BHARAT COKING COAL LTD.
A Mini Ratna Company
(A Subsidiary of Coal India Ltd.)
REGD.Office: KoylaBhawan, Koyla Nagar, Dhanbad-826005
CIN No.U10101JH1972GO1000918
OFFICE OF THE GENERAL MANAGER
BARORA AREA

Ref No.GM/AR -1/SUR/2019 4758 **Dated: -** 16-5-19

To
The Director
Ministry of Environment, Forest& CC
Regional Office(ECZ), Bungalow No.-2
Shyamali Colony
Ranchi- 834002

Sub: Six monthly reports on implementation of Environmental measures for the Period from Oct'2018 to Mar'2019 in respect of Cluster –I group of mines.

Ref: -EC Order No. J-11015/93/2009-IA.II (M)

Dear Sir,
Kindly find enclosed herewith the six monthly reports on implementation of Environmental measures for the period from**Oct'2018 to Mar'2019** in respect of Cluster –I group of mines.
Hope you will find the same in order.

Yours faithfully,

16/5/19
General Manager
Barora Area

Encl: as above
C.C to
1. The Director, 1A monitoring cell ,
   ParyavaranBhawan CGO Complex, New Delhi-110003
2. Regional office, JSPCB ,Housing colony, Dhanbad
3. Dy.GM (Env.) BCCL KoylaBhawan, Dhanbad.
4. Environment Officer, Damoda colliery

Compliance of Conditions of Environmental Clearance Granted by MoEF for Cluster-1 (01.10.18 to 31.03.19)

EC Order No. J-11015/93/2009-IA.II (M)

Sl. no.	A. Specific Conditions by MOEF:	Compliance
i	**Production shall not exceed beyond that for which environmental clearance has been granted for the 3 mines of cluster-1.**	The production for the cluster is within the limit for which environment clearance has been granted.
ii	**The measures identified in the environmental management plan for Cluster-I group of mines and the conditions given in this environmental clearance letter shall be dovetailed to the implementation of the Jharia Action Plan.**	Master Plan is dovetailed with environmental clearance conditions.
iii	**(a)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.** **(b) And monitoring temperatures of 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 re-start fresh/spread fires in other areas including in mines of cluster-I shall be undertaken.**	The latest NRSA map is being submitted to RO, Ranchi & enclosed herewith. (Soft copy Enclosed) Action is being taken as specified in EC and as per Jharia Master Plan. Further fire patches are under operation to dig out the fiery coal and combustible materials to save the coal from burning and to stop further spread of the fire.
iv	**No mining shall be undertaking where underground fires continue.** **Measures shall be taken prevent/check such fires including in old OB dump areas where fire could start due to presence of coal/ shale with sufficient carbon content.**	It is being complied. Mining is being carried out as per the guidelines of DGMS. In area only Open Cast working is being practiced, However sufficient precaution is being taken to guard against fire.
v	**There shall be no external OB dumps. OB from the 2 patches shall be backfilled. At the end of the mining there shall be no void and the entire mined out area shall be re-vegetated. Areas where opencast mining was carried out and completed shall be reclaimed immediately thereafter.**	Action is being taken as specified in EMP. At the end of the mining, there shall not be voids and area will be re-vegetated and reclaimed with the proper eco-restoration techniques suggested by the experts available in BCCL and in external agencies i.e. FRI Dehradun, CEMDE Delhi.
vi	**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-1 shall be drawn up and implemented**	Calendar plan has been prepared. Mine closure plan as per the guidelines of Ministry of Coal have been prepared by Central Mine Planning and Design Institute (CMPDI) and it is being implemented.
vii	**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 Damoda (Albion Section) 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. Since mines is discontinued from 25.01.2017 due to Failure of Hired HEMM agency, Development of underground working has been completed and OCP working discontinued due to land related problems. A proposal is being initiated for the construction of garland drain along the OB dump and will be completed before the start of mining operation.
viii	**Thick green belt shall be developed along undisturbed areas, mine boundary and in mine reclamation. A total area of 237.79 ha shall be reclaimed and afforested.**	Green belt of 6.00 Ha exits in Damoda lease hold area and Eco restoration of 12.68 Ha has been already developed and being maintained properly.
ix	**Specific imitative measures identified for the Jharia Coalfields in the Environmental Action Plan prepared for Dhanbad as a critically polluted area and relevant for Cluster-1 shall be implemented.**	Dhanbad Action Plan is being implemented. The salient actions of this area: 1. Covered transportation of Coal. 2. Water sprinkling. 3. Plantation. 4. Utilization of surplus mine water.

x	**A detailed CSR Action Plan shall be prepared for Cluster-I group of mines. Specific activities shall be identified for CSR for the budget of Rs 13.75 crores provided for CSR for 2010-11 and Rs 5/T of coal as recurring expenditure. The 190.51 ha of area within Cluster-I ML existing as waste land and not being acquired shall be put to productive use under CSR and developed with fruit bearing and other useful species for the local communities. In addition to afforesting 237.79 ha of are at the post-mining stage, the 204.67 ha of fallow/abandoned land and 40.64 ha waste land/barren land within Cluster-I ML shall berehabilitated/reclaimed as forest/agricultural land under CSR Plan in consultation with local communities. Third party evaluation shall be got carried out regularly for the proper implementation of activities undertaken in the project area under CSR. Issues 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 expenditure thereon shall be uploaded on the company website every year.**	BCCL is implementing CSR activities, as per Govt. norms with a CSR Committee being evaluated by Tata Institute of Social Science. A CSR department has been established at the headquarter level and area level for proper executing the CSR activities. All welfare/ CSR activities are also uploaded in Company web site.(**CSR SOFT COPY ENCLOSED**) TISS, Mumbai has conducted the baseline survey and accordingly an action plan is being formulated.
xi	**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 points and proper records maintained thereof and uploaded regularly on the company website.**	Mine water is being stored at sump of Albion OCP and after treatment through Pressure Filter is being used for domestic purpose. A work order has been issued to CMPDIL, Ranchi. Regular monitoring of Water Quality Parameters is being carried out by CMPDIL. **(Soft copy of monitoring report is enclosed)**
xii	**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 due to dewatering of mine.**	Surface mine water is being used for industrial purpose and domestic purposes. Mine water after treatment through Filtration by Pressure Filters is supplied to villagers or nearby communities. Two nos. pressure filter of capacity 10,000 litre /day have already been installed at Damoda Colliery.
xiii	**Continuous monitoring of long-term impacts of dumping of fly ash (for life of the mine) and leaching of heavy metals on soil and water quality of the study area shall be undertaken and the details of which shall be submitted to the Central Ground Water Board, SPCB and to the Regional Office of this Ministry at Bhubaneswar, as part of the compliance report. Permanent monitoring arrangements such as peizometers shall be established in and around mine areas covering potential impact zone for contamination of heavy metals due to leachates from fly ash. In case of increasing levels of heavy metals detected in groundwater, further dumping of fly ash shall be stopped immediately. Independent third party monitoring of impacts of dumping of fly ash shall also be undertaken and reported to the regulatory authorities and uploaded on the company website. In case, the disposal of fly ash into the de-coaled voids is not found to be an environmentally suitable option, the balance void shall be converted into water reservoir of a maximum depth of 35m which shall be gently sloped. The upper benches of the reservoir shall be stabilized with plantation and the periphery of the reservoir fenced.**	At present there is no fly ash being dumped.

<table>
<tr>
<td>xiv</td>
<td>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 peizometers. The monitoring for quantity shall be done four times a year in pre-monsoon (May), monsoon (August), post monsoon (November) and winter (January) seasons and for quality including As and F during the month of May. Data thus collected shall be submitted to the Ministry of Environment & Forests 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.</td>
<td>Groundwater level and quality is being monitored by CMPDIL. The Location and design of Piezometers to be installed have been finalized by CMPDIL .
<table>
<tr><th rowspan="2">Sl No.</th><th rowspan="2">Well No.</th><th rowspan="2">Location</th><th colspan="4">Water level (bgl in meters)</th></tr>
<tr><th>Feb'18</th><th>Apr'18</th><th>Aug'18</th><th>Nov'18</th></tr>
<tr><td>1</td><td>B-15</td><td>BeraBasti</td><td>1.56</td><td>1.85</td><td>0.75</td><td>0.85</td></tr>
<tr><td>2</td><td>B-21A</td><td>Dugdha</td><td>6.73</td><td>9.65</td><td>3.45</td><td>2.65</td></tr>
<tr><td>3</td><td>B-51</td><td>Taranga</td><td>3.00</td><td>5.02</td><td>2.25</td><td>2.42</td></tr>
<tr><td>4</td><td>B-53</td><td>Karmatanr</td><td>2.52</td><td>3.92</td><td>1.62</td><td>1.42</td></tr>
<tr><td colspan="3">Average WL (bgl)</td><td>3.68</td><td>5.11</td><td>2.02</td><td>1.84</td></tr>
</table>
Peizometer installation: Tender was done on 01.03.2019. No bidder participated in the tender. Hence, the tender was cancelled. Re-tendering in process.

(Soft copy of Ground level monitoring report is enclosed)</td>
</tr>
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<td>xv</td>
<td>ETP shall also be provided for workshop, and CHP, if any. Effluents from the mines shall be treated to conform to prescribed standards if is discharged into any water course outside the lease area. The quality of effluent/water discharged shall be monitored at outlet points. Proper records shall be maintained thereof and uploaded regularly on the company's website.</td>
<td>Construction of ETP/Oil grease Trap will be taken-up as mine will be continue in operation.</td>
</tr>
<tr>
<td>xvi</td>
<td>For monitoring the land use pattern and 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 to the end of mine life, shall be prepared once in 3 years (for anyone particular season which is consistent in the time series). The report shall be submitted to MOEF and its Regional office at Bhubaneswar.</td>
<td>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 & it has been uploaded on the official website of company.
Further CMPDI has been requested to prepare "Time series of land use maps based on satellite imagery of the core zone and buffer zone in the scale 1:5000
(Soft copy of land reclamation report is enclosed)</td>
</tr>
<tr>
<td>xvii</td>
<td>A Final Mine Closure Plan along with a Plan for Habitat Restoration and with details of Corpus Fund shall be submitted to the Ministry of Environment & Forests for approval before the final mine closure. The species selected for Habitat Restoration for post-mining land shall include a specific Plan for development of agro-forestry using a mix of native species found in the study area.</td>
<td>CMPDI has prepare the "Final Mine Closure Plan along with a Plan for Habitat Restoration and with details of Corpus Fund". BCCL has deposited the amount in a separate ESCROW ACCOUNT for corpus fund as per Mine Closure Guidelines as specified in the mine closure Plan.</td>
</tr>
</table>

xviii	**Corporate Environment Responsibility:** **The Company shall have a well laid down Environment Policy approved by the Board of Directors'.** **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.** **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.** **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.**	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. Complied. A hierarchical system of the company to deal with environmental issues from corporate level to mine level already exists. Being complied.
B	**General Conditions by MoEFCC::**	
i	**No change in technology and scope of working shall be made without prior approval of the Ministry of Environment and Forests.**	Being complied.
ii	**No change in the calendar plan including quantum of mineral coal and waste being produced shall be made.**	Being complied.
iii	**Four ambient air quality monitoring stations shall be established in the core zone as well as in the buffer zone for monitoring PM_{10}, $PM_{2.5}$, SOx and NO_x. 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, in particulates shall be carried out at least once in a year.**	The location of monitoring stations in Jharia Coal Field has been finalized in consultation with the Jharkhand State Pollution Control Board. Ambient air quality along with heavy metals such as Hg,As,Ni,Cd,Cr ,etc is regularly monitored by CMPDIL**.** **(Soft copy of monitoring report is enclosed)**
Iv	**Data on ambient air quality (PM_{10}, $PM_{2.5}$, SOx and NO_x and heavy metals such as Hg, As, Ni, Cr, etc) 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 recognised under the EP Rules, 1986 shall be furnished as part of the compliance report.**	Data on ambient air and other monitoring data is being regularly submitted to the Ministry along with compliance report**.** **(Soft copy of monitoring report is enclosed)**
v	**Adequate measures shall be taken for control of noise levels below 85 dBA in the work environment. Workers engaged in blasting and drilling operations, operation of HEMM, etc shall be provided with ear plugs/muffs.**	It is being Complied in mines and also the Noise levels are below the Ambient Noise Standard (Day time 75 dB & Night Time (70 dB for Industrial Area). Regular maintenance of vehicles and other machineries are being practiced for control of noise level. Ear plugs/muffs are provided to the persons engaged in blasting and drilling operations, operation of HEMM, etc . **(Soft copy of monitoring report is enclosed.)**
vi	**Industrial wastewater (workshop and wastewater from the mine) shall be properly collected, and treated so as to conform to the standards including for heavy metals before discharge prescribed under GSR422 (E) dated 19th May 1993 and 31st December**	The work of monitoring of ambient environment is being done by CMPDIL, Ranchi.Physico-Chemical characteristics of effluents are well within the prescribed limit. **(Soft copy of monitoring report is enclosed.)**

	1993 or as amended from time to time. Oil and grease trap shall be installed before discharge of workshop effluents.	
vii	**Vehicular emissions shall be kept under control and regularly monitored. Vehicles used for transportation of the mineral shall be covered with tarpaulins and optimally loaded.**	Being complied. Regular maintenance of vehicle is being practiced to kept vehicular emission under control. Coal is being transported in tarpaulin covered trucks.
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 analysed through a laboratory recognized under EP Rules, 1986.**	Monitoring of Environmental quality parameters have been regularly done by CMPDIL, Ranchi with proper analysis equipment. **(Soft copy of monitoring report is enclosed)**
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. Occupational health surveillance programmeof the workers shall be undertaken periodically to observe any contractions due to exposure to dust and to take corrective measures, if needed.**	It is being complied. A separate full-fledged Human Resource Development Department is conducting regular training programme on these issues. Apart from this Vocational Training Centers are existing in all the areas of BCCL, which provides periodical training on the safety and occupational health issue to each of the workers working in the mines.
x	**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.**	Complied. A full-fledged Environment cell, with a suitable qualified multidisciplinary team of executives has been established. GM (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. Socio economic issues and capacity building are being evaluated by Tata Institute of Social Science.
xi	**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.**	It is being complied.
xii	**The Project authorities shall advertise at least in two local newspapers that are 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 http://envfor.nic.in**	Complied. Advertisement in local newspaper has been given.
xiii	**A copy of the environmental clearance letter shall be marked to concerned Panchayat/ZilaParishad, 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 the company's website.**	Complied. Clearance letter has been displayed on Company web site.
xiv	**A copy of the clearance letter shall 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 Centre and Collector's Office/Tehsildar's Office for 30 days.**	Complied.
xv	**The clearance letter shall be uploaded on the company's website. The compliance status of the stipulated 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 the public domain. The monitoring data of environmental quality parameters (air, water, noise and soil) and critical' pollutants such as PM_{10}, $PM_{2.5}$, and NO_x (ambient and**	Complied.

	stack if any) and critical sectoral parameters shall also be displayed at the entrance of the project premises and mines office and in corporate office and on the company's website.	
xvi	The project proponent shall submit six monthly reports on the status of compliance of the stipulated environmental clearance conditions (both in hard copy and in e-mail) to the respective Regional Office of the MOEF, the respective Zonal offices of CPCB and the SPCB.	Complied/Being complied.
xvii	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.	Noted.Project authority is ready to extend its full cooperation for any kind of visit and inspection conducted by Regional Office in connection with EC Conditions Compliance.
xviii	The environmental statement for each financial year, ending 31st March, in Form-V to be submitted mandatorily by the project proponent to the State Pollution Control Board concerned as prescribed under the Environment (Protection) Rules, 1986, as amended subsequently. This shall also be uploaded on to 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.	Environmental Statement (Form-V) has been regularly submitted for each financial year to Jharkhand State Pollution Control Board. **(Soft copy of Form V is enclosed)**
C	Other Conditions by MoEFCC:	
i	The Ministry or any other competent authority may stipulate any further condition for environmental protection.	Agree.
ii	Failure to comply with any of the conditions mentioned above may result in withdrawal of this clearance and attract the provisions of the Environment (Protection) Act, 1986.	Agree.
iii	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, 1991 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 mining operations.	It is being complied.
iv	The Environmental Clearance is subject to the outcome of the Writ Petition filed by 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.	Agree.

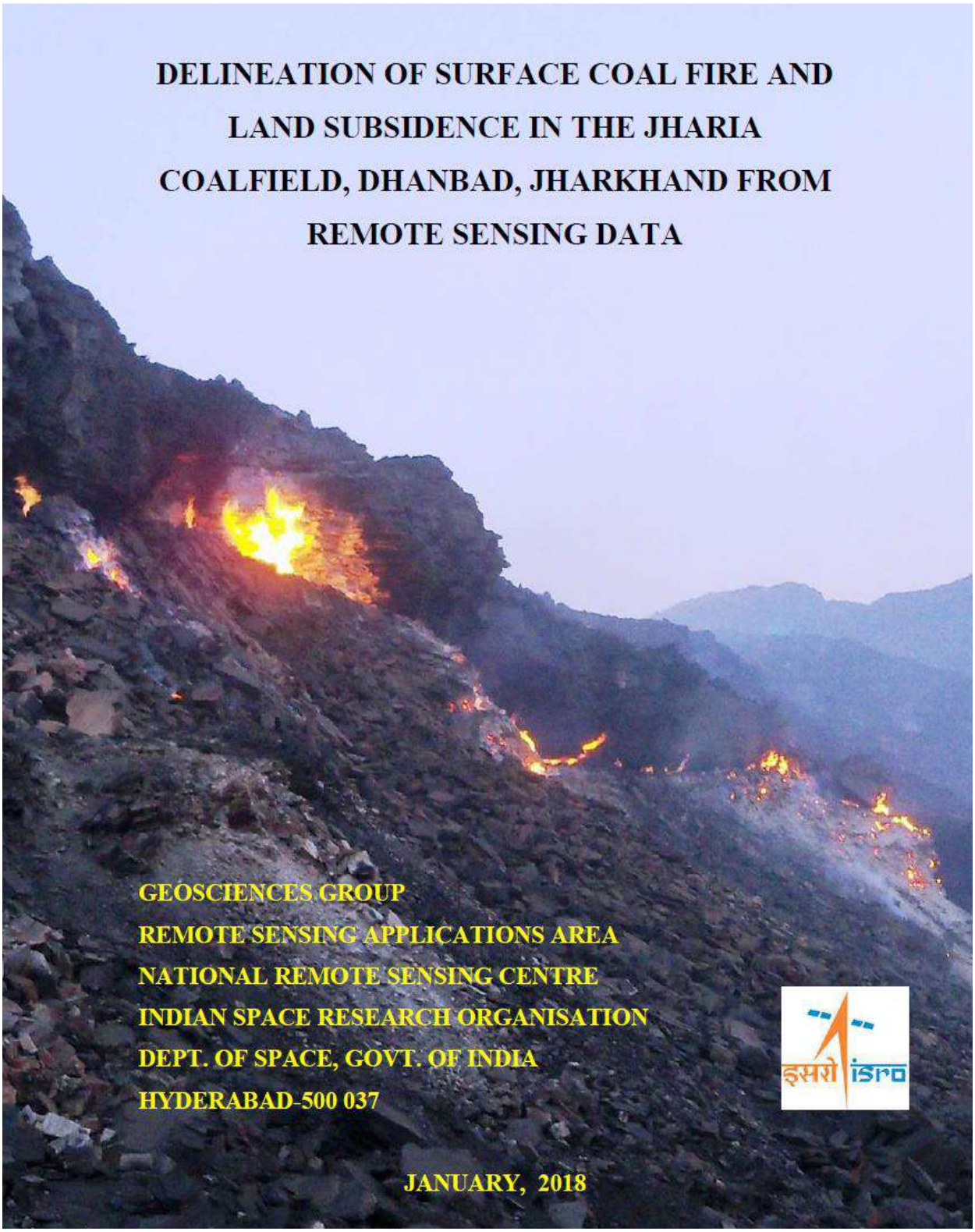
20/5/19.

General Manager
Barora Area

16/5/19

Project Officer
Damoda colliery

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



GEOSCIENCES GROUP
REMOTE SENSING APPLICATIONS AREA
NATIONAL REMOTE SENSING CENTRE
INDIAN SPACE RESEARCH ORGANISATION
DEPT. OF SPACE, GOVT. OF INDIA
HYDERABAD-500 037

JANUARY, 2018

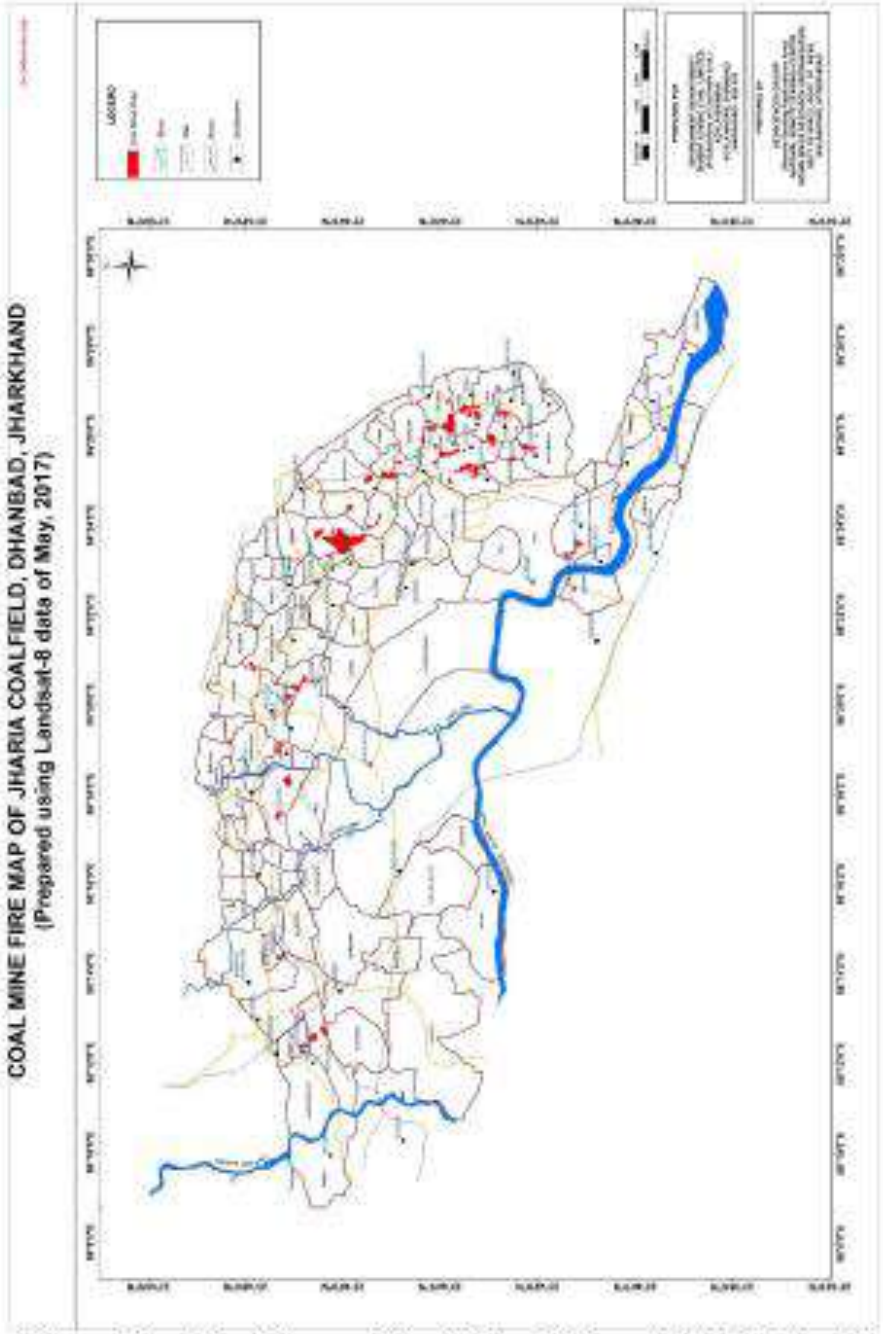


Figure 5: Coal mine fire map (May, 2017) of Jharia coal field, Dhanbad. The fire areas shown in this map have been verified in the field as per field points in figure 13.

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.

BHARAT COKING COAL LTD.

(A Subsidiary of Coal India Ltd.)

REGD. Office: Koyla Bhawan, Koyla Nagar, Dhanbad-826005

CIN No.U10101JH1972GOI000918

OFFICE OF THE PROJECT OFFICER, DAMODA COLLIERY

BARORA AREA

Ref No. DC/Area-1/Form-V/3407 /2018Dated: -16/9/2018

To,
The Member Secretary
Jharkhand State Pollution Control Board
E-1, CTI Colony, Dhurwa
Ranchi - 834004.

Sub: Environmental Statement for the financial year ending the 31st March, 2018, Damoda colliery of Barora Area.

Dear Sir,

Kindly find enclosed herewith the Environmental Statement for the financial year ending the 31st March, 2018, **Damoda colliery** of Barora Area.

Yours faithfully,

16/9/18

Project officer
Damoda colliery

Encl: as above

C.C to

1.Regional office, H.I.G.-1, Sardar Patel Nagar, Hirapur ,Dhanbad.
2. Dy. GM (Env.), Koyla Bhawan
2. Nodal officer(Env.) Barora Area.

[FORM – V]

(See rule 14)

Environmental Statement for the financial year ending the 31st March, 2018

PART – A

(i) Name and address of the mine :- Director Tech(P&P)
Bharat Coking Coal Ltd.
Post : Koyla Nagar
Dist. : Dhanbad-826005, Jharkhand
(ii) Industry category : Primary (coal mining industry)
(iii) Production capacity : 1.17 (Peak) MTPA Raw Coal.

(iv)Year of establishment

- Colliery operating since pre nationalization period and vested in BCCL through Coal mine nationalization act 1972-73.

(iii) Date of the last environmental statement submitted – 18/05/2017.

PART – B

Water and River Material Consumption

Water consumption m^3/d:

- **Process-** consumed for dust suppression and fire fighting
- **Cooling- Nil**
- **Domestic-** 100 KL/DAY **water supplies to colonies**

Name of Products	**Process water consumption per unit of product output.**	
	During the previous financial Year	During the Current financial Year
	(1)	(2)
.....	Not applicable.....	

Raw Material Consumption:-NIL

Name of raw materials*	Name of Products	Consumption of raw material per unit of output	
		During the previous financial year	During the current financial year
COAL	COAL	.0722MT	00MT

*Industry may use codes if disclosing details of raw material would violate contractual obligations, otherwise all industries have to name the raw materials used.

PART - C

Pollution discharged to environment/unit of output
(Parameter as specified in the consent issued)

Pollutants	Quantity of pollutants discharged (mass/day)	Concentrations of pollutants in discharges (mass/volume)	Percentage of variation from prescribed standards with reasons
Water	*NIL**	*NIL*	Mine water analysis report shows that parameters are well within prescribed standard
Air	*NIL***	*NIL*	Regular air quality monitoring is being carried out.

* Mine water is reutilized in dust suppression, firefighting and also by nearby community for agricultural purpose.

**No stack is there. However regular air quality monitoring is being carried out.

PART – D

Hazardous Wastes

(As specified under Hazardous Waste Management and Handling Rules, 1989)

Hazardous Wastes	Total Quantity (Kg.)	
	During the previous Financial Year (2016-17)	During the current Financial year(2017-18)

A) From process-

- Burnt oil --- 00 KL
- Cotton waste --- 00 kg

Burnt oil sent to the regional store for selling purpose. Cotton waste/oil soaked filters which is generated during the different process are handled as Hazardous waste management and Handling rules, 1989.

B) From pollution control facilities. : - NIL

PART – E

Solid Wastes

	Total Quantity in million cubic meter.	
	During financial year (2017-18)	During financial year (2016-17)
(a)From Process(Mining) Overburden	00 Mm^3	----
(b) From pollution control facilities	Nil	Nil
(c)Quantity recycled or reutilized	During both financial year, the entire volume of OB has been used for refilling the decoaled area of the quarry.	

PART – F

Please specify the characteristics (in terms of concentration and quantum) of hazardous as well as solid wastes and indicate disposal practice adopted for both these categories of wastes

The overburden removed from the quarry is presently accommodated in the voids of the same quarry. Hazardous waste is E-auctioned from HQ to authorized recycler for disposal.

PART – G

Impact of the pollution control measures taken on conservation of natural resources and consequently on the cost of production.

Pollution control measures are reducing the adverse effect of mining on natural resources. Consent fee, etc. are regularly deposited. Expenditure is incurred on monitoring and other pollution control measures due to which cost of production increased slightly.

PART – H

Additional measures/investment proposal for environmental protection including abatement of pollution.

Ecological restoration site of 13.00 Ha has been developed in the premises of lease hold area after reclamation.

Source apportionment study and reduction in pollution load by reducing road transport study for Damodacolliery is being proposed.

PART – I

MISCELLANEOUS:

Any other particulars in respect of environmental protection and abatement of pollution.

Ecological restoration site of 13.00 Ha has been taken up and developed in the premises of lease hold area.

Project Officer
Damoda Colliery

GROUNDWATER LEVEL & QUALITY REPORT

FOR CLUSTER OF MINES, BCCL

(Assessment year – 2018-19)

[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)

Prepared by
Hydrogeology Department
Exploration Division
CMPDI (HQ), Ranchi

MARCH – 2019

JOB NO - 514218177

CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ANNEXURES

DETAILS OF THE REPORT

Sl No.	ITEMS	INFORMATIONS
1	Geographical Area	Jharia Coalfield (JCF): 453 sq. km. Raniganj Coalfield (RCF part): 19.64 sq. km. (Cluster-XVI area only)
2	Major Physiographic Units	Dissected Pediplain with surface Reduced Level (RL) varies from 160 m to 220 m above mean sea level (AMSL) in JCF and 100 m to 140 m AMSL in RCF.
3	Drainage System	Damodar River is the master drainage flowing along western boundary of the JCF. Jamunia River, Khudia River, Katri River, Jarian Nala, Ekra Jore, Kari Jore, Kashi Jore, Chatkari Jore and their tributaries are flowing through the JCF area. Damodar River, Barakar River is the master drainage of the part of RCF area (CV Area).
4	Annual Rainfall	Jharkhand State – 1264.0 mm (2016) Dhanbad District - 1271.60 mm (2016) Normal Rainfall – 1296.30 mm (Source: Rainfall Statistics of India-2016, IMD, Ministry of Earth Sciences)
5	Geological Formations	Gondwana Formation (Talchir Formation, Barakar Formation, Barren Measure & Raniganj Formation)
6	Aquifer System	Top Unconfined/Phreatic Aquifer – average thickness 25 m Semi-confined to confined Aquifer – average thickness 50–200 m
7	Hydrogeological properties	Unconfined Aquifer (Damoda BJ Section & Block-III): Hydraulic Conductivity – upto 0.50 m/day Transmissivity – 10 - 42 m^2/day Semi-confined to confined Aquifer (Sitanala & Kumari Block): Hydraulic Conductivity – 0.0006-1.44 & 0.05-0.0027 m/day Transmissivity – 0.06 – 0.573 m^2/day
8	Groundwater Level Monitoring Network	Out of total 254 no of monitoring stations 64 nos located within core mining area and rest comes within Buffers zone. 60 Nos. of Groundwater monitoring well (Dug Wells) network is established by CMPDI to record groundwater level data in and around the Core Zone of JCF and 4 Nos. of Groundwater monitoring well (Dug Wells) in RCF (CV Area).
9	Groundwater Levels Below Ground Level (bgl)	JCF area: Pre-monsoon – 1.20 to 14.58 m (Avg. 5.55 m bgl) in '2018 Post-monsoon – 0.40 to 07.17 m (Avg. 2.83 m bgl) in '2018 RCF area (part): Pre-monsoon – 2.34 to 8.70 m (Avg. 4.35 m bgl) in '2018 Post-monsoon – 1.75 to 5.70 m (Avg. 2.75 m bgl) in '2018
10	Groundwater Quality	Potable (Annexure- IV)
11	Proposed Piezometers	New piezometers (23 nos.) have been proposed to monitor impact of coal mining on groundwater regime within the coalfield area (JCF & part of RCF) for maximum depth upto 290 m to monitor deeper aquifers.
12	Stage of Groundwater Development (CGWB)	Dhanbad District – 77% (GWRE-2013)

1.0 INTRODUCTION

1.1 CLIMATE, TEMPERATURE & RAINFALL

The Jharia Coalfield (JCF) and part of Raniganj Coalfield (RCF) area in Dhanbad District belongs to sub-humid tropical climatic region. The maximum temperature during summer shoots upto 45^{o} C and falls between 10^{o} C to 5^{o} C in winter. The maximum rainfall occurs during the period between June and September.

The annual rainfall in the Dhanbad District is 1271.60 mm (Rainfall Statistics of India-2016, IMD (Ministry of Earth Sciences), has been considered. The non-monsoon rainfall in the District is 93.60 mm (Winter-19.5 mm, Pre-monsoon-48.8 mm and Post-monsoon-25.3 mm) and the monsoon rainfall is 1178.10 mm of total annual rainfall. Monsoon Rainfall is around 92.65% of total annual rainfall in 2016 in Dhanbad District. Rainfall is the primary source of groundwater recharge. The normal rainfall of Jharkhand is 1296.30 mm (2015) as documented in MOSPI, Govt. of India.

1.2 GEOMORPHOLOGY

Northern part of the JCF area is covered with hills and thin forest. In general the altitude varies from 220 m AMSL in Barora area (Cluster-I) to 160 m above mean sea level (AMSL) in Sudamdih area (Cluster-X). Pediplains are developed over sedimentary rocks or Gondwana formation consisting of Sandstone, Shale, coal, etc. Dissected pediplains are developed over Gondwana formations found in Jharia, Baghmara, Katras areas etc. However, in RCF (part) areas the altitude varies from 100 m to 140 m AMSL (Cluster-XVI). The general slope of the topography is towards south, i.e. Damodar River.

1.3 DRAINAGE

The drainage pattern of the area is dendritic in nature. The drainage system of the area is the part of Damodar sub-basin. All the rivers that originate or flow through the coalfield area have an easterly or south easterly course and ultimately joins Damodar River, the master drainage.The drainage of the JCF is mainly controlled by Jamuniya River (5th order), Khudia nala (3rd order), Katri River (4th) and Chatkari nala (3rd order) flowing from north to south and joins Damodar River. Whereas, Barakar River and Khudia River are controlling the drainage pattern of RCF (part) and joins Damodar River in the south. Damodar River is the main drainage channel and flows from west to east along the southern boundary of JCF and RCF.

The drainage map of the JCF and part of RCF has been prepared on topographic map of scale 1:50,000 (**Figure No-1**). The watershed of all tributary rivers (Jamuniya River to Barakar River) falls within the north-western part of Damodar sub-basin which comes under Lower Ganga Basin.

Besides, a large number of ponds/tanks are distributed in and around JCF, out of which one prominent lake is located at Topchanchi in the north-west part. Two reservoirs, Maithon dam in Barakar River and Panchet dam in Damodar River near to Chanch Victoria Area of BCCL (part of RCF) are the main source of water supply to the nearby area. Jharia Water Board, Damodar Water Supply Scheme and Mineral Area Development Authority (MADA) are supplying water to the various coalfield area from Maithon dam, Damodar River, Jamunia River, Topchachi Lake, etc.

2.0 GROUNDWATER SYSTEM

2.1 GEOLOGY OF THE AREA

The Jharia Coalfield covers an area of 453 sq. km. located in Dhanbad District, Jharkhand. The non-coal bearing Talchir Formation is exposed in patches along the northern fringe of the Coalfield. The Barakar Formation which overlies the Talchir is covering the most part of the Jharia Coalfield and having an area of 218 sq. km. This is successively overlain by the non-coal bearing Barren Formation which is mainly exposed in the central part of the Coalfield. This, in turn, is overlain by the Raniganj formation (Coal Bearing horizon) in the south-western part of the Coalfield and covers an area of 54 sq. km.

Chanch-Victoria Area which is located in the western part of Raniganj Coalfield. The Raniganj coalfield represents the eastern most coal basin in the Damodar Valley Region and located in Burdwan District, West Bengal. The Coalfield is almost elliptical in shape and covers an area of about 1530 sq. km. out of which only 35 sq. km. comes under leasehold area of BCCL out of which 19.64 sq. km is the study area (Cluster-XVI only). The coal bearing formations of the area belongs to Barakar Formation of the Lower Gondwana.

2.2 HYDROGEOLOGY OF THE STUDY AREA

The permeable formations mainly composed of sandstone behave as aquifer units. The coal seam and shales developed in the area act as impermeable beds i.e. aquiclude. The aquifer materials of Gondwana Formation are constituted of fine to coarse grained sandstone having primary porosity of intergranular void space. The secondary porosity formed due to presence of faults, fracture, joints, etc. Sandstone of Gondwana formations in JCF and RCF are very hard, compact and cemented sandstone and forming less potential aquifer, particularly the deeper aquifer system. The secondary porosity along with primary porosity forms a conduit system making these formations good aquifers for movement and storage of ground water.

2.3 AQUIFER DISPOSITION

The aquifer system for shallow and deeper aquifer has been established through hydrogeological studies, exploration, surface and subsurface geophysical studies in the JCF and RCF (part) covering all geological formations. The aquifer can be divided into two zones – Un-confined/Phreatic (shallow) and Semi-confined to confined (deeper) aquifer.

PHREATIC/UN-CONFINED AQUIFER

The top aquifer occurred above the top most coal seam/shale bed is called un-confined or water table aquifer and it consists of relatively permeable formation such as weathered sandstone and loose soil. The thickness of the un-confined aquifer is varies from few meters to 50 m. This un-confined aquifer is more potential than deep seated semi-confined to confined aquifer.

SEMI-CONFINED TO CONFINED AQUIFER

The semi-confined to confined aquifer consisting of sandstone bed is sandwiched with coal seams/shale beds and multiple aquifer system developed due to presence of multiple numbers of coal seams/shale beds. With the presence of intercalated shale and carbonaceous shale beds and reduction in permeability with depth, the lower aquifers are poor in potential.

2.4 AQUIFER PARAMETERS

PHREATIC/UN-CONFINED AQUIFER – The wells are tested by CMPDI for determination of aquifer parameters in Damuda (BJ Section) and Block-III area of JCF. The hydraulic conductivity of the un-confined aquifer is 0.50 m/day as computed from pumping tests on the wells. The transmissivity of the unconfined aquifer ranges from 10.68 m^2 /day to 41.48 m^2 /day.

SEMI-CONFINED TO CONFINED AQUIFER – Below the un-confined aquifer, the sandstone partings in-between impervious layers of shale and coal seams is designated as semi-confined / confined aquifers. The sandstones in these aquifers are fine to coarse grained, hard and compact with very low porosity. Mostly groundwater occurs in the weak zones formed due to weathering, fracture, faults, which create the secondary porosity. The hydrogeological parameter has been determined by CMPDI in Sitanala Block by conducting aquifer performance test (APT). The hydraulic conductivity (K) of semi-confined aquifer in Barakar Formation ranges from 0.0006 m/day to 1.44 m/day. The hydrogeological parameter has also been determined at Kumari OCP Block in the central JCF by conducting aquifer performance test. The hydraulic conductivity (K) of semi-confined aquifer in Barakar Formation in this area ranges from 0.0027 m/day to 0.05 m/day.

Aquifer Type	Hydraulic Conductivity (m/day)	Transmissivity (m^2 /day)	Remarks
Unconfined	0.50	10.68 – 41.48	Site: Damuda (BJ Section) and Block-III area
Semi-confined	0.0006 – 1.44 (1) 0.0027 – 0.05 (2)	-	Site: (1): Sitanala Block (2): Kumari Block

3.0 GROUNDWATER LEVEL MONITORING

To collect the representative groundwater levels in the study area, CMPDI has established a monitoring network of total 254 monitoring stations out of which 64 located within core zone and rest comes within Buffer zone. 60 dug wells within JCF and 04 dug wells within RCF (part) area (Details of the Hydrograph stations & water level are given in **Annexure-I, IIA** & **IIB**) spread over the entire BCCL leasehold area, **Figure No-1**. Water level monitoring in 254 hydrograph stations has been done in pre-monsoon as well as in post monsoon whereas in 64 stations monitoring done in quarterly (March, May, August and November month of 2018) basis.

Depth to water level of the water table depict the inequalities in the position of water table with respect to ground surface and is useful in delineating recharge / discharge areas, planning of artificial recharge structure and shows the overall status of the groundwater level in the area. Historical groundwater level (GWL) of entire JCF and part of RCF with fluctuation, GWL of Non-mining / Mining areas and GWL of the Cluster of Mines of BCCL are shown in this report to assess the effect of Coal mining activity in the groundwater regime in and around the Coalfield area.

Mining is a dynamic phenomenon. The mining activity creates dis-equilibrium in environmental scenario of the area and disturbs the groundwater conditions/regime in particular. The impact on shallow water regime due to mining activity can be broadly viewed as under:

- Historical GWL with annual fluctuation over the years
- GWL scenario in Non-mining and Mining area (OC/UG mines)
- GWL scenario of Cluster of mines of BCCL

**Construction of piezometers within Jharia Coalfield and part of Raniganj Coalfield to monitor groundwater level of deeper aquifers is already in progress.*

3.1 HISTORICAL GROUNDWATER LEVEL

Historical GWL of JCF and part of RCF are given from 2005 to 2018 of CMPDI monitoring stations (total 66 stations within Coalfield area). Pre-monsoon and Post-monsoon GWL with Fluctuation has been mentioned below in the table.

Table No – 1: Historical Groundwater Level

Period		(Water level in metre below ground level)								
		Pre-Monsoon (April/May)			Post-Monsoon (Nov/Dec)			Fluctuation		
		From	To	Average	From	To	Average	From	To	Average
JCF	2005	0.07	19.08	6.29	0.84	12.13	3.20	0.12	12.45	3.21
	2007	0.40	19.27	5.66	0.35	8.21	2.87	0.02	16.15	2.96
	2008	0.45	18.35	5.42	0.35	14.20	3.62	0.03	9.22	2.45
	2010	0.85	14.47	5.24	0.10	15.88	4.48	0.02	5.55	1.54
	2012	1.27	18.68	5.58	0.15	7.80	2.72	0.08	13.45	2.96
	2013	0.70	19.20	5.65	0.45	8.35	2.77	0.29	15.88	3.17
	2014	0.70	16.28	4.92	0.75	14.98	3.27	0.25	10.15	2.17
	2015	1.38	17.20	6.00	0.45	14.58	3.92	0.28	7.62	2.15
	2016	0.78	16.73	5.64	0.30	12.43	3.19	0.23	6.35	2.88
	2017	0.67	16.28	5.61	0.15	6.97	2.41	0.10	12.10	3.25
	2018	1.20	14.58	5.55	0.40	7.17	2.83	0.20	9.45	2.68
RCF (part)	2008	5.02	10.50	7.59	2.85	4.90	3.71	1.82	6.60	3.87
	2010	2.20	8.85	4.74	2.78	9.58	4.63	0.68	1.10	0.89
	2011	3.57	8.02	4.98	2.50	6.21	3.75	0.55	1.90	1.23
	2012	3.10	7.34	4.59	1.55	7.00	3.66	0.05	2.78	0.94
	2013	1.70	9.87	6.54	2.90	8.85	4.71	1.02	5.54	2.84
	2014	3.27	6.48	4.57	2.13	3.03	2.63	0.54	3.45	1.94
	2015	3.38	9.52	5.33	2.68	8.20	5.11	1.06	1.32	1.81
	2016	3.61	10.65	6.24	0.90	6.50	3.18	1.63	4.40	3.06
	2017	1.93	5.80	3.25	1.63	3.78	2.47	1.63	3.78	0.78
	2018	2.34	8.70	4.35	1.75	5.70	2.75	0.41	2.55	1.59

3.2 GROUNDWATER LEVEL SCENARIO IN NON-MINING/MINING AREA

Depth to water level (DTW) range in different formations with respect of mining and non-mining areas is summarized in the Table No-2.

Table No – 2: Depth to water table

Formation	***Area***		***DTW (bgl, m) [Year-2018]***		***Average GWL (m)***	
			Pre-monsoon (Apr/May)	***Post-monsoon (Nov/Dec)***	***Pre-monsoon***	***Post-monsoon***
Sedimentary (Gondwana)	Non-mining		1.85-9.65	0.85-3.70	5.47	2.49
	Mining	OC	1.59-10.93	0.45-7.10	5.00	2.57
		UG	1.20-14.58	0.60-7.17	6.52	3.28
Metamorphics	Peripheral part of the Coalfield		0.75-13.68	0.45-8.00	7.12	3.90

The study revealed that water table is in shallow depth and there is no significant stress in the water table due to coal mining activity. Mining and Non-mining areas shows barely any difference in water table condition in the JCF and RCF (part) area. The average hydraulic gradient of the water table within mining and non-mining areas is given in Table No-3. There is no significant change in hydraulic gradient has been observed. Relatively steep gradient near active opencast mining areas w.r.t., Non-Mining, Underground mines and Metamorphics areas is observed.

Table No – 3: Average hydraulic gradient

Sl. No	***Formation***	***Area***		***Average hydraulic gradient***
1	Sedimentary (Gondwana)	Non-Mining		1.5×10^{-3} to 2.0×10^{-3}
2		Mining	OC	5.0×10^{-2} to 4.0×10^{-3}
3			UG	2.0×10^{-2} to 3.0×10^{-3}
4	Metamorphics	Peripheral part of the Coalfield		1.0×10^{-3} to 2.0×10^{-3}

3.3 QUARTERLY GROUNDWATER LEVEL, CLUATER OF MINES (BCCL)

3.3 A Monitoring of Ground Water Levels of Cluster-I

Cluster-I (Damuda Group of Mines) consisting of Damoda (BJ and Gutway section) UG, Damoda (Albion section) OCP, proposed Damoda (B.J.section) OCP and Closed Gutway OCP of Barora Area of BCCL. It is located in the extreme western part of JCF in Bokaro district of Jharkhand.

The present leasehold area of Cluster-I is 575 Ha. The Damoda block area is marked by more or less flat and gently undulating topography. The RL varies from 179 m to 208 m AMSL and the general slope of topography is towards east. Jamuniya River, Kari Jore, Podo Jore and its tributaries are controlling the drainage system of the area. The area comes under the watershed of Jamuniya River.

4 hydrograph stations (**B-15, B-21A, B51 and B-53**) 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 and 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	B-15	Bera Basti	1.56	1.85	0.75	0.85
2	B-21A	Dugdha	6.73	9.65	3.45	2.65
3	B-51	Taranga	3.00	5.02	2.25	2.42
4	B-53	Karmatanr	2.52	3.92	1.62	1.42
Average WL (bgl)			3.45	5.11	2.02	1.84

Ground Water Level (in bgl) varies from 1.56 to 6.73 m during February, 1.85 to 9.65 m during April, 0.75 to 3.45 m during August and 0.85 to 2.65 m during November within the Core Zone of Cluster-I area.

3.3 B Monitoring of Ground Water Levels of Cluster-II

Cluster-II consists of seven mines namely; Block-II mixed mine (OCP & UGP), Jamunia OCP, Shatabdi OCP, Muraidih mixed mine (OCP & UGP) and Phularitand OCP is under administrative control of Block-II Area and Barora Area of BCCL. It is located in the extreme western part of Jharia Coalfield in Dhanbad district of Jharkhand.

The present leasehold area of Cluster-II is 2025.71 Ha. The Damoda block area is marked by more or less flat and gently undulating topography. The RL varies from 176 m to 235 m AMSL. Jamuniya River, Khudia River and its tributaries are controlling the drainage system of the area. The area comes under the watershed of Jamuniya River and Khudia River.

5 hydrograph stations (**B-1, B-59, B-60, B-61A and B-62A**) 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	B-1	Muraidih	1.68	2.88	1.48	2.08
2	B-59	Khodovaly	1.38	5.47	0.90	1.10
3	B-60	Bahiyardih	8.21	13.68	3.13	4.23
4	B-61A	Kesargora	1.27	2.57	2.62	2.02
5	B-62A	Sadiyardih	5.87	8.27	4.00	4.78
Average WL (bgl)			3.68	6.57	2.43	2.84

Ground Water Level (in bgl) varies from 1.27 to 8.21 m during February, 2.57 to 13.68 m during April, 0.90 to 4.00 m during August and 1.10 to 4.78 m during November within the Core Zone of Cluster-II area.

3.3 C Monitoring of Ground Water Levels of Cluster-III

Cluster-III consists of nine mines namely, Jogidih UG, Maheshpur UG, South Govindpur UG, Teturiya UG, Govindpur UG, New Akashkinaree mixed mine (OC & UG) and Kooridih/Block-IV mixed mine (OC & UG) under the administrative control of Govindpur Area of BCCL. This Cluster of mines is located in western part of Jharia Coalfield in Dhanbad district of Jharkhand.

The present leasehold area of Cluster-III is 1420.0 Ha. The area is plain with gentle undulation with RL varies from 160 m to 208.80 m AMSL. The general slope of the area is towards south. Khudia River, Baghdihi Jore, Katri River and its tributaries are controlling the drainage system of the area. The area comes under the watershed of Khudia River.

5 hydrograph stations (**A-12, A-25, A-29, B-14 and B-60**) 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	A-12	Jamua	1.20	2.80	0.40	1.0
2	A-25	Sinidih	4.88	6.63	2.88	3.13
3	A-29	Dharmaband	3.25	6.45	2.86	2.10
4	B-14	Mathadih	1.69	3.64	1.22	2.84
5	B-60	Sonardih	8.21	13.68	3.13	4.23
Average WL (bgl)			3.85	6.64	2.12	2.64

Ground Water Level (in bgl) varies from 1.20 to 8.21 m during February, 2.73 to 13.68 m during April, 0.40 to 3.13 m during August and 1.0 to 4.23 m during November within the Core Zone of Cluster-III area.

3.3 D Monitoring of Ground Water Levels of Cluster-IV

Cluster-IV consists of six mines namely, Salanpur UG, Katras-Choitudih UG, Amalgamated Keshalpur & West Mudidih OC, Amalgamated Keshalpur & West Mudidih UG, Amalgamated Angarpathra & Ramkanali UG and closed Gaslitand UG of Katras Area of BCCL. It is located in the north-central part of Jharia Coalfield in Dhanbad district of Jharkhand.

The present leasehold area of Cluster-IV is 1123.79 Ha. The area has a general undulating topography, with an overall gentle south-westerly slope. The RL varies from 182 m to 216 m AMSL. Katri River, Kumari Jore and its tributaries are controlling the drainage pattern of the area. The area comes under the watershed of Katri River.

4 hydrograph stations (**A-26, A28A, B-64 and B-65A**) 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	A-26	Malkhera	4.75	6.23	3.58	3.88
2	A28A	Lakarka	2.22	4.15	2.00	2.51
3	B-64	Keshalpur	1.42	2.15	0.55	1.85
4	B-65A	Jhinjipahari	4.18	10.03	2.10	2.40
Average WL (bgl)			3.14	5.64	2.16	2.66

Ground Water Level (in bgl) varies from 1.42 to 4.75 m during February, 2.15 to 10.03 m during April, 0.55 to 3.58 m during August and 1.85 to 3.88 m during November within the Core Zone of Cluster-IV area.

3.3 E Monitoring of Ground Water Levels of Cluster-V

Cluster-V consists of twelve mines namely; Tetulmari OC & UG mine, Mudidih OC & UG mine, Nichitpur OC, Sendra Bansjora OC & UG, Bansdeopur OCP (proposed) & UG, Kankanee OC & UG and closed Loyabad UG under the administrative control of Sijua Area of BCCL. This Cluster of mines is located in northern part of Jharia Coalfield in Dhanbad district of Jharkhand.

The present leasehold area of Cluster-V is 1957.08 Ha. The area has a general undulating topography, with an overall gentle south westerly slope. The RL varies from 210 m to 170 m AMSL. Jarian Nala, Nagri Jore, Ekra Jore and its tributaries are controlling the drainage pattern of the area. The area comes under the watershed of Jarian Nala and Ekra Jore.

4 hydrograph stations (**A-3, A-16, A-27 and D-23**) 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	A-3	Sijua	0.77	1.27	0.37	0.47
2	A-16	Ekra	2.60	4.30	2.05	3.65
3	A-27	Tetulmari	1.90	2.90	1.49	1.00
4	D-23	Jogta	2.70	4.40	2.60	3.40
Average WL (bgl)			1.99	3.22	1.63	2.13

Ground Water Level (in bgl) varies from 0.77 to 2.70 m during February, 1.27 to 4.40 m during April, 0.37 to 2.60 m during August and 0.47 to 3.65 m during November within the Core Zone of Cluster-V area.

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***

3.3 G Monitoring of Ground Water Levels of Cluster-VII

Cluster-VII consists of fourteen mines namely; Dhansar mixed mine, Kusunda OCP, Viswakarma OCP, Industry UG (closed), Alkusa UG, Ena OCP, S.Jharia/Rajapur OCP, Burragarh UG, Simlabahal UG, Hurriladih UG, Bhutgoria UG, Kustore UG (closed) and E.Bhuggatdih UG (closed) under the administrative control of Kusunda Area and Kustore Area of BCCL. This Cluster of mines is located in east central part of Jharia Coalfield in Dhanbad district of Jharkhand.

The present leasehold area of Cluster-VII is 2127.70 Ha. The area has a general undulating topography with general slope towards south. The RL varies from 172 m to 221 m above M.S.L. Kari Jore, Chatkari Jore and its tributaries are controlling the drainage pattern of the area. The area comes under the watershed of Kari Jore and Chatkari Jore.

7 hydrograph stations (**D-3, D-4, D-33, D-34, D-47, D-55 and D-80**) 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-3	Dhansar	1.65	3.43	1.50	2.45
2	D-4	Jharia	1.21	1.91	0.91	1.56
3	D-33	Kustore	0.55	2.85	0.55	0.95
4	D-34	Kusunda	0.60	2.80	0.45	0.70
5	D-47	Parastanr	3.55	5.33	2.55	3.65
6	D-55	Hariladih	4.42	8.42	1.57	4.02
7	D-80	Bastacolla	4.35	9.35	3.28	4.20
Average WL (bgl)			2.33	4.87	1.54	2.50

Ground Water Level (in bgl) varies from 0.55 to 4.42 m during February, 1.91 to 9.35 m during April, 0.45 to 3.28 m during August and 0.70 to 4.20 m during November within the Core Zone of Cluster-VII area.

3.3 H Monitoring of Ground Water Levels of Cluster-VIII

Cluster-VIII consists of ten mines namely; Bastacolla mixed mines (OC & UG), Bera mixed mines (OC & UG), Dobari UG, Kuya mixed (OC & UG), proposed Goluckdih (NC) OC, Ghanoodih OC and Kujama OC under the administrative control of Bastacolla Area of BCCL. This Cluster of mines is located in eastern part of Jharia Coalfield in Dhanbad district of Jharkhand.

The present leasehold area of Cluster-VIII is 1200.41 Ha. The area has a general undulating topography with general slope towards south and south-west. The ground elevation in the area ranges from 175 m to 221 m AMSL. Chatkari Jore, Tisra Jore and its tributaries controlling the drainage pattern of the area. The area comes under the watershed of Chatkari Jore.

4 hydrograph stations (**D-8, D-43, D-49 and D-51**) 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-8	Alokdiha	3.20	5.65	1.65	1.85
2	D-43	Alagdih	3.05	7.15	2.90	3.45
3	D-49	Galucdih	1.98	3.45	1.45	2.45
4	D-51	Chankuiya	8.26	10.93	4.80	7.10
Average WL (bgl)			4.12	6.80	2.70	3.71

Ground Water Level (in bgl) varies from 1.98 to 8.26 m during February, 3.45 to 10.93 m during April, 1.45 to 4.80 m during August and 1.85 to 7.10 m during November within the Core Zone of Cluster-VIII area.

3.3 I Monitoring of Ground Water Levels of Cluster-IX

Cluster-IX consists of eight mines namely; North Tisra/South Tisra Expansion OCP, Lodna UG, Bagdigi UG, Bararee UG and Joyrampur UG and Jealgora UG (closed) are under the administrative control of Lodna Area of BCCL. This Cluster of mines is located in eastern part of Jharia Coalfield in Dhanbad district of Jharkhand.

The present leasehold area of Cluster-IX is 1942.12 Ha. The topography of the area is undulating with gentle slope towards south. The RL varies from 221 m to 188.44 m AMSL. Chatkari Jore, Tisra Jore, Sulunga Jore and its tributaries controlling the drainage pattern of the area. The area comes under the watershed of Chatkari Jore.

6 hydrograph stations (**D-5, D-7, D-39, D-40A, D-41 and D-74**) 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-5	Jiyalgora	5.80	7.80	4.39	5.30
2	D-7	Golden Pahari	5.15	7.53	2.23	2.83
3	D-39	Tilaboni	3.18	4.95	2.50	4.35
4	D-40A	Khapa Dhawra	1.70	2.10	1.10	1.40
5	D-41	Joyrampur	1.30	1.59	1.08	1.32
6	D-74	Bhulan Bararee	5.80	8.60	3.40	4.80
Average WL (bgl)			3.82	5.43	2.45	3.33

Ground Water Level (in bgl) varies from 1.30 to 5.80 m during February, 1.59 to 8.60 m during April, 1.08 to 4.39 m during August and 1.32 to 5.30 m during November within the Core Zone of Cluster-IX area.

3.3 J Monitoring of Ground Water Levels of Cluster-X

Cluster-X consists of ten coal mines and one coal Washery namely; Bhowrah North mixed mines (UG & OC), Bhowrah South mixed mines (UG, 3 Pit OCP, Chandan OCP), Patherdih Mixed mines (UG, Chandan OCP), Sudamdih incline UG mine, Sudamdih Shaft UG mine, Amlabad UG (Closed) and Sudamdih Coal Washery under the administrative control of Eastern Jharia Area of BCCL. This cluster of mines is located in the eastern part of Jharia Coalfield in Dhanbad district of Jharkhand.

The present leasehold area of Cluster-X is 2057.47 Ha. The area has an undulating topography with gentle slope towards south and south east. The RL varies from 185 m to 150.0 m AMSL. Gaurkuthi Nala and few seasonal streams are controlling the drainage pattern of the area. The area comes under the watershed of Damodar River.

4 hydrograph stations (**A-19, D-35, D-36 and D-77**) 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	A-19	Bhowrah	2.95	5.55	1.85	2.45
2	D-35	Patherdih	6.58	8.40	3.58	4.45
3	D-36	Sudamdih	1.00	1.20	0.45	0.60
4	D-77	Amlabad	3.63	6.30	4.00	5.20
Average WL (bgl)			3.54	5.36	2.47	3.18

Ground Water Level (in bgl) varies from 1.00 to 6.58 m during February, 1.20 to 8.40 m during April, 0.45 to 4.0 m during August and 0.60 to 5.20 m during November within the Core Zone of Cluster-X area.

3.3 K Monitoring of Ground Water Levels of Cluster-XI

Cluster–XI consists of eight coal mines and one coal Washery namely; Gopalichak UG Project, Kachi Balihari 10/12 Pit UG, Pootkee Balihari Project UG, Bhagaband UG, Kendwadih UG (closed), Pootkee UG (closed), Kachi Balihari 5/6 Pit UG (closed) are under the administrative control of Pootkee Balihari Area and Moonidih UG & Moonidih Washery are under the administrative control of Western Jharia 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-XI is 3527.58 Ha. The area has an undulating topography with gentle slope towards south. The RL varies from 201 m to 166 m AMSL. Katri River, Jarian Nala, Ekra Jore and Kari Jore are controlling the drainage of the area. The area comes under the watershed of Katri River and Kari Jore.

5 hydrograph stations (**A-17, A-18, A-20, A-32 and D-34**) 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 below (bgl in meters)			
			Feb’18	Apr’18	Aug’18	Nov’18
1	A-17	Kachi Balihari	2.07	3.34	1.64	2.84
2	A-18	Baghaband	0.89	1.24	1.34	0.99
3	A-20	Gorbudih	3.59	4.57	1.92	2.57
4	A-32	Baludih	0.60	2.80	0.45	0.70
Average GW (bgl)			2.26	3.20	1.64	2.16

Ground Water Level (in bgl) varies from 0.60 to 3.59 m during February, 1.24 to 4.57 m during April, 0.45 to 1.92 m during August and 0.70 to 2.84 m during November within the Core Zone of Cluster-XI area.

3.3 L Monitoring of Ground Water Levels of Cluster-XIII

Cluster-XIII consists of one operating mine i.e. Murulidih 20/21 pits UG mine and six abandoned mines (Bhurungiya Colliery, Muchraidih colliery, Hantoodih colliery, Padugora colliery, Murulidih colliery, Bhatdee colliery) of Western Jharia Area of BCCL. It is located in the south-western part of Jharia Coalfield in Dhanbad district of Jharkhand.

The present leasehold area of Cluster-XIII is 1898.62 Ha. The area has an undulating topography with gentle slope towards south-east. The maximum RL is 224 m AMSL in the north-western part of the area whereas the minimum RL is 179 m AMSL at southern part. The area comes under the watershed area of Jamunia River and Katri River.

6 hydrograph stations (**A-22, A-23, A-33, A-34, B-25 and B-48**) 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	A-22A	Nagdah Basti	1.70	3.35	1.10	1.30
2	A-23	Machhayara	8.92	11.15	6.46	7.17
3	A-33	Mahuda Washery	2.24	4.07	1.26	2.35
4	A-34	Mahuda Mosque	5.32	9.45	4.75	5.35
5	B-25	Mahuda More	3.68	5.90	2.90	3.70
6	B-48	Mahuda	3.55	7.33	2.95	3.97
Average GW (bgl)			4.24	6.88	3.24	3.97

Ground Water Level (in bgl) varies from 1.70 to 8.92 m during February, 3.35 to 11.15 m during April, 1.10 to 6.46 m during August and 2.35 to 7.17 m during November within the Core Zone of Cluster-XIII area.

3.3 M Monitoring of Ground Water Levels of Cluster-XIV

Cluster-XIV consists of two mines namely; Lohapatty UG and Lohapatty Opencast Patch (proposed). These are under the administrative control of Western Jharia of BCCL. This Cluster of mines is located in western part of Jharia Coalfield in Dhanbad district of Jharkhand.

The present leasehold area of Cluster-XIV is 1577.22 Ha. The topography of the area is undulating with slope towards south west. The maximum RL is 224 m in the north-eastern part whereas the minimum RL is 170 m above mean sea level on the south-western part of the area. Jamunia River and its tributaries are controlling the drainage of the area. The area comes under the watershed area of Jamunia River.

3 hydrograph stations (**B-23, B-24 and B-67**) 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	B-23	Lohapatti	3.04	6.64	1.74	2.14
2	B-24	Telmuchu	6.43	9.28	3.31	4.33
3	B-67	Simatanr	6.50	9.55	3.60	4.00
Average GW (bgl)			5.32	8.49	2.88	3.49

Ground Water Level (in bgl) varies from 3.04 to 6.50 m during February, 6.64 to 9.55 m during April, 1.74 to 3.60 m during August and 2.14 to 4.00 m during November within the Core Zone of Cluster-XIV area.

3.3 N Monitoring of Ground Water Levels of Cluster-XV

Cluster–XV consists of four coal mines; Kharkharee UG and Dharmaband UG are under the administrative control of Govindpur Area and Madhuband UG & Phularitand UG are under the administrative control of Barora Area of BCCL. This Cluster of mines is located in western part of Jharia Coalfield in Dhanbad district of Jharkhand.

The present leasehold area of Cluster-XV is 1696.55 Ha. The topography of the area is undulating with slope towards south west. The maximum RL is 235 m in the Kharkharee mine area whereas the minimum RL is 165 m AMSL on the eastern & western part of the Cluster. Jamunia River and Khudia River are controlling the drainage of the area. The area comes under the watershed area of both Jamunia River and Khudia River.

3 hydrograph stations (**A-24, B-32A and B-61A**) 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	A-24	Pipratanr	11.68	14.58	5.78	6.88
2	B-32A	Madhuband	3.23	6.75	2.80	3.90
3	B-61A	Kesargora	1.27	2.57	2.0	2.02
Average GW (bgl)			5.39	7.97	3.63	4.27

Ground Water Level (bgl) varies from 1.27 to 11.68 m during February, 2.57 to 14.58 m during April, 2.0 to 5.78 m during August and 2.02 to 6.88 m during November within the Core Zone of Cluster-XV area.

3.3 O Monitoring of Ground Water Levels of Cluster-XVI

Cluster-XVI consists of five mines namely, Dahibari-Basantimata OC, Basantimata UG, New Laikidih OC, Laikdih Deep UG and Chunch UG under the administrative control of Chanch-Victoria Area of BCCL. This cluster of mines is located in the western part of Raniganj Coalfield in Dhanbad district of Jharkhand.

The present leasehold area of Cluster-XVI is 1964.21 Ha. The topography of the area is undulating with slope towards south west. The area is plain with gently undulating with elevation varying from 100 m to 140 m AMSL. The general slope of the area is towards southeast. Barakar River and Khudia River are controlling the drainage of the area. The area comes under the watershed area of Barakar River.

4 hydrograph stations (**DB-22, DB-23, DB-24 and DB-25**) 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	DB-22	Dahibari, Niche Basti	1.98	2.34	1.35	1.93
2	DB-23	Dahibari OC	2.00	2.85	1.20	1.75
3	DB-24	Dahibari	8.70	8.25	4.43	5.70
4	DB-25	Palasya	3.23	3.93	1.41	1.63
Average GW Level			3.98	4.34	2.10	2.75

Ground Water Level (in bgl) varies from 1.98 to 8.70 m during February, 2.34 to 8.25 m during April, 1.20 to 4.43 m during August and 1.63 to 5.70 m during November within the Core Zone of Cluster-XVI area.

4.0 GROUNDWATER LEVEL SCENARIO

During the month of February'2018 the depth to water level (in bgl) within 15 nos Cluster of mines varies from 0.50 m to 11.68 m with an average varies from of 1.55 m to 5.39 m. During the month of April'2018 the depth to water level varies from 1.20 m to 14.58 m with an average varies from 3.12 m to 8.50 m. During the month of August'2018 the depth to water level varies from 0.80 m to 6.47 m with an average varies from 0.80 m to 3.73 m. During the month of November'2018 the depth to water level varies from 0.40 m to 7.17 m with an average varies from 1.75 m to 4.26 m. The summarized water level data of all clusters are given in **Table No – 4**.

Depth to water level (in bgl) values described that water level goes down to maximum 14.58 m during pre-monsoon'2018 and maximum upto 8.50 m during post-monsoon'2018. Un-confined aquifer is affected around 20 m to 30 m maximum close to active opencast mining areas, showing steep gradient towards mine void. Other than that, there is no mining effect in the water level within JCF area and RCF area (part). Historical water level data and hydrograph of permanent observation stations from CGWB shown in **Annexure–III**.

Monitoring groundwater (quantity & quality) to assess the present condition and resource has been done regularly in the coalfield areas. Well hydrographs (**Annexure–III and VI**) are prepared and studied to identify potentially adverse trends so that appropriate action can be taken to protect groundwater resource. According to the hydrograph trend analysis of CGWB monitoring wells and CMPDI observation wells, there are decline trends in both Pre and Post-monsoon GW level trends (max. upto 0.50 cm/year in Patherdih/D-35) but no significant decline trend (>1.0 m/year) of water level is noticed in any particular area for the last 10 years within the coalfield area. Regarding quality monitoring, the water sample location map (**Figure No–2**) with collection points details (dug wells) are given in **Annexure–IV** and Quality is given in **Annexure–V**.

Table No–4: Groundwater level data Cluster-wise

Sl. No.	Cluster of BCCL	No. of Monitoring Wells	Water level fluctuation Below ground level (Feb, Apr, Aug & Nov'18)	Formation
1	I	4 nos.	0.75 to 9.65 m	Barakar
2	II	5 nos.	0.90 to 13.68 m	Barakar
3	III	5 nos.	0.40 to 6.63 m	Barakar
4	IV	4 nos.	0.55 to 10.03 m	Barakar
5	V	4 nos.	0.37 to 4.40 m	Barakar
6	VI	2 nos.	0.50 to 4.58 m	Barakar
7	VII	7 nos.	0.45 to 9.35 m	Barakar
8	VIII	4 nos.	1.45 to 10.93 m	Barakar
9	IX	6 nos.	1.08 to 8.60 m	Barakar
10	X	4 nos.	0.45 to 8.40 m	Barakar
11	XI	5 nos.	1.0 to 3.65 m	Barakar & Barren Measure
12	XIII	6 nos.	1.10 to 11.15 m	Raniganj
13	XIV	3 nos.	1.74 to 9.55 m	Raniganj
14	XV	3 nos.	1.27 to 14.58 m	Barakar & Barren Measure
15	XVI	4 nos.	1.20 to 8.70 m	Barakar

5.0 GROUNDWATER QUALITY

The ground water sample of the study area (15 nos. of Cluster of mines, BCCL) have been collected from dug wells and analysed. Fifteen ground water samples (GW-1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 13, 14, 15 & 16) were analysed quarterly (March, May, August and November'2018) at CMPDI, RI-II, Dhanbad. The water sampling details are given in **Annexure–IV** and Water sample locations are shown in **Figure No-2**. The water quality data are enclosed in **Annexure–VA, VB, VC and VD**.

The study of the variations in water quality parameters are described below:

During the month of March, May, August and December'2018:

The pH of the groundwater samples varies between 7.45 to 7.92 in March'18, 7.19 to 8.11 in May'18, 7.71 to 8.23 in August'18 and 7.14 to 8.24 in December'18. The pH is within the ISI limit of drinking water standard.

During the month of March, May, August and December'2018:

The mineral constituents dissolved in water constitute the dissolved solids. The total dissolve solids varies from 188 to 485 mg/l in March'18, from 286 to 566 in May'18, from 320 to 1060 in August'18 and from 132 to 830 in December'2018. The TDS values are above the IS 10500 standards of drinking water.

During the month of March, May, August and December'2018:

During the month of March'18 the alkalinity of the water samples varies from 64 to 132 mg/l and are within the stipulated standard of (200 mg/l) drinking water. The concentrations of calcium in the water samples vary from 30 to 46 mg/l and are within the permissible limit (75 mg/l) of drinking water standards. The total hardness ranges between 68 to 196 mg/l and the value of total hardness in water samples are within the permissible limit (200 mg/l). The sulphate ranges between 08 to 96 mg/l and the value of sulphate in water sample are within the permissible limit (200 mg/l). The Iron, Copper, Manganese, Lead, Zinc and Chromium concentration in the water samples are found to be below the upper ISI limits for drinking water.

During the month of May'18 the alkalinity of the water samples varies from 70 to 188 mg/l and are within the stipulated standard of (200 mg/l) drinking water. The concentrations of calcium in the water samples vary from 29 to 58 mg/l and are within the permissible limit (75 mg/l) of drinking water standards. The total hardness ranges between 132 to 326 mg/l and the value of total hardness in water samples are ***above*** the permissible limit (200 mg/l). The sulphate ranges between 65 to 180 mg/l and the value of sulphate in water sample are within the permissible limit (200 mg/l). The Iron, Copper, Manganese, Lead, Zinc and Chromium concentration in the water samples are found to be below the upper ISI limits for drinking water.

During the month of August'18 the alkalinity of the water samples varies from 45 to 152 mg/l and are within the stipulated standard of (200 mg/l) drinking water. The concentrations of calcium in the water samples vary from 30 to 194 mg/l and are above the permissible limit (75 mg/l) of drinking water standards. The total hardness ranges between 130 to 740 mg/l and the value of total hardness in water samples are above the permissible limit (200 mg/l). The sulphate ranges between 34 to 228 mg/l and the value of sulphate in water sample are ***slightly above*** the permissible limit (200 mg/l). The Iron (***slightly above the limit***), Copper, Manganese, Lead, Zinc and Chromium concentration in the water samples are found to be below the upper ISI limits for drinking water.

During the month of December'18 the alkalinity of the water samples varies from 112 to 212 mg/l and are ***slightly above*** the stipulated standard of (200 mg/l) drinking water. The concentrations of calcium in the water samples vary from 12 to 28 mg/l and are within the permissible limit (75 mg/l) of drinking water standards. The total hardness ranges between 286 to 602 mg/l and the value of total hardness in water samples are ***above*** the permissible limit (200 mg/l). The sulphate ranges between 48 to 84 mg/l and the value of sulphate in water sample are within the permissible limit (200 mg/l). The Iron, Manganese (***slightly above the limit***), Copper, Lead, Zinc and Chromium concentration in the water samples are found to be below the upper ISI limits for drinking water.

6.0 STAGE OF GROUNDWATER DEVELOPMENT

The groundwater is mainly utilized for domestic needs and for irrigation purposes. The groundwater abstraction is mainly through dug wells and bore wells. The stage of groundwater development in Dhanbad District is 77%. The highest stage of development is in Jharia Block (127.0%) & Dhanbad Block (107.50%) and lowest stage of development is in Baliapur Block (78.24%). The Gondwana sandstones in general, are known to constitute good aquifers at many places. However, the yield potential of the area adjoining to active mines in the coal belt is poor. The active mines often act as groundwater "sinks". In contrast, the water logged abandoned mines and pits act as potential sources of groundwater. As per the assessment done by Central Ground Water Board (CGWB), Patna in 2013, the Block wise data of Dhanbad District is given below:

Table No–5: Block-wise Stage of Groundwater development

Sl No.	Administrative Unit		Stage of GW Development	Category
	District	Block		
1	Bokaro	Bermo	156.30%	**Over- exploited**
2	Dhanbad	Baghmara	91.74%	Critical
3	Dhanbad	Baliapur	78.24%	Semi- Critical
4	Dhanbad	Dhanbad	107.50%	**Over- exploited**
5	Dhanbad	Jharia	127.0%	**Over- exploited**
6	Dhanbad	Topchachi	98.45%	Critical

- **Dynamic Groundwater Resource Assessment (as on 31st March, 2013), CGWB**

Table No–6: Cluster-wise Groundwater development scenario

Cluster/ Area	Adminis-trative Blocks/Stage Of GW Develo-Pment (SOD)	Total Water demand (Lakh cum/year)				Avg. GW level (bgl in m) 2018		GW level declining trend 2005-2018		Quantity Recharge/ future use (Lakh Cum/ Year)
		Mine Discharge (GW + Rainwater)	Surface Water Source	Total Use (Domestic + Industrial)	Excess Or other use	Pre-monsoon	Post-monsoon	Pre-monsoon	Post-monsoon	
Cluster-I	Bermo (SOD: Over-exploited)	9.56	NIL	7.42	2.14	5.11	1.84	YES	YES	NIL
Cluster-II	Baghmara (SOD: Critical)	170.17	Jamunia river	22.55	23.83	6.57	2.84	YES	NO	123.75
Cluster-III		58.18	NIL	2.58	12.65	6.64	2.64	NO	YES	42.95
Cluster-IV		68.84	MADA (Damodar river)	18.47	12.31	5.64	2.66	NO	NO	38.06
Cluster-V		127.29	MADA	77.92	31.02	3.22	2.13	YES	YES	18.35
Cluster-VI	Dhanbad (SOD: Over-exploited)	3.86	MADA (Damodar river)	3.69	0.0	3.60	1.75	YES	YES	NIL (loss due to FF)
Cluster-VII		93.33	MADA	27.70	6.87	4.87	2.50	YES	NO	58.76
Cluster-VIII	Jharia (SOD: Over-exploited)	29.27	MADA	24.04	1.18	6.80	3.71	NO	NO	4.05
Cluster-IX		310.34	MADA	160.28	45.05	5.43	3.33	NO	NO	105.01
Cluster-X		59.38	Damodar river	11.47	0.0	5.36	3.18	YES	NO	47.91
Cluster-XI	Dhanbad (SOD: Over-exploited)	249.67	MADA & DVC	19.86	43.92	3.20	2.16	YES	YES	185.89
Cluster-XIII	Baghmara (SOD: Critical)	64.61	Damodar river	10.09	9.86	6.88	3.97	YES	YES	44.66
Cluster-XIV		NA	NA	NA	NA	8.49	3.49	NO	NO	NA
Cluster-XV		5.11	Jamunia river	0.0	5.11	7.97	4.27	NO	YES	0.0
Cluster-XVI	Nirsa (SOD:Safe)	29.78	DVC (Barakar river)	14.60	6.57	4.34	2.75	NO	NO	8.61

7.0 CONSERVATION MEASURES & FUTURE STRATEGY

- BCCL has installed 25 Pressure Filter Plant of total capacity of 4.16 MGD to meet drinking water requirement nearby the area. At present 63 Water Treatment Plants are operational having capacity of 16.16 MGD within Jharia Coalfield area. Further installation of 28 more Pressure Filter Plants with the capacity of 5.84 MGD are in progress.

- BCCL participated in development of low cost technology for drinking water in a CSIR project along with CIMFR, Dhanbad and a pilot plant of 4000 Liters/hour is functional at PB Project site of BCCL. Similar plant has been proposed at other sites of BCCL.

- A scheme entitled 'Scheme for multi-purpose utilization of surplus mine water of Barora Area, Block II and Govindpur Area of BCCL' was prepared with a view to harness the excess water discharge to take care of the persistence problem of water scarcity in the nearby villages. In the scheme, two water reservoirs of capacity 27 MG and 17 MG have been proposed in the non-coal bearing area for storage of 3250 GPM and 2000 GPM surplus mine water which will be fed through pipe line by mine discharge at mines of Barora, Block-II and Govindpur Area.

- Roof-top rainwater harvesting (RWH) will be taken up in the project area using the administrative buildings. 138 no. of quarters having roof-top area of about 14950 sq. m. is already prepared to harvest rainwater and around 13150 cum/annum of water is going to be recharged the nearby groundwater system through RWH structures. Proposal already made to facilitate this kind of RWH structure at suitable locations i.e. Lodna Area, Kusunda Area (Jawahar Nagar, Matkuria, Coal Board Colony), Sijua Area (Nichitpur and Tetulmari Colony) within Jharia Coalfield to augment groundwater recharge.

- After cessation of mining, with plenty rainfall and abundant ground water recharge, the water levels will recoup and attain normalcy. Thus, the impact of mining on groundwater system may be considered as a temporary

phenomenon. The abandoned mine workings (UG) behave as water pool and improves the resources availability in the coalfield area.

- Utilization of treated mine water discharge by both industry and local people in the mine influence area. The excess mine water can be used to recharge groundwater system through connecting pipeline to abandoned dug wells. Utilization of mine water for irrigation use will also enhance the ground water recharge potential through artificial recharge in the area.

- Increase vegetative cover by plantation in the mine area under land amelioration measures. This will contain the surface run-off and increase the groundwater recharge.

- Creation of awareness among workers and local peoples about Rain water harvesting and artificial recharge will be given priority. This aspect is usually covered during the Environmental Week celebrated every year (5 to 12 June).

- Monitoring of water quality of mine water discharge, local River/nala and domestic water source (dug well/hand pump wells) will be continued under routine monitoring (February, May, August & November).

Annexure – I

Location of Hydrograph Stations (Dug Wells)

Well No	Latitude	Longitude	Well No	Latitude	Longitude
A-3	23^{0}47'53.35" N	86^{0}19'55.14" E	**B-63**	Abandoned due to OCP	
A-12	23^{0}48'20.31" N	86^{0}16'51.64" E	**B-64**	23^{0}48'43.14" N	86^{0}18'44.25" E
A-16	23^{0}46'57.00" N	86^{0}21'38.57" E	**B-65A**	23^{0}48'53.65" N	86^{0}18'11.82" E
A-17	23^{0}45'09.44" N	86^{0}22'16.35" E	**B-67**	23^{0}43'30.70" N	86^{0}14'01.45" E
A-18	23^{0}44'37.65" N	86^{0}22'58.90" E	**D-3**	23^{0}46'46.31" N	86^{0}24'49.30" E
A-19	23^{0}41'12.86" N	86^{0}23'55.27" E	**D-4**	23^{0}44'29.37" N	86^{0}24'42.88" E
A-20	23^{0}44'56.64" N	86^{0}19'55.35" E	**D-5**	23^{0}42'20.05" N	86^{0}24'86.06" E
A-22	23^{0}43'06.65" N	86^{0}14'48.53" E	**D-7**	23^{0}43'12.08" N	86^{0}27'11.89" E
A-23	23^{0}45'06.38" N	86^{0}15'12.69" E	**D-8**	23^{0}44'06.13" N	86^{0}27'20.72" E
A-24	23^{0}45'20.44" N	86^{0}13'45.12" E	**D-23**	23^{0}47'20.89" N	86^{0}20'09.96" E
A-25	23^{0}47'06.20" N	86^{0}15'27.79" E	**D-25**	23^{0}47'03.28" N	86^{0}23'29.56" E
A-26	23^{0}46'49.24" N	86^{0}18'12.12" E	**D-30**	23^{0}48'36.10" N	86^{0}21'50.07" E
A-27	23^{0}48'42.55" N	86^{0}20'21.80" E	**D-33**	23^{0}45'34.62" N	86^{0}23'18.50" E
A-28A	23^{0}47'34.74" N	86^{0}18'04.18" E	**D-34**	23^{0}45'36.50" N	86^{0}23'02.45" E
A-29	23^{0}47'08.02" N	86^{0}16'02.72" E	**D-35**	23^{0}40'46.54" N	86^{0}25'46.33" E
A-32	23^{0}44'15.56" N	86^{0}20'43.80" E	**D-36**	23^{0}40'19.26" N	86^{0}25'18.98" E
A-33	23^{0}44'32.58" N	86^{0}16'58.28" E	**D-39**	23^{0}43'28.50" N	86^{0}26'0.10" E
A-34	23^{0}42'58.63" N	86^{0}15'19.31" E	**D-40A**	23^{0}43'20.18" N	86^{0}25'45.70" E
B-1	23^{0}48'48.06" N	86^{0}14'16.87" E	**D-41**	23^{0}42'40.00" N	86^{0}26'17.20" E
B-14	23^{0}48'00.81" N	86^{0}16'25.88" E	**D-43***	NA	NA
B-15	23^{0}46'06.92" N	86^{0}08'59.30" E	**D-47**	23^{0}45'20.59" N	86^{0}24'34.86" E
B-21A	23^{0}45'10.50" N	86^{0}09'36.38" E	**D-49**	23^{0}44'08.96" N	86^{0}26'32.71" E
B-23	23^{0}44'13.05" N	86^{0}11'46.56" E	**D-51**	23^{0}44'20.86" N	86^{0}27'11.37" E
B-24	23^{0}44'26.80" N	86^{0}13'09.38" E	**D-55**	23^{0}43'58.37" N	86^{0}24'07.45" E
B-25	23^{0}44'44.98" N	86^{0}13'57.80" E	**D-74**	23^{0}41'33.66" N	86^{0}25'06.10" E
B-32A	23^{0}45'49.18" N	86^{0}13'03.64" E	**D-77**	23^{0}41'00.74" N	86^{0}22'25.55" E
B-48	23^{03}4'35.09" N	86^{0}16'38.30" E	**D-80**	23^{0}46'09.46" N	86^{0}24'33.08" E
B-51	23^{0}47'40.20" N	86^{0}09'11.90" E	**DB-22**	23^{0}43'38.81" N	86^{0}45'09.00" E
B-53	23^{0}45'55.25" N	86^{0}09'35.44" E	**DB-23**	23^{0}43'44.24" N	86^{0}45'06.39" E
B-53A	-	-	**DB-24**	23^{0}43'53.00" N	86^{0}45'03.88" E
B-59	23^{0}47'59.87" N	86^{0}13'37.97" E	**DB-25**	23^{0}44'10.75" N	86^{0}44'35.84" E
B-60	23^{0}48'7.87" N	86^{0}15'37.12" E			
B-61A	23^{0}45'59.85" N	86^{0}11'40.80" E			
B-62A	23^{0}45'44.15" N	86^{0}11'27.80" E			

Annexure – IIA

Details of Hydrograph Stations (Dug Wells)

Well No	Location	M.P. (agl) in m	Well Dia in m	Well Depth (m bmp)	R.L. (G.L) (m)	Formation	Owner	Utility
A-3	Sijua	0.53	3.00	5.20	203	Barakar	Govt.	Domestic
A-12	Jamua	0.80	1.90	3.30	202	Barakar	Govt.	Domestic
A-16	Ekra, Kalali More	0.45	3.10	6.50	205	Barakar	Govt.	Domestic
A-17	Kachi Balihari	0.56	1.60	5.30	182	Barakar	Govt.	Domestic
A-18	Bhagabandh	0.61	1.45	3.37	182	Barakar	Govt.	Domestic
A-19	Bhaura	0.54	3.15	11.65	162	Barakar	Govt.	Domestic
A-20	Gorbhudih	0.43	3.30	8.30	181	BM	Govt.	Domestic
A-22	Nagdah, Niche tola	0.00	1.40	9.50	171	Raniganj	Govt	Irrigation
A-23	Machhyara	0.43	1.85	12.40	203	Raniganj	Govt	Domestic
A-24	Pipra Tanr	0.22	1.80	19.55	208	Raniganj	Govt	Domestic
A-25	Sinidih	0.22	2.00	11.30	203	Barakar	Govt	Domestic
A-26	Pasitanr (Malkera)	0.32	1.80	9.65	198	Barakar	Govt	Domestic
A-27	Chandor	0.60	2.50	5.50	221	Barakar	Govt	Domestic
A-28A	Lakarka 6 no.	0.65	1.30	5.25	199	Barakar	BCCL	Domestic
A-29	Aambagan (Gobindpur)	0.10	2.60	9.15	186	Barakar	Govt	Domestic
A-32	Baludih	0.55	2.30	6.85	182	BM	Govt	Domestic
A-33	Mahuda	0.75	2.00	10.80	195	BM	BCCL	Domestic
A-34	Bhatdih	0.55	3.50	24.50	162	Raniganj	BCCL	Domestic
B-1	Muraidih	0.47	1.80	5.35	212	Talchir	Govt	Domestic
B-14	Mathadih	0.76	2.15	3.75	201	Barakar	Govt	Domestic
B-15	Bera Basti	0.55	1.60	2.50	221	Talchir	Dhanu Roy	Domestic
B-21A	Dugdha	0.55	2.10	10.35	220	Metamorphics	Govt	Domestic
B-23	Lohapati	0.26	3.60	10.85	204	Raniganj	Govt	Domestic
B-24	Telmuchu	0.67	4.35	10.83	207	Raniganj	Govt	Domestic
B-25	Mahuda More	0.10	2.45	8.45	205	Raniganj	Govt	Domestic
B-32A	Madhuband	0.80	4.30	8.60	205	Barakar	BCCL	Domestic
B-48	Mahuda	0.65	2.10	11.50	181	Raniganj	Mosque	Domestic
B-51	Taranga	0.00	2.50	5.75	215	Metamorphics	Bisun	Irrigation
B-53	Karmatanr	0.58	2.70	13.25	195	Barakar	Govt	Domestic
B-53A	Karmatanr-Damoda OCP							
B-59	Khodovaly	0.60	2.40	9.30	202	Barakar	BCCL	Domestic
B-60	Bahiyardih	0.77	3.00	15.60	196	Barakar	BCCL	Domestic
B-61A	Kesargora	0.48	2.00	11.20	201	Barakar	BCCL	Domestic
B-62A	Sadariyadih	0.15	3.10	9.50	188	Barakar	Govt	Domestic

Annexure – IIA

Details of Hydrograph Stations (Dug Wells)

Well No	Location	M.P. (agl) in m	Well Dia in m	Well Depth (m bmp)	R.L. (G.L) (m)	Formation	Owner	Utility
B-63	West Mudidih	0.60	1.70	3.35	196	Barakar	BCCL	Domestic
B-64	Keshalpur	0.65	1.10	3.40	195	Barakar	BCCL	Domestic
B-65A	Jhinjipahari	0.95	2.20	12.40	196	Barakar	Shiv Temple	Domestic
B-67	Simatanr	0.55	2.20	11.80	198	Raniganj	Govt	Domestic
D-3	Dhansar	0.60	1.70	8.70	217	Barakar	Govt	Domestic
D-4	Jharia	0.59	1.90	5.73	218	Barakar	Govt	Domestic
D-5	Jiyalgora	0.70	2.80	10.55	183	Barakar	Govt	Domestic
D-7	Golden Pahari	0.67	2.85	10.05	201	Barakar	BCCL	Domestic
D-8	Alokdiha	0.35	1.75	7.57	201	Metamorphics	BCCL	Domestic
D-23	Jogta (Sindra)	0.40	3.10	7.25	205	Barakar	BCCL	Domestic
D-25	Godhar More	0.60	2.75	5.60	219	Barakar	Govt	Domestic
D-30	Borkiboa	0.70	2.00	5.60	221	Talchir	H.Kumbhakar	Domestic
D-33	Kustore-4	0.55	1.85	3.45	196	Barakar	BCCL	Domestic
D-34	Kusunda-7	0.60	1.50	3.45	201	Barakar	BCCL	Domestic
D-35	Patherdih	0.40	2.00	11.20	160	Barakar	BCCL	Domestic
D-36	Sudamdih	0.90	2.00	6.20	141	Barakar	BCCL	Domestic
D-39	Tilabani	0.85	2.00	5.90	178	Barakar	BCCL	Domestic
D-40A	Khapra Dhaora	0.55	1.95	3.70	180	Barakar	Panchayat	Domestic
D-41	Joyrampur	0.50	1.80	4.00	180	Barakar	BCCL	Domestic
D-43	Alagdih	0.45	2.20	8.90	200	Metamorphics	Govt	Domestic
D-47	Parastanr	0.45	3.20	23.80	206	Barakar	BCCL	Domestic
D-49	Goluckdih	0.55	1.80	6.15	192	Barakar	BCCL	Domestic
D-51	Chankuiya	0.55	3.70	11.90	197	Barakar	BCCL	Domestic
D-55	Hariladih	0.48	2.80	11.80	184	Barakar	Govt	Domestic
D-74	Bhulan Barari	0.10	1.60	12.80	173	Barakar	Govt	Domestic
D-77	Rohoniatanr	0.40	3.15	6.70	156	Barakar	Govt	Domestic
D-80	Bastacolla	0.70	2.50	24.95	219	Barakar	Govt	Domestic
DB-22	Nichebasti	0.67	2.40	10.65	121	Barakar	Govt	Domestic
DB-23	Dahibari OC	0.70	2.30	8.00	-	Barakar	BCCL	Domestic
DB-24	Dahibari	0.60	3.60	13.70	125	Barakar	BCCL	Domestic
DB-25	Palasya	0.37	1.55	5.25	127	Barakar	Govt	Domestic

MP: Measuring Point **R.L.: Reduced Level** **W.L.: Water Level m: Meter**

Abn.: Abandoned **b.g.l.: Below Ground Level** **a.g.l.: Above Ground Level**

G.L.: Ground Level **bmp: Below Measuring Point** **BM: Barren Measure**

Annexure – IIB

Historical Water Level data of Hydrograph Stations

Well No	Water level below ground level (bgl) in meters														
	May, 11	May, 12	Nov, 12	May, 13	Nov, 13	May, 14	Nov, 14	May, 15	Nov, 15	May, 16	Nov, 16	May, 17	Nov, 17	May, 18	Nov, 18
A-3	4.77	4.25	1.87	4.47	4.45	4.67	2.37	3.70	3.42	4.87	0.47	0.67	0.77	1.27	0.47
A-12	2.80	2.80	1.30	3.00	1.17	2.45	1.4	3.00	2.68	2.50	0.70	2.55	0.85	2.80	1.0
A-16	5.80	3.53	1.60	3.80	3.35	5.5	2.9	5.55	4.17	5.85	3.15	3.65	2.20	4.30	3.65
A-17	2.24	2.52	2.34	2.32	1.54	2.19	1.91	3.79	2.64	2.44	2.69	2.44	2.24	3.34	2.84
A-18	2.49	2.59	0.90	2.87	0.91	1.76	1.19	2.84	1.29	1.14	0.89	1.29	0.99	1.24	0.99
A19		9.61	2.46	7.46	4.46	3.00	2.75	3.05	2.75	7.81	4.11	6.37	2.45	5.55	2.45
A-20	7.87	7.17	1.57	6.47	0.67	3.97	2.55	4.59	2.93	7.49	3.50	4.27	1.77	4.57	2.57
A22A		1.90	1.05	1.79	1.00	1.50	2.0	3.20	1.96	3.25	1.75	4.27	1.77	3.35	1.30
A-23	11.92	9.87	4.75	10.57	5.82	8.76	6.82	11.3	9.37	11.87	8.13	6.40	1.50	11.15	7.17
A-24	18.28	18.68	5.23	16.01	3.25	16.28	14.98	17.2	14.5	16.62	12.43	11.87	6.97	14.58	6.88
A-25	6.83	10.23	4.43	10.23	2.98	7.03	5.28	7.78	5.85	7.43	4.58	6.38	2.88	6.63	3.13
A-26	9.18	8.76	4.28	7.56	4.28	7.71	4.58	7.73	3.18	8.93	4.48	5.28	2.53	6.23	3.88
A-27	3.00	2.13	1.10	1.62	1.25	1.63	1.55	4.40	3.95	4.85	1.80	2.90	1.25	2.90	1.0
A28A	3.90	2.90	2.45	3.35	2.45	3.29	1.91	4.35	3.60	3.35	1.47	4.30	1.55	4.15	2.51
A-29	5.50	9.30	1.42	6.95	1.67	3.3	2.35	4.55	4.60	5.92	6.96	4.40	1.30	6.45	2.10
A-32	2.30	2.19	1.10	2.45	1.95	3.15	2.45	4.41	2.13	4.75	2.10	3.15	1.55	2.80	0.70
A-33	3.07	5.25	1.25	4.13	1.80	4.08	1.57	4.91	1.97	5.75	2.60	6.45	1.55	4.07	2.35
A-34	2.90	6.95	2.90	6.21	2.50	4.45	4.45	8.40	4.81	4.75	4.45	12.45	4.45	5.90	3.70
B-1	1.78	2.08	1.73	1.53	1.83	2.43	1.81	3.28	2.75	3.58	1.93	2.33	0.85	2.88	2.08
B-14	2.49	1.34	1.42	1.74	1.45	3.24	4.44	2.94	2.29	2.44	0.47	2.94	1.84	3.64	2.84
B-15	1.37	1.27	0.45	1.20	0.55	0.95	1.45	1.50	0.45	1.85	0.55	4.85	0.15	1.85	0.85
B21A	7.60	9.00	5.05	8.01	4.95	9.54	3.7	7.37	4.65	5.55	4.50	8.85	5.65	9.65	2.65
B-23	9.14	3.71	1.74	5.27	1.39	6.57	2.74	7.86	4.29	6.81	2.41	7.74	2.14	6.64	2.14
B-24	10.33	-	3.09	8.88	2.83	9.40	2.21	10.0	5.78	10.63	4.28	10.03	4.03	9.28	4.33
B-25	8.35	8.35	2.60	7.08	2.15	5.82	5.15	6.88	-	7.05	1.70	6.70	1.40	5.90	3.70
B32A	7.80	7.75	3.22	6.25	2.68	8.33	2.05	7.55	3.32	6.95	3.07	6.95	2.80	6.75	3.90
B-48	5.75	5.43	3.85	4.69	3.20	6.38	4.35	7.90	5.42	9.35	4.60	7.70	4.15	7.33	3.97
B-51	3.95	3.60	2.05	3.35	2.49	2.09	1.98	4.65	3.40	4.90	3.18	4.98	2.55	5.02	2.42
B-53	1.67	6.97	1.42	4.15	1.12	3.39	-	5.58	2.82	4.70	1.45	4.02	1.92	3.92	1.42
B-59	8.25	6.90	0.60	7.56	0.30	2.65	1.0	4.12	1.60	4.40	0.50	5.40	0.60	5.47	1.10
B-60	11.44	10.18	5.13	11.29	5.23	9.82	4.59	9.21	5.28	10.33	5.03	13.23	3.18	13.68	4.23
B61A	10.72	5.42	2.40	8.17	2.02	6.93	3.57	6.15	4.52	6.58	3.87	2.57	0.82	2.57	2.02
B62A	8.85	7.85	4.90	7.73	4.63	8.83	5.85	9.10	5.21	9.30	4.95	8.15	4.35	8.27	4.78

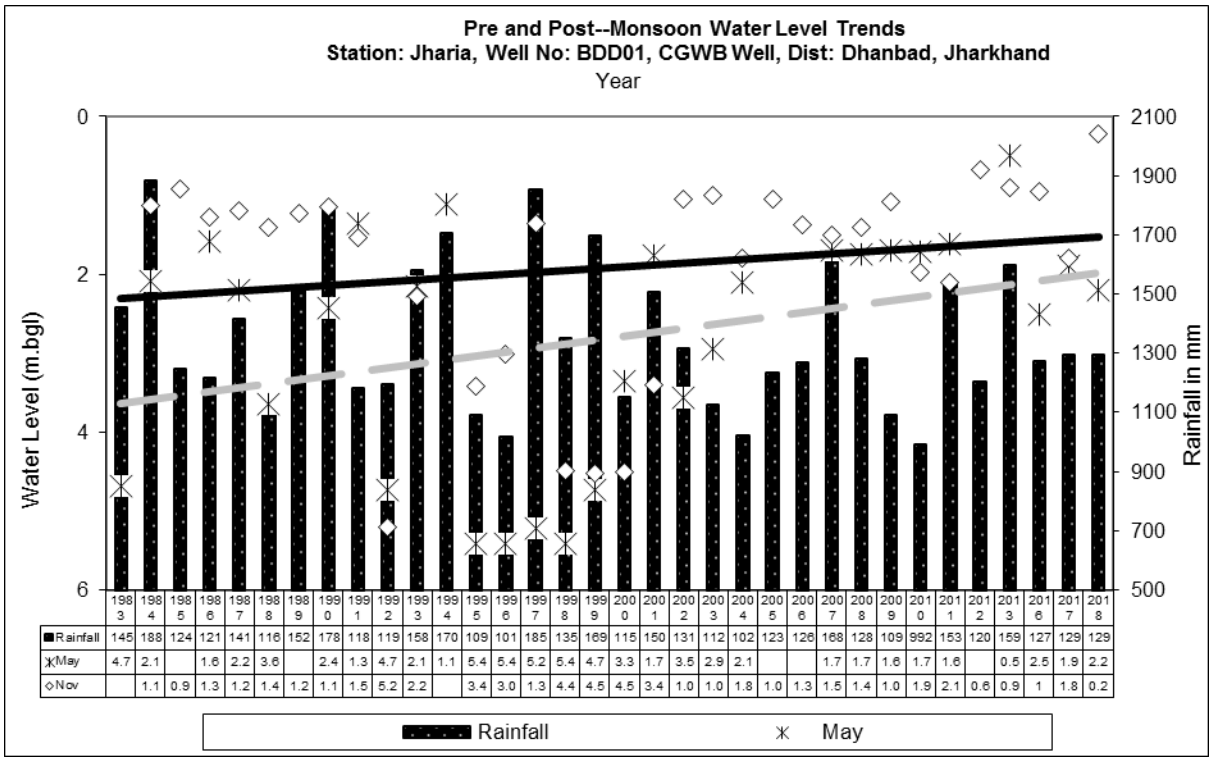
Annexure – IIB

Historical Water Level data of Hydrograph Stations

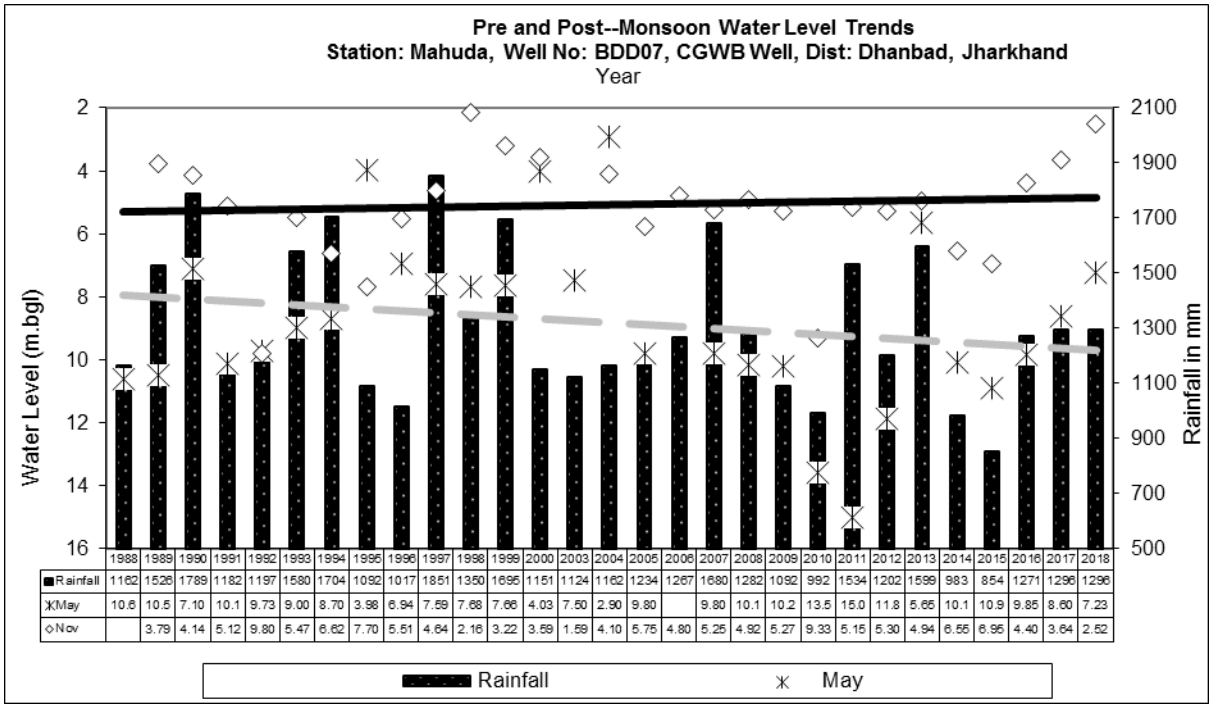
Well No	*Water level below ground level (bgl) in meters*														
	May, 11	***May, 12***	***Nov, 12***	***May, 13***	***Nov, 13***	***May, 14***	***Nov, 14***	***May, 15***	***Nov, 15***	***May, 16***	***Nov, 16***	***May, 17***	***Nov, 17***	***May, 18***	***Nov, 18***
B-64	0.85	1.05	1.00	1.35	0.85	0.7	1.15	1.38	0.95	2.35	0.55	1.25	0.85	2.15	1.85
B65A	9.65	11.45	1.73	10.11	1.82	10.45	2.4	7.82	5.87	7.15	2.68	9.05	1.25	10.03	2.40
B-67	11.25	8.55	6.50	9.73	5.31	9.80	3.72	9.23	5.53	9.53	4.30	10.00	2.15	9.55	4.0
D-3	2.55	2.93	1.80	3.45	1.68	2.54	2.11	4.25	2.25	2.35	1.90	2.15	2.30	3.43	2.45
D-4	1.51	1.94	0.91	2.41	0.98	1.23	0.91	2.41	1.27	1.21	1.36	1.21	1.46	1.91	1.56
D-5	9.05	9.50	6.45	9.32	4.59	9.0	7.8	9.37	8.33	9.40	6.40	7.90	5.20	7.80	5.30
D-7	9.33	6.08	5.83	7.19	4.63	5.28	5.53	8.25	5.61	7.53	4.03	7.33	2.88	7.53	2.83
D-8	7.75	6.15	3.75	6.65	2.85	7.73	-	6.24	4.38	8.00	3.43	5.15	1.85	5.65	1.85
D-23	6.80	6.00	3.30	6.60	1.20	6.38	2.4	6.55	3.48	5.70	1.63	2.80	2.98	4.40	3.40
D-25	4.70	5.20	3.65	4.26	3.45	4.42	2.9	4.48	2.45	2.40	1.90	2.40	1.20	2.60	2.40
D-30	5.10	3.88	1.80	4.38	3.08	4.17	3.3	4.55	3.15	4.45	3.20	4.40	1.25	4.58	1.10
D-33	0.95	2.85	0.35	1.80	0.45	1.72	0.35	2.25	1.10	2.50	1.95	0.75	0.75	2.85	0.95
D-34	2.85	2.35	2.50	2.50	2.13	2.80	0.30	2.55	1.45	2.30	0.30	0.80	0.55	2.80	0.45
D-35	8.20	8.05	5.55	7.70	4.10	6.94	6.15	9.80	7.90	9.52	6.45	8.80	3.60	8.40	4.45
D-36	1.95	1.55	0.15	1.28	0.80	1.82	0.75	1.66	1.13	0.78	0.95	1.30	0.70	1.20	0.60
D-39	5.05	5.05	3.65	3.98	2.50	5.03	2.25	5.00	2.61	2.18	2.65	6.17	4.75	4.95	4.35
D40A	1.95	2.45	1.70		2.25	2.35	2.45	3.07	2.45	1.40	0.85	1.45	1.35	2.10	1.40
D-41	1.55	1.50	1.50	1.72	1.35	3.20	1.35	2.65	2.32	1.30	1.52	1.40	1.20	1.59	1.32
D-43	7.65	7.05	4.00	6.23	4.05	6.0	4.75	6.61	5.05	8.20	3.35	7.50	3.60	7.15	3.45
D-47	4.35	1.95	2.12	2.60	2.97	8.0	2.37	9.60	3.60	3.18	2.95	3.15	2.85	5.33	2.55
D-49	1.55	1.60	1.65	1.30	1.45	2.51	1.65	3.55	2.35	2.45	1.72	2.70	2.05	3.45	2.45
D-51	10.85	10.00	7.85	8.94	8.35	9.60	9.05	10.48	9.15	11.15	6.45	10.45	5.43	10.93	7.10
D-55	5.97	1.93	1.82	3.90	1.45	1.95	2.07	6.15	1.57	2.52	3.62	6.42	2.37	8.42	1.57
D-74	4.05	4.95	3.60	4.55	3.41	5.0	4.0	10.05	7.20	7.73	5.00	9.25	3.85	8.60	4.80
D-77	6.30	6.50	4.75	4.79	5.10	6.23	6.0	6.44	5.60	4.60	2.90	6.50	4.90	6.30	5.20
D-80	17.45	14.20	3.35	15.25	3.32	13.3	3.15	10.97	3.35	6.55	4.15	8.65	3.70	9.35	4.20
RCF (part)		***May, 12***	***Nov, 12***	***May, 13***	***Nov, 13***	***May, 14***	***Nov, 14***	***May, 15***	***Nov, 15***	***May, 16***	***Nov, 16***	***May, 17***	***Nov, 17***	***May, 18***	***Nov, 18***
DB22		2.43	2.38	8.18	2.64	6.48	3.03	4.59	3.53	5.38	3.33	1.93	1.63	2.34	1.93
DB23		2.90	2.33	5.05	3.10	3.95	2.13	3.38	6.04	5.30	0.90	2.05	1.90	2.85	1.75
DB24		-	-	-	8.25	-	8.45	9.52	8.20	10.65	6.50	5.80	3.78	8.25	5.70
DB25		3.96	1.18	1.33	2.53	3.27	2.73	3.83	2.68	3.61	1.98	3.23	2.58	3.93	1.63

Annexure – III

HYDROGRAPHS OF CGWB PERMANENT OBSERVATION STATIONS



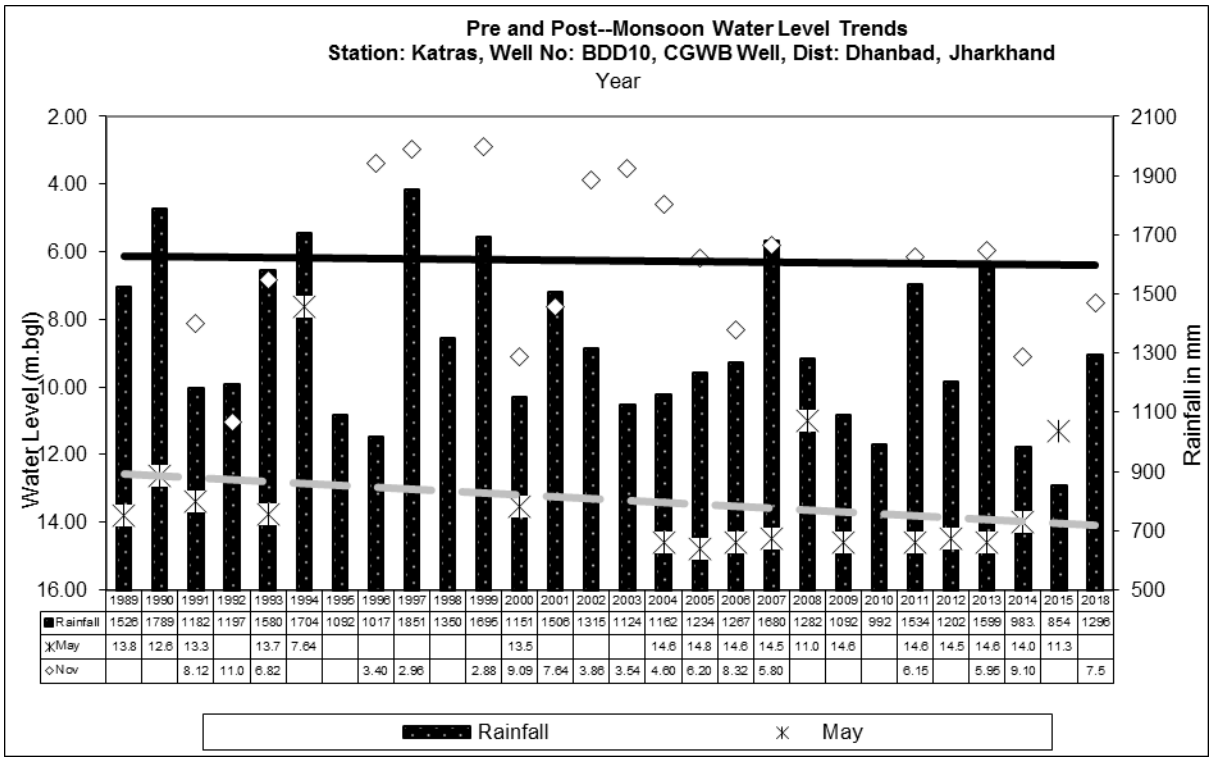
	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	145	188	124	121	141	116	152	178	118	119	158	170	109	101	185	135	169	115	150	131	112	102	123	126	168	128	109	992	153	120	159	127	129	129		
May	4.7	2.1		1.6	2.2	3.6		2.4	1.3	4.7	2.1	1.1	5.4	5.4	5.2	5.4	4.7	3.3	1.7	3.5	2.9	2.1			1.7	1.7	1.6	1.7	1.6		0.5	2.5	1.9	2.2		
Nov		1.1	0.9	1.3	1.2	1.4	1.2	1.1	1.5	5.2	2.2		3.4	3.0	1.3	4.4	4.5	4.5	3.4	1.0	1.0	1.8	1.0	1.3	1.5	1.4	1.0	1.9	2.1	0.6	0.9	1	1.8	0.2		



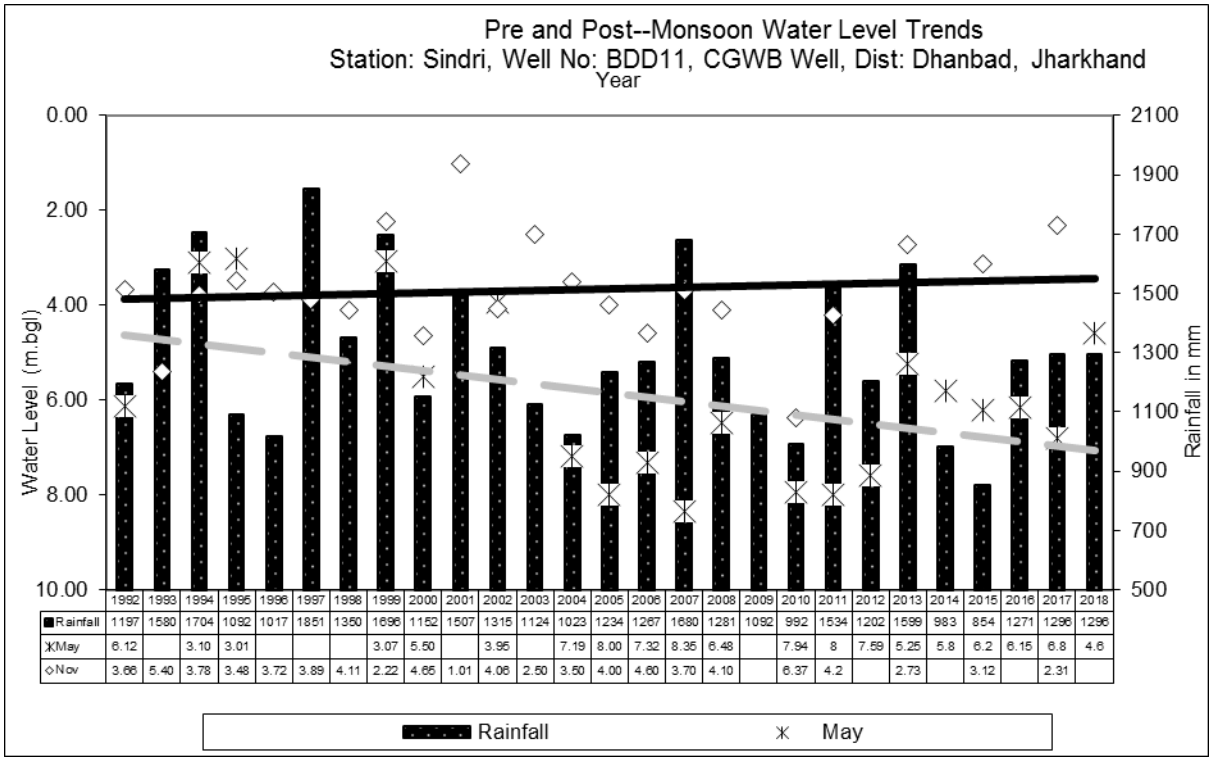
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	1162	1526	1789	1182	1197	1580	1704	1092	1017	1851	1350	1695	1151	1124	1162	1234	1267	1680	1282	1092	992	1534	1202	1599	983	854	1271	1296	1296
May	10.6	10.5	7.10	10.1	9.73	9.00	8.70	3.98	6.94	7.59	7.68	7.66	4.03	7.50	2.90	9.80		9.80	10.1	10.2	13.5	15.0	11.8	5.65	10.1	10.9	9.85	8.60	7.23
Nov		3.79	4.14	5.12	9.80	5.47	6.62	7.70	5.51	4.64	2.16	3.22	3.59	1.59	4.10	5.75	4.80	5.25	4.92	5.27	9.33	5.15	5.30	4.94	6.55	6.95	4.40	3.64	2.52

Annexure – III

HYDROGRAPHS OF CGWB PERMANENT OBSERVATION STATIONS



	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2018
Rainfall	1526	1789	1182	1197	1580	1704	1092	1017	1851	1350	1695	1151	1506	1315	1124	1162	1234	1267	1680	1282	1092	992	1534	1202	1599	983	854	1296
May	13.8	12.6	13.3		13.7	7.64						13.5				14.6	14.8	14.6	14.5	11.0	14.6		14.6	14.5	14.6	14.0	11.3	
Nov			8.12	11.0	6.82			3.40	2.96		2.88	9.09	7.64	3.86	3.54	4.60	6.20	8.32	5.80				6.15		5.95	9.10		7.5



	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	1197	1580	1704	1092	1017	1851	1350	1696	1152	1507	1315	1124	1023	1234	1267	1680	1281	1092	992	1534	1202	1599	983	854	1271	1296	1296
May	6.12		3.10	3.01				3.07	5.50		3.95		7.19	8.00	7.32	8.35	6.48		7.94	8	7.59	5.25	5.8	6.2	6.15	6.8	4.6
Nov	3.66	5.40	3.78	3.48	3.72	3.89	4.11	2.22	4.65	1.01	4.06	2.50	3.50	4.00	4.60	3.70	4.10		6.37	4.2		2.73		3.12		2.31	

Annexure – IV

GROUNDWATER SAMPLE LOCATION DETAILS

Sampling month: March, May, August & December month of assessment year'2018

Sl No	Name of Cluster	Ground Water Sample	Dug well (CMPDI)	Location	Sampling Date			
					March'18	May'18	Aug'18	Dec'18
1	CLUSTER-I	GW-1	B-15	BERA VILLAGE	08.03.18	30.05.18	16.08.18	10.12.18
2	CLUSTER-II	GW-2	B-59	KHODOVALY VILLAGE	08.03.18	30.05.18	16.08.18	10.12.18
3	CLUSTER-III	GW-3	A-29	GOVINDPUR,AMBAGAN VILLAGE	08.03.18	30.05.18	16.08.18	10.12.18
4	CLUSTER-IV	GW-4	B-63	KESHALPUR, BATIGHAR	08.03.18	30.05.18	16.08.18	10.12.18
5	CLUSTER-V	GW-5	D-30	BORKIBOA VILLAGE	08.03.18	30.05.18	16.08.18	10.12.18
6	CLUSTER-VI	GW-6	D-25	GODHUR MORE	08.03.18	30.05.18	16.08.18	11.12.18
7	CLUSTER-VII	GW-7	D-80	DHANSAR MINE RESCUE STN.	07.03.18	31.05.18	17.08.18	11.12.18
8	CLUSTER-VIII	GW-8	D-49	NEAR GHANOODIH OC	07.03.18	31.05.18	17.08.18	11.12.18
9	CLUSTER-IX	GW-9	D-5	JEALGORA, NEAR P.O.	07.03.18	31.05.18	17.08.18	11.12.18
10	CLUSTER-X	GW-10	D-35	PATHERDIH RLY. COLONY	07.03.18	31.05.18	17.08.18	11.12.18
11	CLUSTER-XI	GW-11	A-32	MONNIDIH BAZAR	08.03.18	30.05.18	18.08.18	10.12.18
12	CLUSTER-XIII	GW-13	A-23	MACHHAYARA	08.03.18	30.05.18	18.08.18	10.12.18
13	CLUSTER-XIV	GW-14	B-23	LOHAPATTI VILLAGE	08.03.18	30.05.18	18.08.18	10.12.18
14	CLUSTER-XV	GW-15	B-32A	MADHUBAND VILLAGE	08.03.18	30.05.18	18.08.18	10.12.18
15	CLUSTER-XVI	GW-16	D-22	DAHIBARI,NICHE BASTI	07.03.18	31.05.18	17.08.18	11.12.18

Annexure – VA

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: March'2018

Stations: 1. Cluster-I (GW-1), Bera Village, Date: 08/03/2018
2. Cluster-II (GW-2), Khodovaly village, Date: 08/03/2018
3. Cluster-III (GW-3), Govindpur, Date: 08/03/2018

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		1	2	3			
1	Boron (as B), mg/l, Max	<0.20	<0.20	<0.20	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	02	03	4.0	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	34	44	30	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	28	34	52	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.001	<0.001	<0.001	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.43	0.26	0.38	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	<0.02	<0.02	<0.02	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	0.12	0.08	0.18	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	<0.02	<0.02	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	6.20	15.20	8.9	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	7.63	7.45	7.92	0.2	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	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	65.0	82.0	75	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_aco_3),, mg/l, Max	76.0	84.0	78.0	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	301	442	393	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_aco_3), mg/l, Max	156	188	172	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	2.0	4.0	3.0	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	<0.01	<0.01	<0.01	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame
25	Nickel as Ni, mg/l max	<0.005	<0.005	<0.005	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV**.

Annexure – VA

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: March'2018

Stations: 4. Cluster-IV (GW-4), Keshalpur Village, Date: 08/03/2018
5. Cluster-V (GW-5), Borkiboa village, Date: 08/03/2018
6. Cluster-VI (GW-6), Godhur, Date: 08/03/2018

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		4	5	6			
1	Boron (as B), mg/l, Max	<0.20	<0.20	<0.20	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	03	03	1.0	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	32	46	34	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	24	38	48	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.001	<0.001	<0.001	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.19	0.32	0.45	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	<0.02	<0.02	<0.02	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	0.14	0.06	0.12	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	<0.02	<0.02	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	14.10	15.10	3.9	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	7.81	7.69	7.54	0.2	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	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	64.0	78.0	82	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_aco_3),, mg/l, Max	104	94.0	88.0	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	459	456	485	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_aco_3), mg/l, Max	186	168	192	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	4.0	2.0	1.0	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	<0.01	<0.01	<0.01	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame
25	Nickel as Ni, mg/l max	<0.005	<0.005	<0.005	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV**.

Annexure – VA

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: March'2018

Stations: 7. Cluster-VII (GW-7), Dhansar, Date: 07/03/2018
8. Cluster-VIII (GW-8), Ghanudih, Date: 07/03/2018
9. Cluster-IX (GW-9), Jealgora, Date: 07/03/2018

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		7	8	9			
1	Boron (as B), mg/l, Max	<0.20	<0.20	<0.20	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	04	02	4.0	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	42	36	30	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	34	38	52	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.001	<0.001	<0.001	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.33	0.28	0.16	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	<0.02	<0.02	<0.02	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	0.06	0.06	0.08	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	<0.02	<0.02	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	6.70	2.60	12.40	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	7.49	7.88	7.67	0.2	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	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	8.0	58.0	46	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_aco_3),, mg/l, Max	98	72.0	86.0	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	396	272	224	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_aco_3), mg/l, Max	182	168	96	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	3.0	2.0	2.0	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	<0.01	<0.01	<0.01	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame
25	Nickel as Ni, mg/l max	<0.005	<0.005	<0.005	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV**.

Annexure – VA

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: March'2018

Stations: 10. Cluster-X (GW-10), Patherdih, Date: 07/03/2018
11. Cluster-XI (GW-11), Moonidih, Date: 08/03/2018
12. Cluster-XIII (GW-13), Machhayara, Date: 08/03/2018

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		10	11	12			
1	Boron (as B), mg/l, Max	<0.20	<0.20	<0.20	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	03	01	1.0	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	42	38	32	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	24	36	30	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.001	<0.001	<0.001	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.24	0.31	0.40	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	<0.02	<0.02	<0.02	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	0.10	0.06	0.08	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	<0.02	<0.02	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	3.50	4.40	7.90	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	7.84	7.87	7.72	0.2	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	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	38.0	72.0	62	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_ac_{03}),, mg/l, Max	64	108	124	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	188	344	316	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_ac_{03}), mg/l, Max	68	156	148	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	3.0	2.0	1.0	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	<0.01	<0.01	<0.01	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame
25	Nickel as Ni, mg/l max	<0.005	<0.005	<0.005	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV**.

Annexure – VA

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: March'2018

Stations: 13. Cluster-XIV (GW-14), Lohapatti, Date: 08/03/2018
14. Cluster-XV (GW-15), Madhuband, Date: 08/03/2018
15. Cluster-XVI (GW-16), Dahibari, Date: 07/03/2018

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		13	14	15			
1	Boron (as B), mg/l, Max	<0.20	<0.20	<0.20	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	04	01	05	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	46	40	34	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	42	36	32	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.001	<0.001	<0.001	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.35	0.17	0.26	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	<0.02	<0.02	<0.02	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	0.06	0.16	0.08	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	<0.02	<0.02	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	4.40	1.70	19.70	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	7.61	7.98	7.80	0.2	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	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	65.0	70.0	96	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_aco_3),, mg/l, Max	70	92	132	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	290	364	434	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_aco_3), mg/l, Max	132	174	196	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	2.0	1.0	1.0	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	<0.01	<0.01	<0.01	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame
25	Nickel as Ni, mg/l max	<0.005	<0.005	<0.005	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV**.

Annexure – VB

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: May'2018

Stations: 1. Cluster-I (GW-1), Bera Village, Date: 30/05/2018
2. Cluster-II (GW-2), Khodovaly village, Date: 30/05/2018
3. Cluster-III (GW-3), Govindpur, Date: 30/05/2018

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		1	2	3			
1	Boron (as B), mg/l, Max	<0.20	<0.20	<0.20	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	05	04	05	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	35.2	57.6	44.8	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	36	44	102	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.001	<0.001	<0.001	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.37	0.14	0.94	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	0.02	0.03	0.02	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	0.07	0.08	0.06	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	<0.02	<0.02	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	7.1	18.30	11.7	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	7.54	7.19	7.82	0.2	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	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	81	178	90	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_aco_3),, mg/l, Max	144	104	96	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	312	566	404	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_aco_3), mg/l, Max	164	236	196	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	2.0	1.0	4.0	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	<0.01	<0.01	<0.01	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame
25	Nickel as Ni, mg/l max	<0.005	<0.005	<0.005	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV**.

Annexure – VB

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: May'2018

Stations: 4. Cluster-IV (GW-4), Keshalpur Village, Date: 30/05/2018
5. Cluster-V (GW-5), Borkiboa village, Date: 30/05/2018
6. Cluster-VI (GW-6), Godhur, Date: 30/05/2018

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		4	5	6			
1	Boron (as B), mg/l, Max	<0.20	<0.20	<0.20	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	04	03	05	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	43.2	41.6	48	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	48	80	72	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.001	0.001	<0.001	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.12	0.17	0.38	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	0.02	0.03	0.02	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	0.06	0.08	0.06	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	<0.02	<0.02	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	13.6	12.80	4.7	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	7.38	7.21	8.07	0.2	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	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	132	153	172	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_ac_o3),, mg/l, Max	108	92	172	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	470	454	490	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_ac_o3), mg/l, Max	188	180	196	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	2.0	1.0	3.0	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	<0.01	<0.01	<0.01	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame
25	Nickel as Ni, mg/l max	<0.005	<0.005	<0.005	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV**.

Annexure – VB

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: May'2018

Stations: 7. Cluster-VII (GW-7), Dhansar, Date: 31/05/2018
8. Cluster-VIII (GW-8), Ghanudih, Date: 31/05/2018
9. Cluster-IX (GW-9), Jealgora, Date: 31/05/2018

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		7	8	9			
1	Boron (as B), mg/l, Max	<0.20	<0.20	<0.20	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	05	04	04	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	41.6	46.4	33.6	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	78	34	46	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	0.003	0.001	<0.001	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.71	0.31	0.58	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	0.03	0.02	<0.02	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	0.19	0.11	0.08	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	<0.02	<0.02	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	8.3	3.7	16.3	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	7.45	7.92	7.76	0.2	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	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	147	176	107	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_ac_{03}),, mg/l, Max	116	112	104	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	418	478	334	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_ac_{03}), mg/l, Max	176	184	152	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	2.0	2.0	2.0	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	<0.01	<0.01	<0.01	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame
25	Nickel as Ni, mg/l max	<0.005	<0.005	<0.005	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV**.

Annexure – VB

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: May'2018

Stations: 10. Cluster-X (GW-10), Patherdih, Date: 31/05/2018
11. Cluster-XI (GW-11), Moonidih, Date: 30/05/2018
12. Cluster-XIII (GW-13), Machhayara, Date: 30/05/2018

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		10	11	12			
1	Boron (as B), mg/l, Max	<0.20	<0.20	<0.20	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	02	03	03	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	28.8	48	49.6	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	66	44	68	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	0.001	<0.001	<0.001	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.64	0.03	0.72	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	<0.02	0.03	0.02	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	0.06	0.09	0.21	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	<0.02	<0.02	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	4.8	7.9	6.1	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	7.33	7.98	8.11	0.2	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	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	78	180	119	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_ac_{03}),, mg/l, Max	100	124	188	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	286	488	398	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_ac_{03}), mg/l, Max	132	212	192	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	1.0	3.0	1.0	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	<0.01	<0.01	<0.01	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame
25	Nickel as Ni, mg/l max	<0.005	<0.005	<0.005	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV**.

Annexure – VB

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: May'2018

Stations: 13. Cluster-XIV (GW-14), Lohapatti, Date: 30/05/2018
14. Cluster-XV (GW-15), Madhuband, Date: 30/05/2018
15. Cluster-XVI (GW-16), Dahibari, Date: 31/05/2018

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		13	14	15			
1	Boron (as B), mg/l, Max	<0.20	<0.20	<0.20	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	04	01	05	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	46	40	34	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	42	36	32	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.001	<0.001	<0.001	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.35	0.17	0.26	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	<0.02	<0.02	<0.02	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	<0.06	0.16	0.08	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	<0.02	<0.02	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	4.4	1.7	19.7	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	7.61	7.98	7.80	0.2	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	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	65	70	96	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_ac_{03}),, mg/l, Max	70	92	132	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	290	364	434	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_ac_{03}), mg/l, Max	132	174	196	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	2.0	1.0	3.0	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	<0.01	<0.01	<0.01	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame
25	Nickel as Ni, mg/l max	<0.005	<0.005	<0.005	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV**.

Annexure – VC

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: August'2018

Stations: 1. Cluster-I (GW-1), Bera Village, Date: 16/08/2018
2. Cluster-II (GW-2), Khodovaly village, Date: 16/08/2018
3. Cluster-III (GW-3), Govindpur, Date: 16/08/2018

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		1	2	3			
1	Boron (as B), mg/l, Max	<0.2	<0.2	<0.2	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	12	1	16	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	43.2	40	52.8	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	24	26	20	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	0.02	0.03	0.03	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.27	0.19	0.24	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	<0.02	<0.02	<0.02	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	0.32	<0.06	0.18	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	0.02	0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	<0.02	<0.02	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	3.86	0.21	3.81	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	8.16	8.13	8.15	0.2	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	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	40	34	47	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_aco_3),, mg/l, Max	118	145	140	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	0.1	0.1	0.1	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	156	142	154	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_aco_3), mg/l, Max	134	134	130	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	2	1	2	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	<0.01	<0.01	<0.01	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame
25	Nickel as Ni, mg/l max	<0.005	<0.005	<0.005	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV**.

Annexure – VC

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: August'2018

Stations: 4. Cluster-IV (GW-4), Keshalpur Village, Date: 16/08/2018
5. Cluster-V (GW-5), Borkiboa village, Date: 16/08/2018
6. Cluster-VI (GW-6), Godhur, Date: 16/08/2018

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		4	5	6			
1	Boron (as B), mg/l, Max	<0.2	<0.2	<0.2	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	3	4	4	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	40	177.6	59.2	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	24	104	30	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	0.02	0.02	0.02	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.22	0.53	0.15	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	<0.02	<0.02	<0.02	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	<0.06	0.01	<0.06	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	0.01	0.009	0.008	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	<0.02	<0.02	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	0.40	4.83	7.50	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	8.12	7.73	8.07	0.2	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	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	40	228	85	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_ac_{03}),, mg/l, Max	152	95	105	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	0.1	0.1	0.2	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	144	830	204	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_ac_{03}), mg/l, Max	130	740	192	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	1	<1	<1	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	<0.01	<0.01	<0.01	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame
25	Nickel as Ni, mg/l max	<0.005	<0.005	<0.005	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV**.

Annexure – VC

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: August'2018

Stations: 7. Cluster-VII (GW-7), Dhansar, Date: 17/08/2018
8. Cluster-VIII (GW-8), Ghanudih, Date: 17/08/2018
9. Cluster-IX (GW-9), Jealgora, Date: 17/08/2018

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		7	8	9			
1	Boron (as B), mg/l, Max	<0.2	<0.2	<0.2	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	6	16	5	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	68.8	49.6	163.2	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	34	20	88	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	0.04	0.04	0.005	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.18	0.20	0.66	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	<0.02	<0.02	<0.02	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	0.08	0.08	0.12	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	0.005	0.006	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	<0.02	<0.02	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	39.70	4.55	4.87	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	8.19	8.23	7.71	0.2	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	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	84	48	225	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_aco_3),, mg/l, Max	45	135	90	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	0.1	0.1	0.2	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	226	140	782	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_aco_3), mg/l, Max	144	134	732	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	1	1	1	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	0.16	<0.01	<0.01	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame
25	Nickel as Ni, mg/l max	<0.005	<0.005	<0.005	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV**.

Annexure – VC

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: August'2018

Stations: 10. Cluster-X (GW-10), Patherdih, Date: 17/08/2018
11. Cluster-XI (GW-11), Moonidih, Date: 16/08/2018
12. Cluster-XIII (GW-13), Machhayara, Date: 16/08/2018

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		10	11	12			
1	Boron (as B), mg/l, Max	<0.2	<0.2	<0.2	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	5	3	3	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	49.6	30.4	187.2	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	58	28	96	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.001	0.005	0.005	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.31	0.24	0.58	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	<0.02	<0.02	<0.02	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	0.08	0.12	0.12	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	0.02	0.01	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	<0.02	<0.02	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	7.07	0.90	4.88	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	8.02	8.15	7.88	0.2	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	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	225	93	39	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_aco_3),, mg/l, Max	102	147	95	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	0.2	0.1	0.1	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	220	132	792	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_aco_3), mg/l, Max	202	126	722	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	<1	<1	1	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	<0.01	<0.01	<0.01	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame
25	Nickel as Ni, mg/l max	<0.005	<0.005	<0.005	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV**.

Annexure – VC

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: August'2018

Stations: 13. Cluster-XIV (GW-14), Lohapatti, Date: 16/08/2018
14. Cluster-XV (GW-15), Madhuband, Date: 16/08/2018
15. Cluster-XVI (GW-16), Dahibari, Date: 17/08/2018

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		13	14	15			
1	Boron (as B), mg/l, Max	<0.2	<0.2	<0.2	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	7	3	4	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	51.2	193.6	115.2	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	46	98	64	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	0.02	0.02	0.005	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.32	0.61	0.44	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	<0.02	<0.02	<0.02	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	<0.06	<0.06	0.08	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	<0.02	<0.02	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	5.74	5.16	43.57	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	7.78	8.05	8.06	0.2	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	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	81	226	144	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_aco_3),, mg/l, Max	107	102	112	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	0.04	0.1	0.1	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	210	776	552	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_aco_3), mg/l, Max	200	710	584	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	1	<1	<1	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	<0.01	<0.01	<0.01	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame
25	Nickel as Ni, mg/l max	<0.005	<0.005	<0.005	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV**.

Annexure – VD

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: December'2018

Stations: 1. Cluster-I (GW-1), Bera Village, Date: 10/12/2018
2. Cluster-II (GW-2), Khodovaly village, Date: 10/12/2018
3. Cluster-III (GW-3), Govindpur, Date: 10/12/2018

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		1	2	3			
1	Boron (as B), mg/l, Max	<0.2	<0.2	<0.2	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	3	2	4	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	24	12	16	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	28	20	22	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.001	<0.001	<0.001	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.28	0.16	0.62	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	<0.02	<0.02	<0.02	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	0.47	0.11	<0.06	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	0.38	0.02	<0.02	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	12.8	15.6	14.4	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	8.19	8.21	8.11	0.2	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	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	64	48	56	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_aco_3),, mg/l, Max	112	185	178	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	612	720	686	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_aco_3), mg/l, Max	432	518	408	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	3	3	1	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	0.08	<0.01	<0.01	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame
25	Nickel as Ni, mg/l max	<0.005	<0.005	<0.005	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV.**

Annexure – VD

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: December'2018

Stations: 4. Cluster-IV (GW-4), Keshalpur Village, Date: 10/12/2018
5. Cluster-V (GW-5), Borkiboa village, Date: 10/12/2018
6. Cluster-VI (GW-6), Godhur, Date: 11/12/2018

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		4	5	6			
1	Boron (as B), mg/l, Max	<0.2	<0.2	<0.2	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	4	2	3	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	20	16	28	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	26	24	34	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.001	<0.001	<0.001	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.33	0.29	0.18	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	<0.02	<0.02	<0.02	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	0.5	<0.06	0.47	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	0.009	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	0.08	<0.02	0.13	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	22.6	10.4	16.7	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	8.08	8.12	7.96	0.2	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	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	68	56	84	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_ac_o3),, mg/l, Max	165	212	190	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	832	764	592	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_ac_o3), mg/l, Max	532	602	338	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	5	4	1	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	<0.01	<0.01	<0.01	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame
25	Nickel as Ni, mg/l max	<0.005	<0.005	<0.005	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV**.

Annexure – VD

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: December'2018

Stations: 7. Cluster-VII (GW-7), Dhansar, Date: 11/12/2018
8. Cluster-VIII (GW-8), Ghanudih, Date: 11/12/2018
9. Cluster-IX (GW-9), Jealgora, Date: 11/12/2018

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		7	8	9			
1	Boron (as B), mg/l, Max	<0.2	<0.2	<0.2	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	1	1	4	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	12	16	12	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	36	26	24	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.001	<0.001	<0.001	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.18	0.25	0.17	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	<0.02	<0.02	<0.02	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	<0.06	<0.06	<0.06	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	0.02	<0.02	<0.02	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	17.8	14.4	20.8	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	7.67	8.05	7.46	0.2	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	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	56	78	62	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_ac_o3),, mg/l, Max	176	192	201	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	938	664	704	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_ac_o3), mg/l, Max	528	420	386	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	2	2	2	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	<0.01	<0.01	<0.01	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame
25	Nickel as Ni, mg/l max	<0.005	<0.005	<0.005	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV**.

Annexure – VD

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: December'2018

Stations: 10. Cluster-X (GW-10), Patherdih, Date: 11/12/2018
11. Cluster-XI (GW-11), Moonidih, Date: 10/12/2018
12. Cluster-XIII (GW-13), Machhayara, Date: 10/12/2018

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		10	11	12			
1	Boron (as B), mg/l, Max	<0.2	<0.2	<0.2	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	3	3	2	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	12	24	16	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	32	26	34	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.001	<0.001	<0.001	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.26	0.44	0.19	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	<0.02	<0.02	<0.02	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	<0.06	<0.06	0.11	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	<0.02	<0.02	0.02	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	12.7	18.1	19.6	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	8.01	8.17	8.19	0.2	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	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	61	57	65	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_aco_3),, mg/l, Max	148	169	188	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	556	804	728	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_aco_3), mg/l, Max	286	536	444	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	1	3	4	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	<0.01	<0.01	<0.01	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame
25	Nickel as Ni, mg/l max	<0.005	<0.005	<0.005	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

*Sampling location details and sampling date has been given in **Annexure-IV**.

Annexure – VD

GROUNDWATER QUALITY DATA (DUG WELLS)
Month: December'2018

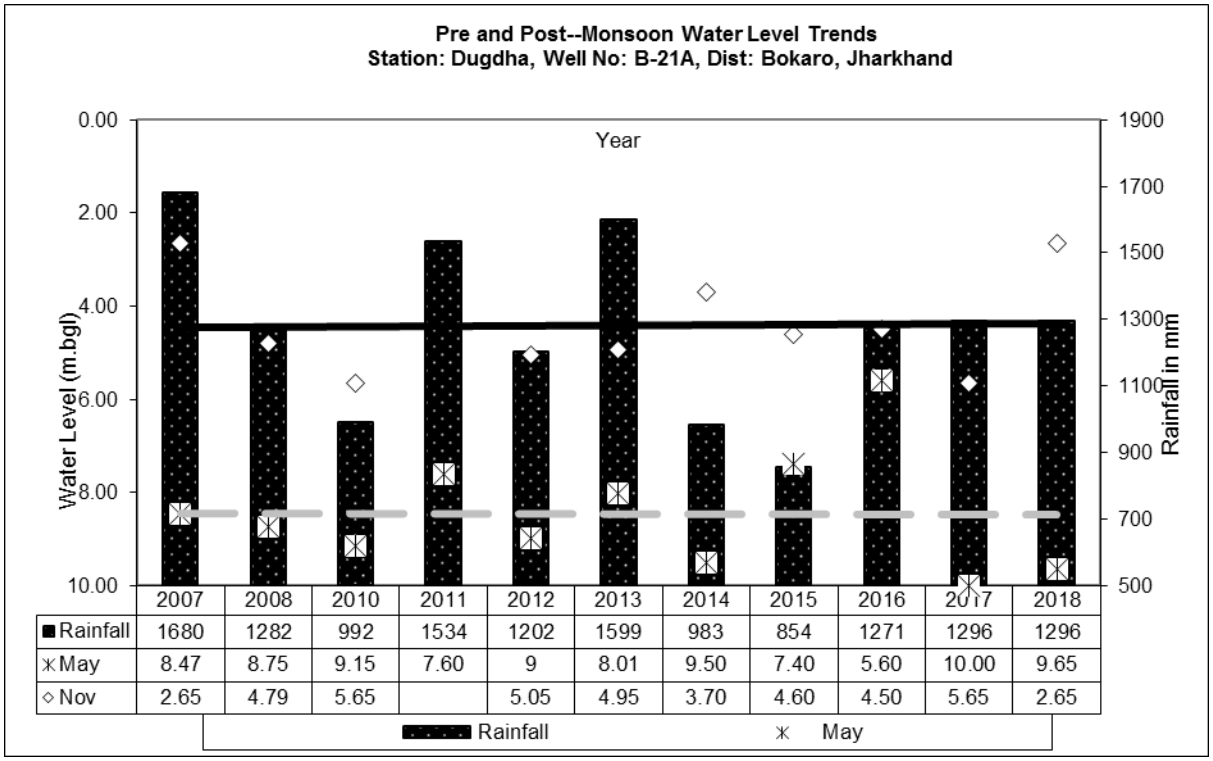
Stations: 13. Cluster-XIV (GW-14), Lohapatti, Date: 10/12/2018
14. Cluster-XV (GW-15), Madhuband, Date: 10/12/2018
15. Cluster-XVI (GW-16), Dahibari, Date: 11/12/2018

Sl. No	Parameter	Sampling Stations			Detection Limit	IS:10500 Drinking Water Standards	Standard / Test Method
		13	14	15			
1	Boron (as B), mg/l, Max	<0.2	<0.2	<0.2	0.20	0.5	APHA, 22nd Edition ,Carmine
2	Colour,in Hazen Units	4	4	3	1	5	APHA, 22nd Edition ,Pt.-Co. Method
3	Calcium (as Ca), mg/l, Max	20	16	12	1.60	75	IS-3025/40:1991, EDTA
4	Chloride (as Cl), mg/l, Max	18	26	30	2.00	250	IS-3025/32:1988, R-2007, Argentometric
5	Copper (as Cu), mg/l, Max	<0.001	<0.001	<0.001	0.03	0.05	IS 3025/42 : 1992 R : 2009, AAS-Flame
6	Fluoride (as F) mg/l, Max	0.37	0.31	0.43	0.02	1.0	APHA, 22nd Edition , SPADNS
7	Free Residual Chlorine, mg/l, Min	<0.02	<0.02	<0.02	0.02	0.2	APHA, 22nd Edition, DPD
8	Iron (as Fe), mg/l, Max	0.14	<0.06	<0.06	0.06	0.3	IS 3025 /53 : 2003, R : 2009 , AAS-Flame
9	Lead (as Pb), mg/l, Max	<0.005	<0.005	<0.005	0.005	0.01	APHA, 22nd Edition, AAS-GTA
10	Manganese (as Mn), mg/l, Max	0.22	0.08	0.14	0.02	0.1	IS-3025/59:2006, AAS-Flame
11	Nitrate (as NO_3), mg/l, Max	9.6	13.6	11.4	0.5	45	APHA, 22nd Edition, UV-Spectrphotometric
12	Odour	Agreeable	Agreeable	Agreeable	Qualitative	Agreeable	IS 3025 /05:1983, R-2012, Qualitative
13	pH value	8.24	7.98	7.14	0.2	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	0.001	0.001	APHA, 22nd Edition,4-Amino Autipyrine
15	Selenium (as Se), mg/l, Max	<0.002	<0.002	<0.002	0.002	0.01	APHA, 22nd Edition, AAS-GTA
16	Sulphate (as SO_4) mg/l, Max	72	52	65	2.00	200	APHA, 22nd Edition. Turbidity
17	Taste	Acceptable	Acceptable	Acceptable	Qualitat-ive	Acceptable	APHA, 22nd Edition. Taste
18	Total Alkalinity (c_ac_{03}),, mg/l, Max	147	172	196	4.00	200	IS-3025/23:1986, Titration
19	Total Arsenic (as As), mg/l, Max	<0.002	<0.002	0.002	0.002	0.01	IS 3025/ 37:1988 R : 2003, AAS-VGA
20	Total Chromium (as Cr), mg/l, Max	<0.04	<0.04	<0.04	0.04	0.05	IS-3025/52:2003, AAS-Flame
21	Total Dissolved Solids, mg/l, Max	638	704	802	25.00	500	IS 3025 /16:1984 R : 2006, Gravimetric
22	Total Hardness (c_ac_{03}), mg/l, Max	308	416	556	4.00	200	IS-3025/21:1983, R-2002, EDTA
23	Turbidity, NTU, Max	2	1	4	1.0	1	IS-3025/10:1984 R-1996, Nephelometric
24	Zinc (as Zn), mg/l, Max	<0.01	<0.01	<0.01	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame
25	Nickel as Ni, mg/l max	<0.005	<0.005	<0.005	0.01	5.0	IS 3025/ 49 : 1994, R : 2009, AAS-Flame

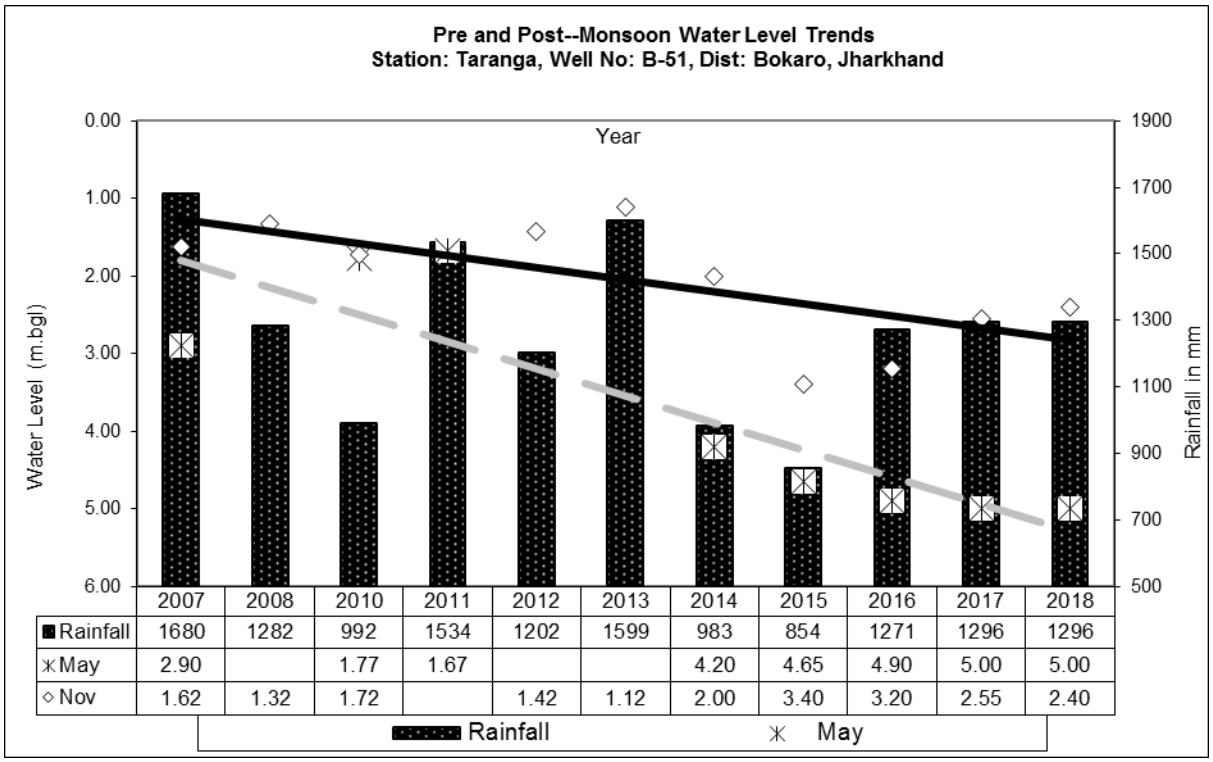
*Sampling location details and sampling date has been given in **Annexure-IV**.

Annexure – VI

HYDROGRAPHS OF CLUSTER-I



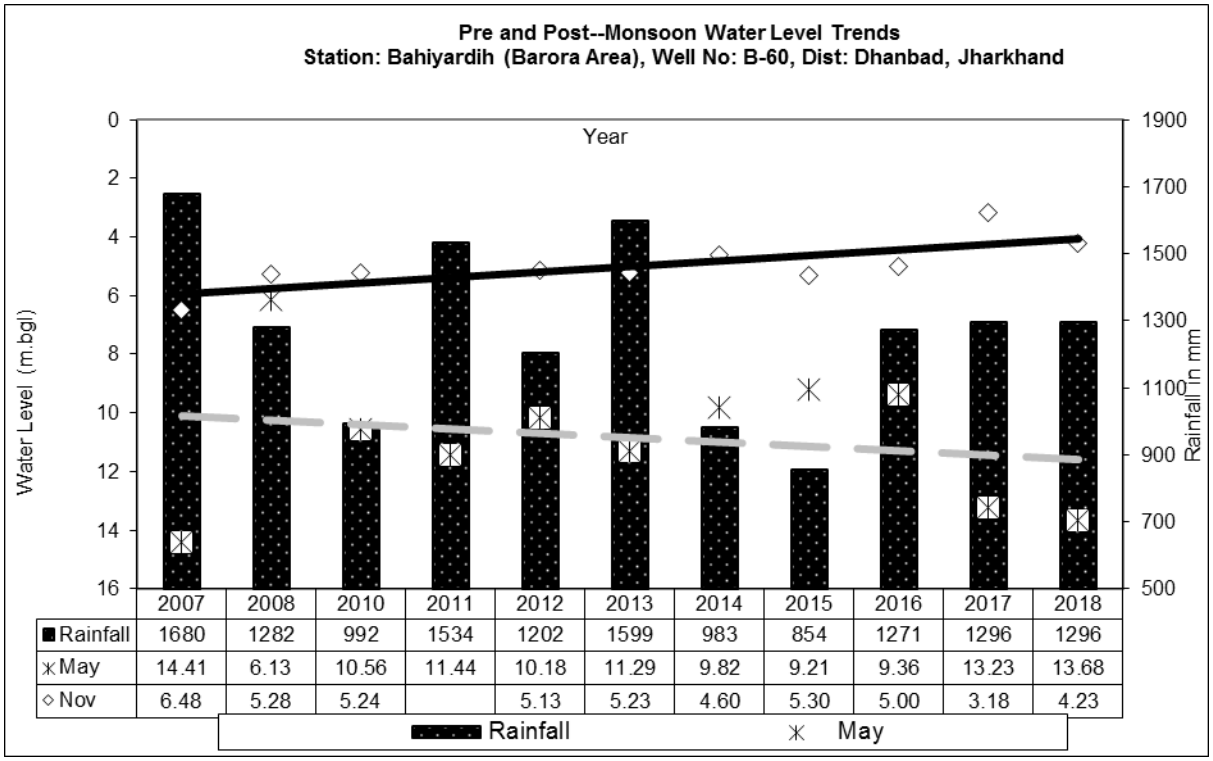
	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	1680	1282	992	1534	1202	1599	983	854	1271	1296	1296
May	8.47	8.75	9.15	7.60	9	8.01	9.50	7.40	5.60	10.00	9.65
Nov	2.65	4.79	5.65		5.05	4.95	3.70	4.60	4.50	5.65	2.65



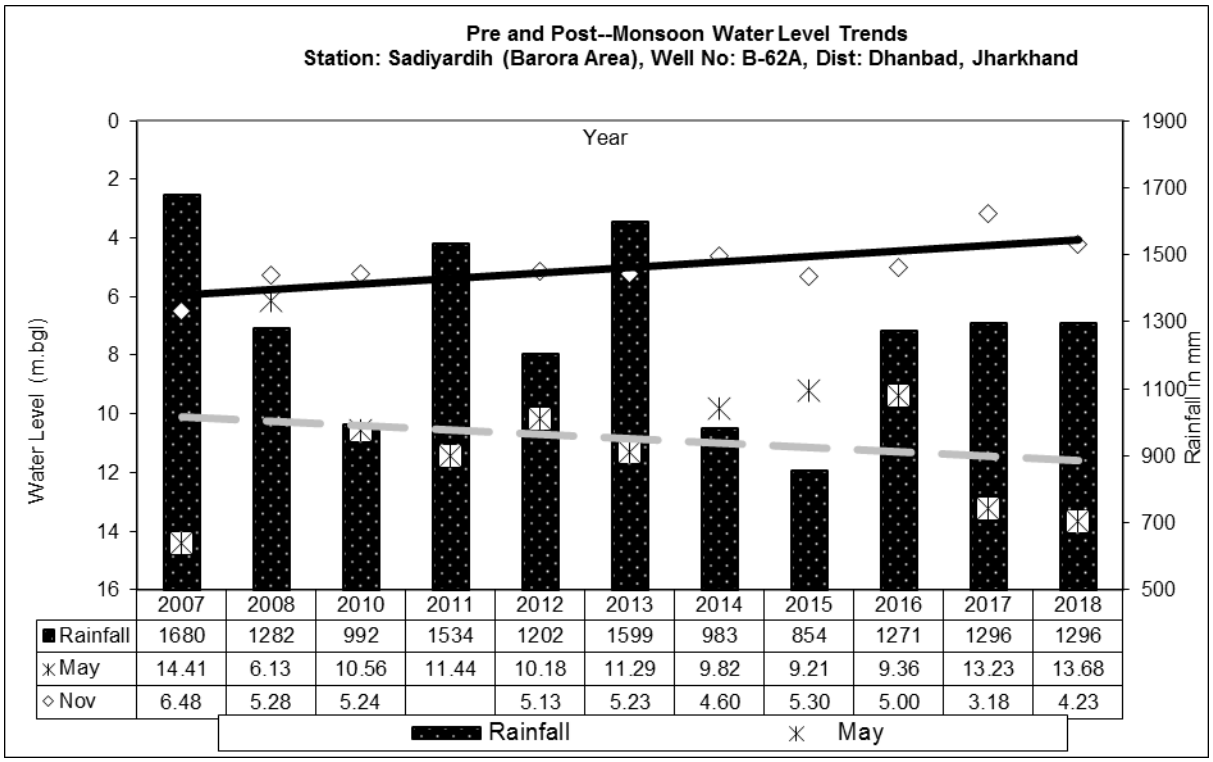
	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	1680	1282	992	1534	1202	1599	983	854	1271	1296	1296
May	2.90		1.77	1.67			4.20	4.65	4.90	5.00	5.00
Nov	1.62	1.32	1.72		1.42	1.12	2.00	3.40	3.20	2.55	2.40

Annexure – VI

HYDROGRAPHS OF CLUSTER-II



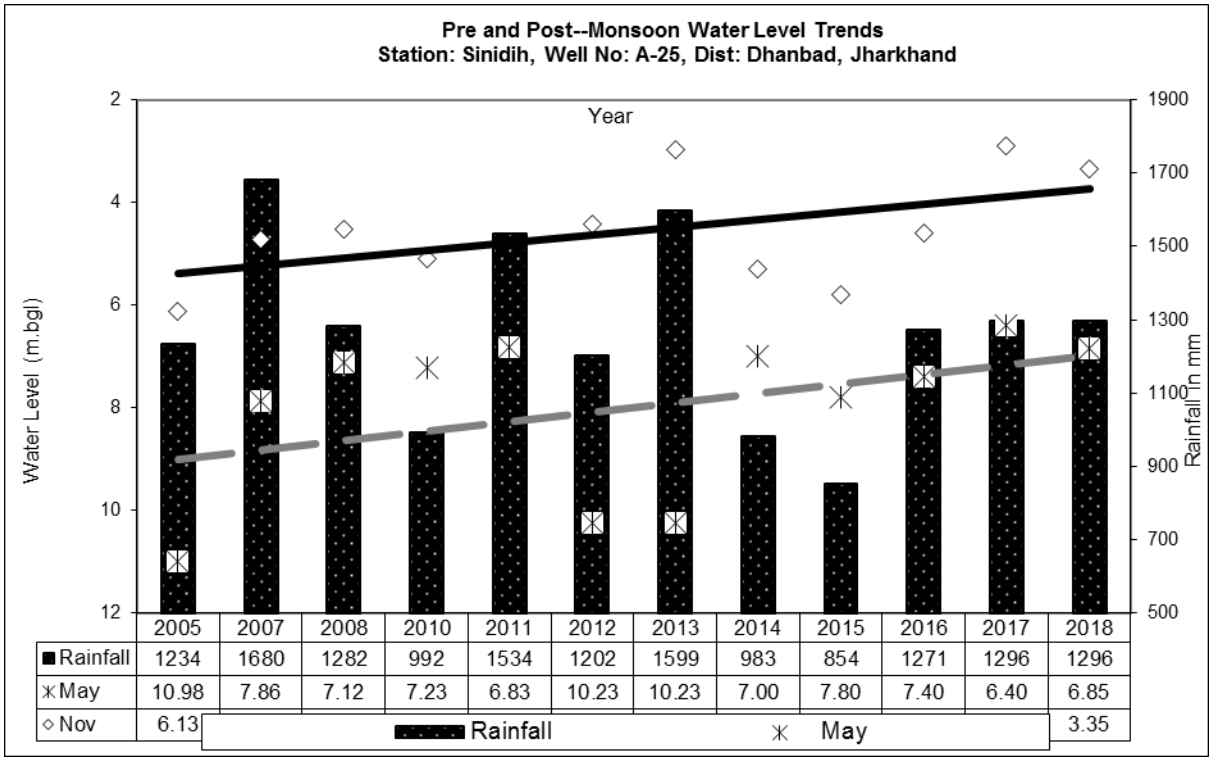
	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	1680	1282	992	1534	1202	1599	983	854	1271	1296	1296
May	14.41	6.13	10.56	11.44	10.18	11.29	9.82	9.21	9.36	13.23	13.68
Nov	6.48	5.28	5.24		5.13	5.23	4.60	5.30	5.00	3.18	4.23



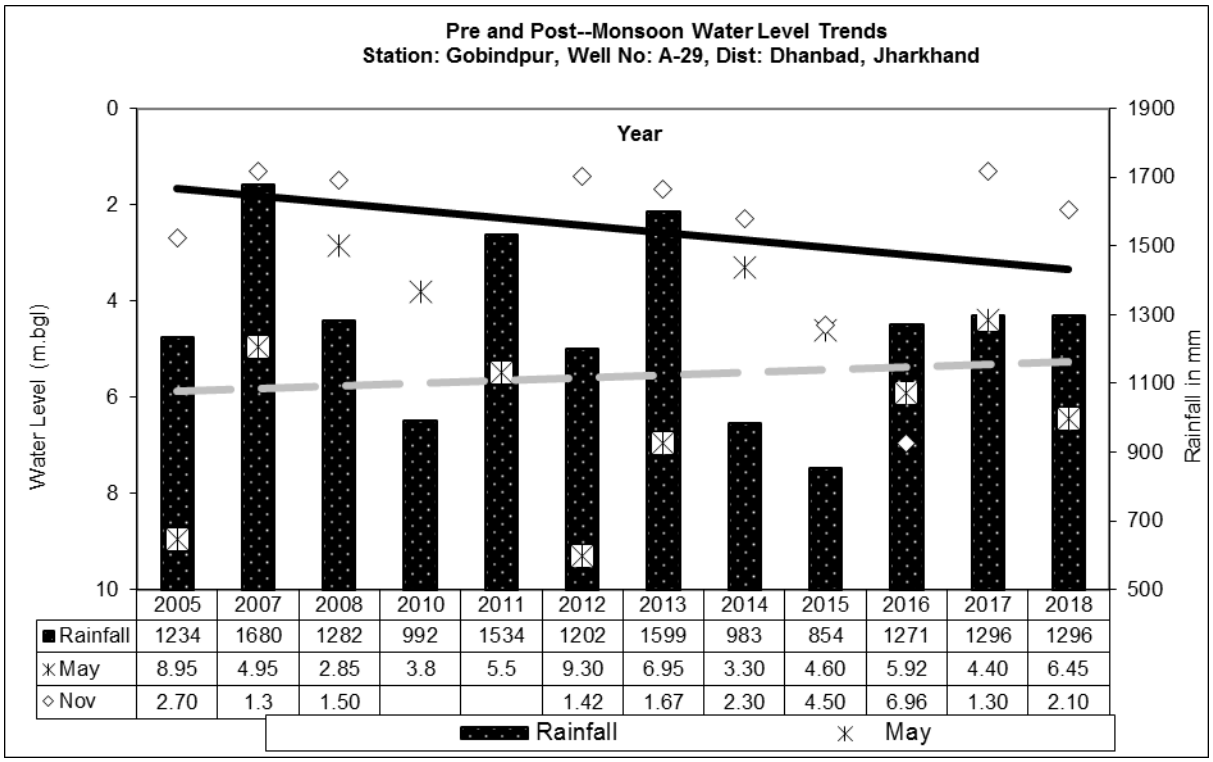
	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	1680	1282	992	1534	1202	1599	983	854	1271	1296	1296
May	14.41	6.13	10.56	11.44	10.18	11.29	9.82	9.21	9.36	13.23	13.68
Nov	6.48	5.28	5.24		5.13	5.23	4.60	5.30	5.00	3.18	4.23

Annexure – VI

HYDROGRAPHS OF CLUSTER-III



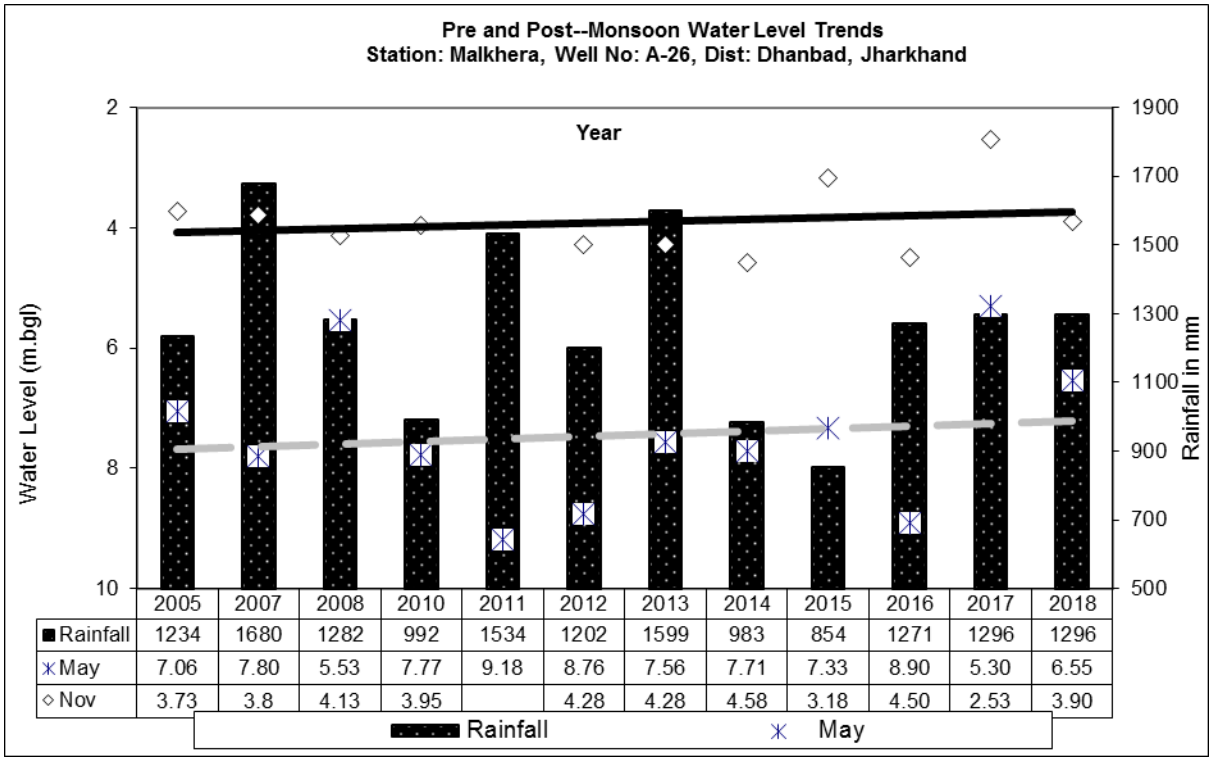
	2005	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	1234	1680	1282	992	1534	1202	1599	983	854	1271	1296	1296
May	10.98	7.86	7.12	7.23	6.83	10.23	10.23	7.00	7.80	7.40	6.40	6.85
Nov	6.13											3.35



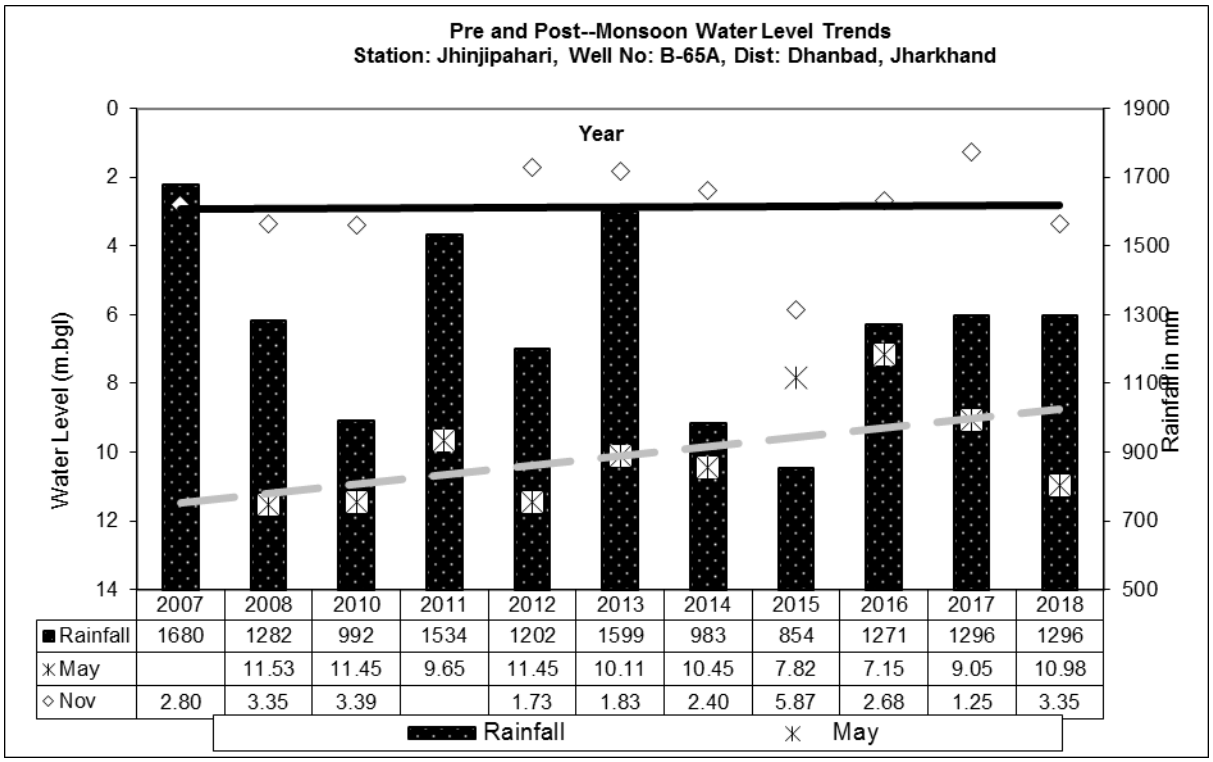
	2005	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	1234	1680	1282	992	1534	1202	1599	983	854	1271	1296	1296
May	8.95	4.95	2.85	3.8	5.5	9.30	6.95	3.30	4.60	5.92	4.40	6.45
Nov	2.70	1.3	1.50			1.42	1.67	2.30	4.50	6.96	1.30	2.10

Annexure – VI

HYDROGRAPHS OF CLUSTER-IV



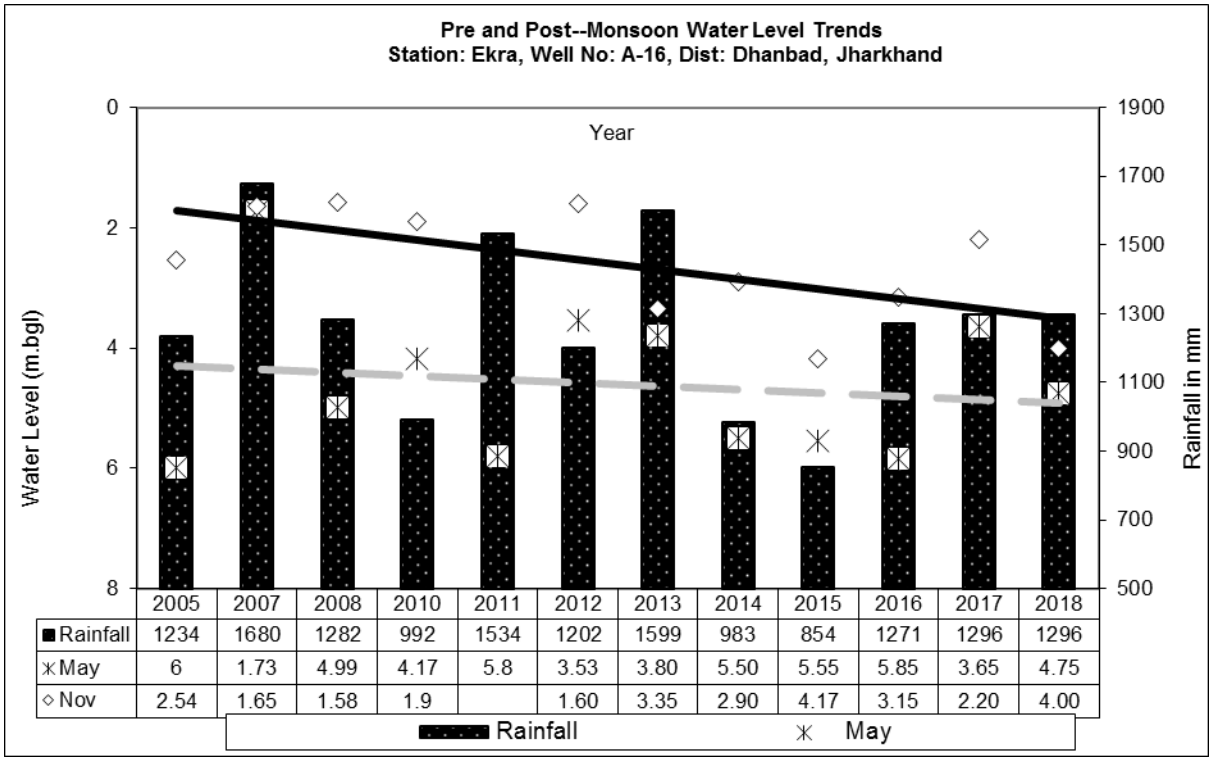
	2005	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	1234	1680	1282	992	1534	1202	1599	983	854	1271	1296	1296
May	7.06	7.80	5.53	7.77	9.18	8.76	7.56	7.71	7.33	8.90	5.30	6.55
Nov	3.73	3.8	4.13	3.95		4.28	4.28	4.58	3.18	4.50	2.53	3.90



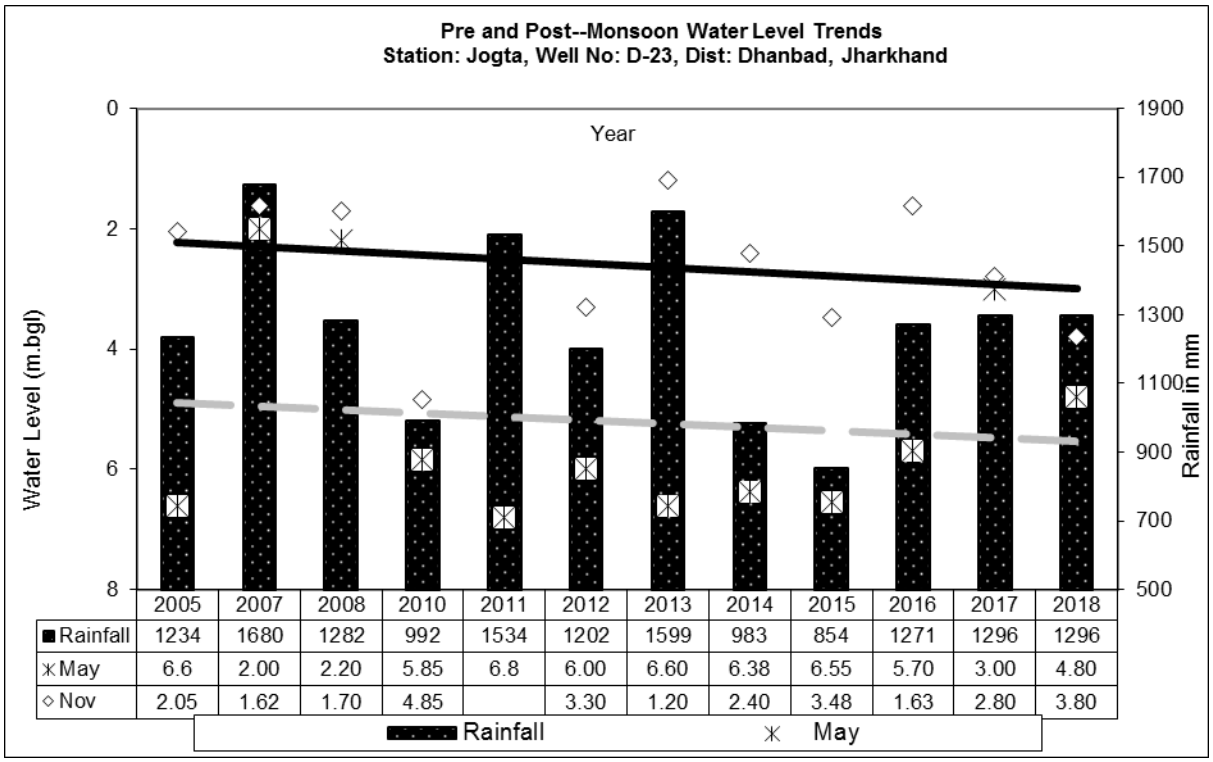
	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	1680	1282	992	1534	1202	1599	983	854	1271	1296	1296
May		11.53	11.45	9.65	11.45	10.11	10.45	7.82	7.15	9.05	10.98
Nov	2.80	3.35	3.39		1.73	1.83	2.40	5.87	2.68	1.25	3.35

Annexure – VI

HYDROGRAPHS OF CLUSTER-V



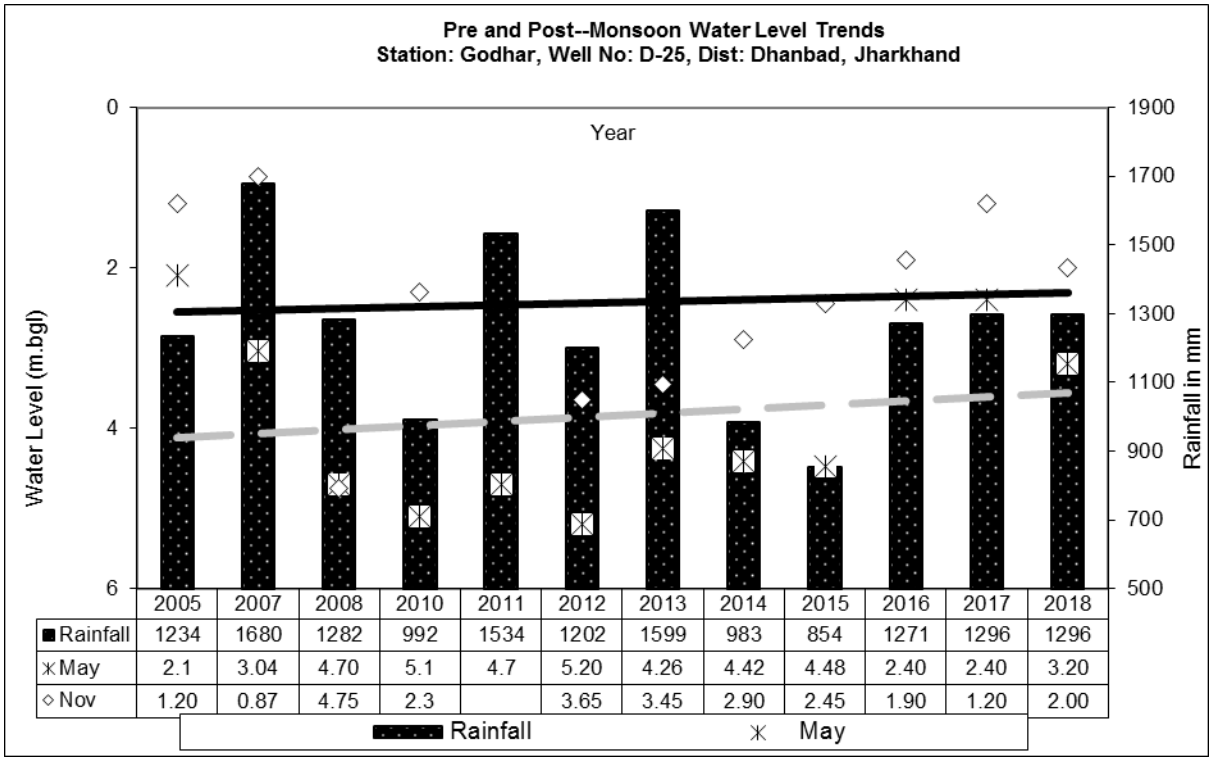
	2005	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	1234	1680	1282	992	1534	1202	1599	983	854	1271	1296	1296
May	6	1.73	4.99	4.17	5.8	3.53	3.80	5.50	5.55	5.85	3.65	4.75
Nov	2.54	1.65	1.58	1.9		1.60	3.35	2.90	4.17	3.15	2.20	4.00



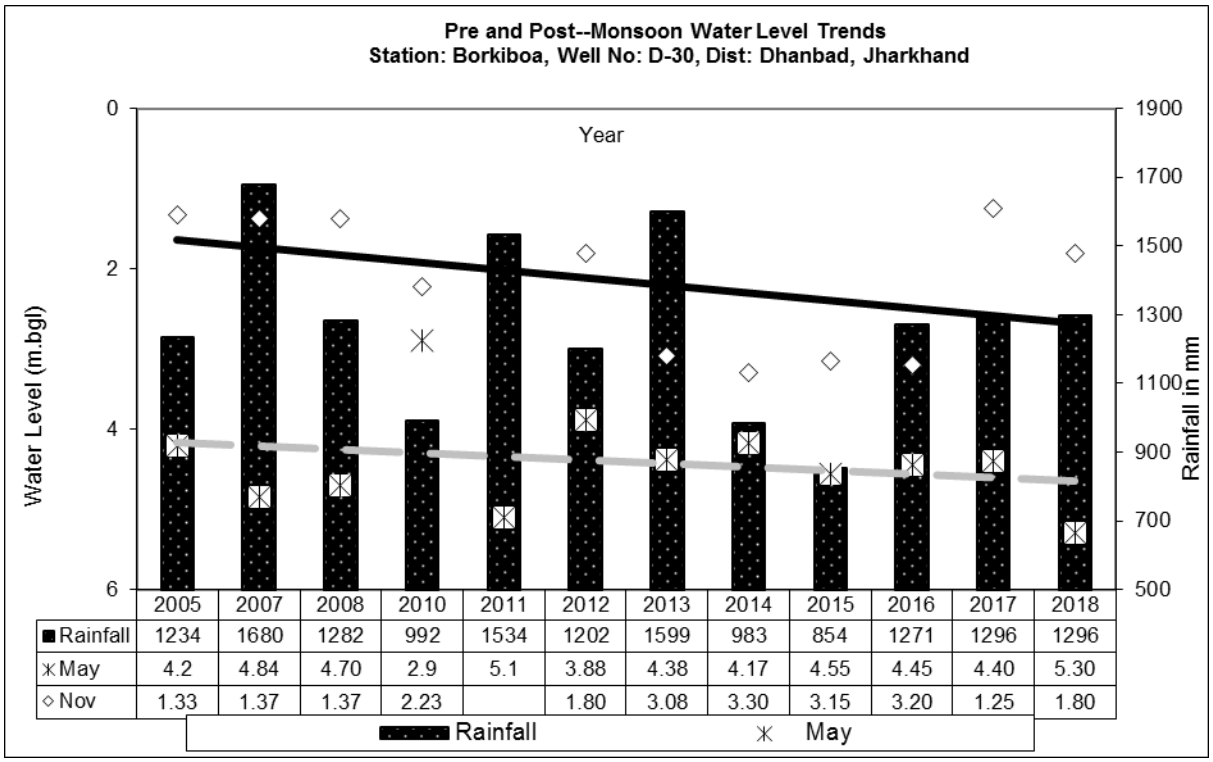
	2005	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	1234	1680	1282	992	1534	1202	1599	983	854	1271	1296	1296
May	6.6	2.00	2.20	5.85	6.8	6.00	6.60	6.38	6.55	5.70	3.00	4.80
Nov	2.05	1.62	1.70	4.85		3.30	1.20	2.40	3.48	1.63	2.80	3.80

Annexure – VI

HYDROGRAPHS OF CLUSTER-VI



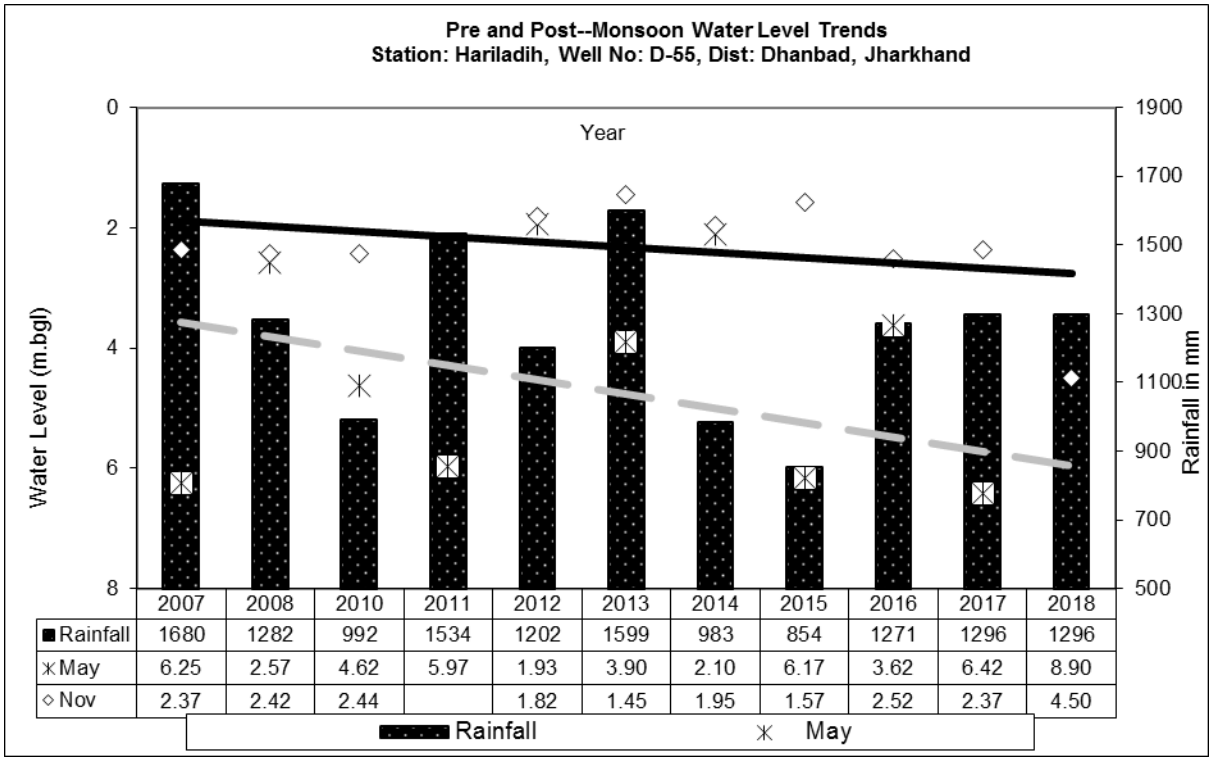
	2005	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	1234	1680	1282	992	1534	1202	1599	983	854	1271	1296	1296
May	2.1	3.04	4.70	5.1	4.7	5.20	4.26	4.42	4.48	2.40	2.40	3.20
Nov	1.20	0.87	4.75	2.3		3.65	3.45	2.90	2.45	1.90	1.20	2.00



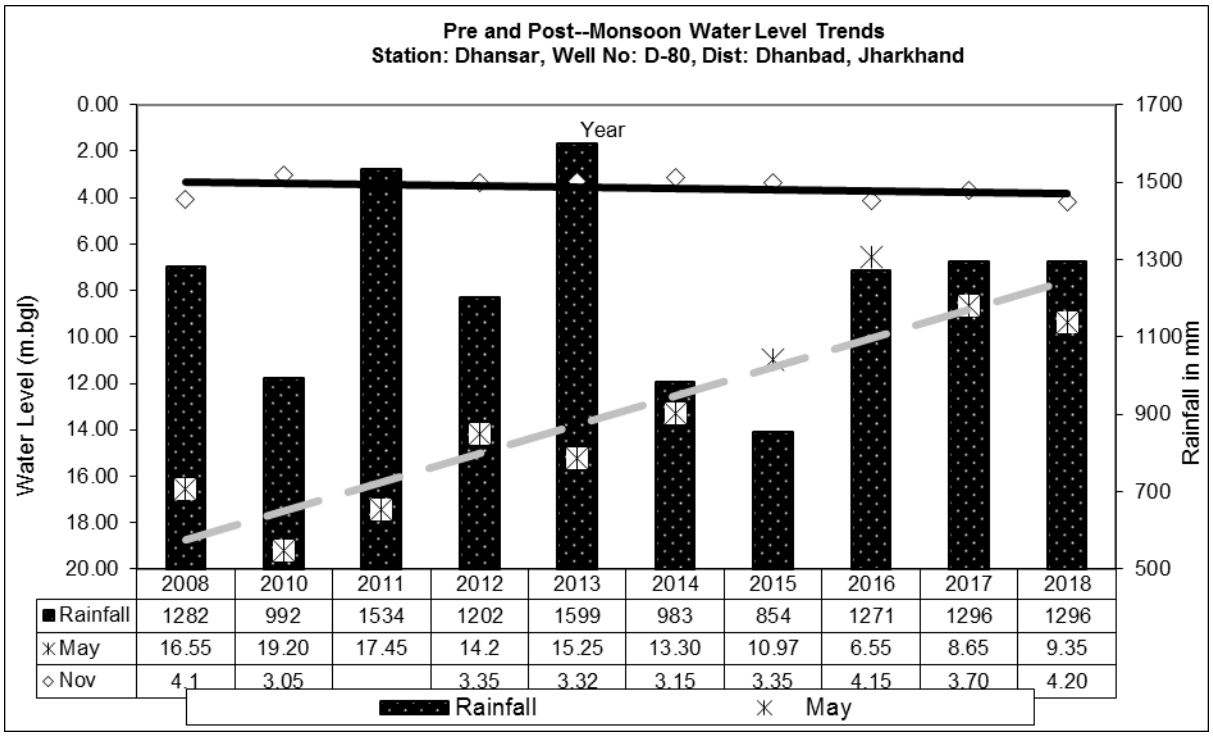
	2005	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	1234	1680	1282	992	1534	1202	1599	983	854	1271	1296	1296
May	4.2	4.84	4.70	2.9	5.1	3.88	4.38	4.17	4.55	4.45	4.40	5.30
Nov	1.33	1.37	1.37	2.23		1.80	3.08	3.30	3.15	3.20	1.25	1.80

Annexure – VI

HYDROGRAPHS OF CLUSTER-VII



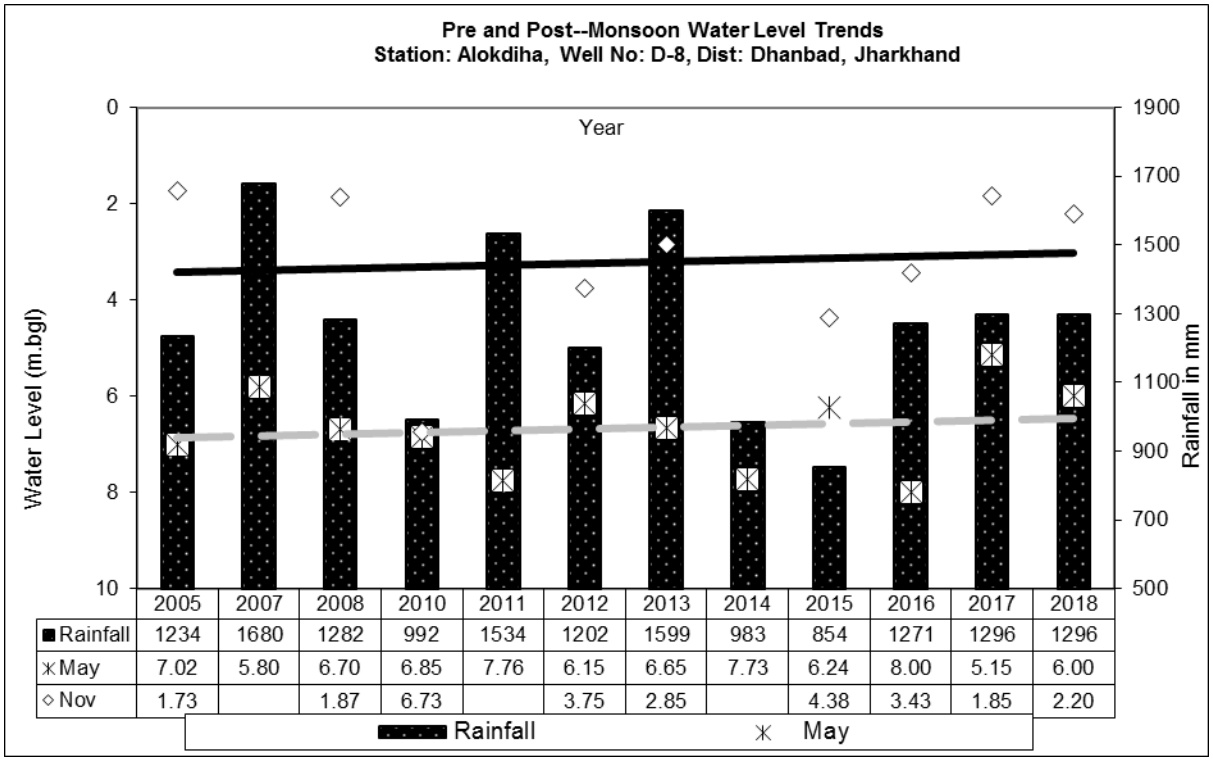
	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	1680	1282	992	1534	1202	1599	983	854	1271	1296	1296
May	6.25	2.57	4.62	5.97	1.93	3.90	2.10	6.17	3.62	6.42	8.90
Nov	2.37	2.42	2.44		1.82	1.45	1.95	1.57	2.52	2.37	4.50



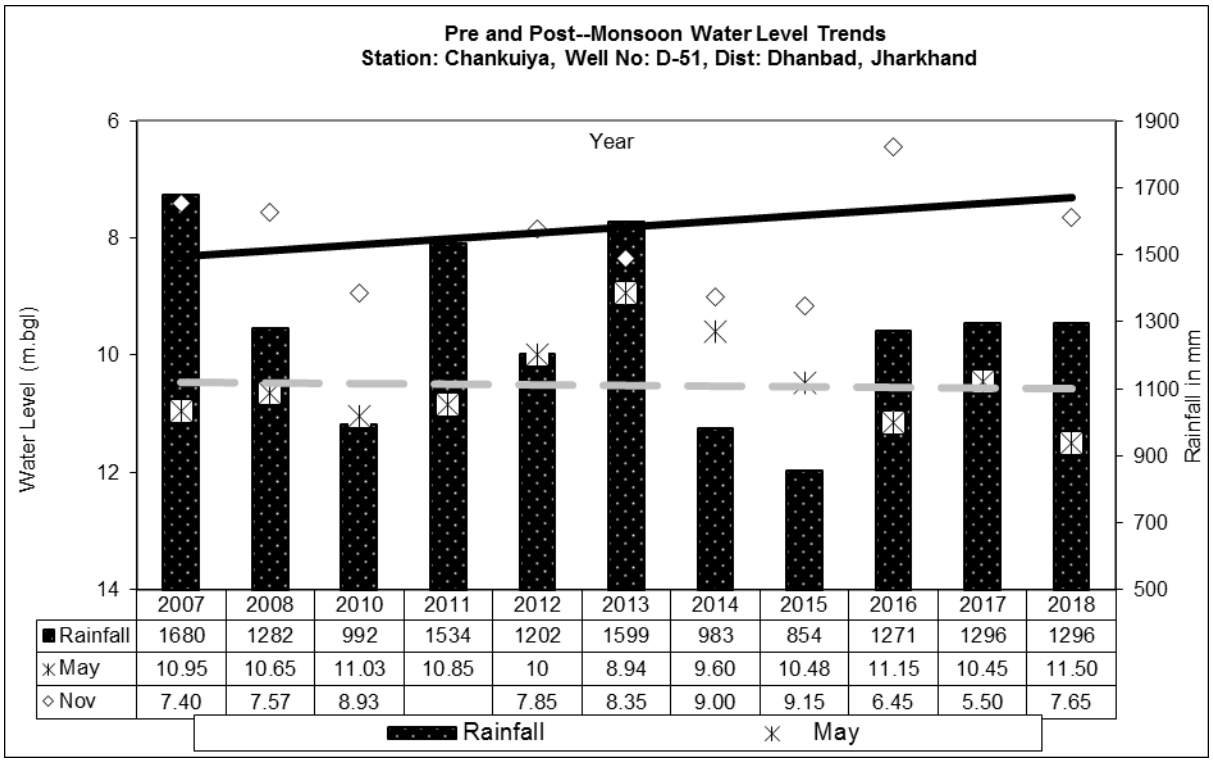
	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	1282	992	1534	1202	1599	983	854	1271	1296	1296
May	16.55	19.20	17.45	14.2	15.25	13.30	10.97	6.55	8.65	9.35
Nov	4.1	3.05		3.35	3.32	3.15	3.35	4.15	3.70	4.20

Annexure – VI

HYDROGRAPHS OF CLUSTER-VIII



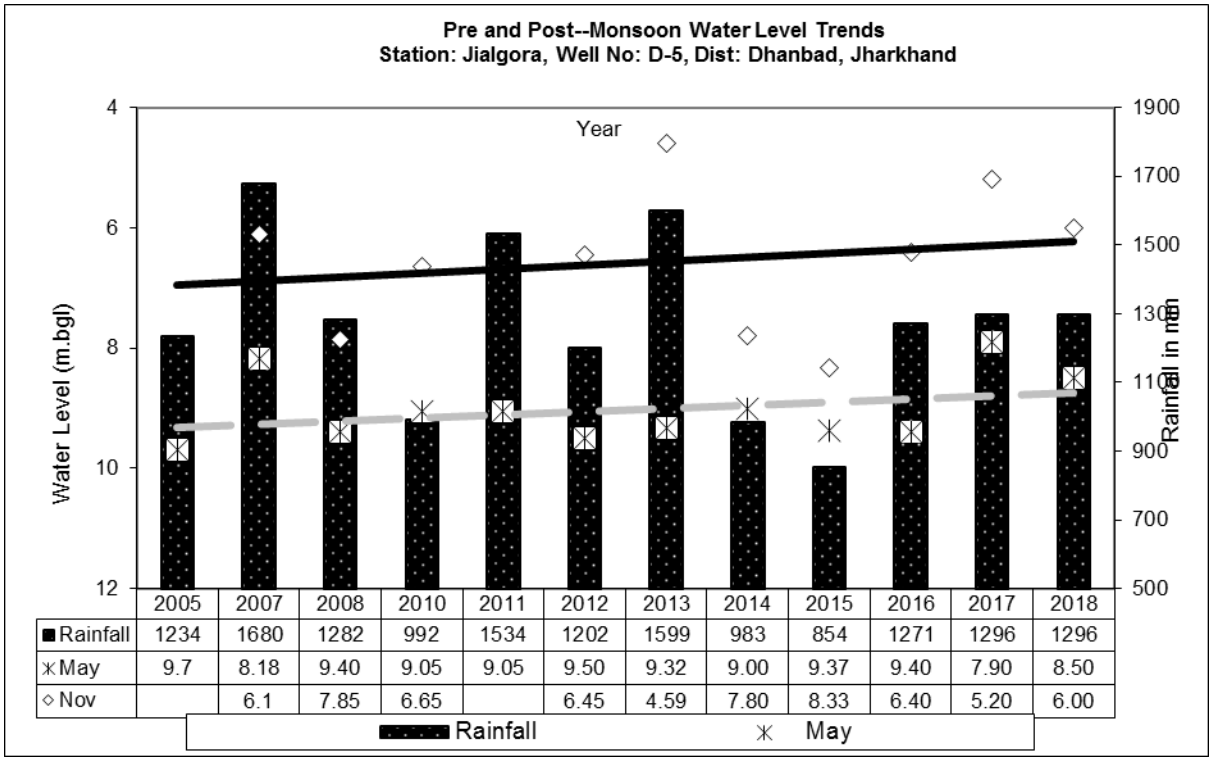
	2005	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	1234	1680	1282	992	1534	1202	1599	983	854	1271	1296	1296
May	7.02	5.80	6.70	6.85	7.76	6.15	6.65	7.73	6.24	8.00	5.15	6.00
Nov	1.73		1.87	6.73		3.75	2.85		4.38	3.43	1.85	2.20



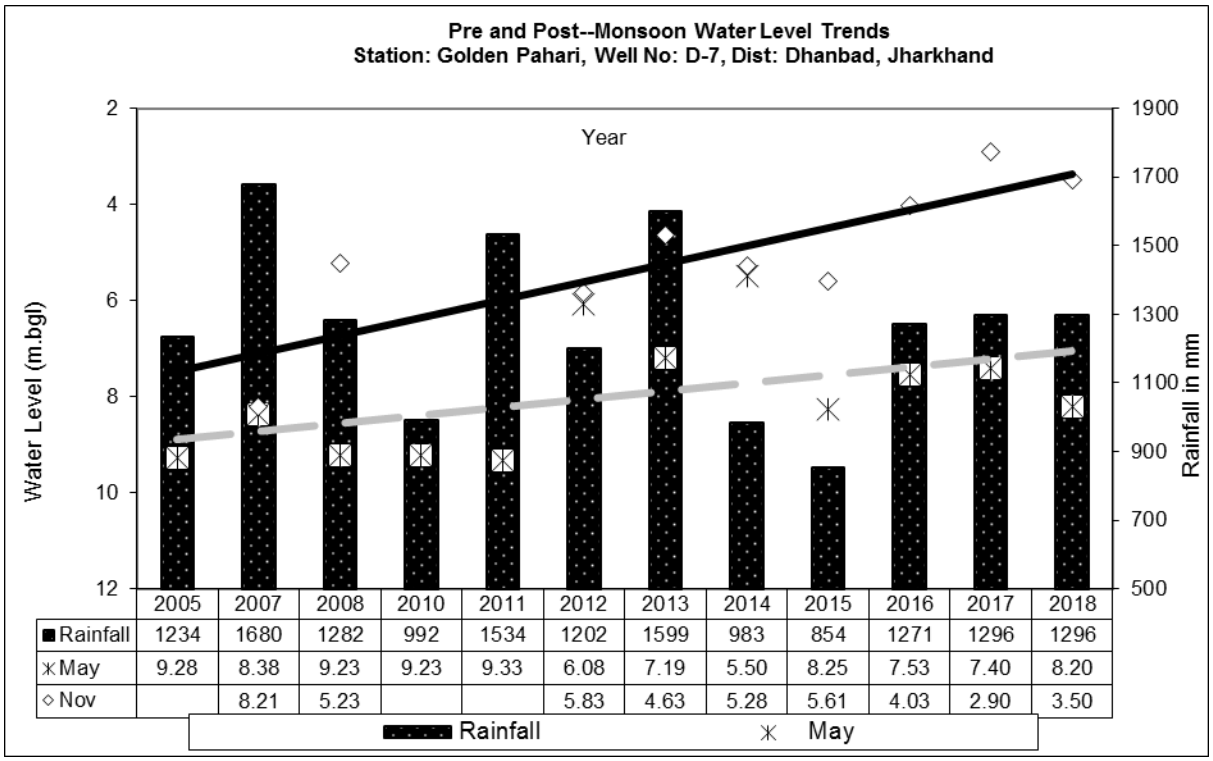
	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	1680	1282	992	1534	1202	1599	983	854	1271	1296	1296
May	10.95	10.65	11.03	10.85	10	8.94	9.60	10.48	11.15	10.45	11.50
Nov	7.40	7.57	8.93		7.85	8.35	9.00	9.15	6.45	5.50	7.65

Annexure – VI

HYDROGRAPHS OF CLUSTER-IX



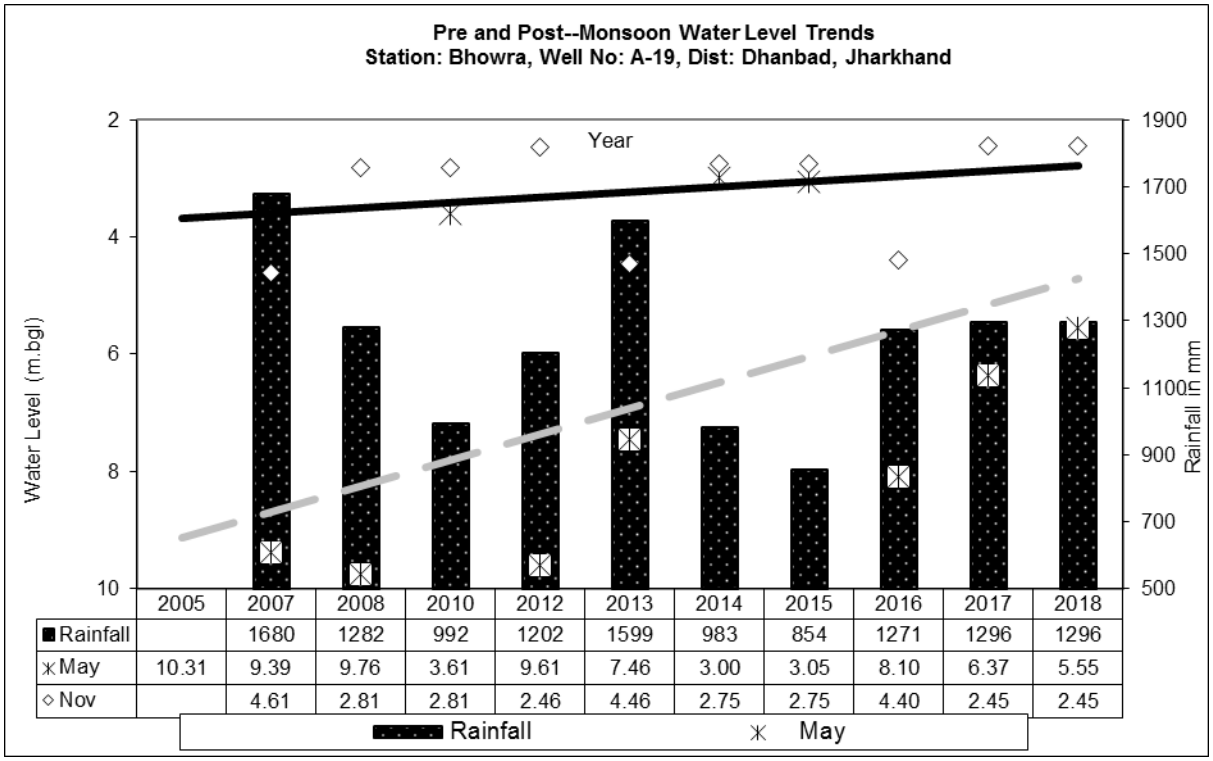
	2005	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	1234	1680	1282	992	1534	1202	1599	983	854	1271	1296	1296
May	9.7	8.18	9.40	9.05	9.05	9.50	9.32	9.00	9.37	9.40	7.90	8.50
Nov		6.1	7.85	6.65		6.45	4.59	7.80	8.33	6.40	5.20	6.00



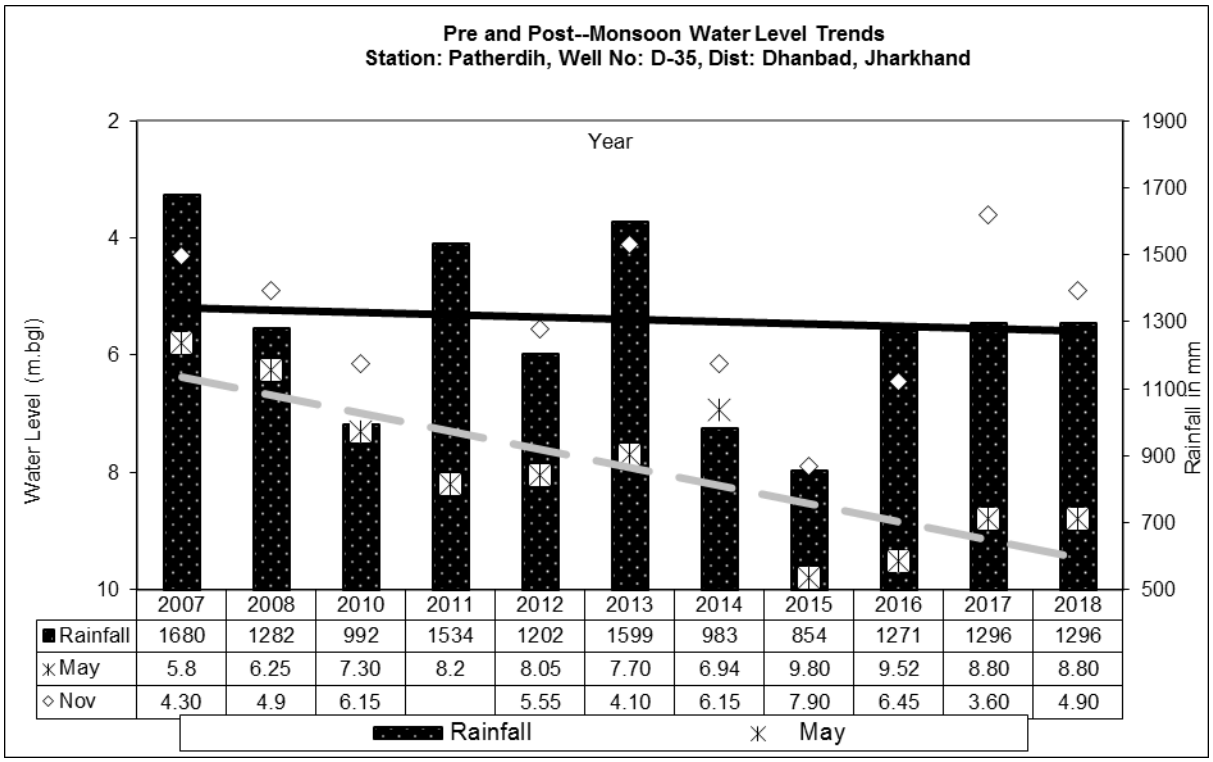
	2005	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	1234	1680	1282	992	1534	1202	1599	983	854	1271	1296	1296
May	9.28	8.38	9.23	9.23	9.33	6.08	7.19	5.50	8.25	7.53	7.40	8.20
Nov		8.21	5.23			5.83	4.63	5.28	5.61	4.03	2.90	3.50

Annexure – VI

HYDROGRAPHS OF CLUSTER-X



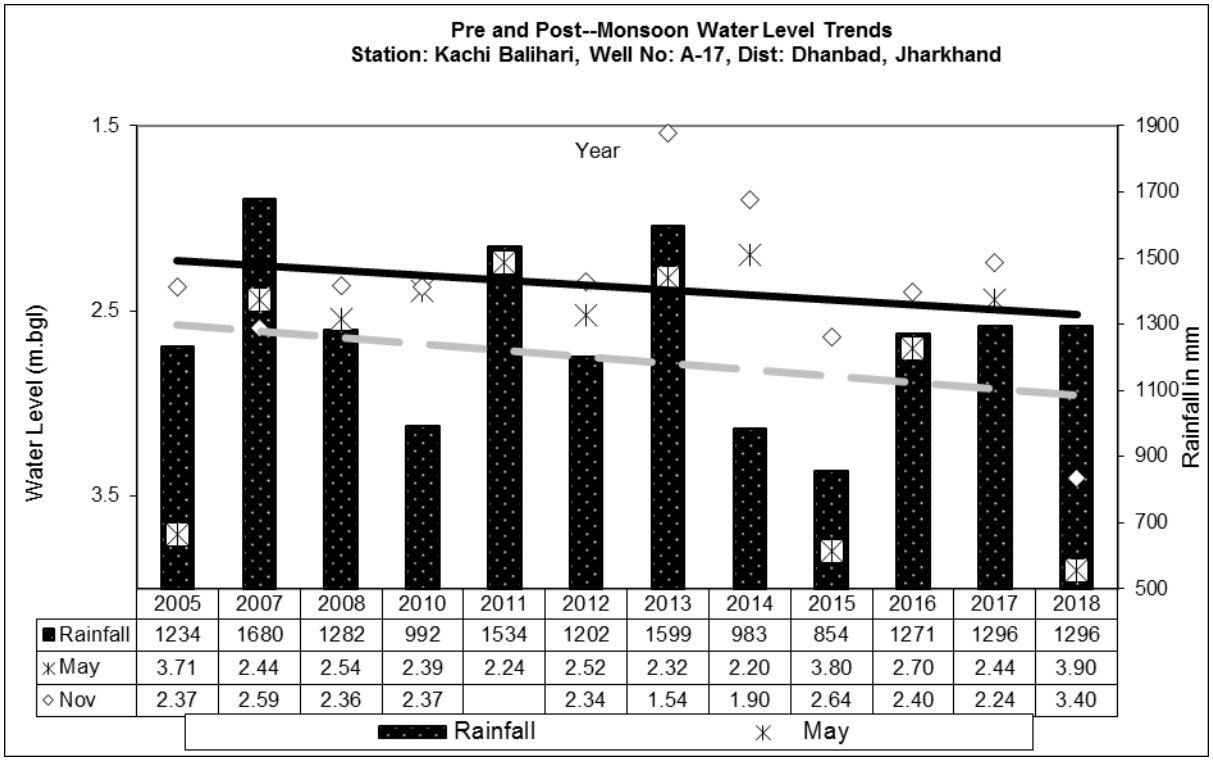
	2005	2007	2008	2010	2012	2013	2014	2015	2016	2017	2018
Rainfall		1680	1282	992	1202	1599	983	854	1271	1296	1296
May	10.31	9.39	9.76	3.61	9.61	7.46	3.00	3.05	8.10	6.37	5.55
Nov		4.61	2.81	2.81	2.46	4.46	2.75	2.75	4.40	2.45	2.45



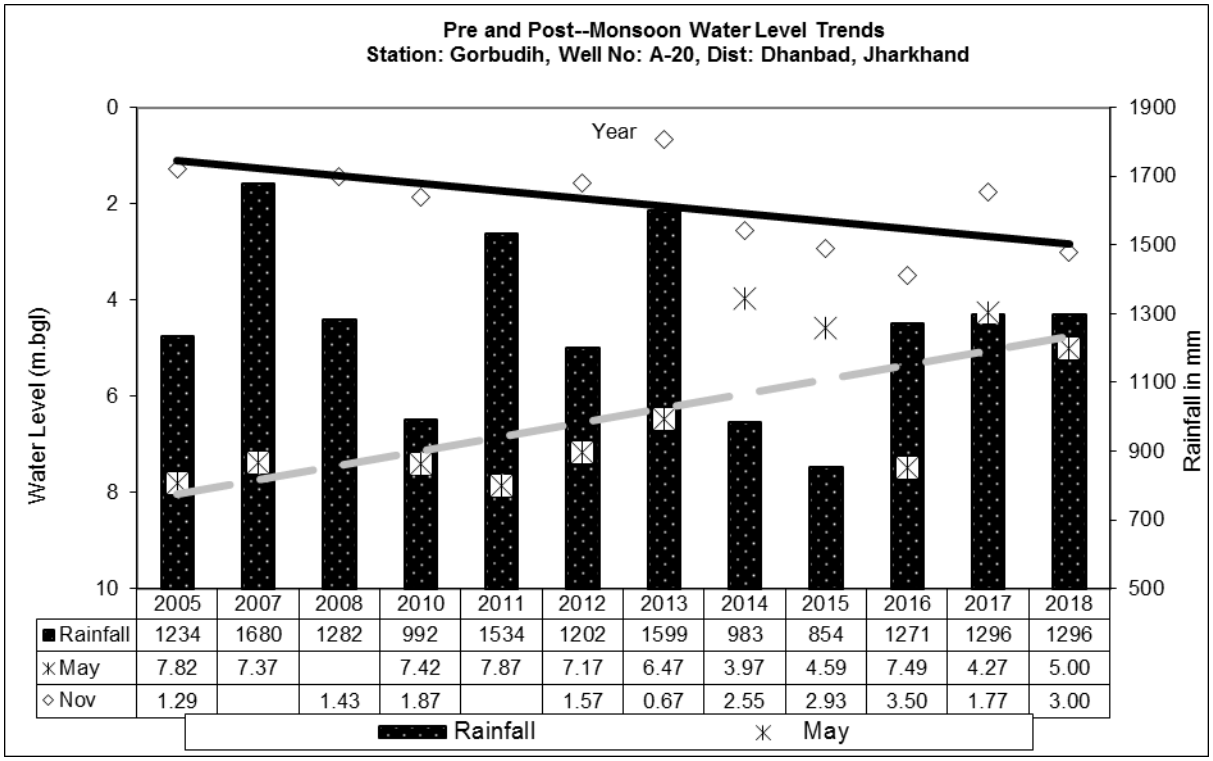
	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	1680	1282	992	1534	1202	1599	983	854	1271	1296	1296
May	5.8	6.25	7.30	8.2	8.05	7.70	6.94	9.80	9.52	8.80	8.80
Nov	4.30	4.9	6.15		5.55	4.10	6.15	7.90	6.45	3.60	4.90

Annexure – VI

HYDROGRAPHS OF CLUSTER-XI



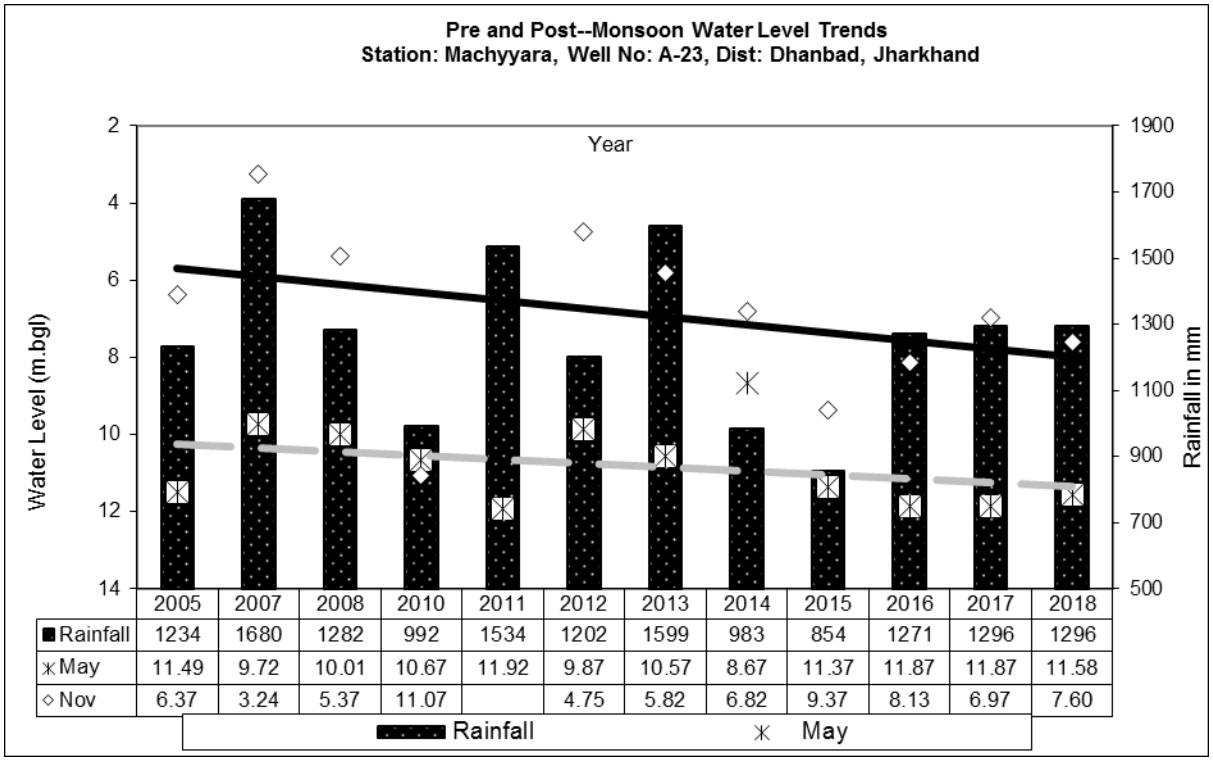
	2005	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	1234	1680	1282	992	1534	1202	1599	983	854	1271	1296	1296
May	3.71	2.44	2.54	2.39	2.24	2.52	2.32	2.20	3.80	2.70	2.44	3.90
Nov	2.37	2.59	2.36	2.37		2.34	1.54	1.90	2.64	2.40	2.24	3.40



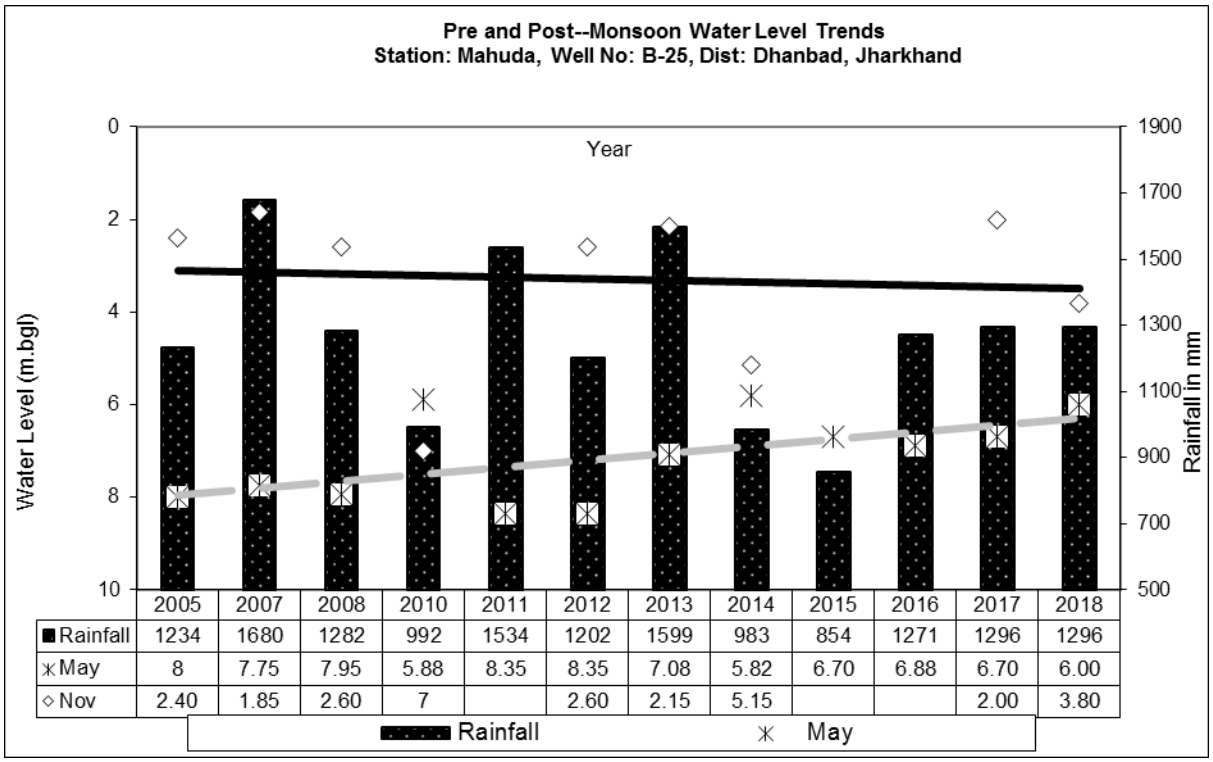
	2005	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	1234	1680	1282	992	1534	1202	1599	983	854	1271	1296	1296
May	7.82	7.37		7.42	7.87	7.17	6.47	3.97	4.59	7.49	4.27	5.00
Nov	1.29		1.43	1.87		1.57	0.67	2.55	2.93	3.50	1.77	3.00

Annexure – VI

HYDROGRAPHS OF CLUSTER-XIII



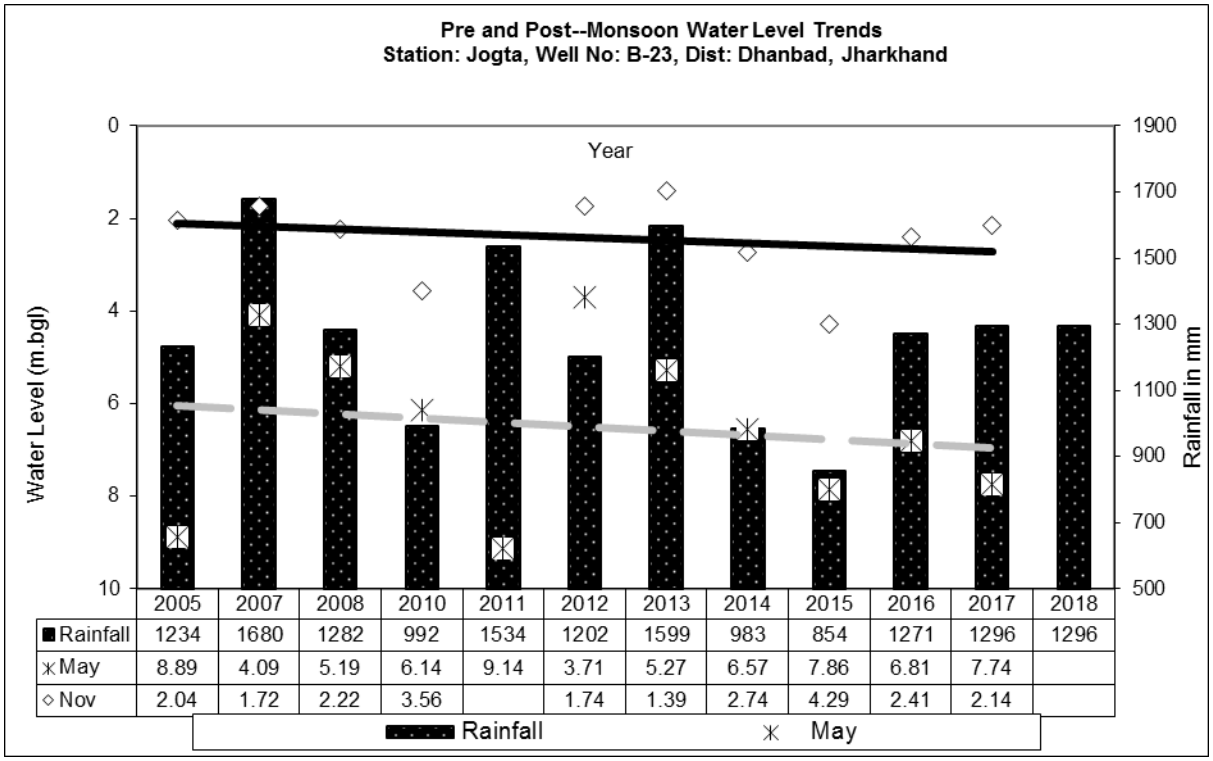
	2005	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	1234	1680	1282	992	1534	1202	1599	983	854	1271	1296	1296
May	11.49	9.72	10.01	10.67	11.92	9.87	10.57	8.67	11.37	11.87	11.87	11.58
Nov	6.37	3.24	5.37	11.07		4.75	5.82	6.82	9.37	8.13	6.97	7.60



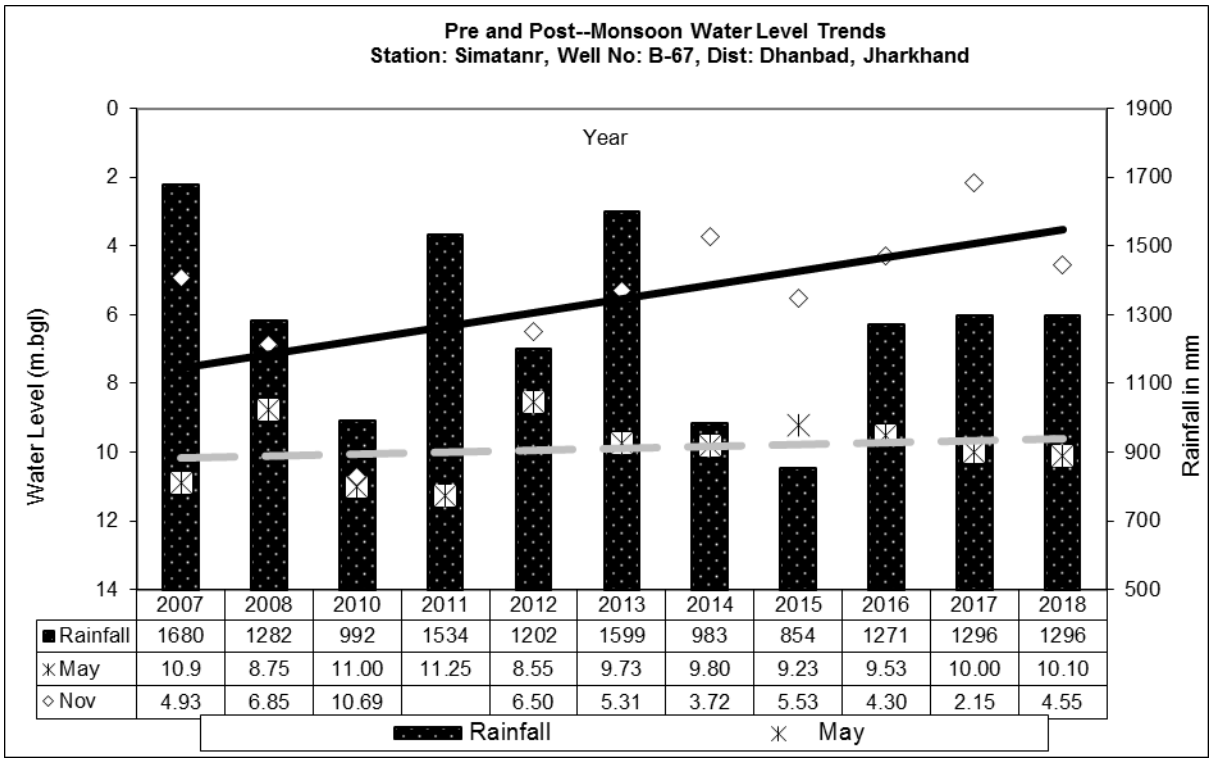
	2005	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	1234	1680	1282	992	1534	1202	1599	983	854	1271	1296	1296
May	8	7.75	7.95	5.88	8.35	8.35	7.08	5.82	6.70	6.88	6.70	6.00
Nov	2.40	1.85	2.60	7		2.60	2.15	5.15			2.00	3.80

Annexure – VI

HYDROGRAPHS OF CLUSTER-XIV



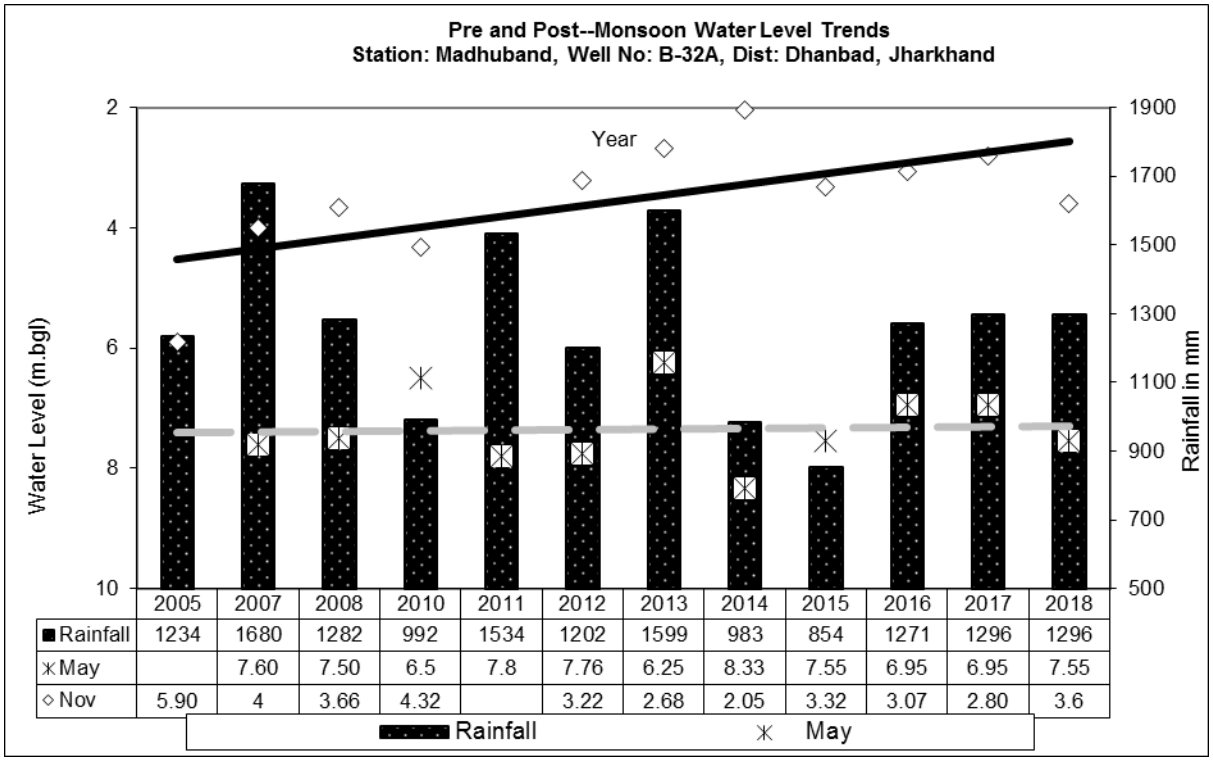
	2005	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	1234	1680	1282	992	1534	1202	1599	983	854	1271	1296	1296
May	8.89	4.09	5.19	6.14	9.14	3.71	5.27	6.57	7.86	6.81	7.74	
Nov	2.04	1.72	2.22	3.56		1.74	1.39	2.74	4.29	2.41	2.14	



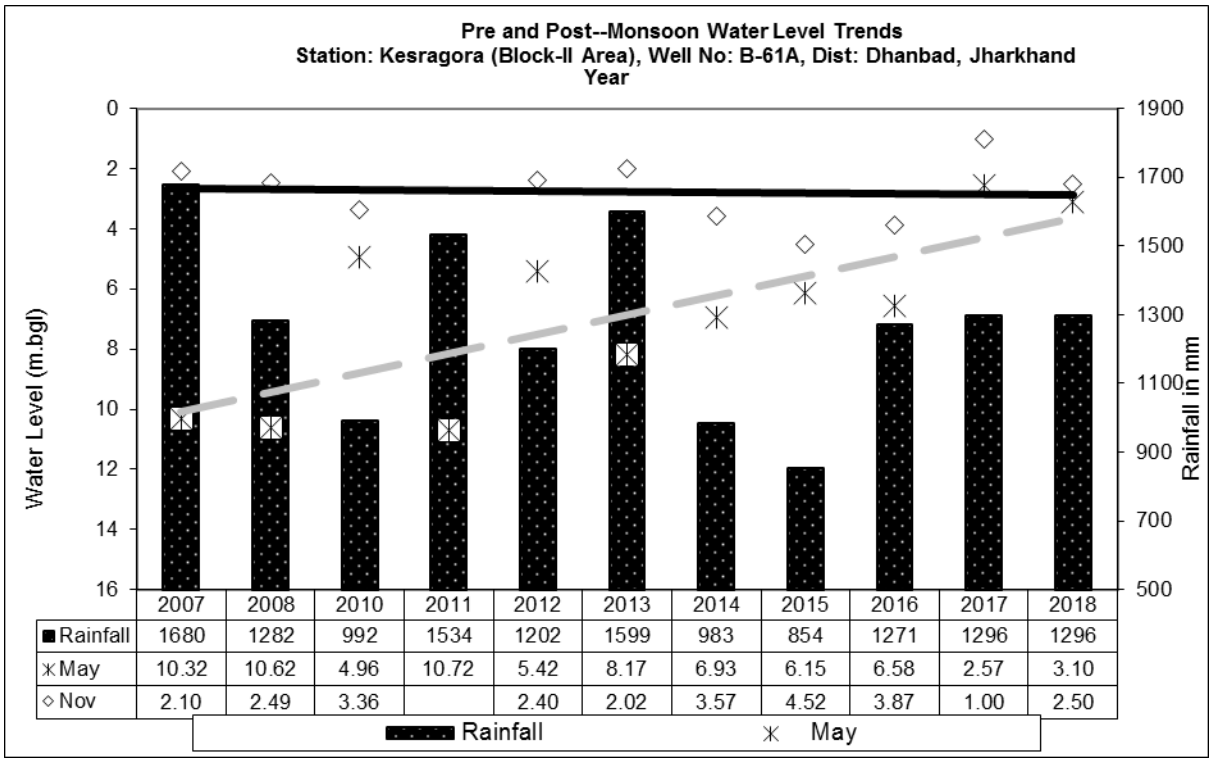
	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	1680	1282	992	1534	1202	1599	983	854	1271	1296	1296
May	10.9	8.75	11.00	11.25	8.55	9.73	9.80	9.23	9.53	10.00	10.10
Nov	4.93	6.85	10.69		6.50	5.31	3.72	5.53	4.30	2.15	4.55

Annexure – VI

HYDROGRAPHS OF CLUSTER-XV



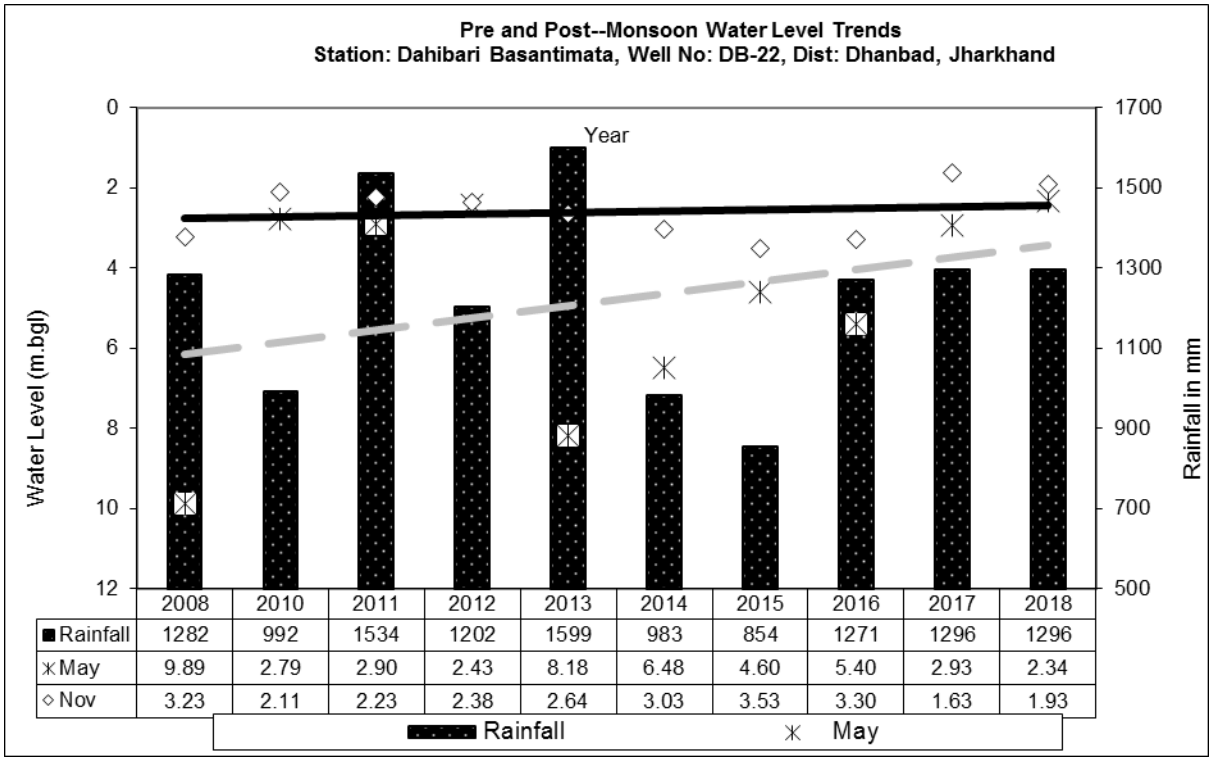
	2005	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	1234	1680	1282	992	1534	1202	1599	983	854	1271	1296	1296
May		7.60	7.50	6.5	7.8	7.76	6.25	8.33	7.55	6.95	6.95	7.55
Nov	5.90	4	3.66	4.32		3.22	2.68	2.05	3.32	3.07	2.80	3.6



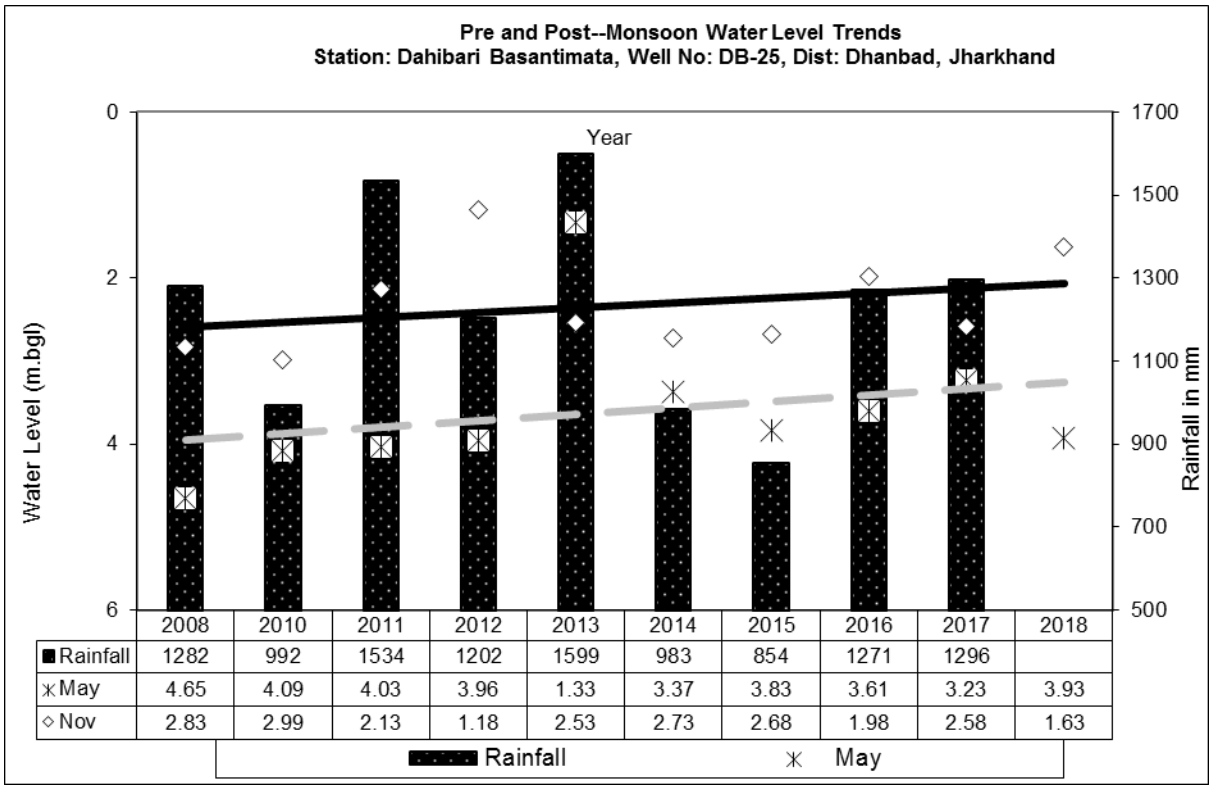
	2007	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	1680	1282	992	1534	1202	1599	983	854	1271	1296	1296
May	10.32	10.62	4.96	10.72	5.42	8.17	6.93	6.15	6.58	2.57	3.10
Nov	2.10	2.49	3.36		2.40	2.02	3.57	4.52	3.87	1.00	2.50

Annexure – VI

HYDROGRAPHS OF CLUSTER-XVI



	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	1282	992	1534	1202	1599	983	854	1271	1296	1296
May	9.89	2.79	2.90	2.43	8.18	6.48	4.60	5.40	2.93	2.34
Nov	3.23	2.11	2.23	2.38	2.64	3.03	3.53	3.30	1.63	1.93



	2008	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rainfall	1282	992	1534	1202	1599	983	854	1271	1296	
May	4.65	4.09	4.03	3.96	1.33	3.37	3.83	3.61	3.23	3.93
Nov	2.83	2.99	2.13	1.18	2.53	2.73	2.68	1.98	2.58	1.63

Abbreviations

AMSL: Above mean sea level

Avg.: Average

APT: Aquifer Pumping Test

BCCL: Bharat Coking Coal Ltd.

bgl: Below Ground Level

Buffer zone: periphery of the 10 km radius from the project boundary

Core zone: Project / mine / colliery boundary (leasehold area)

CMPDI: Central Mine Plan & Design Institute

DVC: Damodar Valley Corporation

DTW: Depth to water level

GW: Groundwater

IMD: Indian Meteorological Division

JCF: Jharia Coalfield

RCF: Raniganj Coalfield

MADA: Mineral Area Development Authority

MCM: Million Cubic Meter

MGD: Million Gallon per day

NTU: Nephlometric Turbidity unit

OC / UG: Opencast / Underground

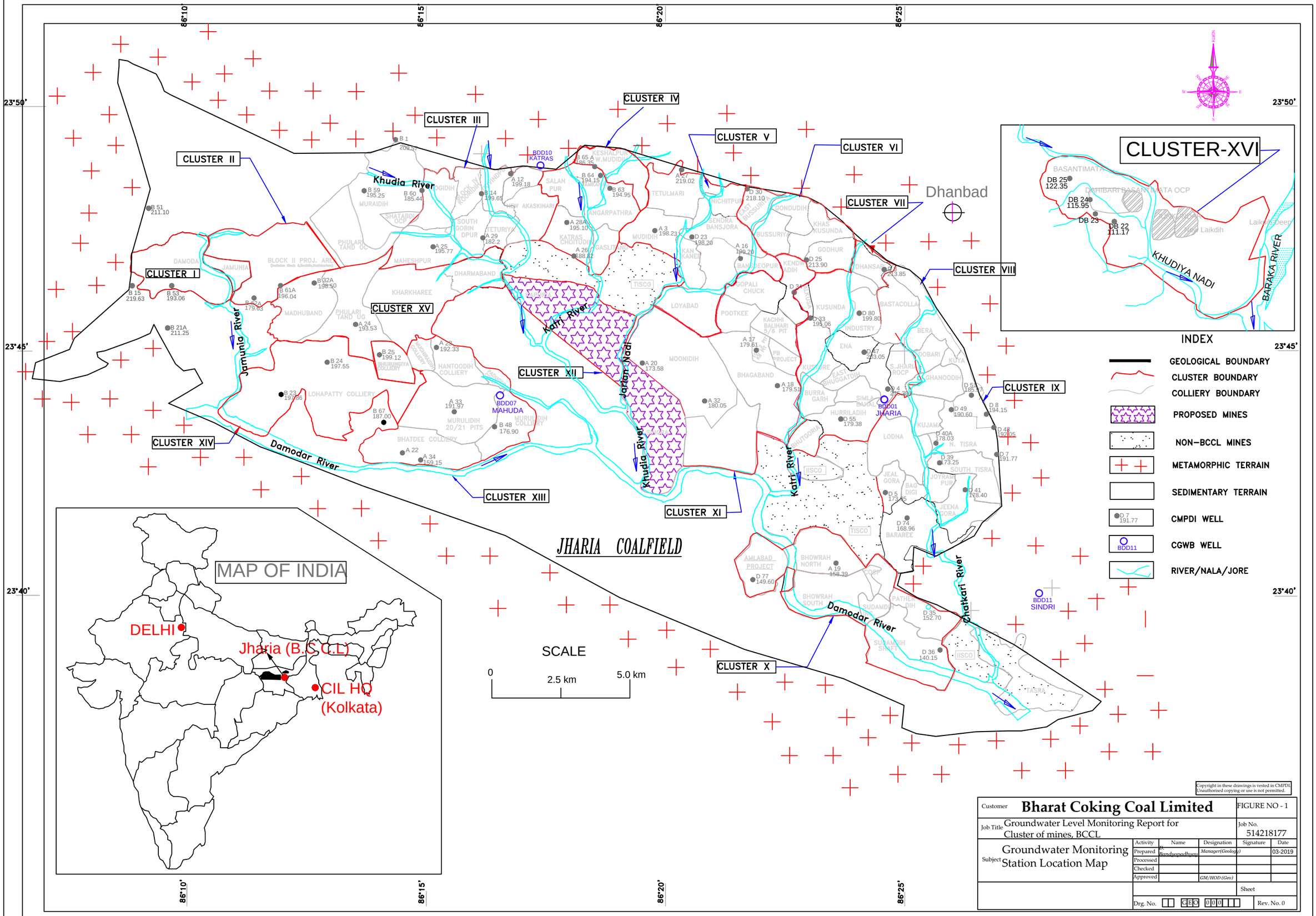
OCP / UGP: Opencast Project / Underground Project

RL: Reduced Level

RWH: Rainwater Harvesting

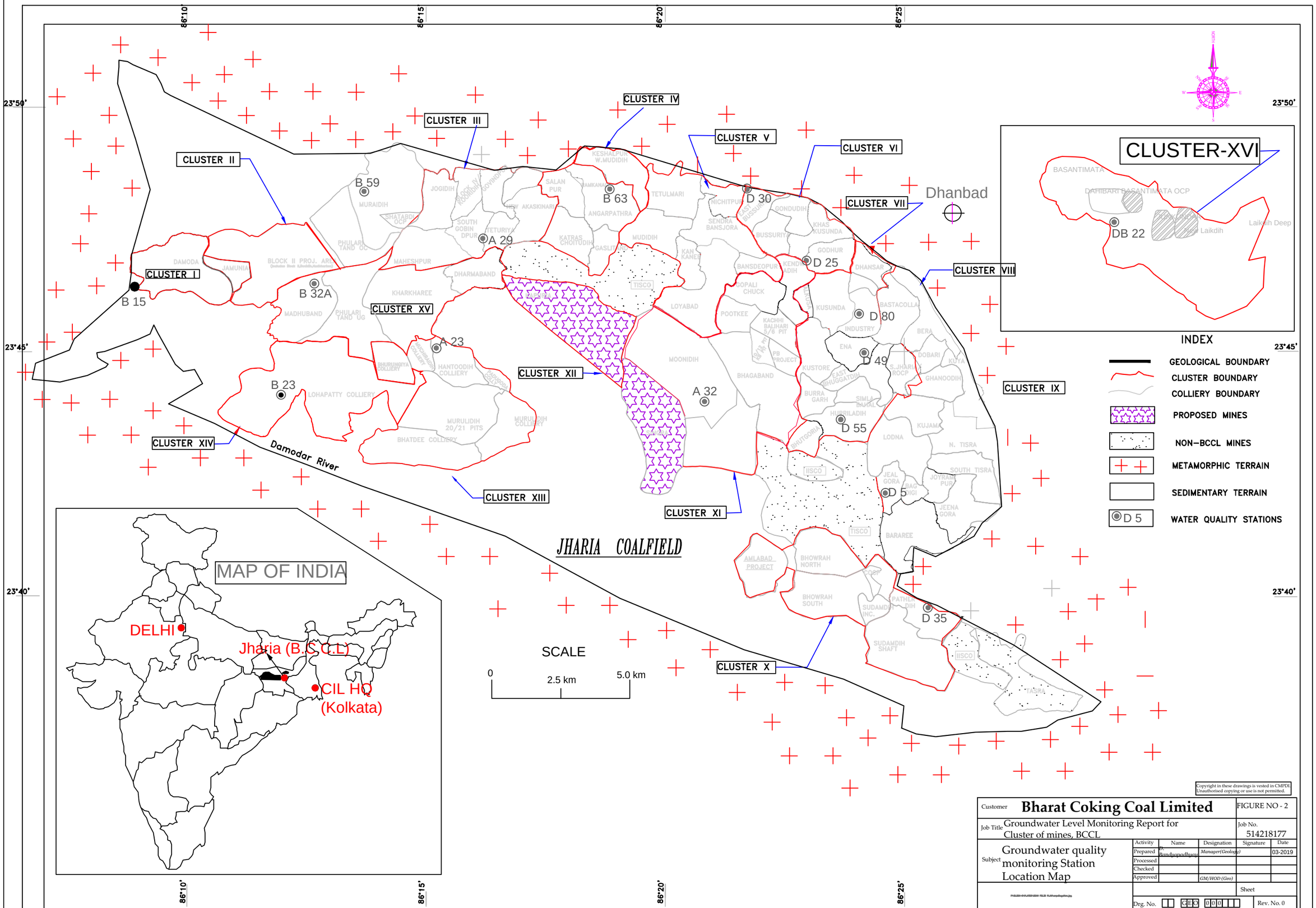
FF: Fire Fighting

GROUNDWATER MONITORING STATION LOCATION MAP



Customer	**Bharat Coking Coal Limited**					FIGURE NO - 1
Job Title	Groundwater Level Monitoring Report for Cluster of mines, BCCL					Job No. 514218177
Subject	Groundwater Monitoring Station Location Map	Activity	Name	Designation	Signature	Date
		Prepared	S. Bandyopadhyay	Manager(Geolog.)		03-2019
		Processed				
		Checked				
		Approved		GM/HOD (Geo)		
					Sheet	
		Drg. No.		CEO		Rev. No. 0

GROUNDWATER QUALITY MONITORING STATION LOCATION MAP



Customer	**Bharat Coking Coal Limited**					FIGURE NO - 2
Job Title	Groundwater Level Monitoring Report for Cluster of mines, BCCL					Job No. 514218177
Subject	Groundwater quality monitoring Station Location Map	Activity	Name	Designation	Signature	Date
		Prepared	P. Bandyopadhyay	Manager(Geology)		03-2019
		Processed				
		Checked				
		Approved		GM/HOD (Geo)		
					Sheet	
		Drg. No.	CEC	0 0 0		Rev. No. 0

WATER TABLE CONTOUR MAP OF PRE-MONSOON 2018

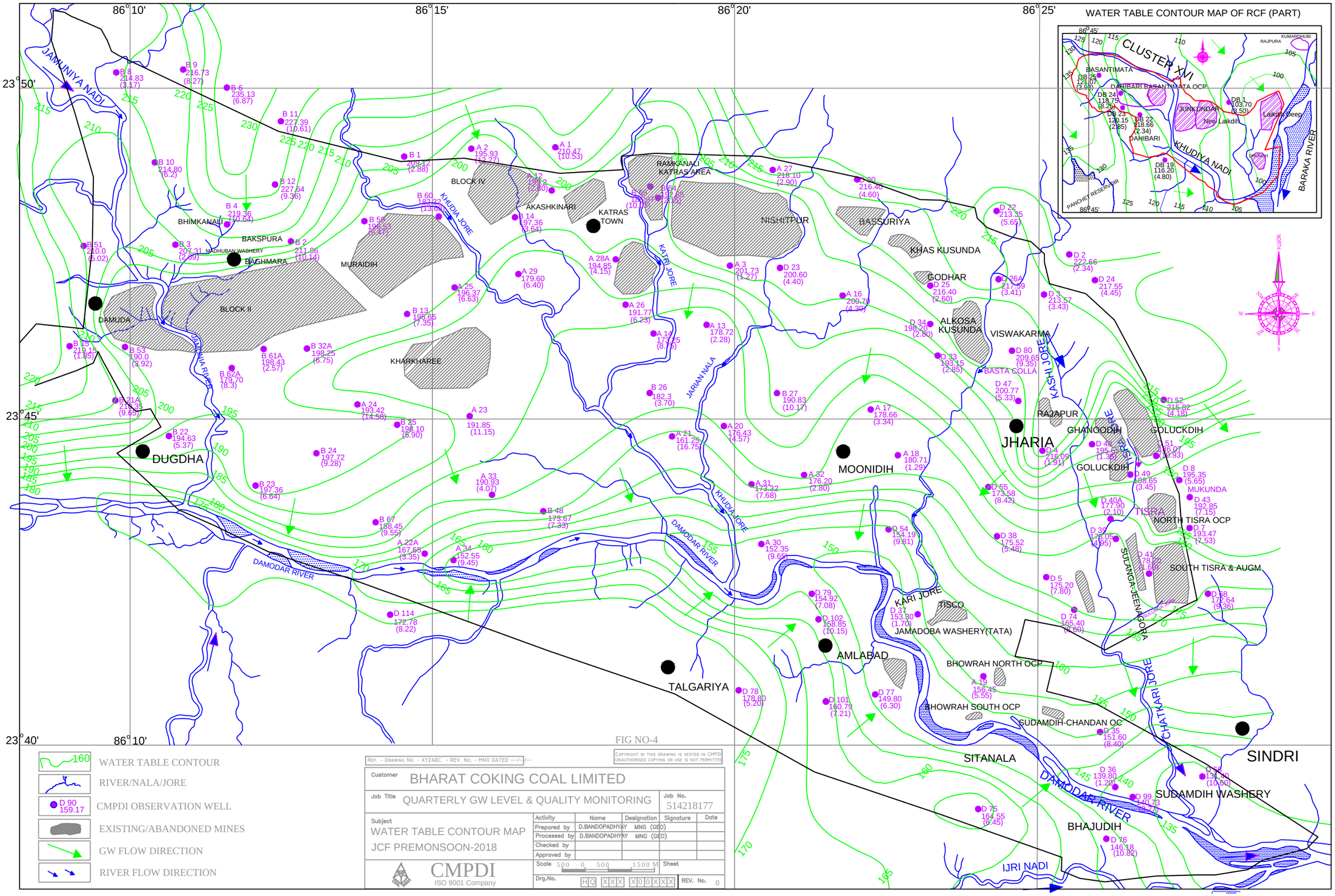


FIG NO-4

160 WATER TABLE CONTOUR

RIVER/NALA/JORE

D 90 159.17 CMPDI OBSERVATION WELL

EXISTING/ABANDONED MINES

GW FLOW DIRECTION

RIVER FLOW DIRECTION

REF. - DRAWING No. - XYZABC - REV. No. - MNO DATED ----/--/--

Customer: BHARAT COKING COAL LIMITED

Job Title: QUARTERLY GW LEVEL & QUALITY MONITORING

Job No.: 514218177

Subject: WATER TABLE CONTOUR MAP JCF PREMONSOON-2018

Activity	Name	Designation	Signature	Date
Prepared by	D.BANDOPADHYAY	MNG (GEO)		
Processed by	D.BANDOPADHYAY	MNG (GEO)		
Checked by				
Approved by				

CMPDI ISO 9001 Company

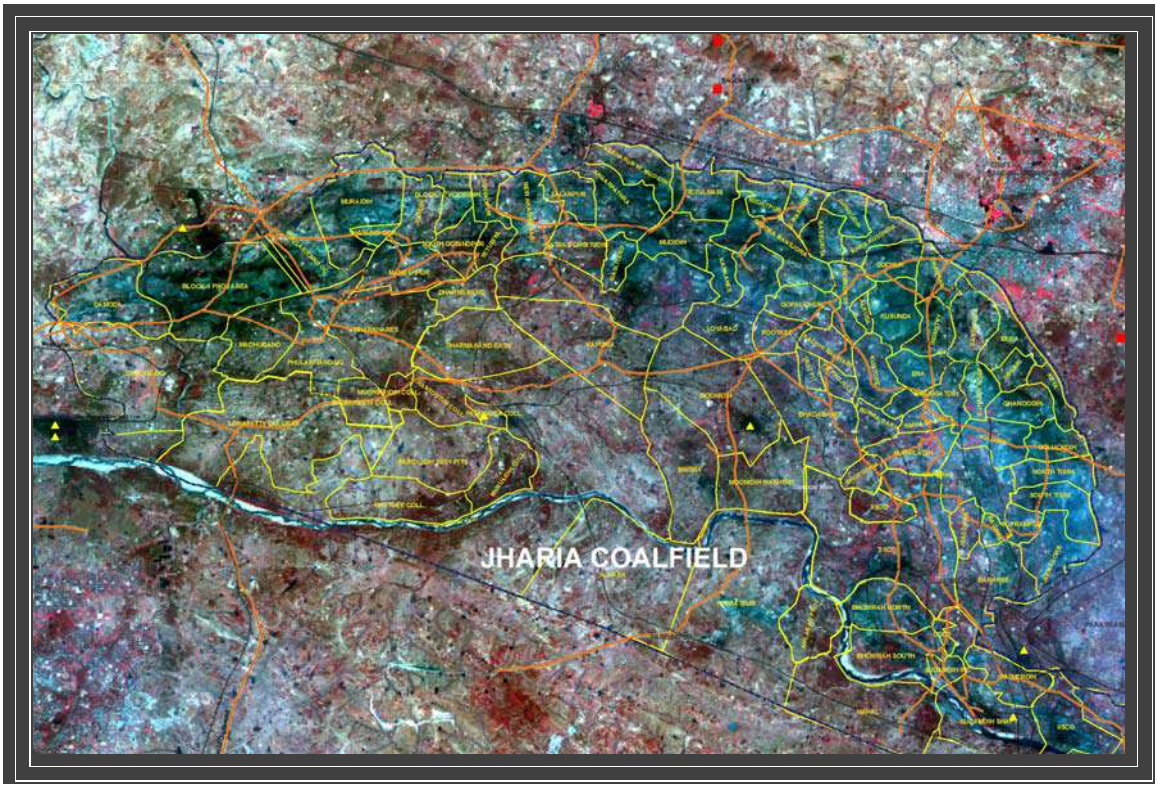
Scale 500 0 500 1500 M

Sheet

Drg.No. HQ XXX X0 0 XXX

REV. No. 0

Vegetation Cover Mapping of Jharia Coalfield based on Satellite Data of the Year- 2016



Submitted to

Bharat Coking Coal Ltd (BCCL)

Dhanbad

March 2017

cmpdi

A Mini Ratna Company

Vegetation Cover Mapping of Jharia Coalfield based on Satellite Data of the Year- 2016

March-2017

Remote Sensing Cell
Geomatics Division
CMPDI, Ranchi

Document Control Sheet

(1)	Job No.	RSC/561410027
(2)	Publication Date	March 2017
(3)	Number of Pages	49
(4)	Number of Figures	6
(5)	Number of Tables	10
(6)	Number of Plates	17
(7)	Title of Report	Vegetation cover mapping of Jharia Coalfield based on satellite data for the year 2016.
(8)	Aim of the Report	To prepare Land use and vegetation cover map of Jharia Coalfield on 1:50000 scale based on satellite data for monitoring the impact of coal mining on land use pattern and vegetation cover & also to prepare cluster wise Land use/ Cover maps falling under Jharia Coalfield.
(9)	Executing Unit	Remote Sensing Cell, Geomatics Division Central Mine Planning & Design Institute Limited, Gondwana Place, Kanke Road, Ranchi 834008
(10)	User Agency	Coal India Ltd.(CIL) / Bharat Coking Coal Ltd.(BCCL)
(11)	Authors	Ms Ayesha Parida, Assistant Manager (Remote Sensing)
(12)	Security Restriction	Restricted Circulation
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(14)	Distribution Statement	Official

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Chapter 1

Introduction

1.1 Project Reference

To monitor the regional impact of coal mining on land use pattern and vegetation cover in the 28 major coalfields at regular interval of three years based on remote sensing satellite data, Coal India Ltd. issued a work order to CMPDI vide letter no.CIL/WBP/ENV/2011/4706 dated 12.10.12. As the Impact of coal mining on land environment has to be assessed regularly at interval of three years, Geo-environmental data base for Jharia coalfield based on satellite data was prepared earlier in the year 2010, 2012 under the above project. The present study is based on the satellite data of the year 2016. BCCL vide their letter No BCCL/ DGM(Env)/File-/16/276 dated 25.05.2016 requested that the map of each cluster under Jharia Coalfield shall also be incorporated in the report for EC compliance. Therefore cluster-wise land use/cover maps are also included in this report.

1.2 Objective

The objective of the present study is to prepare a regional land use and vegetation cover map of Jharia coalfield on 1:50,000 scale based on satellite data of the year 2016, using digital image processing technique for monitoring the impact of coal mining and other industrial activities on land use and vegetation cover in the coalfield area in period of last three years.

1.4 Location of the Area & Accessibility

The Jharia Coalfield (JCF) is located in the north east part of the State of Jharkhand, approximately 260 km west of Kolkata. It is linked to Kolkata and Delhi through NH 2, which is the part of Golden Quadrilateral highway network of India. The coalfield contains proven coal reserves of approximately one billion tonnes in a crescent-shaped basin of approximately 400 km^2. BCCL operates within an area of approximately 258 Sq km. The Jharia coalfield covers an area of about 393 sq km. it is bounded by Lat $23^0$49'0.63"N and $23^0$38'36.50"N and Long $86^0$08'49.91"E and $86^0$25'54.92E. The major part of coalfield (about 400 sq km) lies in Dhanbad district of Jharkhand. Coalfield is connected by Major Highways road with Ranchi (117 km), Asansol (60 km), Jamshedpur (108 km) and Dhanbad (8 km). The nearest major railway station is Dhanbad, located on Delhi-Howrah Grand Chord line oh East Central Railway which passes parallel to northern boundary of the coalfield.

1.5 Physiography and Geology

Jharia coalfield is characterized by gently undulating to a rolling topography with an overall slope towards east-southeast. The coalfield is roughly sickle shaped on plan and occurs as a basin with its axis trending broadly east-west and plunging towards the west. The southern flank is truncated by a major Boundary Fault. The general dip of the formation is 10 to 15 degrees. Flatter dips have also been noted at places. The entire southern part of Jharia coalfield in the vicinity of the Boundary Fault, however shows generally steep dipping beds with amounts increasing even up to 70 degrees.

The drainage pattern in the Jharia coalfield is dendritic in nature. This may be due to more or less homogeneous lithology and structural controls. Damodar river is the main control of drainage system along the Jharia coalfield. It is a fourth order stream to which a number of third to first order streams, viz.

Jamunia, Khudia, Katri, Ekra, Tisra, Chatkari etc. join. Damodar river flows along the southern periphery of the coalfield and is guided by the Main Boundary Fault. The main flow direction is from west to east.

The strike of the formation is generally WSW to ENE in the western part and WNW to ESE in the southern part of the coalfield. This gradually swings to EW in the centre of the coalfield and then to NS further east. In the south-eastern part the strike is generally WNW-ESE. Besides the boundary part the coalfield is traversed by a number of other major and minor faults.

The Barakar formation contains 18 standard coal horizons (numbered I to XVIII). Of the Barakar formations, the coal seams XIII and above are generally thin and of relatively superior quality. Seams XII to IX/X are of medium to superior quality and attain sizable thickness at places. The V, VI, VII, IV, III & II are generally thick seams of inferior quality. The bottom most seam I is of superior medium coking quality in the eastern part of the coalfield.

A map of India showing the location of Jharia Coalfield is given in Fig1.1.

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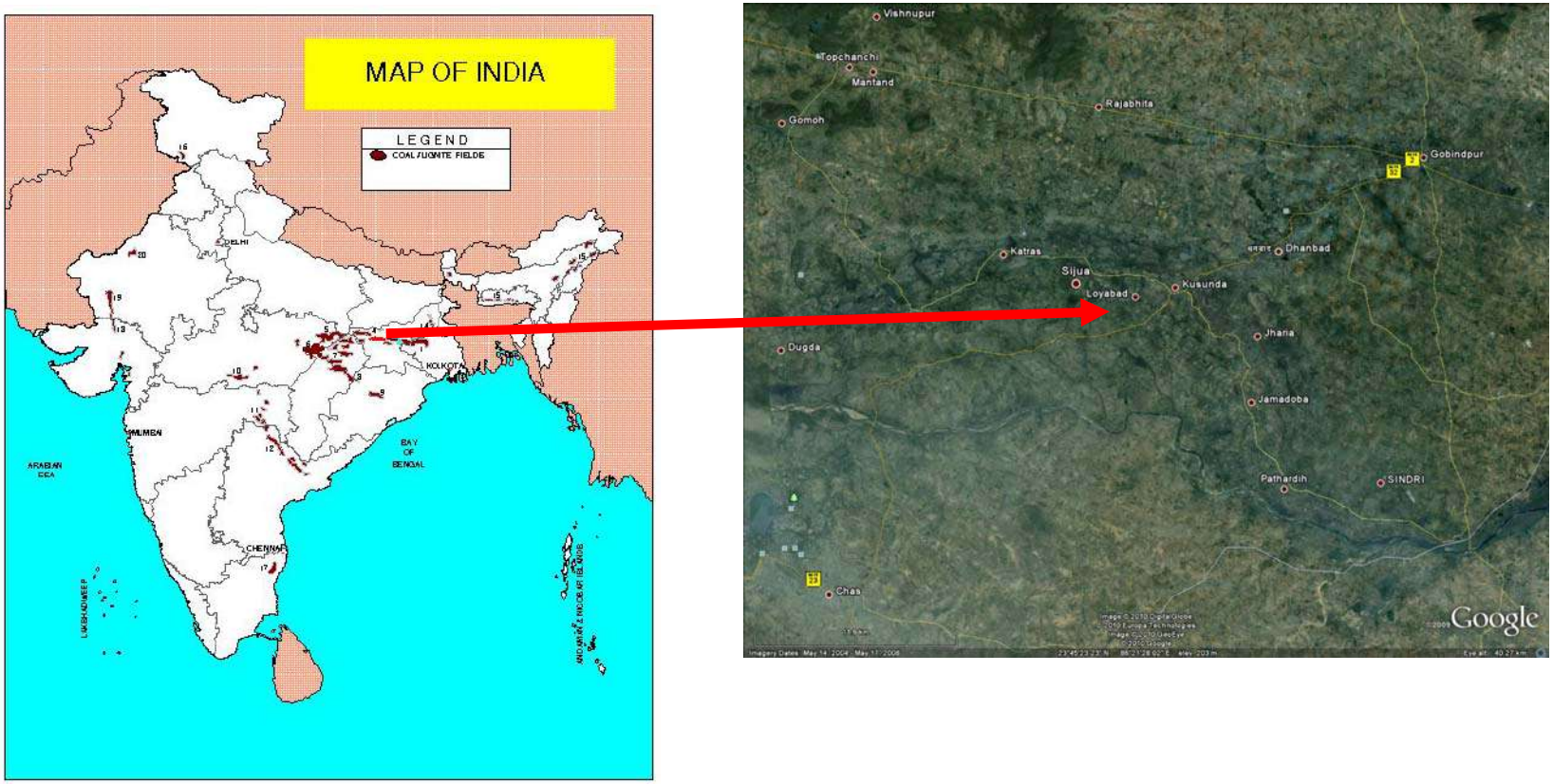


Fig 1.1: Map of India Showing the Location of Jharia Coalfields

Chapter 2

Remote Sensing Concepts and Methodology

2.1 Remote Sensing

Remote sensing is the science and art of obtaining information about an object or area through the analysis of data acquired by a device that is not in physical contact with the object or area under investigation. The term *remote sensing* is commonly restricted to methods that employ electro-magnetic energy (such as light, heat and radio waves) as the means of detecting and measuring object characteristics.

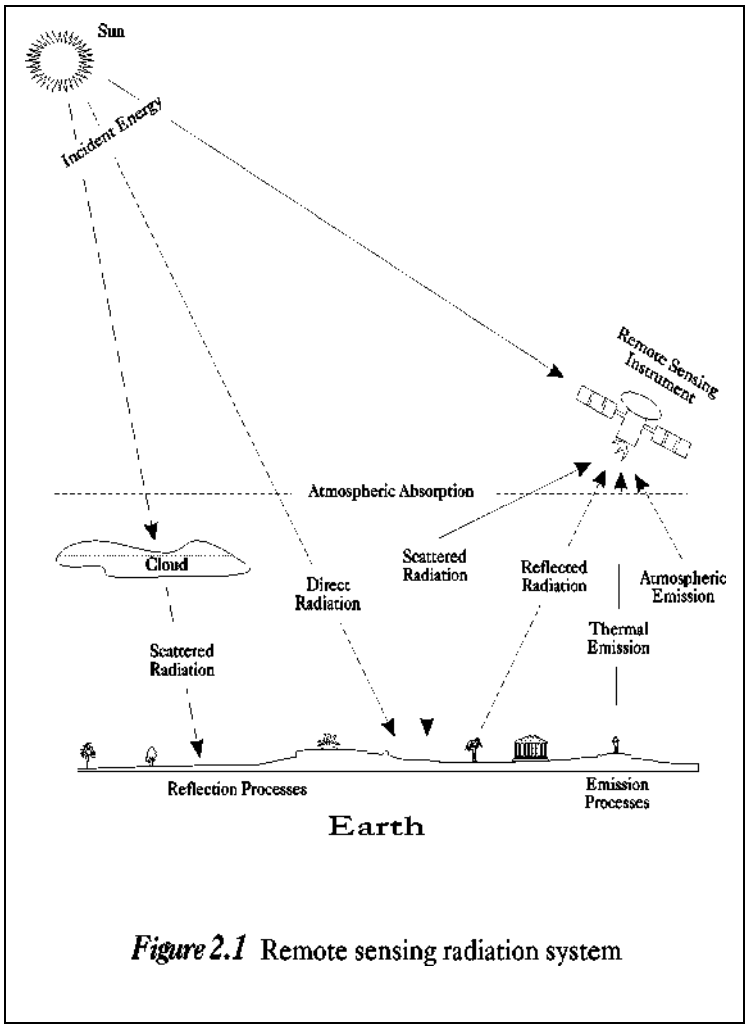


Figure 2.1 Remote sensing radiation system

All physical objects on the earth surface continuously emit electromagnetic radiation because of the oscillations of their atomic particles. Remote sensing is largely concerned with the measurement of electro-magnetic energy from the *SUN*, which is reflected, scattered or emitted by the objects on the surface of the earth. Figure 2.1 schematically illustrate the generalised processes involved in electromagnetic remote sensing of the earth resources.

2.2 Electromagnetic Spectrum

The electromagnetic (EM) spectrum is the continuum of energy that ranges from meters to nanometres in wavelength and travels at the speed of light. Different objects on the earth surface reflect different amounts of energy in various wavelengths of the EM spectrum.

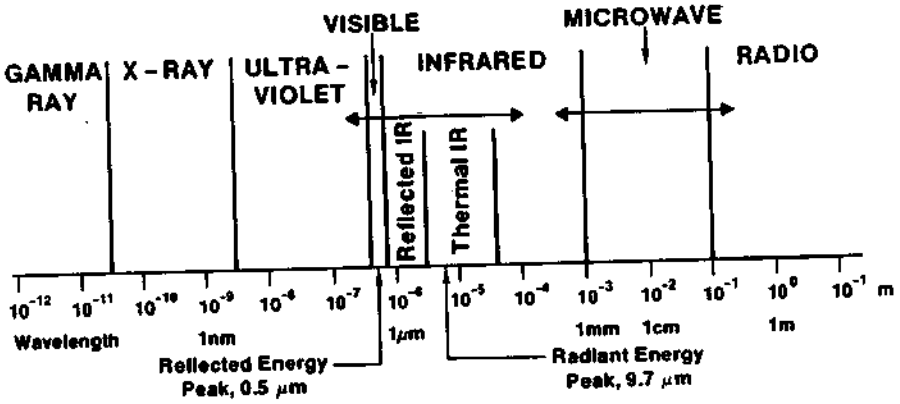


Figure 2.2 Electromagnetic spectrum. Expanded versions of the visible, infrared and microwave regions are shown in Figure 2.3.

Figure 2.2 shows the electromagnetic spectrum, which is divided on the basis of wavelength into different regions that are described in Table 2.1. The EM spectrum ranges from the very short wavelengths of the gamma-ray region to the long wavelengths of the radio region. The visible region (0.4-0.7µm wavelengths) occupies only a small portion of the entire EM spectrum.

Energy reflected from the objects on the surface of the earth is recorded as a function of wavelength. During daytime, the maximum amount of energy is reflected at 0.5µm wavelengths, which corresponds to the green band of the visible region, and is called the *reflected energy peak* (Figure 2.2). The earth also radiates energy both day and night, with the maximum energy 9.7µm wavelength. This *radiant energy peak* occurs in the thermal band of the IR region.

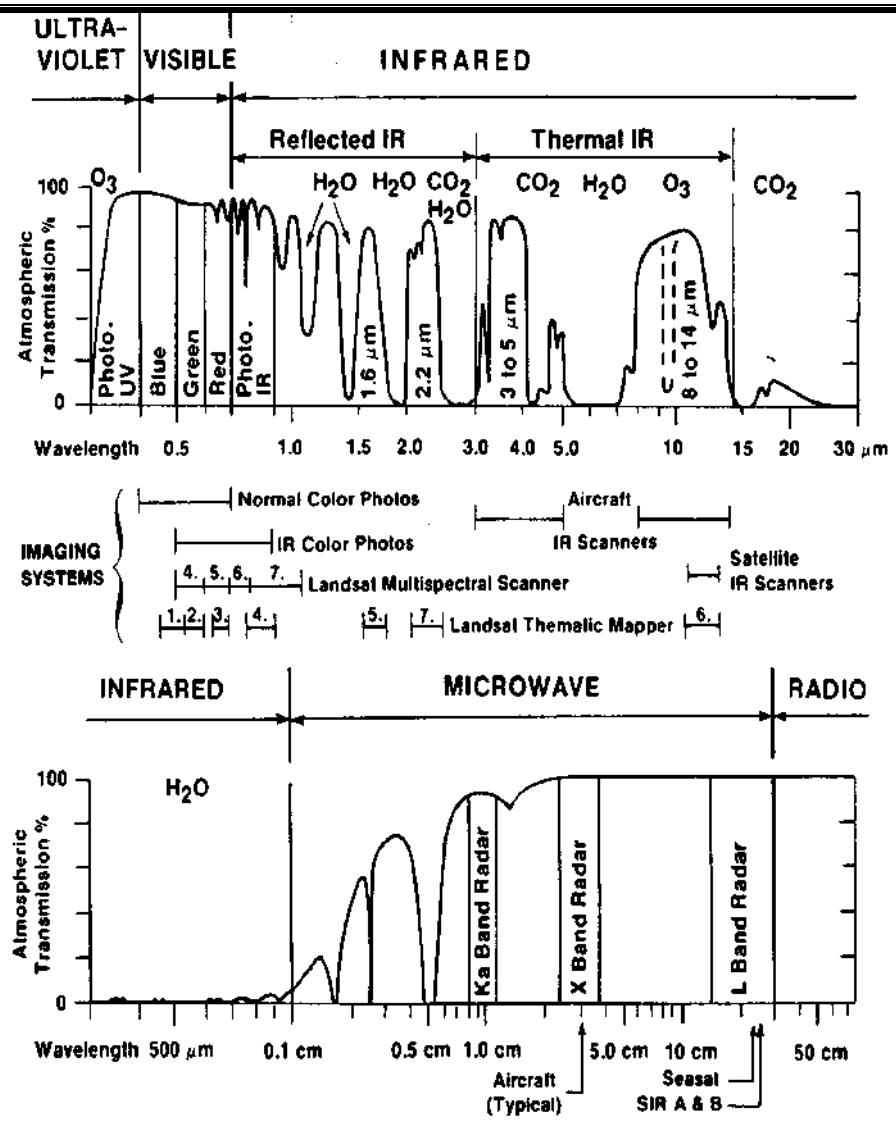


Figure 2.3 Expanded diagrams of the visible and infrared regions (upper) and the microwave regions (lower) showing atmospheric windows. Wavelength bands of commonly used remote sensing systems are indicated. Gases responsible for atmospheric absorption are shown.

Table 2.1 Electromagnetic spectral regions

Region			Wavelength		Remarks
Gamma ray		<	0.03	**nm**	Incoming radiation is completely absorbed by the upper atmosphere and is not available for remote sensing.
X-ray	0.03	to	3.00	**nm**	Completely absorbed by atmosphere. Not employed in remote sensing.
Ultraviolet	0.03	to	0.40	**µm**	Incoming wavelengths less than 0.3mm are completely absorbed by Ozone in the upper atmosphere.
Photographic UV band	0.30	to	0.40	**µm**	Transmitted through atmosphere. Detectable with film and photo detectors, but atmospheric scattering is severe.
Visible	0.40	to	0.70	**µm**	Imaged with film and photo detectors. IBCCLudes reflected energy peak of earth at 0.5mm.
Infrared	0.70	to	100.00	**µm**	Interaction with matter varies with wavelength. Absorption bands separate atmospheric transmission windows.
Reflected IR band	0.70	to	3.00	**µm**	Reflected solar radiation that contains no information about thermal properties of materials. The band from 0.7-0.9mm is detectable with film and is called the *photographic IR band*.
Thermal IR band	3.00	to	5.00	**µm**	Principal atmospheric windows in the thermal region. Images at these wavelengths are acquired by optical-mechanical scanners and special Videocon systems but not by film.
	8.00	to	14.00	**µm**	
Microwave	0.10	to	30.00	**cm**	Longer wavelengths can penetrate clouds, fog and rain. Images may be acquired in the active or passive mode.
Radar	0.10	to	30.00	**cm**	Active form of microwave remote sensing. Radar images are acquired at various wavelength bands.
Radio		>	30.00	**cm**	Longest wavelength portion of electromagnetic spectrum. Some classified radars with very long wavelength operate in this region.

The earth's atmosphere absorbs energy in the gamma-ray, X-ray and most of the ultraviolet (UV) region; therefore, these regions are not used for remote sensing. Details of these regions are shown in Figure 2.3. The horizontal axes show wavelength on a logarithmic scale; the vertical axes show percent atmospheric transmission of EM energy. Wavelength regions with high transmission are called *atmospheric windows* and are used to acquire remote sensing data. The major remote sensing sensors record energy only in the visible, infrared and micro-wave regions. Detection and measurement of the recorded energy enables identification of surface objects (by their characteristic wavelength patterns or spectral signatures), both from air-borne and space-borne platforms.

2.3 Scanning System

The sensing device in a remotely placed platform (aircraft/satellite) records EM radiation using a *scanning system*. In scanning system, a *sensor*, with a narrow field of view is employed; this sweeps across the terrain to produce an image. The sensor receives electromagnetic energy radiated or reflected from the terrain and converts them into signal that is recorded as numerical data. In a remote sensing satellite, multiple arrays of linear sensors are used, with each array recording simultaneously a separate band of EM energy. The array of sensors employs a spectrometer to disperse the incoming energy into a spectrum. Sensors (or *detectors*) are positioned to record specific wavelength bands of energy. The information received by the sensor is suitably manipulated and transported back to the ground receiving station. The data are reconstructed on ground into digital images. The digital image data on *magnetic/optical media* consist of picture elements arranged in regular rows and columns. The position of any picture element, *pixel*, is determined on a x-y co-ordinate system. Each pixel has a numeric value, called digital number (DN), which records the intensity of electromagnetic energy measured for the ground resolution cell represented by that pixel. The range of digital numbers in an image data is controlled by the radiometric resolution of the satellite's sensor system. The digital image data are further processed to produce master images of the study area. By analysing the digital data/imagery, digitally/visually, it is possible to detect, identify and classify various objects and phenomenon on the earth surface.

Remote sensing technique provides an efficient, speedy and cost-effective method for assessing the changes in vegetation cover certain period of time due to its inherited capabilities of being multi-spectral, repetitive and synoptic aerial coverage.

2.4 Data Source

The following data are used in the present study:

- **Primary Data** –Raw satellite data, obtained from National Remote Sensing Centre (NRSC), Hyderabad, as follows, was used as primary data source for the study.

  IRS R2/ L4FMX; Band 2,3,4,5; Path # 106, Row # 055; Date of pass 5.01.2016*.

  The detail specification of the data is also given in Table 2.2.

- **Secondary Data**

  Secondary (ancillary) and ground data constitute important baseline information in remote sensing, as they improve the interpretation accuracy and reliability of remotely sensed data by enabling verification of the interpreted details and by supplementing it with the information that cannot be obtained directly from the remotely sensed data.

2.5 Characteristics of Satellite/Sensor

The basic properties of a satellite's sensor system can be summarised as:

(a) Spectral coverage/resolution, i.e., band locations/width; (b) spectral dimensionality: number of bands; (c) radiometric resolution: quantisation; (d) spatial resolution/instantaneous field of view or IFOV; and (e) temporal resolution. Table 2.2 illustrates the basic properties of IRS-R2 satellite/sensor that is used in the present study.

Table 2.2 Characteristics of the satellite/sensor used in the present project work										
Platform	Sensor	Spectral Bands in µm					Radiometric Resolution	Spatial Resolution	Temporal Resolution	Country
IRS- P-6	LISS-IV	B2 B3 B4 B5	0.52 0.62 0.77 1.55	- - - -	0.59 0.68 0.86 1.70	Green Red NIR MIR	10 bits (7 bits transmitted with DPCM)	5.8m	24 days	India
NIR: Near Infra-Red MIR: Middle Infra-Red										

2.6 Data Processing

The methodology for data processing carried out in the present study is shown in Figure 2.4. The processing involves the following major steps:

(a) Geometric correction, rectification and geo-referencing;

(b) Image enhancement;

(c) Training set selection;

(d) Signature generation and classification;

(e) Creation/overlay of vector database;

(f) Validation of classified image;

(g) Layer wise theme extraction using GIS

(g) Final vegetation map preparation.

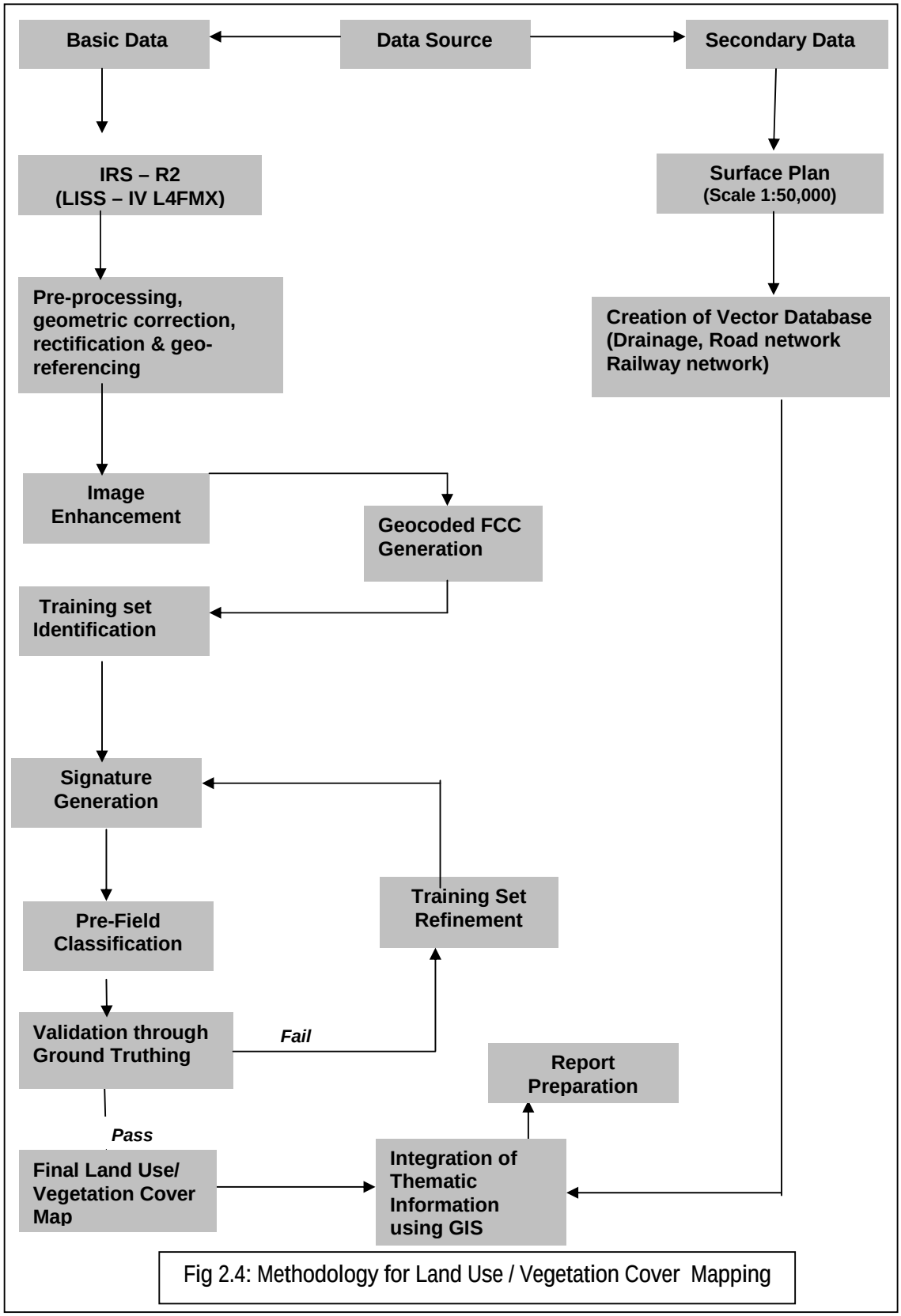


Fig 2.4: Methodology for Land Use / Vegetation Cover Mapping

2.6.1 Geometric correction, rectification and georeferencing

Inaccuracies in digital imagery may occur due to 'systematic errors' attributed to earth curvature and rotation as well as 'non-systematic errors' attributed to intermittent sensor malfunctions, etc. Systematic errors are corrected at the satellite receiving station itself while non-systematic errors/ random errors are corrected in pre-processing stage.

In spite of 'System / Bulk correction' carried out at supplier end; some residual errors in respect of attitude attributes still remains even after correction. Therefore, fine tuning is required for correcting the image geometrically using ground control points (GCP).

Raw digital images contain geometric distortions, which make them unusable as maps. A map is defined as a flat representation of part of the earth's spheroidal surface that should conform to an internationally accepted type of cartographic projection, so that any measurements made on the map will be accurate with those made on the ground. Any map has two basic characteristics: (a) scale and (b) projection. While *scale* is the ratio between reduced depiction of geographical features on a map and the geographical features in the real world, *projection* is the method of transforming map information from a sphere (round Earth) to a flat (map) sheet. Therefore, it is essential to transform the digital image data from a generic co-ordinate system (i.e. from line and pixel co-ordinates) to a projected co-ordinate system. In the present study geo-referencing was done with the help of Survey of India (SoI) topo-sheets so that information from various sources can be compared and integrated on a GIS platform, if required.

An understanding of the basics of projection system is required before selecting any transformation model. While maps are flat surfaces, Earth however is an irregular sphere, slightly flattened at the poles and bulging at the Equator. Map projections are systemic methods for "*flattening the orange peel*" in measurable ways. When transferring the Earth and its irregularities onto the plane surface of a map, the following three factors are involved: (a) geoid (b) ellipsoid and (c) projection. Figure 2.5 illustrates the relationship between these three factors. The *geoid* is the rendition of the irregular spheroidal shape of the Earth; here the variations in gravity are taken into account. The observation made on the geoid is then transferred to a regular geometric reference surface, the *ellipsoid*. Finally, the geographical relationships of the ellipsoid (in 3-D form) are transformed into the 2-D plane of a map by a transformation process called map projection. As shown in Figure 2.5, the vast majority of projections are based upon *cones*, *cylinders* and *planes*.

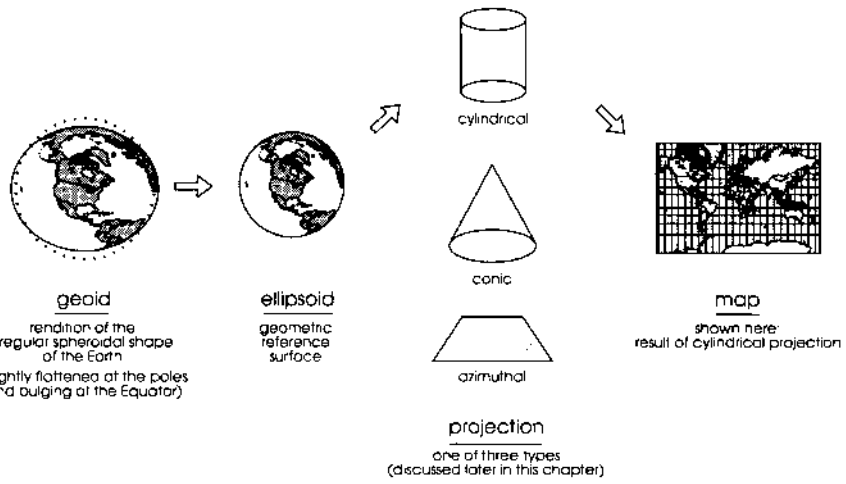


Fig 2.5 : Geoid – Ellipsoid – Projection Relationship

In the present study, ***UTM projection*** *along with* ***WGS 84 model*** was used so as to prepare the map compatible with the SoI topo-sheets**.** UTM projection is used in SoI topo-sheets as it is best suited for small-scale mapping and larger area as well as for areas with North-South orientation (viz. India). Maps prepared using this projection is a compromise of many properties; it is neither conformal perspective nor equal area. Distances, areas and shapes are true only along central meridian. Distortion increases away from central meridian. Image transformation from generic co-ordinate system to a projected co-ordinate system was carried out using ERDAS Imagine 2014 digital image processing system.

2.6.2 Image enhancement

To improve the interpretability of the raw data, image enhancement is necessary. Most of the digital image enhancement techniques are categorised as either point or local operations. Point operations modify the value of each pixel in the image data independently. However, local operations modify the value of each pixel based on brightness value of neighbouring pixels. Contrast manipulations/stretching technique based on local operation were applied on the image data using ERDAS Imagine 2014 s/w. The enhanced and geocoded FCC (False colour composite) image of Jharia Coalfield is shown in Plate No. 1 for the year 2013.

2.6.3 Training set selection

The image data were analysed based on the interpretation keys. These keys are evolved from certain fundamental image-elements such as tone/colour, size, shape, texture, pattern, location, association and shadow. Based on the image-elements and other geo-technical elements like land form, drainage pattern and physiography; training sets were selected/ identified for each land use/cover class. Field survey was carried out by taking selective traverses in order to collect the ground information (or reference data) so that training sets are

selected accurately in the image. This was intended to serve as an aid for classification. Based on the variability of land use/cover condition and terrain characteristics and accessibility, 90 points were selected to generate the training sets.

2.6.4 Signature generation and classification

Image classification was carried out using the minimum distance algorithm. The classification proceeds through the following steps: (a) calculation of statistics [i.e. signature generation] for the identified training areas, and (b) the decision boundary of maximum probability based on the mean vector, variance, covariance and correlation matrix of the pixels.

After evaluating the statistical parameters of the training sets, reliability test of training sets was conducted by measuring the statistical separation between the classes that resulted from computing divergence matrix. The overall accuracy of the classification was finally assessed with reference to ground truth data. The aerial extent of each land use class in the coalfield was determined using ERDAS Imagine 2014 s/w. The classified image for the year 2016 for Jharia Coalfield is shown in Drawing No. HQREMA10002.

2.6.5 Creation /overlay of vector database in GIS

Plan showing leasehold areas of mining projects supplied by BCCL are superimposed on the image as vector layer in the GIS database. Road network, rail network and drainage network are digitised on different vector layers in GIS database. Layer wise theme extraction was carried out using Arc GIS s/w and imported the same on GIS platform for further analysis.

2.6.6 Validation of classified image

Ground truth survey was carried out for validation of the interpreted results from the study area. Based on the validation, classification accuracy matrix was prepared.

The overall classification accuracy was found to be 88.59%.

2.6.7 Interpretation of Data

Interpretation of data for Land Use/vegetation cover was carried out through GIS by analysing the Land Use/ vegetation Cover map of the year 2016. Final Land Use/vegetation cover maps (on 1:50,000 scale) were printed using HP Design jet 4500 Colour Plotter.

Chapter 3

Land Use/ Vegetation Cover Monitoring

3.1 Introduction

Land is one of the most important natural resource on which all human activities are based. Therefore, knowledge on different type of lands as well as its spatial distribution in the form of map and statistical data is vital for its geospatial planning and management for optimal use of the land resources. In mining industry, the need for information on land use/ vegetation cover pattern has gained importance due to the all-round concern on environmental impact of mining. The information on land use/vegetation cover inventory that includes type, spatial distribution, aerial extent, location, rate and pattern of change of each category is of paramount importance for assessing the impact of coal mining on land use/ cover.

Remote sensing data with its various spectral and spatial resolution offers comprehensive and accurate information for mapping and monitoring of land use/cover pattern, dynamics of changing pattern and trends over a period of time.. By analysing the data of different cut-off dates, impact of coal mining on land use and vegetation cover can be determined.

3.2 Land Use / Vegetation Cover Classification

The array of information available on land use/cover requires be arranging or grouping under a suitable framework in order to facilitate the creation of database. Further, to accommodate the changing land use/vegetation cover pattern, it becomes essential to develop a standardised classification system that is not only

flexible in nomenclature and definition, but also capable of incorporating information obtained from the satellite data and other different sources.

The present framework of land use/cover classification has been primarily based on the '***Manual of Nationwide Land Use/ Land Cover Mapping Using Satellite Imagery***' developed by National Remote Sensing Agency, Hyderabad, which has further been modified by CMPDI for coal mining areas. Land use/vegetation cover map was prepared on the basis of image interpretation carried out based on the satellite data for the year 2016. Following land use/cover classes are identified in the Jharia coalfield region (Table 3.1).

Table 3.1
Land use / Vegetation Cover classes identified in Jharia Coalfield

	LEVEL –I	LEVEL-II
1	Vegetation Cover	3.1 Dense Forest 3.2 Open Forest 3.3 Scrub 3.4 Plantation under Social Forestry 3.5 Plantation on OB Dumps
2	Mining Area	5.1 Coal Quarry 5.2 Barren OB Dump 5.3 Area Under Backfilling 5.4 Coal Dump 5.5 Water Filled Quarry
3	Agricultural Land	2.1 Crop Land 2.2 Fallow Land
4	Wasteland	4.1 Waste upland with/without scrubs 4.2 Slurry Pond 4.3 Sand Body
5	Settlements	1.1 Urban 1.2 Rural 1.3 Industrial
6	Water Bodies	6.1 River/Streams /Reservoir

3.3 Data Analysis of Jharia Coalfiled

Satellite data of the year 2016 was processed using ERDAS Imagine v.2014 image processing s/w in order to interpret the various land use and vegetation cover classes present in the Jharia coalfield. The analysis was carried out for entire coalfield covering about 393 sq. km.

The area of each class was calculated and analysed using *ERDAS Digital Image Processing* s/w and *ArcGIS* s/w. Analysis of land use / vegetation cover pattern in Jharia Coalfield in the year 2016 has been done and details are and shown in table 3.2.

TABLE – 3.2: STATUS OF LAND USE/COVER PATTERN IN JHARIA COALFIELD DURING YEAR 2013 & 2016

LAND USE CLASSES	Year 2013		Year 2016		Change		Reasons for change
SETTLEMENTS	**Area (Km^2)**	**%**	**Area (Km^2)**	**%**	**Area (Km^2)**	**%**	
Urban Settlement	35.05	8.92	35.05	8.92	0.00	0.00	No change
Rural Settlement	3.17	0.81	3.74	0.95	0.57	0.15	Migration of population to mining areas
Industrial Settlement	3.35	0.85	2.29	0.58	-1.06	-0.27	Dismantling of some industrial structures, eg Lodna Washery
Total Settlements	**41.57**	**10.58**	**41.08**	**10.46**	**-0.49**	**-0.12**	
VEGETATION COVER							
FORESTS							
Dense Forest	0.29	0.07	0.29	0.07	0.00	0.00	No Change
Open Forest	8.51	2.16	6.27	1.60	-2.24	-0.56	Minor decrease due to deforestation
Total Forest (A)	**8.8**	**2.23**	**6.56**	**1.67**	**-2.24**	**-0.56**	
SCRUBS							
Scrubs (B)	**122.5**	**31.2**	**105.87**	**26.95**	**-16.63**	**-4.25**	Coversion of UG mines into OC mines, Land with scrubs were used
PLANTATION							
Social forestry	19.41	4.94	19.52	4.97	0.11	0.03	Increase in plantation along roads, creation of ecological resoration parks
Plantation on OB Dump	11.94	3.04	8.59	2.19	-3.35	-0.85	Decrese due to increase in mining activity & conversion of UG mines into OC mines
Total Plantation (C)	**31.35**	**7.98**	**28.11**	7.16	-3.24	-0.82	
Total Vegetation (A+B+C)	**162.65**	**41.4**	**140.54**	**35.77**	**-22.11**	**-5.63**	
MINING AREA							
Coal Quarry	6.98	1.78	11.36	2.89	4.38	1.11	Increase in mining activity
Coal Dump	1.3	0.33	0.23	0.06	-1.07	-0.27	Places where coal dumps were obeserved have been shifted
Quarry filled with water	0.25	0.06	0.77	0.20	0.52	0.13	Minor change in places with water filled quarries
Barren OB Dump	19.06	4.85	12.55	3.19	-6.51	-1.66	Some area under small OB dumps coming under new amalgamated projects
Area Under Backfilling	7.36	1.87	15.62	3.98	8.26	2.10	Due to increase in excavation due to opencast mining activities
Toal Mining Area	**35.22**	**8.97**	**40.53**	**10.32**	**5.31**	**1.35**	
AGRICULTURE							
Crop Lands	3.94	1	3.71	0.94	-0.23	-0.06	Derease due to crop land being converted into fallow land
Fallow Lands	35.85	9.13	40.68	10.36	4.83	1.23	Conversion of scrub land into fallow land
Total Agriculture	**39.79**	**10.13**	**44.39**	**11.30**	**4.60**	**1.17**	
WASTELANDS							
Wastelands	100.05	25.47	113.97	29.01	13.92	3.54	Scrubland converted to wasteland
Ash pond/Slurry/ Tailing Ponds	0.26	0.07	0	0.00	-0.26	-0.07	
Sand Body	1.53	0.39	4.85	1.23	3.32	0.85	Temporal change over period
Total Wastelands	**101.84**	**25.92**	**118.82**	**30.25**	**16.98**	**4.32**	
WATERBODIES							
River, Lakes, Nallas, ponds, etc	11.78	3	7.48	1.90	-4.30	-1.09	Temporal change over period
TOTAL	**392.85**	**100**	**392.85**	**100.00**	**0.00**	**0.00**	

3.3.1 Vegetation Cover

Vegetation cover in the coalfield area comprises following five classes:

- Dense Forest
- Open Forest
- Scrubs
- Plantation on Over Burden(OB) Dumps / Backfilled area, and
- Social Forestry

There has been significant variation in the land use under the vegetation classes within the area as shown below in Table 3.3.

TABLE – 3.3

Status of change in Vegetation Cover in Jharia Coalfield during the year 2013 & 2016

VEGETATION COVER	Year 2013		Year 2016		Change	
FORESTS	Area (sq Km)	%	Area (sq Km)	%	Area (sq Km)	%
Dense Forest	0.29	0.07	0.29	0.07	0.00	0.00
Open Forest	8.51	2.16	6.27	1.60	-2.24	-0.56
Total Forest (A)	**8.80**	**2.23**	**6.56**	**1.67**	**-2.24**	**-0.56**
SCRUBS						
Scrubs (B)	**122.50**	**31.20**	**105.87**	**26.95**	**-16.63**	**-4.25**
PLANTATION						
Social forestry	19.41	4.94	19.52	4.97	0.11	0.03
Plantation on OB Dump	11.94	3.04	8.59	2.19	-3.35	-0.85
Total Plantation (C)	**31.35**	**7.98**	**28.11**	7.16	-3.24	-0.82
Total Vegetation (A+B+C)	**162.65**	**41.40**	**140.54**	**35.78**	**-22.11**	**-5.63**

Dense forest – Forest having crown density of above 40% comes in this class. Dense forest over the area is same as in year 2013.. A total dense forest is estimated to be 0.29

sq km, i.e. 0.07% of the coalfield area. The area of the dense forest within the coalfield has remained same since 2013.

Open Forest – Forest having crown density between 10% to 40% comes under this class. Open forest cover over Jharia coalfield which was estimated to be 8.51 sq km (2,16%) in 2013 has marginally decreased to 6.27 sq km, i.e. 1.60 % of the coalfield area. Thus the area reduced is 2.24 sq km which is 0.56 % of the total coalfield area. This reduction is due to deforestation by local inhabitants.

Scrubs – Scrubs are vegetation with crown density less than 10%. Scrubs in the coalfield are seen to be scattered signature all over the area mixed with wastelands. There is 105.87 sq km, of scrubs, ie 26.95% of the coalfield area. In year 2013 the scrubs covered 122.50 sq km which were 31.20% of the coalfield area. There is a decrease of 16.63 sq km which is 4.25% of the coalfield area .The decrease is due to increase in mining areas and conversion of underground mine into open cast ones & also increase in agricultural land & waste land.

Social Forestry – Plantation which has been carried out on wastelands, along the roadsides and colonies on green belt come under this category. Analysis of data reveals Social Forestry covers 19.52 sq km, which is 4.97% of the coalfield area. In 2013 the area covered under social forestry was 19.41 sq km (4.94%) . there is an increase of 0.11 sq km (0.03%). This increase is due to creation of some ecological restoration sites.

Plantation over OB Dump and backfilled area – Analysis of the data reveals that BCCL has carried out significant plantation on OB dumps as well as backfilled areas during the period for maintaining the ecological balance of the area. The plantation on the OB dumps and backfilled areas are estimated to be 8.59 sq km, i.e. 2.19% of the coalfield area. In year 2013 the plantation on OB Dumps were estimated to cover an area of 11.94 sq km which was 3.04% of the coalfield area. There is a decrease of 3.35 sq km (0.85%) in plantation over OB dumps. This is due to increase in mining activity & conversion of UG mines into OC mines.

3.3.2 Mining Area

The mining area was primarily been categorized as.

- Coal Quarry
- Barren OB Dump

To make the study more relevant and to give thrust on land reclamation, in the current study some more classes have been added as follows:

- Barren Backfilled Area
- Coal Dumps
- Water filled Quarry

The overall area where mining operations are being carried out has increased significantly by 5.31 sq km which is 1.35% of the total area. In the year 2013 this area was estimated to be 35.22 sq km (8.97%) which has increased to 40.53 sq km (10.32%) in the year 2016. This increase is due to increase in production of coal from Open cast areas. The status of land Use in the mining area over the Jharia Coalfield is shown in the table 3.4 below.

TABLE – 3.4

Status of change in Mining Area in Jharia Coalfield during the year 2013 & 2016

	2013		2016		Change	
MINING AREA	**Area (Sq km)**	**%**	**Area (Sq km)**	**%**	**Area (Sq km)**	**%**
Coal Quarry	6.98	1.78	11.36	2.89	4.38	1.11
Coal Dump	1.30	0.33	0.23	0.06	-1.07	-0.27
Quarry filled with water	0.25	0.06	0.77	0.20	0.52	0.14
Barren OB Dump	19.06	4.85	12.55	3.20	-6.51	-1.65
Area Under Backfilling	7.36	1.87	15.62	3.97	8.26	2.10
Total Mining Area	**35.22**	**8.97**	**40.53**	**10.32**	**5.31**	**1.35**

3.3.3 Agricultural Land

Land primarily used for farming and production of food, fibre and other commercial and horticultural crops falls under this category. It includes crop land (irrigated and unirrigated) and fallow land (land used for cultivation, but temporarily allowed to rest)

Total agricultural land is 44.39 sq km in year 2016, which is 11.31 % of the coalfield area.. in year 2013 the total agricultural area was estimated to be 39.79 sq km which was 10.12% of the coalfield area. There is an increase on 4.60 sq km which is 1.19% of the coalfield area. The details are shown below in Table 3.5**.**

TABLE – 3.5

Status of change in Agricultural land in Jharia Coalfield during the year 2013 & 2016

	2013		2016		Change	
AGRICULTURE	**Area (Sq km)**	**%**	**Area (Sq km)**	**%**	**Area (Sq km)**	**%**
Crop Lands	3.94	1.00	3.71	0.95	-0.23	-0.05
Fallow Lands	35.85	9.12	40.68	10.36	4.83	1.24
Total Agriculture	**39.79**	**10.12**	**44.39**	**11.31**	4.60	1.19

3.3.4 Wasteland

Wasteland is degraded and unutilised class of land which is deteriorating on account of natural causes or due to lack of appropriate water and soil management. Wasteland can result from inherent/imposed constraints such as location, environment, chemical and physical properties of the soil or financial or management constraints. There are two types of wastelands predominant within the coalfield area, viz waste upland and fly ash pond.

The land use pattern within the area for waste lands is shown below in Table – 3.6. The waste land was estimated to be 101.84 sq km (25.93%) in the year 2013. This has increased by 16.98 sq km (4.32%) to 118.82 sq km (30.24%) over the 3 year period because some scrubland has been converted to wasteland.

TABLE – 3.6

Status of Change in Wastelands in Jharia Coalfield during the year 2013 & 2016

	2013		2016		Change	
WASTELANDS	**Area (Sq km)**	**%**	**Area (Sq km)**	**%**	**Area (Sq km)**	**%**
Wastelands	100.05	25.47	113.97	29.01	13.92	3.54
Ash pond/Slurry/ Tailing Ponds	0.26	0.07	0.00	0.00	-0.26	-0.07
Sand Body	1.53	0.39	4.85	1.23	3.32	0.85
Total Wastelands	**101.84**	**25.93**	**118.82**	**30.24**	16.98	4.32

3.3.5 Settlements

All the man-made constructions covering the land surface are included under this category. Built-up land has been further divided in to rural, urban and industrial classes. In the present study, industrial settlement indicates only industrial complexes excluding residential facilities. In the year 2013 the total area covered by settlements were estimated to be 41.57 sq km (10.58%). In year 2016 the estimated area under settlements has grown to 41.08 sq km (10.45%). There is a decrease in settlements by 0.49 sq km which is about 0.12% of the total area. This decrease is due to decrease in industrial settlement which may be due to dismantling of some establishments.

The details of the land use under this category are shown in Table 3.7 as follows:

TABLE 3.7

Status of Change in Settlements in Jharia Coalfield during the year 2013 & 2016

	2013		2016		Change	
SETTLEMENTS	Area (Sq km)	%	Area (Sq km)	%	Area (Sq km)	%
Urban Settlement	35.05	8.92	35.05	8.92	0.00	0.00
Rural Settlement	3.17	0.81	3.74	0.95	0.57	0.15
Industrial Settlement	3.35	0.85	2.29	0.58	-1.06	-0.27
Total Settlements	**41.57**	**10.58**	**41.08**	**10.45**	-0.49	-0.12

3.3.6 Water bodies

It is the area of impounded water includes natural lakes, rivers/streams and man made canal, reservoirs, tanks etc**.** The water bodies in the study area have found to be 11.78 sq km in year 2013, which is 3.00% of the coalfield area. In 2016 there is a reduction in the area of water bodies 4.30 sq km (1.10%) of the total area.

3.4 Data Analysis of clusters under Jharia Coalfield

Land use and vegetation cover classes present in each cluster (Cluster I to Cluster XV) falling under the Jharia coalfield has also been prepared. The map of each cluster is included in this report under pages 31 to 45. Each map contains the area statistics of Land use/cover classes present in them. The cluster wise Land Use/Cover statistics for cluster I to cluster XV falling under Jharia Coalfield is given under Table 3.8.

Table-3.8

(Area in Hectare)

		CLUSTER I		CLUSTER II		CLUSTER III		CLUSTER IV		CLUSTER V		CLUSTER VI		CLUSTER VII		CLUSTER VIII		CLUSTER IX		CLUSTER X		CLUSTER XI		CLUSTER XII		CLUSTER XIII		CLUSTER XIV		CLUSTER XV		TOTAL	
		Area	%	Area	%	Area	%	Area	%																					Area	%	Area	%
FORESTS	Dense Forest	14.56	2.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.56	0.06
	Open Forest	15.11	2.43	0.00	0.00	32.73	2.11	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.02	0.00	0.00	0.00	0.00	65.50	3.16	0.00	0.00	0.00	0.00	172.73	9.23	0.00	0.00	63.05	3.46	349.50	1.38
	Total Forest	29.67	4.77	0.00	0.00	32.73	2.11	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.02	0.00	0.00	0.00	0.00	65.50	3.16	0.00	0.00	0.00	0.00	172.73	9.23	0.00	0.00	63.05	3.46	364.06	1.44
SCRUBS	Scrubs	182.00	29.24	233.14	10.31	274.77	17.70	87.26	7.04	237.06	13.74	63.71	7.66	301.39	14.59	117.43	8.82	275.34	14.00	482.12	23.25	1470.72	40.79	256.27	29.60	583.41	31.19	494.37	34.86	610.87	33.58	5669.86	22.45
PLANTATION	Social Forestry	16.60	2.67	150.07	6.64	110.03	7.09	82.10	6.62	60.01	3.48	33.83	4.07	99.35	4.81	12.99	0.97	163.31	8.30	136.29	6.57	269.08	7.46	24.30	2.81	125.11	6.69	54.94	3.87	138.17	7.59	1476.18	5.85
	Plantation on OB Dump	47.32	7.60	105.98	4.69	23.17	1.49	38.25	3.08	20.80	1.21	21.03	2.53	20.08	0.97	23.80	1.79	30.68	1.56	92.78	4.47	0.12	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	424.01	1.68
	Plantation on Backfill	10.65	1.71	81.89	3.62	12.96	0.83	0.01	0.00	30.64	1.78	31.36	3.77	60.62	2.93	33.98	2.55	57.92	2.94	44.31	2.14	1.18	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	365.52	1.45
	Total Plantation *(Biological Reclamation)*	74.57	11.98	337.94	14.95	146.16	9.41	120.36	9.70	111.45	6.47	86.22	10.37	180.05	8.71	70.77	5.31	251.91	12.80	273.38	13.18	270.38	7.50	24.30	2.81	125.11	6.69	54.94	3.87	138.17	7.59	2265.71	8.97
	Total Vegetation	286.24	45.99	571.08	25.26	453.66	29.22	207.62	16.74	348.51	20.21	149.93	18.03	481.82	23.32	188.20	14.13	527.25	26.80	821.00	39.59	1741.10	48.29	280.57	32.41	881.25	47.11	549.31	38.73	812.09	44.63	8299.63	32.87
ACTIVE MINING	Coal Quarry	11.60	1.86	148.85	6.58	82.36	5.30	178.26	14.37	117.63	6.82	57.63	6.93	86.60	4.19	180.71	13.57	112.86	5.74	31.34	1.51	34.83	0.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1042.67	4.13
	Coal Face	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Coal Dump	0.00	0.00	9.32	0.41	1.94	0.13	0.62	0.05	1.03	0.06	0.65	0.08	2.99	0.14	3.13	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19.68	0.08
	Advance Quarry Site	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Quarry Filled With Water	7.30	1.17	20.45	0.91	13.26	0.85	0.00	0.00	8.62	0.50	1.18	0.14	4.13	0.20	0.70	0.05	4.82	0.25	3.68	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	64.14	0.25
	Total Area under *Active Mining*	18.90	3.03	178.62	7.90	97.56	6.28	178.88	14.42	127.28	7.38	59.46	7.15	93.72	4.53	184.54	13.85	117.68	5.99	35.02	1.69	34.83	0.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1126.49	4.46
RECLAIMED	Barren OB Dump	16.32	2.62	194.48	8.60	93.67	6.03	181.14	14.61	150.31	8.72	64.88	7.80	81.38	3.94	112.23	8.42	135.88	6.91	94.20	4.54	18.22	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1142.71	4.53
	Area Under Backfilling	28.54	4.58	393.74	17.42	77.77	5.01	66.69	5.38	181.89	10.55	99.13	11.92	312.89	15.15	162.24	12.18	106.51	5.41	107.49	5.18	18.20	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1555.09	6.16
	Total Area under *Technical Reclamation*	44.86	7.20	588.22	26.02	171.44	11.04	247.83	19.99	332.20	19.27	164.01	19.72	394.27	19.09	274.47	20.60	242.39	12.32	201.69	9.72	36.42	1.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2697.80	10.68
	Total Area under Mine Operation	63.76	10.23	766.84	33.92	269.00	17.32	426.71	34.41	459.48	26.65	223.47	26.87	487.99	23.62	459.01	34.45	360.07	18.31	236.71	11.41	71.25	1.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3824.29	15.15
WASTELAND	Waste Lands	133.62	21.47	624.95	27.65	503.68	32.44	350.38	28.25	585.22	33.93	318.55	38.29	528.08	25.56	415.58	31.20	683.07	34.72	404.11	19.48	917.12	25.44	275.00	31.76	705.27	37.71	504.15	35.55	640.16	35.19	7588.94	30.05
	Sand Body	10.66	1.71	4.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.55	4.85	7.03	0.19	0.00	0.00	22.18	1.18	42.35	2.99	0.00	0.00	186.77	0.74
	Total Wasteland	144.28	23.18	628.95	27.83	503.68	32.44	350.38	28.25	585.22	33.93	318.55	38.29	528.08	25.56	415.58	31.20	683.07	34.72	504.66	24.33	924.15	25.63	275.00	31.76	727.45	38.89	546.50	38.54	640.16	35.19	7775.71	30.79
WATERBODIES	Reservoir, nallah, ponds	14.75	2.37	20.39	0.90	14.71	0.95	8.82	0.71	5.45	0.32	8.97	1.08	13.55	0.66	8.11	0.61	16.01	0.81	126.31	6.09	33.20	0.92	19.37	2.24	25.94	1.39	18.24	1.29	19.94	1.09	353.76	1.40
	Total Waterbodies	14.75	2.37	20.39	0.90	14.71	0.95	8.82	0.71	5.45	0.32	8.97	1.08	13.55	0.66	8.11	0.61	16.01	0.81	126.31	6.09	33.20	0.92	19.37	2.24	25.94	1.39	18.24	1.29	19.94	1.09	353.76	1.40
AGRICULTURE	Crop Lands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.88	0.40	0.00	0.00	39.16	1.89	16.12	1.21	0.31	0.02	19.11	0.92	94.10	2.61	2.90	0.33	60.45	3.23	6.88	0.48	6.51	0.36	252.42	1.00
	Fallow Lands	91.85	14.76	77.09	3.41	58.05	3.74	53.69	4.33	40.02	2.32	1.02	0.12	20.38	0.99	65.11	4.89	42.59	2.16	62.64	3.02	323.90	8.98	254.61	29.40	93.18	4.98	224.53	15.83	211.56	11.63	1620.22	6.42
	Total Agriculture	91.85	14.76	77.09	3.41	58.05	3.74	53.69	4.33	46.90	2.72	1.02	0.12	59.54	2.88	81.23	6.10	42.90	2.18	81.75	3.94	418.00	11.59	257.51	29.73	153.63	8.21	231.41	16.31	218.07	11.99	1872.64	7.42
SETTLEMENTS	Urban Settlement	0.00	0.00	163.66	7.24	243.23	15.67	192.99	15.56	269.93	15.65	113.08	13.59	475.46	23.02	169.76	12.75	332.56	16.91	243.91	11.76	375.11	10.40	23.83	2.75	26.10	1.40	0.00	0.00	83.80	4.61	2713.42	10.75
	Rural Settlement	20.73	3.33	24.84	1.10	8.33	0.54	0.00	0.00	0.00	0.00	0.00	0.00	1.35	0.07	0.00	0.00	0.00	0.00	41.47	2.00	12.11	0.34	9.64	1.11	54.28	2.90	72.37	5.10	42.38	2.33	287.50	1.14
	Industrial Settlement	0.87	0.14	7.69	0.34	1.87	0.12	0.00	0.00	9.03	0.52	16.81	2.02	17.90	0.87	10.06	0.76	5.36	0.27	18.27	0.88	30.76	0.85	0.00	0.00	1.82	0.10	0.42	0.03	2.86	0.16	123.72	0.49
	Total Settlement	21.60	3.47	196.19	8.68	253.43	16.33	192.99	15.56	278.96	16.17	129.89	15.61	494.71	23.96	179.82	13.51	337.92	17.18	303.65	14.64	417.98	11.59	33.47	3.86	82.20	4.40	72.79	5.13	129.04	7.10	3124.64	12.37
	Grand Total	622.48	100.00	2260.54	100.00	1552.53	100.00	1240.21	100.00	1724.52	100.00	831.83	100.00	2065.69	100.00	1331.95	100.00	1967.22	100.00	2074.08	100.00	3605.68	100.00	865.92	100.00	1870.47	100.00	1418.25	100.00	1819.30	100.00	25250.67	100.00

Chapter 4

Conclusion & Recommendations

4.1 Conclusion

In the present study, land use/ vegetation cover mapping has been carried out based on IRS-R2/ L4FMX satellite data of January, 2016 in order to monitor the impact of coal mining on land environment which may helps in formulating the mitigation measures required, if any.

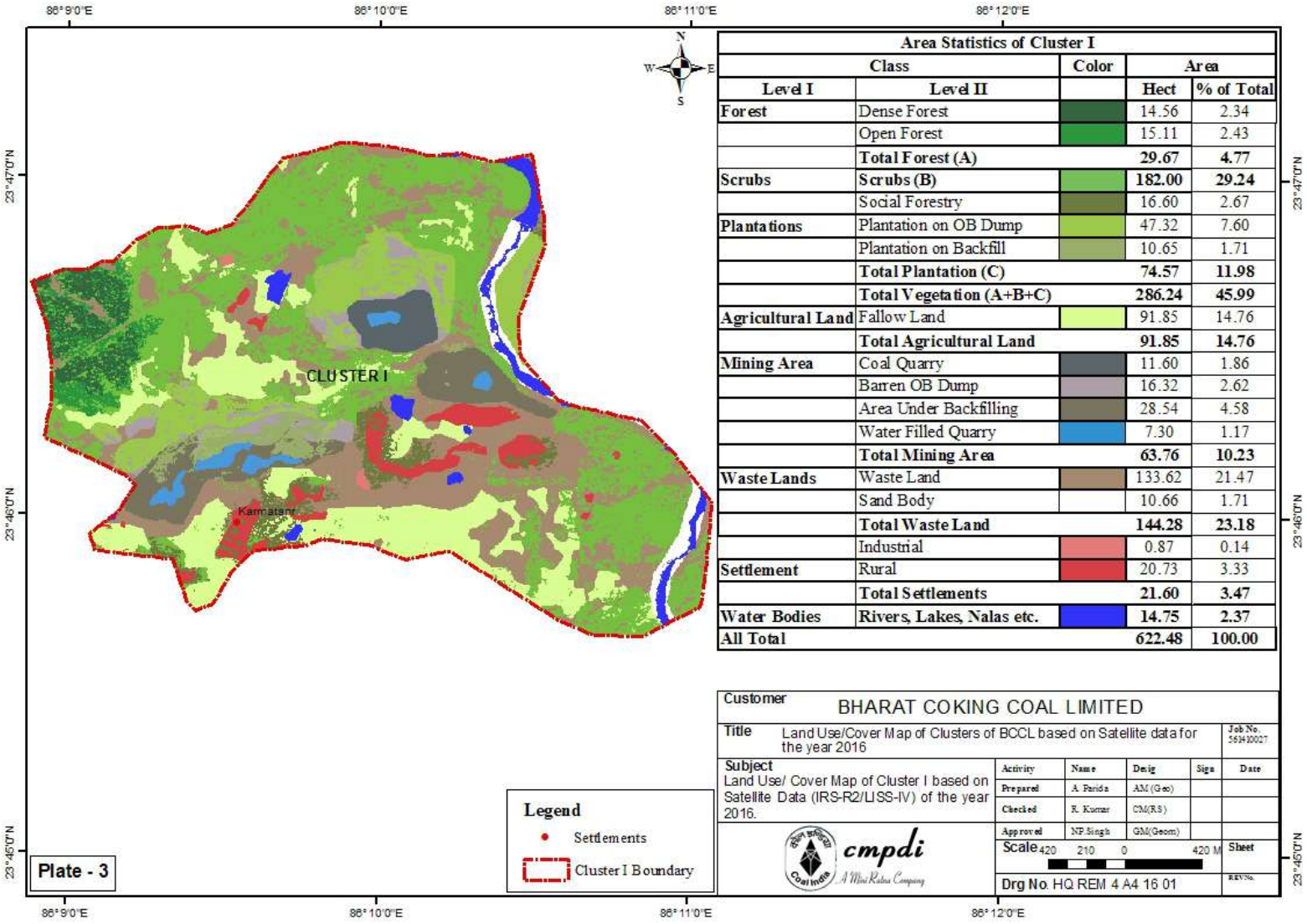
Study reveals that the total area of settlements which includes urban, rural and industrial settlements in the Jharia coalfields covers 41.08 km^2 (10.45%) area. There is a decrease in settlements by 0.49 sq km over the 2013 study primarily because dismantling of some industrial establishments. Vegetation cover which includes dense forests, open forests, scrubs, avenue plantation & plantation on over-burden dumps, covers an area of 140.54 km^2 (35.78%). As compared to 2013 study there is a decrease in overall vegetation cover by 22.11 sq km (5.62%) this is mainly because there is a reduction in scrubs areas. Area of scrubs has decreased by 16.63 sq km. because of its use in opencast mines and use of scrub land for agriculture. The analysis further indicates that total agricultural land which includes both crop and fallow land covers an area of 44.39km^2 (11.31%) has increased 4.60 sq km (1.19%) from that was in 2013. The increase in 4.60 sq km is due to some scrubland getting converted into agricultural land. The mining area which includes coal quarry, advance quarry site, barren OB dump, area under backfilling, covers 40.53 km^2 (10.32%). There is a significant increase in areas under mining operations because large areas have now been taken up for Open cast mining in BCCL. As compared to 2013 there is an increase of 5.31 sq km (1.35%) in the areas under mining operation. Wasteland covers 118.82 km^2

(30.24%). Waste lands have increased because some scrubland has been converted to wasteland. Surface water bodies covered area of 7.48 km^2 (1.90).

The detail statistical analysis is given under Table-3.2.

4.2 Recommendations

It is essential to maintain the ecological balance for sustainable development of the area together with coal mining in Jharia Coalfield. It is recommended that land reclamation of the mining area should be taken up on top priority by BCCL. Such studies should be carried out regularly to assess the impact of coal mining on land use pattern and vegetation cover in the coalfield to formulate and take remedial measures, if any, required for mitigating the adverse impact of coal mining on land environment. Regional study will also be helpful in assessing the environmental degradation / up gradation carried out by different industries operating in the coalfield area.



Area Statistics of Cluster I				
Class		Color	Area	
Level I	Level II		Hect	% of Total
Forest	Dense Forest		14.56	2.34
	Open Forest		15.11	2.43
	Total Forest (A)		**29.67**	**4.77**
Scrubs	**Scrubs (B)**		**182.00**	**29.24**
	Social Forestry		16.60	2.67
Plantations	Plantation on OB Dump		47.32	7.60
	Plantation on Backfill		10.65	1.71
	Total Plantation (C)		**74.57**	**11.98**
	Total Vegetation (A+B+C)		**286.24**	**45.99**
Agricultural Land	Fallow Land		91.85	14.76
	Total Agricultural Land		**91.85**	**14.76**
Mining Area	Coal Quarry		11.60	1.86
	Barren OB Dump		16.32	2.62
	Area Under Backfilling		28.54	4.58
	Water Filled Quarry		7.30	1.17
	Total Mining Area		**63.76**	**10.23**
Waste Lands	Waste Land		133.62	21.47
	Sand Body		10.66	1.71
	Total Waste Land		**144.28**	**23.18**
	Industrial		0.87	0.14
Settlement	Rural		20.73	3.33
	Total Settlements		**21.60**	**3.47**
Water Bodies	**Rivers, Lakes, Nalas etc.**		**14.75**	**2.37**
All Total			**622.48**	**100.00**

Customer: BHARAT COKING COAL LIMITED

Title: Land Use/Cover Map of Clusters of BCCL based on Satellite data for the year 2016

Job No. 561410027

Subject: Land Use/ Cover Map of Cluster I based on Satellite Data (IRS-R2/LISS-IV) of the year 2016.

Activity	Name	Desig	Sign	Date
Prepared	A. Farida	AM (Geo)		
Checked	R. Kumar	CM(RS)		
Approved	NP.Singh	GM(Geom)		

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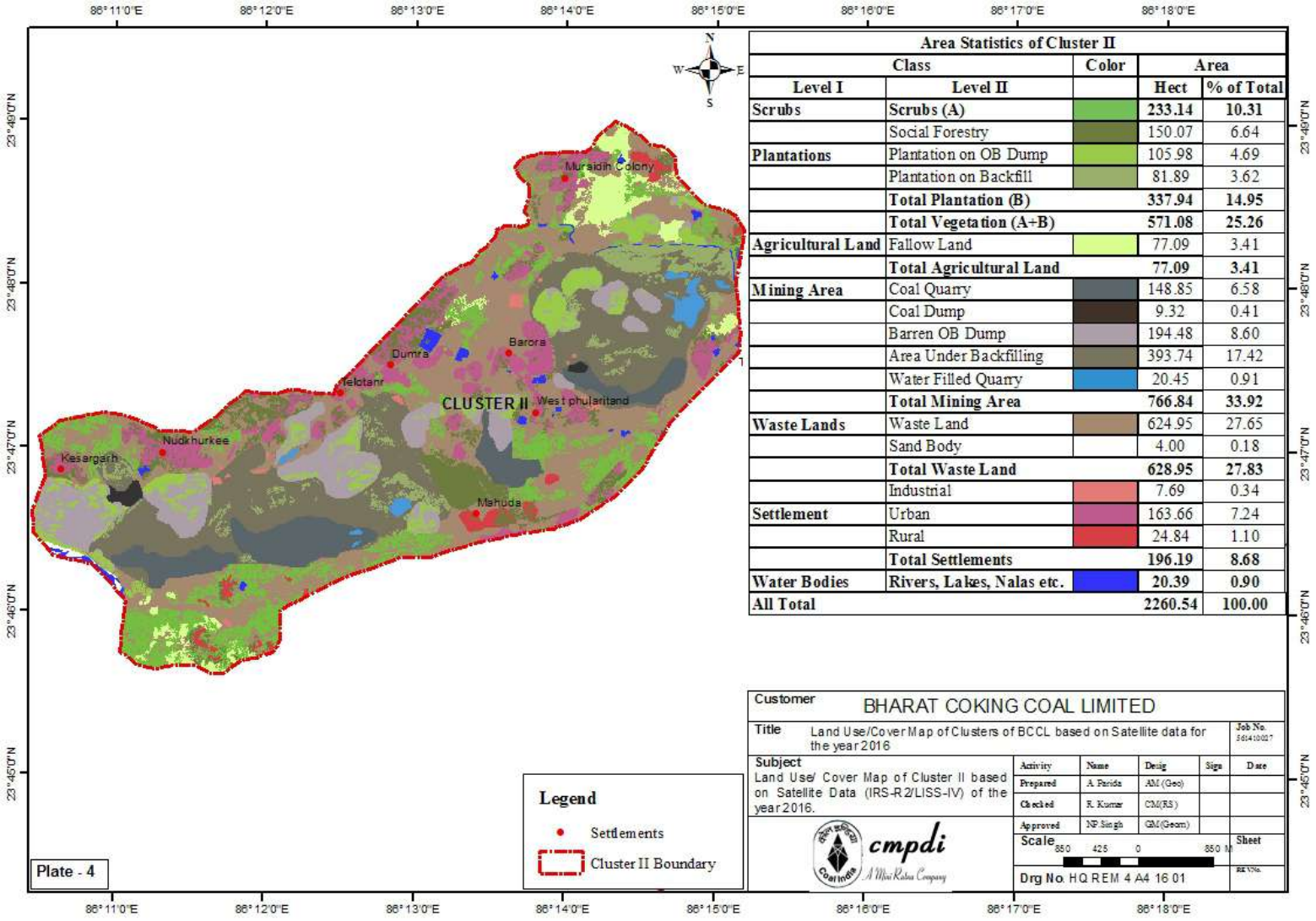

Area Statistics of Cluster II				
Class		Color	Area	
Level I	Level II		Hect	% of Total
Scrubs	Scrubs (A)		233.14	10.31
	Social Forestry		150.07	6.64
Plantations	Plantation on OB Dump		105.98	4.69
	Plantation on Backfill		81.89	3.62
	Total Plantation (B)		**337.94**	**14.95**
	Total Vegetation (A+B)		**571.08**	**25.26**
Agricultural Land	Fallow Land		77.09	3.41
	Total Agricultural Land		**77.09**	**3.41**
Mining Area	Coal Quarry		148.85	6.58
	Coal Dump		9.32	0.41
	Barren OB Dump		194.48	8.60
	Area Under Backfilling		393.74	17.42
	Water Filled Quarry		20.45	0.91
	Total Mining Area		**766.84**	**33.92**
Waste Lands	Waste Land		624.95	27.65
	Sand Body		4.00	0.18
	Total Waste Land		**628.95**	**27.83**
	Industrial		7.69	0.34
Settlement	Urban		163.66	7.24
	Rural		24.84	1.10
	Total Settlements		**196.19**	**8.68**
Water Bodies	Rivers, Lakes, Nalas etc.		20.39	0.90
All Total			2260.54	100.00

Customer: BHARAT COKING COAL LIMITED

Title: Land Use/Cover Map of Clusters of BCCL based on Satellite data for the year 2016

Job No. 561410027

Subject: Land Use/ Cover Map of Cluster II based on Satellite Data (IRS-R2/LISS-IV) of the year 2016.

Activity	Name	Desig	Sign	Date
Prepared	A Parida	AM (Geo)		
Checked	R. Kumar	CM(RS)		
Approved	NP Singh	GM(Geom)		

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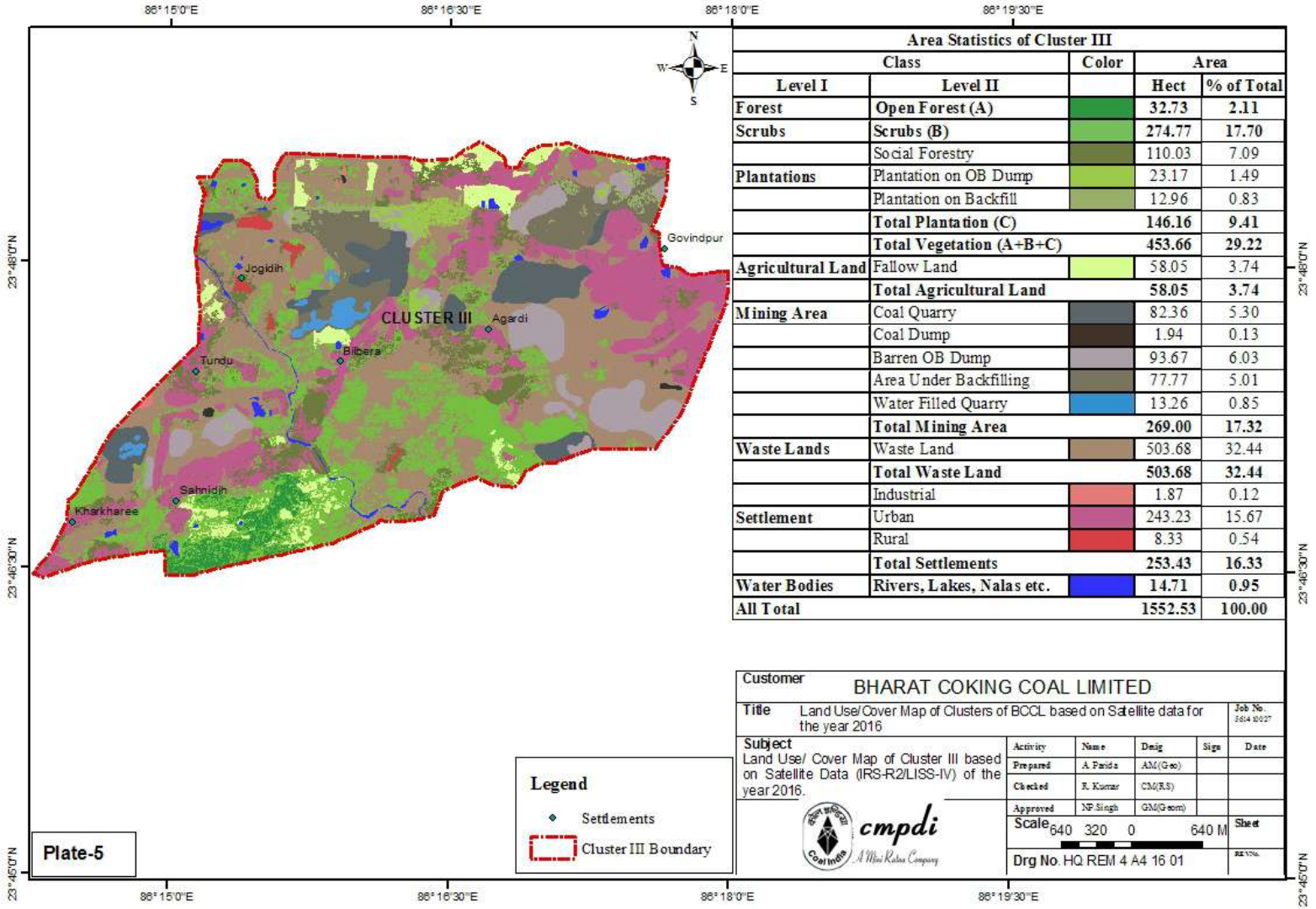

Area Statistics of Cluster III

Class		Color	Area	
Level I	**Level II**		**Hect**	**% of Total**
Forest	**Open Forest (A)**		**32.73**	**2.11**
Scrubs	**Scrubs (B)**		**274.77**	**17.70**
	Social Forestry		110.03	7.09
Plantations	Plantation on OB Dump		23.17	1.49
	Plantation on Backfill		12.96	0.83
	Total Plantation (C)		**146.16**	**9.41**
	Total Vegetation (A+B+C)		**453.66**	**29.22**
Agricultural Land	Fallow Land		58.05	3.74
	Total Agricultural Land		**58.05**	**3.74**
Mining Area	Coal Quarry		82.36	5.30
	Coal Dump		1.94	0.13
	Barren OB Dump		93.67	6.03
	Area Under Backfilling		77.77	5.01
	Water Filled Quarry		13.26	0.85
	Total Mining Area		**269.00**	**17.32**
Waste Lands	Waste Land		503.68	32.44
	Total Waste Land		**503.68**	**32.44**
	Industrial		1.87	0.12
Settlement	Urban		243.23	15.67
	Rural		8.33	0.54
	Total Settlements		**253.43**	**16.33**
Water Bodies	**Rivers, Lakes, Nalas etc.**		**14.71**	**0.95**
All Total			**1552.53**	**100.00**

Customer: BHARAT COKING COAL LIMITED

Title: Land Use/Cover Map of Clusters of BCCL based on Satellite data for the year 2016

Job No. 5614 10027

Subject: Land Use/ Cover Map of Cluster III based on Satellite Data (IRS-R2/LISS-IV) of the year 2016.

Activity	Name	Desig	Sign	Date
Prepared	A. Parida	AM(Geo)		
Checked	R. Kumar	CM(RS)		
Approved	NP.Singh	GM(Geom)		

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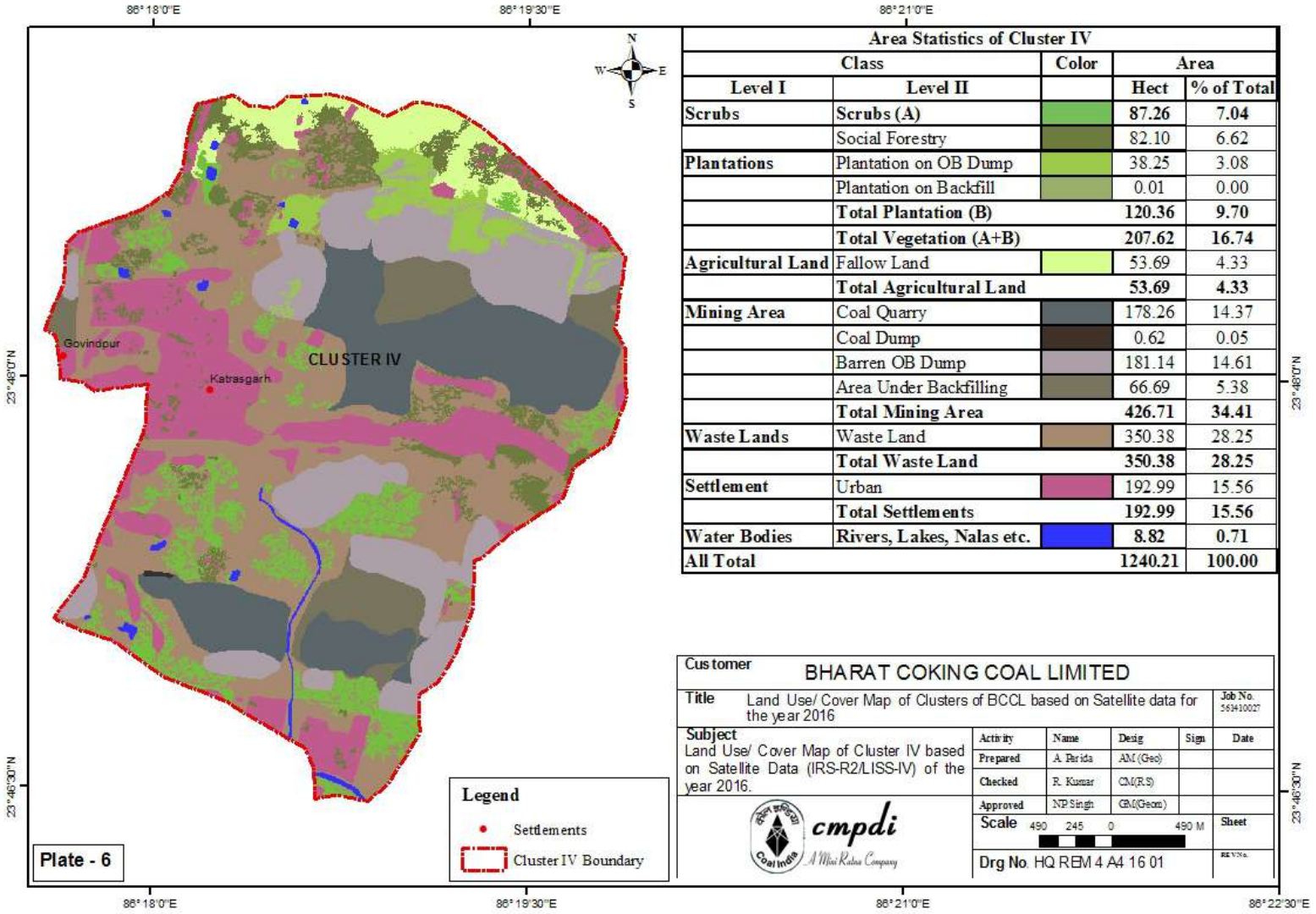

Area Statistics of Cluster IV

Class		Color	Area	
Level I	Level II		Hect	% of Total
Scrubs	Scrubs (A)		87.26	7.04
	Social Forestry		82.10	6.62
Plantations	Plantation on OB Dump		38.25	3.08
	Plantation on Backfill		0.01	0.00
	Total Plantation (B)		**120.36**	**9.70**
	Total Vegetation (A+B)		**207.62**	**16.74**
Agricultural Land	Fallow Land		53.69	4.33
	Total Agricultural Land		**53.69**	**4.33**
Mining Area	Coal Quarry		178.26	14.37
	Coal Dump		0.62	0.05
	Barren OB Dump		181.14	14.61
	Area Under Backfilling		66.69	5.38
	Total Mining Area		**426.71**	**34.41**
Waste Lands	Waste Land		350.38	28.25
	Total Waste Land		**350.38**	**28.25**
Settlement	Urban		192.99	15.56
	Total Settlements		**192.99**	**15.56**
Water Bodies	Rivers, Lakes, Nalas etc.		8.82	0.71
All Total			1240.21	100.00

Customer: BHARAT COKING COAL LIMITED

Title: Land Use/ Cover Map of Clusters of BCCL based on Satellite data for the year 2016

Job No. 561410027

Subject: Land Use/ Cover Map of Cluster IV based on Satellite Data (IRS-R2/LISS-IV) of the year 2016.

Activity	Name	Desig	Sign	Date
Prepared	A. Parida	AM (Geo)		
Checked	R. Kumar	CM(RS)		
Approved	NP Singh	GM(Geom)		

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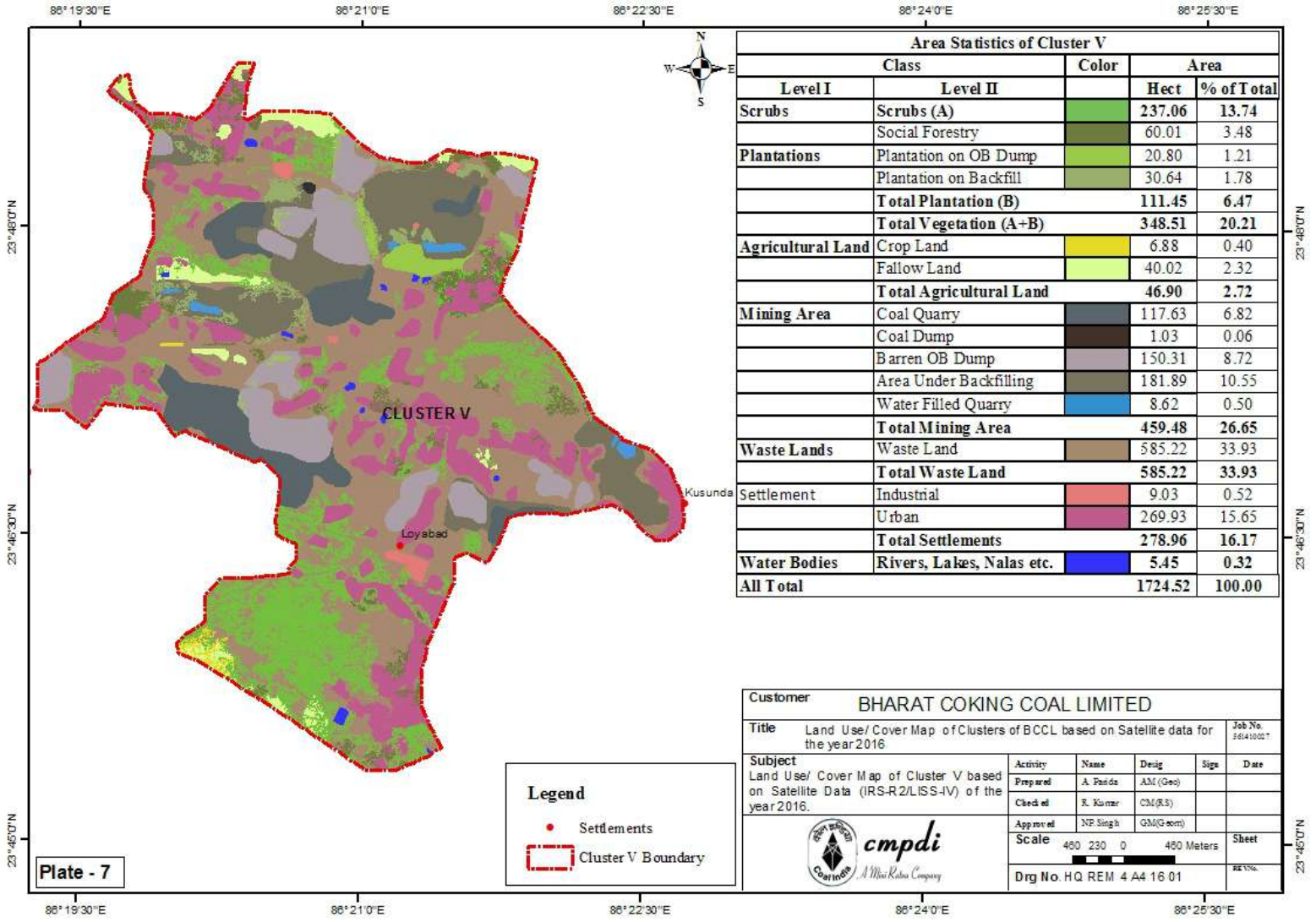

Area Statistics of Cluster V				
Class		Color	Area	
Level I	Level II		Hect	% of Total
Scrubs	Scrubs (A)		237.06	13.74
	Social Forestry		60.01	3.48
Plantations	Plantation on OB Dump		20.80	1.21
	Plantation on Backfill		30.64	1.78
	Total Plantation (B)		**111.45**	**6.47**
	Total Vegetation (A+B)		**348.51**	**20.21**
Agricultural Land	Crop Land		6.88	0.40
	Fallow Land		40.02	2.32
	Total Agricultural Land		**46.90**	**2.72**
Mining Area	Coal Quarry		117.63	6.82
	Coal Dump		1.03	0.06
	Barren OB Dump		150.31	8.72
	Area Under Backfilling		181.89	10.55
	Water Filled Quarry		8.62	0.50
	Total Mining Area		**459.48**	**26.65**
Waste Lands	Waste Land		585.22	33.93
	Total Waste Land		**585.22**	**33.93**
Settlement	Industrial		9.03	0.52
	Urban		269.93	15.65
	Total Settlements		**278.96**	**16.17**
Water Bodies	Rivers, Lakes, Nalas etc.		5.45	0.32
All Total			1724.52	100.00

Customer: BHARAT COKING COAL LIMITED

Title: Land Use/ Cover Map of Clusters of BCCL based on Satellite data for the year 2016

Job No. 561410027

Subject: Land Use/ Cover Map of Cluster V based on Satellite Data (IRS-R2/LISS-IV) of the year 2016.

Activity	Name	Desig	Sign	Date
Prepared	A. Panda	AM (Geo)		
Checked	R. Kumar	CM(RS)		
Approved	NP Singh	GM(Geom)		

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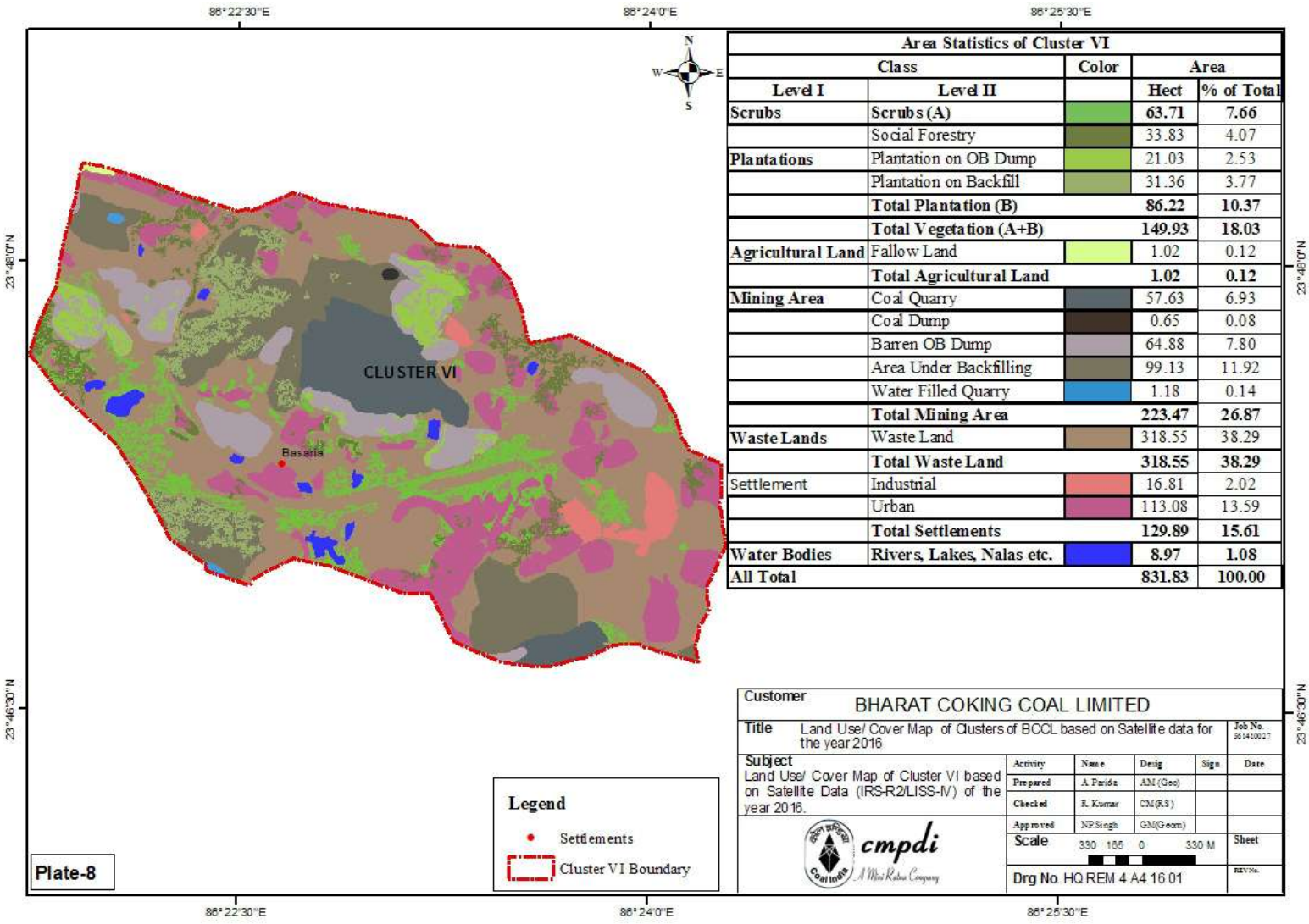

Area Statistics of Cluster VI				
Class		Color	Area	
Level I	Level II		Hect	% of Total
Scrubs	Scrubs (A)		63.71	7.66
	Social Forestry		33.83	4.07
Plantations	Plantation on OB Dump		21.03	2.53
	Plantation on Backfill		31.36	3.77
	Total Plantation (B)		86.22	10.37
	Total Vegetation (A+B)		149.93	18.03
Agricultural Land	Fallow Land		1.02	0.12
	Total Agricultural Land		1.02	0.12
Mining Area	Coal Quarry		57.63	6.93
	Coal Dump		0.65	0.08
	Barren OB Dump		64.88	7.80
	Area Under Backfilling		99.13	11.92
	Water Filled Quarry		1.18	0.14
	Total Mining Area		223.47	26.87
Waste Lands	Waste Land		318.55	38.29
	Total Waste Land		318.55	38.29
Settlement	Industrial		16.81	2.02
	Urban		113.08	13.59
	Total Settlements		129.89	15.61
Water Bodies	Rivers, Lakes, Nalas etc.		8.97	1.08
All Total			831.83	100.00

Customer: BHARAT COKING COAL LIMITED

Title: Land Use/ Cover Map of Clusters of BCCL based on Satellite data for the year 2016

Job No. 561410027

Subject: Land Use/ Cover Map of Cluster VI based on Satellite Data (IRS-R2/LISS-IV) of the year 2016.

Activity	Name	Desig	Sign	Date
Prepared	A. Parida	AM (Geo)		
Checked	R. Kumar	CM(RS)		
Approved	NP.Singh	GM(Geom)		

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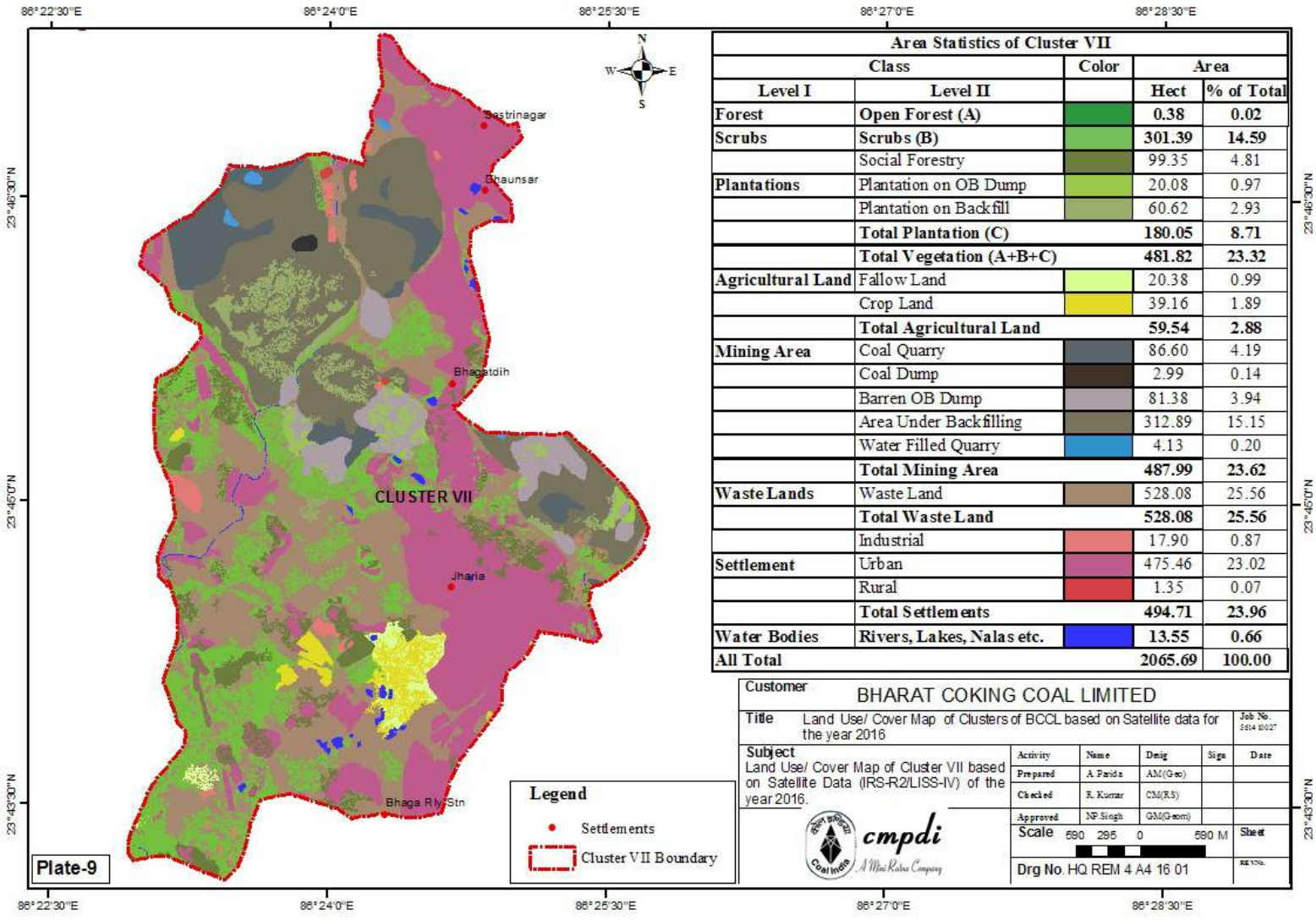

Area Statistics of Cluster VII				
Class		Color	Area	
Level I	Level II		Hect	% of Total
Forest	Open Forest (A)		0.38	0.02
Scrubs	Scrubs (B)		301.39	14.59
	Social Forestry		99.35	4.81
Plantations	Plantation on OB Dump		20.08	0.97
	Plantation on Backfill		60.62	2.93
	Total Plantation (C)		180.05	8.71
	Total Vegetation (A+B+C)		481.82	23.32
Agricultural Land	Fallow Land		20.38	0.99
	Crop Land		39.16	1.89
	Total Agricultural Land		59.54	2.88
Mining Area	Coal Quarry		86.60	4.19
	Coal Dump		2.99	0.14
	Barren OB Dump		81.38	3.94
	Area Under Backfilling		312.89	15.15
	Water Filled Quarry		4.13	0.20
	Total Mining Area		487.99	23.62
Waste Lands	Waste Land		528.08	25.56
	Total Waste Land		528.08	25.56
	Industrial		17.90	0.87
Settlement	Urban		475.46	23.02
	Rural		1.35	0.07
	Total Settlements		494.71	23.96
Water Bodies	Rivers, Lakes, Nalas etc.		13.55	0.66
All Total			2065.69	100.00

Customer: BHARAT COKING COAL LIMITED

Title: Land Use/ Cover Map of Clusters of BCCL based on Satellite data for the year 2016

Job No. 5614 10027

Subject: Land Use/ Cover Map of Cluster VII based on Satellite Data (IRS-R2/LISS-IV) of the year 2016.

Activity	Name	Desig	Sign	Date
Prepared	A.Parida	AM(Geo)		
Checked	K. Kumar	CM(RS)		
Approved	NP.Singh	GM(Geom)		

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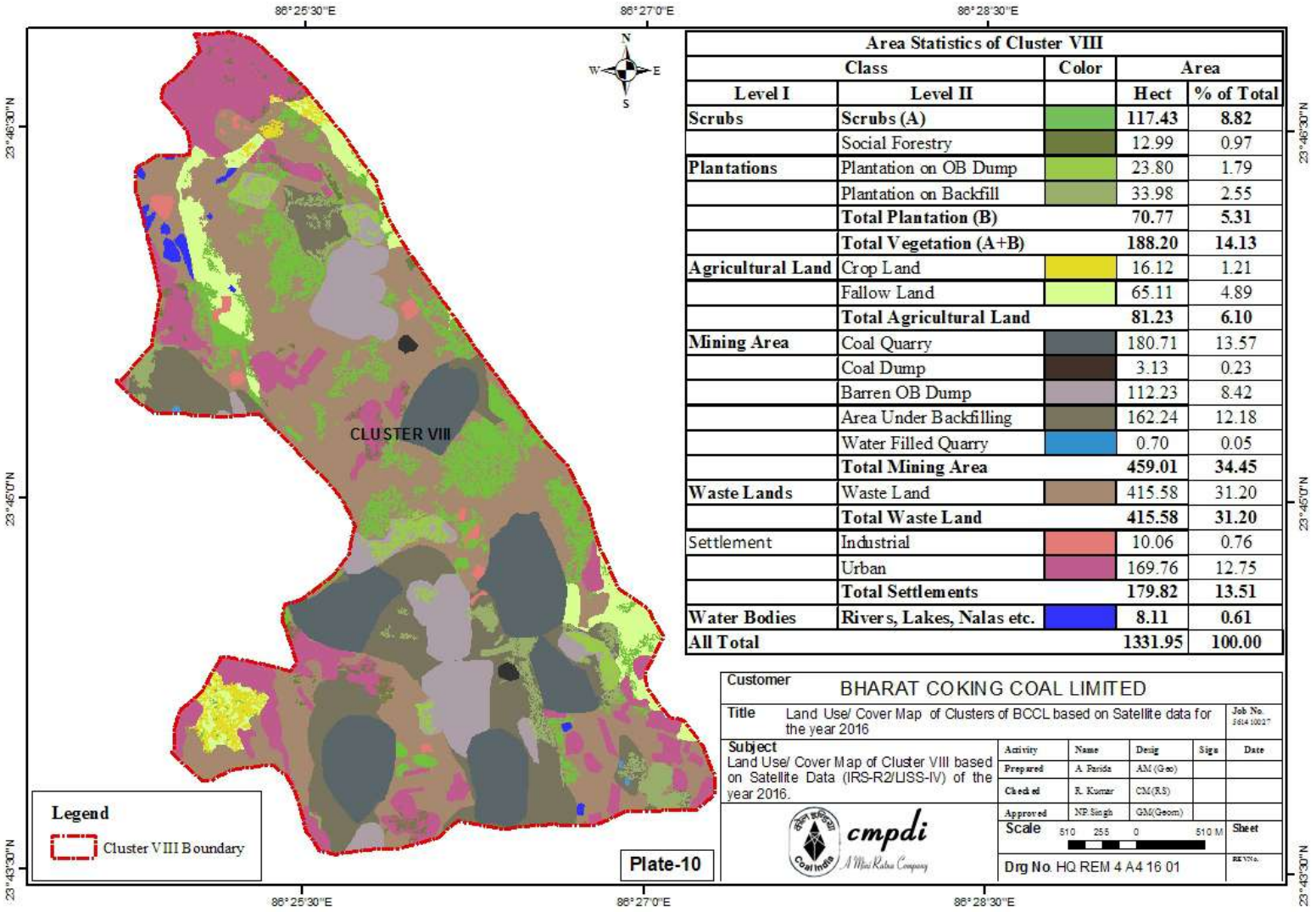

Area Statistics of Cluster VIII				
Class		Color	Area	
Level I	Level II		Hect	% of Total
Scrubs	Scrubs (A)		117.43	8.82
	Social Forestry		12.99	0.97
Plantations	Plantation on OB Dump		23.80	1.79
	Plantation on Backfill		33.98	2.55
	Total Plantation (B)		70.77	5.31
	Total Vegetation (A+B)		188.20	14.13
Agricultural Land	Crop Land		16.12	1.21
	Fallow Land		65.11	4.89
	Total Agricultural Land		81.23	6.10
Mining Area	Coal Quarry		180.71	13.57
	Coal Dump		3.13	0.23
	Barren OB Dump		112.23	8.42
	Area Under Backfilling		162.24	12.18
	Water Filled Quarry		0.70	0.05
	Total Mining Area		459.01	34.45
Waste Lands	Waste Land		415.58	31.20
	Total Waste Land		415.58	31.20
Settlement	Industrial		10.06	0.76
	Urban		169.76	12.75
	Total Settlements		179.82	13.51
Water Bodies	Rivers, Lakes, Nalas etc.		8.11	0.61
All Total			1331.95	100.00

Customer: BHARAT COKING COAL LIMITED

Title: Land Use/ Cover Map of Clusters of BCCL based on Satellite data for the year 2016

Job No. 5614 10027

Subject: Land Use/ Cover Map of Cluster VIII based on Satellite Data (IRS-R2/LISS-IV) of the year 2016.

Activity	Name	Desig	Sign	Date
Prepared	A. Farida	AM (Geo)		
Checked	R. Kumar	CM (RS)		
Approved	NP. Singh	GM(Geom)		

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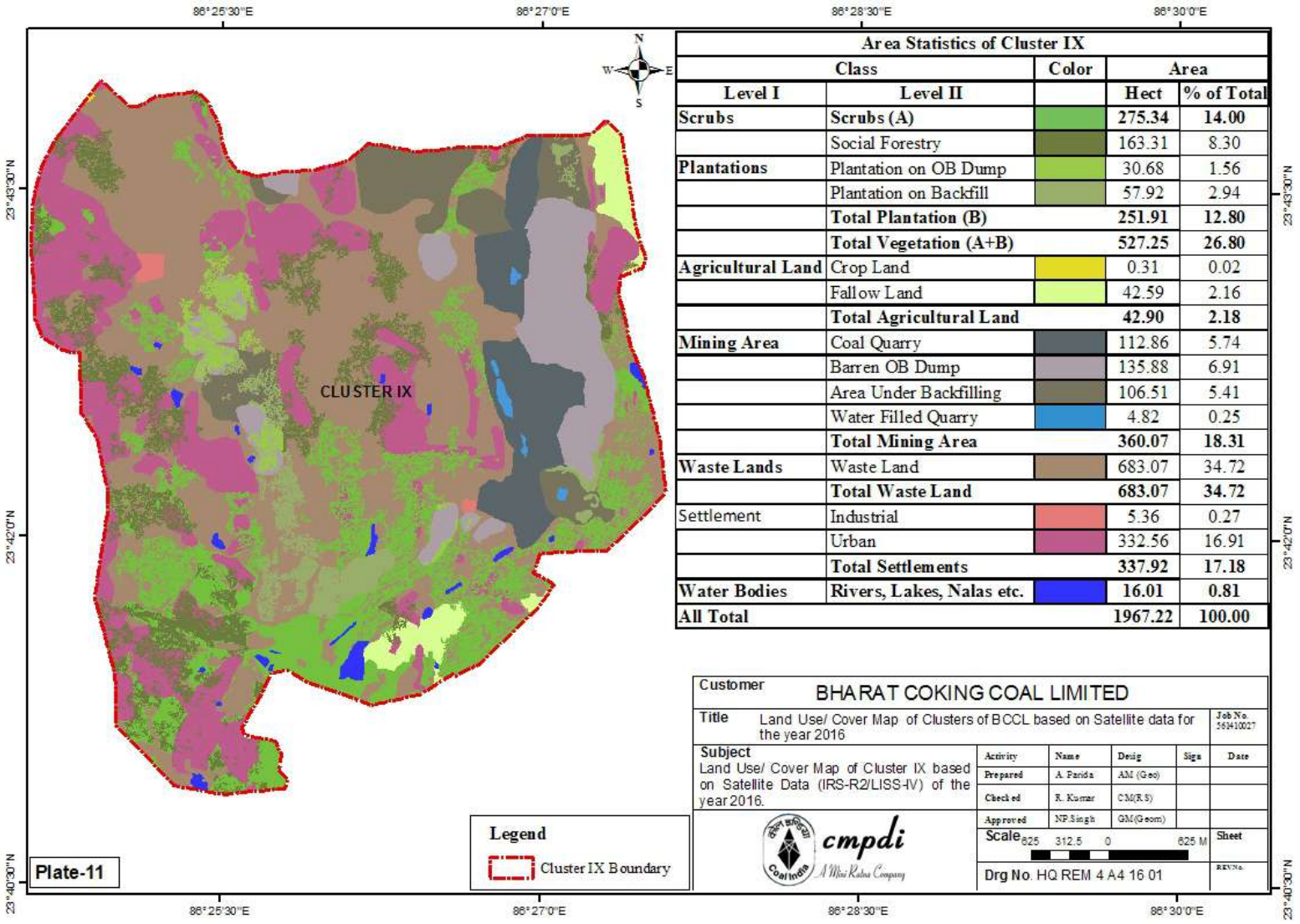

Area Statistics of Cluster IX

Class		Color	Area	
Level I	Level II		Hect	% of Total
Scrubs	Scrubs (A)		275.34	14.00
	Social Forestry		163.31	8.30
Plantations	Plantation on OB Dump		30.68	1.56
	Plantation on Backfill		57.92	2.94
	Total Plantation (B)		**251.91**	**12.80**
	Total Vegetation (A+B)		**527.25**	**26.80**
Agricultural Land	Crop Land		0.31	0.02
	Fallow Land		42.59	2.16
	Total Agricultural Land		**42.90**	**2.18**
Mining Area	Coal Quarry		112.86	5.74
	Barren OB Dump		135.88	6.91
	Area Under Backfilling		106.51	5.41
	Water Filled Quarry		4.82	0.25
	Total Mining Area		**360.07**	**18.31**
Waste Lands	Waste Land		683.07	34.72
	Total Waste Land		**683.07**	**34.72**
Settlement	Industrial		5.36	0.27
	Urban		332.56	16.91
	Total Settlements		**337.92**	**17.18**
Water Bodies	Rivers, Lakes, Nalas etc.		16.01	0.81
All Total			1967.22	100.00

Customer: BHARAT COKING COAL LIMITED

Title: Land Use/ Cover Map of Clusters of BCCL based on Satellite data for the year 2016

Job No. 561410027

Subject: Land Use/ Cover Map of Cluster IX based on Satellite Data (IRS-R2/LISS-IV) of the year 2016.

Activity	Name	Desig	Sign	Date
Prepared	A. Farida	AM (Geo)		
Checked	R. Kumar	CM(RS)		
Approved	NP.Singh	GM(Geom)		

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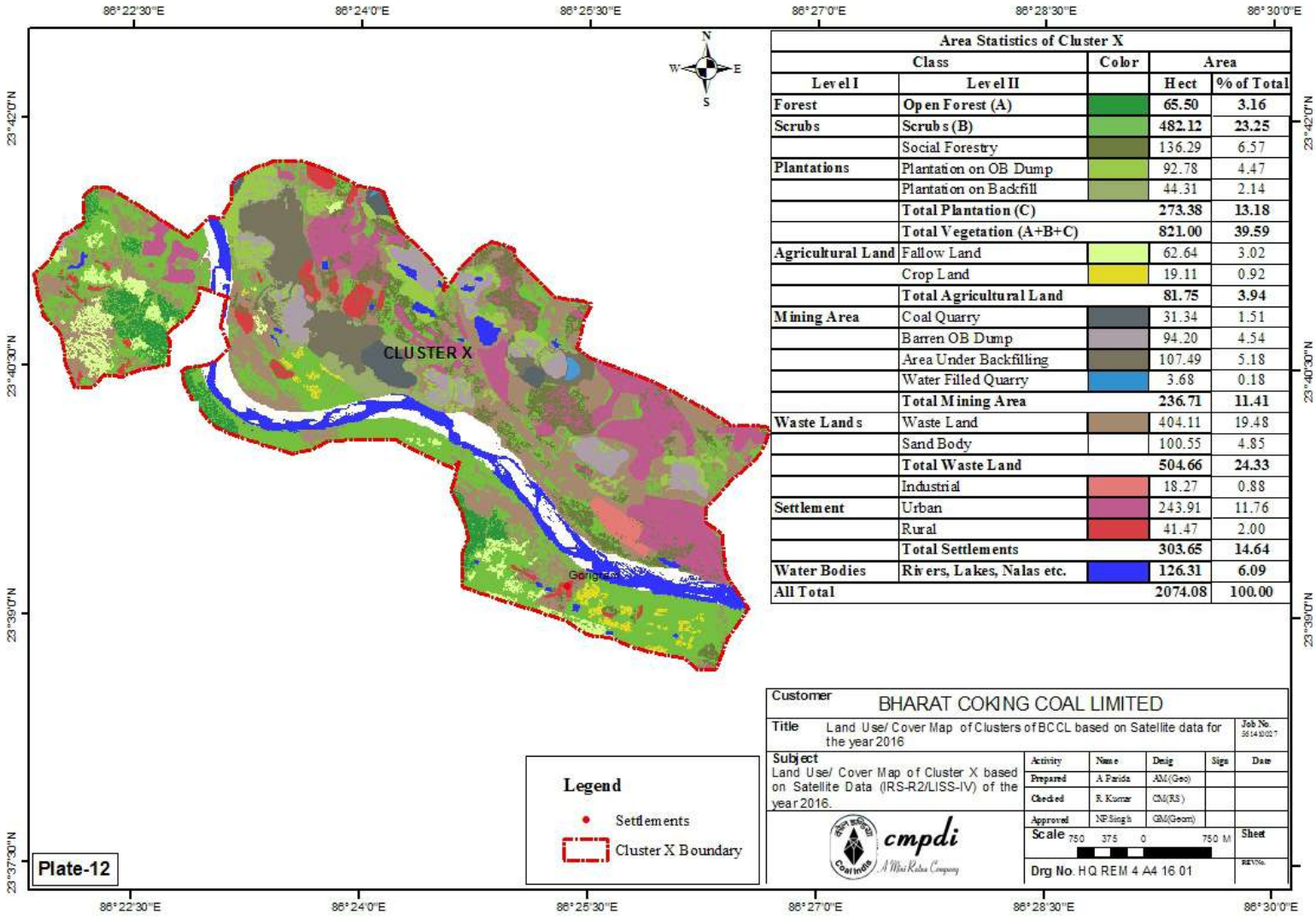

Area Statistics of Cluster X				
Class		Color	Area	
Level I	Level II		Hect	% of Total
Forest	Open Forest (A)		65.50	3.16
Scrubs	Scrubs (B)		482.12	23.25
	Social Forestry		136.29	6.57
Plantations	Plantation on OB Dump		92.78	4.47
	Plantation on Backfill		44.31	2.14
	Total Plantation (C)		273.38	13.18
	Total Vegetation (A+B+C)		821.00	39.59
Agricultural Land	Fallow Land		62.64	3.02
	Crop Land		19.11	0.92
	Total Agricultural Land		81.75	3.94
Mining Area	Coal Quarry		31.34	1.51
	Barren OB Dump		94.20	4.54
	Area Under Backfilling		107.49	5.18
	Water Filled Quarry		3.68	0.18
	Total Mining Area		236.71	11.41
Waste Lands	Waste Land		404.11	19.48
	Sand Body		100.55	4.85
	Total Waste Land		504.66	24.33
	Industrial		18.27	0.88
Settlement	Urban		243.91	11.76
	Rural		41.47	2.00
	Total Settlements		303.65	14.64
Water Bodies	Rivers, Lakes, Nalas etc.		126.31	6.09
All Total			2074.08	100.00

Customer	BHARAT COKING COAL LIMITED				
Title	Land Use/ Cover Map of Clusters of BCCL based on Satellite data for the year 2016				Job No. 561410027
Subject	Land Use/ Cover Map of Cluster X based on Satellite Data (IRS-R2/LISS-IV) of the year 2016.	Activity	Name	Desig	Sign	Date
		Prepared	A Parida	AM(Geo)		
		Checked	R. Kumar	CM(RS)		
		Approved	NP Singh	GM(Geom)		
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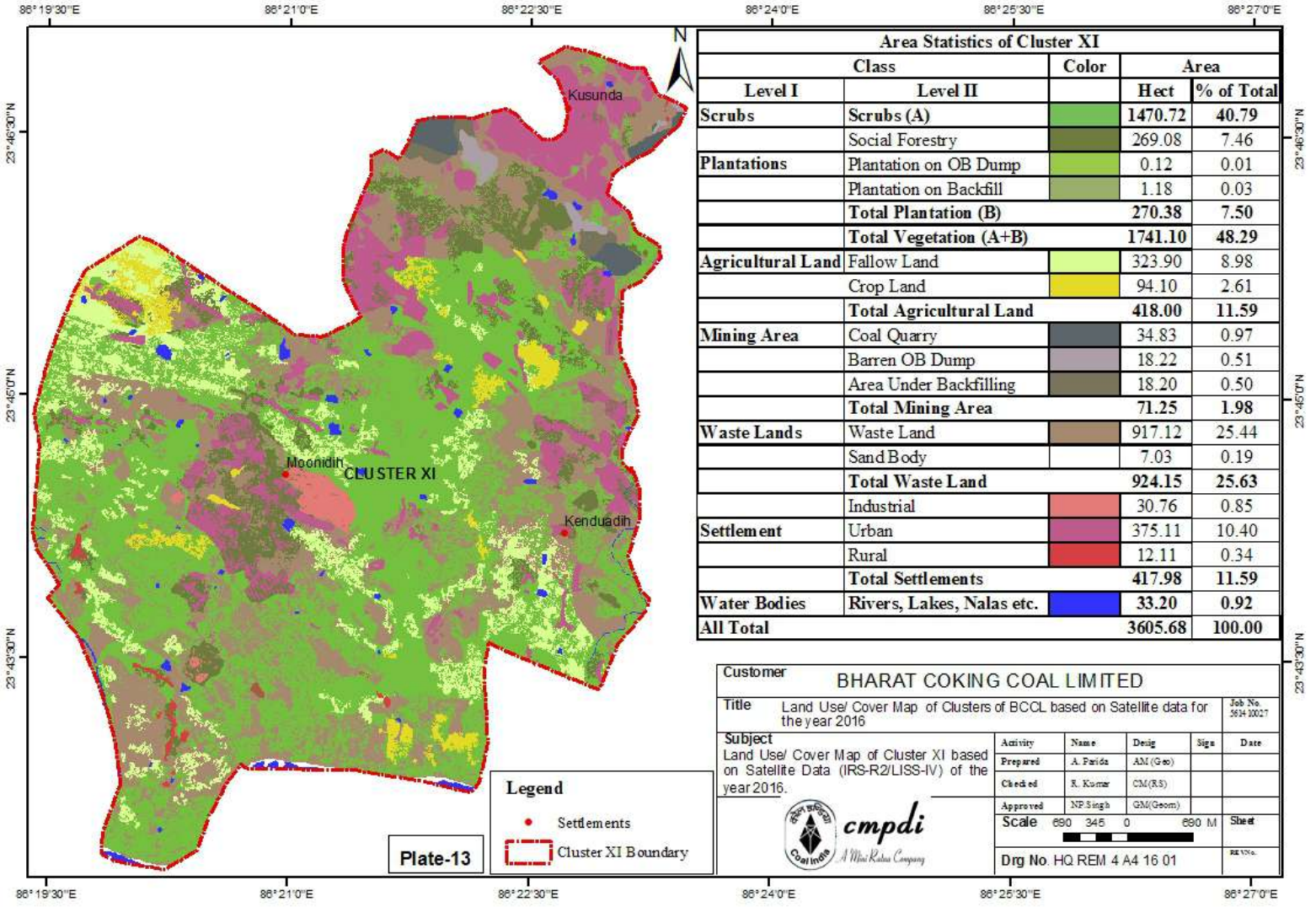

Area Statistics of Cluster XI				
Class		Color	Area	
Level I	Level II		Hect	% of Total
Scrubs	Scrubs (A)		1470.72	40.79
	Social Forestry		269.08	7.46
Plantations	Plantation on OB Dump		0.12	0.01
	Plantation on Backfill		1.18	0.03
	Total Plantation (B)		**270.38**	**7.50**
	Total Vegetation (A+B)		**1741.10**	**48.29**
Agricultural Land	Fallow Land		323.90	8.98
	Crop Land		94.10	2.61
	Total Agricultural Land		**418.00**	**11.59**
Mining Area	Coal Quarry		34.83	0.97
	Barren OB Dump		18.22	0.51
	Area Under Backfilling		18.20	0.50
	Total Mining Area		**71.25**	**1.98**
Waste Lands	Waste Land		917.12	25.44
	Sand Body		7.03	0.19
	Total Waste Land		**924.15**	**25.63**
	Industrial		30.76	0.85
Settlement	Urban		375.11	10.40
	Rural		12.11	0.34
	Total Settlements		**417.98**	**11.59**
Water Bodies	Rivers, Lakes, Nalas etc.		33.20	0.92
All Total			3605.68	100.00

Customer: BHARAT COKING COAL LIMITED

Title: Land Use/ Cover Map of Clusters of BCCL based on Satellite data for the year 2016

Job No. 5614 10027

Subject: Land Use/ Cover Map of Cluster XI based on Satellite Data (IRS-R2/LISS-IV) of the year 2016.

Activity	Name	Desig	Sign	Date
Prepared	A. Parida	AM (Geo)		
Checked	R. Kumar	CM (RS)		
Approved	NP Singh	GM (Geom)		

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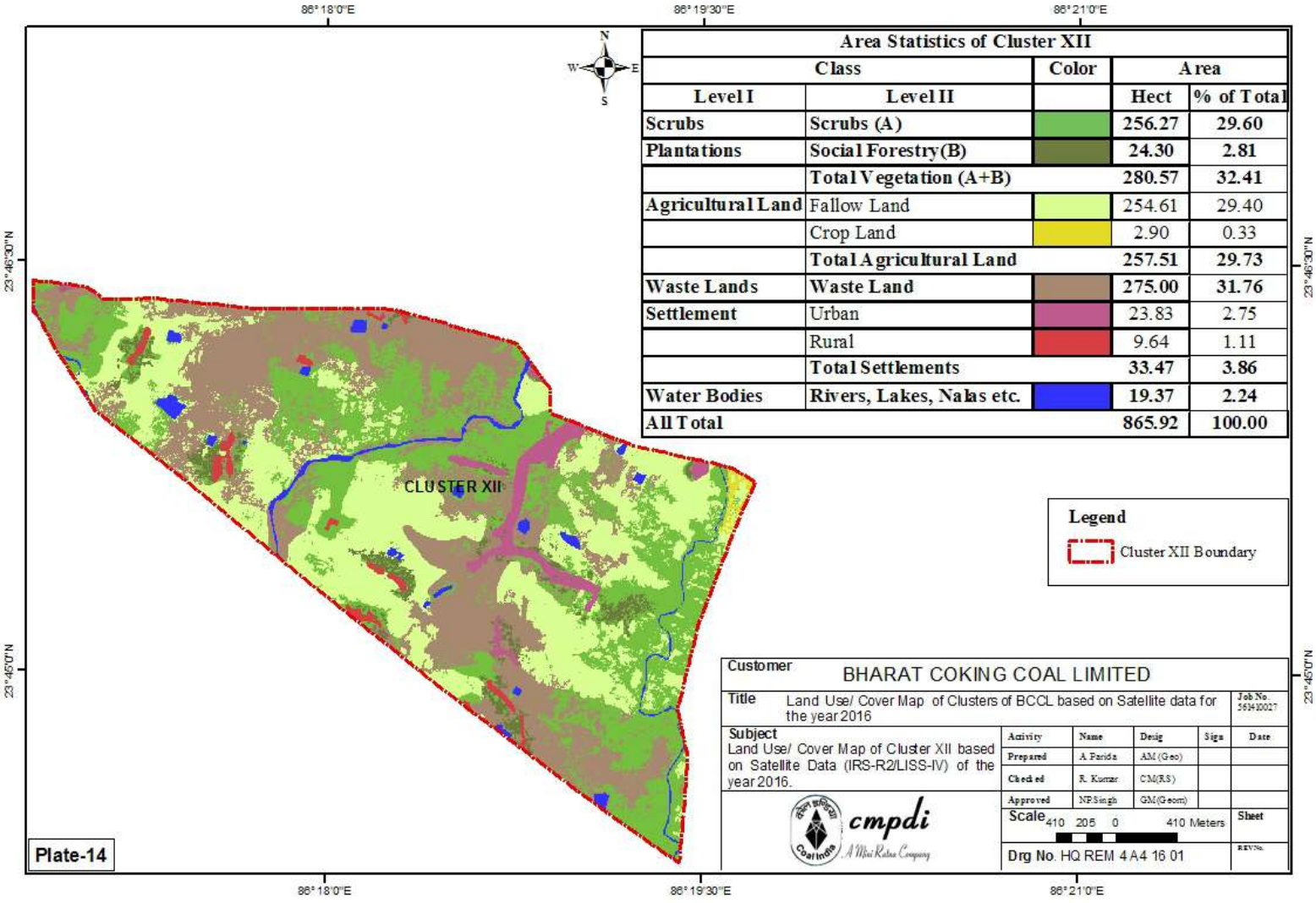

Area Statistics of Cluster XII

Class		Color	Area	
Level I	Level II		Hect	% of Total
Scrubs	Scrubs (A)		256.27	29.60
Plantations	Social Forestry(B)		24.30	2.81
	Total Vegetation (A+B)		280.57	32.41
Agricultural Land	Fallow Land		254.61	29.40
	Crop Land		2.90	0.33
	Total Agricultural Land		257.51	29.73
Waste Lands	Waste Land		275.00	31.76
Settlement	Urban		23.83	2.75
	Rural		9.64	1.11
	Total Settlements		33.47	3.86
Water Bodies	Rivers, Lakes, Nalas etc.		19.37	2.24
All Total			865.92	100.00

Legend

Cluster XII Boundary

Customer: BHARAT COKING COAL LIMITED

Title: Land Use/ Cover Map of Clusters of BCCL based on Satellite data for the year 2016

Job No. 561410027

Subject: Land Use/ Cover Map of Cluster XII based on Satellite Data (IRS-R2/LISS-IV) of the year 2016.

Activity	Name	Desig	Sign	Date
Prepared	A Farida	AM (Geo)		
Checked	R. Kumar	CM(RS)		
Approved	NP Singh	GM(Geom)		

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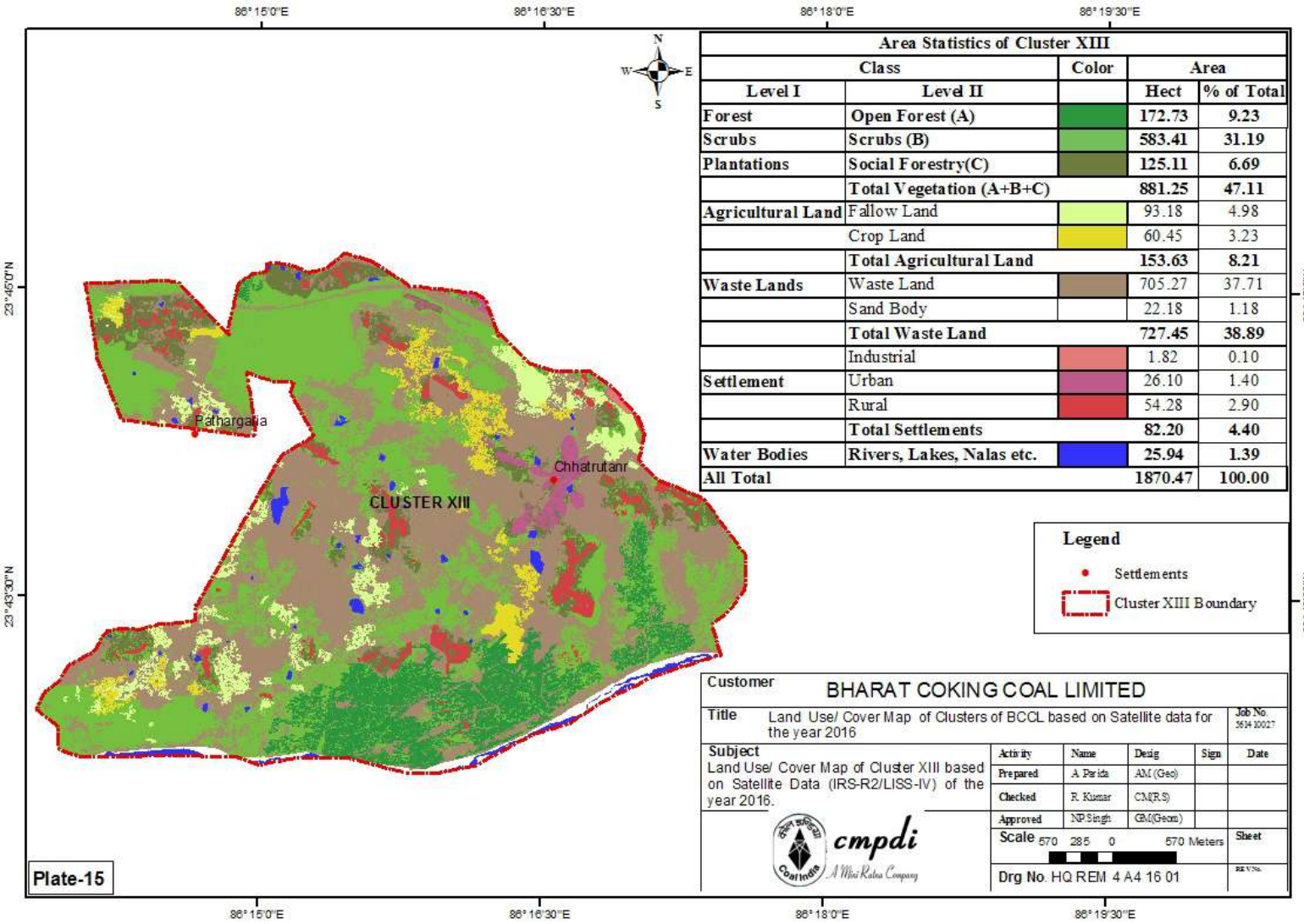

Area Statistics of Cluster XIII				
Class		Color	Area	
Level I	Level II		Hect	% of Total
Forest	Open Forest (A)		172.73	9.23
Scrubs	Scrubs (B)		583.41	31.19
Plantations	Social Forestry(C)		125.11	6.69
	Total Vegetation (A+B+C)		881.25	47.11
Agricultural Land	Fallow Land		93.18	4.98
	Crop Land		60.45	3.23
	Total Agricultural Land		153.63	8.21
Waste Lands	Waste Land		705.27	37.71
	Sand Body		22.18	1.18
	Total Waste Land		727.45	38.89
	Industrial		1.82	0.10
Settlement	Urban		26.10	1.40
	Rural		54.28	2.90
	Total Settlements		82.20	4.40
Water Bodies	Rivers, Lakes, Nalas etc.		25.94	1.39
All Total			1870.47	100.00

Customer	BHARAT COKING COAL LIMITED				
Title	Land Use/ Cover Map of Clusters of BCCL based on Satellite data for the year 2016				Job No. 5614 10027
Subject	Land Use/ Cover Map of Cluster XIII based on Satellite Data (IRS-R2/LISS-IV) of the year 2016.	Activity	Name	Desig	Sign	Date
		Prepared	A Parida	AM (Geo)		
		Checked	R. Kumar	CM(RS)		
		Approved	NP Singh	GM(Geom)		
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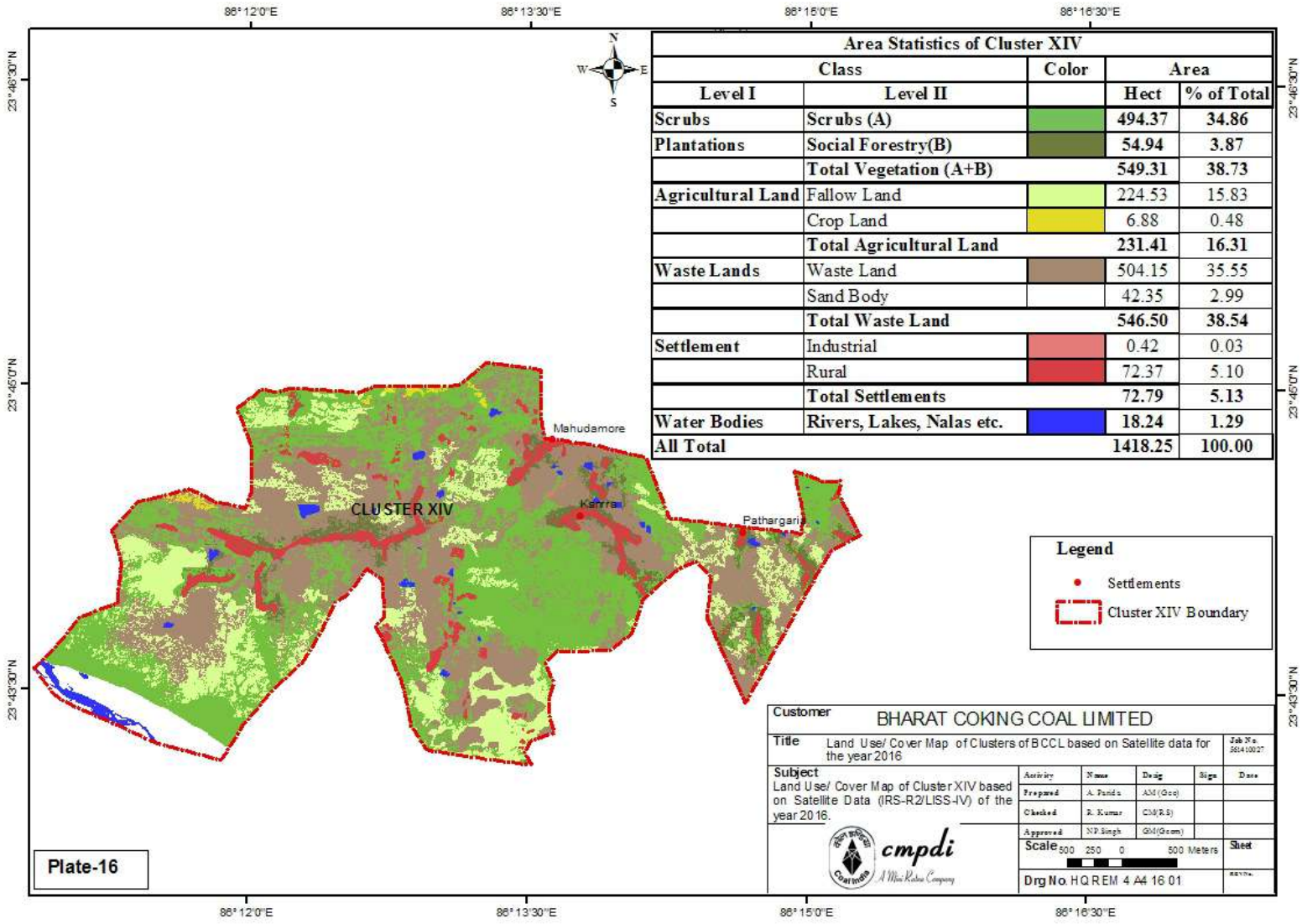
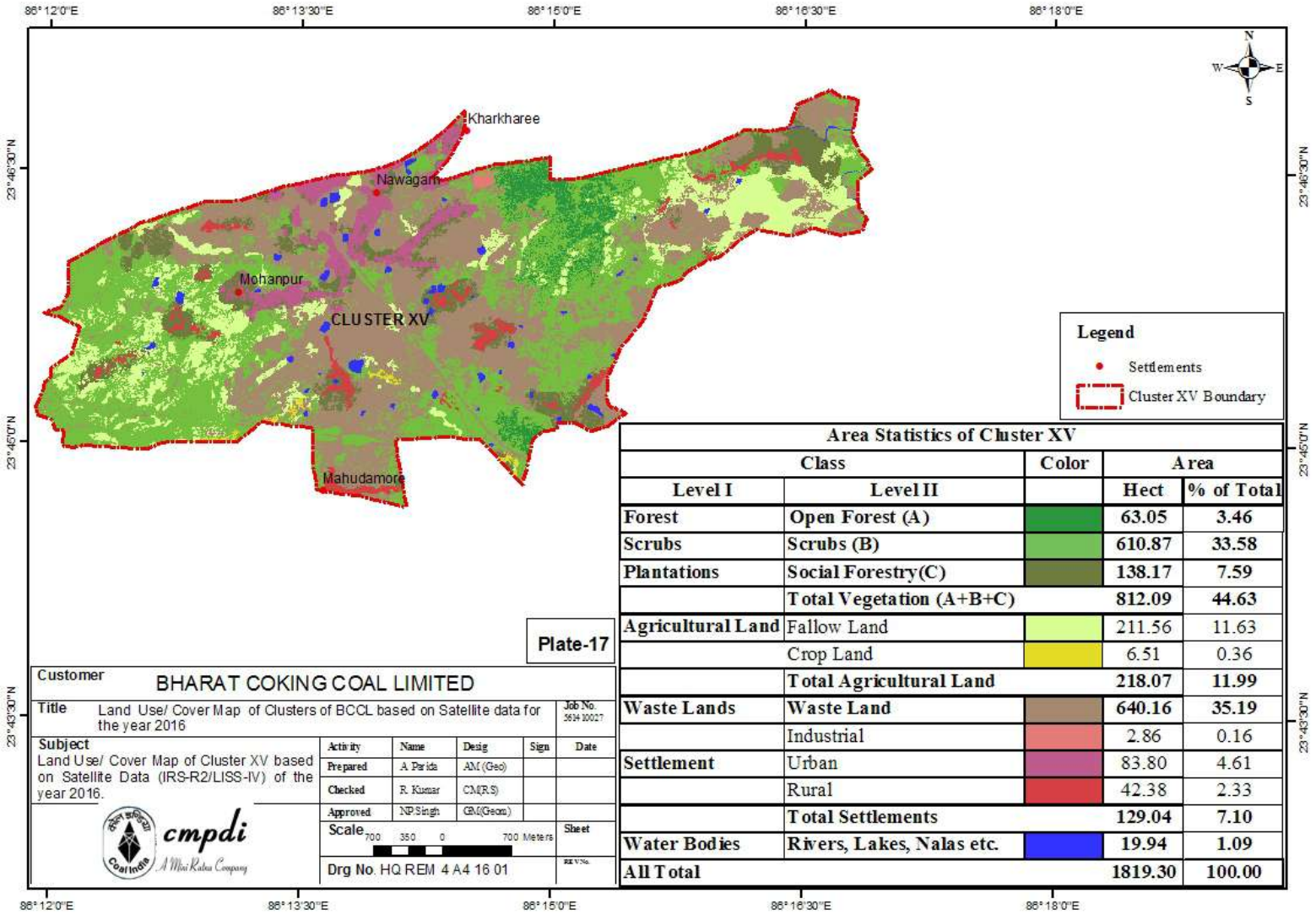


Area Statistics of Cluster XIV

Class		Color	Area	
Level I	Level II		Hect	% of Total
Scrubs	Scrubs (A)		494.37	34.86
Plantations	Social Forestry(B)		54.94	3.87
	Total Vegetation (A+B)		549.31	38.73
Agricultural Land	Fallow Land		224.53	15.83
	Crop Land		6.88	0.48
	Total Agricultural Land		231.41	16.31
Waste Lands	Waste Land		504.15	35.55
	Sand Body		42.35	2.99
	Total Waste Land		546.50	38.54
Settlement	Industrial		0.42	0.03
	Rural		72.37	5.10
	Total Settlements		72.79	5.13
Water Bodies	Rivers, Lakes, Nalas etc.		18.24	1.29
All Total			1418.25	100.00



Area Statistics of Cluster XV

Class		Color	Area	
Level I	**Level II**		**Hect**	**% of Total**
Forest	**Open Forest (A)**		**63.05**	**3.46**
Scrubs	**Scrubs (B)**		**610.87**	**33.58**
Plantations	**Social Forestry(C)**		**138.17**	**7.59**
	Total Vegetation (A+B+C)		**812.09**	**44.63**
Agricultural Land	Fallow Land		211.56	11.63
	Crop Land		6.51	0.36
	Total Agricultural Land		**218.07**	**11.99**
Waste Lands	**Waste Land**		**640.16**	**35.19**
	Industrial		2.86	0.16
Settlement	Urban		83.80	4.61
	Rural		42.38	2.33
	Total Settlements		**129.04**	**7.10**
Water Bodies	**Rivers, Lakes, Nalas etc.**		**19.94**	**1.09**
All Total			**1819.30**	**100.00**

Central Mine Planning & Design Institute Ltd.
(A Subsidiary of Coal India Ltd.)
Gondwana Place, Kanke Road, Ranchi - 834 008,India
Phone : (+91-0651) 2230001, 2230002, 2230483, Fax (91-0651) 2231851, 2231447
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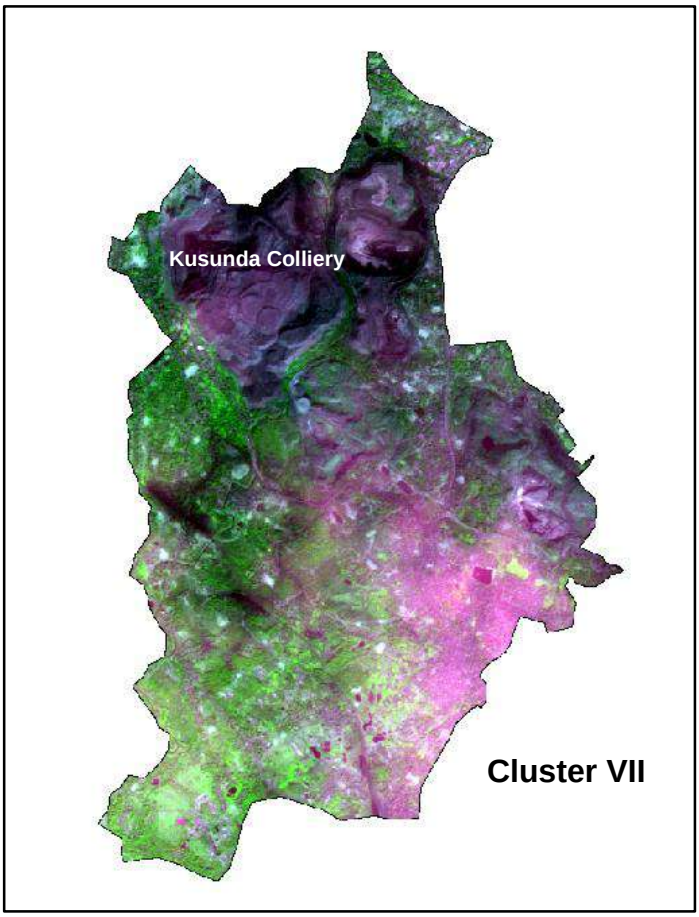
Land Restoration / Reclamation Monitoring of Clusters of (Opencast + Underground) Coal Mines of Bharat Coking Coal Limited based on Satellite Data for the Year 2018



Submitted to

Bharat Coking Coal Limited

cmpdi

A Mini-Ratna Company

Land Restoration / Reclamation Monitoring of Clusters of (Opencast + Underground) Coal Mines of Bharat Coking Coal Limited based on Satellite Data for the Year 2018

March-2019

Remote Sensing Cell
Geomatics Division
CMPDI, Ranchi

CONTENTS

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Executive Summary

1. Project

Land restoration / reclamation monitoring of clusters of (Opencast + Underground) coal mines of Bharat Coking Coal Ltd. (BCCL), based on satellite data, on every three year basis.

2. Objective

Objective of the land restoration / reclamation monitoring is to assess the area of backfilled, plantation, social forestry, active mining area, water bodies, and distribution of wasteland, agricultural land and forest in the leasehold area of the project. This will help in assessing the progressive status of mined land reclamation and to take up remedial measures, if any, required for environmental protection.

3. Salient Findings

- Four Clusters viz. I, IV, VII, X were selected in 2018-19 for land reclamation/restoration monitoring. These clusters consist of mainly opencast mines.

- Out of the total leasehold area of 5883.96 Ha., total mined out area is only 1075.76 Ha., belonging to the OC mines.

- It is evident from the analysis that 58.11% of excavated area is under technical reclamation and 35.02% of the excavated area is under active mining. Cluster wise details are given in Table-1 & Fig-1.

- 13.61% of total leasehold area has come under plantation (% green cover)

- Study reveals that out of total mine leasehold area of 5883.96 Ha. of the above mentioned 04 nos. clusters of BCCL taken up for the land reclamation monitoring during the year 2018-19; total excavated area is 1075.76 Ha. (18.28%) out of which 73.92 Ha. (6.87%) has been planted *(Biologically Reclaimed)*, 625.15 Ha. (58.11%) is under backfilling *(Technical Reclamation)* and

balance 376.69 Ha. (35.02%) is under active mining

- This report and the findings will act as the basis for further monitoring and reclamation related activities.

- Out of the four clusters of BCCL, maximum land reclamation has been done in Cluster VII (76.09%) followed by Cluster X (71.00%).

Table 1

Land Reclamation Status in Clusters of (Underground + Opencast) Projects of BCCL based on Satellite Data of the Year 2018

(Area in Hectare)

Sl. No.	Cluster No.	Total Leasehold Area	Technical Reclamation	Plantation			Area under Active Mining	Total Excavated Area	Total Area under Plantation (% Green Cover	Total Area under Reclamation
				Biological Reclamation	Other Plantations					
			Area under Backfilling	Plantation on Excavated / Backfilled Area	Plantation on External Over Burden Dumps	Social Forestry, Avanue Plantation Etc.				
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9 (=4+5+8)*	*10 (=5+6+7)*	*11(=4+5)*
1	Cluster I	575.00	10.11	7.29	47.99	25.53	28.39	45.78	80.80	17.40
			22.08%	15.91%			62.00%		14.05%	38.00%
2	Cluster IV	1123.79	147.22	0.00	27.11	165.09	166.67	313.88	192.20	147.22
			46.90%	0.00%			53.10%		17.10%	46.90%
3	Cluster VII	2127.70	351.54	37.47	15.52	238.67	122.23	511.24	291.67	389.01
			68.76%	7.33%			23.91%		13.71%	76.09%
4	Cluster X	2057.47	116.28	29.16	66.09	140.75	59.41	204.86	236.00	145.44
			56.76%	14.23%			29.00%		11.47%	71.00%
	TOTAL	**5883.96**	**625.15**	**73.92**	**156.71**	**570.04**	**376.69**	**1075.76**	**800.66**	**699.07**
			58.11%	**6.87%**			**35.02%**	**18.28%**	**13.61%**	**64.98%**

(% is calculated with respect to Excavated Area as applicable)

Note: In reference of the above Table, different parameters are classified as follows:

1. Area under Biological Reclamation includes Areas under Plantation done on Backfilled Area Only.
2. Area under Technical Reclamation includes Area under Barren Backfilling only
3. Area under Active Mining Includes Coal Quarry, Advance Quarry Site and Quarry filled with water etc., if any.
4. Social Forestry and Plantation on External OB Dumps are not included in Biological Reclamation and are put under separate categories as shown in the above Table.
5. (%) calculated in the above Table is in respect to Total Excavated Area except for “”Total Area under Plantation”” where % is in terms of “Leasehold Area””.

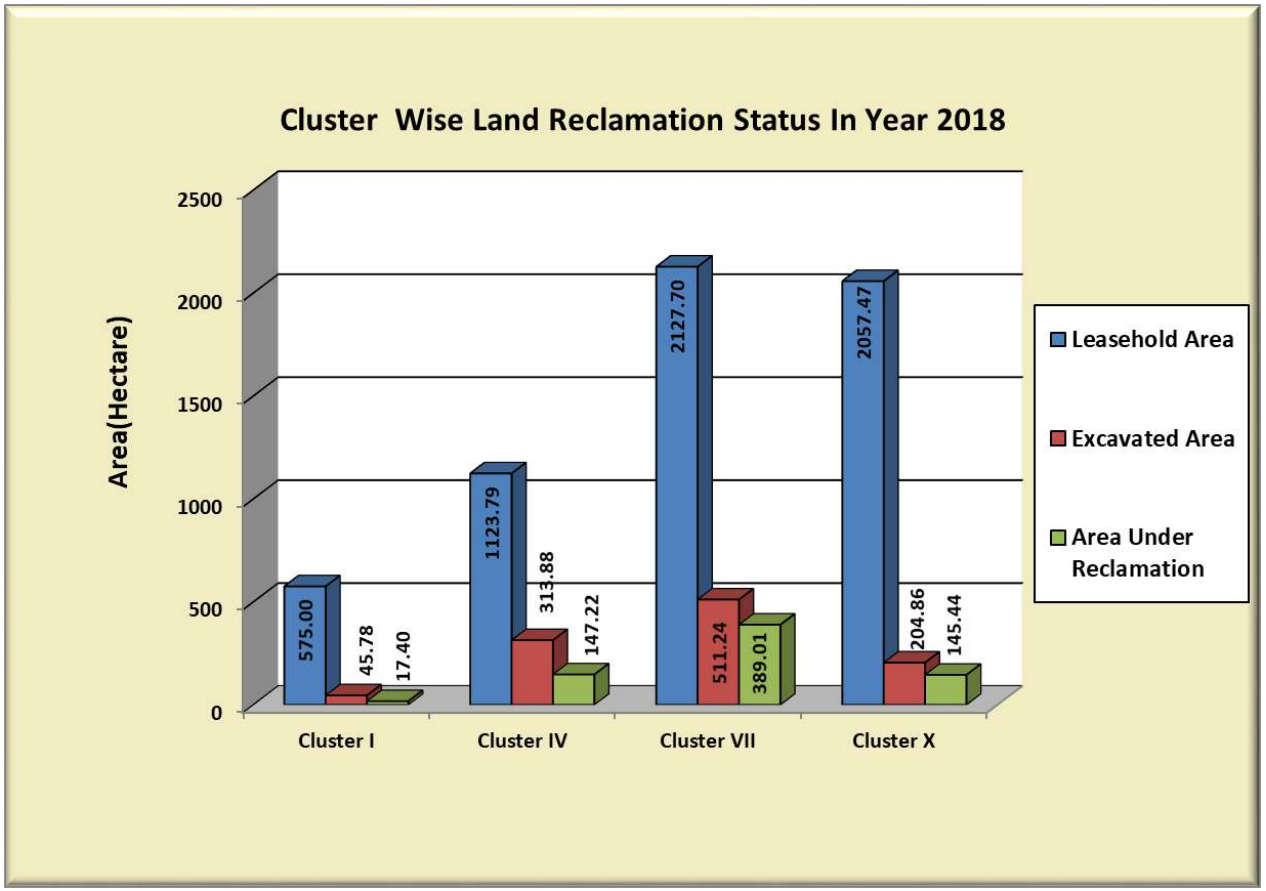


Fig. 1: Cluster wise Land Reclamation Status-2018 (BCCL)

1. Background

1.1 Land is the most important natural resource which embodies soil, water, flora, fauna and total ecosystem. All human activities are based on the land which is the scarcest natural resource in our country. Mining is a site specific industry and it could not be shifted anywhere else from the location where mineral occurs. It is a fact that surface mining activities do affect the land environment due to ground breaking. Therefore, there is an urgent need to reclaim and restore the mined out land for its productive use for sustainable development of mining. This will not only mitigate environmental degradation, but would also help in creating a more congenial environment for land acquisition by coal companies in future.

1.2 Keeping above in view, Coal India Ltd. (CIL) issued a work order vide letter no. CIL/WBP/ENV/2017/DP/8391 dated 22.06.2017 to Central Mine Planning & Design Institute (CMPDI), Ranchi, for monitoring of clusters with coal mines (both underground and open cast projects) having less than 5 million m^3 per annum capacity (Coal +OB) at an interval of three years based on remote sensing satellite data for sustainable development of mining. Earlier, CMPDI used to carry out land reclamation monitoring for individual projects of less than 5 million capacity, but from 2018 the same will be carried out cluster wise for mines of ECL & BCCL. For operational reasons and convenience, underground and opencast mines (often with multiple overlapping seams), have now been clustered together. The result of land reclamation status of all such mines are hosted on the website of CIL, (www.coalindia.in), CMPDI (www.cmpdi.co.in) and the concerned coal companies in public domain. Detailed report is submitted to Coal India and respective subsidiaries.

1.3 Land reclamation monitoring of all cluster coal mining projects would also comply the statutory requirements of Ministry of Environment & Forest (MoEF). Such monitoring would not only facilitate in taking timely mitigation measures against environmental degradation, but would also enable coal companies to utilize the reclaimed land for larger socio-economic benefits in a planned way.

1.4 Present report is embodying the finding of the study based on satellite data of the year 2018 carried out for four clusters of mines comprising both underground and OC projects for Bharat Coking Coal Ltd.

2. Objective

Objective of the land reclamation/restoration monitoring is to assess the area of backfilled, plantation, OB dumps, social forestry, active mining area, settlements and water bodies, distribution of wasteland, agricultural land and forest land in the leasehold area of the project. This is an important step taken up for assessing the progressive status of mined land reclamation and for taking up remedial measures, if any, required for environmental protection.

3. Methodology

There are number of steps involved between raw satellite data procurement and preparation of final map. National Remote Sensing Centre (NRSC) Hyderabad, being the nodal agency for satellite data supply in India, provides only raw digital satellite data, which needs further digital image processing for extracting the information and map preparation before uploading the same in the website. Methodology for land reclamation monitoring is given in fig 2. Following steps are involved in land reclamation /restoration monitoring:

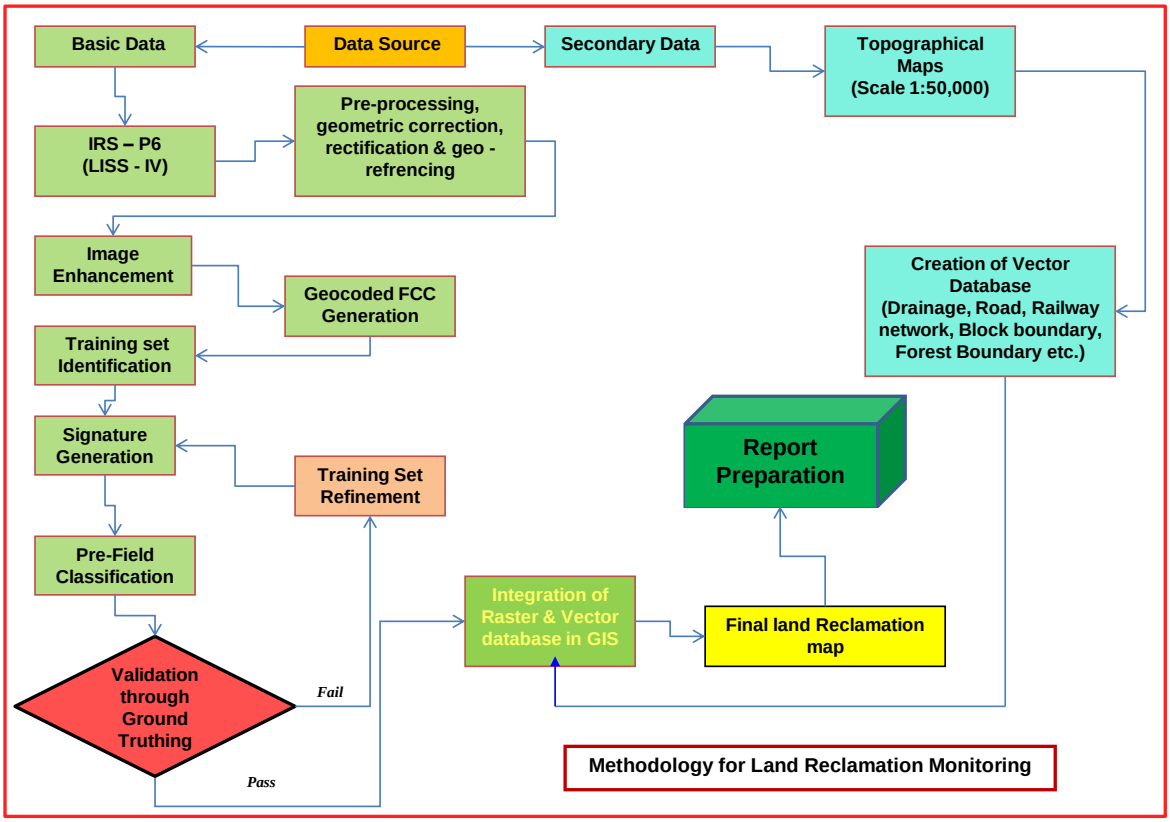


Fig. 2: Methodology of Land Reclamation Monitoring

3.1 **Data Procurement:** After browsing the data quality and date of pass on internet, supply order for data is placed to NRSC. Secondary data like leasehold boundary, toposheet are procured for creation of vector database.

3.2 **Satellite Data Processing:** Satellite data are processed using ERDAS IMAGINE digital image processing s/w. Methodology involves the following major steps:

- **Rectification & Geo-referencing:** Inaccuracies in digital imagery may occur due to 'systematic errors' attributed to earth curvature and rotation as well as 'non-systematic errors' attributed to satellite receiving station itself. Raw digital images contain geometric distortions, which make them

unusable as maps. Therefore, geo-referencing is required for correction of image data using ground control points (GCP) to make it compatible to SoI toposheet.

- **Image enhancement:**

  To improve the interpretability of the raw data, image enhancement is necessary. Local operations modify the value of each pixel based on brightness value of neighbouring pixels using ERDAS IMAGINE 14.0 s/w. and enhance the image quality for interpretation.

- **Training set selection**

  Training set requires to be selected, so that software can classify the image data accurately. The image data are analysed based on the interpretation keys. These keys are evolved from certain fundamental image-elements such as tone/colour, size, shape, texture, pattern, location, association and shadow. Based on the image-elements and other geo-technical elements like land form, drainage pattern and physiography; training sets were selected/identified for each land use/cover class. Field survey was carried out by taking selective traverses in order to collect the ground information (or reference data) so that training sets are selected accurately in the image. This was intended to serve as an aid for classification.

- **Classification and Accuracy assessment**

  Image classification is carried out using the maximum likelihood algorithm. The classification proceeds through the following steps: (a) calculation of statistics [i.e. signature generation] for the identified training areas, and (b) the decision boundary of maximum probability based on the mean vector, variance, covariance and correlation matrix of the pixels. After evaluating the statistical parameters of the training sets, reliability test of training sets is conducted by measuring the statistical separation between

the classes that resulted from computing divergence matrix. The overall accuracy of the classification was finally assessed with reference to ground truth data.

- **Area calculation**

  The area of each land use class in the leasehold is determined using ERDAS IMAGINE v. 14.0 s/w.

- **Overlay of Vector data base**

  Vector data base is created based on secondary data. Vector layer like drainage, railway line, leasehold boundary, forest boundary etc. are superimposed on the image as vector layer in the Arc GIS database.

- **Pre-field map preparation**

  Pre-field map is prepared for validation of the classification result

3.3 Ground Truthing:

Selective ground verification of the land use classes are carried out in the field and necessary corrections if required, are incorporated before map finalization.

3.4 Land reclamation database on GIS:

Land reclamation database is created on GIS platform to identify the temporal changes identified from satellite data of different cut - of dates.

4. Land Reclamation Status in Bharat Coking Coal Ltd.

4.1 In BCCL, a total of twelve clusters of mines are selected for land reclamation monitoring. Following four clusters of mines comprising both underground and OC projects of Bharat Coking Coal Ltd. have been taken up for land reclamation monitoring in 2018.

- Cluster I (Damoda OCP)
- Cluster IV (Salanpur Colliery, Katras Choitudih Colliery, Gaslitand Colliery, Amalgamated Keshalpur West Mudidih Colliery, Angarpathra Colliery & Ramkanali Colliery)
- Cluster VII (Amalgamated East Bhuggatdih Simlabahal Colliery, Ena OC, Vishwakarma OCP, Kustore OCP)
- Cluster X (Bhowrah North, Bhowrah South, Patherdih)

4.2 All the four above clusters, have been mapped during the year 2018 for assessing the progress of land reclamation.

4.3 Area statistics of different land use classes present in OC projects till the year 2018 is given in Table 2. Land use maps derived from the satellite data are given in Plate nos.1, 2, 3 & 4. The land use status are shown in Fig. 3, 4, 5 & 6.

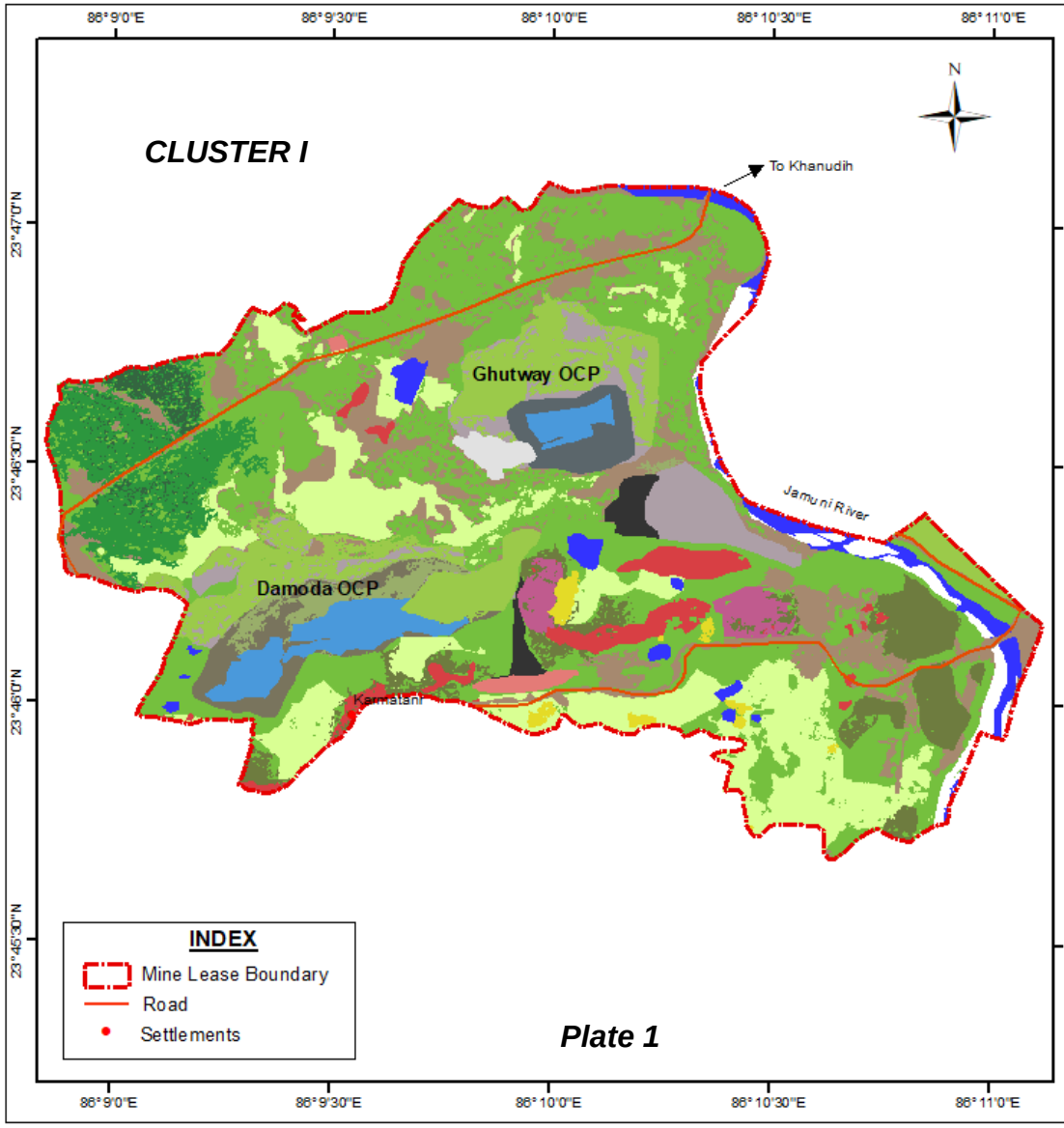
4.4 Study reveals that majority of the mines under the clusters considered for monitoring are of opencast type. 35.02% of excavated area is under active mining in the opencast mines. 58.11% of the excavated area have come under technical reclamation till 2018

Table 2

Status of Land Use/Reclamation Status in Clusters of (OC + Underground) mines of Bharat Coking Coal Limited based on Satellite Data of the year 2018

(Area in Hectare)

		CLUSTER I		CLUSTER IV		CLUSTER VII		CLUSTER X		TOTAL	
		Area	%	Area	%	Area	%	Area	%	Area	%
FORESTS	Dense Forest	5.36	0.93	0.00	0.00	0.00	0.00	0.00	0.00	5.36	0.09
	Open Forest	29.81	5.18	0.00	0.00	0.00	0.00	180.80	8.79	210.61	3.58
	Total Forest	35.17	6.12	0.00	0.00	0.00	0.00	180.80	8.79	215.97	3.67
SCRUBS	Scrubs	194.77	33.87	154.53	13.75	618.49	29.07	559.57	27.20	1527.35	25.96
PLANTATION	Social Forestry/Avenue Plantation	25.53	4.44	165.09	14.69	238.67	11.22	140.75	6.84	570.04	9.69
	Plantation on OB Dump	47.99	8.35	27.11	2.41	15.52	0.73	66.09	3.21	156.71	2.66
	Plantation on Backfill (Biological Reclamation)	7.29	1.27	0.00	0.00	37.47	1.76	29.16	1.42	73.92	1.26
	Total Plantation	80.80	14.05	192.20	17.10	291.67	13.71	236.00	11.47	800.66	13.61
	Total Vegetation	**310.75**	**54.04**	**346.73**	**30.85**	**910.15**	**42.78**	**976.37**	**47.45**	**2543.99**	**43.24**
	Coal Dump	5.26	0.91	20.40	1.82	16.03	0.75	2.84	0.14	44.53	0.76
ACTIVE MINING	Coal Quarry	8.79	1.53	158.87	14.14	119.18	5.60	46.10	2.24	332.94	5.66
	Advance Quarry Site	3.24	0.56	0.00	0.00	0.00	0.00	0.00	0.00	3.24	0.06
	Quarry Filled With Water	16.36	2.84	7.80	0.69	3.05	0.14	13.31	0.65	40.52	0.69
	Total Area under *Active Mining*	**28.39**	**4.93**	**166.67**	**14.83**	**122.23**	**5.74**	**59.41**	**2.89**	**376.69**	**6.40**
	Barren OB Dump	20.58	3.58	154.32	13.73	75.79	3.56	89.57	4.35	340.25	5.78
RECLAIMED	Area Under Backfilling (Technical Reclamation)	10.11	1.76	147.22	13.10	351.54	16.52	116.28	5.65	625.15	10.62
	Total Area under *Technical Reclamation*	**10.11**	**1.76**	**147.22**	**13.10**	**351.54**	**16.52**	**116.28**	**5.65**	**625.15**	**10.62**
	Total Area under Mine Operation	**64.33**	**11.19**	**488.60**	**43.48**	**565.59**	**26.58**	**268.10**	**13.03**	**1386.62**	**23.57**
WASTELAND	Waste Lands	69.03	12.00	51.99	4.63	162.76	7.65	153.62	7.47	437.40	7.43
	Fly Ash Pond / Sand Body	9.94	1.73	0.00	0.00	0.00	0.00	44.69	2.17	54.63	0.93
	Total Wasteland	**78.97**	**13.73**	**51.99**	**4.63**	**162.76**	**7.65**	**198.30**	**9.64**	**492.02**	**8.36**
WATERBODIES	Reservoir, nallah, ponds	14.43	2.51	14.84	1.32	18.39	0.86	194.65	9.46	242.30	4.12
	Total Waterbodies	**14.43**	**2.51**	**14.84**	**1.32**	**18.39**	**0.86**	**194.65**	**9.46**	**242.30**	**4.12**
AGRICULTURE	Crop Lands	3.52	0.61	3.45	0.31	37.65	1.77	18.29	0.89	62.91	1.07
	Fallow Lands	79.43	13.81	34.97	3.11	20.73	0.97	91.05	4.43	226.18	3.84
	Total Agriculture	**82.95**	**14.43**	**38.42**	**3.42**	**58.37**	**2.74**	**109.35**	**5.31**	**289.09**	**4.91**
SETTLEMENTS	Urban Settlement	7.17	1.25	160.59	14.29	380.73	17.89	228.39	11.10	776.88	13.20
	Rural Settlement	13.83	2.41	22.63	2.01	9.93	0.47	57.90	2.81	104.29	1.77
	Industrial Settlement	2.58	0.45	0.00	0.00	21.79	1.02	24.42	1.19	48.80	0.83
	Total Settlement	**23.58**	**4.10**	**183.21**	**16.30**	**412.45**	**19.38**	**310.71**	**15.10**	**929.96**	**15.80**
	Grand Total	**575.00**	**100.00**	**1123.79**	**100.00**	**2127.70**	**100.00**	**2057.47**	**100.00**	**5883.96**	**100.00**



Area Statistics - Cluster-I (2018)				
Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forests	Dense Forest		5.36	0.93
	Open Forest		29.81	5.18
	Total Forest (A)		**35.17**	**6.12**
	Scrubs (B)		**194.77**	**33.87**
Plantation Area	Social Forestry		25.53	4.44
	Plantation on OB		47.99	8.35
	Plantation on Backfill		7.29	1.27
	Total Plantation (C)		**80.80**	**14.05**
	Total Vegetation (A+B+C)		**310.75**	**54.04**
Agriculture Land	Crop land		3.52	0.61
	Fallow Land		79.43	13.81
	Total Agriculture Land		**82.95**	**14.43**
Waste Land	Waste Land		69.03	12.00
	Sand Body		9.94	1.73
	Total Waste Land		**78.97**	**13.73**
Mining Area	Advance Quarry area		3.24	0.56
	Coal Quarry		8.79	1.53
	Barren OB Dump		20.58	3.58
	Back Fill		10.11	1.76
	Coal Dump		5.26	0.91
	Water Filled Qry		16.36	2.84
	Total Mining Area		**64.33**	**11.19**
Settlements	Urban Settlements		7.17	1.25
	Rural Settlements		13.83	2.41
	Industrial Settlements		2.58	0.45
	Total Settlement Area		**23.58**	**4.10**
Water Body	**River/ Ponds**		**14.43**	**2.51**
	Total Area		**575.00**	**100.00**

Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of Cluster Mines				Job No. 561410027
Subject: Land Reclamation Status of Cluster-I mines, based on Satellite Data (RS-2/L-IV) of the year 2018	Activity	Name	Designation	Signature	Date
	Prepared	A. Mandal	M.T (Geology)		
	Checked	Hariharalal B	Sr. Mgr(System)		
	Approved	R. Kumar	HOD(Geomatics)		
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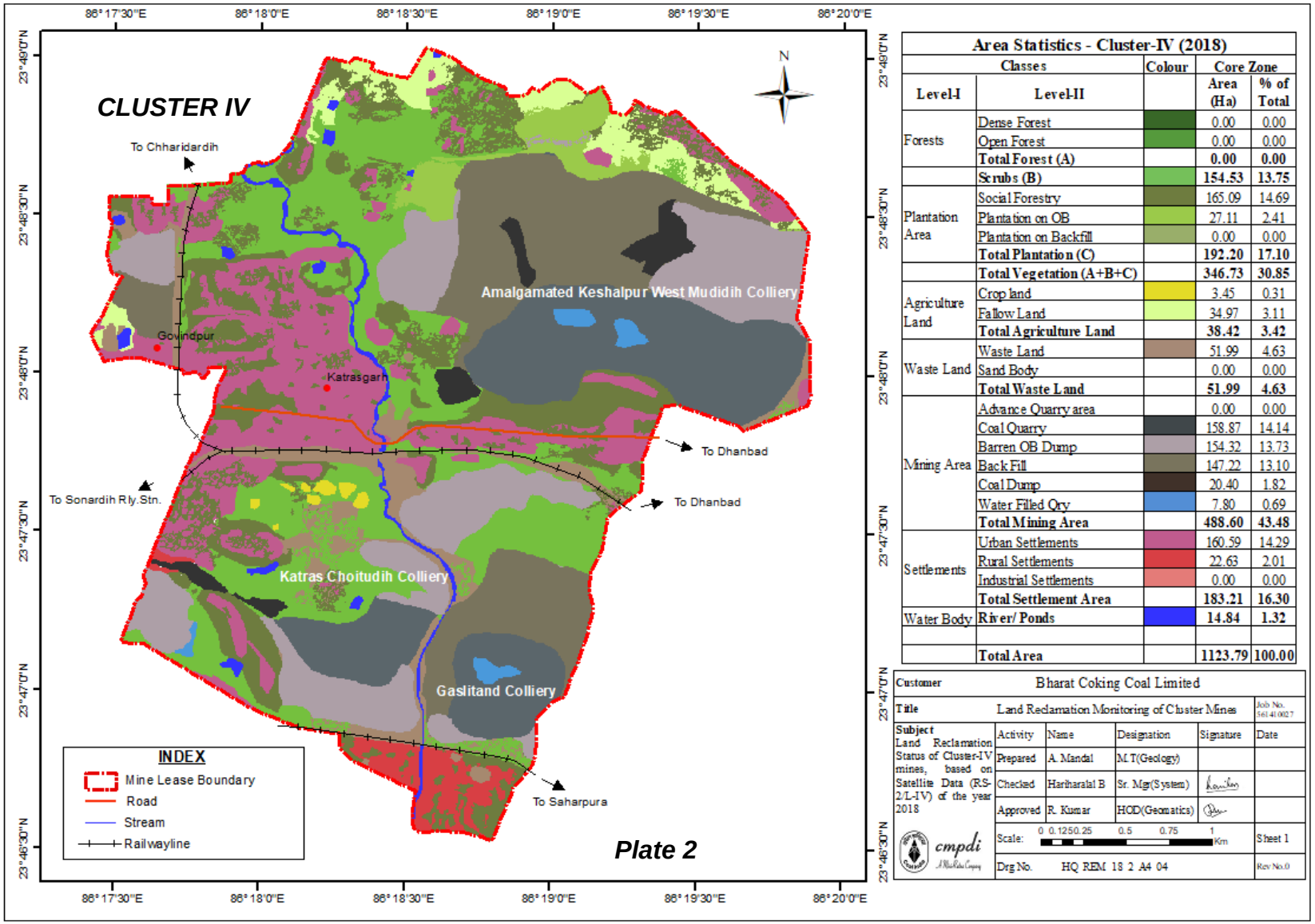

Area Statistics - Cluster-IV (2018)

Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forests	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
	Scrubs (B)		**154.53**	**13.75**
Plantation Area	Social Forestry		165.09	14.69
	Plantation on OB		27.11	2.41
	Plantation on Backfill		0.00	0.00
	Total Plantation (C)		**192.20**	**17.10**
	Total Vegetation (A+B+C)		**346.73**	**30.85**
Agriculture Land	Crop land		3.45	0.31
	Fallow Land		34.97	3.11
	Total Agriculture Land		**38.42**	**3.42**
Waste Land	Waste Land		51.99	4.63
	Sand Body		0.00	0.00
	Total Waste Land		**51.99**	**4.63**
Mining Area	Advance Quarry area		0.00	0.00
	Coal Quarry		158.87	14.14
	Barren OB Dump		154.32	13.73
	Back Fill		147.22	13.10
	Coal Dump		20.40	1.82
	Water Filled Qry		7.80	0.69
	Total Mining Area		**488.60**	**43.48**
Settlements	Urban Settlements		160.59	14.29
	Rural Settlements		22.63	2.01
	Industrial Settlements		0.00	0.00
	Total Settlement Area		**183.21**	**16.30**
Water Body	**River/ Ponds**		**14.84**	**1.32**
	Total Area		**1123.79**	**100.00**

Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of Cluster Mines				Job No. 561410027
Subject: Land Reclamation Status of Cluster-IV mines, based on Satellite Data (RS-2/L-IV) of the year 2018	Activity	Name	Designation	Signature	Date
	Prepared	A. Mandal	M.T(Geology)		
	Checked	Hariharalal B	Sr. Mgr(System)		
	Approved	R. Kumar	HOD(Geomatics)		
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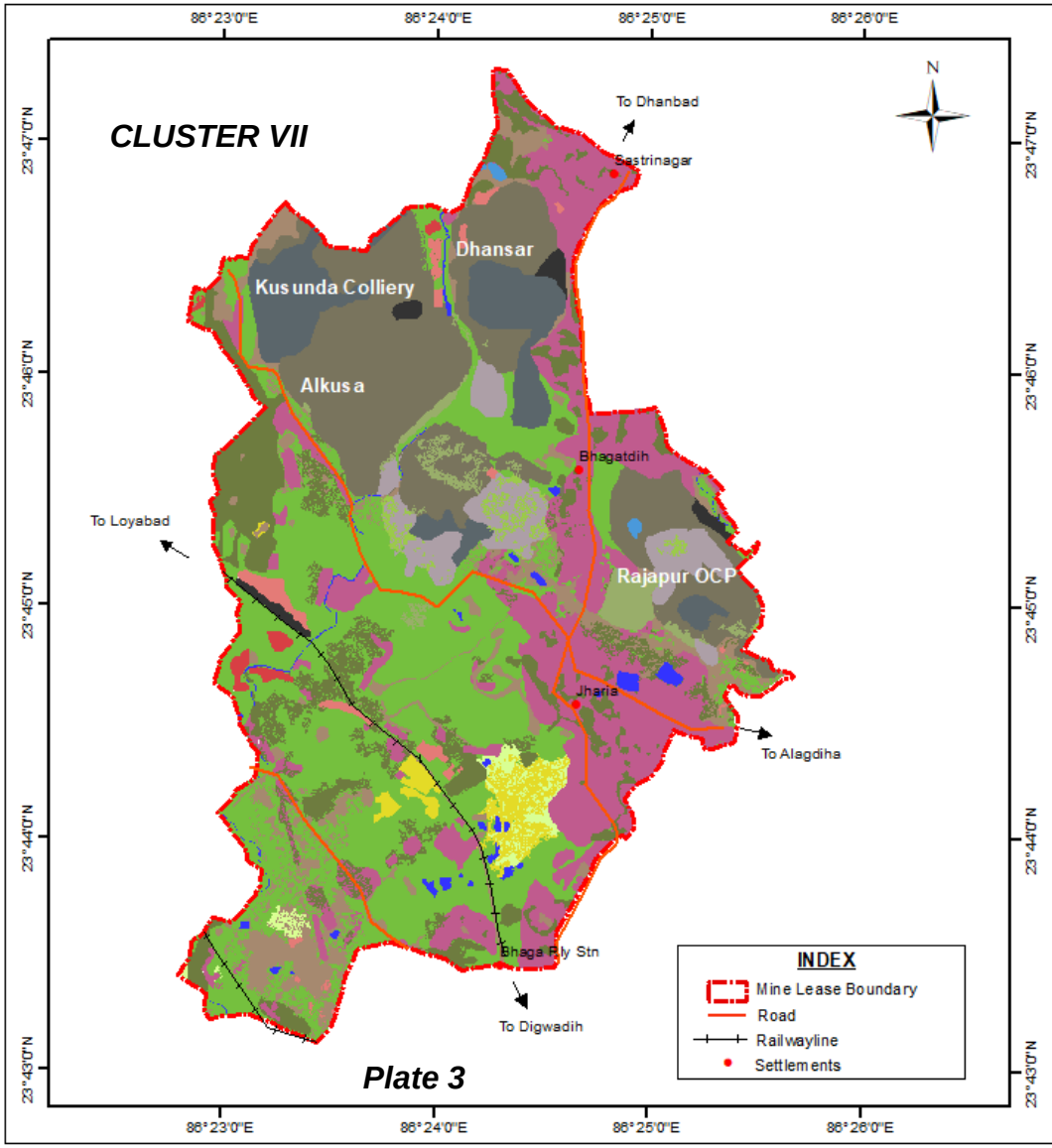

Area Statistics - Cluster-VII (2018)

Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forests	Dense Forest		0.00	0.00
	Open Forest		0.00	0.00
	Total Forest (A)		**0.00**	**0.00**
	Scrubs (B)		**618.49**	**29.07**
Plantation Area	Social Forestry		238.67	11.22
	Plantation on OB		15.52	0.73
	Plantation on Backfill		37.47	1.76
	Total Plantation Area (C)		**291.67**	**13.71**
	Total Vegetation (A+B+C)		**910.15**	**42.78**
Agriculture Land	Crop land		37.65	1.77
	Fallow Land		20.73	0.97
	Total Agriculture Land		**58.37**	**2.74**
Waste Land	Waste Land		162.76	7.65
	Sand Body		0.00	0.00
	Total Waste Land		**162.76**	**7.65**
Mining Area	Advance Quarry area		0.00	0.00
	Coal Quarry		119.18	5.60
	Barren OB Dump		75.79	3.56
	Back Fill		351.54	16.52
	Coal Dump		16.03	0.75
	Water Filled Qry		3.05	0.14
	Total Mining Area		**565.59**	**26.58**
Settlements	Urban Settlements		380.73	17.89
	Rural Settlements		9.93	0.47
	Industrial Settlements		21.79	1.02
	Total Settlement Area		**412.45**	**19.38**
Water Body	**River/ Ponds**		**18.39**	**0.86**
	Total Area		**2127.70**	**100.00**

Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of Cluster Mines				Job No. 561410027
Subject: Land Reclamation Status of Cluster-VII mines, based on Satellite Data (RS-2/L-IV) of the year 2018	Activity	Name	Designation	Signature	Date
	Prepared	A. Mandal	M.T(Geology)		
	Checked	Hariharalal B	Sr. Mgr(System)		
	Approved	R. Kumar	HOD(Geomatics)		
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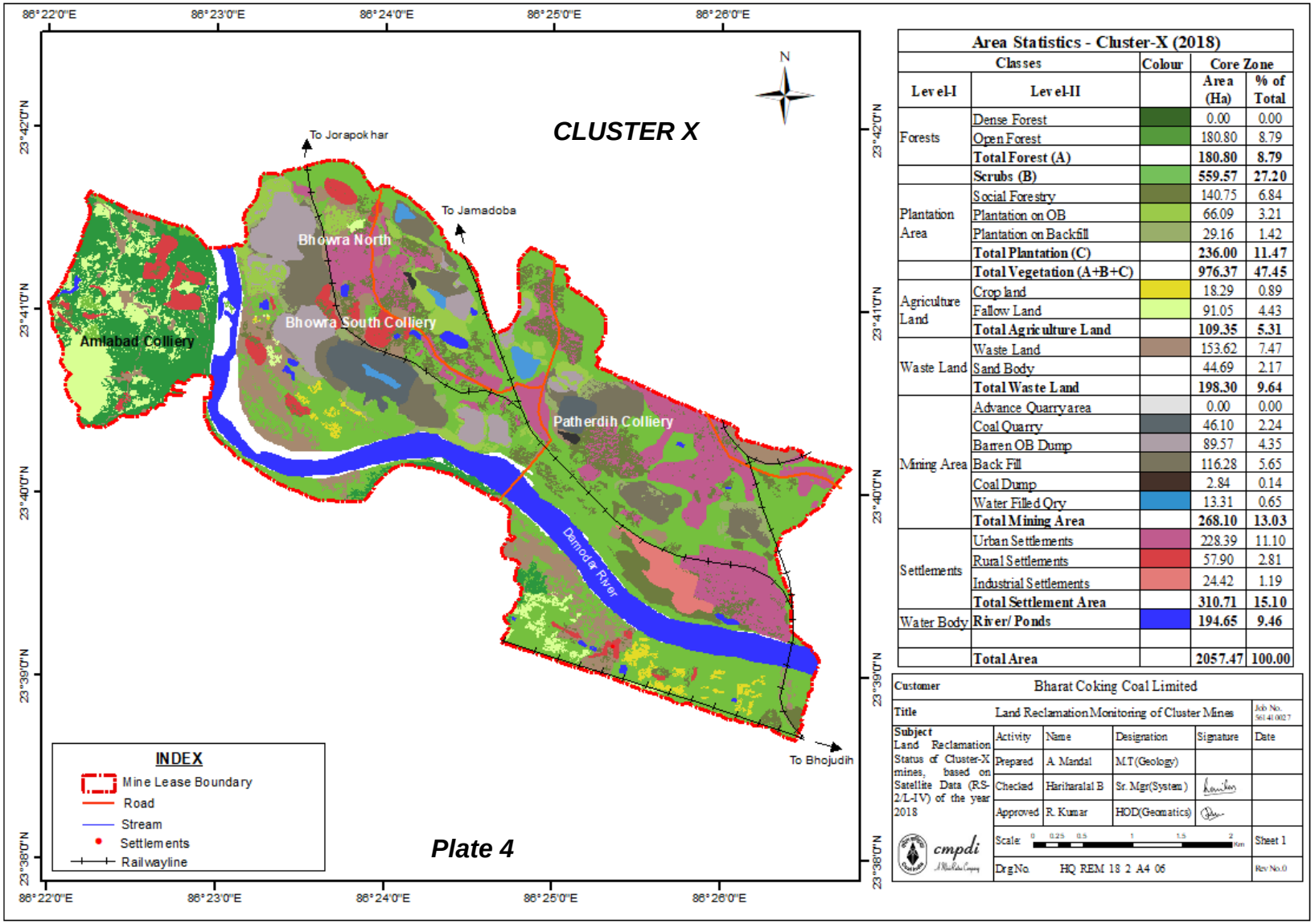

Area Statistics - Cluster-X (2018)

Classes		Colour	Core Zone	
Level-I	Level-II		Area (Ha)	% of Total
Forests	Dense Forest		0.00	0.00
	Open Forest		180.80	8.79
	Total Forest (A)		**180.80**	**8.79**
	Scrubs (B)		**559.57**	**27.20**
Plantation Area	Social Forestry		140.75	6.84
	Plantation on OB		66.09	3.21
	Plantation on Backfill		29.16	1.42
	Total Plantation (C)		**236.00**	**11.47**
	Total Vegetation (A+B+C)		**976.37**	**47.45**
Agriculture Land	Crop land		18.29	0.89
	Fallow Land		91.05	4.43
	Total Agriculture Land		**109.35**	**5.31**
Waste Land	Waste Land		153.62	7.47
	Sand Body		44.69	2.17
	Total Waste Land		**198.30**	**9.64**
Mining Area	Advance Quarry area		0.00	0.00
	Coal Quarry		46.10	2.24
	Barren OB Dump		89.57	4.35
	Back Fill		116.28	5.65
	Coal Dump		2.84	0.14
	Water Filled Qry		13.31	0.65
	Total Mining Area		**268.10**	**13.03**
Settlements	Urban Settlements		228.39	11.10
	Rural Settlements		57.90	2.81
	Industrial Settlements		24.42	1.19
	Total Settlement Area		**310.71**	**15.10**
Water Body	**River/ Ponds**		**194.65**	**9.46**
	Total Area		**2057.47**	**100.00**

Customer	Bharat Coking Coal Limited				
Title	Land Reclamation Monitoring of Cluster Mines				Job No. 561410027
Subject: Land Reclamation Status of Cluster-X mines, based on Satellite Data (RS-2/L-IV) of the year 2018	Activity	Name	Designation	Signature	Date
	Prepared	A. Mandal	M.T (Geology)		
	Checked	Hariharalal B	Sr. Mgr(System)		
	Approved	R. Kumar	HOD(Geomatics)		
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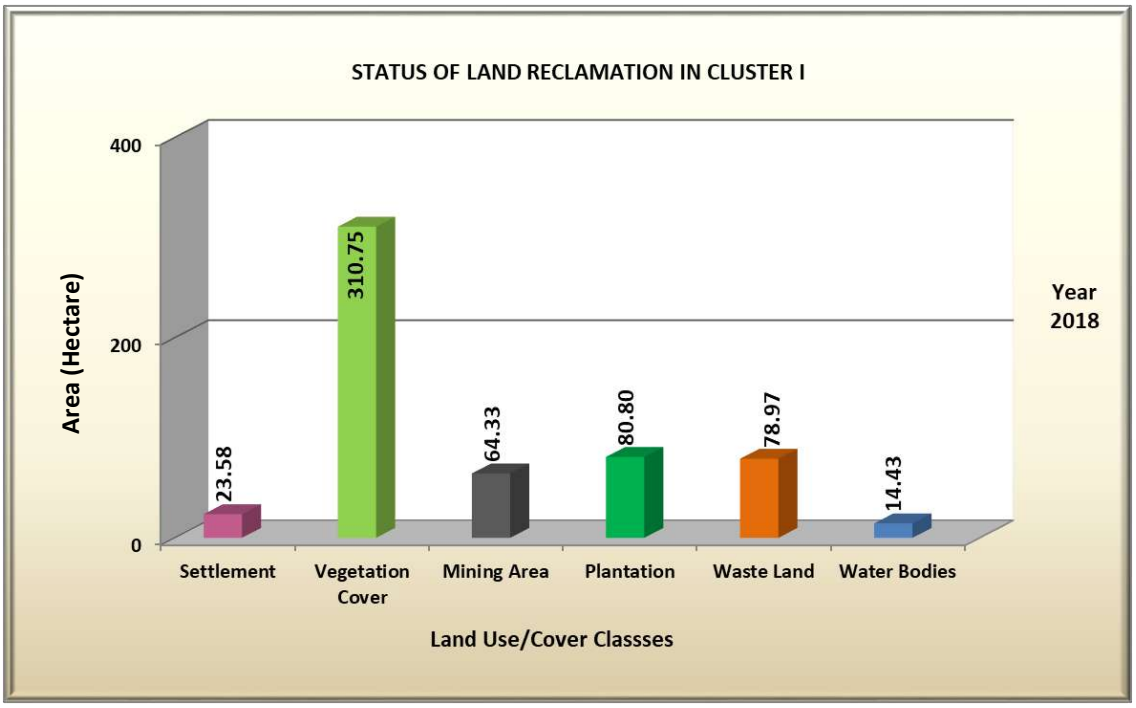

Fig. 3: Land Reclamation status of Cluster I

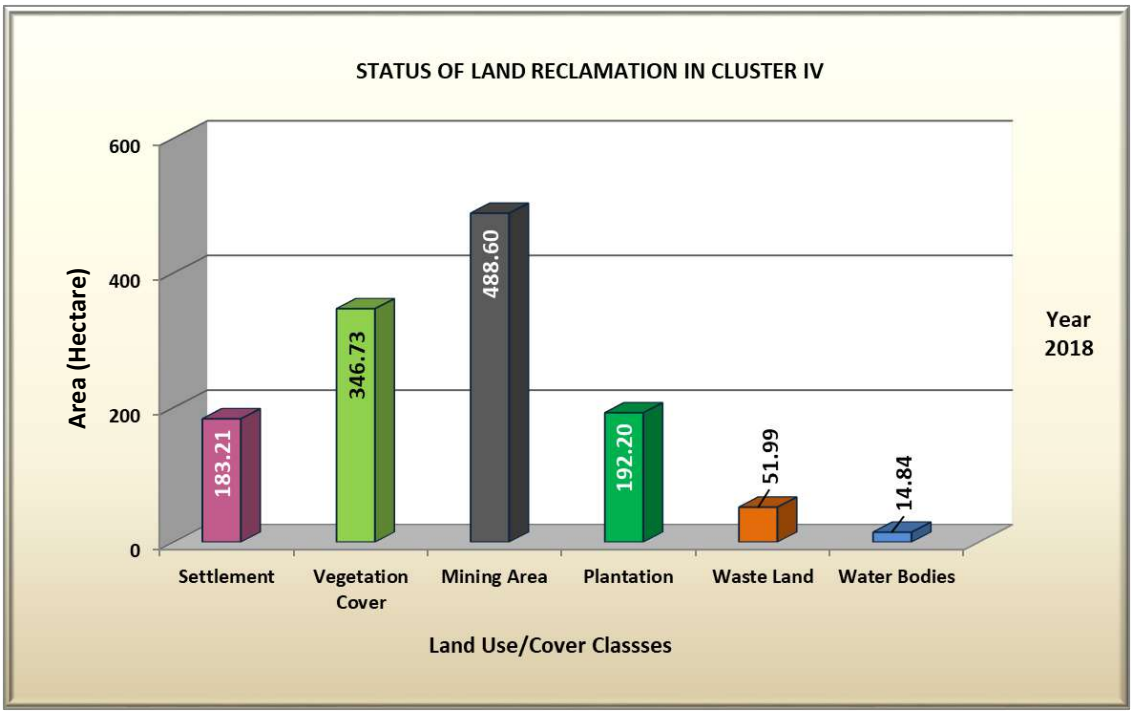

Fig. 4: Land Reclamation status of Cluster IV

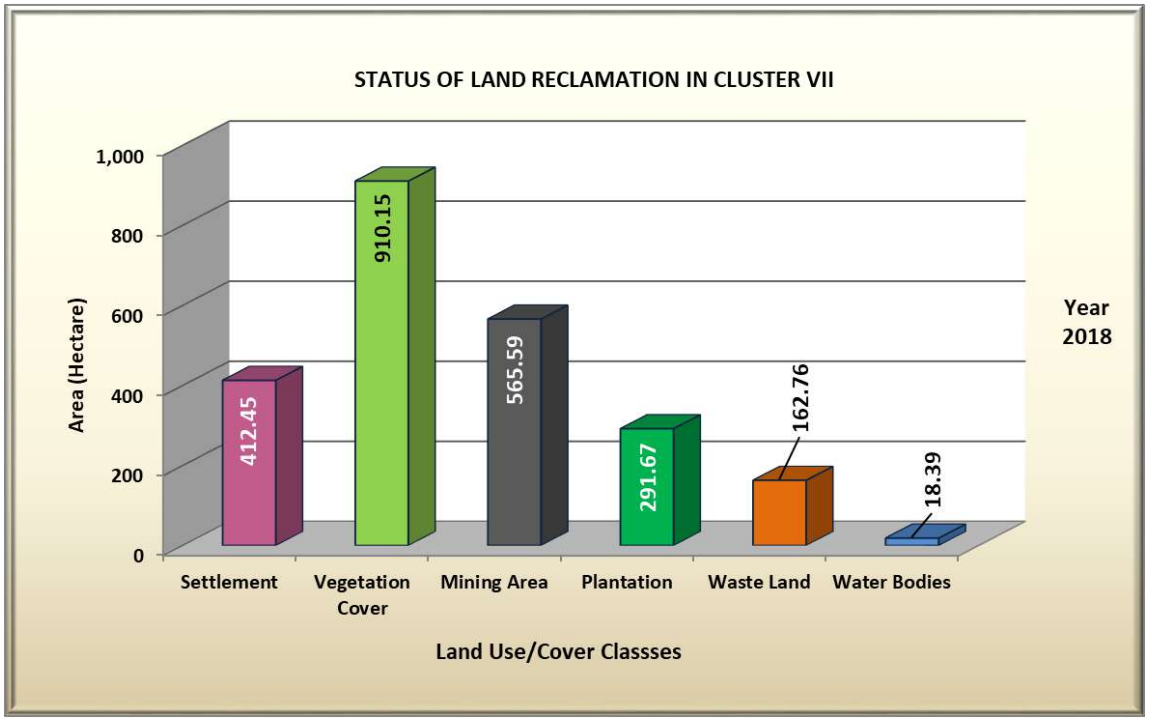

Fig. 5: Land Reclamation status of Cluster VII

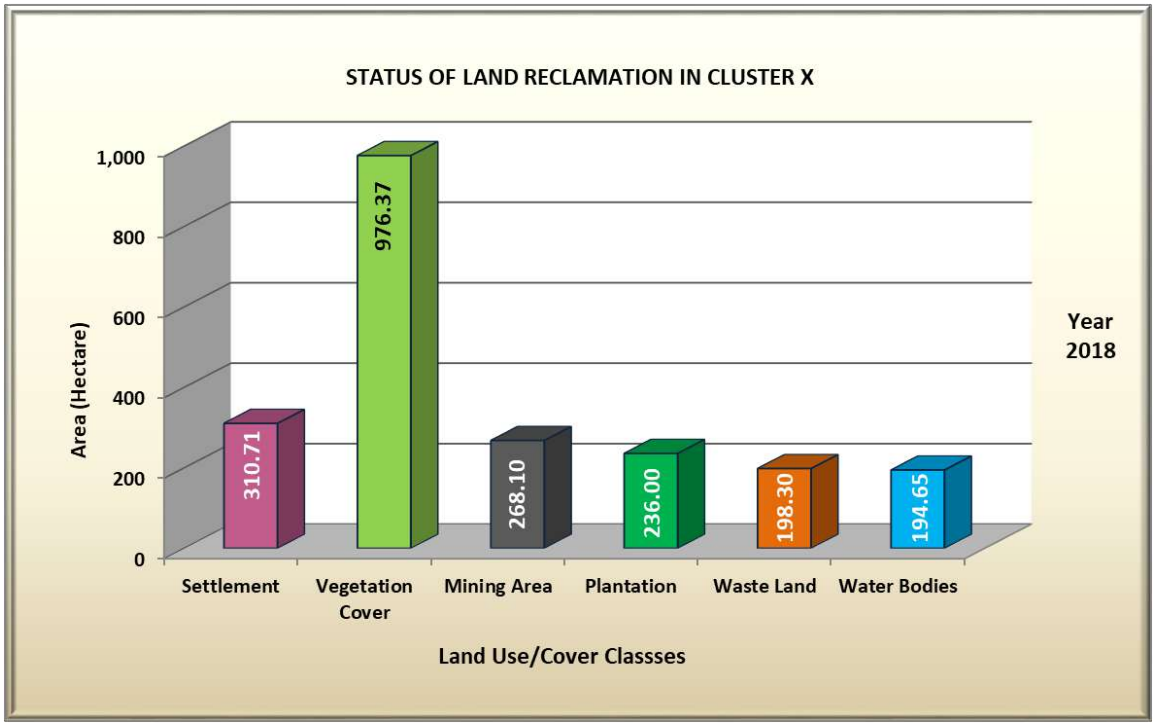

Fig. 6: Land Reclamation status of Cluster X

Photo 1: Ecological Restoration Site, Damoda Colliery, Cluster I

Photo 2: Ecological Restoration Site in Cluster IV

Photo 3: Ecological Restoration Site in Cluster VII

Photo 4: Plantation on OB in Cluster X

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CSR Booklet

Barora Area

Bharat Coking Coal Limited

Contents

1.0 INTRODUCTION

Coal India has adopted CSR as a strategic tool for sustainable growth. For Coal India in the present context, CSR means not only investment of funds for Social Activity but also Integration of Business processes with Social processes. Even much before the issue of CSR became global concern; Coal India was aware of its Corporate Social Responsibility and was fulfilling the aspiration of the Society through well-defined "Community Development Policy" within the periphery of 8 Kms. of the Project sites. This has resulted into a harmonious relationship between Coal India and the peripheral Communities. Coal India has identified land outsee, PAP and those staying within the radius of 25 Kms of the Project as primary beneficiaries. Poor and needy section of the society living in different parts of India is second beneficiaries. For carrying out CSR activities, 80% of the budgeted amount are be spent within the radius of 25 Km of the Project Site/Mines/Area HQ/Company HQ and 20% of the budget to be spent within the States in which operating.

2.0 SCOPE

As per Schedule VII of New Companies Act 2013 the following should be the Scope of Activities under Corporate Social Activities:

1) Eradicating hunger, poverty and malnutrition, promoting healthcare including preventive health care and sanitation and making available safe drinking water.
2) Promoting education, including special education and employment enhancing vocation skills especially among children, women, elderly, and differently able and livelihood enhancement projects.
3) Promoting gender equality, empowering women, setting up homes and hostels for women and orphans, setting up old age homes, day care centers and such other facilities for senior citizens and measures for reducing inequalities faced by socially and economically backward groups.
4) Ensuring environmental sustainability, ecological balance, protection of Flora and Fauna, animal welfare, agro-forestry, conservation of natural resources and maintaining quality of soil, air and water.
5) Protection of national heritage, art and culture including restoration of buildings and sites of historical importance and works of art; setting up public libraries, promotion and development of traditional arts and handicrafts.
6) Measures for the benefit of armed forces veterans, war widows and their dependents
7) Training to promote rural sports, nationally recognized sports, Paralympics sports and Olympic Sports.
8) Contribution to the Prime Minister's National Relief Fund or any other fund set up by the Central Government for socio-economic development and relief and welfare of the Scheduled Castes, the Scheduled Tribes, other backward classes, minorities and women.
9) Contributions or funds provided to technology incubators located within academic institutions which are approved by the Central Government.
10) Rural development projects.

3.0 SOURCE OF FUND

The fund for the CSR should be allocated based on 2% of the average net profit of the Company for the three immediate preceding financial years or Rs. 2.00 per tonne of Coal Production of previous year whichever is higher.

4.0 ACTION PLAN FOR CORPORATE SOCIAL RESPONSIBILITY

When the EC was granted, it was estimated as per prevailing policy, 5% of the retained earnings of the previous year subject to minimum of Rs. 5 per tonne of coal production of the previous year will be provided for Corporate Social Responsibility (CSR).

5.0 STATUS OF CSR ACTIVITIES

5.1 Medical Camps:

(A) During FY 2014-15:

SN	Month	No. of Medical Camp	Beneficiaries	Amount (in Rs.)
1	April 14	24	538	6074.02
2	May 14	15	555	6265.95
3	June 14	17	423	4775.67
4	July 14	11	300	3387.00
5	August 14	13	422	4764.38
6	September 14	19	630	7112.70
7	October 14	14	415	4685.35
8	November 14	15	350	3951.50
9	December 14	15	413	4662.77
10	January 15	10	257	2921.52
11	February 15	17	517	5836.93
12	March 15	11	324	3657.96
	Total	**181**	**5144**	**58095.75**

(B)During FY 2015-16:

SN	Month	No. of Medical Camp	Beneficiaries	Amount (in Rs.)
1	April 15	12	325	3669.25
2	May 15	12	289	3262.81
3	June 15	13	335	3782.15
4	July 15	14	452	5103.08
5	August 15	12	348	3928.92
6	September 15	9	265	2991.85
7	October 15	9	360	4064.40
8	November 15	9	305	3443.45
9	December 15	6	148	1670.92
10	January 16	12	291	3285.39
11	February 16	11	229	2585.41
12	March 16	2	50	564.50
	Total	**121**	**3397**	**38352.13**

(C) **During FY 2016-17:**

SN	Month	Beneficiaries	Amount (in Rs.)
1	May 16	243	13463.00
2	Nov 16	352	16857.00
	Total	**595**	**30320.00**

(D) **During FY 2017-18: NIL**

5.2 Health Awareness Programme:

(A) **During 2014-15:**

SN	Date	Activities	Amount (in Rs.)
1	25.04.2014	Nasa Mukti Abhiyan	10000.00
2	06.06.2014	Blood Pressure Detection	5000.00
4	30.07.2014	Aids Awareness Programme	5000.00
5	20.11.2014	Eye Checkup camp	25000.00

5.3 CSR Clinics :

SN	Month	Beneficiaries 2014-15	Beneficiaries 2015-16	Beneficiaries 2016-17	Beneficiaries 2017-18
1	April	121	115	307	113
2	May	112	101	70	98
3	June	137	152	164	115
4	July	153	132	260	161
5	August	101	120	149	127
6	September	531	109	139	169
7	October	83	86	139	99
8	November	85	87	241	66
9	December	73	80	207	99
10	January	67	80	99	73
11	February	102	158	55	77
12	March	95	81	65	96
	Total	**1660**	**1301**	**1895**	**1293**

5.4 Civil work under CSR:

(A) **During 2014-15:**

S. N.	Details	Award value (In Lac)	Remarks
1	Construction of PCC road at Gonduadih west under Mohanpur village (from Khalil Mahto home to Primary school).	3.98	25.01.2015 to 24.03.2015 (60 days)
2	Construction of Janaja shed at Ramakunda west under Amtand village	3.15	15.10.2014 to 14.12.2014 (60 days)
3	Construction of 1 no. chhathh ghat at Muraidih colony, Hirak road river side	3.01	15.10.2014 to 14.12.2014 (60 days)
4	Construction of Janaja shed at Muraidih colony near river of Hirak road	0.46	31.03.2014 to 29.04.2014 (30 days)
	PCC Road jhunu Rajwar House to Tarkeswar Gope House at Bakaspura Village Luti Pahari (Jhunu Tarkeshwar)Road Length:-	2.30	This is benefiting to approx. 200 families in this locality by all-weather connectivity.
	Making PCC Path from Manoj Matha House to Sahabuddin Ansari house at Ghunghusa Village (Mahato Shahbhuddin)	1.85	This is benefiting to approx. 300 families in this locality by all-weather connectivity
	Steps for Ghat at sarbandh near hirak chowk under B-II Area	2.67	This will ease in performing rituals by local villages of Dumara ,harina & Bada pandeydih.
	Cutting of earth from pond at Chaudhary bandh at Harina Basti,under B-II Area	19.22	This is benefiting to approx 5000 persons in this locality. This pond is used for multipurpose like irrigation,water for households drinking water for animals etc.it will also maintain the water leval in locality.
	Drinking Water pipe line works in hadi basti at Bhamkanali.	0.44	This is benefiting to approx. 150 families in this locality
	Rep/Maint of Hand pump at Bara pandeydih (08 Nos).	0.26	This is benefiting to approx. 500 persons in this locality
	Development work at rehabilitation site at Bhimkanali.	6.45	This is benefiting to approx. 500 persons in this locality
	Construction of community hall at Bara Pandeydih Village Under Block-II Area	11.9	This is benefiting to approx. 1000 persons in this locality
	Surplus mine water supply from Xth seam & Madhuban quarrey of B-II Area Khonathi Pond	400	This is a multipurpose project to provide water for irrigation & other agricultural use along with maintaining water availability throughout the year along with developing a tourist destination in long run.

(B) **During 2015-16:**

S.N.	Details	Award value (In Lac)	Remarks
1	Rep. Of Main road & Drain at Bakashpura rehabilitation site.	9.71	This is benefiting to approx. 1500 persons in this locality
2	Engagement of tankers for drinking water supply in nearby villages of B-II Area	1.9	This is benefiting to approx. 2000 families in Viallages like Benidih Baghmara, Luttipahadi, Harina, Kessurgarh, Rathtand, Nudkhurkee,Pinalgarhia,Mandra.
3	Engagement of departmental tankers for drinking water supply in nearby villages of B-II Area as on need bais.	-	This is benefiting to approx. 2000 families in Viallages like Benidih Baghmara, Luttipahadi Kessurgarh, Madhuban Etc.

(B) **During 2016-17:**

S.N.	Details	Award value (In Lac)	Remarks
1	Construction and maintenance for 5 years of toilets in Government schools in Gumla District under Swachh Vidyalaya Abhiyan. 125 toilets in 69 schools were constructed.	191.67	This is benefiting to approx. 7500 students
2	Construction and maintenance for 5 years of toilets in Government schools in Bokaro District under Swachh Vidyalaya Abhiyan. 179 toilets in 181 schools were constructed.	1702.98	This is benefiting to approx. 10000 students

6.0 COAL TRANSPORTATION PLAN:

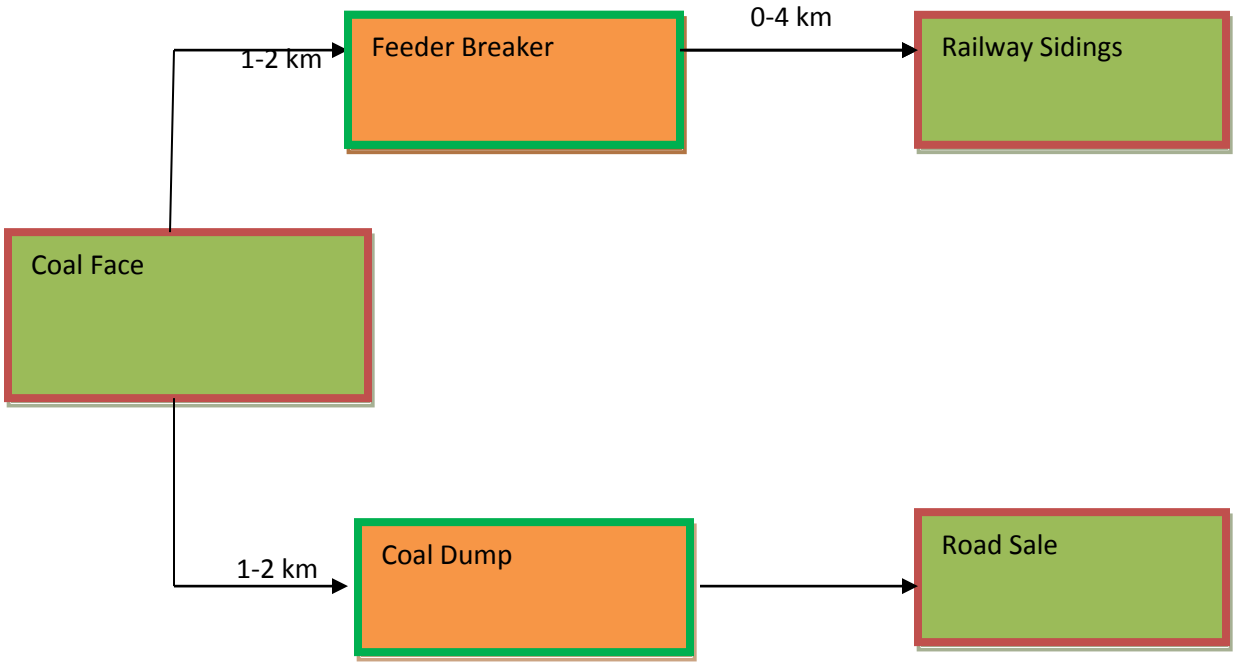


Fig: Coal transportation route

7.0 REHABILITATION AND RESETTLEMENT PLAN:

REHABILITATION AND RESETTLEMENT POLICY OF COAL INDIA LTD 2012.

Preamble

The location and quality of coal reserves, and their distance from major consumers determines to a great extent the selection of mine sites. For reserves that are close to the surface, opencast mining has proven to be the most efficient mining method. Opencast mines require relatively large areas of land. Population growth, particularly in India's eastern region, has made it increasingly difficult for the subsidiary coal companies to acquire the land they need for expanding their operations under the present Resettlement and Rehabilitation policy,2008 of Coal India.

The resettlement and rehabilitation policies followed by the subsidiary companies have evolved over time and undergone numerous changes in response to changing circumstances. As and when the Central or State Governments enact amendments to the Land Acquisition Act, issue new guidelines for resettlement and rehabilitation, as per its requirement Coal India reviews and modifies its resettlement and rehabilitation policy taking into account the changing conditions in coal producing areas.

In addition to compensation for land coal companies provide Rehabilitation and Resettlement (R&R) package for project affected persons to compensate for loss of livelihood. Apart from compensation for house site, house, trees, cow shed, cost of shifting etc., employment is also provided to land oustees. In addition to this, efforts are made to rehabilitate them by construction of houses, building roads, streets, schools, providing water etc. wherever feasible . However, demand for both more land compensation and better R&R package has been raised by project affected persons and has been highlighted in various Parliamentary Committees. Coal Companies often have to face representations and agitations by these land oustees who obstruct the smooth working of existing mines and come in the way of expansion of new projects.

In the past, subsidiaries found it relatively easy to acquire land, if they were able to offer employment. Partly because of this practice, subsidiaries have built up a largely unskilled labour force beyond their needs. This has contributed to the heavy losses and many mines are incurring and has also affected their efficiency and viability. The subsidiaries may still need to hire people in selected locations and continue to give preference to those whose livelihood will be affected by coal mining operations. However, increasingly subsidiaries will need to develop other ways and means to compensate land owners and others adversely affected by their projects and give them the option to choose which method of compensation best suits their needs. Greater emphasis will also need to be given to community requirements like schools, hospitals etc. Only proper resettlement and rehabilitation will elicit the required cooperation of project affected people, and make it possible for Coal India to acquire the land it needs to fulfill the ever increasing demand of coal for the economic development of the Country.

- 1 -

The purpose of the Resettlement and Rehabilitation Policy 2012 is to revise and provide greater flexibility to the basic principles for the resettlement and rehabilitation of people affected by coal mining projects i.e. Project Affect People (PAPs). It attempts to consolidate the different resettlement and rehabilitation practices that are being followed by subsidiaries as per the different State land Acquisition Acts and various decisions of the Coal India Board and to modify the Policy of 2008 so as to give the Board of the subsidiary Companies greater flexibility to deal more effectively with resettlement and rehabilitation issues and determine the rehabilitation packages best suited to local needs in line with this policy. The provisions of the National Rehabilitation and Resettlement Policy, 2007 and the Land Acquisition, Rehabilitation & Resettlement Bill, 2011 have also been kept in mind while framing the policy.

While Coal India's basic philosophy for compensating land-losers and other project-affected people remains substantially unchanged, the revised policy emphasizes the need to cultivate and maintain good relationships with the people affected by Coal India's projects starting as early as possible; it also underscores that the subsidiaries have a responsibility towards the land oustees whose livelihood is often taken away. On the other hand, subsidiaries need to protect themselves more effectively against unjustified claims, redundant manpower and swelling Wage Bills. To this end, the statement proposes that subsidiaries prepare detailed resettlement and rehabilitation action plans (RAPs) that clearly identify, at an early stage, the entitlements of the people affected by coal projects and enables them to exercise a choice between various options. The concept of Annuity in lieu of compensation/employment is also being introduced to mitigate, if not eliminate the ever dependence of Project Affected Families (PAFs) on CIL for provision of employment.

(1) The revised Resettlement & Rehabilitation Policy, 2012 is based on the deliberations of the inter Ministerial Committee set up vide O.M. 490191/2011-PRIW-I dated 01-07-2011 of Ministry of Coal , deliberations of the CMDs meet held on 05/03/2012 at New Delhi and has been approved by the CIL Board in its 279th meeting held on 12th.and 13th March, 2012.

(2) Objectives and general principles of Coal India's Resettlement and Rehabilitation Policy- 2012

A. To re-visit CIL's existing R&R policy 2008 and evolve a PAP friendly policy by incorporating such provisions of the National Policy and The Draft Land Acquisition, Rehabilitation and Resettlement Bill-2011 as considered suitable in light of the growing difficulties many subsidiaries face in land acquisition.

B. To accord the highest priority for avoiding or minimizing disturbance of the local population while taking decisions to open new mines or expand existing ones too (exploring alternative sites and project designs) and to ensure that wherever people are likely to be adversely affected by a project, the subsidiaries will prepare resettlement and rehabilitation action plans for the project.

C. To ensure a humane, participatory, informed consultative and transparent process for land acquisition for coal mining and allied activities with the least disturbance to the owners of the land and other affected families.

D. To provide just and fair compensation to the affected families whose land has been acquired or proposed to be acquired or are affected by such acquisition and make

adequate provisions for loss of livelihood of such affected persons including their rehabilitation and resettlement.

E. To ensure that the cumulative outcome of compulsory acquisition should be that the affected persons become partners in development leading to an improvement in their post acquisition social and economic status and matters connected therewith or incidental thereto.

F. Through the preparation of resettlement and rehabilitation action plans, subsidiaries will safeguard that project-affected people improve or at least regain their former standard of living and earning capacity after a reasonable transition period. The transition period is to be kept to a minimum. However, the involvement of subsidiaries in resettlement and rehabilitation activities may continue until all the actions specified in the rehabilitation plan have been completed.

G. Involuntary resettlement is conceived and executed as a development programme with project-affected people being provided sufficient resources and opportunities to share in a project's benefits. The efforts of subsidiaries are complementary to the Government's schemes in rural development and the concurrence, approvals and support from concerned Government authorities will be sought.

H. In parallel, subsidiaries will work closely with non-governmental organizations of proven repute which are legally constituted and recognized and also have the confidence of the project-affected people, in the preparation and implementation of rehabilitation plans.

I. Corporate Social Responsibility (CSR) : Activities shall be intensified in and around the villages where land is being acquired in accordance with the CSR Policy of Coal India.

J. Actual implementation of R&R package must follow a detailed survey of the project-affected villages to formulate the list of persons/families affected by the project, nature of the affect, the likely loss of income, etc. For this purpose, if necessary, the services of a reputed NGO with an impressive record of integrity and performance may be engaged.

3. SCOPE:

This Policy may be called "Rehabilitation and Resettlement Policy of Coal India Limited-2012". It extends to the Coal India Limited and its subsidiary companies in India. It shall come into force from the date of its approval by the CIL Board and is applicable to all cases in which land is taken after the date of approval by the CIL Board. While implementing the policy it is to be ensured that the provisions of the concerned Acts applicable and Rules mentioned there under shall not be violated .

4. Definitions

(a) ***"affected family"*** means:

(i) a family whose primary place of residence or other property or source of livelihood is adversely affected by the acquisition of land (including direct negotiation) for a project or involuntary displacement for any other reason; or

(ii) any tenure holder, tenant, lessee or owner of other property, who on account of acquisition of land (including plot in the *abadi* or other property) in the affected area or other wise, has been involuntarily displaced from such land or other property; or

(iii) any agricultural or non-agricultural labourer, landless person (not having homestead land, agricultural land, or either homestead or agricultural land), rural artisan, small trader or self-employed person, who has been residing or engaged in any trade, business, occupation or vocation continuously for a period of not less than three years preceding the date of declaration of the affected area, and who has been deprived of earning his livelihood or alienated wholly or substantially from the main source of his trade, business, occupation or vocation because of the acquisition of land in the affected area or being involuntarily displaced for any other reason.

(b) "***family***" includes a person, his/her spouse, son including minor sons, dependant daughters, minor brothers, unmarried sisters, father, mother residing with him or her and dependent on him/her for their livelihood; and includes "***nuclear family***" consisting of a person, his/her spouse and minor children. Provided that where there are no male dependants, the benefit due to a land loser may devolve on dependent daughter nominated by the land loser.

(c) "land owner" includes any person—

(i) whose name is recorded as the owner of the land or part thereof, in the records of the concerned authority; or

(ii) who is entitled to be granted Patta rights on the land under any law of the State including assigned lands; or

(iii) who has been declared as such by an order of the court or District Collector;

(d) Displaced person - means and includes any person who is deprived of his homestead on account of acquisition. Provided that the person/family who does not ordinarily reside in the homestead land acquired for the project can be termed "Displaced" but he will be eligible for compensation only for homestead and not for livelihood.

(e) Ordinarily resides" shall mean residing in the homestead / acquired land for a period more than 6 months every year for at least the preceding 5 years.

5. Socio-economic Survey and preparation of RAP.

A baseline socioeconomic survey will be carried out to identify the PAPs who are enlisted to receive benefits in line with Coal India's Resettlement and Rehabilitation Policy. This survey will be conducted within two months of notification under the relevant land acquisition Acts by the subsidiaries with the help of reputed independent institutional agencies, who are well versed with the social matrix of the area.

The basic objective of the socio-economic study will be to generate baseline data on the social and economic status of the population who are likely to lose their means of livelihood or homestead due to the acquisition of the land for the project. The data base will be used to formulate a viable and practical Rehabilitation Action Plan (RAP) for the affected persons in line with their entitlements. Digital Satellite Maps would also be prepared of the project Area freezing the dwelling units and habitations existing at the time of negotiation for Land Acquisition wherever feasible .The RAP will also address the following-

(A) Implementation, Monitoring and Evaluation, Dispute Mechanism

The rehabilitation action plan will address the following:

i) The project design, including an analysis of alternative designs aimed at avoiding or minimizing resettlement;
ii) Socio-economic survey and activities to ensure restoration of incomes of PAPs in line with Coal India's Resettlement and Rehabilitation Policy;
iii) Description of the institutional and other mechanisms for provision of entitlements;
iv) Time table for the acquisition and preparation of the resettlement site(s);
v) The cost and budgets for the resettlement and rehabilitation of PAFs;
vi) Project-specific arrangements to deal with grievances of PAFs; and
vii) Time tables, benchmarks and arrangements for monitoring the resettlement and rehabilitation effort.

The RAP will be formulated in consultation with PAPs and State government.

(B). Environment Impact Assessment (EIA) will be conducted as per any law, rule and regulation of the locality in which the land has been acquired.

6. Eligibility Criteria -

(A) Eligibility Criteria for Economic Rehabilitation Benefits

This benefit shall accrue only to Entitled Project Affected Person. Entitled Project Affected Person shall be one from the following categories.

(i) Persons from whom land is acquired including tribals cultivating land under traditional rights.
(ii) Persons whose homestead is acquired.
(iii) ,Sharecroppers, land lessees , tenants & day labourers.
(iv) Tribal dependent on forest produce as certified by the District Forest Officer/Revenue Authorities.

(B) Eligibility Criteria for Resettlement Benefits

1 . Only a 'Displaced' family / person shall be eligible for resettlement benefits.

2. A family/person shall be termed 'displaced' and hence eligible for resettlement benefits if such family/person has been a permanent resident and ordinarily residing in the project area on the date of publication of notification U/S 9 of CBA(A&D) 1957 / U/S 11 of LA Act, 1894/ Or both/ on the date of the land vested with the State/ Central government as the case may be.

and

(a) on account of acquisition of his/her homestead land / structure is displaced from such areas

or

(b) He/she is a homesteadless or landless family/person who has been/is required to be displaced.

7 .Census & Identification of displaced families:

1. Within two months of publication of notice U/S 4(1) of the Land Acquisition Act or U/S 7(1) of CBA (A.D) Act 1957 for acquisition of land for the project a census would be undertaken in the manner to be decided by the Collector / project authority for identification of displaced families and for preparing their socio-economic profile and list of eligible persons for the purpose of receiving Rehabilitation & Resettlement Benefits.

2. A photo identity card to each Entitled Project Affected Person shall be issued under the signature of the Collector / project authority concerned indicating the following particulars:

(a) Name of the village/GP/PS :
(b) Name, Father's name and address of the head of the family :
(c)Category of entitlement :
(d)Whether S.C./S.T./O.B.C./General :
(e)Age,Sex,educational qualification of the members of the family :

8. Types of Compensation and Rehabilitation Entitlement

Option to the land losers regarding Rehabilitation & Resettlement Benefit - The land losers shall have the option for Rehabilitation and Resettlement benefits in accordance with the awards for each affected family in terms of the entitlements passed by the Concerned Collector of the State or as per this Policy with the consent of the concerned Collector.

8.1 Eligibility and Compensation

The table below shows the compensation and rehabilitation benefits will be offered by the subsidiaries for each Project Affected Person or family, affected by one of their projects. Evidence to the effect that a person is a legitimate PAP will need to be provided in the form of a written legal document, or reference to a record, such as a revenue officer certificate, electoral roll, ration card or school record.

Category of Persons affected by the Project	***Compensation and Rehabilitation entitlement option***
	Provisions
(i) Persons (including tribals cultivating land under traditional rights) from whom land is acquired.	All land owners with titles will receive monetary compensation for the land acquired from them. The value of the land is determined on the basis of prevailing legal norms. *In respect of tribals cultivating land under traditional rights, authentication of land held under traditional rights by state authorities will be necessary.* In addition to above the following shall apply.

Category of Persons affected by the Project	*Compensation and Rehabilitation entitlement option*
	Provisions
	A). Land Compensation - Land compensation shall be paid as per the provisions of the concerned Act or State Govt. notification. Where no notification of the State Govt. is available the concerned subsidiary Board may decide on the rate of compensation keeping in view the compensation provided by the neighboring states. Authentication of land held under traditional rights by state authorities will be necessary. In addition to above Solatium will be paid as per provisions of the concerned Act / as imposed by the Concerned State Govt. Escalation of land compensation – Escalation will be paid as per provisions of the concerned Act / as imposed by the Concerned State Govt. or Escalation at the rate of 12% per anum for a maximum period of three years. **(B): Employment provision:** Apart from payment of the land compensation, employment may be given in the following manner – **1)** The maximum total number of employments that may by provided to the land losers would be limited to the total no. of acres of land acquired divided by two. However employments will be released in proportion to the land possessed . **2)** For every two acres of land one employment can be considered; 3) Subsidiaries of CIL may give an option to the Land losers having less than two acres of land to club together their land to the extent of two acres and nominate one of the land losers among the groups or their dependent for employment under package deal or employment under Descending order system by preparing the list of eligible land oustees in the descending order of land lost subject to the cut off equivalent to the total number of permissible employments or any other method with the approval of the respective Board of the subsidiary. **4)** The land loser must be a domiciled resident/Mool Niwasi and the certificate to this effect shall be issued by the concerned State Authority **5)** The modalities for offering employment shall be such as may be approved by the Board of the Subsidiary companies as per the unique conditions of the subsidiary provided that - **a)** The initial employment shall be given with pay of Category-I pay scale of NCWA, with training period of 6 months. b) In the seniority list, the seniority of the appointee should be reflected in appropriate manner in order to keep the senior most as senior. **c)** The land loser trainees shall be posted as per requirement, including underground duties.

Category of Persons affected by the Project	*Compensation and Rehabilitation entitlement option*
	Provisions
	(C): Lumpsum Monetary Compensation – 1. All the land losers who are not eligible for employment as above shall be entitled to receive monetary compensation in lieu of employment at the rate of Rs.5,00,000/- (Five Lakhs) for each acre of land on pro-rata basis . 2. Land losers who are offered employment as per principle specified in point No (8.(i)B) above will have the option either to opt for employment or to forego employment and opt for monetary compensation at the rate of Rs.5,00,000/- (Five lakhs) for each acre of land on pro-rata basis with minimum of Rs. 50,000 (Fifty thousands) provided that the employment thus surrendered shall not be available for offer to any other person and will stand lapsed from the total sanctioned number of employments as specified in point No.(8.(i)B1). 3. The Land losers who have clubbed their land in Package Deal can claim employment for only one land loser of the clubbed two acres of land and remaining land losers of the package cannot claim either employment or lump sum monetary compensation in lieu of the land contributed by them. 4. Annuity – All land losers who are entitled to get lump sum monetary compensation may opt for payment of compensation amount in the form of annuity made payable to the land losers monthly, annually or at such intervals (not less than one year) as may be opted for by him. The annuity be paid for a maximum period extending to 60 years of age or the life of the project for which the land has been acquired, whichever is earlier. **Note:** *A person receiving a job forgoes all claims to above compensation and a person receiving above compensation forgoes all claims to employment.*
(ii) Person whose homestead is acquired	I. Compensation for homestead shall be paid as per the standard valuation method of the L.A Act. of the concerned State Govt. II. One time lump sum payment of Rs.3,00,000/- (three lakhs),shall be paid in lieu of alternate House site, Assistance in designing Shifting Allowance,compensation for construction of cattle shed , Monetary compensation for construction of work shed etc.The compensation shall be paid to displaced persons only after vacation and demolition of the homestead/ work shed etc. III. Subsistence allowance :Each affected displaced family will get subsistence allowance at the rate of 25 days (Minimum Agricultural Wage) per month for one year.

Category of Persons affected by the Project	*Compensation and Rehabilitation entitlement option*
	Provisions
(iii)Sharecroppers, land lessees, tenants and day labourers	The subsidiary will assist PAP to take-up non farm self employment through petty contracts or formation of cooperatives. If such co-operatives will not be entitled for awarding work as per Manual for lack of experience, the said co-operative will be facilitated by awarding small jobs to acquire experience after relaxation of the provisions of the Manual pertaining to experience with approval of the Subsidiary Boards. Subsequent jobs may be awarded after getting report of the timely completion / quality / of the awarded jobs from the concerned Department or contractors. Contractors will also be persuaded to give job to eligible PAPs on a preferential basis, where feasible as per terms of contract.
(iv)Landless tribals, Tribal dependent on forest produce	The subsidiary will assist PAP to establish non farm self employment through the provision of infrastructure, petty contracts or formation of cooperatives and encourage provisions of Jobs with contractors. Contractors will be persuaded to give jobs to eligible PAPs on preferential basis, where feasible. - In addition, the subsidiaries will shift the tribal community as a unit and provide facilities to meet the specific needs of the tribal community that will allow them to maintain their unique cultural identity. - Tribal affected family will be given one time financial assistance of 500 days of MAW for loss of customary right or usages of forest produce. Loss of customary rights needs to be authenticated by the district authority. - Tribal affected families resettled out of the district shall be given 25% higher rehabilitation and resettlement benefit.

9. Resettlement & Rehabilitation Committee - A Committee will be constituted at project Level under the chairmanship of the Collector to be called the Rehabilitation and Resettlement Committee with the following objectives to monitor and review the progress of implementation of the Rehabilitation and Resettlement scheme and to carry out post-implementation social audits in consultation with the village panchayat in rural areas and municipality in urban areas in the manner will be decided by the concerned State Govt.

I. To approve the list of land losers and other PAPs;
II. To approve the list of persons eligible to be offered employment as per R&R Policy;
III. To approve the detailed Rehabilitation Plan for the project in consultation with the displaced persons and Gram Sabhas;
IV. To expedite issue of domicile certificates and other necessary documentation required for State Authorities;
V. To monitor and review the progress of the Rehabilitation Scheme, grant of benefits and handing over of possession of land in a smooth manner;
VI. To facilitate the land acquisition process in any other manner as may be required including resolution of disputes;
VII. To carry out post implementation social audit in consultation with the authorities.

10. Community facilities - The subsidiary will provide at the resettlement site a school, road with street light, pucca drain, pond, dugwell and/or tubewell for drinking water supply, community center, place of worship, dispensary, grazing land for cattle and play ground. Similar infrastructural facility, if necessary, will be extended to the host locality. The community facilities and services would be available to all residents of the area, including PAPs and the host population.

The approach for operation of community facilities would be flexible and all efforts will be made to involve the State and local self Government / Panchayat for operating the facilities. To achieve this, subsidiaries will pursue with these agencies to ensure the same. The planning of the community facilities and their construction should be undertaken in consultation with the affected community.

11. Corporate Social Responsibilities - This should be as per Company's Corporate Social Responsibility (CSR) Policy.

12. Monitoring and Evaluation Mechanism.

The RAP will be monitored and evaluated periodically after the completion of the land acquisition process.

I. The resettlement and rehabilitation activities are the responsibility of a separate group, both at the projects and corporate level, which will be constituted for planning, implementation, monitoring and evaluation of the Rehabilitation Action Plan. At the corporate level the group will be headed by a senior manager, whereas at the project, an executive of the rank of manager will head the group. The project group should have at least one member with social science qualification / experience and skills.

II. The project group will closely interact with the state authorities during the implementation of the RAP. Although the subsidiaries will develop the plots and infrastructural facilities in the resettlement colony and actively implement the RAP, assistance of State authorities will be taken for administrative services such as allotment of land. Implementation will be planned, monitored and corrective measures will be incorporated in the RAP, if needed. In addition to the State Government, the PAPs, the village leaders including the Pradhans and NGOs will be consulted and associated with the implementation of the RAP.

III. The Resettlement and Rehabilitation Cell at the corporate level will evaluate the implementation of the RAP after its completion.

13. Flexibility to the Subsidiary Companies – The Subsidiary Companies Boards have been authorised to approve necessary modifications in the R&R Policy with reference to unique conditions prevailing at the concerned Subsidiaries as the policy is not exhaustive.

(The above list is only indicative and not exhaustive)

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

(FOR THE MONTH MARCH, 2019)

E. C. no. J-11015/93/2009-IA.II (M) dated 06.02.2013.

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 analysed in Environmental Laboratory of CMPDI, RI-II, Dhanbad.

3.2 Water quality

Water samples were collected as per standard practice. The Mine effluent samples were collected and analysed for four parameters on fortnightly basis. Thereafter the samples were preserved and analysed at the Environmental Laboratory of CMPDI, RI- II, Dhanbad.

3.3 Noise level monitoring

Noise level measurements in form of 'L_{EQ}' were taken using Integrated Data Logging Sound Level Meter. Noise levels were measured in Decibels, 'A' weighted average, i.e. dB(A).

4.0 Results and interpretations

4.1 Air quality

It has been seen from the analysis results that the 24 hours average concentration parameters like $PM_{10,}$ $PM_{2.5}$, SO_2 and NO_X are mostly within the permissible limits in all sampling locations as per MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000 Standards for Coal Mines and National Ambient Air Quality Standard -2009. Sometimes the concentration of PM_{10}& $PM_{2.5}$ exceeds the limits due to heavy public traffic, poor road condition, coke oven plants, burning of coal by surrounding habitants, brick making, municipal waste dumps and industries like Steel Plant, thermal Plants including their fly ash etc.

The following preventive and suppressive mitigative measures can be undertaken to contain the pollution level within prescribed level:-

- Wet drilling and controlled blasting should be practice.
- Explosive used should be optimised to restrict the dust generation.
- Transportation roads should be permanently asphalted free of ruts, potholes etc.
- Water should be sprayed on coal transportation road, service road more frequently and at regular interval.
- Dust from roads should be removed physically or mechanically.
- Greenbelts around industrial sites, service building area besides Avenue plantation along roads should be created.
- Coal dust should be suppressed by using fixed sprinklers.
- Regular maintenance of plant and machinery should be undertaken.

4.2 Water quality

The test results indicate that the major parameters compared with MoEF&CC Gazette Notification No. GSR 742(E) dt 25.09.2000

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 I is in the westernmost part of the Jharia coalfield. It includes Damoda OCP, Damoda UG. The Cluster – I is situated at a distance of about 40 - 45 kms from Dhanbad Railway Station. The mines of this cluster 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 Jamunia River.

1.2 The Cluster I is designed to produce 0.9 MTPA (normative) and 1.17 MTPA peak capacity of coal. The average grade of coal W-II to W-IV.

The Project is being worked by deploying shovel dumper combination.

The Project has been granted Environmental Clearance from Ministry of Environment, Forest and Climate Change (MoEF&CC) for a rated capacity of 0.9 MTPA (normative) and 1.17 MTPA peak capacity of coal production vide letter no **E. C. no. J-11015/93/2009-IA.II (M) dated 06.02.2013.**

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) Damoda (A2): Industrial Area

The location of the sampling station is 23°46'9.00"N & 86°10'38.00"E. The sampler was placed at a height of approx. 1.5m above ground level.

II. BUFFER ZONE Monitoring Location

i) Karmatand village (A1) : Residential area

The location of the sampling station is at 23°45'58.20"N & 86° 9'30.59"E in Karmatand village. The sampler was placed at a height of approx. 1.5m above ground level.

ii) Madhuband washery (A3) : Industrial area

The location of the sampling station is at 23°47'24.01"N & 86°11'32.00"E in the Washery premises. The sampler was placed at a height of approx. 1.5m above ground level.

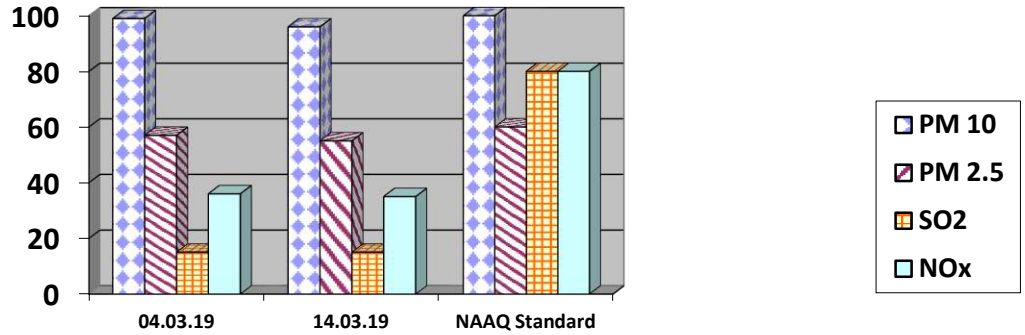
iii) Block II OCP (A4): **Industrial Area**

The location of the sampling station is 23°47'2.00"N & 86°11'15.00"E . The sampler was placed at an elevated platform of approx. height 1.5m above ground level near water treatment plant of Block II OCP.

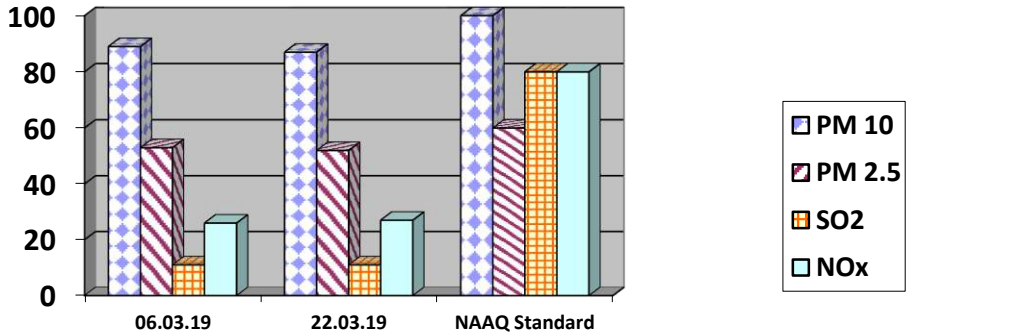
AMBIENT AIR QUALITY DATA

Cluster – I, Bharat Coking Coal limited Month: **MARCH, 2019** Year : **2018-19.**

Station Name: A2, Damoda		**Zone: Core**		**Category: Industrial**	
Sl. No.	**Dates of sampling**	**PM 10**	**PM 2.5**	**SO_2**	**NO_X**
1	04.03.19	99	57	15	36
2	14.03.19	96	55	15	35
	NAAQ Standard	100	60	80	80



Station Name: A1, Karmatand village		**Zone: Buffer**		**Category: Residential**	
Sl. No.	**Dates of sampling**	**PM 10**	**PM 2.5**	**SO_2**	**NO_X**
1	06.03.19	89	53	11	26
2	22.03.19	87	52	11	27
	NAAQ Standard	100	60	80	80



Note:

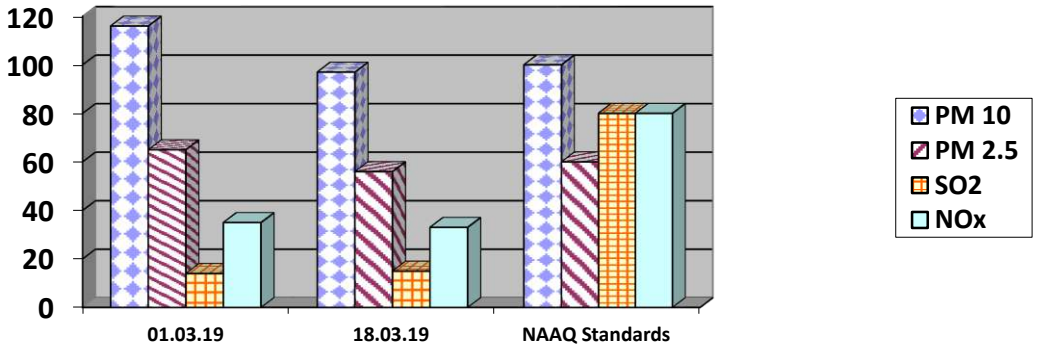
- *All values are expressed in microgram per cubic meter.*
- *24 hours duration*

Analysed By
JSA/SA/SSA

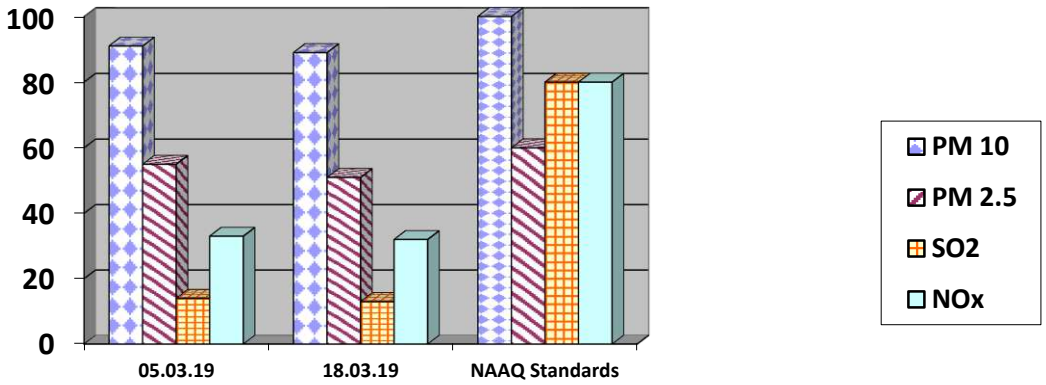
Checked By
Lab In Charge
RI-2, CMPDI, Dhanbad

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

Station Name: A3 Madhuband Washery		Zone: Buffer		Category: Industrial	
Sl. No.	Dates of sampling	PM 10	PM 2.5	SO2	NOx
1	01.03.19	116	65	14	35
2	18.03.19	97	56	15	33
	NAAQ Standards	100	60	80	80



Station Name: A4 – Block II OCP		Zone: Buffer		Category: Industrial	
Sl. No.	Dates of sampling	PM 10	PM 2.5	SO2	NOx
1	05.03.19	91	55	14	33
2	18.03.19	89	51	13	32
	NAAQ Standards	100	60	80	80



Note:

- *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**)

i) Mine Discharge of Damoda (MW1)

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

3.2 Methodology of sampling and analysis

Water samples were collected as per standard practice. The effluent samples were collected and analysed for four parameters on fortnightly basis at the Environmental Laboratory of CMPDI RI-II, Dhanbad.

3.3 Results & Interpretations

The results are given in tabular form along with the applicable standards. Results are compared with Schedule - VI, effluent prescribed by MoEF&CC. Results show that most of the parameters are within the permissible limits.

WATER QUALITY DATA

(EFFLUENT WATER- FOUR PARAMETERS)

Name of the Cluster: **Cluster -I**		Month: **MARCH, 2019**	Name of the Station: **Mine Discharge of Damoda**	
Sl. No.	**Parameters**	**MW1** First Fortnight	**MW1** Second Fortnight	**As per MOEF General Standards for schedule VI**
		04.03.19	19.03.19	
1	Total Suspended Solids	22	36	*100 (Max)*
2	pH	7.94	8.31	*5.5 - 9.0*
3	Oil & Grease	<2.0	<2.0	*10 (Max)*
4	COD	28	32	*250 (Max)*

All values are expressed in mg/lit unless specified.

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) **Karmatand village (N1)**
ii) **Damoda Colliery(N2)**
iii) **Madhuband Washery (N3)**
iv) **Block – II OCP (N4)**

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 MoEFCC. 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 -I**			Month: **MARCH, 2019**		
Sl. No.	**Station Name/Code**	**Category of area**	**Date**	**Noise level dB(A)LEQ**	***Permissible Limit of Noise level in dB(A)***
1	Karmatand Village(N1)	Residential area	06.03.19	49.6	*55*
2	Karmatand Village	Residential area	22.03.19	48.3	*55*
3	Damoda(N2)	Industrial area	04.03.19	60.8	*75*
4	Damoda	Industrial area	14.03.19	62.1	*75*
5	Madhuband Washery(N3)	Industrial area	01.03.19	52.3	*75*
6	Madhuband Washery	Industrial area	18.03.19	60.5	*75*
7	Block-II(N4)	Industrial area	05.03.19	62.6	*75*
8	Block-II	Industrial area	18.03.19	60.9	*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/8hourly values shall be met 92% of the time in a year. However, 8% of the time it may exceed but not on two consecutive days.

NATIONAL AMBIENT AIR QUALITY STANDARDS

New Delhi the 18th November 2009

In exercise of the powers conferred by Sub-section (2) (h) of section 16 of the Air (Prevention and Control of Pollution) Act, 1981 (Act No. 14 of 1981), and in supersession of the notification No(s).S.O.384(E), dated 11th April 1994 and S.O.935(E), dated 14th October 1998, the Central Pollution Control Board hereby notify the National Ambient Air Quality Standards with immediate effect.

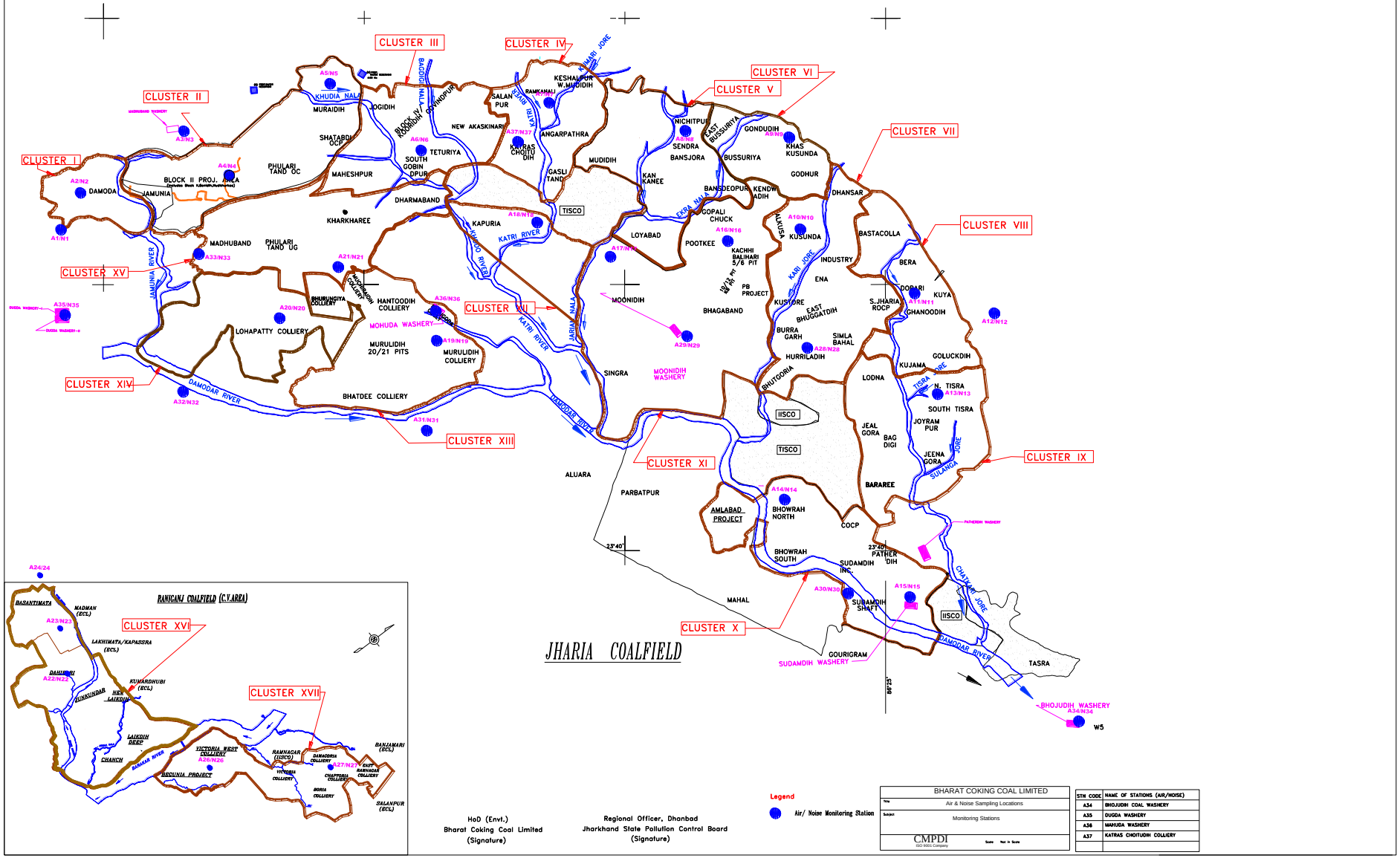
Pollutant	Time Weighted Average	Concentration in Ambient Air		Methods of Measurement
		Industrial, Residential, Rural and other Areas	Ecologically Sensitive Area (Notified by Central Government)	
Sulphur Dioxide (SO_2), µg/m³	Annual * 24 Hours **	50 80	20 80	-Improved West and Gaeke Method -Ultraviolet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

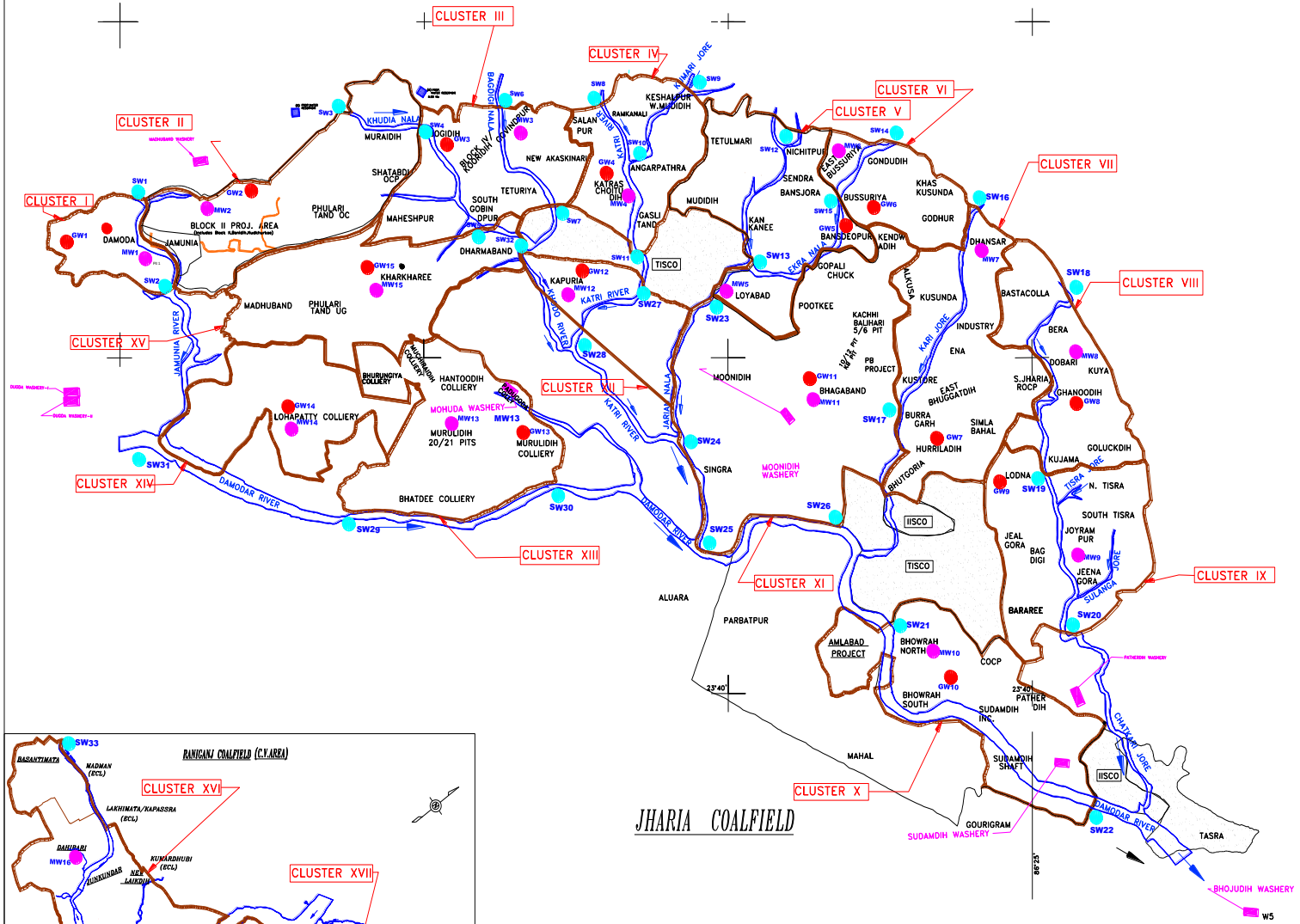
** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

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