality

Water samples were collected as per standard practice. Effluent samples were analyzed for 25 parameters on quarterly basis and for 27 parameters on half yearly basis. The drinking and Surface water samples were collected and analyzed for 25 and 17 parameters respectively, on quarterly basis. Thereafter the samples were preserved and analyzed at the Environmental Laboratory at CMPDI (HQ), Ranchi.

3.2 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) & fine particulates for PM 2.5 sampler

were used for sampling PM 10 & PM 2.5 respectively. These heavy metals are analyzed regularly on half yearly basis. The samples were analyzed in Environmental Laboratory of CMPDI, RI-II, Dhanbad.

4.0 Results and interpretations

4.1 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, IS.10500/2012 (Drinking water) and IS: 2296 (Surface water), were with in permissible limits.

4.2 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 guide-lines stipulated by Ministry of Environment, Forest and Climate Change (MoEF&CC), Govt. of India.

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.

1.1 The Cluster-VI is situated in the Northern part of the Jharia coalfield. It includes a group of 4 Mines (viz. East Basseriya Colliery (OC), Basseriya colliery (UG), Gondudih Khas Kusunda colliery (OC) and Godhur Colliery (Mixed). The Cluster – VI is situated about 25 - 30 kms from Dhanbad Railway Station. The mines of this Cluster – VI 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 Sendra and Ekra nalas.

1.2 The Cluster-VI is designed to produce 5.87 MTPA (normative) and 7.631 MTPA (peak) capacity of coal. The average grade of coal W – III & W- IV.

The Project has Environmental Clearance from Ministry of Environment, Forest and Climate Change (MoEF&CC) for a rated capacity 5.87 MTPA (normative) and 7.631 MTPA (peak) capacity of coal production vide letter no. J-11015/183/2011-IA.II (M) dated 26th August, 2013.

In compliance of these conditions the Environmental Monitoring has been carried out & report prepared for submission to MoEF&CC & SPCB and other statutory authorities.

CHAPTER – II

AMBIENT AIR QUALITY MONITORING

2.1 Location of sampling station and their rationale:

(As per G.S.R. 742 (E) dt. 25th December, 2000)

2.2 Ambient Air Quality Sampling Locations

I. CORE ZONE Monitoring Location

i) Basseriya Managers Office (A9): Industrial Area

The location of the sampling station is 23^0 48'11.53" N & 86^0 22'17.50" E.

II. BUFFER ZONE Monitoring Location

i) Nichitpur (A8) : Industrial Area

The location of the sampling station is 23^0 48'18.59" N $86^0$21'30.93" E.

ii) Kusunda OCP (A10) : Industrial Area

The location of the sampling station is 23^0 46' 49.07'' N & 86^0 24' 15.71'' E.

Iii) Pootki Balihari Office (A16): **Industrial Area**

The location of the sampling station is 23^o45.17.23' N 86^o21.46.27'E.

2.3 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.

AMBIENT AIR QUALITY DATA

Name of the Company: **Bharat Coking Coal Limited** Year : **2018-19[1].**
Name of the Cluster : **Cluster -VI** PERIOD: **Q. E. DEC- 2018.**
Month: DEC 2018

Heavy Metal Analysis report of Ambient Air Quality

SAMPLE	Cadmium(Cd) (µg/m3)	Mercury(Hg) (µg/m3)	Arsenic(As) (ng/m3)	Chromium(Cr) (µg/m3)	Nickel (Ni) (ng/m3)	Lead (Pb) (µg/m3)
Nichitpur (A8)	<0.001	<0.001	<0.005	<0.01	<0.1	0.005
Basseriya Managers Office (A9)	<0.001	<0.001	<0.005	<0.01	<0.1	0.07
Kusunda OCP (A10)	<0.001	<0.001	<0.005	<0.01	<0.1	0.07
Pootki Balihari Office (A16)	<0.001	<0.001	<0.005	<0.01	<0.1	0.04

[1] **AUTHORISED FOR RELEASE BY HOD (ENV), CMPDI, RL-2, DHANBAD,** 21/07/19 **DATED 20.07.19**

CHAPTER – III

WATER QUALITY MONITORING

3.1 Location of sampling sites

(Refer **Plate No. - I**)

i) Drinking Water Quality at **Bansjora Borewell (DW6)**

ii) Surface Water Quality at **U/S of Ekra Nala (SW14)**

iii) Surface Water Quality at **D/S of Ekra Nala (SW15)**

iv) **Mine Effluent Quality at East Bassuria UGP(MW6)**

3.2 Methodology of sampling and analysis

Water samples were collected as per standard practice. Effluent samples were analyzed for 25 parameters on quarterly basis and for 27 parameters on half yearly basis. The drinking and Surface water samples were collected and analyzed for 25 and 17 parameters respectively, on quarterly basis. Thereafter the samples were preserved and analyzed at the Environmental Laboratory at CMPDI (HQ), Ranchi and Environmental Laboratory at CMPDI, HQ, Ranchi.

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 parmeters are within the permissible limits.

WATER QUALITY

(SURFACE WATER- ALL PARAMETERS)

Name of the Company: **Bharat Coking Coal Limited** Year : **2018-19[2].**

Name of the Cluster : **Cluster - VI** Month: **Q. E. December, 2018**

Stations: **Date of Sampling:**

1. Upstream in Ekra Nala SW-14 22/12/2018
2. Down stream in Ekra Nala SW-15 22/12/2018

Sl. No	Parameter	Sampling Stations				Detection Limit	IS:2296 – 1982 (Inland surface water) Class C	BIS Standard & Method
		SW-14	Sw-15					
1	Arsenic (as As), mg/l, Max	<0.002	<0.002			0.002	0.2	IS 3025/37:1988 R : 2003, AAS-VGA
2	BOD (3 days 27ºC), mg/l, Max	2.2	2.4			2.00	300	IS 3025 /44: 1993, R : 2003 3 day incubation at 27°C
3	Colour	colourless	Colourless			Qualitative	300	Physical/Qualitative
4	Chlorides (as Cl), mg/l, Max	24	28			2.00	600	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.03	<0.03			0.03	1.5	IS 3025 /42 : 1992 R : 2009, AAS-Flame
6	Disolved Oxygen, min.	4.0	4.0			0.10	4	IS 3025/381989, R : 2003, Winkler Azide
7	Fluoride (as F) mg/l, Max	0.44	0.52			0.02	1.5	APHA, 22nd Edition SPADNS
8	Hexavalent Chromium, mg/l, Max	0.024	0.031			0.01	0.05	APHA, 22nd Edition, 1,5 - Diphenylcarbohydrazide
9	Iron (as Fe), mg/l, Max	0.422	0.422			0.06	50	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
10	Lead (as Pb), mg/l, Max	<0.005	<0.005			0.005	0.1	APHA, 22nd Edition AAS-GTA
11	Nitrate (as NO_3), mg/l, Max	11.56	12.93			0.50	50	APHA, 22nd Edition, UV-Spectrphotometric
12	pH value	8.45	8.25			2.5	6.5-8.5	IS-3025/11:1983, R-1996, Electrometric
13	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.002	<0.002			0.002	0.0005	APHA, 22nd Edition 4-Amino Antipyrine
14	Selenium (as Se), mg/l, Max	<0.002	<0.002			0.002	0.05	APHA, 22nd Edition AAS-GTA
15	Sulphate (as SO_4) mg/l, Max	50	63			2.00	400	APHA, 22nd Edition Turbidity
16	Total Dissolved Solids, mg/l, Max	260	264			25.00	1500	IS 3025 /16:1984 R : 2006, Gravimetric
17	Zinc (as Zn), mg/l, Max	0.133	0.179			0.01	5.0	IS 3025 /49 : 1994, R : 2009, AAS-Flame

All values are expressed in mg/lit unless specified.

[2] **AUTHORISED FOR RELEASE BY HOD (ENV), CMPDI, RL-2, DHANBAD,** 21/07/19 **DATED 20.07.19**

WATER QUALITY

(DRINKING WATER- ALL PARAMETERS)

Name of the Company: **Bharat Coking Coal Limited** Year : **2018-19[3].**

Name of the Cluster : **Cluster - VI** Month: **Q. E. December, 2018**

Stations: Bansjora Borewell DW-6 **Date of sampling: 24-12-2018**

Sl.No	Parameter	Result	Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
1	Boron (as B), mg/l, Max	<0.2	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	2	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	106	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	38	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	0.04	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.31	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	<0.02	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	<0.06	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	0.009	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	0.26	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	8.33	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	7.83	2.5	6.5 to 8.5	IS-3025/11:1983, R-1996, Electrometric
14	Phenolic compounds (as C_6H_5OH), mg/l, Max	<0.001	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	166	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Qualitative	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_aco_3),, mg/l, Max	140	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	0.003	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	666	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_aco_3), mg/l, Max	588	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	2	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	0.02	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame
25	Nickel as Ni, mg/l Max	<0.005	0.005	0.02	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

All values are expressed in mg/lit unless specified.

[3] **AUTHORISED FOR RELEASE BY HOD (ENV), CMPDI, RL-2, DHANBAD,** 21/07/19 **DATED 20.07.19**

WATER QUALITY

(MINE EFFLUENT-27 PARAMETERS)

Name of the Company: **Bharat Coking Coal Limited** Year : **2018-19[4].**

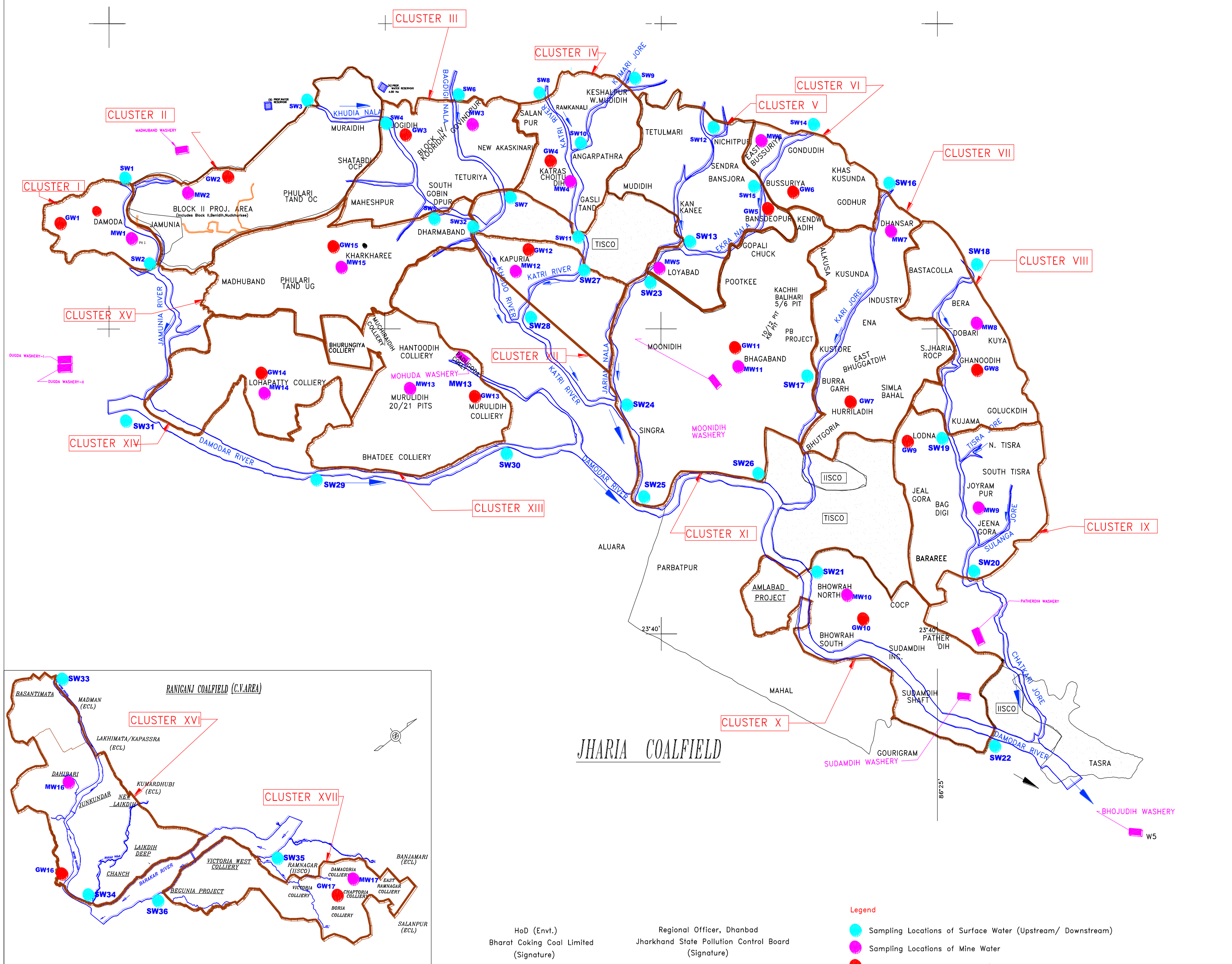
Name of the Cluster : **Cluster - VI** Month: **Q. E. December, 2018**

Effluent water of BCCL Mines					**Date of Sampling:**
Sample Code : MW 6					27.12.18
Sl.No.	**Parameter**	**Results MW-6**	**Detection Limit**	**MOEF -SCH-VI STANDARDS Class 'A'**	**BIS Standard & Method**
1	Ammonical Nitrogen, mg/l, Max	0.06	0.02	50.0	IS 3025/34:1988, R : 2009, Nessler's
2	Arsenic (as As), mg/l, *Max*	<0.002	0.002	0.2	IS 3025/37:1988 R : 2003, AAS-VGA
3	B.O.D (3 days 27°C), mg/l, Max	<2.0	2.00	30.0	IS 3025 /44:1993,R:2003 3 day incubation at 27°C
4	Colour	colourless	Qualitative	Qualitative	Physical/Qualitative
5	COD, mg/l, Max	28	4.00	250.0	APHA, 22nd Edition, Closed Reflux, Titrimetric
6	Copper (as Cu), mg/l, *Max*	<0.03	0.03	3.0	IS 3025/42: 1992 R : 2009, AAS-Flame
7	Dissolved Phosphate, mg/l, Max	0.70	0.30	5.0	APHA, 22nd Edition Molybdovanadate
8	Fluoride (as F) mg/l, *Max*	0.64	0.02	2.0	APHA, 22nd Edition, SPADNS
9	Free Ammonia, mg/l, Max	<0.01	0.01	5.0	IS:3025/34:1988, Nesseler's
10	Hexavalent Chromium, mg/l, Max	0.049	0.01	0.1	APHA, 22nd Edition, Diphenylcarbohydrazide
11	Iron (as Fe), mg/l, *Max*	0.115	0.06	3.0	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
12	Lead (as Pb), mg/l, *Max*	0.017	0.005	0.1	APHA, 22nd Edition, AAS-GTA
13	Manganese(as Mn), mg/l, Max	0.147	0.02	2.0	IS-3025/59:2006, AAS-Flame
14	Nickel (as Ni), mg/l, *Max*	<0.10	0.005	3.0	IS-3025/54:2003, AAS-Flame
15	Nitrate Nitrogen, mg/l, *Max*	0.98	0.50	10.0	APHA, 22nd Edition, UV-Spectrphotometric
16	Oil & Grease, mg/l, Max	<2.0	2.00	10.0	IS 3025/39:1991, R : 2003, Partition Gravimetric
17	pH value	7.34	2.5	5.5 to 9.0	IS-3025/11:1983, R-1996, Electrometric
18	Phenolic compounds (as C_6H_5OH),mg/l, *Max*	<0.002	0.002	1.0	APHA, 22nd Edition 4-Amino Antipyrine
19	Selenium (as Se), mg/l, *Max*	<0.002	0.002	0.05	APHA, 22nd Edition, AAS-GTA
20	Sulphide (as SO_3), mg/l, Max	0.016	0.005	2.0	APHA, 22nd Edition Methylene Blue
21	Temperature (° C)	27.0	Shall not exceed 5^0 C above the receiving temp.		IS-3025/09:1984, Thermometeric
22	Total Chromium (as Cr), mg/l, *Max*	0.210	0.04	2.0	IS-3025/52:2003, AAS-Flame
23	Total Kjeldahl Nitrogen, mg/l, Max	1.6	1.00	100.0	IS:3025/34:1988, Nesseler's
24	Total Residual Chlorine, mg/l, Max	<0.02	0.02	1.0	APHA, 22nd Edition, DPD
25	Total Suspended Solids, mg/l, Max	22	10.00	100.0	IS 3025/17:1984, R :1996, Gravimetric
26	Zinc (as Zn), mg/l, *Max*	<0.01	0.01	5.0	IS 3025 /49 : 1994, R : 2009, AAS-Flame
27	Odour	Agreeable	Agreeable	Qualitative	Is-3015/5:1983/R:2012/Qualitative

All values are expressed in mg/lit unless specified.

[4] **AUTHORISED FOR RELEASE BY HOD (ENV), CMPDI, RL-2, DHANBAD,** 21/07/19 **DATED 20.07.19**

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	Bhagabandh 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

Legend

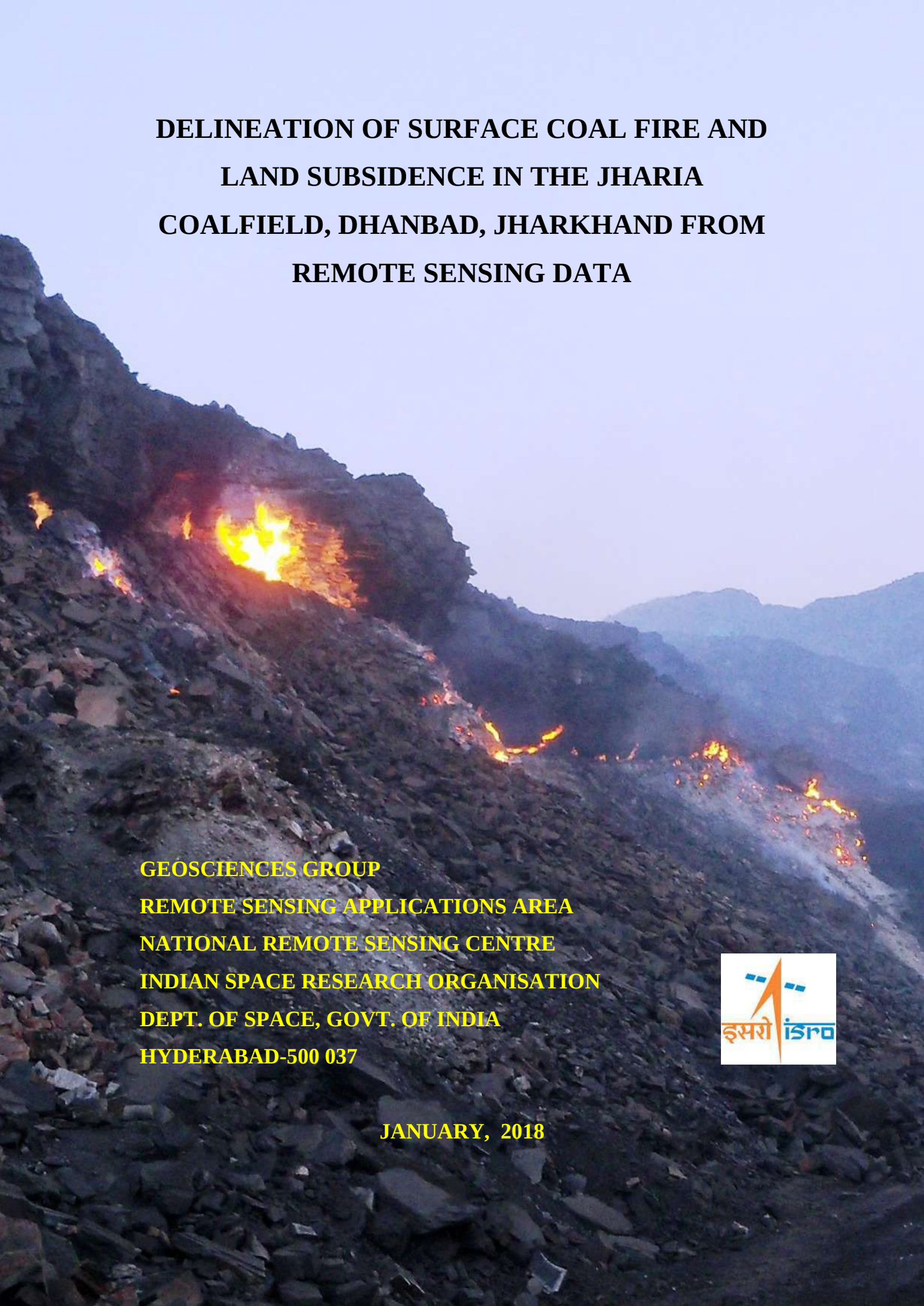
- Sampling Locations of Surface Water (Upstream/ Downstream)
- Sampling Locations of Mine Water

HoD (Envt.)
Bharat Coking Coal Limited
(Signature)

Regional Officer, Dhanbad
Jharkhand State Pollution Control Board
(Signature)

Customer	BHARAT COKING COAL LIMITED
Title	WATER SAMPLING LOCATIONS
Subject	MONITORING STATIONS

DELINEATION OF SURFACE COAL FIRE AND LAND SUBSIDENCE IN THE JHARIA COALFIELD, DHANBAD, JHARKHAND FROM REMOTE SENSING DATA



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REMOTE SENSING APPLICATIONS AREA

NATIONAL REMOTE SENSING CENTRE

INDIAN SPACE RESEARCH ORGANISATION

DEPT. OF SPACE, GOVT. OF INDIA

HYDERABAD-500 037

JANUARY, 2018

DELINEATION OF SURFACE COAL FIRE **AND** LAND SUBSIDENCE IN THE JHARIA COALFIELD, DHANBAD, JHARKHAND FROM REMOTE SENSING DATA

Report for

BHARAT COKING COAL LIMITED (BCCL)

(A SUBSIDIARY OF COAL INDIA LTD.)

ENVIRONMENT DEPARTMENT, KOYLA BHAWAN

KOYLA NAGAR, DHANBAD – 826 005, JHARKHAND

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NATIONAL REMOTE SENSING CENTRE

INDIAN SPACE RESEARCH ORGANISATION

DEPT. OF SPACE, GOVT. OF INDIA

HYDERABAD-500 037

JANUARY, 2018

PROJECT TEAM

1. **Dr. K VINOD KUMAR**, Group Head, Geosciences Group
   Project formulation and coordination
2. **Dr. Tapas R. Martha**, Scientist 'SF'
   Field survey and report preparation
3. **Shri Priyom Roy,** Scientist 'SD'
   Image processing, interpretation, field survey, maps and report preparation

CONTENTS

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EXECUTIVE SUMMARY

Coal fire is a serious problem in Jharia coal field, where high ranking coals are gradually burnt due to these fires. The combined effect of surface and sub-surface fires and mining related subsidence has endangered the environmental stability of Jharia coal field. Coupled with the ecological changes instigated by open cast mining, the landscape in and around Jharia have changed drastically over the years. In the present study, delineation of coal fire and mining related land subsidence have been addressed. Thermal band of Landsat-8 (100m resolution) have been used to demarcate the coal mine fire areas from non fire areas. For this study, Landsat-8 data of May, 2017 have been used. The band 10 (10.60-11.19 μm) of Landsat-8 data is used to derive the relative radiant temperature. Further ALOS-PALSAR 2, L band microwave data has been used to delineate zone of probable land subsidence (using differential interferometry) due to mining. The study reflects that, compared to 2012, the eastern flanks (Lodna and Tisra) show a larger fire area. The western flank (Nadkhurkee and Shatabdi) and the northern flank (Katras and Gaslitand) show isolated fire pockets in active mines as well as OB dumps. Among all the colliery areas, Kusunda and Lodna area is most affected by coal mine fire. The current fire area mapped is 3.28 sq.km. Apart from this, five distinctive areas of land subsidence have been identified using interferometric method. These are primarily caused by older or active underground mining. The Moonidih Project is most affected by subsidence. The coal mine fire and subsidence areas are further verified on the ground. The final coal mine fire and subsidence map of Jharia coal field is prepared by using remote sensing data analysis with field validation.

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CHAPTER I

INTRODUCTION

Coal fire is a perennial problem in Jharia coal field (JCF) covering 447 sq. km. area in the Dhanbad district of Jharkhand state. Subsurface and surface coal fires are a serious problem in many coal-producing countries. The severity and extent of mine fires in some of the Indian coalfields, particularly Jharia and Raniganj coalfields, are quite alarming. Combustion can occur either within coal or in coal dumps on the surface. Considerable economic loss and environmental problem arises due to the coal fire. Coal fire burns valuable coal and also creates difficulties in mining by increasing the cost of production or making existing operations difficult. Noxious gases like sulphur dioxide, nitrogen oxide, carbon monoxide, carbon dioxides, which are the result of coal burning processes, often affect the immediate surroundings of an active coal fire area (Gangopadhyay, 2003). These greenhouse gases not only affect local atmosphere but also play a crucial role in the damages, found associated with coal fire such as land surface subsidence and surface cracking. Coal fires are caused by oxidation of coal but the reaction involved in oxidation of coal is not understood till date. Broadly, the potential for spontaneous combustion lies in its ability to react with oxygen at ambient temperature. This occurs through the reaction of oxygen at the surface of the coal resulting in an exothermic reaction. As a consequence, the temperature of coal rises and if temperature reaches the threshold temperature, ranging between 80^0 to 120^0C, a steady reaction starts, which produces carbon dioxide. Temperature keeps on increasing once CO_2 started to form and at 2300°C, the exothermic reaction becomes rapid. It is known that high grade coals (high carbon content) are more fire prone, though the reason behind this is not well understood. Another important parameter, which controls fire, is the size of the particles. Larger the effective area of coal (fire particles), more rapidly the reaction proceeds. Cracks, fissures play a role like positive catalysts to coal oxidation by slowly supplying oxygen / air through their conduits.

Coal mining in Jharia Coal Field (JCF) started way back in 1895. History of fire in Jharia Coal Field date back to 1916 when the first incidence of fire was reported from XIV seam of Bhowrah colliery. JCF was nationalised in 1972 and over the decades, the fire has spread or been contained but never extinguished. The combination of underground fire and subsidence have affected vast areas of JCF.

1.1 Background

Remote sensing technique in thermal band offers a cost-effective and time-saving technology for mapping various geoenvironmental / hazardous features such as coal fires, forest fires, oil well fires, volcanic eruptions etc. NRSC has carried out coal fire mapping projects in the past; conducting an airborne campaign in 1989 and using Landsat-5 TM data in 1995 (Bhattacharya *et. al.*, 1995), over Jharia coalfield, Jharkhand and using Landsat-5 TM data for 2001 over Raniganj coalfield, West Bengal. Further, projects were executed in 2006 and 2012 in which coal fires of the JCF were mapped using Landsat-7 ETM+ and ASTER data, respectively. Additionally, a R&D study was taken up in 2013 to delineate subsidence areas using differential interferomteric (DInSAR) technique. In view of the past experiences, based on the letter (Ref. no. NRSC/16/76) from Director (Tech.), Operations, BCCL addressed to Director, NRSC on 01 February 2016. a project was formulated to take up Coal fire and Land Subsidence study of the Jharia Coal Field using space-borne remote sensing technique. The formal Memorandum of Understanding between BCCL and NRSC was signed on 23rd of Dec, 2016.

1.2 Objectives

The following objectives are formulated on the basis of the above mentioned background:

I. To map Coal fire in the study area based on pixel integrated relative radiant temperature derived from latest available Landsat-8 data of 2016-17 time period.

II. To compare the change in the coal fire distribution in the Jharia coalfield within the period of 2012 and 2016-17.

III. To delineate probable subsidence areas in the region using differential interferometry method.

1.3 Study Area

Jharia Coalfield is located in the Dhanbad district of Jharkhand state (Figure 1) and it is named after the main coal mining town of Jharia. It is situated in the Damodar River valley and is about 250 km NW of Kolkata. The coalfield is contained roughly within latitudes 23º 42' N and 23º 50'N and longitudes 86º 09'E and 86º 30'E.

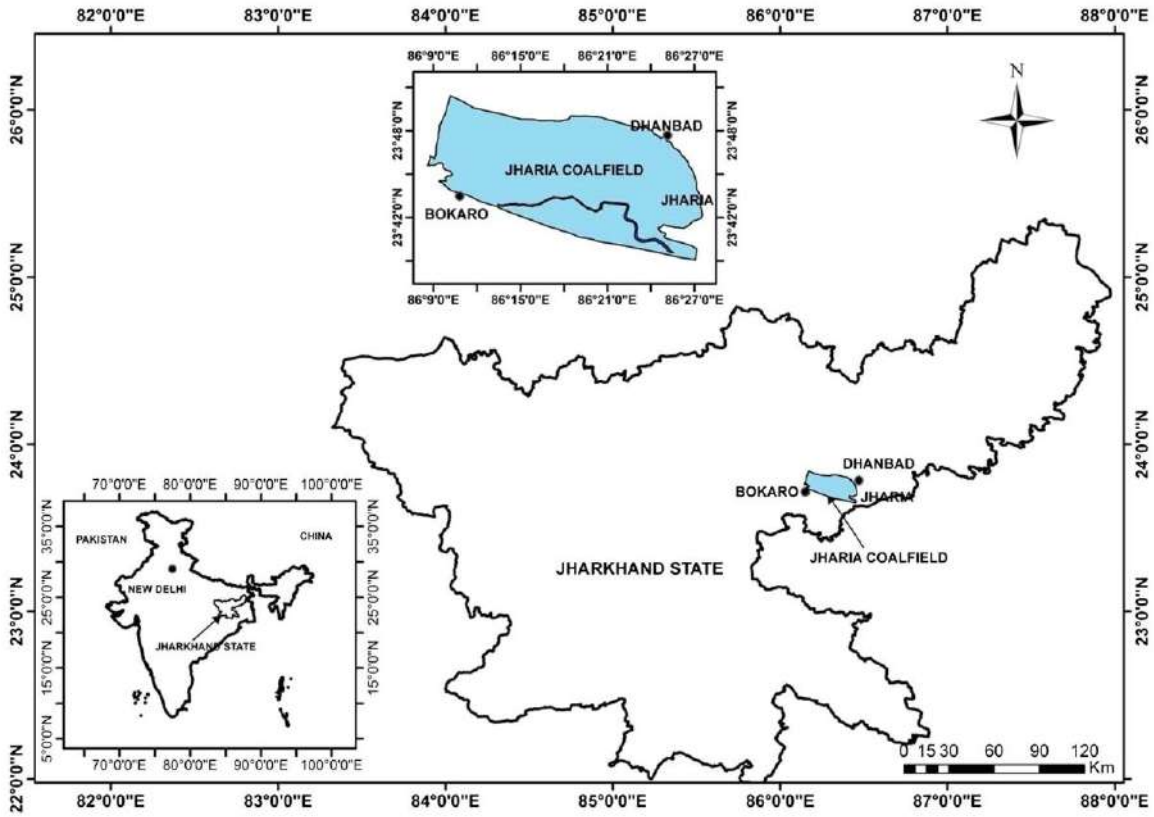

Figure 1: Study area map of Jharia Coalfied, Jharkhand

CHAPTER II

GENERAL DESCRIPTION OF THE STUDY AREA

2.1 Location and Accessibility

Jharia is an old mining town in the Dhanbad district of Jharkhand. This town is famous for its surrounding mines producing high grade coal and supplying mainly to the neighbouring industrial areas. Jharia is approximately 6 km in south western direction from Dhanbad town and connected by metal road. Dhanbad is well connected to Kolkata by road and rail.

2.2 Physiography, Drainage and Climate

Jharia coalfield is characterised by undulatory topography with very low rolling slope towards the eastern part of the area. The average height of the area is around 200 meters above the mean sea level. Damodar is the major river in the study area. The other tributaries to the Damodar River in this area are Jamuniya Nadi, Khudia Nadi, Khatri Nadi, Jarian Nala, Kari Jora and Domohani Nadi. Damodar River flows from west to east in this area. The minimum temperature is <10º C in the month of December – January and maximum temperature is >50º C in the month of May – June.

2.3 General Geology

Gondwana Super Groups of rocks of Up. Carboniferous to Lr. Cretaceous age (i.e. from 320 MY to 98 MY) are exposed here. Gondwana Super Group rocks unconformably overlie Archaean rocks. In Gondwana Rocks, Raniganj and Barakar Formations of Permian age have more potential as far as the coal production is concerned. Barakar Formation is exposed in north and north eastern part of the basin (Figure 2). Most of the coal mines are confined to the Barakar Formation in JCF. Barakars consists of coarse, medium grey and white sandstones, shales and coal seams. Raniganj consists of grey and greenish soft feldspathic sandstones, shales and coal seams. Faults are prevalent in this portion of basins (Figure 2). NW trending faults are conspicuous north to Jharia. Many lamprophyre and dolerite dykes are also exposed in this area in a criss-cross manner. The Raniganj Formation though coal bearing, has suffered much deformation due to faulting, thus causing difficulty for

mining in the area. The generalised stratigraphy of JCF is mentioned below (after Saraf, et al., 1995).

FORMATION	LITHOLOGY	MAXIMUM THICKNESS
Supra Panchet	Red and Grey sandstones and shales	300m
Panchet	Micaceous Yellow and Grey sandstones, Red and Greenish shales	600m
Raniganj	Grey and Greenish soft feldspathic sandstones, shales and coal seams	1050m
Ironstone Shales	Dark carbonaceous shales with ironstone bands	360m
Barakar	Coarse and medium Grey and white sandstones, shales and coal seams	630m
Talchir Boulder Bed	Coarse sandstones above and Greenish shales below	300m

Table 1: Generalised stratigraphy of JCF.

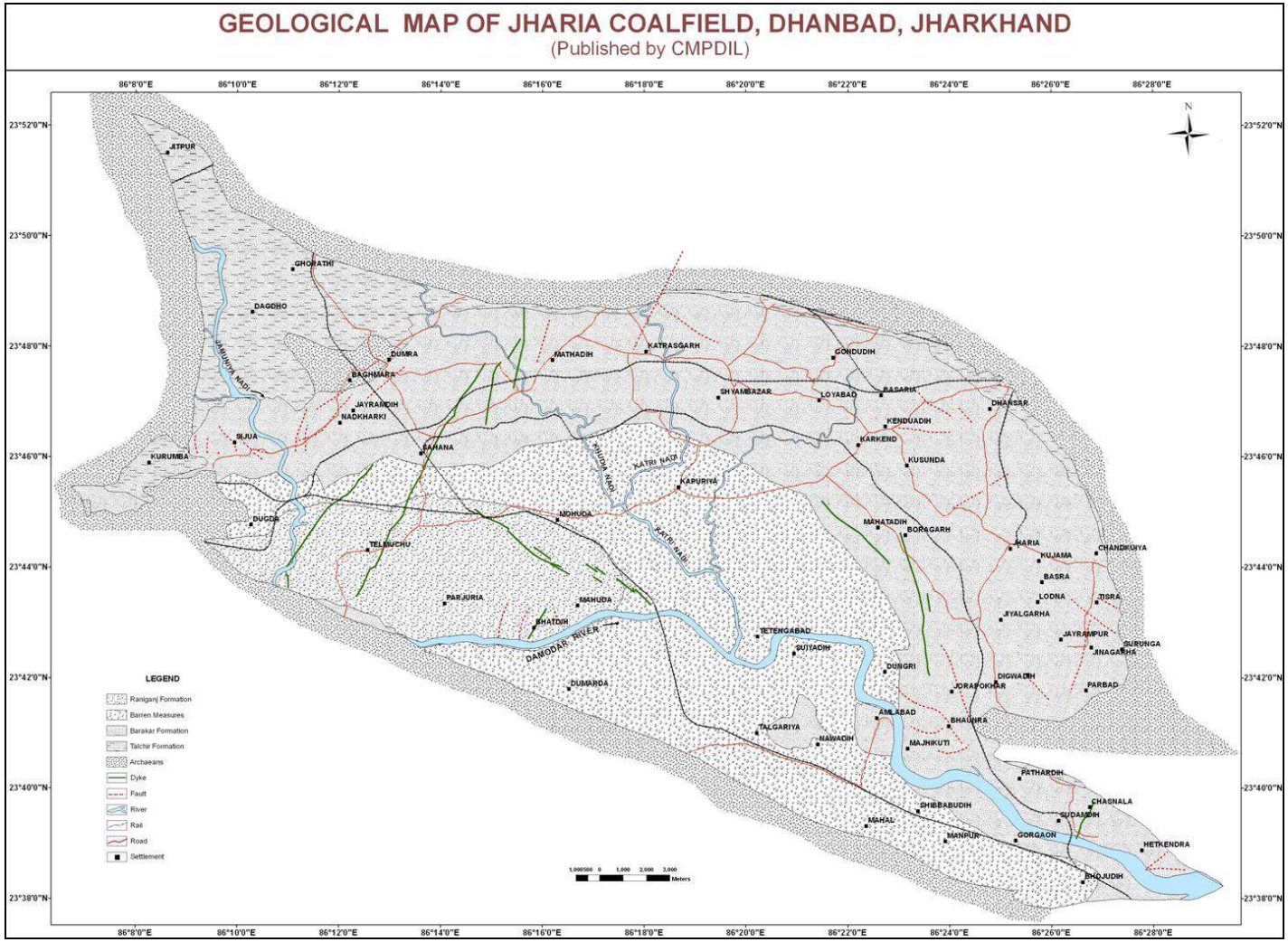

Figure 2 : Geological map of Jharia coal field, Dhanbad, Jharkhand (published by CMPIDL)

CHAPTER III

DATA REQUIREMENTS

3.1 Remote Sensing Data

The most recent available thermal satellite data was used in conjunction with the fieldwork for mapping coal fire in JCF. A coal fire map generated from the same, would serve as a reference for the fieldwork, as the observations can be verified in the field. For this purpose, a coal fire map was created from LANDSAT 8 TIRS data of 14-May 2017 .

Further, the coal fire map of 2012 prepared by NRSC (NRSC, 2012) from ASTER data was used as a reference to identify the changes that has occurred in the extent and disposition of the fires from 2012 to 2017.

For the land subsidence study, L-band microwave data from ALOS-PALSAR satellite (JAXA) were used. Five scenes of "Fine mode" SLC data were taken from PALSAR-2 archives over a period from October, 2014 to February, 2017. This was done to identify long term terrain changes and differentiate the same from short term changes due to mining excavations and overburden dumping.

Table 2: List of satellite data used in the present study.

Sl. No	Satellite	Sensor	Time	Date	Data source
1	LANDSAT-8	TIRS	Daytime	14 May 2017	USGS, USA
2	ALOS-PALSAR-2 (Fine mode)	PALSAR-2	-	4 October. 2014	JAXA, Japan
3				3 October, 2015	
4				20 February. 2016	
5				01 October, 2016	
6				18 February. 2017	

3.2 Ancillary data

1. Geological map of Jharia coal field.
2. Mine surface plans as provided by BCCL.

CHAPTER IV

REMOTE SENSING DATA ANALYSIS

4.1 Methodology

4.1.1 Processing of Landsat 8 Data

With the launch of the LANDSAT-8 mission in February, 2013; thermal space borne data is available from its thermal infrared sensor (TIRS). This has enabled monitoring of the earth with a spatial resolution of 100 m in the thermal domain with a repeat cycle of 16 days. The LANDSAT-8 has two channels (Band 10 and Band 11) in the thermal infrared region (Table 1) which ranges from 10.4 micrometer to 12.5 micrometer. In present study, band 10 of TIRS sensor (acquired on 14 May, 2017) has been used coal fire mapping (Gangopadhyay et al. 2012). The spectral domain of the band is known for its maximum transmittance (Chatterjee et al. 2007; Martha et al. 2010). The data are freely accessible through USGS portal (Landsat 8 download source: http://landsatlook.usgs.gov).

Landsat-8 data are available in GeoTiff format and the data are converted to top of the atmosphere spectral radiance using the radiance rescaling factors provided in the metadata file, using equation 1.

$$L_\lambda = M_L Q_{cal} + A_L \text{ …….. (1)}$$

Where:

L_λ = Spectral radiance (Watts/ (m2 * srad * μm)).

M_L = Band-specific multiplicative rescaling factor from the metadata.

A_L = Band-specific additive rescaling factor from the metadata.

Q_{cal} = Quantized and calibrated standard product pixel values (DN).

Once the spectral radiance (Lλ) for ASTER Band 13 and Landsat-8 band 10 data is generated, it is possible to calculate radiant (brightness) temperature directly using equation 2. Planck's radiation function (Planck, 1914) forms the basis of radiant temperature derivation from spectral radiances and the theory is discussed in detail in existing literatures (Gupta, 2003).

$$T_R = K_2 / \ln ((K_1 / L_\lambda) + 1) \text{…….. (2)}$$

T_R = Radiant (brightness) temperature,

K_1 = Calibration constant (1260.56 K),

K_2 = Calibration constant (666.09 watts/ (m2 *ster*μm)),

L_λ = Spectral radiance

4.1.2 Thresholding of radiant temperature image

Once the Landsat-8 data are converted to radiant temperature image, the next step was to segregate fire pixels from the background, which requires the estimation of the cut-off temperature (Roy et al. 2015). This has been attempted by the statistical analysis of sensor derived radiant temperature to delineate clusters (in the scatter-plot) indicative for fire and non-fire pixels. Mean and maximum radiant temperatures are derived from randomly sampled uniform sized pixel blocks distributed in entire spatial extent of Barakar formation (Figure 3) known for fire bearing coal seams. The pixel block sizes are chosen to adequately represent the overall areal extent of the coalfield and homogeneously encompass all the mining blocks (27x27 pixels for Landsat-8, Figure 3). The maximum temperature value recorded in each representative area, derived from each of the datasets, is plotted against the mean temperature. The maximum temperature represents that of fire (wherever present), whereas the mean temperature represents the average background temperature, for normalization. The fire and background populations show considerable variance, separating coal fire and background radiant temperatures. The cut-off temperature derived is the maximum temperature of the background cluster, above which all temperatures represent coal fires. In the case of the Landsat-8 data used in this study, the cut-off temperature was determined around 39°C (Figure 4). Based on this cut-offs, regional coal fire map was prepared (Figure 5).

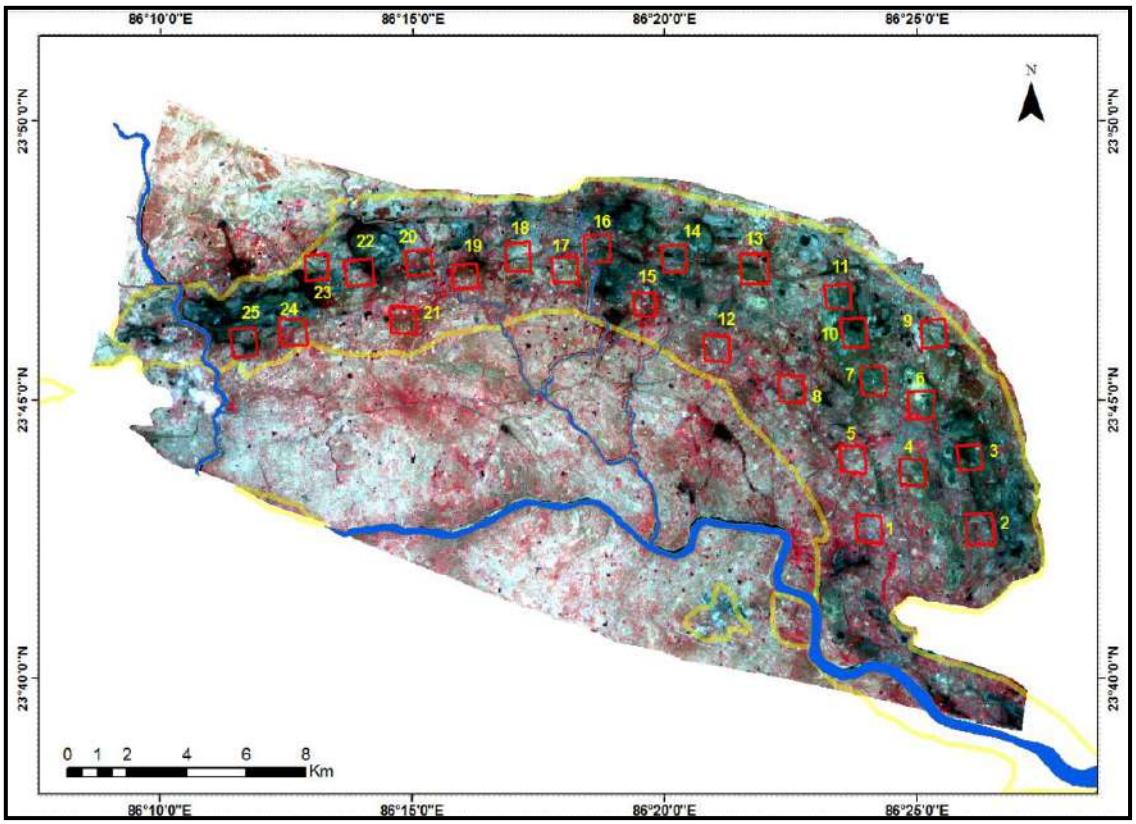

Figure 3. False colour composite image of Jharia Coalfield, with subset blocks (in red boxes) to obtain temperature values (from radiant temperature image) within the Barakar formation across the Jharia coalfield.

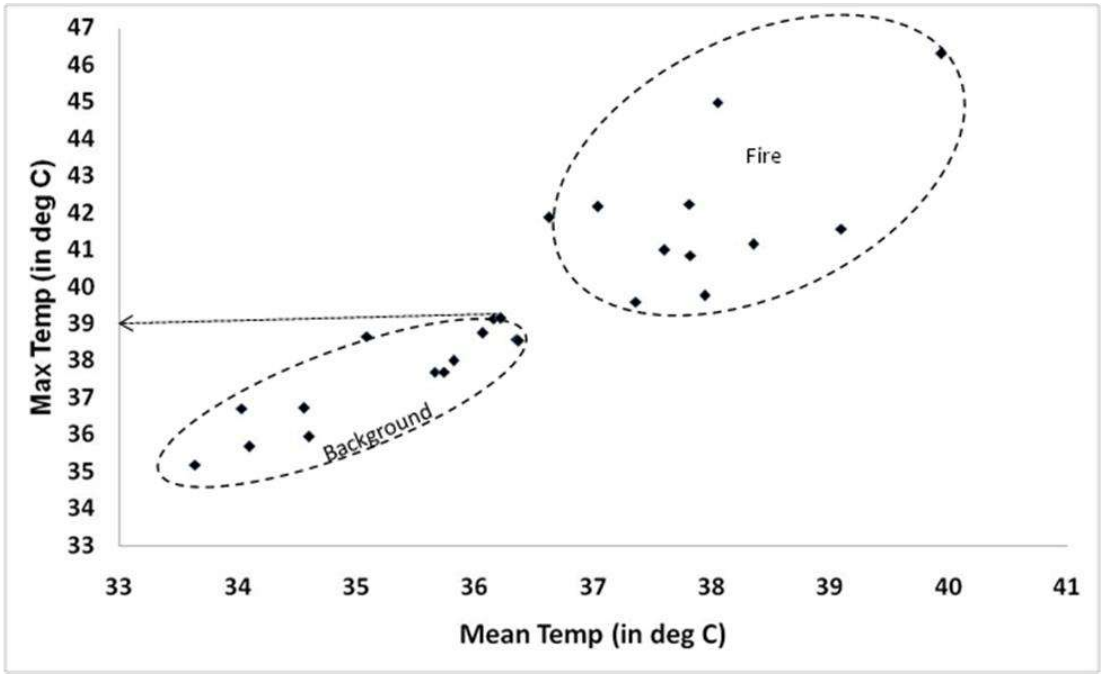

Figure 4. Maximum temperature plotted against mean temperature for various locations; cluster separation observed around 39 °C (marked with arrow)

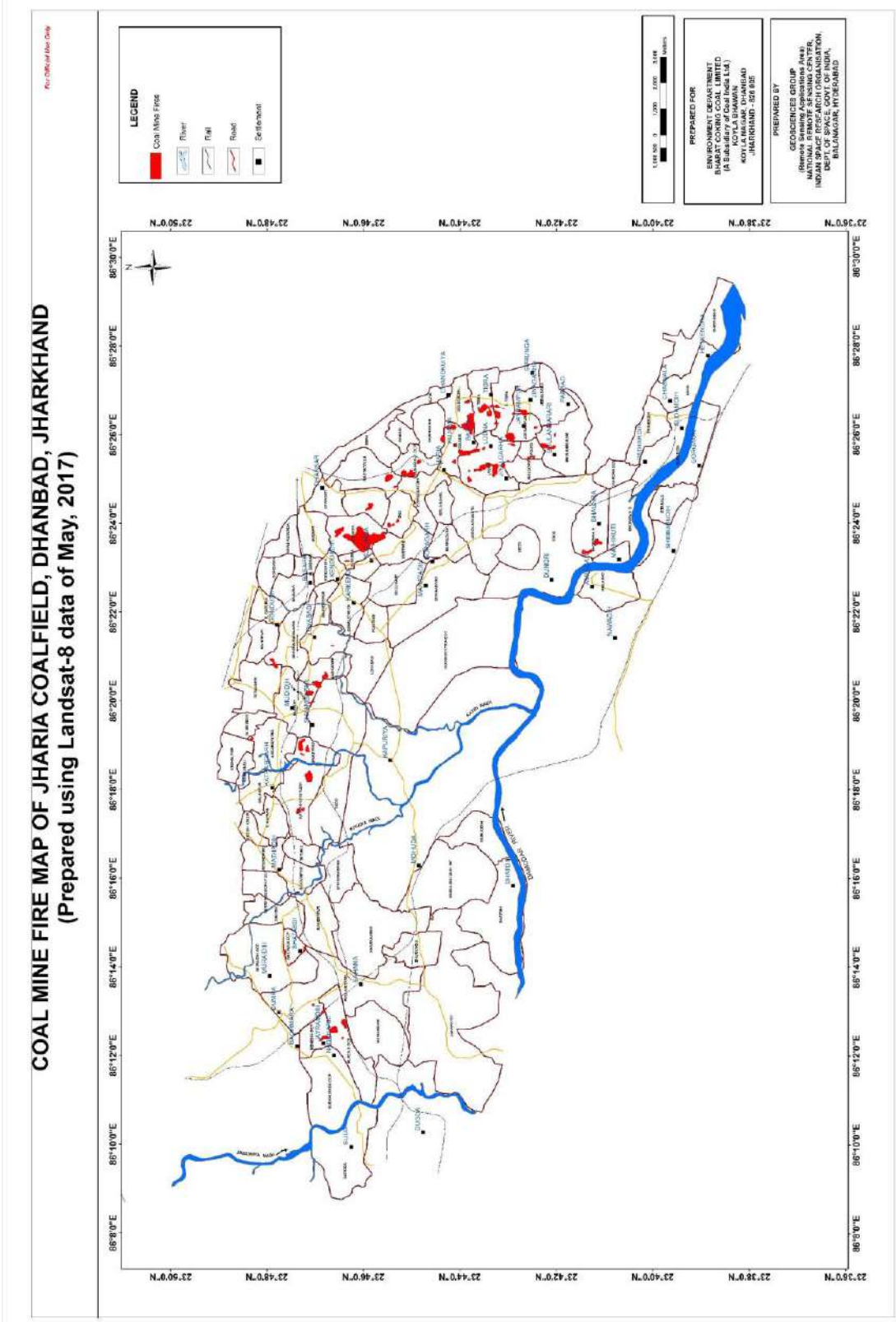

Figure 5: Coal mine fire map (May, 2017) of Jharia coal field, Dhanbad. The fire areas shown in this map have been verified in the field as per field points in figure 13.

4.2 Methodology For Subsidence Detection

4.2.1 Processing of ALOS-PALSAR 2 Data

Differential Interferometric SAR (DInSAR) techniques consist of combination of two SAR images of the same area acquired from slightly different positions (Figure 6).

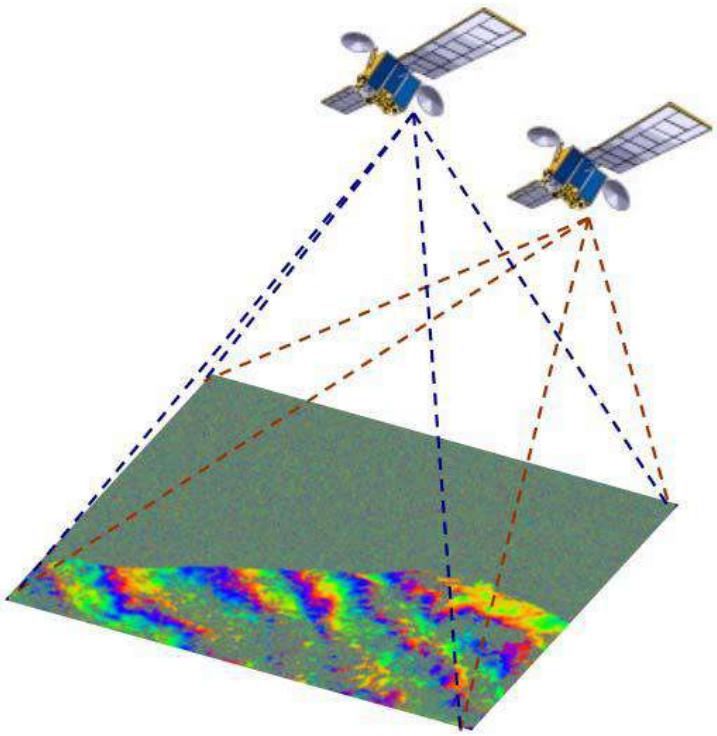

Figure 6. DInSAR acquisition scheme.

The result of this combination provides a new image, known as 'interferogram', whose phase component is formed by the following term:

$$\Delta\Phi Int = \Phi Topo + \Phi Mov + \Phi Atm + \Phi Noise \quad (3)$$

where, ΦTopo denotes the topographic component, ΦMov denotes the terrain deformation/ displacement component, ΦAtm is the noise component and ΦNoise is the thermal noise.

Topography, atmospheric effects and thermal noise needs to be removed or optimized to obtain precise measurements of terrain movement. When working with classical DInSAR interferograms (combination of two SAR images) the main problem is the presence of atmospheric artefacts, since there is no way to cancel them without a priori information. On the other hand, the term related with topography can be cancelled out using and external Digital Elevation Model (DEM) and the orbital ephemeris from the SAR acquisitions, considering no height errors on the DEM.

$$\Delta\Phi dif = \Phi ErrorTopo + \Phi Mov + \Phi Atm + \Phi Noise \qquad (ii)$$

Since the coal mine area is very dynamic in terms of its surfacial changes (open cast mine, abandoned mine, fire affected waste/reclaimed land, over burden dumps) over time, it is proposed to utilize an advanced DInSAR technique. It is a recent remarkable improvements in SAR differential interferometry that has led to an innovative approach based on the use of a large dataset of SAR images over the same area to overcome the intrinsic limitations of conventional DInSAR in terms of temporal and geometrical decorrelation as well as atmospheric disturbances (Ferretti et al 2001; Hooper et al 2004; Kampes, 2006; Lanari et al 2004; Mora et al 2003;Werner et al 2003).

Broad work flow diagram for generating land subsidence map using satellite based DInSAR technique is shown in Figure 7.

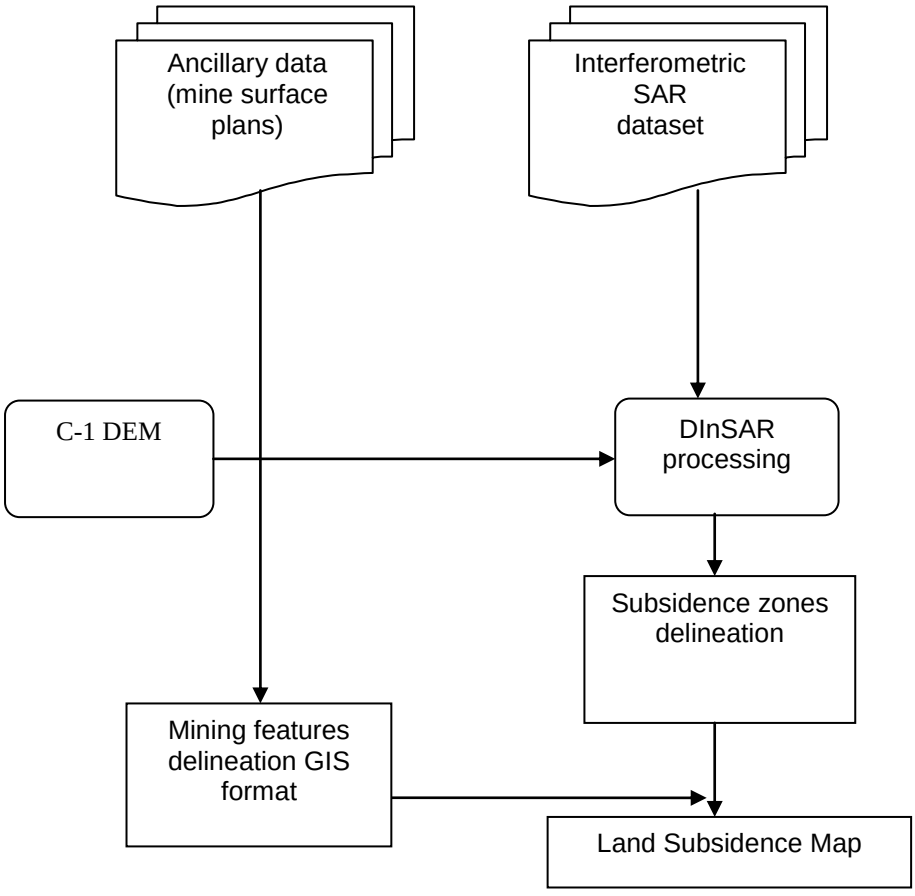

Figure 7. Work flow diagram for generating land subsidence map using DInSAR technique.

In the present study, 5 sets of ALOS-PALSAR L-band microwave data (as mentioned in table 1) were procured. The datasets were paired into master-slave pairs as per short and long temporal baselines. The short temporal baseslines include master slave pairs of time difference of six months or less, whereas long temporal baselines include data pairs of time difference of one year or more. This has been illustrated in figure 8.

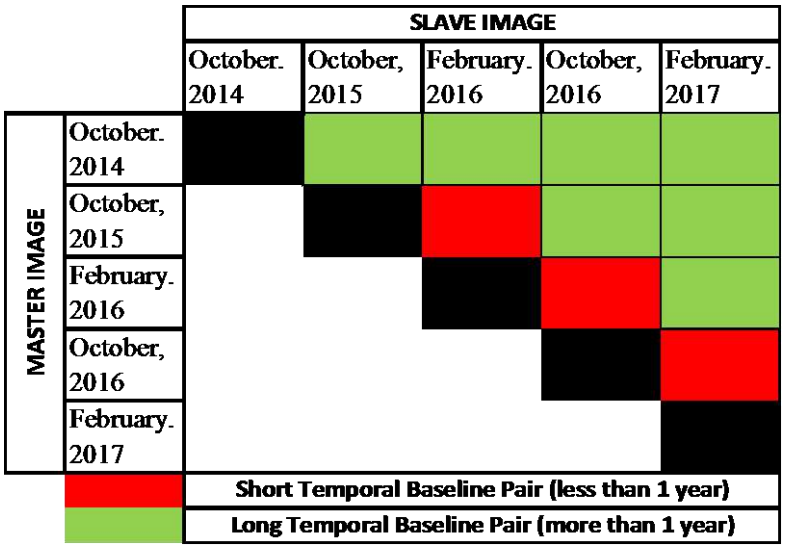

Figure 8. ALOS-PALSAR - 2 Master-Slave pairs for short and long temporal base line processing

The interferometric fringes generating from short baseline pairs will generally indicate terrain changes due to mining activity happening over a short period of time. This will include mining excavations and creation of new OB dumps adjacent to the mining area. Any incidences of slow land subsidence will not be demarcated in the results (figure 9).

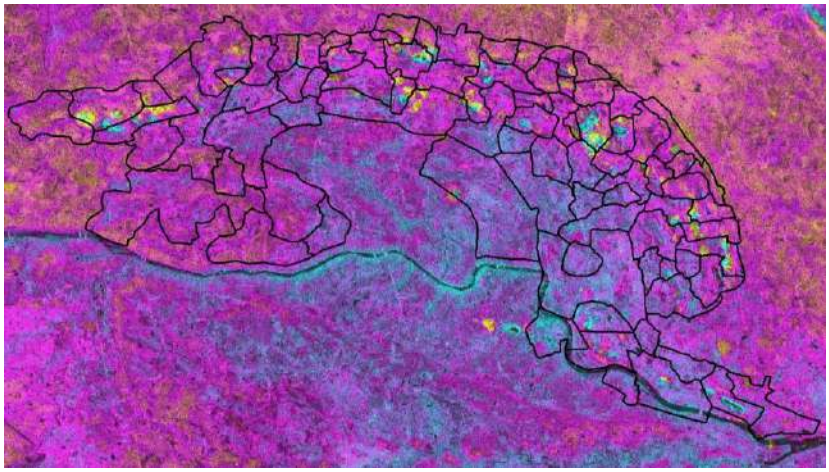

Figure 9. Fringe patterns generated from short baseline processing (e.g. Master: Oct, 16, Slave: Feb, 17).

On the other hand, master-slave pairs of long temporal baseline (one year or more, as shown in figure 8) will incorporate terrain changes due to mining activities as well, as long term ground subsidence from underground mining where ever present (figure 10).

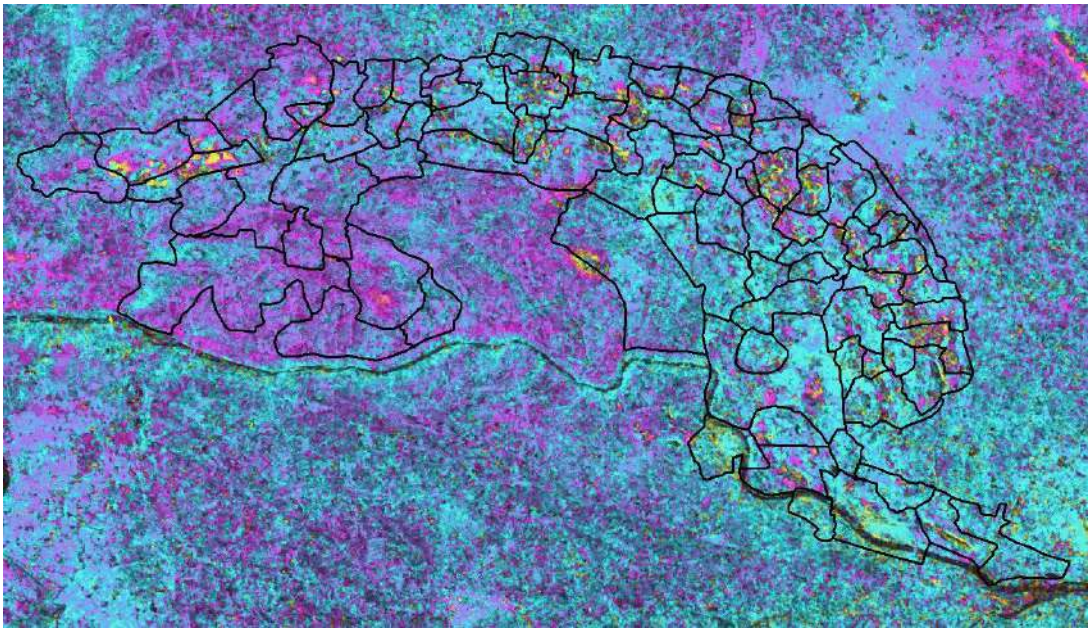

Figure 10. Fringe patterns generated from long baseline processing (e.g. Master: Oct, 15, Slave: Feb, 17).

The results from the long and short baseline processing can be compared and zone where fringes have been developed due to terrain changes due to mining excavation and dumping, can be systematically identified and demarcated. The remaining fringes from the long temporal baseline processing will then indicated towards zones where subsidence has taken place due to underground mining. Using this, a terrain change

map of the Jharia Coalfield was generated demarcating terrain changes due to mining activities and subsidence areas (Figure 11).

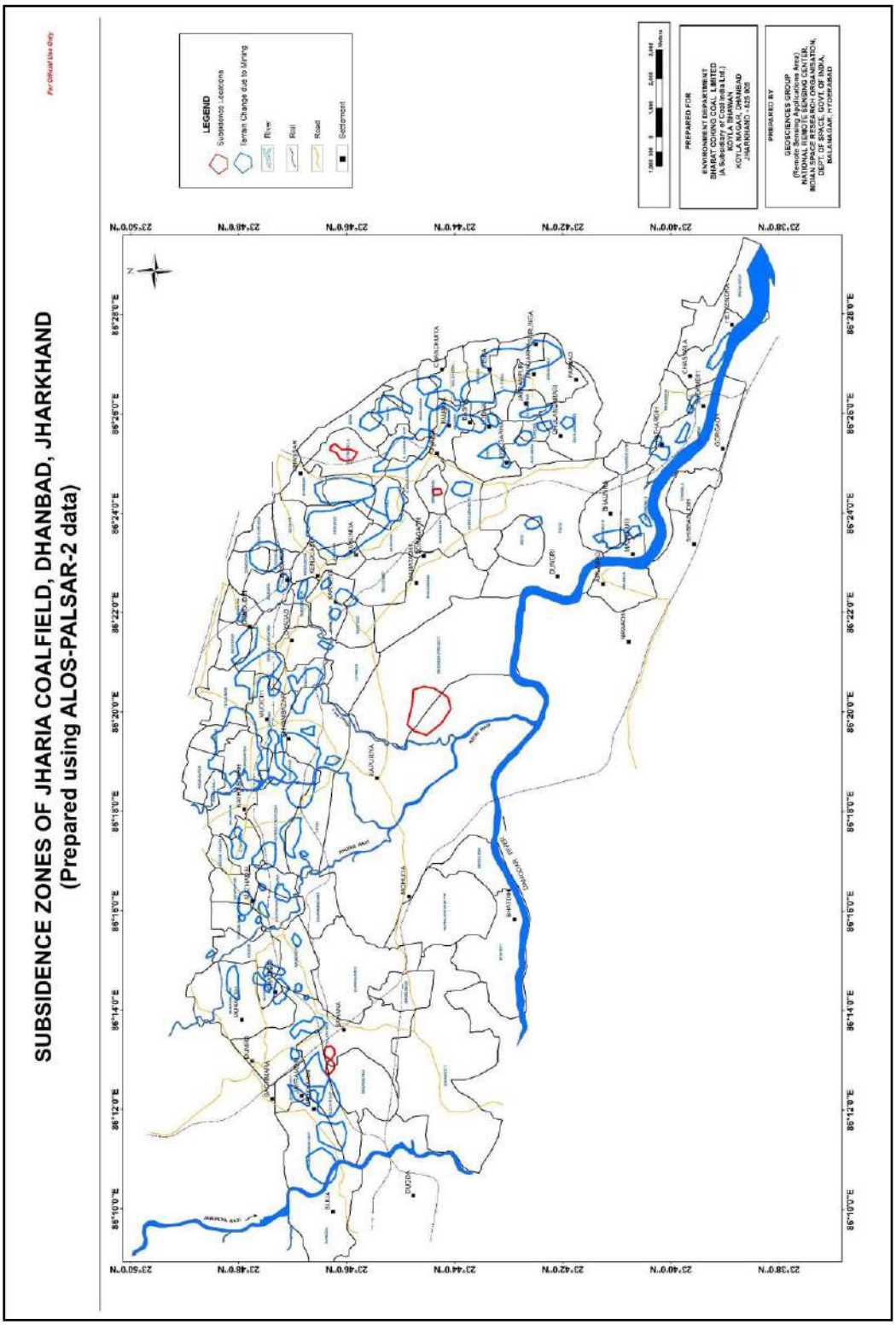

Figure 11: Subsidence map of Jharia coal field, Dhanbad.

CHAPTER V

FIELD WORK

A field work for verification of the coal fire locations and the subsidence zones as identified by the satellite data were taken up in December, 2017. A total of 53 coal fire points and 37 land subsidence locations were identified from the satellite data analysis. The locations of these points along with geographic coordinates were given to BCCL prior to the December, 2017 field work for their feedback on the status of these points. Out of the 53 coal fire locations identified, 52 points were confirmed to be fire bearing as per the present masterplan of the Jharia coalfield created by BCCL Both the coal fire and the subsidence locations were further independently verified by NRSC during the fieldwork in December, 2017. The locations and the observations are coal fire and subsidence are provided in annexure 1 and annexure 2 of this report respectively.

The salient overview of the field observations are as follows:

Coal-fire observations:

1. The coal fires as observed identified by the Landsat-8 data are mostly accurately delineated. Fires have been identified in the western, northern and eastern flank of the coalfield with considerable accuracy in the spatial locations.
2. In the eastern flank, the main fire affected mines are Kusunda, Lodna and Tisra. Active fires area present in the mines and fumes can be seen from the OB dumps. The Bhowra and Bhulanbarari mines also show presence of fire, however, the extent of the fire area appears to be underestimated in the data. Similarly, the extent of fires in Lodna and Tisra appears to have been overestimated in the data. The largest extent of fire in the single mine block is that in Kusunda.
3. In the northern flank, the main fire bearing mines are Katras, Gaslitand and Mudidih, However, it is seen that in these areas, the fires appears in pockets and are not pervasively present. The spatial extent of the fires on the ground and as estimated in the data can be correlated.

4. In the western flank, the Block II OCP is the primary fire affected region. However, it is seen that the Shatabdi OCP also bears fire pockets along semi-vertical mine walls, This is not identified in the data.

Subsidence location observations:

1. Subsidence locations as identified by the data area difficult to verify in the field, unless there are tell-tale signatures like large cracks or fissures on the ground or damage to anthropogenic constructions like vertical cracks on building cracks etc.
2. Out of the 37 identified subsidence locations from the microwave data, it is seen that 32 are due to terrain changes resulting from mining activities like ongoing excavations or formation of new mining dump. These decrease or increase in elevations has resulted in forming of interferometric fringes in the data thus creating false positives.
3. Five areas were firmly established as subsidence zones. Out of these, the main area where subsidence is occurring in a pervasive scale, is that in the Moonidih Underground Project. The Moonidih Project is an underground long wall mine where excavations are going on for over decades. This may have resulted in pervasive subsidence in the region. The signatures of subsidence such as ground cracks are observed in the area.
4. Two adjacent locations are observed south of the Block II OCP and in Phularitand mining block. This may be resulted due to older underground mining in the area. Signatures such as sagging of ground is seen.
5. Another minor subsidence region was identified around the Simlabahal underground mining project. This is again due to active underground mining in the area. A similar region was also observed in the northern part of the Bastacolla mines where active underground mining is ongoing.

In lieu of the observations in field on the fire and subsidence locations, few post field work correction in the coal fire and subsidence maps was necessitated and has been discussed in the next chapter.

CHAPTER VI

POST FIELDWORK ANALYSIS

As observed in the fieldwork, there were certain mine areas where the presence of fire was not detected by the satellite data. For example in Shatabdi and Bhulanbarari mine areas, the fire appears in small pockets on mine faces and was possibly not detected by the threshold temperature calculated for the entire mine area. On the other hand, in the Bhowra, Lodna and Tisra mine areas, the spatial extent of fire appears to have been overestimated by the regional threshold temperature use to separate the fire and the background areas.

Therefore, mine specific threshold temperature analysis was carried out for Shatabdi, Bhulanbarari, Bhowra, Lodna and Tisra mine areas to correctly depict the fire areas on the ground. The threshold temperature selected from each of these mine areas are given in Table 3.

Table 3: Threshold temperature for fire area estimation of individual mines.

Name of the Mine Block	Threshold Temperature (in °C)
Bhowra	38.5
Tisra (north and south)	North : 41; South : 40.5
Lodna	41
Bhulanbarari	38.5
Shatabdi	38

Using the threshold temperatures as mentioned in the table 3, the previously undetected fire areas in the Shatabdi and Bhulanbarari mines were detected. Further the spatial extent of the fire areas in Bhowra, Lodna and Tisra mines were changed to adequately represent the actual extent of the fire on the ground. These were incorporated in the coalfire map shown in figure 5.

CHAPTER VII

DISCUSSIONS AND CONCLUSIONS

7.1 Discussions

7.1.1 Coal fire analysis

The present study is aimed to provide the status of coal fire in the Jharia coal field for the period of 2017. Landsat-8 data of May, 2012 was used to prepare the coal mine fire map (Figure 5) for the year 2017. The data have 100 m spatial resolution in the thermal bands and is as on study date, the best thermal satellite data available. The Coal fire maps of 2017 when compared to map of 2012 (NRSC, 2014) depicts the dynamics of coal fire. Coal fire is difficult to mitigate because of its dynamic nature. But the understanding the trend in the shift of coal fire zones and over all distribution of coal fire will help in environmental and risk management related to coal mining activities.

The coal mine fire map for the year 2017 (Figure 5 illustrates the overall fire distribution in the area). The maps reveal that the coal fires are distributed across the Jharia coal field in pockets associated with major open cast mining activities. All most all the coal mine fires are restricted to the Barakar Formation where coal seams are exposed. In the eastern flank of the arcuate shaped mining extent, the collieries in Lodna and Tisra (North and South) is the highest fire affected mining blocks and Bhowra, Bhulanbarari, Kujama and Jharia are also affected by multiple smaller fire pockets. The fire in the areas is mostly manifested by high temperature fume cracks with occasional presence of active flames especially the the Lodna-Tisra area. Further, towards the north east, in Ena and Kusunda active fires are more prevalent and the area is extensively affected. The highest radiant temperatures (in order of ~50°C) are recorded by the satellite sensors in these areas. In the north, a large number of moderate to small fire pockets are seen in the areas around Shyambazar (Figure 5 & 6). These are related to the mining areas of Katras, Gaslitand, Mudidih and Kankanee. Mining activity, over the last few of years has exposed new, isolated and discontinuous fires in these regions.

In the western flank, three distinguishable fire affected zones are seen. Toward the western end of the mining area, the Benedih and Block II OCP are affected by smaller fires from isolated coal seams. These again are surfacialy manifested in the

form of fume cracks with smoke emanating from them. The Shatabdi OCP are also affected but fire is manifested in the along vertical mining wall sections.

Comparison of the 2017 coal fire map with that of 2012 (NRSC, 2014) indicated the dynamism in the spatial extent and distribution of the coal fires. The changes are highlighted as follows:

i. In reference to the map generated in 2012, the 2017 map shows that the emergence/re-emergence of fires in the eastern flank, namely Kujama, Tisra, Lodna and Jharia etc. The entire zone has been affected by multiple fire occurrences. The spatial disposition of fires in Bastacolla, Jharia and Bhulanbarari appear to have a minor increase.
ii. The areal extent of major fire zone around Kusunda/Kenduadih and Ena appears to remain the same, though here again the spatial location of the anomalies has changed. This is probably due to the mitigation and active mining in this region.
iii. The fire zones in Benedih/Block II OCP and Shatabdi OCP have also changed/diminished in areal extent with presence of isolated smaller anomalies. There has been a considerable reduction in fire areas in and around the Shatabdi OCP.
iv. The spatial disposition of fire areas around Katras, Gaslitand and Mudidih show minor change. In 2012, a number of small fire pockets were seen, however presently those fire pockets have given away to a few fire zones of moderate disposition.
v. It needs to be noted that the 2012 study was carried out using ASTER data whereas the present study is carried out using Landsat-8 data. Therefore, the difference of sensor sensitivities will have a influence on the way the fires are sensed on the ground. Difference of sensor sensitivities will influence the number of fires identified as well as the areal extent of the fires in the data.

In summary, there is a change in the areal disposition of the fires from 2012 to 2017. Observations suggest the emergence/re-emergence of new areas in the eastern flanks in areas around Lodna and Tisra. Concurrently, there is a decrease in extent of fire areas Shatabdi, Nadkhurkee area in the western flank from 2012 to 2017. A quantitative comparison of the 2012 and 2017 data was carried out. As compared

2012, when the total fire affected extent of about 2.18 km^2; in 2017 total fire affected extent is about 3.28 km^2. The colliery wise break-up of change in fire area from 2012 to 2017 is given in Annexure III.

7.1.2 Subsidence analysis

An attempt to identify subsidence zones in the Jharia Coalfield was also carried out using ALOS-PALSAR-2 L band microwave data using differential interferometric technique. 5 scenes of PALSAR-2 data spanning over a period of 2014 to 2017 were used to delineate the subsidence if any in the region and separately identify them from the terrain changes due to mining. Verification of the subsidence zones as seen from data is difficult as it requires visible signatures of subsidence in the form of cracks on the ground and damage to anthropogenic structures. In this study, data analysis and consequent field verification resulted in identification is 5 prominent subsidence areas. Of these, the major area where considerable ground subsidence is occurring is the Moonidih UG project. Long term underground mining has resulted in continuous subsidence in the area. Apart from this, the other four areas are south of Block II OCP, Simlabahal and Bastacolla. No quantitative estimates of the subsidence has been carried out in the study.

7.2 Conclusions

The following conclusions can be made:

1. As of the date of study in the year 2017 and in comparison with the previous study done in 2012, there has been a change in areal extent and disposition of the fire affected areas.
2. Compared to 2012, the eastern flanks (Lodna, Tisra areas) show considerable increase in fire disposition and the western flank (Shatabdi and Block II area) show diminished fire presence.
3. The major new fire areas are observed in the northern flank in the areas around Lodna and Tisra etc. These areas were not mapped as fire in the 2012 study.
4. The mines in Kenduadih and Lodna remain to be the worst affected with maximum presence of active fires.
5. There is a increase in areal extent of the fire (Figure 12) from 2012 to 2017.

Note: *Estimations of fire extent (in terms of sq.km.) both in 2012 and in the present 2017 study are pixel based. They do not represent the actual ground area under fire. These estimations are made for comparative purpose only, to indicate the increase or decrease of areal disposition of fire. Hence, they should not be quoted as fire area on the ground.*

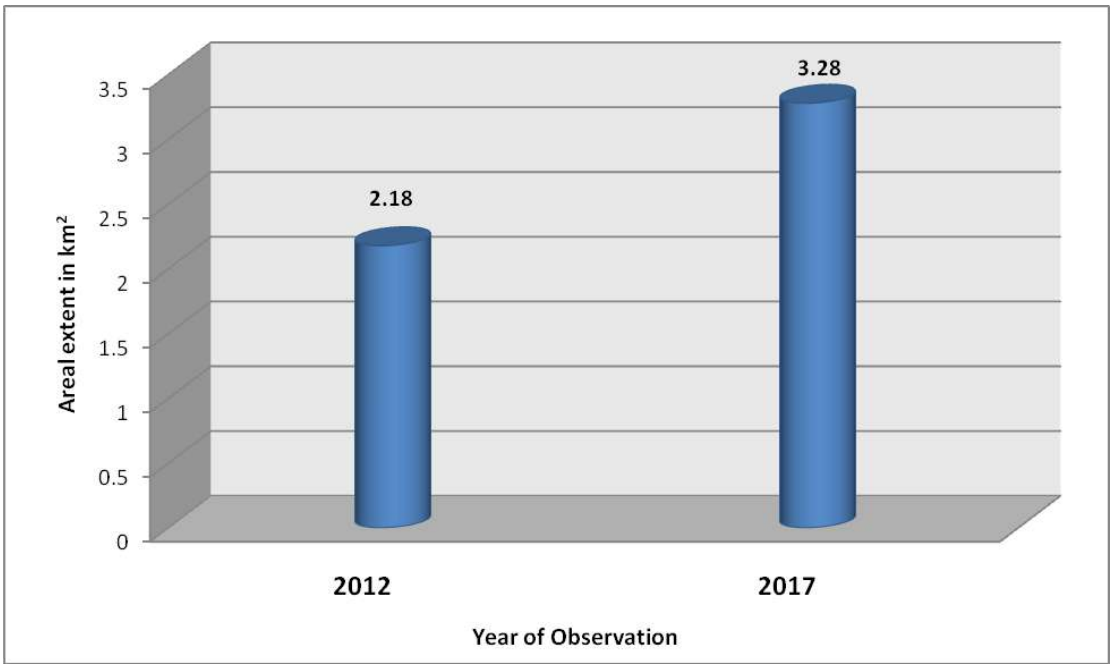

Figure 12: Total fire area statistics

CHAPTER VIII

LIMITATIONS

Delineation and mapping of coal fire from thermal data of remote sensing platforms carries with it some inherent limitations which needs to be understood in order to decipher the results obtained from it. This will assist is deducing the correct information and remove any ambiguity associated with the results. The key limitations of the data and the results obtained are as follows:

1) An anomalous pixel from LANDSAT data represents an area of 30m x 30m (resampled from spatial resolution of 100m) on the ground whose temperature is considerably higher than its surroundings. This can be attributed to two circumstances, namely the area has a very high intensity fire located within a smaller pocket or there are a number of low intensity fires spread across it. In both the mentioned cases the actual areal extent of the fire on the surface differs, but appears as a single anomalous pixel in the data. Hence, representation of fire affected ground area by means of pixel area is ambiguous and hence should be considered with caution.

2) There are locations as observed during the fieldwork, where coal seams are affected by active fires along vertical/semi-vertical sections of open cast mines (see cover page). In such cases, the actual areal expression of the fire affected area as seen by the sensor changes considerably and the representation from the same is not accurate.

3) As discussed in section 4.2.1, thresholding the data to separate the fires from the non fire areas, is a statistical technique. However, this method is dependent on how the temperature of non-fire background area is distinctive from the fire temperature.

4) The background temperatures vary with the time of the day when the data is collected, topography, and season of the year when the data is acquired. Night-time data has lower background temperature as compared to day-time. Similarly a data collected in October-November will have a considerably lower background temperature than that collected in May-June due to seasonal temperature variations. Hence, identification of the background temperature range becomes essential in

estimation of threshold temperature and the same varies depending upon the discussed controlling factors.

5) Generally, a constant threshold temperature is estimated over the entire study area, and the same is applied to delineate the fire areas from those of non-fire. However, it is seen that the application of such global thresholding may mask fires which are in turn seen in the field and that the threshold temperature value may vary locally. In the current scenario, it is seen that the fire locations as verified in the fieldwork at Bhulanbarari and Shatabdi were not identified in the data on application of a global threshold of 39°C. However, a subset of the data within the Bulanbarari area only, is analyzed with a lower threshold of 38.5°C, the fire pixels are manifested in the data. Hence, the appropriateness of a singular thresholding temperature value may need to be relooked upon. Future studies can be carried out using colliery wise statistical local thresholding to create a composite coal fire map.

6) Due to the mitigation measures taking place in various mines, it is seen that in a number of places the fire affected seam is excavated and dumped as overburden. However, these overburden dumps retains the excavated burning coals and thus are seen to have active fires occasionally. There lies a possibility that the same will be identified as anomalous pixels and hence, although the fire is not a part of any active coal seam, it will be included as a fire affected area in the final map.

7) Verification of the subsidence zones as detected from the interferometric technique is sometimes difficult due to lack in observable signatures of subsidence such as cracks on the ground and damage to anthropogenic structures.

Therefore, in quantitative estimation of fire affected areas and areas denoted as subsidence, the above mentioned limitations needs to be taken into account diligently, as it is inevitable that the area estimate will not define the actual fire/subsidence affected area on the ground. However, the areal extent estimated from the data can be "like to like" compared to earlier estimates of similar studies to understand the change and dynamism of the fire in terms of area affected and spatial disposition.

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Annexure –I

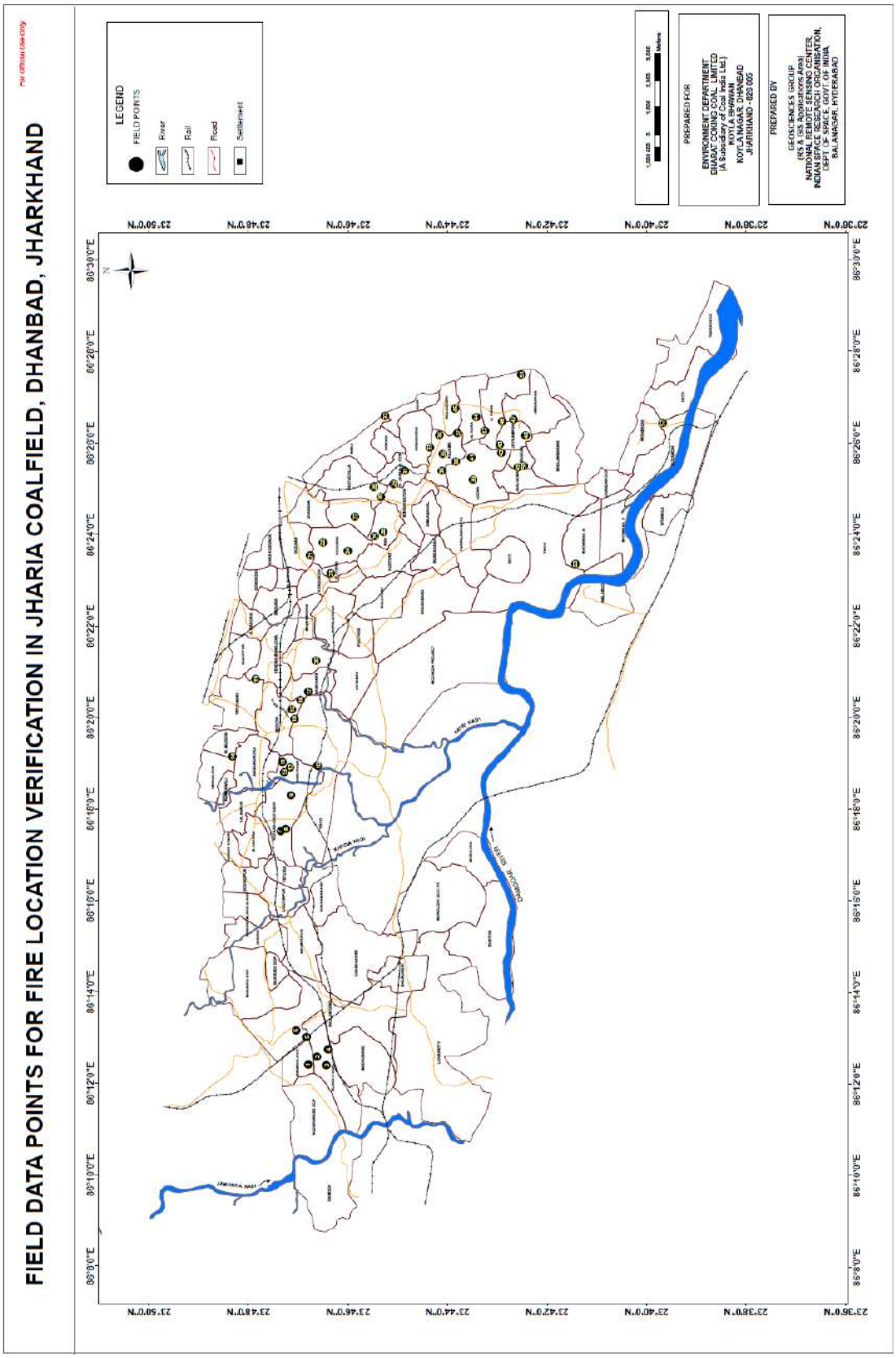

Figure 13. Field data points for coal fire verification

Table – 4: Coal Fire observations during fieldwork (see figure 13 for reference)

SL. No.	Point of Observations		Comments		
	Latitude	Longitude	Type of Mining Activity	Presence of Coal Fire	Mine name and Any other Comments
1	23.7801	86.2068	OB Dump	Fire	ABOCP
2	23.7771	86.2097	Active Mine	Fire	ABOCP
3	23.7739	86.2066	Active Mine	Fire	ABOCP
4	23.7733	86.2124	OB Dump	Fire	ABOCP
5	23.7806	86.2168	No Working	Fire	ABOCP
6	23.7841	86.2192	No Working	Fire	Phularitand
7	23.7893	86.2919	No Working	Fire	Katras Chatudih
8	23.7875	86.2926	No Working	Fire	Katras Chatudih
9	23.7857	86.3049	Working	Fire	Gaslitand
10	23.7768	86.3157	Outside Jharia Mines		Tata
11	23.7887	86.3170	OB Dump	Fire	Gaslitand
12	23.7862	86.3151	OB Dump	Fire	Gaslitand
13	23.7880	86.3133	OB Dump	Fire	Gaslitand
14	23.8054	86.3191	Working	Fire	AKWMC
15	23.7855	86.3363	OB Dump	Fire	Mudidh
16	23.7826	86.3397	Working	Fire	Kankanee
17	23.7800	86.3427	Working	Fire	Kankanee
18	23.7848	86.3327	OB Dump	Fire	Mudidih
19	23.7977	86.3473	OB Dump	Fire	Sendra Bansjora
20	23.7775	86.3540	OB Dump	Fire	Loyabad
21	23.7793	86.3924	No Working	No fire	Kusunda (Domestic coal burning)
22	23.7753	86.3970	Working	Fire	Kusunda
23	23.7724	86.3858	Working	Fire	Kusunda
24	23.7669	86.3940	OB Dump	Fire	Kusunda
25	23.7578	86.3993	OB Dump	Fire	Ena
26	23.7550	86.4009	OB Dump	Fire	Ena
27	23.7645	86.4065	Working	Fire	ADIC
28	23.7580	86.4172	Old Quarry	Fire	ROCP
29	23.7515	86.4184	OB Dump	Fire	ROCP
30	23.7559	86.4137	OB Dump	Fire	ROCP
31	23.7476	86.4232	Working	Fire	ROCP
32	23.7543	86.4431	Outside Jharia Mines		Unknown site (Out side of Kuya)
33	23.7394	86.4317	Active Mine	Fire	Ghanoodih
34	23.7360	86.4362	OB dump	Fire	Goluckdih
35	23.7349	86.4293	OB Dump	Fire	Kujama
36	23.7354	86.4232	No Working	Fire	Kujama
37	23.7301	86.4369	Working	Fire	NT-ST
38	23.7305	86.4265	OB dump	Fire	Kujama
39	23.7249	86.4200	No Working	Fire	Lodna
40	23.7159	86.4327	Working	Fire	Joyrampur
41	23.7254	86.4280	No Working	No fire	Lodna
42	23.7209	86.4376	Working	Fire	NT-ST
43	23.7154	86.4296	Working	Fire	Lodna
44	23.7238	86.4427	Working	Fire	NT-ST
45	23.7309	86.4457	OB dump	Fire	NT-ST
46	23.7151	86.4412	Active Mine	Yes	NT-ST
47	23.7114	86.4419	OB Dump	Fire	NT-ST
48	23.7073	86.4360	Active Mine	Fire	Joyrampur
49	23.7097	86.4243	Working	Fire	Bagdigi/Joyrampur
50	23.7079	86.4249	Active Mine	Fire	Bagdigi/Joyrampur
51	23.7086	86.4582	Outside Jharia Mines		Unknown site (Out side of NT-ST)
52	23.6614	86.4404	Outside Jharia Mines		Chasnala
53	23.6906	86.3892	OB dump	Fire	Bhowrah (North)

Annexure –II

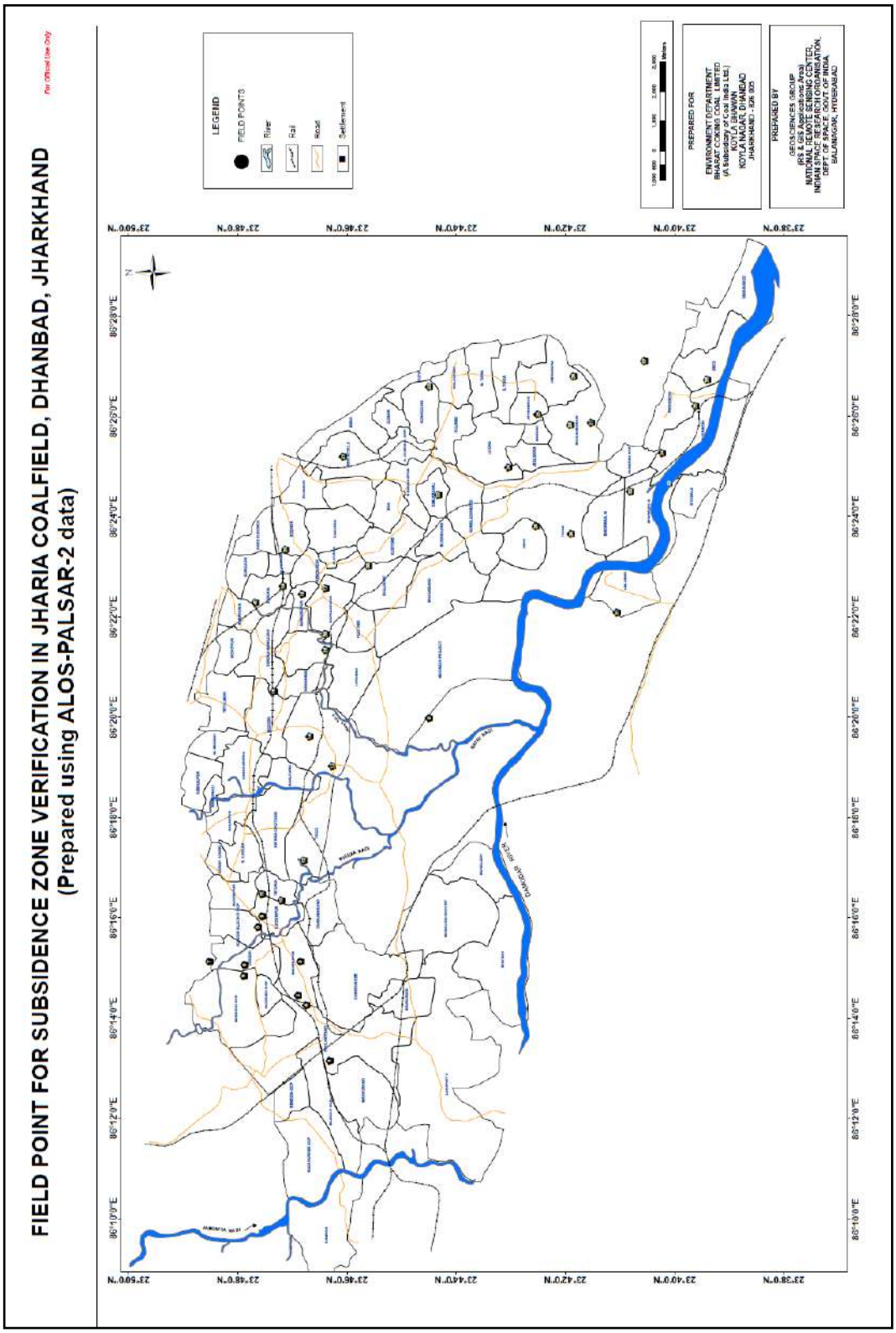

Figure 14. Field data points for subsidence verification

Table – 5: Coal Fire observations during fieldwork (see figure 14 for reference)

	Point of Observations		Comments	
Sr. no.	Latitude	Longitude	Mine name and Any other Comments	Signs of Subsidence (crack on building/ground crack etc.)
0	**23.7416**	**86.3338**	Moonidih UG Project	Sagged area, Building damage
1	**23.7722**	**86.2192**	South of Block II (2 areas)	Cracks on the ground
2	**23.7817**	**86.2409**	Terrain Change due to mining	
3	**23.7811**	**86.2521**	Terrain Change due to mining	
4	**23.7792**	**86.2376**	Terrain Change due to mining	
5	**23.7983**	**86.2473**	Terrain Change due to mining	
6	**23.7981**	**86.2510**	Terrain Change due to mining	
7	**23.8088**	**86.2521**	Terrain Change due to mining	
8	**23.7941**	**86.2636**	Terrain Change due to mining	
9	**23.7926**	**86.2671**	Terrain Change due to mining	
10	**23.7868**	**86.2724**	Terrain Change due to mining	
11	**23.7928**	**86.2746**	Terrain Change due to mining	
12	**23.7800**	**86.2857**	Terrain Change due to mining	
13	**23.7713**	**86.3171**	Terrain Change due to mining	
14	**23.7783**	**86.3270**	Terrain Change due to mining	
15	**23.7893**	**86.3419**	Terrain Change due to mining	
16	**23.7734**	**86.3556**	Terrain Change due to mining	
17	**23.7734**	**86.3762**	Terrain Change due to mining	
18	**23.7804**	**86.3742**	Terrain Change due to mining	
19	**23.7865**	**86.3769**	Terrain Change due to mining	
20	**23.7855**	**86.3890**	Terrain Change due to mining	
21	**23.7679**	**86.4199**	Bastacolla	Sagged areas
22	**23.7390**	**86.4071**	Simlabahal UG	Sagged areas
23	**23.7417**	**86.4431**	Terrain Change due to mining	
24	**23.7176**	**86.4163**	Terrain Change due to mining	
25	**23.7085**	**86.4339**	Terrain Change due to mining	
26	**23.6986**	**86.4304**	Terrain Change due to mining	
27	**23.6923**	**86.4312**	Terrain Change due to mining	
28	**23.6977**	**86.4466**	Terrain Change due to mining	
29	**23.7092**	**86.3967**	Terrain Change due to mining	
30	**23.6985**	**86.3942**	Terrain Change due to mining	
31	**23.6845**	**86.3681**	Terrain Change due to mining	
32	**23.6804**	**86.4083**	Terrain Change due to mining	
33	**23.6685**	**86.4110**	Terrain Change due to mining	
34	**23.6706**	**86.4211**	Terrain Change due to mining	
35	**23.6603**	**86.4366**	Terrain Change due to mining	
36	**23.6568**	**86.4454**	Terrain Change due to mining	
37	**23.6760**	**86.4516**	Terrain Change due to mining	
38	**23.7603**	**86.3836**	Terrain Change due to mining	
39	**23.7734**	**86.3609**	Terrain Change due to mining	
40	**23.7948**	**86.3715**	Terrain Change due to mining	

Annexure –III

SL. NO.	COLLIERY AREA NAME	FIRE AREA 2012 (SQ. KM.)	FIRE AREA 2017 (SQ. KM.)	AREA CHANGE (SQ. KM.)	Increase/Decrease
1	DAMODA	0.0000	0.0000	0.000	**NO FIRE**
2	TISCO (west)	0.0000	0.0000	0.000	**NO FIRE**
3	IISCO	0.0000	0.0000	0.000	**NO FIRE**
4	TISCO (north)	0.0885	0.0153	-0.073	**DECREASE**
5	NUDKHURKEE OCP	0.0000	0.0000	0.000	**NO FIRE**
6	BENEDIH OCP	0.0530	0.0453	-0.008	**DECREASE**
7	BLOCK-II OCP	0.0530	0.1353	0.082	**INCREASE**
8	MURAIDIH OCP	0.1478	0.0022	-0.146	**DECREASE**
9	SHATABDI OCP	0.0378	0.0361	-0.002	**DECREASE**
10	TETURIA	0.0000	0.0000	0.000	**NO FIRE**
11	S.GOVINDPUR	0.0000	0.0000	0.000	**NO FIRE**
12	KORIDIH BLOCK-IV OCP	0.0000	0.0000	0.000	**NO FIRE**
13	JOGIDIH	0.0000	0.0000	0.000	**NO FIRE**
14	DHARAMABAND	0.0000	0.0000	0.000	**NO FIRE**
15	MAHESHPUR	0.0000	0.0000	0.000	**NO FIRE**
16	PHULARITAND	0.0133	0.0205	0.007	**INCREASE**
17	MADHUBAND	0.0000	0.0000	0.000	**NO FIRE**
18	AKASH KINARI	0.0000	0.0000	0.000	**NO FIRE**
19	GOVINDPUR	0.0000	0.0000	0.000	**NO FIRE**
20	E. KATRAS	0.0133	0.0000	-0.013	**DECREASE**
21	KATRAS-CHOITUDIH	0.1021	0.1368	0.035	**INCREASE**
22	KESHALPUR	0.0000	0.0013	0.001	**INCREASE**
23	RAMKANALI	0.0000	0.0000	0.000	**NO FIRE**
24	NICHITPUR	0.0000	0.0000	0.000	**NO FIRE**
25	E. BASURIA	0.0000	0.0000	0.000	**NO FIRE**
26	KHAS KUSUNDA	0.0000	0.0000	0.000	**NO FIRE**
27	GONDUDIH	0.0000	0.0000	0.000	**NO FIRE**
28	W. GODHAR	0.0012	0.0000	-0.001	**DECREASE**
29	BASURIA	0.0000	0.0000	0.000	**NO FIRE**
30	TETULMARI	0.0223	0.0220	0.000	**DECREASE**
31	DHANSAR	0.0000	0.0000	0.000	**NO FIRE**
32	GODHAR	0.1073	0.0000	-0.107	**DECREASE**
33	INDUSTRY	0.0119	0.0513	0.039	**INCREASE**
34	KUSUNDA	0.4243	0.7398	0.315	**INCREASE**
35	SENDRA-BANSJORA	0.0796	0.0275	-0.052	**DECREASE**
36	BASTACOLLA	0.0663	0.0810	0.015	**INCREASE**
37	BERA	0.0000	0.0000	0.000	**NO FIRE**
38	KUYA	0.0000	0.0000	0.000	**NO FIRE**
39	GOLUCKDIH	0.0301	0.1122	0.082	**INCREASE**
40	KUJAMA	0.0398	0.2404	0.201	**INCREASE**

41	S. JHARIA-R. OCP	0.0244	0.1118	0.087	INCREASE
42	DOBARI	0.0000	0.0000	0.000	NO FIRE
43	GONHOODIH	0.0398	0.0322	-0.008	DECREASE
44	SIMLABAHAL	0.0000	0.0000	0.000	NO FIRE
45	HURRILADIH&STD	0.0000	0.0000	0.000	NO FIRE
46	ENA	0.0918	0.0432	-0.049	DECREASE
47	BURRAGARH	0.0000	0.0000	0.000	NO FIRE
48	N. TISRA	0.0098	0.1802	0.170	INCREASE
49	LODNA	0.0000	0.3527	0.353	INCREASE
50	S. TISRA	0.0000	0.1015	0.102	INCREASE
51	BARAREE	0.1037	0.1074	0.004	INCREASE
52	AMLABAD	0.0000	0.0000	0.000	NO FIRE
53	PATHERDIH	0.0000	0.0000	0.000	NO FIRE
54	SUDAMDIH	0.0000	0.0000	0.000	NO FIRE
55	SITANALA	0.0000	0.0000	0.000	NO FIRE
56	MURULIDIH 20/21 PIT	0.0000	0.0000	0.000	NO FIRE
57	MURULIDIH	0.0000	0.0000	0.000	NO FIRE
58	BHATDIH	0.0000	0.0000	0.000	NO FIRE
59	LOHAPATTY	0.0000	0.0000	0.000	NO FIRE
60	IISCO	0.0000	0.0000	0.000	NO FIRE
61	TASRA-IISCO	0.0000	0.0000	0.000	NO FIRE
62	KENDUADIH	0.0610	0.0000	-0.061	DECREASE
63	BULLIHARY	0.0000	0.0000	0.000	NO FIRE
64	GOPALICHUCK	0.0000	0.0000	0.000	NO FIRE
65	POOTKEE	0.0000	0.0000	0.000	NO FIRE
66	BHURUNGIA	0.0000	0.0000	0.000	NO FIRE
67	KHARKHAREE	0.0000	0.0000	0.000	NO FIRE
68	GASLITAND	0.1194	0.1215	0.002	INCREASE
69	KANKANEE	0.0530	0.0525	-0.001	DECREASE
70	MUDIDIH	0.1141	0.1104	-0.004	DECREASE
71	W. MUDIDIH	0.0171	0.0000	-0.017	DECREASE
72	LOYABAD	0.0133	0.0063	-0.007	DECREASE
73	BHAGABAND	0.0000	0.0000	0.000	NO FIRE
74	MOONIDIH PROJECT	0.0000	0.0000	0.000	NO FIRE
75	E.BHUGGATDIH	0.0022	0.0214	0.019	INCREASE
76	ALKUSHA	0.0326	0.0294	-0.003	DECREASE
77	KUSTORE	0.0524	0.0463	-0.006	DECREASE
78	ANGARAPATRA	0.1331	0.0149	-0.118	DECREASE
79	SALANPUR	0.0000	0.0000	0.000	NO FIRE
80	BHOWRAH. N	0.0133	0.0980	0.085	INCREASE
81	BHOWRAH. S	0.0000	0.0000	0.000	NO FIRE
82	BAGDIGI	0.0000	0.0209	0.021	INCREASE
83	JEALGORA	0.0000	0.0067	0.007	INCREASE
84	JEENAGORA	0.0000	0.0470	0.047	NO FIRE

85	JOYRAMPUR	0.0099	0.1042	0.094	**INCREASE**
86	CHANDAN OCP	0.0000	0.0000	0.000	**NO FIRE**
87	BANSDEOPUR	0.0000	0.0000	0.000	**NO FIRE**
	TOTAL AREA	**2.18**	**3.28**	**1.10**	**INCREASE**

Table 6: Colliery wise break-up of change in fire area from 2012 to 2017

Note:
1) "**NO FIRE**" implicates that the fire has not been identified satellite data *(either absent or below sensor resolution)*
2) "**INCREASE**" implies, increase in fire area OR emergence of fire areas not identified in 2012 study.
3) "**DECREASE**" implies, decrease in fire area OR fire areas of 2012, which are not identified in present study *(either absent or below sensor resolution).*
4) Estimations of fire extent (in terms of sq.km.) both 2012 and in present 2017 study are pixel based. They do not represent the actual ground area under fire. These estimations are made for comparative purpose only, to indicate the increase or decrease of areal disposition of fire. Hence, they should not be quoted as fire area on the ground.

Annexure –IV

Figure 15: Fume cracks in Lodna-Tisra Area. (point 39 in figure 13 and table 4)

Figure 16: Burnt area near OB dump in Lodna area (point 41 in figure 13 and table 4)

Figure 17: Coalfries in active seams in Kusunda (point 23 in figure 13 and table 4)

Figure 18: Sagged area due to subsidence, south of Block II OCP. (point 1 in figure 14 and table 5)

Figure 19: Fire in OB dumps in Kusunda area. (point 24 in figure 13 and table 4)

Figure 20: Fume cracks in the Bhulanbarari area.

Progress Report

1st Phase Air Monitoring report for

"Source apportionment of ambient air particulate matter in Jharia coalfields region, Jharkhand"

Sponsor

Bharat Coking Coal Limited (BCCL)

CSIR-National Environmental Engineering Research Institute, Nagpur

2019

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1. Introduction

1.1 Project Background

Bharat Coking Coal Limited, a subsidiary of Coal India Limited, has been operating the majority of the coal mines in the Jharia coal field regions since its inception in 1972. Jharia coal mines are special for its low ash content and high calorific value coals. Therefore, they are often used directly in iron and steel plants for metal oxide reduction after washing. Although these coal mines are highly priced for their high quality coal, they are notorious for their mine fires, which causes lot of fugitive gaseous and PM emissions. Hence, Jharia region has been under scrutiny by various public authorities and common public with a vision to improve the ambient air quality.

Various sources contribute to high particular matter concentration in the Jharia region: vehicles, mining activities, re-suspended dusts, fugitive emissions, fuel oils, household LPGs, etc. The percentage contribution of these factors in the ambient depends exclusively on the economic activities of that particular region. In order to improve the existing ambient air quality, the major sources of PM emissions first need to be identified. Hence, the environmental clearance committee of MoEF has directed BCCL to conduct a source apportionment study for particulate matter. In this context, BCCL has approached CSIR-NEERI to conduct a source apportionment study of ambient air particulate matter in Jharia coalfields region in order to quantify the various sources PM emissions and suggest an effective environmental management plan.

1.2 Project objectives

The major objective of the study is to assess the current ambient air quality, sources of air pollution and propose the priorities for the actions for improvement of air quality. The study to include the entire Jharia Coalfield along with area up to 10 Km from the periphery / boundary of BCCL mines.

The detailed objectives are as following:

i. Ambient Air Monitoring

- ✓ Monitoring of ambient air quality at selected receptor locations for pollutants including PM10, PM 2.5(limited), SO2, NOx, PAHs to establish the status of the air quality in Jharia Coalfields along with area up to 10 K.M from the periphery/boundary of BCCL mines. Also, review of the available air quality monitoring data from Central Pollution Control Board (CPCB) /Jharkhand State Pollution Control Board (JSPCB).

- ✓ To calibrate dispersion modelling predictions using measured air quality parameters.

- ✓ To draw supportive data through specific site related monitoring regarding impact causing sources such as kerbside monitoring.
- ✓ To establish the impact of meteorological conditions on a few select indicator pollutants in different micro meteorological conditions of the Jharia Coalfields.

ii. Emission Inventory related of Jharia Coalfields along with area up to 10 Km from the periphery / boundary of BCCL mines.

- ✓ To identify the pollution load grid wise for point, line and area source
- ✓ To establish possibilities of receptor level concentrations of air pollutants by matching dispersion modelling and air quality-monitoring data.

iii. Source apportionment related

- ✓ To identify and apportion the pollution load at receptor level to various sources in the Jharia Coalfields along with area up to 10 Km from the periphery / boundary of BCCL mines.
- ✓ To carry out the source apportionment using molecular markers for a limited number of samples through a time resolved sample collection at various period of the day and day-of-the-week.

iv. Any other item in consensus between both BCCL/CIL & NEERI evolved during the study.

2. Field visit

In connection with the above objectives, the NEERI's team and BCCL's team visited BCCL's Jharia coal filed for 3 days from 23 September to 27 September 2018. The team covered the entire Jharia coalfield, which spans roughly 30km in length and 22 km wide in three days with the following purpose.

To identified the location for air monitoring station in entire Jharia Coal Field region.

2.1 Jharia coalfield maps:

BCCL environmental department provided the map of the Jharia region. The site visit was carried out with assistance from BCCL's team. The 15 Jharia mines coal fields were segregated into three parts and details of the visit along with mine cluster names are given in Table 2.1.

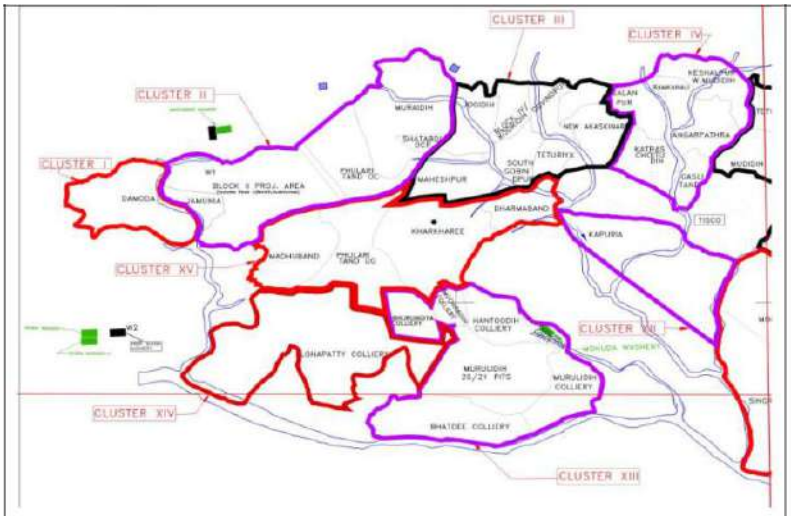
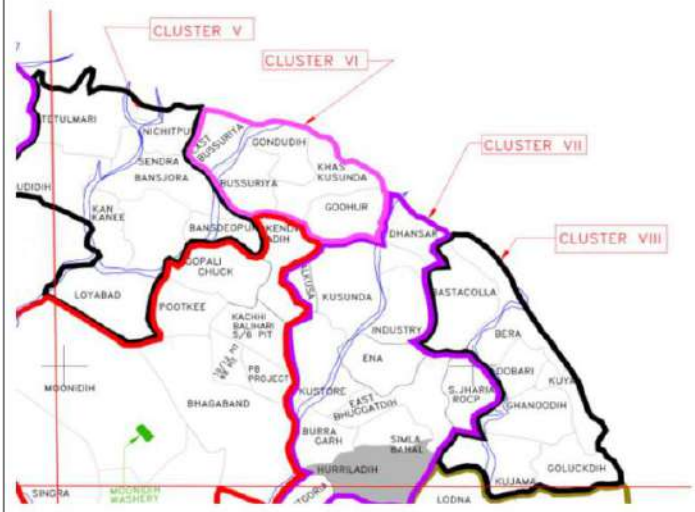
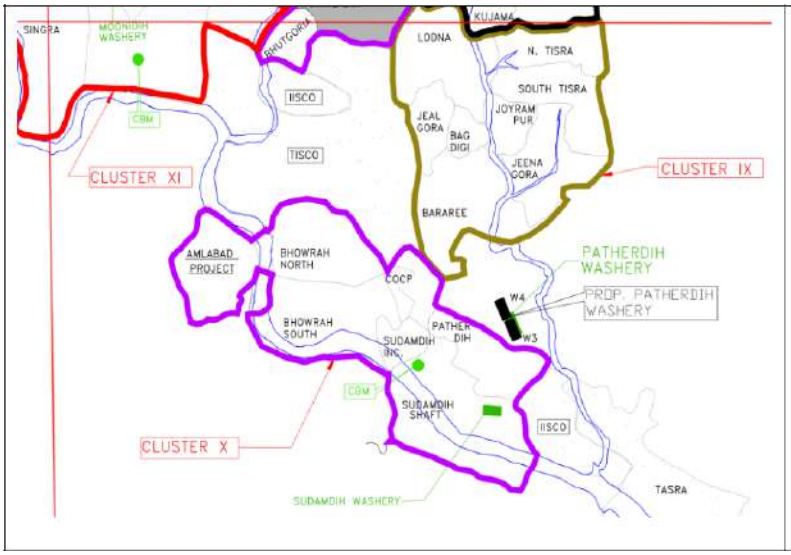
 	**Part 1:** Cluster VI, VII, VIII, and X **Part 2:** I, II,III, IV, V, XI, XII, XIII, and XV
	**Part 3:** Cluster IX

Table 2.1 Jharia coalfields Site visit on cluster-base

Based on the objectives and outcomes envisaged, the various mine areas were visited to identify sources of emissions such dumpsite emissions, fugitive emissions, blasting emissions. Furthermore, the already existing PM monitoring sites of BCCL were also visited to explore of possibility of installing NEERI's PM monitoring stations.

2.2 Site Identification:

The Entire Jharia Coal Field (JCF) is divided into 16 clusters. Both opencast and underground mines are operational in JCF. Standard mining operations like drilling, blasting, hauling, accumulation, and transfer are the major sources of emissions and air pollution. Apart from that, a typical emission source, mine fire, is prevailing at JCF. Besides, JCF encompasses large non-mining regions, which have their own emission sources like vehicular emission in congested traffics, road dust, Power Plant emission, other industrial emissions (coke oven plants, brick kilns, stone crushers, etc.), crematoria, domestic burning, open burning etc.

Based on the preliminary field visit by CSIR-NEERI Scientists along with BCCL staffs, the following locations are selected for the establishment of Air Quality Monitoring Stations for source apportionment study;

Core Zone

1. Cluster XIV (Lohapatty) – nearby sources: Chandrapura Thermal Power Plant
2. Cluster VII (Mine rescue station)- nearby sources: Coal Mine, Industry
3. Cluster IV or Cluster V – Banssuriya or Katras
4. Cluster IX (Lodhna)
5. Cluster XI (Moonidih)
6. Cluster X (Patherdih): nearby sources: Coal Mine, Steel Industry
7. Cluster VIII (Bastacola)

Buffer Zone

8. Bank More
9. Harina
10. Bhuli
11. Sindri
12. Parbatpur Electrosteel/ Bhaga

13. Background site (Upwind & away from sources) and also secondary Data from DVC, CCL mines Sail Bokaro and Jharkhand pollution Control Board will be obtained.

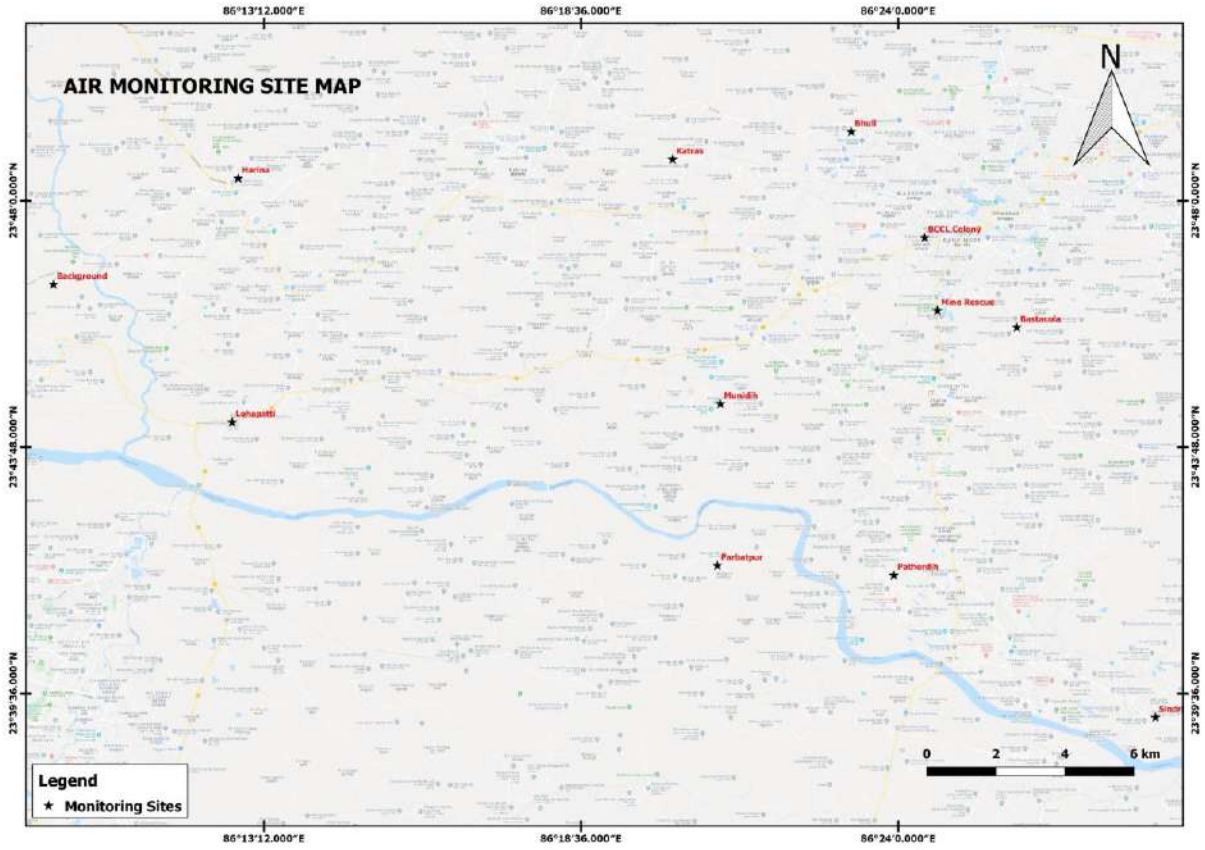


Figure2.1 Identified air monitoring station in Jharia Coalfield

3. Sampler Selection and Procurement

Standard equipment were catered for the parameter required towards ambient air particulate characterization and gaseous sampling in the initial phase of the project.

Table 3.1 Samplers Procured for Monitoring

Sampler	**Brief Description of operating conditions**
Fine Dust Sampler	Sampling Inlets- $PM_{2.5}$, PM_{10} and TSP Flow rate-16.7LPM
FRM Sampler	Versatile inlet configurations for $PM_{2.5}$, PM_{10}, or TSP sampling FRM quality 24-hour sampling at 16.7 LPM
Gaseous Sampler	Sampling Rate-0.5-1.0 LPM Operation time-8 hours

4. Monitoring parameters

Parameters of monitoring were decided based on the objectives of air pollution and source apportionment study. The source apportionment analysis required air monitoring for particulate matter ($PM_{2.5}$ and PM_{10}) and its chemical speciation to develop signature profiles of pollution sources that can be used in chemical mass balance models. The analysis data could also be used to interpret the overall loading of different chemicals contributed varied sources. Monitoring included air quality attributes such as Particulate matter, Sulphur Dioxide (SO_2) and Oxides of Nitrogen as NO_2, to understand not only the regulatory compliance but also their inter-correlations with other species such as Heavy metals, EC, OC etc. Since the objective of source apportionment study is to determine the contributions from various sources such as industries, vehicular and other area sources additional parameters were also monitored such as Polycyclic Aromatic Hydrocarbons (PAHs). List of all parameters, sampling flow rate and analytical methods are provided in Table 4.1

Table 4.1 Ambient Air Quality Sampling/Analysis Methodology for Target Pollutants

Particulars	Parameters			
	PM_{10}	$PM_{2.5}$	NO_2	SO_2
Sampling Instrument	Fine Dust Sampler & FRM Sampler	Fine Dust Sampler & FRM Sampler	APM sampler	APM sampler
Sampling Principle	Cyclonic Flow Technique	Cyclonic Flow Technique/ WINS Impactor	Chemical absorption in suitable media	Chemical absorption in suitable media
Flow rate	16.7 LPM	16.7 LPM	0.5 LPM	0.5 LPM
Sampling Period	24 hourly	24 hourly	8 hourly	8 hourly
Sampling Frequency	10 days continuous, Teflon and quartz on alternate days	10 days continuous, Teflon and quartz on alternate days	10 days continuous	10 days continuous

Analytical Instrument	Electronic Micro Balance	Electronic Micro Balance	Spectrophoto-meter	Spectrophoto-meter
Analytical Method	Gravimetric	Gravimetric	Colorimetric Improved West & Gaeke Method	Colorimetric Improved West & Gaeke Method
Minimum reportable value	5 µg/m^3	5 µg/m^3	9 µg/m^3	4 µg/m^3

4.1 Monitoring Frequency

All pollutants exhibit diurnal and seasonal variations, which have been taken into account while determining the frequency of the sampling. In order to assess the impact of the diurnal variations in source contributions for a given meteorology of the day, 24 hourly monitoring plan was envisaged (8 hourly sampling for gaseous pollutants and 24 hourly sampling for particulate matter). The field study was planned for a period of 10 days at each monitoring site for the season to represent variation in air quality. The sampling frequency details are presented in Table 4.1.

Table 4.1.1 Frequency of Air pollutants sampling in Jharia Coalfield

Parameter	Number of Days	Change of Filter/ absorbing media	Reporting
PM_{10}	10	24 hourly, Teflon: 05 days Quartz: 05 days	24 hourly
$PM_{2.5}$	10	24 hourly Teflon: 05 days Quartz: 05 days	24 hourly
NO_2	10	8 hourly	8 hourly
SO_2	10	8 hourly	8 hourly

The glimpses of air monitoring of some locations are shown in Figure 4.1.

Kataras

Lodhana

Moonidih

Patherdiha

Bastacola

Sindri

Figure 4.1 Glimpses of air monitoring of some locations

4.2 Filter handling and Weighing:

Teflon-membrane and quartz-fibre filter are most commonly used for chemical analysis. Each filter was individually examined prior to labelling for discoloration, pinholes, creases, separation of ring, chaff or flashing, loose material, or other defects.

Gravimetry measured the net mass on a filter by weighing the filter before and after sampling with balance in temperature and relative humidity controlled environment. To minimize particle volatilization and aerosol liquid water bias, $PM_{2.5}$ Filters were equilibrated for 24 hours at a constant (within ±5%) relative humidity between 30% and 40% at a constant (within ±2°C) temperature between 20°C and 23°C. PM_{10} filters were equilibrated at 20% to 45% relative humidity (±5%) and 15°C to 30°C temperature (±3°C).

Methods of Chemical characterization:

Sulphur dioxide (SO_2)	: Modified West and Gaeke method
Nitrogen dioxide (NO_2)	: Sodium Arsenite method
Suspended Particulate Matter (SPM)	: High Volume method (Gravimetric method)
Respirable suspended Particulate Matter (RSPM)	: Gravimetrically with GFA/EPM 2000 filter paper using respirable dust sampler (Cyclonic Flow Technique)

5. Ambient Air Quality Monitoring

Core Zone

Site 1: Cluster XIV (Lohapatty)

The samplers were installed on the roof of area office of Lohapatty (Latitude 23.737066 and Longitude 86.210894). It was located near residential colony. Coal mine was 1 km away from the sampling site. Coal has been transported through railway line which is 1.5 km away on a daily basis and also through trucks. NH-32 construction was going on 500 m away from the site. The major fuel used for cooking is coal in the study area.

Site 2: Cluster VII Mine rescue Station

Monitoring station was positioned in Mine rescue station, Dhansar on the roof of office building (Latitude 23.768746 and Longitude 86.411141). Mine rescue station is next to

the state highway 12 where continuous movement of heavy vehicles takes place. Mining activities were also observed nearby the location.

Site 3: Cluster V Katras

In Katras, samplers were installed at Expert hostel (Latitude 23.811692 and Longitude 86.335910). There was a settlement residential area nearby. Mining activities was in progress within 500m area. Railway track was nearly at 150m distance from the site. Coal was used for cooking. Many other activities were observed during sampling in the nearby area which may contribute. 'Mela' and continuous 'Hawan' were going on within 100m area. Also road construction was in progress near 7km.

Site 4: Cluster IX (Lodhana)

Samplers were installed at office in Lodhna (Latitude 23.721713 and Longitude 86.410260). Near Lodhna, colliery was 2 km away from the site. Nearest Railway track was 1.5 km away. Coal was mostly used for cooling.

Site 5: Cluster XI (Moonidih)

Moonidih mine is one of the underground mine of BCCL. Sampler was stationed in Area office of Moonidih mine (Latitude 23.742228 and Longitude 86.349494). Since monitoring location was 250-300m from the mine, movement of heavy vehicles was continuous. There is washery also at distance of 500m where trucks and conveyor were used for transportation of coal. So the mining activities nearby contributes to particulate matter emission.

Site 6: Cluster X (Patherdih)

Samplers were stationed in guest house of BCCL in Patherdih area (Latitude 23.693577 and Longitude 86.398728). It is situated beside highway where continuous movement of heavy vehicles observed. TATA steel coal mine is situated 1km away from the location where continuous mining activities takes place. Transportation of coal through railway wagons in same area also contributes to particulate matter emission.

Site 7: Cluster VIII (Bastacola)

The samplers were positioned in area office of Bastacola mine (Latitude 23.763966 and Longitude 86.433635). Here also, coal was used as a cooking media. Railway track was

at Jodaphata which was 3-4 km away from the site. Residential area was nearly 0.5-1km. Mine was situated 3km from the site but no Mining activity was observed during monitoring.

Buffer zone

Site 8: Bank More (BCCL Colony)

Sampling station was installed in BCCL colony, Jawahar Nagar on the roof of a resident (Latitude 23.789463 and Longitude 86.407448). No mining activities were observed but the colony was beside the NH 18 highway so it may contribute to particulate matter emission.

Site 9: Harina

At Harina, the site chosen for air sampling was BCCL colony (Latitude 23.806308 and Longitude 86.212641). Since it was BCCL residential area, fuel used for cooking purpose was LPG. Settlement residential area was observed nearby where coal was used as a media for cooking. Colliery and Railway track were 3km and 2 km away from the site respectively. Highway was 1km away from the site and Coal washery at distance of 4.5km.

Site 10: Bhuli

The samplers were installed on the roof of Saraswati Vidya Mandir, Bhuli (Latitude 23.819554 and Longitude 86.386647). The location was in residential area. Mining activity was going at a distance of 8-10km. A closed Brick factory was located in the nearby area. Fuel used for cooking was mostly coal. Railway track used for coal transportation was 4km from the site. Construction of highway was also going on within 1.5km area during the monitoring.

Site 11: Sindri

Air samplers were installed at BIT Sindri college campus (Latitude 23.653214 and Longitude 86.473022). Transportation of coal was done by railway wagons at distance of 2km from monitoring site. LPG was mostly used for cooking rather than coal. A construction activity was going on nearby. The site was near the highway at a distance of <100m.

Site 12: Parbatpur

The sampling station was installed on roof of a house (Latitude 23.696296 and Longitude 86.348609). Mining activity was no longer going nearby. Coal was primarily used for cooking.

Site 13: Background

The air monitoring samplers were installed on roof of resident's house which was near to the highway at a distance of less than 1 km (Latitude 23.776180 Longitude 86.160177). Construction activities were going on nearby the location. Heavy rainfall also occurred during monitoring period. Mine activities were also observed in radius of 2-3km. Settlement resident's uses coal for cooking purposes.

Sample collection Transportation and Preservation

Ambient $PM_{2.5}$ and PM_{10} samples were collected using suitable sampler at a desired flow rate. Filters were wrapped carefully with aluminium foil and stored in re-sealable plastic bags. At sampling site, the filter that collected the particle sample on the previous day was taken out of the filter holder and immediately wrapped with aluminium foil and sealed. The sample filers were transported back to the laboratory in an isolated cooler container with ice and then frozen at -10°C until analysis.

Table 5. 1 Physical and Chemical components for characterization of Particulate matter

Components	**Filter Matrix**	**Analytical Methods**
PM10/ PM2.5	Teflon/Quartz filter paper	Gravimetric
Elements (Na, Mg, Al, Si, P, S, Cl, Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, As, Se, Br, Rb, Sr, Y, Zr, Mo, Pd, Ag, Cr, Cd, In, Sn, Sb, Ba, La, Hg, Ti, and Pb)	Teflon/Quartz filter paper	ICP-OES
Ions ($NO2^-$, $NO3^-$, SO_4^{-2}, K+, NH^{4+}, Na^+)	Teflon/Quartz filter paper	Ion chromatography with conductivity detector
Carbon Analysis (OC, EC)	Quartz filter paper	TOR/TOT method
PAHs	Teflon/Quartz filter paper	Extraction followed by GC-MS analysis with and without derivatization