

## **CHAPTER- I**

### **INTRODUCTION**

#### **1.1 Background of the Mining Company:-**

Bharat Coking Coal Limited (BCCL), a subsidiary of Coal India Limited, is a Central Public Sector undertaking, owned by the Govt of India, engaged for extraction of Coal in Jharkhand and West Bengal. BCCL was incorporated in January 1972 to operate coking coal mines in the Jharia & Raniganj Coalfields, taken over by the Govt. of India on 16<sup>th</sup> Oct 1971 to ensure planned development of the scarce coking coal resources in the country. Nationalisation of the non-coking coal mines followed soon after in May 1973 when 182 non-coking units located near to coking coal mines were also put under the control of BCCL. BCCL has 37 coal mines which includes 11 underground, 19 opencast and 7 mixed mines as on 31<sup>st</sup> March 2018.

#### **1.2 Location of End use Plants-**

The existing amalgamated Muraidih Colliery (i.e amalgamated Muraidih Colliery & Shabdi Colliery) is departmentally producing coking coal of Washery II to IV grade by opencast mining on the other hand, Phularitand Colliery is producing Washery-II to IV grade coal through opencast method by outsourcing i.e Hired OC HEMM Patch. The Phularitand Colliery is also producing non coking coal by underground mining method in small scale.

Presently, the ROM (run off mine) coal of amalgamated Muraidih OC Colliery is being sized by three(3) number of Feeder Breaker/Crusher and dispatched to KKC Link Siding located besides of Mahuda-Gomoh Railway line passing (NS) through western part of the property.

In Phularitand Colliery, ROM coal is also sized to the required size by two (2) number of existing feeder breakers before dispatching of coal to the same KKC link siding. ROM coal produced of Phularitand Colliery is partly dispatched to the end user through siding and partly by road transport as per existing linkage. From KKC siding, coal is being sent to different Power Plants like Mithon Power Plant (MPL), BTPS, NTCD, GHDL, HDCG, etc. Coal is also being sent to Mithon Power Plant partly by road and partly by rail.

**ASHOK KUMAR**  
Project Officer  
Muraidih Colliery



### 1.3 Brief on Amalgamated Muraidih-Phularitand (part) Colliery

Earlier, there were three separate Collieries namely Muraidih, Shatabdi and Phularitand Colliery having separate lease boundaries. All these Collieries are under the administrative control of Barora area, BCCL. In past, these Collieries were worked in large scale by opencast as well as underground Board & Pillar mining method upto V/VI/VII combined seam.

In Muraidih Colliery, seams incrops within the property are VIIIA to I and in Shatabdi Colliery, VIIC to I seam in descending order upto Mahespur Dyke located on southern part of the Colliery.

In Phularitand Colliery, incrop occur from Seam-XIII to Seam-I in descending order within the property considering upto Dhanbad Chandrapura Railway Line passing on southern side of the property.

The V/VI/VII seam is a thick seam and occurs as combined seam in all these Collieries. Earlier large scale of underground mining by Bord & Pillar method has been done in three to four sections in this thick V/VI/VII combined seam in all these collieries and except in small areas on southern side which are left as virgin. Seams lying above this combined seam were also partly developed /partly depillared by underground mining method.

Later-on separate opencasts mines were made in Muraidih Colliery, Shatabdi Colliery as well as Phularitand Colliery to extract this V/VI/VII combined seam keeping the floor of this seam as base for the opencast. Thus, all the underground working of V/VI/VII combined seam along with B&P workings of overlying seams have been extracted and still extraction is in progress in these areas.

Due to large scale of opencast mining in Muraidih Colliery and Shatabdi Colliery, the common boundaries between these two mines have been excavated and merged and becomes a single mine. Subsequently, these two Collieries are amalgamated into one single Colliery after obtaining permission from DGMS (Annexure-IX) and it is presently known as Amalgamated Muraidih Colliery. At present, excavation is being done departmentally with shovel dumper combination only at one location on the south-western corner of amalgamated Muraidih Colliery existing boundary.

*Ashok*  
**ASHOK KUMAR**  
Project Officer  
Muraidih Colliery



In Phularitand Colliery, a quarry named as Pure Benedih Section (P B Quarry)) was worked in past with floor of V/VI/VII seam as base on north-western part of Phularitand Colliery which is lying between D B Road & Mahuda-Gomoh Railway Line and presently it is abandoned. Except this, a number of small quarries were also made in incrop regions of V/VI/VII Seam. At present, an quarry is running on outsourced basis (i.e hired HEMM patch) with floor of V/VI/VII combined seam as base which is located almost southern part of the Phularitand property and located on northern side of Dhanbad-Chandrapura (DC) Railway line.

To extract seams lying below V/VI/VII seam in Phularitand Colliery, Mine Officials initiated a proposal to drive Inclines from the floor of abandoned V/VI/VII seam quarry (P B Section) to Seam-III. The Incline sites are selected by the Colliery Officials. Subsequently, two Inclines/drift drivages were made upto the floor of Seam-III as shown in Plate no.II. Presently, coal is being extracted from Seam-III by Bord & Pillar method of mining and produced coal is transported to surface by SDL-Haulage combination.

The EC (Environmental clearance) of Cluster-II was granted by MoEF on 6<sup>th</sup> Feb 2013 when these mines were operating independently. Now, the life of the earlier Muraidih OCP has exhausted. Moreover, area of Muraidih and Shatabdih mines are amalgamated due to operational safety to excavate fire in common boundary and made a one amalgamated mine for which permission has been obtained from DGMS. Presently amalgamated area is named as "Amalgamated Muraidih Colliery" and it is operational. Due to exhaustion of life of Muraidih Colliery and also due to amalgamation of two independent mines, amendment is required for earlier granted EC.

It is to be noted that the area of Cluster-II for group of mines of BCCL is located on northern side of Dhanbad-Chandrapura Railway line and Cluster-XV is located on southern side of this line. Thus, this D C Railway line divides the boundary of two Clusters. The entire area of amalgamated Muraidih Colliery is located in Cluster-II but the northern part of the lease boundary of Phularitand Colliery falls within Cluster-II and southern part of this Colliery in Cluster-XV. Thus, the amalgamated Muraidih Colliery and part of lease hold area of Phularitand Colliery which is lying on northern side of D C Railway line falls in Cluster-II group of mines of BCCL.

Hence, to decide the strategy for preparation of mining plan and mine closure plan for these two Collieries of Cluster-II, a meeting has been convened with Officials of P&F



Dept, Env. Dept, Mine authorities of BCCL along with Officials of CMPDIL, RI-II in the Conference Hall of CMPDIL RI-II on 17-12-2018 (Refer Annexure-I)

It has been decided in the meeting that instead of preparing separate mining plan for the above to independent Collieries, one amalgamated mining plan will be prepared considering the area of existing Muraidih Colliery and part of Phularitand Colliery falling in Cluster-II as stated above. Both Collieries are presently operating independently.

BCCL desires to operate as one mine by amalgamation of two independent Collieries falling in Cluster-II. As per the mine authorities, application has been processed to DGMS for further amalgamation of "amalgamated Muraidih Colliery" and "Phularitand Colliery (part)" falling in Cluster-II.

It has been considered that the area proposed to be amalgamated as stated in above paragraph, DGMS permission would be required and has to be adhere to all conditions as mentioned in permission of DGMS before commencement of any work as proposed in this amalgamated mining plan.

#### 1.4 Mining activity/History

As stated in earlier paragraph that Muraidih, Shatabdi & Phularitand Collieries are three independent Collieries with separate lease boundaries. Incrop of different coal seams occur within the property of these Collieries. The number of seams increases from north to south-western side. The V/VI/VII seam occurs as combined seam within the entire property of these Collieries. To extract these coal seams in past, underground Bord & Pillar mining as well as number of small quarries were made within the lease area of above mentioned Collieries. Underground workings were left as partly developed and partly depillared whereas quarries were made in scatter manner and mostly located near the incrop regions. In V/VI/VII combined seam is a thick seam; hence, underground workings were made in three to four sections in this seam. Underground mining by Bord & Pillar method has also been done in past in different seams lying above this combined seam. Underlying Seam-IV to Seam-I are almost virgin in entire area of proposed amalgamated property except in Muraidih Colliery, where an small area on rise side property of Seam-III has been worked by B&P underground method in the year 1988 and abandoned working is located near incrop region of Seam-III. Presently Inclines of these workings were sealed or dozed.

*Ashok*  
**ASHOK KUMAR**  
Project Officer  
Muraidih Colliery



BCCL management had taken decision to extract coal from all these old underground B&P and patch working of different seams as well as virgin areas by opencast mining method with floor of V/VI/VII seam as base in all these Collieries. Thus, surface and underground fire can be controlled which was broke out in these old workings. Muraidih was an operational mine at the time of nationalization. The Muraidih OCP was sanctioned as patch deposited scheme in 1979 for an annual coal production of 0.45 Mt. Due to favourable geo-mining conditions and availability of free mineable area, a Feasibility report for Muraidih Expansion(OCP) was preared and approved by BCCL Board in its 160th meeting on 3<sup>rd</sup> Dec 1994 for capatity of 2.16 Mty with capital investment of Rs.19.84 Crores.

The Project report for Shatabdi OCP was approved by BCCL Board on 27.09.1999 for capital investment of Rs.60.04 Crs. Shatabdih OCP was carved out of Muraidih OCP in 2000 on the southern side of Dumra-Tundoo D B road and since then it was an independent mine. A supplementary note was prepared considering the aspects of power supply, land acquisition and rehabilitation as pointed out by CMD, BCCL. The project report along with supplementary note was discussed in TSC of BCCL board on 12.01.2000. and it was approved by BCCL Board on 20<sup>th</sup> January 2000 for Capital investment of Rs.57.00Crs. The comprehensive Project Report incorporating the supplementary Note was placed before the ESC of CIL Board in its 53<sup>rd</sup> meeting held on 23.05.2000. Later-on a Recast Project report Shatabdih OCP was approved by BCCL Board on October 2002 for production of 0.80Mty. As per Colliery record, the production from Shatabdih OC was commenced from 2000-01 with production 0.515Mty.

At present, the common boundary between Muaridih & Shatabdi OCP has been excavated and became a one mine "Amalgamated Muraidih Colliery" after obtaining permission from DGMS on 03.08.2012. Regarding Opencast activities, presently Coal/OB excavation is being carried out departmentally with V/VI/VII seam as base of the opencast in south-western part near the earlier Barora Railway siding (which has been dismantled at present) in area of existing amalgamated Muraidih Colliery

In Phularitand Colliery, a Phularitand(West) opencast was operated departmentally with floor of V/VI/VII combined seam as base of the Quarry/OC upto the year 2002-03. Later-on, the same OC was outsourced to continue further excavation as Hired HEMM patch with floor of V/VI/VII seam as base of the quarry. The production from this hired patch OCP was started from 2009-10 and still it is in operation. The quarry face is advancing towards eastern side within the lease area of Phularitand Colliery and extracting

ASHOK KUMAR  
Project Officer  
Muraidih Colliery



overlying earlier developed Bord & Pillar workings of different coal seams including virgin areas.

As stated earlier that seams lying below V/VI/VII combined seam are Seam-IV(Top)/IV(Bot), Seam-III, Seam-II & Seam I in descending order in all these Collieries and mostly virgin in entire area under consideration.

To extract coal from these underlying seams, BCCL has proposed for opening of Muraidih underground mine within the lease area of Muraidih OCP Colliery and Shatabdi OCP Colliery covering an area of about 4.758 Sq.km which presently falls under existing "Amalgamated Muraidih Colliery".

Taking that into consideration, BCCL decided to go for Global Bid Tender for extraction of virgin seams (i.e III & I) by underground mining method. BCCL floated a tender on 26<sup>th</sup> March 2010, on total turnkey basis starting from planning, designing, and construction, execution, supply, and procurement, installation/operation of equipment/machineries, production and evacuation of coal up to the desired location on surface of the mine. The NIT envisaged the "Development of Muraidih Underground mines and extraction of coal from Muraidih III, II & I Seam by mass production technology package for minimum guaranteed production of 2.0 MTPA of coal on turnkey basis". The scope of work involves mining operation for production of guaranteed quantity of 2.0 mty for a minimum nine (9) years of commercial production period.

Subsequent to completion of tender process, M/s MINOP Innovative Technologies(P) Ltd & Beijing Huayu Engineering Co. Ltd (BHEC) (consortium partner of MINOP) emerged as L1 bidder, The successful bidder proposed for extraction of Seam-III & Seam-I by longwall method of mining deploying one PSLW set and gate road development by one Bolter Miner The project report (DPR) was approved in 265<sup>th</sup> Board meeting held on 14.02.2011 for an estimated capital of Rs.339.875 Crores.

BCCL had entered into contracts for supplies and services with the successful bidder, Minop Innovative Technologies (P) Limited (MINOP) on March 25, 2011 ('Supply Contract' or 'Original Agreement') and Minop had since commenced work on the Project. Subsequently, the parties had executed amendments to the contracts for supplies and services on June 22, 2012 ('Amendment Agreement'). The Consortium submitted its DPR which was accepted by BCCL on 29.01.2013:

*Ashok Kumar*  
**ASHOK KUMAR**  
Project Officer  
Muraidih Colliery  
(H)



Based on the above, Incline drivage at proposed site has been started in January 2014. Air Shaft Excavation started around 23.01.2015. Shaft sinking work was suspended since Dec' 2015 as DGMS has imposed violation due water logging in Seam III workings of adjacent Jogidih Colliery.

Due to the constraint of handing over the land by BCCL at the proposed site of Inclines and Shaft as well as land required for construction of infra-structure, BCCL authority has suggested for changing the location of the inclines as well as shaft site so that the requirement of private land is kept as minimum as possible. Based on that the location of Air shaft as well as Auxiliary incline has been changed and MINOP has prepared a revised surface layout plan showing mining complex at three isolated locations. In view of the above, MINOP has submitted a supplementary report on approved DPR and the "Supplementary report on approved DPR" was accepted by BCCL vide letter no. BCCL/D(T) P&P/F-114/2015/297 dated 24.12.2015.

Opening of LC for procurement of Equipment is delayed as M/S MINOP has asked for modification in terms of payment as contained in the agreement. Work has been suspended by the contractor, M/S MINOP, since 01.06.2016. It is expected that the Contractor is likely to re-start / commence the suspended project work soon.

In Phularitand Colliery, a proposal to drive three nos. of Inclined Shafts No. 1/III, 2/III & 3/III from floor of V/VI/VII Seam abandoned old quarry (PB Section) to III Seam was initiated by Phularitand Mine officials. The same was sent to CMPDI, RI-II for preparation of cost estimates for the above drifts. The opinion of the CMPDI, RI-II was communicated to General Manager (P&P), BCCL, vide letter No. RI-II/M/01/4703 dated 26.02.2011.

However, drivage of two inclines was started departmentally at the site selected by the Colliery officials. Presently, Incline/drift drivages for Incline no.1 and Incline no.2 have already been made from the selected site upto Seam-III. Incline No.1/III is being used as intake airways whereas Incline No.2 as return airways and fan is installed at the Incline mouth of Incline no.2. Instead of driving Incline no.3, sinking of an air shaft is under consideration which will act as main return in future. Presently, development in Seam-III is going on by Board & Pillar method with SDL-Haulage combination.

*Ashu*  
**ASHOK KUMAR**  
Project Officer  
Muraidih Colliery  
(H)





### 1.5 Need for preparation Mining Plan-

Earlier Muraidih Colliery and Shatabdi Colliery were operating as separate mine. Later-on due to operational constraint, occurrence of fires etc, these two mines have been amalgamated into a single mine and named as "amalgamated Muraidih Colliery" for which permission from DGMS has been obtained. This Colliery falls in Cluster-II.

On the western side, a part of the lease area Phularitand Colliery (i.e northern side of Dhanbad-Chandrapura Railway line) also falls in Cluster-II which forms the western boundary of above mentioned amalgamated Muraidih Colliery.

Environmental Clearance (EC) for Cluster-II group of mines of BCCL was obtained in 6<sup>th</sup> Feb 2013 for 5 Mines namely Block-II Colliery (UG & OC), Jamunia OC, Shatabdih OC, Muraidih (OC & UG) and Phularitand OC. Presently Muraidih & Shatabdih has been amalgamated to an one Muraidih Colliery. Out of 5 mines of Cluster-II, there is no Phularitand UG section which has to be included in Cluster-II group of Mines. Moreover, as per BCCL authority, the life of Muraidih OCP has been expired. Hence, the EC of Cluster-II which was granted in 6<sup>th</sup> Feb 2013, has to be amended for which approved Mining Plan by board of directors of BCCL is required.

Further, BCCL management desires to amalgamate the part area of Phularitand Colliery falling in Cluster-II with already amalgamated Muraidih Colliery to make an "Amalgamated Muraidih-Phularitand(part) Colliery" and a single amalgamated Mining Plan should be prepared considering the area of these two Collieries as states above. Hence, this amalgamated Mining plan and mine Closure has been prepared.

This amalgamated mining plan has to be approved by Board of Directors of BCCL for amendment of Environmental Clearance for Cluster-II. The permission from DGMS has to be obtained for such amalgamation and according to mine authority, application for amalgamation has been submitted to DGMS on January 2019 (Letter no. D(T) P&P/F/12(1)/2019/20 dated 31.01.2019 (Annexure-XIII).

### 1.6 Coal Washery –

Presently, produced coal from existing amalgamated Muraidih Colliery and Phularitand Colliery are not linked to any existing Washery. A number of Non-coking coal Washeries of BCCL are under construction. It is proposed to send coal from these Collieries to Madhuband NLW Washery which is under construction and, about 61% construction has been done upto the end of first quarter of 2018-19. Coal produced from these Collieries are presently being sent to KKC Link Railway Siding lying on Mohuda-Gomoh S E Railway line and from the siding, coal is sent to different linkages mostly to the Power Sectors. According to Mine authority, only in MPL, coal is being sent partly by road and partly by Railway wagons.



## CHAPTER-II

### DETAILS OF EARLIER APPROVAL OF MINING PLAN AND MINE CLOSURE PLAN

The Mine Closure Plan for Muraidih - Shatabdi Group of mines was approved in 300th meeting by Board of Director of BCCL held on 21.09.2013

The Mine Closure Plan for Phularitand Mixed mines (Cluster-II) was approved in 305th meeting by Board of Director of BCCL 12.03.2014

The Environmental Clearance for Cluster-II group of mines of BCCL was granted by MoEF on 6<sup>th</sup> Feb 2013.

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*Ashu*  
**ASHOK KUMAR**  
Project Officer  
Muraidih Colliery  
(M)



## CHAPTER-III

### LOCATIONS, TOPOGRAPHY & COMMUNICATION

#### **3.1 Location-**

3.1.1. The area under consideration is located in the Western part of Jharia Coalfield and constitutes of amalgamated boundary of Muraidih Colliery and Phularitand Colliery (Part) falling in Cluster-II. These Mines are under administrative control of Barora Area of BCCL. The amalgamated area of Muraidih-Phularitand (part) Colliery under consideration has a total surface area of 1118.71 Ha. Out of which, area of "Amalgamated Muraidih Colliery" is 717.71 Ha and the area of Phularitand (part) falling in Cluster-II is 401 Ha. The considered area lies between Latitude 23°46'30.732" to 23°49'0.436" (N) and Longitude 86°12'38.997" to 86°15'15.998" (E). The area falls in Open Source Survey of India Toposheet No. F45C1 (RF-1:50000/Year-2009). (Refer Plate no.II)

The Project Area is demarcated as 887.75 Ha considering the proposed mining area within lease boundary of amalgamated Muraidih-Phularitand (Part) Colliery.

#### **3.2. Accessibility-**

The Project area is about 30 Km West of Dhanbad town and is well connected by road and rail. The Project area is easily negotiable by Hirak ring road (Dhanbad – Chandrapura Road) from Dhanbad town and distance is about 40 Km.

The Dhanbad-Chandrapura (E C Rly) Railway Line passes through the southern part of the considered area and also form southern boundary limit which also southern limit of Cluster-II. Phularitand railway station is located on Dhanbad-Chandrapura (E C Rly) Railway Line. The Mohuda-Gomoh (SE Rly.) Railway Line passes towards western side of the area and also forms western boundary of the considered area. (Refer Plate no.-II)

#### **3.3. Climate & Rainfall data-**

The area under consideration falls in the sub-humid region of the state of Jharkhand. The maximum temperature rises as high as 48°C during summer (April to middle of June) and falls down to minimum of 6°C during winter (December to January). The area receives fair to moderate rainfall, the average annual precipitation being 1400 mm, most of which is received between Junes to September.

ASHOK KUMAR  
Project Officer  
Muraidih Colliery



### 3.4. Topography -

The area has a general undulating topography with a gentle slope towards east to South East. The mining activity which is going on in the area for decades has severely obliterated the general topography. Several small quarries, subsided goaf, OB dump, fire etc. have shattered the original topography of the area. The highest elevation (224.69) has been observed near borehole no.BA-10 in the west-central part, whereas, the lowest ground elevation (185.45m) has been observed in the eastern part of the project area.

### 3.5. Boundaries of Amalgamated Muraidih-Phularitand (part) Colliery -

As stated earlier that this mining plan considers an amalgamated area of existing amlagamated Muraidih Colliery and a part of total lease area of Phularitand Colliery falls in Cluster-II and as per official record area is measured as 1118.71 Ha. Both Collieries are mixed mine having underground as well as opencast workings. The boundaries (1118.71 Ha) of this amalgamated Muaridih-Phaularitand(part) Colliery has been demarcated as follows-

North -	Talcher formation
South -	Dhanbad-Chandrapura Railway Line and Mahespur Dyke
East -	Western Boundary of Jogidih Colliery
West -	Gomoh-Mohuda Railway Line of S.E Railway

The Project boundaries (887.75 Ha) considering the proposed extent of both opencast and underground mine workings within the above mentioned amalgamated boundaries is defined as follows-

North -	Incrop of Seam I
South -	Upto a line keeping 45m barrier from Railway property of Dhanbad-Chandrapura Railway Line and Mahespur Dyke
East -	Western Boundary of Jogidih Colliery
West -	Upto a line keeping 45m barrier from Railway property of Gomoh-Mohuda Railway Line of S.E Railway

### 3.6 Availability of Water in the area-

The drainage and topography of the project area is mainly controlled by Damodar River. The Khudia (Khodo)-nala flowing easterly in the north western part swings to south easterly in the the north western part swings to south easterly in the eastern part. It eventually meets the Katri Jore which is a tributary to Damodar River. A drain also flows on western side and joins with Khudia nala.

The accumulated mine water from opencast sump of Muraidih Colliery is being pumped to surface reservoir and this water is made available for utilization for various purpose after proper treatment.



**3.7 Highest Flood Level-** As per the Mine record, the HFL of Khudo Nala is 197.43m

### **3.10 Ownership and occupancy of land and involvement of Forest land**

The total amalgamated surface area under consideration is 1118.71 Ha Out of which, BCCL area is 379.42 Ha. Total Forest land involved within this area is 46.16 Ha and these forest land falls within the property of existing amalgamated Muraidih Colliery. As per the record, there is no forest land involved in part area of Phularitand Colliery falling in Cluster-II which is considered in this mining plan.

### **3.11 Important surface features and major diversion or shifting etc-**

Important surface features present within the above mentioned amalgamated area of Muaridih-Phaularitand(part) Colliery are Hirak Road, District Board Road, High Tension Lines (132 KV), Villages/Temples, BCCL Colonies, Nala etc. Out of these surface features, part of which may require to be diverted, rehabilitated or shifted in future to extract coal lying below this property.

#### **1) Diversion of D B Road-**

A District Board Road (D B Road) runs north-south direction (Dumra to Nawagarh) within the proposed amalgamated property. A huge quantity of coal is blocked below this road and village /basti located besides this road. Moreover, expansion of western side Hired OCP boundary is restricted due to this road. The GM of Barora Area has sent a letter (vide letter no.BCCL/GM/AR-1/2019/03 dated 17.01.2019) to RD, RI-II CMPDIL stating that it will be very difficult to divert D B Road at present scenario and requested not to consider diversion of D B Road during preparation of amalgamated Mining plan for Muraidih-Phularitand(part) Colliery (Annexure-IV).

During presentation of Mining plan before ESC on 27-06-2019 at New Delhi, these constraints related to diversion of road, villages/basti etc has been explained in details. After deliberation, the ESC was in view that blocked coal will be lost forever once quarry is backfilled. Considering coal conservation, the ESC has directed to prepare the Mining Plan considering diversion of D B Road further west by laying diversion road along the Railway property and over the 45m barrier kept from the Railway property. Accordingly rehabilitation and resettlement of villages/basti should be mentioned in the mining plan. Hence, diversion of D B Road is proposed in this mining plan. (Refer Plate No.XVI)

**ASHOK KUMAR**  
Project Officer  
Muraidih Colliery  
(A)



## 2) Diversion of Khodo Nala-

A Khodo Nala is flowing west to east and then flows north to south after crossing the lease hold boundary of Muraidih Colliery. The Muraidih OC has excavated coal from southern side of this nala flowing west to east. To extract coal from underlying Seam-III & Seam-I, the successful bidder has proposed for diversion of Khudo(Khudia) nala towards northern side i.e outside of proposed mining area of seam-I to release coal for Longwall panels identified by Bidders. Since this an approved project by VCCL Board, hence in this mining Plan, diversion of khodo nala is considered. As per the approved DPR and agreement, this diversion has to be made by BCCL. (Refer Plate No.XVIII)

  
**ASHOK KUMAR**  
Project Officer  
Muraidih Colliery



## CHAPTER-IV

### GEOLOGY AND DEPOSIT APPRAISAL

#### 4.0 Geology

##### 4.1. Regional Geology of Jharia coalfield

The Jharia coalfield (453 Km<sup>2</sup>) is sickle shaped on plan and occurs in the form of syncline with its axis trending broadly in E-W direction and plunging towards west. The southern flank of this coalfield is truncated by boundary fault having maximum throw about 2.5 Km at Mohuda Basin. The non-coal bearing Talchir formation is mainly exposed along the northern and western portion of the coalfield. The Barakar formation covering an area of 218 Km<sup>2</sup> which is exposed in the northern, eastern and south-eastern part of the coalfield area contains over 40 coal horizons including local and persistent seams, some of which are exclusive store house of metallurgical coal in India. The Barakar formation is successively overlain by Barren Measure formation which is devoid of workable coal seams. This is mainly exposed in the central part of the coalfield. The Barren Measure is overlain by the coal bearing Raniganj formation (54 Km<sup>2</sup>). These are exposed within a sub-elliptical basin the south-western part of the coalfield.

##### 4.2. Stratigraphy

The Regional stratigraphic succession of Jharia coalfield is given in table no. 4.1

**Archeans:** The Archeans, consisting of gneisses and mica schists are exposed all along the periphery of Jharia Coalfield. A tongue or protrusion of metamorphic, thrusting into the Gondwanas, is observed near Patherdih in the south-eastern part of the coalfield. Besides, a small inlier of metamorphic has been noticed near Khenudih in the north-western part of the coalfield. Metamorphic high has been interpreted in the south-eastern part of the coalfield in Sitanala area, resulting in the omission of older seams. The metamorphics are profusely intruded by quartz veins.

**Talchir:** In an Archean basement, the lower Gondwana sediments are deposited with a pronounced unconformity. The lowermost Gondwana sediments of Talchir formation are represented by variegated shale and greenish sandstones which at times show laths of unaltered feldspars. They are exposed all along the northern



fringe of the coalfield. They are, however not exposed along the southern fringe due to boundary fault. Near Lutipahar in the north-western part of the coalfield, Talchir formation is comparatively well developed in a large area and boulder bed shows exposures of spheroidal weathering.

**Barakar:** In the eastern, northern and north-eastern parts of the coalfield, the Barakar are extensively developed. All along the southern boundary they are extending under the thick over of Barren Measures. The Barakar formation comprises of pebbly sandstones, conglomerate, grit, coarse to fine grained sandstones, shales, carbonaceous shales and coal seams. Verma *et. al.* (1989) have observed a gradual decrease in thickness of Barakar from east to west. A maximum thickness more than 1250 m has been observed in the south-eastern part of the coalfield in Tasra region, while minimum thickness of around 600m is noticed in Damuda area. Barakar is the most important geological formation as it contains more than 40 coal horizons having thickness more than 50 cm. In general seam X (Ten) and younger seams are better quality coal (prime coking) than older seams which change with depth to non-coking coal.

**Barren Measure:** The Barren Measure formation lying conformably over the Barakar formation consists of massive multistoried sandstone alternating with carbonaceous shale, grey shale and sandstone/shale intercalations with occasionally very thin impersistent, non-workable coal horizons in the lower part of the formation. The Barren Measures shows a widespread development extending from the central part of the coalfield up to the southern margin. The maximum thickness of the Barren Measure has been estimated to be around 625m in the central part of the basin. It gradually decreases westward and eastward and reduces to a minimum of 375m in the south-eastern part.

**Raniganj:** Raniganj formation is deposited in sub-elliptical basin that is called Mohuda basin the south-western part of the coalfield. The formation is represented by sandstone, shale, carbonaceous shale and coal seams. 24 coal seams have been reported from this formation. These seams comprise high volatile, high moisture, medium coking coal. The maximum thickness around 725m of Raniganj formation has been observed.



**Igneous Intrusive:** Mica peridotite and dolerite are the two most common Post Gondwana intrusives. The mica peridotite occurs as dyke and sill throughout the coalfield and has caused widespread devolatilisation of the coal seams. The dolerite dyke is mostly confined in the western part of the coalfield and has limited effect on coal seams. A number of dykes and their offshoots have been established in the coalfield, but the most surprising phenomenon of a 250m zone characterized by pyrolytization and devolatilisation has been observed in the north-western part of the coalfield at Daumda Block where presence of any igneous intrusives has not been noticed. The mica periodotite sills have devolatilised the extensive resource of good quality coal in the coalfield.

As mentioned earlier, most of the area is covered by sandy soil and alluvium. The thickness of soil varies from 1.0 m to 10.0 meter.

**Table-4.1**  
**Geological Succession of Jharia Coalfield**

Stratigraphic Division	Age	Formation	Lithological characters
	Recent	Alluvium/Soil/Sand	
	Cretaceous to Jurassic	Mica Peridotite/Dolerite Dyke	
----- <b>Unconformity</b> -----			
<b>Lower Gondwana</b>	Upper Permian	Raniganj Formation	Mainly fine to medium grained grey current bedded sandstone with shale and coal seam
	Middle Permian	Barren Measures	Black carbonaceous micaceous shale with clay, ironstone and sandstone.
	Lower Permian	Barakar Formation	Coarse grained to conglomeratic white sandstone with shale and coal seams
	Lower Permian	Talchir Formation	Coarse grained sandstone, white or slightly variegated at Top, green shale with undecomposed feldspar, boulder bed etc.
----- <b>Unconformity</b> -----			
Archeans		Granites, gneisses and schists.	



#### 4.3. Geology of Amalgamated Muraidih-Phularitand (part) Colliery-

The area under consideration is located in the north western corner of the Jharia coalfield, and it is primarily covered by the Barakar formation which is overlain by thin layers of sandy soil and clay. The thickness of soil ranges between <1.0 m. (MR-22, PH-19) to 13.83.0 m. (BA009). Metamorphics is exposed as faulted contact in the north-eastern part of the leasehold area. The rocks of Barakar formation consist of grits, fine to coarse grained sandstone, intercalation of sandstone and shale, sandy shale, grey shale, carbonaceous shale, and number of coal seams. Coal seams XIII to I occur within the project area and are under the purview of this Geological Report (Plate No.II).

Good rock exposures are rather are observed extensively, particularly in the northern and north western portion area and in quarries. These rock exposures are mainly of sandstone. The thickness of soil and weathered mantle varies upto 13.83m. The incrop position of coal seams has been taken from the geological reports and are interpretative. Geology and correlation of the seams have been established mainly on the basis of sub-surface data obtained from borehole and mine workings.

##### **Igneous Intrusion:**

Mahespur dolerite dyke-This dyke is located in the south eastern quadrant of the block and runs almost NE-SW along the boundary of Mahespur-Phularitand collieries and thereafter through Jogidih colliery. It is reported to be upto about 40m thick. The dip of the dyke is 80° due SE.

##### **4.3.1 Amalgamated Muraidih-Phularitand(Part) Colliery Boundary-**

The project boundary is demarcated on surface and individual seam folio /floor contour plans of XIII, XI/XII, IX/X, VIII C, VIII B, VIII A, VIII, V/VI/VII, VI Top, IV/IV Bot, III, II I & I/II seam.



#### 4.3.2 Status of Exploration

A total of 53 boreholes have been drilled within the project area involving a total meterage of 10793.06 meters within the project area.

##### Status of Exploration

Serial No	Series	Drilling Agency	No. of BH	Meterage drilled
1	BA	CMPDI	23	4876.25
2	MR	CMPDI	25	4871.09
4	PH	CMPDI	5	1045.72
<b>Total</b>			<b>53</b>	<b>10793.06</b>

The density of boreholes comes to about 5 BHs/Km<sup>2</sup> within the leasehold area.

#### 4.3.2 Scope and Limitations

1. The scope of the present assessment is to assess the potentiality of seams (XIII to I Bottom) occurring within the project area and their extraction by opencast (XIII to V/VI/VII seam) as well by underground mining method (III to I&I/II seam).
2. The updated mine plan / data generated and supplied by colliery authorities have been used in preparing this report. Additionally, few old workings present in the geological report of OCP-III Block have also been considered in the present report. The surface plan of this report is mainly based on colliery plan and Open Source Survey of India toposheet of Survey of India.
3. Only standard geological nomenclature of seams has been used in the present note.
4. An element of approximation exists in location and extent of mine workings when matched with borehole location plan. Surface features like quarries, Incline, roads etc. shown on the plan supplied by colliery do not match well with Open Source Survey of India Survey Toposheet and surface plan of OCP-III Block.
5. Areas having thickness less than 0.5 m have not been considered for geological resource estimation.

**ASHOK KUMAR**  
Project Officer  
Muraidih Colliery



6. In the past, seams V/VI/VII has been reported to be affected by fire in the central part and seam VIIIA, IX/X and XI/XII have been reported to be affected by fire in the south-western part of the project limit. There are many old underground workings of these seams present in and around that earlier fire affected area, possibility remains that some of the underground workings of these seams may also affected by fire. However Colliery authority could not able to provide the data regarding loss of coal resource damage due to fire, therefore coal resource has been estimated without consideration of fire therefore coal resource may vary within the fire affected area with actual insitu coal resource.
7. Quality for seam boreholes (seam III, II, I/II, & I) in these reports is given based on opencast norms (I100) and that has been converted to (I30) norm for their extraction by underground method.
8. As per data received as per colliery authorities damage of coal due to fire is not known therefore resource of fire area has been estimated assuming that no coal has been damage due to fire, therefore resource may vary from actual resource.
9. **Nomenclature of different Coal Seams used in "Geology chapter" is Geological coal Seam name only.**



#### 4.4 Sequence of Coal Seams

The seam sequence and parting within the amalgamated area (northern part of DC Line falling in Cluster-II) is covered in Table-4.2.

**Table-4.2**

Seam/ Parting (P)	Range of thickness of coal seams and their intervening parting (m)			No. of full seam intersection	Depth Range (m)
	Minimum	Maximum	Average		
1	2	3	4	5	6
XIII	4.61(PH009)	4.61(PH009)	4.61	1	INCROP-50
P	18.8(PH009)	18.8(PH009)	18.80	1	
XII/XI	6.1(PH009)	6.1(PH009)	6.10	1	INCROP-60
P	32.78(PH009)	32.78(PH009)	32.78	1	
IX/X	4.05(BA020)	8.5(PH019)	6.78	4	INCROP-110
P	10.65(PH009)	15.05(PH018)	12.63	4	
VIIIC	1.26(BA016)	2.98(BA004)	2.20	7	INCROP-115
P	5.35(BA020)	11.95(BA004)	7.19	7	
VIIIB	1.11(PH009)	4.4(PH019)	2.38	11	INCROP-120
P	1.52(BA004)	20.63(PH009)	8.60	11	
VIIIA	2.55(PH018, PH019)	5.45(MR017)	3.48	12	INCROP-130
P	15.83(PH016)	28.3(BA004)	19.01	6	
VIII	0.2(PH020)	1.06(PH016)	0.48	7	INCROP-145
P(VIIIA-V/VI/VII)	31.91(BA016)	37.76(MR009)	34.55	6	
P(VIII-V/VI/VII)	7.41(BA004)	15.6(PH018)	10.39	7	
V/VI/VII	0.76(BA019)	28.05(BA012)	22.31	31	INCROP-200
P(V/VI/VI-IVT)	24.65(BA012)	31.67(MR013)	27.22	10	
P(V/VI/VII-IV)	3.56(BA014)	31.69(MR017)	24.13	20	
IVT	0.2(MR008)	1.55(MR024)	0.71	23	INCROP-105
P	1.04(BA010)	7(MR006)	3.91	23	
IVB	0.12(BA001)	1.83(BA013)	0.65	24	INCROP-115
IV	0.25(MR012)	3.21(BA003)	1.57	23	INCROP-205
P(IVB-III)	22.33(MR024)	31.35(BA022)	26.66	23	
P(IV-III)	15.99(BA011)	32.3(BA019)	26.25	22	
III	2(BA021)	6(BA001)	3.86	50	INCROP-235
P(III-II)	6.35(MR012)	16.73(MR006)	12.26	45	
P(III-II/I)	11.39(BA022)	13.92(BA019)	12.27	4	
II	0.07(MR006)	2.15(MR028)	1.09	47	INCROP-245
II/I	4.63(BA019)	5.2(BA021)	4.91	4	INCROP-130
P(II-I)	1.18(BA015)	12.23(MR018)	5.23	51	
I	1.05(MR002)	4.28(BA004)	2.50	46	INCROP-250



#### 4.5 Nomenclature of coal seams Vs-À-Vis Colliery Nomenclature

Table – 4.3

Geological Nomenclature (Present Work)	Colliery Nomenclature ( Phularitand Colliery)	Colliery Nomenclature ( Muraidih Colliery)
XIII	XIII	
XI/XII	XI/XII	
IX/X	10	
VIIIC	9 TOP	IX TOP
VIII B	9 BOT	VIII TOP
VIII A	8	VIII BOT
VIII	-	Virgin
V/VI/VII Comb	7 (V/VI/VII Comb)	V/VI/VII Comb
IV Top	Virgin	Virgin
IV	Virgin	Virgin
IV Bot	Virgin	Virgin
III	III	III
II	II	II
I/II comb	I/II comb	-
I	I	I

#### 4.6 Geological Structure of the Block

##### 4.6.1 Strike & Dip

The general strike of the area is E-W which swings to N-S locally in the central part and again swinging to NW-SE to almost E-W in the eastern part. The dip of the beds is varying from 5°-10° in the boundary regions to 10°-20° in the central part. The dip direction is generally towards SE.

##### 4.6.2. Faults

Geological structure of the project area is highly complicated as a number of faults have repeatedly dislocated the strata. Based on boreholes/colliery data 6 nos. of faults have been interpreted within the project area. Throw of these faults varies from 5 m to 20 m. The details of fault are given in Table No-4.4.



**Description of faults****Table- 4.4**

Sl. No.	Fault No.	Extent & Location	Strike/Dip	Max Throw (m)/ Direction	Evidence	
					B.H No.	Nature
1	F <sub>1</sub> – F <sub>1</sub>	Central Eastern part of the Block	E-W /northerly Dip.	15m	MR-23  MR-12	VV/VII seam is faulted from roof in MR-23.  VV/VII seam is faulted from floor in MR-12. Reduction in parting between VV/VII and IV seam.  Encountered in the workings of VV/VII and VIIIB seam in Barora and Jogidih collieries respectively.
2	F <sub>2</sub> – F <sub>2</sub>	North Eastern part of the area	NE-SW	10m		Encountered in the working of VIIIA & VIIIB seams of Jogidih Colliery.
3	F <sub>3</sub> – F <sub>3</sub>	Occurring in the Central part of Block	WNW-ESE/ SSW dip	5m.	BA-14	Reduction in the parting between IV and III seam in BA-14  Encountered in the workings of VV/VIII seam in Barora colliery
4	F <sub>4</sub> – F <sub>4</sub>	Western Part of the Block	NE-SW/ Northerly dip.	10m	NK-21	Reduction in parting between seams IV & III seam in NK21.
5	F <sub>5</sub> – F <sub>5</sub>	Occur in the north-western part of the area.	E-W/ southerly dip.	15m	MR-20	III seam is missing in MR-20.
6	F <sub>6</sub> – F <sub>6</sub>	North-Western part of the Area.	E-W/ southerly dip.	20		Barakar is in direct contact with metamorphic.

Besides the above mentioned faults, occurrence of additional minor faults having throws less than 10m and low angle faults cannot be ruled out.



## **4.7 Methodology for assessment of coal seams**

### **4.7.1. Thickness & Spatial Variation of Seams**

The description and the assessment of the quality of coal seam are primarily based on the seam folio plans which depict the iso-core line, iso-ash and iso-GCV lines besides the outer extent of the underground and opencast developments.

### **4.7.2. Iso-chore Line**

Only the vertical thickness (In-band) of the coal seams, as encountered in the boreholes, has been considered for drawing iso-chore. 50 cm thickness has been considered as the minimum limit for resource estimation. Iso-core of 50 cm have been drawn followed by iso-core of 0.9, 1.2, 2, 2.5, 3, 4, 6m and so on.

### **4.7.3. Iso-ash Line**

The ash content forms the basis for grading of coking coals as per notification by Gov. of India, Ministry of Energy, Dept. of Coal, dated 13.02.1981. Coal having ash > 50% (in case of coking coal) have not been assessed.

### **4.7.4. Iso-GCV Line**

The Gross Calorific value forms the basis for grading of non-coking coals. Coal having ash > 50% have not been graded in the present work. (Refer: 4.7.6)

### **4.7.5. Floor contour plans**

Floor contour plans of all persistent coal seams have been drawn. Spot levels of various seam workings have been considered during preparation of floor contour plans. However in some cases, a little variation exists between the floor value and the spot level data of the respective seams. It may be noted that the spot levels are not necessarily on the floor of the respective seams. Necessary corrections have been made while using the data.

### **4.7.6. Basis for thickness and quality determination**

Analytical results of coal cores have been utilized to assess the thickness and quality of the coal seams. To arrive at the in-band thickness of the coal seams as per opencast norms, all dirt bands (combustible) up to 1.00 m thickness occurring within



the seam have been included. Dirt bands having thickness more than 1.00 m occurring within the seam have been excluded. If the non-combustible bands that are developed within the seam persist in a considerable area, the seams have been considered as split and line of split or merger has been drawn in relevant floor contour and seam folio plans. Faulted, partly faulted, worked seam/part worked, part weathered seam thickness encountered in the boreholes have not been considered for the purpose of quality assessment.

To arrive at the in-band thickness of the coal seams as per underground norms, all dirt bands (combustible) up to 0.30 m thickness occurring within the seam have been included. Dirt bands having thickness more than 0.30 m occurring within the seam have been excluded.

The volatile matter on unit coal basis (UVM) wherever unavailable, has been calculated by the following empirical formula –

$$\text{UVM}\% = 100 - (100 \times \text{FC}) / 100 - (1.1\text{A} + \text{M}) \dots\dots\dots (i)$$

Where:

FC = Fixed carbon

A = Ash%

M = Moisture %

Carbonate correction, wherever required have been carried out.

In general, Gross Calorific Values (GCV) that have been determined in the laboratory have been considered for preparation of seam folio plan but where the GCV values are not available, it has been calculated by the following formula ( Majumder's formula for low moisture coal).

$$\text{GCV} = \frac{165\text{F} + 136(\text{VM} - 0.1\text{A}) - 108\text{M}}{1.8} \dots\dots\dots (ii)$$

Where:

F = Fixed carbon %, VM = Volatile Matter %

A = Ash %, M = Moisture %

It has to be noted that the classification of coal into Coking and Non-coking coal has been done as per the criteria mentioned in the Geological Report of OCP-III Block, where seam V/VI/VII and above has been considered as coking coal.



#### 4.8. Seam-wise Description

Seam XIII to I exist within the project limit. In the present work detailed description is given only for persistent seams. (Seams having thickness >0.50m).

##### Seam XIII

This seam occurs below L-6 seam and incrops in Phularitand Colliery and south and west part of the leasehold area. The full coal thickness has been intersected in only 1 borehole within the project limit. The In-band thickness of seam is 4.61m (PH009). The seam has been considered as coking coal within the project area. Detailed quality parameters is given below in table.

##### Quality Parameters

##### Proximate Analysis (On air-dried basis)

Ash%	UVM%	Grade Range	C.I.	G.K.L.T	S.I.	CO <sub>2</sub> %
22.9	25.5	W-III	18-21	E-F/G-G1	2.5-4.5	0.27

##### Roof & Floor

The immediate roof of the seam is mostly sandy shale and intercalation of sandstone and shale whereas floor of the seam is Sandy shale and at places shale/ intercalation of sandstone and shale.

##### Exploitation

This seam has been extensively worked and goaved in major part of the area. Net geological resource is given below in table.

##### Net Geological Resource (Mt.)

Within Leasehold Boundary	Within Proposed Floor Limit
0.271	0.038

##### Seam XI/XII

Seam XI/XII occurs below XIII seam with a parting 18.5m. The full coal thickness has been intersected into only 1 boreholes within the project limit. The In-band thickness



of the seam is 6.1m (PH009). The seam has been considered as coking coal within the project area. Detailed quality parameters and net geological resource is given below in table.

### **Quality Parameters**

#### **Proximate Analysis (On air-dried basis)**

Ash%	UVM%	Grade Range	C.I.	G.K.L.T	S.I.	CO <sub>2</sub> %
30.00	25.00	W-IV	19-22	F-G/G-G1	3.5-4.5	0.21-0.33

### **Roof & Floor**

The roof is generally of grey shale and, while the floor is generally made up with intercalation sandstone and shale.

### **Exploitation**

The seam has been quarried and goaved in major part of the area and part of the seam is under fire. This seam appears to be free from any pyrolitisation in the assessment area.

### **Fire**

Evidence of active fire has been found in the workings of incrop area of the seam which lies in south western part of the leasehold area.

### **Net Geological Resource (Mt.)**

Within Leasehold Boundary	Within Proposed Floor Limit
5.229	3.075

### **Seam IX/X**

This seam underlies seam XI/XII with a parting of m to 32.7m and the full coal thickness has been intersected in 4 boreholes within the project limit. In-band thickness of the seam is from 7.2m (PH018) to 8.5m (PH019). The seam has been considered as coking coal within the project area. Detailed quality parameters and net geological resource is given below in table.



**Quality Parameters****Proximate Analysis (On air-dried basis)**

Ash%	UVM%	Grade Range	C.I.	G.K.L.T	S.I.	CO <sub>2</sub> %
30.2-32.2	23.2-24.8	W-IV	18-22	F/G-G/G1	3-4.5	27.0-41.0

**Net Geological Resource (Mt.)**

Within Leasehold Boundary	Within Proposed Floor Limit
9.83	5.191

**Roof & Floor**

The immediate roof of the seam is mostly carbonaceous shale and grey shale whereas floor of the seam is carbonaceous shale and at places intercalation of sandstone and shale.

**Exploitation**

The seam has been quarried out along the incrop region. The seam has also been worked by U/G method of mining. Part area of the seam has been developed in one section. At places the seam is under fire. The seam appears to be free from any pyrolitisation and the UG working of the seam is very old.

**Fire**

Evidence of active fire has been found in the south-western part in the working of incrop area of the seam IX/X.

**Seam VIIC**

Seam VIIC underlies seam IX/X with a parting of 10.65m to 15.05 m and the full coal thickness has been intersected in 7 boreholes within the project limit. In-band thickness of the seam varies from 1.26m (BA016) to 2.98m (BA004). The seam has been considered as both coking and non-coking coal within the project area. Detailed quality parameters and net geological resource is given below in table.

**Quality Parameters****Proximate Analysis (On air-dried basis)**

*Amer*  
**ASHOK KUMAR**  
 Project Officer  
 Muraidih Colliery



**Coking Coal**

Ash%	UVM%	Grade	C.I.	G.K.L.T	S.I.	CO <sub>2</sub> %
26.5-36.8	21.7-24.6	UG-WIII	21	G	4.5-5.5	0.31-0.45

**Non-Coking Coal**

Ash%	GCV (K.Cal/kg)	Grade Range
30.9	5847	G5

**Net Geological Resource (Mt.)**

Within Leasehold Boundary			Within Proposed Floor Limit		
Coking	Non-coking	Total	Coking	Non-coking	Total
3.627	0.2	3.827	2.131	-	2.131

**Roof & Floor**

The roof of the seam is generally medium grained sandstone and sandy shale while floor is constituted of the seam is grey shale and sandy shale.

**Exploitation**

The seam has been worked by both opencast and underground method in the leasehold area. The seam has been developed in one section only and has been goaved in south eastern part of area.

**Seam VIIIB**

Seam VIIIB occur below seam VIIIC with a parting of 5.35m to 11.95m whereas full coal thickness of seam VIIIB has been intersected in 11 boreholes within the project limit. In-band thickness of the seam varies from 1.11m (PH009) to 4.4m (PH019).

The seam has been considered as both coking and non-coking coal within the project area. Detailed quality parameters and net geological resource is given below in table.

**Quality Parameters****Proximate Analysis (On air-dried basis)**



**Coking Coal**

Ash%	UVM%	Grade	C.I.	G.K.L.T	S.I.	CO <sub>2</sub> %
28.9-47.7	21.3-25.3	UG-W-IV	10-22	F-G/G1	2.5-5.5	0.19-0.61

**Non-Coking Coal**

Ash%	GCV (K.Cal/kg)	Grade Range
33.5-34.9	5330-5913	G5-G7

**Net Geological Resource (Mt.)**

Within Leasehold Boundary			Within Proposed Floor Limit		
Coking	Non-coking	Total	Coking	Non-coking	Total
4.867	0.67	5.537	3.469	0.18	3.649

**Roof & Floor**

The immediate roof of the seam is mostly medium grained sandstone and sandy shale whereas floor of the seam is carbonaceous shale, medium grained sandstone and Grey shale.

**Exploitation**

The seam has been worked extensively by both opencast and underground method in eastern south eastern & south western part of the leasehold area. The seam is developed in small part of the area. The seam is goaved in the western part of the incrop area.

**Seam VIII A**

This seam is lying below seam VIIIB with a parting of 1.52 m to 20.63m and the full coal thickness has been intersected in 12 boreholes within the project limit. In-band thickness of the seam varies from 1.47m (BA004) to 4.43m (MR009). The seam has been considered as both coking and non-coking coal within the project area. Evidence of active fire has been found in the working of incrop region of the seam.

Detailed quality parameters and net geological resource is given below in table.



## Quality Parameters

### Proximate Analysis (On air-dried basis)

#### Coking Coal

Ash%	UVM%	Grade	C.I.	G.K.L.T	S.I.	CO <sub>2</sub> %
28.9-47.9	21.4-29.3	UG-W-IV	12-22	E/F-G/G1	2.5-6.0	0.25-8.51

#### Non-Coking Coal

Ash%	GCV (K.Cal/kg)	Grade Range
30.1	6298	G4

### Net Geological Resource (Mt.)

Within Leasehold Boundary			Within Proposed Floor Limit		
Coking	Non-coking	Total	Coking	Non-coking	Total
9.166	0.13	9.296	6.016		6.016

## Roof & Floor

The roof of the seam is mostly medium grained sandstone and grey shale whereas floor of the seam is intercalation of shale and sandstone.

## Exploitation

The seam has been worked extensively by both opencast and underground method in the leasehold area. Seam is developed partly by underground method in the leasehold area. The seam is goaved in the western part of the incrop area.

## Fire

Evidence of active fire in 2 small patch has been found in the working of VIIIA seam in the south western part of incrop area of the seam.

## Seam VIII

Seam VIII underlies seam VIII A with a parting of 15.83 m to 20.63 m. The full coal thickness of the seam has been intersected in 7 boreholes within the project limit. In-hand thickness of the seam in boreholes varies from 0.2m (PH020) to 1.06m (PH016).

*Ashok*  
**ASHOK KUMAR**  
Project Officer  
Muraidih Colliery



The seam has been considered as both coking & non coking coal within the project area. Detailed quality parameters and net geological resource is given below in table.

### Quality Parameters

#### Proximate Analysis (On air-dried basis)

#### Coking Coal

Ash%	UVM%	Grade Range	C.I.	G.K.L.T	S.I.	CO <sub>2</sub> %
27.3-32.00	23.7	W-IV	-	-	-	-

#### Net Geological Resource (Mt.)

Within Leasehold Boundary			Within Proposed Floor Limit		
Coking	Non-coking	Total	Coking	Non-coking	Total
1.149	-	1.149	0.828		0.828

### Roof & Floor

The roof is generally medium grained sandstone and floor are generally of grey shale.

### Exploitation

The seam has mined by open cast method only.

#### Seam V/VI/VII Combined

Seam V/VI/VII combined underlies seam VIII with a parting of 7.41 m to 15.6m. The full coal thickness of the seam has been intersected in 31 boreholes within the project limit. In-band thickness of the seam in boreholes varies from 16.64m (BA006) to 32.5m (BA016).

The seam has been considered as non-coking coal within the project area. Evidence of active fire has been found in the workings of the seam in the central part of leasehold area. Detailed quality parameters and net geological resource is given below in table.

### Quality Parameters

#### Proximate Analysis (On air-dried basis)

#### Non-Coking Coal



Ash%	GCV (K.Cal/kg)	Grade Range
36.68-47.7	5654-6239	G4-G6

**Net Geological Resource (Mt.)**

Within Leasehold Boundary	Within Proposed Floor Limit
99.66	49.470

Mmn

**Roof & Floor**

The roof of the seam mostly medium grained sandstone and floor are generally of medium to coarse grained sandstone.

**Exploitation**

This seam has been quarried in major part of the area along outcrop region and has been extensively developed and goaved. The seam has also been worked by UG method of mining in four sections. 1<sup>st</sup> section of development extend in the south western part of the leasehold area, 2<sup>nd</sup> section of development found in the central and eastern part of the area and 3<sup>rd</sup> & 4<sup>th</sup> section of development extend in south western as well as central and eastern part of the leasehold area. Seam has been goaved in the western part of the area.

**Fire**

Evidence of old fire has been reported in the seam in workings near incrop region of the seam in central part.

**Seam IV Top**

Seam IV Top underlies seam V/VI/VII with a parting of 24.65m to 31.65 m and the full coal thickness has been intersected in 23 boreholes within the project limit. In-band thickness of the seam varies from 0.2m (MR008) to 1.55m (MR024). The seam has been considered as non-coking coal within the project area. Detailed quality parameters and net geological resource are given below in table.

**Quality Parameters****Proximate Analysis (On air-dried basis)**

*Ashu*  
**ASHOK KUMAR**  
 Project Officer  
 Muraidih Colliery



### Non-Coking Coal

Ash%	GCV (K.Cal/kg)	Grade Range
29.31-42	5027	G8

### Net Geological Resource (Mt.)

Within Leasehold Boundary
2.42

### Roof & Floor

Coarse grained sandstone forms the roof of the seam and shale generally forms the floor of the seam.

### Exploitation

The seam is considered virgin in entire leasehold area.

### Seam IV Combined

This seam IV combined underlies seam V/VI/VIII combined with a parting of 3.56 m to 31.69 m and the full coal thickness has been intersected in 23 boreholes within the project limit. In-band thickness of the seam varies from 0.25 m (MR012) to 3.21m (BA003). The seam has been considered as non-coking coal within the project area. Detailed quality parameters and net geological resource is given below in table.

### Quality Parameters

### Proximate Analysis (On air-dried basis)

### Non-Coking Coal

Ash%	GCV (K.Cal/kg)	Grade Range
35.09-49.92	3978-5423	G7-G9

### Net Geological Resource (Mt.)



**Within Leasehold Boundary**

7.64

**Roof & Floor**

Coarse grained sandstone forms the roof of the seam and shale generally forms the floor of the seam.

**Exploitation**

The seam is considered virgin within the project area.

**Seam IV Bottom**

Seam IV bottom underlies seam IV top with a parting of 1.04 m to 7 m and the full coal thickness has been intersected in 24 boreholes within the project limit. In-band thickness of the seam varies from 0.14m (MR-13) to 1.45m (BA-10). The seam has been considered as non-coking within the project area. Detailed quality parameters and net geological resource is given below in table.

**Quality Parameters**

**Proximate Analysis (On air-dried basis)**

**Non-Coking Coal**

Ash%	Grade Range
30.05-59.82	G9-G18

**Net Geological Resource (Mt.)**

**Within Leasehold Boundary**

0.94

**Roof & Floor**

The roof and floor of this seam is generally made of shale.

**Exploitation**

The seam is considered virgin within the project area.

**Seam III**

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**ASHOK KUMAR**  
Project Officer  
Muraidih Colliery

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This seam III underlies seam IV Bot & IV combined with a parting of 15.99 m to 32.3 m and the full coal thickness has been intersected in 50 boreholes within the proposed project limit. In-band thickness of the seam varies from 2m (BA021) to 6.00m (BA001). The seam has been considered as non-coking coal within the project area. Detailed quality parameters and net geological resource is given below in table.

### Quality Parameters

#### Proximate Analysis (On air-dried basis)

#### Non-Coking Coal

Ash%	GCV (K.Cal/kg)	Grade Range
16.87-46.7	2988-6232	G4-G15

#### Net Geological Resource (Mt.)

Within Leasehold Boundary			Within Proposed Floor Limit		
Proved	Indicated	Total	Proved	Indicated	Total
46.8	3.27	50.07	2.36	-	2.36

### Roof & Floor

The roof is generally carbonaceous shale and medium to coarse grained sandstone while immediate floor is carbonaceous shale and medium to coarse grained sandstone.

### Exploitation

The seam has been mined by underground method in south western part and quarried out by opencast method in small patches in incrop region.

### Seam II

Seam II underlies seam III with a parting of 6.35 m to 16.73m and the full coal thickness has been intersected in 47 boreholes within the project limit. In-band thickness of the seam varies from 0.07m (MR006) to 2.15m (MR026). The seam has been considered as non-coking coal within the project area. Detailed quality parameters and net geological resource is given below in table.



### Quality Parameters

#### Proximate Analysis (On air-dried basis)

#### Non-Coking Coal

Ash%	GCV (K.Cal/kg)	Grade Range
15.4-37.2	6098-7267	G1-G5

### Net Geological Resource (Mt.)

Within Leasehold Boundary		
Proved	Indicated	Total
11.4	1.52	12.93

### Roof & Floor

The roof is generally medium to coarse grained sandstone while immediate floor is either shale or intercalation of shale and sandstone.

### Exploitation

The seam is virgin in the entire area.

### Seam I/II Combined

Seam I/II combined underlies seam III with a parting of 11.39 m to 13.92 m and the full coal thickness has been intersected in 4 boreholes within the project limit. In-band thickness of the seam varies from 3.67m (BA017) to 5.07m (BA022). The seam has been considered as non-coking coal within the project area. Detailed quality parameters and net geological resource is given below in table.

### Quality Parameters

#### Proximate Analysis (On air-dried basis)

#### Non-Coking Coal

Ash%	GCV (K.Cal/kg)	Grade Range
33.5-37.37	6167-6393	G4



**Net Geological Resource (Mt.)**

Within Leasehold Boundary			Within Proposed Floor Limit		
Proved	Indicated	Total	Proved	Indicated	Total
6.59		6.59			

**Roof & Floor**

The roof is generally coarse grained sandstone while immediate floor is either carbonaceous shale.

**Exploitation**

The seam is virgin in the entire area.

**Seam I**

Seam I underlies seam II with a parting of 1.18m to 12.28m and the full coal thickness has been intersected in 46 boreholes within the project limit. In-band thickness of the seam varies from 1.05m (MR002) to 4.28m (BA004). Detailed quality parameters and net geological resource is given below in table.

**Quality Parameters****Proximate Analysis (On air-dried basis)****Non-Coking Coal**

Ash%	GCV (K.Cal/kg)	Grade
26.98-44.80	4510-6652	G3-G10

**Net Geological Resource (Mt.)**

Within Leasehold Boundary			Within Proposed Floor Limit		
Proved	Indicated	Total	Proved	Indicated	Total
28.4	3.29	31.65			

**Roof & Floor**



The roof is generally intercalation of shale and sand while immediate floor is coarse grained sandstone or shale.

### Exploitation

The seam is considered virgin within the project area.

## 4.9 Insitu Coal Quality

The quality of coal seams in this report is taken from seam overall analysis data as available in respective Geological report. Quality for seam boreholes (seam III, II, I/II, & I) in these reports is given based on opencast norms (I100) and that has been converted to (I30) norm for their extraction by underground method. The non-combustible bands like sandy shale, sandstone, siderite, grey shale (Ash > 75 %) etc. irrespective of their thickness have been excluded from the total thickness of the seam for computing the effective thickness of coal seams for the purpose of quality consideration.

Faulted, partly faulted, worked seam/part worked seam thickness encountered in the boreholes have not been considered for the purpose of quality assessment.

### 4.10.1 Resource Estimation Criteria

- A. The seam wise status of developed, depillared and goaved areas in addition to virgin patches has been identified on the basis of seam working plan provided by the colliery authorities. These have been clearly marked on the seam folio plans and floor contour plans of all the seams proposed for quarrying in the area.
- B. **Goaf & Quarries:** These areas have been considered as devoid of coal, however in case of goaf the devoid zone is considered according to the height of the goaf.
- C. **Developed Areas:** In developed areas, where resource are standing on pillars, seam wise dimension of extraction (height & width) have been decided on the basis of seam working plan made available by colliery authorities and after detailed discussion with them

ASHOK KUMAR  
Project Officer  
Muraidih Colliery



**D. Thickness:** Iso-chore thickness of the seam has been considered for resource estimation. Areas having thickness less than 0.5 m have not been considered for resource estimation.

**E. Not developed zone**

Not developed areas have been demarcated and these areas have been excluded from resource estimation.

**F. Assumption on Fire:**

As per data received as per colliery authorities (Annexure-I) damage of coal due to fire is not known therefore resource of fire area has been estimated assuming that no coal has been damage due to fire, therefore resource may vary from actual resource.

Coal resource estimation of individual seam within the proposed floor limit has been assessed by taking the area of each seam extent marked in individual floor contour plan/seam folio plan and considering all the assumptions as discussed above.

#### **4.10.2 Methodology of Resource Calculation**

The resource has been estimated through "MINEX" software.

1. The resource has been calculated using "Detailed Resource Reporting" menu of **MINEX 6.5.3** software.
2. A deduction of 10% from the 'gross resources' of coal has been made to account for unidentified geological uncertainties like structural disturbances, washout zones etc. to arrive at the 'net geological resources'.
3. The seam wise status of developed, depillared, stook, in addition to virgin patches has been identified on the basis of seam working plan supplied by the concerned area/colliery officials. These have been clearly marked on the seam folio plans and floor contour plans of all the seams.
4. **Heave Zone:** The areas falling within the heave zone of a fault has been excluded for the purpose of resource estimation.

*Ashok*  
**ASHOK KUMAR**  
Project Officer  
Muraidih Colliery  
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5. Coal resource estimation of individual seam within the proposed quarry limit of Muraidih-Phularitand Colliery has been assessed by taking the area of each seam extent marked in individual floor contour plan/seam folio plan.

#### 4.11 Band in Coal Seam

All the seams contain several number of bands. The thickness of the band varies from 2 centimeters to 2 meter. The bands generally composed of carbonaceous shale, dark shale, fine grained sandstone, MP etc.

#### 4.12 Conclusion

##### 1. Resource within Leasehold Area.

The integrated geological assessment on the basis of available surface and sub-surface data have clearly established 247.039 million tons of coal within leasehold area out of which 34.139 million tons is coking coal and 212.900 million tons is non-coking coal.

##### 2. Resource within proposed Quarry limit.

Resource within proposed Quarry limit estimated 72.758 million tons of coal out of which 20.748 million tons of coking coal and 52.010 million tons of non-coking has been estimated within the proposed quarry limit.

#### Net Geological Resource of Coal & Jhama

(Within the Leasehold Area of 1118.71 Ha)

Table No: 4.7

##### Seam wise/grade wise proved resource of Coking Coal (Million Tonnes)

Resource of Coking Coal Proved (in million tonnes)								
Within Leasehold Area								
Seam	S-I	S-II	W-I	W-II	W-III	W-IV	UG	TOTAL
XIII				0.155	0.1	0.016		0.271
XI/XII					0.172	4.537	0.52	5.229
IX/X						9.83		9.83
VIIIC					0.082	3.202	0.343	3.627
VIIIB						0.978	3.889	4.867
VIIIA					0.091	5.783	3.292	9.166
VIII					0.018	1.082	0.049	1.149
Total				0.155	0.463	25.43	8.093	34.139
GRAND TOTAL								

Seam wise/grade wise proved resource of Non-coking coal (Million Tonnes) is given below-

*Ashok*  
**ASHOK KUMAR**  
 Project Officer  
 Muraidih Colliery  
 (H)



Non Coking Coal Resource Proved (in million Tonnes)																			
Within the Leasehold Area																			
Seam	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11	G12	G13	G14	G15	G16	G17	G18	TOTAL
XIII																			
XI/XII																			
IX/X																			
VIIIC					0.05	0.15													0.200
VIIIB					0.18	0.23	0.26												0.670
VIIIA				0.01	0.12														0.130
VIII				0	0														0.000
V/VI/VII				6.52	79.5	13.6													99.66
IVT									0.02	0.15	0.26	0.24	0.09	0.12	0.12	0.13	0.13	1.16	2.420
IV							1.08	2.01	1.34	0.57	0.74	0.54	0.11	0.09	0.08	0.07	0.06	0.95	7.640
IVB									0.01	0.11	0.2	0.13	0.11	0.1	0.09	0.06	0.05	0.08	0.940
III				0.39	0.66	0.94	1.8	9.81	23.6	8.67	0.31	0.22	0.18	0.17	0.04				46.800
II	0.56	5.4	4.97	0.48															11.410
I/II			0.72	4.01	1.86														6.590
I			0.43	3.88	8.17	12.6	2.79	0.28	0.15	0.02									28.360
	0.56	5.4	6.12	15.3	90.6	27.6	5.93	12.1	25.1	9.52	1.51	1.13	0.49	0.48	0.33	0.26	0.24	2.19	204.820
TOTAL																			
Non Coking Coal Resource indicated (in million Tonnes)																			
Within the Leasehold Area(Total)																			
Seam	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11	G12	G13	G14	G15	G16	G17	G18	TOTAL
III									1.54	1.73									3.27
II	0.26	1.02	0.24																1.52
I/II																			
I			0.64	2.39	0.26														3.29
	0.26	1.02	0.88	2.39	0.26				1.54	1.73									8.080
TOTAL																			
GRAND TOTAL																			
212.900																			

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Project Officer  
Muraidih Colliery

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5. Coal resource estimation of individual seam within the proposed quarry limit of Muraidih-Phularitand Colliery has been assessed by taking the area of each seam extent marked in individual floor contour plan/seam folio plan.

#### 4.11 Band in Coal Seam

All the seams contain several number of bands. The thickness of the band varies from 2 centimeters to 2 meter. The bands generally composed of carbonaceous shale, dark shale, fine grained sandstone, MP etc.

#### 4.12 Conclusion

##### 1. Resource within Leasehold Area.

The integrated geological assessment on the basis of available surface and sub-surface data have clearly established 247.039 million tons of coal within leasehold area out of which 34.139 million tons is coking coal and 212.900 million tons is non-coking coal.

##### 2. Resource within proposed Quarry limit.

Resource within proposed Quarry limit estimated 72.758 million tons of coal out of which 20.748 million tons of coking coal and 52.010 million tons of non-coking has been estimated within the proposed quarry limit.

#### Net Geological Resource of Coal & Jhama

(Within the Leasehold Area of 1118.71 Ha)

Table No: 4.7

#### Seam wise/grade wise proved resource of Coking Coal (Million Tonnes)

Resource of Coking Coal Proved (in million tonnes)								
Within Leasehold Area								
Seam	S-I	S-II	W-I	W-II	W-III	W-IV	UG	TOTAL
XIII				0.155	0.1	0.016		0.271
XI/XII					0.172	4.537	0.52	5.229
IX/X						9.83		9.83
VIIIC					0.082	3.202	0.343	3.627
VIIIB						0.978	3.889	4.867
VIIIA					0.091	5.783	3.292	9.166
VIII					0.018	1.082	0.049	1.149
Total				0.155	0.463	25.43	8.093	34.139
GRAND TOTAL								

Seam wise/grade wise proved resource of Non-coking coal (Million Tonnes) is given below-

*Ashok*  
**ASHOK KUMAR**  
 Project Officer  
 Muraidih Colliery



Non Coking Coal Resource Proved (in million Tonnes)																			
Within the Leasehold Area																			
Seam	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11	G12	G13	G14	G15	G16	G17	G18	TOTAL
XIII																			
XI/XII																			
IX/X																			
VIII C					0.05	0.15													0.200
VIII B					0.18	0.23	0.26												0.670
VIII A				0.01	0.12														0.130
VIII				0	0														0.000
V/VI/VII				6.52	79.5	13.6													99.66
IV T									0.02	0.15	0.26	0.24	0.09	0.12	0.12	0.13	0.13	1.16	2.420
IV							1.08	2.01	1.34	0.57	0.74	0.54	0.11	0.09	0.08	0.07	0.06	0.95	7.640
IV B									0.01	0.11	0.2	0.13	0.11	0.1	0.09	0.06	0.05	0.08	0.940
III				0.39	0.66	0.94	1.8	9.81	23.6	8.67	0.31	0.22	0.18	0.17	0.04				46.800
II	0.56	5.4	4.97	0.48															11.410
I/II			0.72	4.01	1.86														6.590
I			0.43	3.88	8.17	12.6	2.79	0.28	0.15	0.02									28.360
	0.56	5.4	6.12	15.3	90.6	27.6	5.93	12.1	25.1	9.52	1.51	1.13	0.49	0.48	0.33	0.26	0.24	2.19	204.820
TOTAL																			
Non Coking Coal Resource indicated (in million Tonnes)																			
Within the Leasehold Area(Total)																			
Seam	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11	G12	G13	G14	G15	G16	G17	G18	TOTAL
III									1.54	1.73									3.27
II	0.26	1.02	0.24																1.52
I/II																			
I			0.64	2.39	0.26														3.29
	0.26	1.02	0.88	2.39	0.26				1.54	1.73									8.080
TOTAL																			
GRAND TOTAL																			
212.900																			

**ASHOK KUMAR**  
Project Officer  
Muraidih Colliery

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Total Coking & Non Coking Coal Resource (in million Tonnes)					
Within the Leasehold Area(Total)					
SEAM	COKING		NON-COKING		TOTAL
	PROVED	INDICATED	PROVED	INDICATED	
XIII	0.271				0.271
XI/XII	5.229				5.229
IX/X	9.83				9.83
VIIIC	3.627		0.2		3.827
VIIIB	4.867		0.67		5.537
VIIIA	9.166		0.13		9.296
VIII	1.149		0		1.149
V/VI/VII			99.66		99.66
IVT			2.42		2.42
IV			7.64		7.64
IVB			0.94		0.94
III(for OC)			2.36		2.36
Sub total	34.139	0	114.02	0	148.159
III (Rest)			44.44	3.27	47.71
II			11.41	1.52	12.93
I/II			6.59		6.59
I			28.36	3.29	31.65
Sub-Total	0	0	90.8	8.08	98.880
TOTAL	34.139		204.82	8.08	247.039

Open Cast Norm

Under Ground Norm



**Seam wise/grade wise proved resource of Non-coking coal (Million Tonnes)**  
**(Within the Quarry Extent Area)**  
**Table No: 4.8**

<b>Coking Coal Resource Proved(in million Tonnes)</b>					
<b>Within the Extent</b>					
<b>Seam</b>	<b>W-II</b>	<b>W-III</b>	<b>W-IV</b>	<b>UG</b>	<b>TOTAL</b>
<b>XIII</b>	0.015	0.023	0	0	0.038
<b>XI/XII</b>	0	0	2.772	0.303	3.075
<b>IX/X</b>	0	0	5.191	0	5.191
<b>VIII C</b>	0	0.026	1.948	0.157	2.131
<b>VIII B</b>	0	0	0.98	2.489	3.469
<b>VIII A</b>	0	0	3.107	2.909	6.016
<b>VIII</b>	0	0	0.828	0	0.828
<b>Total</b>	<b>0.015</b>	<b>0.049</b>	<b>14.83</b>	<b>5.858</b>	<b>20.748</b>
<b>GRAND TOTAL</b>					

<b>Non Coking Coal Resource (Proved)</b>							
<b>Within the Extent</b>							
<b>Seam</b>	<b>G4</b>	<b>G5</b>	<b>G6</b>	<b>G7</b>	<b>G8</b>	<b>G9</b>	<b>TOTAL</b>
<b>VIII B</b>	0.1	0.05	0.03				0.180
<b>V/VI/VII</b>	3.74	45.1	0.66				49.470
<b>III</b>	0.31	0.64	0.64	0.32	0.29	0.16	2.360
	<b>4.05</b>	<b>45.8</b>	<b>1.35</b>	<b>0.35</b>	<b>0.29</b>	<b>0.16</b>	<b>52.010</b>
<b>GRAND TOTAL</b>							

<b>Total Coking &amp; Non Coking Coal Resource</b>			
<b>(in million Tonnes)</b>			
<b>Within the Extent (Total)</b>			
<b>SEAM</b>	<b>COKING</b>	<b>NON-COKING</b>	<b>TOTAL</b>
<b>XIII</b>	0.038		0.038
<b>XI/XII</b>	3.075		3.075
<b>IX/X</b>	5.191		5.191
<b>VIII C</b>	2.131		2.131
<b>VIII B</b>	3.469	0.180	3.649
<b>VIII A</b>	6.016		6.016
<b>VIII</b>	0.828		0.828
<b>V/VI/VII</b>		49.470	49.470
<b>IVT</b>			
<b>IV</b>			
<b>IVB</b>			
<b>III</b>		2.360	2.360
<b>II</b>			
<b>I/II</b>			
<b>I</b>			
<b>TOTAL</b>	<b>20.748</b>	<b>52.01</b>	<b>72.758</b>