

# **RECAST PROJECT REPORT FOR GANDHIGRAM U/G MINE**

## **EXECUTIVE SUMMARY**

### **1.0 INTRODUCTION**

#### **1.1 GENERAL**

The proposed Gandhigram U/G mine has been planned in Gandhigram Geological Block, which is a virgin block in Pathakhera Coalfields. The nearest operating U/G mines are Tawa-I & Tawa II. Gandhigram UG Mine will be under administrative control of Pathakhera Area of Western Coalfields Ltd.

#### **1.2 HISTORY OF MINING**

Gandhigram Geological Block is a virgin block. Gandhigram U/G project is aimed at bridging the deficit in supply of coal partially from Pathakhera Coalfield as well as WCL. This mine was slated to replace Satpura-II and Shobhapur U/G mines of Pathakhera Area. The report has proposed the deployment of mass production technology in order to generate high production and productivity levels.

Gandhigram Geological Block is located nearly 9 kms north of Satpura TPS of MPPGCL. Gandhigram Block consists of five sectors namely Sector A, B, C, D and E which are further divided into sub-sectors due to faults. The report has proposed to exploit the proved coal reserves of Sector C and D only. The total area of Gandhigram Geological Block is 10.70 Sq.km out of which the mining area is about 7.06 sq.km.

Tawa Extension Geological Block, located immediate south of this block, is separated by 2 nos. down throw compensating faults  $F_6-F_6$  and  $F_1-F_1$  having throw varying from 120m to 270m. In the Draft Project Report, Sector – IV of Tawa Extension Block was included within the Gandhigram U/G mine. In the Planning Committee Meeting it was decided to exclude Sector-IV and restrict the mine boundary to Sector C and D of Gandhigram Block only.

#### **1.3 RECENT STUDIES AND DEVELOPMENT**

The Recast Project Report for Gandhigram U/G Mine, Pathakhera Area, WCL has been prepared based on the Geological Report on Coal Exploration in Gandhigram block of Pathakhera Coalfields, Betul district, Madhya Pradesh by exploration department of CMPDI, RI-4 Nagpur in March-2002. The area of the geological block is 10.70 sq.km involving drilling of 107 boreholes with a total geological reserves of 81.354 Mt (This includes 61.825 Mt of Net Proved Reserve and 19.529 Mt of Net indicated Reserves). The mine has been projected only in the sectors having proved coal reserves (Sector - C and D).

#### 1.4 PREPARATION OF PROJECT REPORT FOR GANDHIGRAM U/G MINE

Project Report for Gandhigram U/G Mine (1.17 Mty, April 2009) was discussed in the Meeting of Sub-Committee of WCL Board for Projects held on 18/07/2009 . In the meeting Chief General Manager, Pathakhera Area raised doubts regarding the geological structure in view of low borehole density within mine area and appearance of unknown dykes in the adjacent Tawa-II U/G Mine. While accepting the suggestions of C.G.M, Pathakhera Area, the Sub-Committee of WCL Board for Projects directed that the P.R for Gandhigram U/G Mine should be recasted. As a result, the Recasted PR was prepared by CMPDI, RI-4 in November-2009 and submitted to WCL.

The recast PR prepared in September-2009 was discussed in the meeting of sub-committee of WCL Board held on 21.12.2009. In the meeting, CMD WCL expressed his doubts regarding the applicability of Bord & Pillar method of mining at depths exceeding 300m and directed to suggest a better alternative method. Also suggested to explore the possibility of working Sector-E3 (reserves in indicated category) and operating 2 mines in Gandhigram block with separate mine entries. Subsequently, based on the data generated by Magnetic Survey, 3 nos of Dykes have been deciphered (thickness varies from 10m to 35m). By considering & incorporating these additional information, the Recast PR was modified in Feb-2011 & submitted to WCL.

The Recast PR for Gandhigram U/G Mine, 1.20 Mty, prepared in February 2011 was discussed in the Pre-TSC meeting on 22/03/2011. The points discussed including the requirement of subsidence study for EMP clearance, shifting of houses of PAP & their compensation amount and WDV of residential quarters required for this project etc to be included in the P.R. As a result The 2<sup>nd</sup> Recast PR for Gandhigram U/G Mine, 1.20 Mty was updated in May 2011 taking into consideration the points/suggestions of earlier meetings with WCL.

The 2<sup>nd</sup> Recast PR for Gandhigram U/G Mine, 1.20 Mty, updated in May 2011 was discussed in the Meeting of Technical Sub-Committee of WCL Board for Projects held on 05/08/2011. After detailed deliberation, Committee recommended the P.R of Gandhigram U/G Mine on departmental option, for capacity 1.20 Mty and total capital of Rs. 483.6314 crores (additional capital of Rs. 483.3025 crores and WDV of Rs. 0.3289 Cr.) on cost plus basis, for submission to WCL Board for 1<sup>st</sup> stage approval i.e., for the purpose of obtaining Environmental Clearance (for peak capacity of 1.60 Mty) and Forestry Clearance. The Recast PR was updated as per the directives of sub-committee of WCL Board for Projects and submitted to WCL in Sept.-2011. This updated Recast PR for Gandhigram U/G Mine, 1.20 Mty, (May 2011) was discussed in the 233<sup>rd</sup> Meeting of Board of Directors of WCL held on

20/10/2011.

After deliberations, the Board accorded 1<sup>st</sup> Stage approval for Project Report of Gandhigram UG Mine-1.20 Mty for the purpose of obtaining Environmental Clearance from MoEF for a peak production capacity of 1.60 Mty and Forestry Clearance. This Report was approved with an estimated capital investment of Rs 483.6314 Cr (additional capital Rs 483.3025 Cr & WDV of Rs 0.3289 Cr) in Departmental option on Cost Plus basis. Copy of the Board approval letter is enclosed as Annexure-I.

By Letter No: WCL/PKD/GM/P&P/2014/55 Dated 28.07.2014 , Area G.M of Pathakhera Area informed that the proposed site of inclines and other infrastructures are lying within Tiger Corridor where surface activities are not permitted . In the meeting of APOs, GM (L&R), GM (Env.) and GM (UG) CMPDIL with Dir. Tech. (P&P) , it was decided that PR of Gandhigram UG will be updated taking into view of the location of Tiger Corridor. (Refer Annex.-II).

Due to the presence of tiger corridor, the incline & surface infrastructure positions were re-located and the Recast PR was modified accordingly in Dec-2015 with 3 sets of C.M Packages for a target production of 1.20 Mty. (As per the recent information available from WCL, this Geological Block is now out of the boundary area of Tiger Corridor). The concept of "Integrated Power and Coal Transport" for the 3 upcoming UG mines of this Area (Gandhigram, Shaktigarh & Tawa-III) was considered and the pro-rata capital provision w.r.t its production capacity were loaded in this project. As per this concept, 220 kV power lines were to be brought in for the 3 mines & arrangement of belt conveyors for despatch of coal from pit-head to Shobhapur bunker for onward transport to Sarni were to be done. However, the project was not achieving 12% IRR at 85% target capacity in Dept. & P.H options for both Power as well as Non-Power Sectors.

The updation of Recast PR for Gandhigram UG Mine has been taken up after the notification of increase in the pit-head price of non-coking coal for WCL (w.e.f May-2016). The effects of change in production capacity from 1.20 Mty to 1.26 Mty, IXth Wage Board changes , Manpower etc have been considered and the Recast PR for Gandhigram UG mine has been updated as on September-2016.

The economics of the project has been worked out in two options namely Departmental & Partial Hiring Option. The stores cost has been estimated based on the directives of meeting held at WCL (HQ) on 18.09.2015 (for Recast PR for Jamunia UG Report) in which it was decided to work out economics of U/G Mines in Dept. option considering operation and maintenance of C.M. Package by WCL on its own as this technology is no longer new for WCL/CIL. (Enclosed as Annexure-IV). Hiring cost of CM package in P.H option is based on the quoted hiring rate for Tawa-II Expn UG

mine of WCL (August-2016) after due escalation. (Enclosed as Annexure-V).

## 1.5 RISKS / CONSTRAINTS

The risks/constraints/difficulties in opening/implementing the project are detailed as follows:

- a) Sector C is quite clean and large sector. A number of faults within the mining area have been interpreted to die down in Sector C as per GR. In case of any change in the alignment and / or throw of faults in Sector C, the projections shown on the panel layout plans may not hold good. Capital provision for exploratory drilling and geo-physical survey has been made to confirm the geological structure. Boreholes for incline alignment should be drilled before acquisition of land under Surface / All Rights to confirm the touching point of mine entries.
- b) The majority of project area is overlain by Asir Reserve Forest (about 628Ha i.e. 87% of total land requirement). Obtaining EMP approval from MOEF and Forestry Clearance under Forest Conservation Act, 2000 will be the most important activities to be completed before starting the Project. Capital provision for baseline data generation, subsidence prediction studies and land use survey by remote sensing has been made in the report. These activities should be initiated as an advance action so that the EMP, complete in all respects, can be submitted to MOEF.
- c) The productivity of continuous miner district is based on the likely support density and the capability of the roof bolting machines, which are an integral part of the continuous miner package. In case the support density requirement exceeds the envisaged density, provision of single rig hydraulic roof bolter (1 no) has been made so as not to affect the output from the continuous miner district.
- e) Coal of Pathakhera Coalfield is traditionally very hard. The UCS is around 55 to 60 MPa, the HGI is around 45 and the Protodyakonov Index is around 1.2 to 1.4. This indicates that coal will be difficult to cut and consumption of cutting picks is likely to be on the higher side.
- f) Availability of clean water for operating the continuous miner packages during the initial development years could pose a problem since the mines of Pathakhera Area are known to be dry.

## 2.0 MARKETABILITY & JUSTIFICATION

### 2.1 DEMAND OF COAL

The year wise FSA/LOA commitment of WCL up to 2019-20 is tabulated below

SL. NO.	PARTICULARS	FSA / LOA COMMITMENT AS ON 01.07.2016								
		Applicable Trigger Level	2016-17		2017-18		2018-19		2019-20	
			FSA Qty.	Qty. at Trigger Level	FSA Qty.	Qty. at Trigger Level	FSA Qty.	Qty. at Trigger Level	FSA Qty.	Qty. at Trigger Level
<b>A)</b>	<b>FSA ALREADY EXECUTED</b>									
1	Old Power Producers existing as on 31.03.2009 with whom FSAs have been signed	90 %	30.093	27.084	30.093	27.084	30.093	27.084	30.093	27.084
2	Past Commitment of Non Power Sector except Cokeries with whom FSAs are signed prior to 31.12.2011 & Commitment of Bhilai Steel Plant from Nandan washery	60 %	4.879	2.927	4.879	2.927	4.879	2.927	4.879	2.927
3	Past Commitment of Cokeries with whom FSAs are signed prior to 31.12.2011	30 %	0.039	0.012	0.039	0.012	0.039	0.012	0.039	0.012
4	New Non-power FSA executed	50 %	2.779	1.389	2.779	1.389	2.779	1.389	2.779	1.389
5	Cost Plus FSAs with Wardha Power Co. Ltd.	90 %	1.625	1.463	1.625	1.463	1.625	1.463	1.625	1.463
6	New Power FSA executed with MPPGCL on 02.01.2013, with NTPC on 04.09.2013, with VIPL on 10.03.2014 and Mahagenco (as per IMTF's recommendations) on 27.04.2015	75% For 16-17 onwards	6.268	4.701	6.268	4.701	6.268	4.701	6.268	4.701

	<b>Total FSA already executed (1-6)</b>		<b>45.682</b>	<b>37.576</b>	<b>45.682</b>	<b>37.576</b>	<b>45.682</b>	<b>37.576</b>	<b>45.682</b>	<b>37.576</b>
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SL. NO.	PARTICULARS	FSA / LOA COMMITMENT AS ON 01.07.2016								
		Applicable Trigger Level	2016-17		2017-18		2018-19		2019-20	
			FSA Qty.	Qty. at Trigger Level	FSA Qty.	Qty. at Trigger Level	FSA Qty.	Qty. at Trigger Level	FSA Qty.	Qty. at Trigger Level
<b>B)</b>	<b>LOA COMMITMENT</b>									
7	Commitment of Power Plants achieved milestones and appearing in list circulated by MOC vide letter dated 17.07.2013	75% for 16-17 onwards	1.373	1.030	1.373	1.030	1.373	1.030	1.373	1.030
8	NTPC Telangana Cost Plus Tapering LOA for First year (2019-20) – 75%, Second year (2020-21) – 50%, Third year (2021-22) – 25%	90 %	0.000	0.000	0.000	0.000	0.000	0.000	5.688	4.266
9	Wardha Power Cost Plus	90 %	0.635	0.572	0.635	0.572	0.635	0.572	0.635	0.572
	<b>Total FSA to be executed (7-9)</b>		<b>2.008</b>	<b>1.601</b>	<b>2.008</b>	<b>1.601</b>	<b>2.008</b>	<b>1.601</b>	<b>2.008</b>	<b>1.601</b>
<b>C)</b>	<b>OTHER LOA HOLDERS</b>									
10	Power Utility not achieved milestones and not appearing in MoC letter dated 17.7.2013 or achieved milestones but not appearing in Moc letter dated 17.7.20134	75% for 16-17 onwards	9.469	7.102	9.469	7.102	9.469	7.102	9.469	7.102
11	CPP LOA Holders	50 %	0.621	0.311	0.621	0.311	0.621	0.311	0.621	0.311
12	Sponge LOA Holders achieved milestones	50 %	0.144	0.072	0.144	0.072	0.144	0.072	0.144	0.072
13	Cement LOA Holders not achieved milestones but BIFR Court directed not to take coercive action	50 %	0.042	0.021	0.042	0.021	0.042	0.021	0.042	0.021
	<b>TOTAL (10 to 13)</b>		<b>10.276</b>	<b>7.505</b>	<b>10.276</b>	<b>7.505</b>	<b>10.276</b>	<b>7.505</b>	<b>10.276</b>	<b>7.505</b>
	<b>TOTAL FSA / LOA COMMITMENT</b>		<b>57.966</b>	<b>46.682</b>	<b>57.966</b>	<b>46.682</b>	<b>57.966</b>	<b>46.682</b>	<b>63.654</b>	<b>50.949</b>
14	E-Auction		4.800	4.800	5.000	5.000	5.500	5.500	6.000	6.000

TOTAL COMMITMENT INCLUDING E-AUCTION		62.766	51.482	62.966	51.682	63.466	52.182	69.654	56.948
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The above table indicates that WCL has a FSA/LOA commitment of **57.966 Mty** at 100% supply and **46.682 Mty** at trigger level from 2016-17 to 2018-19. The commitment under FSA/ LOA is **63.654 Mty** at 100% supplies and **50.948 Mty** at trigger level in 2019-20. In addition to this, the coal supply through E-Auction is envisaged as 4.80 Mty, 5.00 Mty, 5.50 Mty and 6.00 Mty in 2016-17, 17-18, 18-19 and 20-19-20 respectively.

## 2.2 AVAILABILITY OF COAL

CIL is planning the target of 1 Billion Tonne Coal production by 2020 and the share of WCL is 60 Mt in this 1 BT planned production. The following table shows the availability of coal from the existing, completed, on-going and future mines of WCL:

(Fig. in Mt)

Sl. No.	Sector	Projections of Availability of Coal			
		2016-17	2017-18	2018-19	2019-20
1	Existing mines	0.31	0.30	0.31	0.31
2	Completed projects	16.71	11.32	10.34	8.68
3	On-going projects	30.85	37.74	42.15	47.55
4	Future projects	0.13	1.64	2.20	3.46
	<b>Total</b>	<b>48.00</b>	<b>51.00</b>	<b>55.00</b>	<b>60.00</b>

## 2.3 DEFICIT IN AVAILABILITY OF COAL FROM WCL

Following table shows the deficit in availability of coal, including middling, from the various Existing, Completed, On-going, and Future Projects of WCL:

(Fig. in Mt)

Sl. No.	Sector	Projections of Surplus / Deficit of Coal			
		2016-17	2017-18	2018-19	2019-20
1	Total Commitment + proposed E-Auction	62.766	62.766	62.766	69.954
2	Availability of coal	48.00	51.00	55.00	60.00
3	Surplus / Deficit (+/-)	(-) 14.766	(-) 11.08	(-) 7.58	(-) 9.954

From the above table, it is clear that the deficit in supply of coal from WCL is 14.766 Mt in 2016-17 and this deficit will be narrowed down to 7.58 Mt in 2018-19 and 9.954 Mt in 2019-20 if WCL achieves the target capacity of 55 Mt and 60 Mt in 2018-19 & 2019-20 respectively.

The contribution from the proposed Recast PR for Gandhigram UG is

included in the 60 Mt production target of WCL to be achieved in 2019-20. Thus, there will not be any difficulty in marketing of proposed coal produced from the proposed mine.

### 3.0 PROJECT SITE INFORMATION

#### 3.1 LOCATION

The proposed Gandhigram U/G Mine is located in Gandhigram Geological Block in the north eastern part of Pathakhera Coalfield. The area is covered by Survey of India Toposheet No. 55 J/4 and lies between latitudes  $22^{\circ} 10' 6''$  N and  $22^{\circ} 12' 13''$  N and longitudes  $78^{\circ} 10' 7''$ E and  $78^{\circ} 13' 00''$ E. The block area is  $10.70 \text{ km}^2$ .

#### 3.2 GEOLOGICAL BLOCK BOUNDARIES:

The boundaries after excluding sectors-A (A1, A2, A3, A4 & A5), sectors-B (B1, B2, B3 & B4) and the area considered from Tawa-extension block.

North : Fault F<sub>21</sub>-F<sub>21</sub>

South : Part of Fault F<sub>6</sub>-F<sub>6</sub> , Fault F<sub>10</sub>-F<sub>10</sub>

East : Fault F<sub>13</sub>-F<sub>13</sub> / Incrop of coal seams

West : (a) Eastern bank of Dagdaga Nalla

(b) Arbitrary line 200m away from peripheral boreholes.

#### 3.3 ACCESSIBILITY AND COMMUNICATION

Gandhigram block is located about 8 – 9 km north of Satpura Thermal Power Station, Sarni. Satpura Dam which is located in the southern edge of Tawa Extension block is connected to Sarni (5 km) by an all weather road built by Madhya Pradesh Power Generation Company Limited. The distance of Gandhigram Block from National Highway No. 69 is about 45 km. The nearest rail head is Ghoradongri (18 kms from Sarni) on the Nagpur-Itarsi section of Central Railway on the New Delhi – Chennai trunk route. Sarni is connected to Ghoradongri by an all weather tar road. A railway line connecting Ghoradongri to the MPPGCL railway siding passes through the southern part of Pathakhera Coalfield.

#### 3.4 TOPOGRAPHY & DRAINAGE

The southern and eastern part of the block is hilly and rugged with thick forest cover whereas the northern and north western regions are comparatively flat. The Bagdev Pahad, the highest peak, extends in the NE – SW direction along the eastern limit of the block. The general elevation in the block varies from 424.45m (CMPGH – 35) above mean sea level in the SW part to 548.74m (CMPGH – 15) above mean sea level in the NE part.



The Dagdaga Nalla, which forms the western boundary of the block, controls the drainage system of the block. Several seasonal nallas originating from Bagdev Pahad – Shri Pahad and other elevated regions in the east, discharge into Dagdaga Nalla which flows in SW direction and drains into Tawa River.

### 3.5 CLIMATE AND RAINFALL

The maximum and minimum temperatures recorded for the area are 46<sup>0</sup>C in June, 1994 and 4.0<sup>0</sup>C in January, 1991 respectively.

The rainfall in the area generally varies from 1200 mm to 2268 mm per annum. An average rainfall of 1400 mm per year has been recorded in the neighboring mines of the Area.

### 3.6 PRESENT LAND USE PATTERN

The proposed project area covers 718.073 Ha of land among which major part of the block is covered by Asir Reserve forest (628.067 Ha). The forest is of Class IV i.e. having trees of height above 50'.

Plantation is miscellaneous consisting of mostly Bhuija, Landya, Saja, Tendu etc. The Asir reserve forest is practically devoid of any wild life. However, occasional sighting of Deer, Sambhar, Cheetal and Peacocks is reported. Tiger Corridor area is lying within the block which has also been demarcated in the plans.

About 62.496 Ha of tenancy & 27.51 Ha of Govt land is also required for this project. The western part exhibits sparse vegetation with intermittent cultivated land, which has been transferred to Rehabilitation Department for rehabilitation of displaced persons from Bangladesh.

## 4.0 GEOLOGY AND DEPOSIT APPRAISAL

### 4.1 GENERAL

#### 4.1.1 Recast Project Report for Gandhigram U/G Mine is based on

- (a) Geological Report on Coal Exploration in 'Gandhigram Block', Pathakhera Coalfield, District Betul, MP prepared by Exploration Department of CMPDI, RI-IV, Nagpur in March 2002.
- (b) Report on Magnetic Survey for Delineation of Igneous Intrusives in proposed Gandhigram U/G Mine, Pathakhera Coalfield, January 2010 subsequently revised in April 2010.

- (c) Additional surface contouring data of part area of Gandhigram Block covering the location of proposed mine entries.

#### 4.1.2 STRATIGRAPHIC SEQUENCE OF PATHAKHERA COALFIELDS

Age	Formation	Lithology
Recent	Alluvium	Mostly sandstone
Upper cretaceous to Eocene	Intrusives	Dolerite dykes
----- Unconformity -----		
Upper Permian	Bijori	Mostly sandstone
Lower Permian	Moturs	Medium to coarse grained sandstone greenish at places variegated cholorate and greenish clay
	Barakars	Medium to coarse grained sandstone, fine grained towards bottom, shale, intercalations and coal seams
Upper Carboniferous	Talchirs	Greenish shale and fine grained sandstone
----- Unconformity -----		
Pre-Cambrian		Quartzites

#### 4.1.3 GENERAL GEOLOGY OF THE BLOCK

The stratigraphic succession deciphered from the data of boreholes drilled in the block is given below:

.Age	Formation	Lithology	Recorded thickness range (m)	
			Minimum	Maximum
Recent	Alluvium/Soil	Sandy and clayey soil	1.20 (CMPGH-70)	9.00 (CMPTE-34)
Upper Cretaceous	Intrusives	Dolerite dykes		
Lower Permian	Motur	Medium to coarse grained sandstone with bands of variegated clays	Nil	300.00 (CMPTE-100A)
	Upper Barakars	Medium to coarse grained sandstone devoid of any coal seam	6.00 (CMPTE-50)	250.35 (CMPTE-40)

	Middle Barakar	Medium grained sandstone with coal seam carb shale bands shale and intercalations		
	Lower Barakar	Fine grained garnetiferous sandstone with few thin shale and coal bands	Partly encountered	

## 4.2 GEOLOGICAL STRUCTURE OF THE BLOCK

The geological structure of the Gandhigram block has been deciphered entirely on the basis of sub-surface data obtained from the boreholes drilled in the block. The geological assessment of the proposed geological block area is based on the data of a total 107 boreholes drilled in an area of 10.7 sq.km covering the entire area in the geological block .This includes 20 boreholes drilled in the area including northern part of Tawa-extension block. The density of boreholes in Geological block works out to 10 boreholes / sq km.

### 4.2.1 STRIKE AND DIP

The general trend of the formation in the area is NE-SW dipping towards NW at a gradient of 1 in 7.5 to 1 in 10 i.e, about 8° to 6° dip. However, in the south-east part the strata exhibits a steeper gradient of 1 in 3 to 1 in 4 i.e., about 14° to 18° dip.

### 4.2.2 FAULTS

21 faults with throw varying from 5m to 230m are present in the area. The faults have been deciphered on the basis of sub-surface data. The northern boundary fault F21-F21 is having a throw up to 230 m while the southern boundary fault F6- F6 with a throw of 270m. Other faults within the mining block have varying throw up to 55 m.

#### Description of faults occurring in Gandhigram Block

Sl. No.	Fault No.	Trend	Amt.& direction of throw	Nature of evidence	
1	F <sub>1</sub> -F <sub>1</sub>	Almost E-W	35-120m due North	a)	Difference in FRL values on either side of the fault
				b)	Omission of Bagdona & IA Seams in CMPTE-39, 127
				c)	Reduction in thickness of Bagdona Seam in CMPTE-52.
2	F <sub>3</sub> -F <sub>3</sub>	NE-SW	10m due NW	a)	Difference in FRL values on either side of the fault
				b)	Reduction of parting between LWS and Bagdona Seam in CMPTE-36
3	F <sub>4</sub> -F <sub>4</sub>	Almost E-W	35-40 m due North	a)	Difference in FRL values on either side of the fault
				b)	Omission of Upper Workable Seam in CMPTE-42
4	F <sub>5</sub> -F <sub>5</sub>	NE-SW	25m due NW	a)	Difference in FRL values on either side of the fault
				b)	Reduction of parting between LWS and Bagdona Seam in CMPTE-124

Description of faults occurring in Gandhigram Block...contd

Sl. No.	Fault No.	Trend	Amt.& direction of throw	Nature of evidence	
5	F <sub>6</sub> -F <sub>6</sub>	Almost E-W	20 -250m due south	a)	Difference in FRL values on either side of the fault
				b)	Omission of IA Seam in CMPTE-135, LWS in CMPTE-45, UWS and LWS in CMPTE-48. All seams in CMPGH-79 & UWS & LWS in CMPGH-35.
6	F <sub>7</sub> -F <sub>7</sub>	Almost NE-SW	50m due SE	a)	Difference in FRL values on either side of the fault
				b)	Reduced thickness of LWS in CMPGH-24, omission of Bagdona Seam in CMPTE-33 & CMPGH-26 I-A Seam in CMPTE-33.
7	F <sub>8</sub> -F <sub>8</sub>	NE-SW	15m due SE	a)	Difference in FRL values on either side of the fault
				b)	Reduced parting between Bagdona & IA Seam in CMPGH-27
8	F <sub>9</sub> -F <sub>9</sub>	E-W to NE-SW	150m due South to SE	a)	Difference in FRL values on either side of the fault
				b)	Reduction of parting between LWS & Bagdona Seam in CMPTE-46 & 49.

9	F <sub>10</sub> - F <sub>10</sub>	E-W to NE-SW Curvilinear	5-95m due South to SE	a)	Difference in FRL values on either side of the fault
				b)	Omission of Lower Workable Seam in CMPGH-67 & CMPTE-50
				c)	Omission of IA Seam in CMPTE-49
Sl. No.	Fault No.	Trend	Amt. & direction of throw	Nature of evidence	
10	F <sub>14</sub> - F <sub>14</sub>	Almost E-W	0-55m due North	a)	Difference in FRL values on either side of the fault
				b)	Omission of Bagdona Seam in CMPGH-23
11	F <sub>16</sub> - F <sub>16</sub>	NE-SW to E-W	0-45m due SE & South	a)	Difference in FRL values on either side of the fault
				b)	Reduction of about 45m parting between LWS and Bagdona Seam in CMPGH-12

Description of faults occurring in Gandhigram Block...contd

Sl. No.	Fault No.	Trend	Amt. & dir. of throw	Nature of evidence	
12	F <sub>18</sub> - F <sub>18</sub>	SE-NW to NE-SW Curvilinear	25-130m due NE & NW	a)	Difference in FRL values on either side of the fault
				b)	Reduction of about 25m in parting between LWS & Bagdona Seam in CMPGH-65.
				c)	Omission of Bagdona Seam in CMPGH-68
13	F <sub>19</sub> - F <sub>19</sub>	NE-SW	25-35m due NW	a)	Difference in FRL values on either side of the fault
				b)	Reduction of about 30-35m parting between LWS and Bagdona Seam in CMPGH-46
14	F <sub>20</sub> - F <sub>20</sub>	NE-SE	40-45m due SE	a)	Difference in FRL values on either side of the fault
				b)	Reduction of about 40m in parting between LWS & IA Seam in CMPGH-70
				c)	Omission of Bagdona Seam in CMPGH-70
15	F <sub>21</sub> - F <sub>21</sub>	NE-SE Almost E- W (Curvilinear)	200- due North >230m & NE	a)	Difference in FRL values between CMPGH-48 on down throw side and CMPGH-68 on upthrow side of the fault

		r)		b)	Continuation of Motur formation beyond 400m depth in CMPGH-47 on down throw side
				c)	Reduction of Motur thickness in CMPGH-44 compared to that in CMPGH-47.
Anticipatory faults based on difference in floor reduced levels					
16	F <sub>2</sub> - F <sub>2</sub>	NE-SW	50m due NW	Difference in FRL values on either side of the fault	
17	F <sub>11</sub> - F <sub>11</sub>	NE-SW	0-10m due SE	Difference in FRL values on either side of the fault	
18	F <sub>12</sub> - F <sub>12</sub>	NE-SW	0-15m due SE	Difference in FRL values on either side of the fault	
19	F <sub>13</sub> - F <sub>13</sub>	NE-SW	(+) 150m due north west	a) Intersection of Talchir formation in CMPTE-37 & CMPGH-20 & 69	
20	F <sub>15</sub> - F <sub>15</sub>	Almost E-W	25-55m due South	Difference in FRL values on either side of the fault	
21	F <sub>17</sub> - F <sub>17</sub>	Almost E-W	0-25m due North	Difference in FRL values on either side of the fault. This fault abuts against fault F16-F16 at depth and does not reach the surface. As such, this fault has not been shown on the Surface plan.	

The proposed Gandhigram geological block has been divided into 14 sectors namely A1,A2,A3,A4,A5,B1,B2,B3,B4,C,D,E1,E2 & E3 on the basis of disposition of 21 faults across the block. Out of this, only 2 sectors (Sector-C & D) have coal reserves in proved category while coal reserve in the remaining 12 sectors are of indicated category. The Geological Sectors are shown in table below.

Sector No.	Sector Particulars (Proved / Indicated) and boundaries
<b>1.</b>	<b>Coal Reserves in Proved Category</b>
C	Faults F <sub>6</sub> , F <sub>10</sub> , F <sub>13</sub> , F <sub>15</sub> , F <sub>16</sub> , F <sub>18</sub> & eastern bank of Dagdaga Nalla
D	Faults F <sub>18</sub> , F <sub>20</sub> , F <sub>21</sub> and eastern bank of Dagdaga Nalla
<b>2.</b>	<b>Coal Reserves in Indicated Category</b>
A-1	Faults F <sub>1</sub> -F <sub>1</sub> , F <sub>2</sub> , F <sub>6</sub> and incrop of seam
A-2	Faults F <sub>2</sub> , F <sub>1</sub> , F <sub>3</sub> and F <sub>6</sub>
A-3	Faults F <sub>1</sub> , F <sub>5</sub> and F <sub>4</sub>
A-4	Faults F <sub>5</sub> , F <sub>1</sub> , F <sub>4</sub> and arbitrary line 200m from peripheral B.Hs
A-5	Faults F <sub>6</sub> , F <sub>3</sub> , F <sub>4</sub> and arbitrary line 200m from peripheral B.Hs
B1	Faults F <sub>7</sub> , F <sub>13</sub> , F <sub>6</sub> and incrop of seam

B2	Faults F <sub>8</sub> , F <sub>9</sub> , F <sub>10</sub> , F <sub>13</sub> , F <sub>7</sub> , F <sub>6</sub> and incrop of seam
B3	Faults F <sub>9</sub> , F <sub>8</sub> , F <sub>6</sub> and incrop of seam
B4	Faults F <sub>10</sub> , F <sub>9</sub> and F <sub>6</sub>
E1	Faults F <sub>20</sub> , F <sub>18</sub> , F <sub>19</sub> and F <sub>21</sub>
E2	Faults F <sub>19</sub> , F <sub>18</sub> , F <sub>13</sub> and F <sub>21</sub>
E3	Faults F <sub>18</sub> , F <sub>16</sub> , F <sub>15</sub> and F <sub>13</sub>

The Faults or any other Geological features are being identified and located based on the Geological exploration conducted in the block. Chances of additional faults, dykes or other geological disturbances can not be ruled out as the present borehole density is about 9.20 BHs/sq.km only. Capital provision for additional drilling of 20 exploratory boreholes required for improving borehole density to 12.0 BHs/sq.km is made in this Report. After exploration, a total review of geological structure, coal reserves, quality parameters etc have to be done based on the exploration data.

On account of further exploration or during the course of mining operation, if any additional faults or dykes are encountered, the capital for negotiating these geological disturbances may be drawn from the sanctioned capital with due approval from the competent authority for re-appropriation, if possible.

#### 4.2.3 DYKES

Dolerite dykes have been encountered in 12 boreholes. Possibility of presence of some other dykes cannot be ruled out. Heat effect, however, has been noticed from the coal cores of the Block in a few boreholes and the details are given below:

- i) Lower Workable Seam exhibits heat effect resulting in low V.M. (<10%) on air dried basis in BH No. CMPTE-101.
- ii) Bagdona Seam exhibits heat effect resulting in low V.M. (<10%) on DMMF basis in BH No. CMPTE-48.
- iii) IA Seam exhibits heat effect resulting in low V.M. (<10%) on DMMF basis in BH Nos. CMPTE-48 and CMPGH-25.

#### 4.3 GEOLOGICAL BLOCK BOUNDARIES:

The proposed Gandhigram geological block has been divided into 14 sectors namely A1,A2,A3,A4,A5,B1,B2,B3,B4,C,D,E1,E2 & E3 on the basis of disposition of 21 faults across the block.

North : Fault F<sub>21</sub>-F<sub>21</sub>  
 South : Part of Fault F<sub>6</sub>-F<sub>6</sub>, Fault F<sub>10</sub>-F<sub>10</sub>  
 East : Fault F<sub>13</sub>-F<sub>13</sub> / Incrop of coal seams

- West : (a) Eastern bank of Dagdaga Nalla  
(b) Arbitrary line 200m away from peripheral boreholes.

#### 4.4 COAL SEAMS

Presence of all the four co-relatable coal seams of Pathakhera Coalfield, i.e., Upper Workable Seam, Lower Workable Seam, Bagdona Seam and IA Seam have been established by drilling in Gandhigram Block.

The Upper Workable Seam, the topmost seam of the Coalfield exhibits generally reduced thickness with carb. shale and shale bands rendering it practically unworkable. The thickness of the Lower Workable Seam has also reduced as compared to the central part of the Coalfield. Bagdona Seam, however, has maintained its thickness, whereas IA Seam has attained workable thickness. Hence Lower workable Seam (LWS), Bagdona Seam & IA Seam are considered for Mining from this block in the proposed P.R.

The variation in thickness of different seams (Upper Workable Seam, Lower Workable Seam, Bagdona Seam & IA Seam), their intervening partings, depth range etc as encountered in different boreholes in the block, has been furnished in the following table with the workability potential with respect to this Project Report.

Details of Seams and their intervening partings

Seam	Thickness Range (m)		Depth Range (m)		Remarks
	Min.	Max.	Min.	Max.	
<b>Upper Workable Seam</b>	0.05	1.52	35.03	390.55	Reduced in thickness and highly inter-banded in nature. <b>Unworkable</b>
Parting	4.41	16.60			Predominantly consists of sandstone.
<b>Lower Workable Seam</b>	1.70	3.64	32.51	376.38	<b>Workable</b>
Parting	43.10	60.72			Consists of intercalations of shale and sandstone with a few thin coal bands.
<b>Bagdona Seam</b>	0.95	2.81	92.51	420.38	<b>Workable</b>
Parting	28.49	43.28			Consists mainly of sandstone and alternate shale & sandstone with occasional shale and coal bands.
<b>IA Seam</b>	0.23	2.95	122.51	460.38	<b>Workable</b> Except in a small portion in the north and north eastern parts..

#### 4.5 GEOLOGICAL RESRVES



The Proposed Gandhigram U/G Mine has been proposed in the Gandhigram geological block. Due to very low thickness of Upper Workable Seam, the geological reserves of UWS has not been estimated in Geological Report. The details of in-situ geological coal reserves (Thickness > 0.90m) as contained in this Geological Block have been given in the following table:

(In Million Tonnes)

Nature of Reserves	Seams			Total Reserves
	LWS	Bagdona	IA	
Net Proved (<300m depth)	12.188	9.264	10.657	32.109
Net Proved (>300m depth)	12.221	9.764	7.731	29.716
<b>Sub-Total – Net proved</b>	<b>24.409</b>	<b>19.028</b>	<b>18.388</b>	<b>61.825</b>
Indicated (<300m depth)	4.016	3.591	2.972	10.579
Indicated (>300m depth)	4.678	3.308	0.964	8.950
Sub-Total - Indicated	8.694	6.899	3.936	19.529
<b>Total</b>	<b>33.103</b>	<b>25.927</b>	<b>22.324</b>	<b>81.354</b>

In this report, only the sectors having proved reserves ( Sector-C & Sector-D) have been considered for exploitation. All other sectors are deep seated and narrow. Hence , the total Geological reserve available in this considered in this Recast PR of Gandhigram UG mine is **61.825 Mt** only. In-situ Proved Geological Reserves (thickness wise) is shown in the table below.

Seam Name	Coal Reserves (Figures in Mt)		
	Thickness <1.5m	Thickness > 1.5m	Total
LWS	Nil	24.409	24.409
Bagdona	0.078	18.950	19.028
IA	0.780	17.608	18.388
<b>Total</b>	<b>0.858</b>	<b>60.967</b>	<b>61.825</b>

Total Proved Geological reserves with seam thickness >1.50 m is **60.967 Mt**.

#### 4.6 QUALITY

Seam wise quality parameters for LWS, Bagdona & IA Seam have been given in the following table:

SEAM-WISE QUALITY PARAMETERS (Overall Range)			
Sl. No.	Seam Section	GCV Range (k.Cal/kg)	Grade
1	Lower Workable Seam (LWS)	4165-5930	G11-G5
2	Bagdona Seam	4965-6385	G8-G4

3	IA Seam	4586-6690	G10-G3
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## 5.0 MINE BOUNDARY, RESERVES, PRODUCTION TARGET & MINE LIFE

### 5.1 SELECTION OF SEAMS / SEAM SECTIONS

All the four coal seams of Pathakhera Coalfield, namely, Upper Workable Seam, Lower Workable Seam, Bagdona Seam and IA Seam exist within the boundary of Gandhigram U/G mine.

Upper Workable Seam (UWS) has attained a thickness of >1.5m in a very small area only (in 1 borehole only). Here too, a no. of carb. shale and shale bands are present within the seam making it virtually un-gradable. This seam has not been considered for exploitation in Gandhigram U/G mine.

Lower Workable Seam (LWS) has attained a thickness of >1.5m in the entire mining area and has been considered for exploitation except in a small patch where the seam has got de-volatised. Similarly Bagdona Seam too has attained a thickness of >1.5m in almost the entire mining area. This seam too has been considered for exploitation wherever its thickness is >1.5m and the seam is not de-volatised. IA Seam has been considered for exploitation wherever its thickness is >1.5m and the seam is not de-volatised.

The general thickness range and grade of these seams as well as thickness of parting is tabulated below:

Seam Section/ Parting	Thickness range in the mine area (m)	General depth range in the mine area (m)	Remarks
<b>Upper Workable Seam</b>	0.05 to 1.52	35.03 to 390.55	<b>Un-Workable</b>
Parting	4.41 to 16.60		
<b>Lower Workable Seam</b>	1.70 to 3.64	32.51 to 376.38	<b>Workable</b>
Parting	43.10 to 60.72		
<b>Bagdona Seam</b>	0.95 to 2.81	92.51 to 320.38	<b>Workable</b>
Parting	28.49 to 43.28		
<b>IA Seam</b>	0.23 to 2.95	122.51 to 460.38	<b>Workable</b>

### 5.2 SELECTION OF SECTORS

The proposed Gandhigram geological block has been divided into 14 sectors namely A1,A2,A3,A4,A5,B1,B2,B3,B4,C,D,E1,E2 & E3 on the basis of disposition of 21 faults across the block. Out of 14 sectors, only 2 sectors (Sector-C & D) are having coal reserves in proved category while coal reserve in the remaining 12 sectors are of indicated category. In this report,

only 2 sectors (Sector- C & D) where coal reserves are in proved category is considered for exploitation.

The coal reserves in sectors B3 and E3 of Gandhigram block are categorized as indicated reserves at present. These sectors can be approached by drifting across faults from the proposed panels in a later stage after proving the reserves. Provision for exploratory drilling and geo-physical survey has been made. As and when these reserves are brought into the proved category, the boundaries of Gandhigram U/G mine can be extended to include these sectors so that most of the explored area is included and the mine boundaries are defined either by major faults or surface features.

### 5.3 PROPOSED MINE BOUNDARY

As per the selection of workable seam and workable sectors, the mine boundary of proposed Gandhigram U/G Mine is as follows:

North : Fault F<sub>18</sub>-F<sub>18</sub>, F<sub>21</sub>-F<sub>21</sub>  
 South : Fault F<sub>10</sub>-F<sub>10</sub> and Fault F<sub>6</sub>-F<sub>6</sub>  
 East : Fault F<sub>13</sub>-F<sub>13</sub>, Fault F<sub>15</sub>-F<sub>15</sub>, Fault F<sub>16</sub>-F<sub>16</sub>, Fault F<sub>20</sub>-F<sub>20</sub>  
 West : Eastern bank of Dagdaga Nalla

### 5.4 GEOLOGICAL , MINEABLE & EXTRACTABLE RESERVES

The geological reserves for thickness range +1.5m for the seams considered for exploitation in the proposed Gandhigram U/G mine is 60.967 Mt . The total geological loss estimated in LWS, Bagdona & IA Seams are 1.495 Mt, 1.338 Mt & 0.745 Mt respectively. The total geological loss in all the 3 seams is 3.578 Mt and the total Mineable reserves works out to 57.389 Mt.

The geological loss due to coal blocked belowground due to different barriers in LWS, Bagdona & IA Seam are tabulated below:

(all values in Mt)

Seam Name	Total Geological Reserves	Barrier against faults, dykes, odd shaped areas etc	Barrier against Dagdaga nalla	Total Geological loss	Mineable Reserves
LWS	24.409	1.24	0.255	1.495	22.914
Bagdona Seam	18.950	1.102	0.236	1.338	17.612
IA Seam	17.608	0.505	0.240	0.745	16.863
<b>Total</b>	<b>60.967</b>	<b>2.847</b>	<b>0.731</b>	<b>3.578</b>	<b>57.389</b>

The Mining loss due to coal blocked in panel barriers, angle of draw against surface features, sub-penalization, coal lost in ribs of pillars etc in LWS, Bagdona seam & IA seam are tabulated below. .

(Figs. in Mt)

Seam Name	Mineable Reserves	In barrier pillars	Due to surface features	Lost in sub-panels/ ribs	Total Mining loss	Extractable Reserves
LWS	22.914	0.814	4.35	4.750	9.914	13.00
Bagdona	17.612	0.720	3.482	3.740	7.942	9.67
IA Seam	16.863	0.760	4.825	3.278	8.863	8.00
Total	<b>57.389</b>	2.294	12.657	11.768	<b>26.719</b>	<b>30.67</b>

Based on the proposed method of mining (Continuous Cutting Technology), the mine boundary and after considering geological and mining losses (coal blocked due to various reasons like faults, inaccessible places, odd shaped areas, panel barriers, sub-penalization, ribs in pillars), the net extractable reserves in each seam has been calculated. The Mining loss in LWS, Bagdona seam & IA seam works out to 9.914 Mt, 7.942 Mt & 8.863 Mt respectively. As a result of this, the extractable reserves in LWS, Bagdona seam & IA seam would be 13.00 Mt, 9.67 Mt & 8.00 Mt respectively. Hence the total extractable reserves in the proposed Gandhigram U/G mine works out to **30.67 Mt**.

The average grade of LWS, Bagdona seam & IA seam are G7, G5 & G6 respectively. The weighted average grade of coal throughout the entire life of the mine works out to G6.

## 5.5 PRODUCTION TARGET AND LIFE OF THE MINE

### 5.5.1 Production Target

It has been proposed in the Recast Project Report for Gandhigram U/G Mine to work 3 nos of Continuous Miner panels. With an average production capacity of about 1400 tpd from each panel, the total production from the 3 panels would be about 4200 tpd (ie 1.26 Mty).

### 5.5.2 LIFE OF THE MINE

The extractable reserves in the proposed Recast PR for Gandhigram UG mine have been estimated as 30.67 Mt. With a target capacity of 1.26 Mty, the total life of the mine works out to 31 years. This includes 3 years of pre-developmental & developmental activities and 28 years of revenue life.

## 6.0 PROPOSED MINE ENTRIES

### 6.1 INCLINES AND AIR-SHAFTS

2 inclines (Incline-I which is equipped with belt conveyor & man riding system while Incline-II will be equipped with haulage system) has been considered in this Report. Both the Inclines will be driven from surface (at the southern part of the geological block area which is surrounded by BH Nos CMPTE-

42, CMPTE-43, CMPTE-48 etc) to Floor of IA Seam at the south-central part of the geological block (near BH nos CMPTE-47 & 46). These inclines will cross both LWS and Bagdona Seam before touching IA Seam floor. Both these inclines are driven at 1 in 4.5 gradient and will act as intake airways.

2 Nos of air-shafts are proposed to be driven from surface to floor of IA seam. Both the air-shafts are located near BH nos CMPTE-48 & CMPGH-67 at the southern part of the block. Out of these 2 nos of airshafts, the first one (AS-I) will act as intake airway with a diameter of 5.0m while the second airshaft (AS-II) with diameter of 6.0 m will act as return airway.

The dimensions and purpose of mine outlets are tabulated below:

Mine Entry	Size (m x m)/dia (m)	Length (m) upto IA	Gradient	Purpose
Incline-I	4.8 x 3.0	922	1 in 4.5	Belt conveyor, Man-Riding system. Main intake airway .
Incline-II	4.8 x 3.0	899	1 in 4.5	Haulage for material, main intake airway
AS-I	5.0 m dia	222	Vertical	Main intake - (downcast)
AS-II	6.0 m dia	225	Vertical	Main Return (upcast shaft)

For Incline-I ,the tentative length from surface up to LWS & Bagdona seam floor would be 544m & 761m respectively. For Incline-II, the corresponding length of inclines would be 530m & 738m respectively.

The first airshaft (AS-I) touches the floors of LWS & Bagdona seam floor at depths of 129m & 184m respectively. For second airshaft (AS-II), the touching depths would be 132m & 188m respectively.

The tentative alignment of the inclines and airshaft has been shown in the Panel Layout Plans. The SRL for incline location (here taken as 445.0m) have been arrived considering the RLs of nearby boreholes as contouring has not been done in the proposed incline site. The exact location and its touching point in the floors of LWS, Bagdona & IA seam will depend upon detailed survey of the land. The incline alignment boreholes must be drilled on priority before acquisition of land under surface / all rights in order to ascertain the starting and touching point of mine entries.

## 6.2 ENTRY TO VARIOUS SECTORS / CROSSING FAULTS & DYKES

The following table shows the dimensions, length and year of drifting as per the proposed liquidation plan of the underground drifts for entry into various sectors of the mine with a x-sectional dimension of 4.8m x 3.0 m.

Sl.	Description of Activity	Length	Anticipat-
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No		(m)	ed year
1.	<b>Crossing Dyke-II (Sector-C)</b>		
a)	4 Nos. of Drifts to access LMD-2 from L-MD1 to cross Dyke -II (seam- LWS). Each drift is 27 m long driven along the seam floor of LWS.	108	Year-4
b)	4 Nos. of Drifts to access BMD-2 from B-MD1 to cross Dyke -II (seam- Bagdona). Each drift is 27 m long driven along the seam floor of Bagdona.	108	Year-5
c)	4 Nos. of Drifts to access IA MD-2 from IA-MD1 to cross Dyke -II (seam- IA). Each drift is 27 m long driven along the seam floor of IA Seam.	108	Year-21
2.	<b>Crossing Fault F-14 F-14 (Sector-C)</b>		
a)	4 Nos. of Drifts to access LMD-3 from L-MD2 to cross fault F-14 (seam- LWS). Lengths of drifts are 13.5m,18.0m,27.0m &36.0m driven at 1 In 4.5 gradient in LWS.	94.5	Year-4
b)	4 Nos. of Drifts to access BMD-3 from B-MD2 to cross fault F-14 (seam- Bagdona). Lengths of drifts are 13.5m,18.0m,27.0m &36.0m driven at 1 In 4.5 gradient in Bagdona seam	94.5	Year-5
c)	4 Nos. of Drifts to access IA MD-3 from IA-MD2 to cross fault F-14 (seam- IA). Lengths of drifts are 13.5m,18.0m,27.0m &36.0m driven at 1 In 4.5 gradient in IA seam	94.5	Year-21

Table continued.....

Sl. No	Description of Activity	Length (m)	Anticiptd year
3.	<b>Crossing Fault F-16 F-16 (Sector-C)</b>		
a)	4 Nos. of Drifts to access LMD-4 from L-MD3 to cross fault F-16 (seam- LWS). Lengths of drifts are 108m,117m,126m & 135m driven at 1 In 4.5 gradient in LWS.	486	Year-4
b)	4 Nos. of Drifts to access BMD-4 from B-MD3 to cross fault F-16 (seam- Bagdona). Lengths of drifts are 135m,135m,157.5m & 166.5m driven at 1 In 4.5 gradient in Bagdona.	594	Year-5
c)	4 Nos. of Drifts to access IA MD-4 from IA-MD3 to cross fault F-16 (seam- IA).Lengths of drifts are 117m,144m,157.5m & 166.5m driven at 1 In 4.5 grade in IA	585	Year-21
4.	<b>Crossing Fault F-17 F-17 (Sector-C)</b>		
a)	4 Nos. of Drifts to access LMD-5 from L-MD4 to cross fault F-17 (seam- LWS). Lengths of drifts are 22.5m,27m,27m & 31.5m driven at 1 In 4.5 gradient in LWS.	108	Year-4

b)	4 Nos. of Drifts to access BMD-5 from B-MD4 to cross fault F-17 (seam- Bagdona). Lengths of drifts are 40.5m,31.5m,40.5m & 40.5m driven at 1 In 4.5 gradient in Bagdona	153	Year-5
c)	4 Nos. of Drifts to access IA MD-5 from IA MD4 to cross fault F-17 (seam- IA). Lengths of drifts are 22.5m,22.5m,31.5m & 46m driven at 1 In 4.5 gradient in IA	122.5	Year-21
5.	<b>Crossing Dyke-I (Sector-C)</b>		
a)	4 Nos. of Drifts to to cross Dyke -I in L-MD5 (seam-LWS) . Each drift is 43.5 m long driven along the seam floor of LWS.	174	Year-4
b)	4 Nos. of Drifts to to cross Dyke -I in B-MD5 (seam-Bagdona) . Each drift is 43.5 m long driven along the seam floor of Bagdona	174	Year-5
c)	4 Nos. of Drifts to to cross Dyke -I in IA-MD5 (seam-IA) . Each drift is 43.5 m long driven along the seam floor of IA	174	Year-21
6.	<b>Crossing Fault F18- F18 (from Sector -C to Sector-D). For all 3 seams</b>		
a)	4 drifts from Bagdona seam (Sector-C) to LWS (Sector-D) each @100m long	400	Year-4
b)	4 drifts from IA seam (Sector-C) to Bagdona(Sector-D) each @67m long	268	Year-21
	Seam IA is non-workable in sector D due to less seam thickness. Seam Bagdona(sector-D) is connected to Seam IA(Sector-C) by 4 drifts. LWS (Sector -D) is connected to Bagdona(Sector-C) by 4 drifts.		

Table continued.....

Sl. No	Description of Activity	Length (m)	Anticipd year
7.	<b>Drifts in IA seam (panel IA-2 to IA-1) Crossing Fault F-18-F-18 (Sector C to D)</b>		
a)	2 drifts from IA-2 panel to IA-1 panel to enter Sector-D (to cross fault F-18) each @200m long in IA seam	400	Year-21
8.	<b>Drifts to be made in panels in LWS to cross Dyke-I</b>		
	3 drifts in Panel L-7 each 47 m long	141	Year-7
	3 drifts in Panel L-3 each 42 m long	126	Year-6
	3 drifts in Panel L-10 each 53 m long	159	Year-9
	3 drifts in Panel L-12 each 52 m long	156	Year-11
9.	<b>Drifts to be made in panels in Bagdona Seam to cross Dyke-I</b>		
	3 drifts in Panel B-7 each 45 m long	135	Year-9
	3 drifts in Panel B-3 each 41 m long	123	Year-6
	3 drifts in Panel B-12 each 50 m long	150	Year-16
10.	<b>Drifts to be made in panels in IA Seam to cross Dyke-I</b>		

	3 drifts in Panel IA-3 each 45 m long	135	Year-20
	3 drifts in Panel IA-8 each 55 m long	165	Year-24
11.	<b>Interconnection between Incline-I &amp; II</b>		
a)	interconnections between Incline-I & II.(cross section 4.8mx3.0m)- 5 Nos of inter-connections each @ 44 m long	220	Year-3
b)	Fan drift gallery and evasee suitable for main mechanical ventilator (1no.)	-	Year-3

The guidelines for estimation of average cost per meter for construction of circular shaft and inclines were issued by CMPDI (HQ) with a provision for escalation in labour and material components. As per the above guidelines, the average cost per meter length for drivage of inclines and sinking of airshaft has been estimated after considering due escalations.

The length of inclines & stone drifts and depth of airshaft proposed in this Recast Project Report are tentative and as per the available geological data given in the geological report and could vary depending upon the surface RLs and floor RLs encountered during actual drivage. Thus, at the time of actual drivage of the inclines / drifts, a section should be drawn to firm up the starting and ending position of the inclines & drifts so as to arrive at actual length.

The average incline drivage rate of inclines is considered as 55-60m/month (with advanced incline drivage equipments). The average rate of advance considered for sinking of airshaft is about as 20m/month. Advance rate of underground stone drifting would be about 70m to 90m/month.

## 7.0 MINING STRATEGY

### 7.1 SURFACE CONSTRAINTS

The majority of land area for Gandhigram –UG project falls under Forest Land( ie 628.067 Ha out of total 718.073 Ha) . In addition to this, Gandhigram village lies to the south western part of the geological block. Dagdaga nalla is flowing along the western side boundary of the proposed mine.

### 7.2 GEO-MINING CHARECTERISTICS

#### 7.2.1 Seams to be Worked in this Block

Out of 4 coal seams [Upper workable Seam (UWS), Lower Workable Seam, Bagdona Seam and IA Seam] present in this Geological Block, only 3 seams, namely, Lower Workable Seam, Bagdona Seam and IA Seam have been considered for exploitation in the proposed Recast PR for Gandhigram UG mine. Upper Workable Seam is not proposed for exploitation in this report because of reduced thickness mostly below 1.5m. Apart from reduction in



thickness, several carb. shale and shale bands have developed in the LWS rendering it practically unworkable. All other 3 seams namely Lower Workable Seam(LWS), Bagdona Seam and IA Seam are considered for exploitation where ever seam thickness is more than 1.50 m.

### 7.2.2 Seams Not Considered for Working in this Block.

Upper Workable Seam (UWS) has attained a thickness of >1.5m in a very small area only (in 1 borehole only). Here too, a no. of carb. shale and shale bands are present within the seam making it virtually ungradable. Upper Workable Seam is not proposed for exploitation in this Report because of reduced thickness mostly below 1.5m.

### 7.2.3 GEO-MINING PARAMETERS of the 3 workable seams are tabulated below

Particulars	Characteristics of Seams		
	L.W.S	Bagdona Seam	IA Seam
Geo. Block Area (km <sup>2</sup> )	10.7	10.7	10.7
Mining Area (km <sup>2</sup> )	7.06	7.06	6.05
No. of BHs intersections (Mining Area)	65	65	58
BH Density BHs/ Sq.Km (Mining Area)	9.20	9.20	9.58
Addl BHs proposed for a density of 12 BH/Sq.Km	20		

Table continued

Particulars	Characteristics of Seams		
	L.W.S	Bagdona Seam	IA Seam
Seam Thickness range (m)			
Block Area	1.70 – 3.64	0.95 – 2.81	0.23 – 2.95
Mining Area	1.70 – 3.64	0.95 – 2.81	0.90 – 2.95
Workable Thick. Range (m)	1.50 – 3.50	1.50 – 2.81	1.50 – 2.95
Average Mining Thick. (m)	2.50	2.00	2.20
Seam Gradient	1 in 7 to 1 in 10	1 in 7 to 1 in 10	1 in 7 to 1 in 10
Depth of Cover range (m)			
Block Area	33.00 – 404.67	19.88 – 399.15	85.46 – 437.60
Mining Area	46.70 – 370	92 – 420	122 – 460
Range of Parting with upper	4.41 – 16.60	43.10 – 60.72	28.49 – 43.28

seam (m)			
Avg. Grade of Coal-Extra. reserves	5395 G-7	5825 G-5	5761 G-6
GCV(K.Cal/Kg)/Grade	Overall 5620 / G-6		
Gassiness (anticipated)	Deg. – II	Deg. – II	Deg. – II
Immediate roof	Sandstone	Alt. bands of Shale & Sandstone	Sandstone
Immediate floor	Sandstone	Alt. bands of Shale & Sandstone	Sandstone
Geological Reserves (Mt)			
Proved>0.9m thick.	24.409	19.028	18.388
	Total - 61.825		
Proved>1.5 m thick.	24.409	18.95	17.608
	Total - 60.967		
Mineable Res. (Mt)	22.914	17.612	16.863
	Total - 57.389		
<b>Extractable Res. (Mt)</b>	<b>13.00</b>	<b>9.67</b>	<b>8.00</b>
	Total - <b>30.67</b>		
Status of Mining	Virgin Seam	Virgin Seam	Virgin Seam

#### 7.2.4 Geological Disturbances

21 numbers of faults with throw varying from 5 m to 270 m have deciphered on the basis of exploratory drilling within the block area. Within the mine area, there are 6 faults with throw varying from 5m to 40m. From these, 5 faults are dying out within the mine area. Further extension of these faults may occur. The presence of some additional faults and minor slips cannot be ruled out. Similarly, the throw of the faults as deciphered may be the cumulative throw of more than one fault of lesser magnitude. The faults are mostly trending in E-W direction. A number of dykes have been encountered in boreholes. Heat affected zones are marked on the Seam Folio Plans of individual seams. These zones are not proposed for exploitation.

#### 7.2.5 Geo- Engineering Properties of Strata.

The strength parameters of roof, floor and the coal seams (compressive / tensile strengths etc) have been determined on the basis of geo-engineering tests carried out on the cores of borehole nos. CMPGH-42 and CMPTE-86. The same are summarized as under:

Sl No	Particulars	Dry Uniaxial C.S (MPa)	Wet Uniaxial C.S (MPa)	Tensile strength (MPa)	Protodyk. Index	Lithology of Strata
1.	10 m roof strata above LWS	24.81 to 42.14	12.45 - 23.91	4.27 to 8.80	-	Mgd. sandstone
2.	3 m roof strata above LWS	24.81 to 25.70	12.45 to 17.83	5.11 to 6.24	-	Mgd. sandstone
3.	LWS	30.24	-	3.28	1.43	Coal
4.	1 m floor strata below LWS	44.19	30.85	9.16	-	Sandy Shale
5.	10 m roof strata above Bagdona Seam	16.95 to 53.17	36.94 to 43.77	7.77 to 14.61	-	S.S& shale Intercalation & Fgnd. S.S
6.	3 m roof strata above Bagdona	53.17	40.28	7.77	-	Intercalation, Fgnd. S.S
7.	Bagdona Seam	16.95	-	5.06	1.11	Coal
8.	1 m floor strata below Bagdona	51.31	SNA	22.32	-	Mgd. Sandstone
9.	10 m roof strata above IA Seam	23.58 to 26.08	16.62 to 24.27	3.81 to 5.10	-	Mgd. Sandstone
10	3 m roof strata above IA Seam	25.22	24.27	3.81	-	Mgd. Sandstone
11	IA Seam	SNA	SNA	SNA	1.20	Coal
12	1 m floor strata below IA Seam	39.09	30.79	7.79	-	Fgd., Mgnd Sandstone

From the above table it is observed that the roof of all the seams is competent in line with the experience of operating mines of Pathakhera Coalfield. Even in wet condition the roof is strong enough to support high level of mechanization. The RMR of the 3m roof strata of LWS and Bagdona Seam in other mines of this coalfield is varying from 60 to 65 after applying correction for solid blasting. This indicates that the roof is good and will support mechanization.

The floor of all the seams is quite competent and not likely to get affected due to water and movement of tyre / crawler mounted equipment. The Protodykanov Index of all the coal seams is exceeding 1.0 and the tensile strength is varying from 3.28 to 5.06 Mpa. . The Hardgroove Grindability Index of the workable coal seams is varying from 44 to 57. These parameters indicate that the coal is quite hard. The Continuous Miner should be able to cut the coal but the consumption of picks is likely to be high.

#### 7.2.6 Cavability Characteristics

The sandstone and intercalations overlying the coal seams are massive in

nature and may not cave very easily. In case the sandstone does not cave easily, induced caving by blasting from the goaf edges shall be adopted as is the general practice in the operating mines of the area. Since induced caving of sandstone may not be necessary in all the panels and will not be continuous activity, the manpower and equipment for the same may be drawn from the other working districts or from general shift manpower provided in this Recast Project Report.

#### 7.2.7 Incubation Period

The incubation period of LWS and Bagdona Seam in the operating mines of Pathakhera Coalfield has been assessed as 18 months. IA Seam has not been worked in any nearby mines and hence the incubation period IA Seam is not known.

#### 7.2.8 Wateriness of Seams

The mines of Pathakhera Coalfield are generally dry. The make of water during development stage is negligible and water has to be sent belowground for spraying at the working faces.

During depillaring stage the maximum make of water is around 70 lps which stabilizes to 38 lps. The make of water in Gandhigram U/G mine is likely to be just sufficient to cater to the clean water requirement of 3 Continuous Miner packages and for the hydraulic roof bolters, Feeder breakers etc.

#### 7.2.9 AVERAGE THICKNESS/GRADE OF WORKABLE COAL SEAMS

The following table gives the sequence, thickness and parting of all the 3 workable seams in Gandhigram Geological Block:

Sl. No.	Seam Section/ Parting	Seam / Parting Thickness (m)			GCV (k Cal/kg)	Coal Grade	Avg. Grade
		Min.	Max.	Avg.			
1.	LWS	1.70	3.64	2.50	4165-5930	G11 – G5	G7
2.	Parting	43.10	60.72	52.00	-	-	
3.	BAGDONA Seam	0.95	2.81	2.20	4965-6335	G8-G4	G5
4.	Parting	28.49	43.28	36.00	-	-	
5.	IA Seam	0.23	2.95	2.20	4965-6335	G8 – G4	G6

All the three workable seams in Gandhigram Geological block ( LWS, Bagdona & IA seam) are having their average mining thickness range as 2.50m, 2.20m & 2.20 m respectively. The weighted average GCV of coal of LWS, Bagdona & IA seam are 5341 K.Cal/Kg (G7 grade), 5803 K.Cal/Kg (G5 grade) & 5732 K.Cal/Kg (G6 grade) respectively. The overall grade of all the 3 seams works out to about 5600 K.Cal/Kg (G6 grade).

#### 7.2.10 GASSINESS

The coal seams in the proposed Gandhigram U/G mine are expected to be 'Degree-II' gassy seams. It is necessary that gassiness of the seams should be ascertained just after touching coal seams. Regular gas survey should be carried out as per statute. Adequate provision of chemical type self generating oxygen self rescuers has been made to enable everybody to carry it underground.

### 7.3 UNDERGROUND CONSTRAINTS ON MINE DEVELOPMENT

Gandhigram U/G mine has been projected in the virgin Gandhigram Geological Block. While making panels in workable seams in Gandhigram U/G mine, incubation period of 18 months has been considered. Coal in form of solid pillars shall be left below and around the village and road and also against Dagdaga Nalla. The sandstone and intercalations overlying the coal seams are massive in nature and may not cave easily. In case the sandstone does not cave easily, induced caving by blasting from the goaf edges shall be adopted as is the general practice in the operating mines of the area. The coal seams shall be extracted in descending order – ie from top to bottom with caving.

### 7.4 SELECTION OF MINING METHOD

#### 7.4.1 OPENCAST POTENTIALITY

The vertical cut off ratio for Lower Workable Seam is 17.2 while that for Bagdona Seam and IA Seam is 23.68 and 24.28 respectively. Due to very adverse vertical cut off ratios further exercise for opencast potentiality has not been carried out and opencast mining in Gandhigram U/G mine is ruled out.

#### 7.4.2 UNDERGROUND MINING METHODS

In the underground mining methods, the options available are continuous cutting methods and by blasting-off the solids with intermediate technology.

##### a) Blasting-off-the-solids with Intermediate Technology

Bord and Pillar method of mining with caving involves coal preparation by blasting-off-the-solids and loading by SDLs/LHDs onto coal tubs/chain or belt

conveyor. This method involves discontinuous operation of equipment, is manpower intensive and utilization of equipment is low. Due to the serial nature of operations, the output from the district is governed by the number of blasts in every available face, which normally does not exceed 1.5 per shift. This restricts the output capacity of the district. For a mine to produce around 1.20 Mty with intermediate technology, a large number of production districts have to be operated simultaneously which require a large work force. Traditional approach of opening small mines with more number of production districts can no longer cater to the shortfall in availability of coal. Large mines deploying mass production technology with less manpower involvement can only meet the ever increasing demand for coal.

b) Continuous Cutting Methods

Continuous cutting methods require that extraction of coal be carried out by caving method since sand stowing will not be able to keep pace with the cutting machine and large number of unstowed voids will result. Also the availability of sand or material for stowing is scarce and also capital intensified. In the proposed Gandhigram U/G mine, extraction by caving is possible in most areas.

Continuous cutting technology/method can be deployed mainly in two forms:

i) LongWall Mining using Power Supports

In the entire Gandhigram Block, only the western portion of Sector C is a clear area having a fairly large aerial extent, which could accommodate LongWall panels. 4 faults are observed to die out in Sector C and due to this reason this Sector appears to be clean. Possibility of extension of these faults cannot be ruled out.

Alignment of development headings parallel to major fault planes results in roof trouble in spite of roof strata being competent. More no. of longwall panels can be carved out in Sector C if the panels are aligned parallel to the faults. Longwall mining has been practiced in a no. of mines in CIL with less than satisfactory results. In new generation shearers and powered supports, the cuttability has been increased substantially with improved pick design and metallurgy and increased motor power. The production capacity of a PSLW face operating in 2.0m thick seam is theoretically 1.0-1.50 Mty or more. However, production figures of mines where such equipment is deployed do not confirm this production capacity.

The biggest disadvantage of longwall mining is its poor flexibility. A fault of 5m can reduce the production capacity of longwall face by 20%. Due to fixed face length a lot of coal is lost against faults, which would normally be extracted by Bord and Pillar method. The gate road drirage equipment may at the most

develop this coal but not extract it.

As on today , some LongWall faces have been operated in the mines of CIL in collaboration with European Companies & the Chinese. Longwall packages also require additional gate road drivage equipment. These days Continuous Miners are preferred for gate road drivage instead of road headers because of better performance and flexibility. The capital cost of Longwall package would be much higher such that this kind of investment can be justified only if the production level exceeds 2.0 Mty.

Due to the presence of a number of faults and dykes within the working sectors of the Gandhigram Geological block, the LongWall methods of mining may not be suitable. LongWall methods of mining require geologically undisturbed property with sufficient aerial extent which is not available in this block.

#### ii) Continuous Miner Technology

Continuous Miner Technology on Bord & Pillar method is in operation in many UG mines of CIL. This technology can also be deployed on Rib-Pillar method where the roof condition is difficult.

Continuous miner package will stand better chances of acceptability at grass root level if deployed in a Bord & Pillar district. Continuous miner in conjunction with shuttle cars as transport link can be introduced in Gandhigram U/G mine as it has favorable seam thickness and gradient. The mine is likely to be dry and the roof behavior is expected to be good. This technology is not capital intensive like LongWall method and has greater flexibility for its application in property like Gandhigram.

The other advantages of adopting this technology are as follows:

- 1) Higher production capacity from each district (up to 1500-2000 tpd as per the geological conditions) as against 500 tpd from an intermediate technology district preparing coal by blasting-off-the-solids. Better utilization of men and machines.
- 2) Centralized and concentrated working places enabling better supervision and safety.
- 3) Easier and better management of ventilation.
- 4) Improved roof condition and conservation of coal during depillaring (coal lost in sub-penalization is minimized and 8% extra coal on floor area basis is extracted provided the slice width is 4.8m or more and the ribs are judiciously robbed).

- 5) Requires lesser manpower.
- 6) With increasing depth of workings, roof management becomes difficult and gets further aggravated due to blasting. Continuous cutting of coal not only eliminates blasting but also permits much larger outputs from the production district.

Continuous miner Technology also has certain disadvantages in relation to an intermediate technology district preparing coal by blasting-off-the-solids. These are listed below:

- 1) Capital intensive equipment package.
- 2) Efficient workmanship / maintenance back up is required. Skilled maintenance personnel and inventory of spares and consumables is required for smooth and continuous operation.
- 3) Highly skilled operators and maintenance personnel are required.

By considering all the above mentioned parameters for selection of method of mining for Gandhigram UG mine, Continuous Miner technology has been suggested to harness the Bord & Pillar method for Gandhigram U/G mine.

Therefore this report proposes working of 3 numbers of Continuous Miner districts for simultaneous development & depillaring of panels in all the three seams on Bord and Pillar pattern. The working will be commenced from upper seams and continue towards lower seams. Extraction of panels /pillars shall be followed by caving of roof strata.

## 7.5 MINE DEVELOPMENT STRATEGY

For the development of the proposed Gandhigram U/G Mine, the following strategy is envisaged:

- a) Acquisition of land for mine infrastructure and mine entries which includes tenancy & forest lands is proposed in the first 2 years of mine operation. The total period for land acquisition would be the initial 4 years of mine life.
- b) Arrangement for temporary and permanent power supply and water supply arrangement at the mine entries site and start of drivage / sinking.
- c) Drivage of the inclines (2 nos.) from surface up to the floor of IA Seam at a gradient of 1 in 4.5. These inclines will cross LWS & then Bagdona before touching IA seam floor. Both the inclines (I&II) will act as intake airways.
- d) Drivage of the air-shafts (2 nos.) from surface up to the floor of IA Seam



vertically after crossing LWS and Bagdona Seam. One air-shaft (AS-I) will act as intake airway while the second one (AS-II) will act as return airway.

- e) Main-fan will be installed in the fan drift of AS-II .
- f) Installation of belt & haulage along the Inclines –I & II respectively.
- g) Once the Inclines touch the floor of LWS during the end of 3<sup>rd</sup> year , at least 2 nos of level headings will be developed along LWS floor towards the main-dip galleries . Once main-dip galleries are reached, the 5 headings Main-Dip will be driven from the central part of the block in south side towards the central part of the block in north side(i.e. from rise to dip).

Thus, L-MD1,L-MD2,L-MD3,L-MD4,L-MD5 & L-MD6 will be developed which involves crossing of Dyke-II , Faults F14-F14, F16-F16, F-17-F17, Dyke –I, Fault F18- F18 etc. This operation will be done with 1<sup>st</sup> set of Continuous Miner during 4<sup>th</sup> & 5<sup>th</sup> year of mine operation. During 4<sup>th</sup> year of mine operation, the production is from the single CM district with devt. of Main-Dips in LWS & the total production would be about 0.30 Mty.

- h) For crossing dykes & faults in LWS, 4 nos of drifts are being proposed in 4 headings (out of total 5 nos of main-dip headings). The details of drifts required to cross the faults/ dykes has been detailed & tabulated in earlier chapter- 6.2 “Entry to various sectors by crossing faults & Dykes”.
- i) During 5<sup>th</sup> year, after the completion of devt. of dip most main-dip panel in LWS (L-MD6), the panel L-1 will be developed first and then depillared with CM-1. This procedure will be followed in panel L-3, L-5 in such a way that the depillaring operation is to be commenced from dip side to rise side. Production from CM-1 would be 0.38 Mty during this year.

2<sup>nd</sup> set of Continuous Miner package will be deployed in Bagdona Seam for Main-Dips panels development of Bagdona Seam– ie B-MD1,B-MD2,B-MD3,B-MD4, B-MD5,B-MD6 etc. The main-dips development in Bagdona seam will be completed during 5<sup>th</sup>& 6<sup>th</sup> year of mine operation. Development of Main-dips in Bagdona Seam also involves crossing of Dykes & Faults in the similar fashion of LWS. CM-2 would produce about 0.30 Mty during 5<sup>th</sup> year.

During 5<sup>th</sup> year, the total production from 2 CM panels would be 0.68 Mty.

- j) During 6<sup>th</sup> year, CM-1 will continue to work panels in LWS- ie both development and depillaring of L-1, L-2 ,L-4 etc. A total of 0.42 Mt of coal production is expected from this package during 6<sup>th</sup> year. CM-2 will continue to work in Bagdona Seam- ie development of B-MD5, B-MD-6 etc. Once main-dips development in Bagdona seam is over, panels B-1,B-2,B-4 & B-4 will be developed and then depillared. CM-2 will be able to make a production of about 0.42 Mt during this year.3<sup>rd</sup> set of CM package

will be introduced in the panels of LWS seam in west side of main-dips- i.e for devt. & depillaring of panels L-3, L-5, L-7 etc. The production from this set would be about 0.36 Mty.

The total production expected from all the 3 CM packages during 6<sup>th</sup> year would be 1.20 Mty.

- k) During 7<sup>th</sup> year, CM-1 will continue to work in LWS- ie development & depillaring of L-4 . Once all the 4 panels in sector-D (L-1, L-2, L-3 & L-4) are completed, L-MD6 will be depillared, then devt. & depillaring of L-6 etc. The coal production from CM-1 during this year would be 0.42 Mty. CM-2 will develop & depillar panels in Bagdona seam- ie B-2, B-4, B-3 etc which generates a coal production of 0.42 Mty. CM-3 will complete development & depillaring in L-3, L-5 etc and the coal production would be 0.42 Mty.

The target coal production of 1.26 Mty will be achieved during 7<sup>th</sup> year from 3 CM districts.

- l) Working of CM-1, CM-2 & CM-3 will be followed as per the Mine Liquidation Plan. Till 19<sup>th</sup> year, CM-1 & CM-3 will be deployed in LWS while CM-2 will be in Bagdona Seam. During 20<sup>th</sup> year, CM-3 will be shifted from LWS to Bagdona Seam (eastern flank). During 21<sup>th</sup> year, CM-1 will be shifted from LWS for introduction to IA Seam.

Liquidation plan is so prepared that at any point of time, only 2 seams (out of 3) will be under working. Production target will be achieved during 7<sup>th</sup> year and it will continue till 26<sup>th</sup> year. During 27<sup>th</sup> year, CM-2 will be withdrawn and the production tapering starts. CM-3 will be withdrawn during 29<sup>th</sup> year. The coal production will be 1.23 Mty, 0.84 Mty, 0.70 Mty, 0.42 Mty & 0.10 Mty for the years 27<sup>th</sup>, 28<sup>th</sup>, 29<sup>th</sup>, 30<sup>th</sup> & 31<sup>st</sup> years of Mine working.

Detailed liquidation plan showing yearly machine wise, seam wise & panel wise coal production has been given in para 9.1 "Mining Schedule".

## **8.0 METHOD OF MINING & PRODUCTION PARAMETERS**

### **8.1 METHOD OF DEVELOPMENT**

Gandhigram U/G Mine is proposed to be developed on Bord & Pillar method. The main trunk headings and the panels will generally consist of 5 headings as it gives optimum results with CM technology. In the panels, which are near to the faults or in odd shaped areas, the number of headings may be increased or decreased in view of conservation of coal as against creating another panel. The main-dips headings will be vertically super-imposed in all the 3 workable seams (LWS, Bagdona & IA seam).

The pillar sizes in the panels of each seam will vary as per depth in each sector for a gallery width of 4.8m. The centre to centre pillar size in LWS varies between 25.5 m, 34.5m , 45.0m & 48.0m. In Bagdona Seam & IA seam, the pillar sizes are 34.5m, 45.0m & 48.0m. Pillar size in panel L-26 of LWS

has been increased to accommodate the air-shafts AS-I & II which need to be in vertical coincidence in all the 3 seams. Mostly the pillars designed in square shape except at some places where square shape is not possible. Rectangular shape is preferred in those areas.

The minimum height of main-dips development galleries will be 2.5m or the seam thickness (limited to 3.0m ) whichever is higher. At some panels in LWS where seam thickness is >3.0 m , the galleries will be developed up to the seam height and the galleries be supported only one time using good quality roof bolts so that no further heightening is involved and scope for secondary support is ruled out. The development in panels will be done using the continuous cutting machine package, which operates on a "place changing" system.

Place changing is where the cutting machine cuts for a specific distance beyond the last row of supports using radio or umbilical cord remote control of the cutting machine. For Gandhigram U/G Mine this "cut-out distance" is assumed to be around 10m based on RMR & the likely behavior of roof/floor strata.

Once the continuous cutting machine has been trammed out of a particular heading, the roof bolting machine is trammed in to support the area mined by the cutting machine. The machines therefore operate alternately & independently and have greater flexibility for both cutting and roof bolting operations. The width of the cutting drum of the continuous cutting machine is about 3.3m. The continuous cutting machine sumps in between 0.5m and 0.75m at roof level on one side of the gallery, the rear stab jack on the machine lowered and the head sheared down to floor level. This cycle is repeated 3 to 4 times, the roof and floor trimmed and the operation repeated for the remaining 1.5 m gallery width. The depth of each web is 0.8 m.

## 8.2 METHOD OF EXTRACTION

In Gandhigram U/G mine, extraction of developed pillars is proposed by caving at all places except at places where surface features such as Gandhigram village, Close to Dagdaga nalla, roads etc which are to be supported by taking into consideration the angle of draw. Each panel will be developed first and then depillared it from dip to rise direction. Since caving is practiced, the work commences from upper seam and proceeds towards lower seams. Extraction of coal from each panel would commence immediately upon reaching the panel boundary.

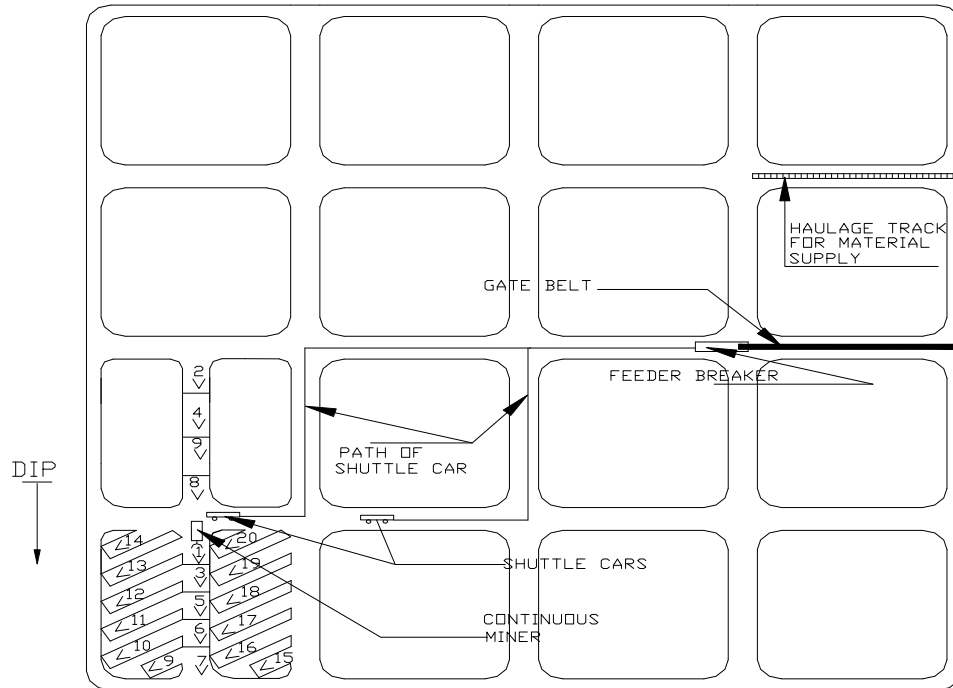
Full mining height will have to be maintained during development and pillar extraction will commence without any advance support being required. Pillar extraction techniques shall follow the 'straight line' method employed with continuous miners. The 'straight line' method helps in optimizing transport

routes & cable lengths. Pillar extraction will be done by splitting and slicing of pillars. The pillars will be split into two/three parts depending upon the pillar size, by driving dip splits and the slices will be driven from the splits/original galleries at 60° to the split direction. Splitting of pillar will be restricted to a distance of one pillar from the pillar under extraction. Two safe outlets shall always be provided from the pillar under extraction. Adequate steps shall be taken to prevent accumulation of water on the surface above the panel. A sump of adequate capacity and adequate pumping arrangement shall be provided to deal with sudden influx of water, if any during strata movement.

The proposed mining cycle for pillar extraction and the sequence of operations is as under:

- Cut 1 is driven to a maximum of length of “cut-out distance”. For the purposes of this report, it has been assumed to be 10 m.
- The continuous cutting machine is trammed to cut 2 and commences cutting while cut 1 is supported by the twin boom roof bolter.
- Once the continuous cutting machine completes cut 2 and roof bolting is completed in cut 1, the continuous cutting machine commences cut 3.
- The roof bolter supports cut 2 while the continuous cutting machine completes cut 3.
- This process is repeated for cut 4.
- The pillar will be split right through and closely spaced roof bolts installed at all the proposed goaf edges. These bolts serve the purpose of breaker line so the need of skin-to-skin chocks at goaf edges with corner props may not be needed. In poor roof conditions, the split is not driven right through the pillar and a 2 m thick coal rib is left against the goaf edge as an additional protection to the goaf edge.
- Flanking cuts 5, 6 and 7 are then taken from the cover of the supported pillar split (cuts 1 and 3). Further support is generally not necessary since the continuous cutting machine operates within 15 m of the face and the continuous cutting machine operator and shuttle car operator are always under the last row of support.
- Additional coal may be extracted from the 'stooks' (remnant portions of the coal pillars) as the continuous cutting machine is retreated judiciously dependent upon the face conditions at the time of extraction.
- The remaining flanking cuts are taken in a similar manner from the cover of the original fully supported development drive.

The schematic diagram showing the above explained cuts for pillar extraction and sequence of operations is given below:



All provisions of CMR, 1957 and DGMS circulars regarding depillaring shall be strictly adhered to. All other provisions of CMR 1957 and DGMS circulars regarding fencing of surface area, formation of sub-panels, standards of construction of isolation stopping, isolation of every panel immediately after it has been goaved out, inspection of depillaring district and around goaved out areas and maintenance of records thereof and maintenance of subsidence records, plan / sections, information regarding local falls etc. and submission for copies thereof to the DGMS, shall be strictly adhered to.

### 8.3 SEAM WISE PANEL WISE EXTRACTABLE RESERVES

#### 8.3.1 Lower Workable Seam

SL. NO.	PANEL NO.	PILLAR SIZE		AVG. SEAM THICK. (M)	DEVT. RES. (Mt)	DEP. RES (Mt)	TOTAL RES. (Mt)
1	L-1	45	45	2.66	0.10	0.23	0.33
2	L-2	45	45	3.03	0.04	0.09	0.13
3	L-3	45	45	2.49	0.19	0.47	0.66
4	L-4	45	45	2.74	0.10	0.25	0.35
5	L-5	45	45	2.29	0.11	0.27	0.38
6	L-6	45	45	2.85	0.12	0.29	0.41
7	L-7	45	45	2.15	0.12	0.30	0.42
8	L-8	45	45	2.92	0.17	0.43	0.60

9	L-9	34.5	34.5	2.31	0.23	0.21	0.44
10	L-10	34.5	34.5	3.11	0.24	0.40	0.64
11	L-11	34.5	34.5	2.64	0.35	0.35	0.70
12	L-12	34.5	34.5	2.92	0.08	0.13	0.21
13	L-13	34.5	34.5	2.7	0.33	0.45	0.78
14	L-14	34.5	34.5	2.56	0.28	0.43	0.71
15	L-15	34.5	34.5	2.98	0.17	0.27	0.44
16	L-16	34.5	34.5	2.7	0.27	0.40	0.67
17	L-17	34.5	34.5	2.96	0.50	0.83	1.33
18	L-18	34.5	34.5	2.82	0.13	0.20	0.33
19	L-19	34.5	34.5	2.26	0.09	0.14	0.23
20	L-20	25.5	25.5	2.63	0.15	0.14	0.29
21	L-21	25.5	25.5	2.24	0.12	0.13	0.25
22	L-22	25.5	25.5	2.82	0.13	0.12	0.25
23	L-23	25.5	25.5	2.39	0.21	0.22	0.43
24	L-24	25.5	25.5	2.5	0.06	0.06	0.12
25	L-25	25.5	25.5	2.73	0.13	0.13	0.26
26	L-26	25.5	25.5	2.51	0.10	0.11	0.21
27	L-27	25.5	25.5	2.42	0.11	0.11	0.22
28	L-MD1	48	25.5	2.51	0.04	0.09	0.13
29	L-MD2	48	25.5	2.14	0.06	0.14	0.20
		48	34.5	2.14	0.01	0.01	0.02
30	L-MD3	48	34.5	2.85	0.07	0.17	0.24
31	L-MD4	48	34.5	3.21	0.03	0.06	0.08
32	L-MD5	48	45	3.04	0.06	0.14	0.20
		48	34.5	3.04	0.01	0.04	0.05
33	L-MD6	48	45	2.81	0.09	0.23	0.32
<b>Total(Mt)</b>					<b>4.99</b>	<b>8.01</b>	<b>13.00</b>

## 8.3.2 Bagdona Seam

SL. NO.	PANEL NO.	PILLAR SIZE (M x M)		AVG. SEAM THICK. (M)	DEVT. RES. (Mt)	DEP. RES. (Mt)	TOTAL RES. (Mt)
1	B-1	48	48	2.21	0.07	0.16	0.23
2	B-2	48	48	2.13	0.03	0.07	0.10
3	B-3	48	48	2.17	0.13	0.32	0.45
4	B-4	48	48	2.13	0.1	0.26	0.36
5	B-5	45	45	1.87	0.1	0.23	0.33
6	B-6	45	45	2.06	0.08	0.2	0.28
7	B-7	45	45	1.87	0.13	0.31	0.44
8	B-8	45	45	2.1	0.12	0.32	0.44

9	B-9	45	45	2.06	0.23	0.31	0.54
10	B-10	45	45	2.04	0.13	0.33	0.46
11	B-11	45	45	2.34	0.3	0.52	0.82
12	B-12	45	45	1.97	0.07	0.16	0.23
13	B-13	45	45	2.42	0.26	0.61	0.87
14	B-14	45	45	2.09	0.16	0.4	0.56
15	B-15	45	45	2.09	0.17	0.37	0.54
16	B-16	34.5	34.5	2.07	0.11	0.15	0.26
17	B-17	34.5	34.5	1.98	0.12	0.2	0.32
18	B-18	34.5	34.5	2.07	0.11	0.17	0.28
19	B-19	34.5	34.5	1.83	0.15	0.25	0.40
20	B-20	34.5	34.5	1.99	0.04	0.06	0.10
21	B-21	34.5	34.5	1.83	0.11	0.19	0.30
22	B-22	34.5	34.5	2.34	0.06	0.1	0.16
		48	34.5	2.34	0.02	0.05	0.07
23	B-23	34.5/48	34.5	1.75	0.06	0.11	0.17
24	B-MD1	48	34.5	1.86	0.02	0.05	0.07
		48	48	1.86	0.01	0.02	0.03
25	B-MD2	48	34.5	2.18	0.07	0.15	0.22
26	B-MD3	48	45	2.17	0.03	0.09	0.12
27	B-MD4	48	45	2	0.02	0.05	0.07
28	B-MD5	48	45	2.09	0.06	0.14	0.20
29	B-MD6	48	48	2.13	0.07	0.18	0.25
<b>TOTAL (Mty)</b>					<b>3.14</b>	<b>6.53</b>	<b>9.67</b>

## 8.3.3 IA Seam

SL. NO.	PANEL NO.	PILLAR SIZE (M x M)		AVG. SEAM THICK (M)	DEVT. RES. (Mt)	DEP. RES (Mt)	TOTAL RES. (Mt)
1	IA-1	48	48	1.75	0.05	0.13	0.18
2	IA-2	48	48	1.75	0.1	0.27	0.37
3	IA-3	45	45	2.25	0.15	0.33	0.48
4	IA-4	45	45	1.62	0.06	0.14	0.20
5	IA-5	45	45	2.42	0.28	0.34	0.62
6	IA-6	45	45	1.91	0.08	0.21	0.29
7	IA-7	45	45	2.49	0.31	0.51	0.82
8	IA-8	45	45	2.27	0.09	0.23	0.32
9	IA-9	45	45	2.3	0.24	0.55	0.79
10	IA-10	45	45	2.26	0.1	0.26	0.36
11	IA-11	45	45	2.23	0.18	0.4	0.58

12	IA-12	34.5	34.5	2.49	0.12	0.17	0.29
13	IA-13	34.5	34.5	2.45	0.14	0.23	0.37
14	IA-14	34.5	34.5	2.53	0.09	0.14	0.23
15	IA-15	34.5	34.5	2.5	0.04	0.05	0.09
16	IA-16	34.5	34.5	2.24	0.17	0.27	0.44
17	IA-17	34.5	34.5	2.28	0.12	0.21	0.33
18	IA-18	34.5	34.5	2.34	0.07	0.1	0.17
		48	34.5	2.34	0.02	0.05	0.07
19	IA-19	34.5/48	34.5	2.29	0.08	0.15	0.23
20	IA-MD1	48	34.5	1.89	0.02	0.05	0.07
		48	48	1.89	0.01	0.02	0.03
21	IA-MD2	48	34.5	2.53	0.07	0.17	0.24
22	IA-MD3	48	45	2.35	0.04	0.1	0.14
23	IA-MD4	48	45	2.24	0.03	0.08	0.11
24	IA-MD5	48	45	1.8	0.04	0.1	0.14
		48	48	1.8	0.01	0.03	0.04
<b>TOTAL (Mty)</b>					<b>2.71</b>	<b>5.29</b>	<b>8.00</b>

The extractable reserves in LWS, Bagdonga seam & IA seam are estimated to 13.00 Mt ,9.67 Mt & 8.00 Mt respectively. Hence the total extractable reserves in the proposed Gandhigram U/G mine works out to **30.67 Mt**.

The average grade of coal in LWS, Bagdonga seam & IA seam are G-7 (GCV-5395 K.Cal/Kg),G-5(5825 K.Cal/Kg) & G-6(5761 K.Cal/Kg) respectively. The weighted average grade of coal during the entire life of the mine works out to **G-6** with a GCV of about 5620 K.Cal/Kg.

The extractable coal reserves and its quality is estimated based on the available Geological exploration data. Any change in the geological structure may affect the estimated coal reserves and its quality/grade.

#### 8.4 PRODUCTION PARAMETERS

Based on the analysis of the time study of Continuous Miner districts in some of CM operating mines of Coal India Ltd ( eg: Anjan Hill Mine of SECL) and the envisaged support system, the production parameters for the CM panels in Gandhigram U/G mine has also been arrived at and tabulated as under-

Sl.No.	Activity	Time Frame
1.	Cutting time at one face for unsupported cut-out distance equal to 10 m and gallery dimensions 4.8 m width and 2.5 m height	30 minutes
2.	Loading, unloading and marching time for 36 nos. shuttle car trips required to carry the cut coal to the feeder breaker.	84 minutes



3.	Marching time of Continuous miner from one face to next in the same heading over a distance of 30 m (avg.)	9 minutes
4.	Cutting and loading time in second face in same heading	84 minutes
5.	Marching time from one heading to adjacent heading over a lead of 130 m	36 minutes
6.	Total time required for 2 cutting and loading cycles plus marching time	213 min. say 3 hrs. 33 min
7.	Time required for bolting 3 nos. holes without W- strap	12 minutes
8.	Bolting time per face for cut-out distance 10 m	72 minutes
9.	Marching time of roof bolter from one face to next in same heading over a lead of 30 m	6 minutes
10.	Bolting time in second face in same heading	72 minutes
11.	Marching time of roof bolter from one heading to the adjacent heading over a lead of 130 m	26 minutes
12.	Total time for bolting 2 faces plus marching time	176 min. = 2 hrs.56 min.

Coal produced in one round =  $4.8 \times 2.5 \times 10 \times 2 \times 1.55 = 372$  t say 360 t.  
 (Gallery size -4.8mx2.5m, cut out distance-10m ,2 cuts/cycle, sp:gr:-1.55t/cum)  
 Time available for production in 3 shifts = 16 hours.  
 Production per day =  $16 \times 60 \times 360/213 = 1622$  t say 1600t.

Time available for roof bolting in 3 shifts = 16 hours.  
 No. of cycles of roof bolter =  $16 \times 60/176 = 5$  cycles.  
 Therefore, number of rounds of cutting and supporting in a day with 16 hours effective working time = 5 rounds  
 Production per day on the basis of bolting time =  $360 \times 5 = 1800$  t.

Based on the time study, the production capacity of CM works out to 1600 tpd (considering cutting cycle & supporting cycle). To be on a safer side ,the average production from CM district considered here would be about 1400 tpd (i.e. 0.42 Mty with 300 working days/year). By introducing 3 nos of of CM districts, Gandhigram UG mine can achieve a production target of **1.26 Mty**.

## 9.0 MINING & EQUIPMENT SCHEDULE

### 9.1 MINING SCHEDULE

After the final approval of the Recast P.R by competent authority, 2 year has been kept for acquisition of land for Incline Site / other surface infrastructures & Forest Clearance and EMP Clearance etc. Tender and Work Award for inclines drivages (Length of Incline-I = 922m & Incline-II = 899m) and sinking of 2 airshafts (Depth AS-I= 222m & AS-II= 225m ) will be completed.

Once Land acquisition and work award for drivage of Inclines/air-shafts are completed, inclines/air-shaft drivages will commence from 3<sup>rd</sup> year. With an advance rate of about 55-60m /month, the inclines (ie Incline-I & II) can touch floor of LWS (incline lengths about 544m & 530m) during the end of 3<sup>rd</sup> year.

Bagdonga Seam & IA Seam floors will be touched by inclines during 4<sup>th</sup> year of mine life. Air-shafts also will be driven simultaneously with the inclines. With an advance rate of about 20m/month, the air-shafts can be completed during 3<sup>rd</sup> year of mine life.

Main-dips development in LWS will start from 4<sup>th</sup> year with 1<sup>st</sup> C.M package (CM-1) .The total production during 4<sup>th</sup> year would be 0.30 Mty which is from one set of CM package. 2<sup>nd</sup> CM district (CM-2) will be introduced in Bagdonga seam for main-dip development during 5<sup>th</sup> year. With 2 nos of CM districts, the total production would be 0.68 Mty during 5<sup>th</sup> year. During 6<sup>th</sup> year, third CM package (CM-3) will be introduced in LWS along with CM-1. The total production during 6<sup>th</sup> year from 3 sets of CM packages would be 1.20 Mty. The mine will be able to achieve its target production capacity of 1.26 Mty from 7<sup>th</sup> year onwards and this production level continues till 26<sup>th</sup> year of mine life. During 27<sup>th</sup> year, CM-2 will be withdrawn and the production tapering starts. CM-3 will be withdrawn during 29<sup>th</sup> year. The coal production will be 1.23 Mty, 0.84 Mty, 0.70 Mty, 0.42 Mty & 0.10 Mty for the years 27<sup>th</sup>, 28<sup>th</sup>, 29<sup>th</sup>, 30<sup>th</sup> & 31<sup>st</sup> years of Mine working.

The year wise production schedule till the achievement of target capacity is shown in the following table:

Particulars	Year Wise Production Phasing (Mty)				
	Year-1-3	Year-4	Year-5	Year-6	Year-7
CM-1	-	0.30	0.38	0.42	0.42
CM-2	-	-	0.30	0.42	0.42
CM-3	-	-	-	0.36	0.42
Total	-	0.30	0.68	1.20	1.26

The year-wise scheduling of 3 sets of Continuous Miner packages (Calendar Programming & Liquidation plan) has been tabulated below-

<b>GANHIGRAM UG - YEARWISE SCHEDULING OF MACHINES FOR PRODUCTION [ MINE LIQUIDATION PLAN ]</b>								
YEA R	M/C	SEA M	PARTICULARS	DEV T. / DEP.	PROD N. (Mt)	M/C WISE PDODN. (Mt)	TOTAL PRODN. (YRLY)- Mt	REMA RKS
Year: 1-2	LAND ACQUISITION						Nil	
Year : 3	DRIVAGE OF 2 NOS OF INCLINES FROM SURFACE UPTO LWS FLOOR (TAKES ABOUT 9 MONTHS). DRIVAGE OF AIR-SHAFT / CONSTRUCTION OF FANDRIFTS ETC COMPLETES. VENTILATION NETWORK ESTABLISHES. (INCLINE DRIVAGE CONTINUES TOWARDS BAGDONA SEAM & THEN IA SEAM).						Nil	
Year : 4	CM-1	LWS	L-MD1 : INTRODUCTION OF 1st C.M PACKAGE (CM-1)- ONCE THE FLOOR OF LWS IS TOUCHED, 2 HEADINGS WILL BE DRIVEN TOWARDS THE MAIN-DIP HEADINGS. L-MD1 WILL BE DEVELOPED.	DEV	0.04	0.30	0.30	CM-1 INTRODUCED (LWS)
			L-MD2 MAIN-DIP DEVELOPMENT	DEV	0.07			

			L-MD3 MAINDIP DEVELOPMENT	DEV	0.07					
			5 nof of headings are proposed for main-dips. 3 headings will be developed by CM first and then the remaining 2 headings. Drifts for entering MD-4 from MD-3 will be started once the 3 headings are developed . In case of any further delay, CM-1 package can be deployed for development of Panel L-14 for the time being.							
			L-MD4 MAINDIP DEVELOPMENT	DEV	0.03					
			In case of any delay in making drifts for crossing dyke, CM-1 package can be again deployed for devt of Panel L-11.							
			L-MD5 DEVELOPMENT	DEV	0.07					
			In case of any delay in making drifts for crossing fault F18-F18 (MD-5 to MD-6), CM package can be deployed for devt of Panel L-8.							
			L-MD6 MAINDIP DEVELOPMENT	DEV	0.03					
BY THE END OF 4TH YEAR , THE INCLINES WILL HAVE TOUCHED SEAM-IA (FLOOR) AFTER CROSSING BAGDONA SEAM FLOOR.										
Year : 5	CM-1	LWS	L-MD6 MAINDIP DEVELOPMENT-BAL	DEV	0.06	0.38	0.68	CM-2 INTRODUCED (BAGDONA)		
			L-1: PANEL DEVELOPMENT	DEV	0.10					
			L-1 : PANEL DEPILLARING	DEP	0.22					
	CM-2	BAGDONA	B-MD1: INTRODUCTION OF 2nd C.M PACKAGE (CM-2) ONCE THE FLOOR OF BAGDONA SEAM IS TOUCHED, 2 HEADINGS WILL BE DRIVEN TOWARDS THE MAIN-DIP HEADINGS. B-MD1 WILL BE DEVELOPED.			DEV			0.03	0.30
			B-MD2 MAIN-DIP DEVELOPMENT			DEV			0.07	
			B-MD3 MAIN-DIP DEVELOPMENT			DEV			0.03	
			In case of any delay in making Drifts for entering MD-4 from MD-3, CM-2 package can be deployed for development of Panel B-14 for the time being.							
			B-MD4 MAIN-DIP DEVELOPMENT			DEV			0.02	
			In case of any delay in making drifts for crossing dyke, CM-2 package can be deployed for devt of Panel B-9.							
			B-MD5 MAIN-DIP DEVELOPMENT			DEV			0.06	
			In case of any delay in making drifts for crossing fault F18-F18 (MD-5 to MD-6), CM package can be deployed for devt of Panel B-8.							
			B-MD6 MAIN-DIP DEVELOPMENT			DEV			0.07	
			B-1 : PANEL DEVELOPMENT			DEV			0.02	

Liquidation Plan- Contd.....

YR	M/C	SE AM	PARTICULARS	DEVT. / DEP.	PRODN. (Mt)	M/C (Mt)	TOTAL (Mt)	REMARKS
Year : 6	CM-1	LWS	L-1 : PANEL DEPILLARING-BAL	DEP.	0.01	0.42	1.20	CM-3 INTRODUCED (LWS)
			L-2: PANEL DEVELOPMENT	DEV.	0.04			
			L-2 : PANEL DEPILLARING	DEP.	0.09			
			L-4: PANEL DEVELOPMENT	DEV.	0.10			
			L-4 : PANEL DEPILLARING	DEP.	0.19			
	CM-2	BAGDONA	B-1 : PANEL DEVELOPMENT-BAL	DEV.	0.05	0.42		
			B-1 : PANEL DEPILLARING	DEP.	0.16			
			B-2 : PANEL DEVELOPMENT	DEV.	0.03			
			B-2 : PANEL DEPILLARING	DEP.	0.07			
			B-4 : PANEL DEVELOPMENT	DEV.	0.10			
CM-3	LWS	B-4 : PANEL DEPILLARING	DEP.	0.01	0.36			
		L-3 : INTRODUCTION OF 3 rd C.M PACK	DEV.	0.19				

Year : 7	CM-1	LWS	L-3 : PANEL DEPIllARING	DEP.	0.17	1.26				
			L-4 : PANEL DEPIllARING-BAL	DEP.	0.06					
			L-MD6 : DEPIllARING OF PANEL	DEP.	0.23					
			L-6 : PANEL DEVElOPMENT	DEV.	0.12					
	CM-2	BAGDONA	B-4 : PANEL DEPIllARING-BAL	DEP.	0.25			0.42		
			B-3 : PANEL DEVElOPMENT	DEV.	0.13					
			B-3 : PANEL DEPIllARING	DEP.	0.04					
	CM-3	LWS	L-3 : PANEL DEPIllARING BAL.	DEP.	0.30			0.42		
			L-5 : PANEL DEVElOPMENT	DEV.	0.11					
			L-5 : PANEL DEPIllARING	DEP.	0.01					
	Year : 8	CM-1	LWS	L-6 : PANEL DEPIllARING BAL	DEP.			0.28	1.26	
				L-8 : PANEL DEVElOPMENT	DEV.			0.14		
CM-2		BAGDONA	B-3 : PANEL DEPIllARING BAL.	DEP.	0.28	0.42				
			B-MD6 : DEPIllARING OF PANEL	DEP.	0.14					
CM-3		LWS	L-5 : PANEL DEPIllARING BAL.	DEP.	0.26	0.42				
			L-7 : PANEL DEVElOPMENT	DEV.	0.12					
		L-7 : PANEL DEPIllARING	DEP.	0.04						
Year : 9	CM-1	LWS	L-8 : PANEL DEVElOPMENT BAL.	DEV.	0.03	0.42	1.26			
			L-8 : PANEL DEPIllARING	DEP.	0.39					
	CM-2	BAGDONA	B-MD6 : DEPIllARING OF PANEL BAL	DEP.	0.04	0.42				
			B-5 : PANEL DEVElOPMENT	DEV.	0.10					
			B-5 : PANEL DEPIllARING	DEP.	0.23					
			B-6 : PANEL DEVElOPMENT	DEV.	0.05					
	CM-3	LWS	L-7 : PANEL DEPIllARING BAL	DEP.	0.26	0.42				
			L-9 : PANEL DEVElOPMENT	DEV.	0.16					
Year : 10	CM-1	LWS	L-8 : PANEL DEPIllARING BAL	DEP.	0.04	0.42	1.26			
			L-MD5 : DEPIllARING OF PANEL	DEP.	0.18					
			L-10 : PANEL DEVElOPMENT	DEV.	0.20					
	CM-2	BAGDONA	B-6 : PANEL DEVElOPMENT BAL	DEV.	0.03	0.42				
			B-6 : PANEL DEPIllARING	DEP.	0.20					
			B-7 : PANEL DEVElOPMENT	DEV.	0.13					
			B-7 : PANEL DEPIllARING	DEP.	0.06					
	CM-3	LWS	L-9 : PANEL DEVElOPMENT BAL.	DEV.	0.07	0.42				
			L-9 : PANEL DEPIllARING	DEP.	0.21					
		L-11 : PANEL DEVElOPMENT	DEV.	0.14						

Liquidation Plan- Contd.....

Y R	M/ C	SE AM	PARTICULARS	DEVT. / DEP.	PRODN . (Mt)	M/C (Mt)	TOTAL (Mt)	REMARKS
Year : 11	CM-1	LWS	L-10 : PANEL DEVElOPMENT BAL.	DEV.	0.04	0.42	1.26	
			L-10 : PANEL DEPIllARING	DEP.	0.38			
	CM-2	BAGDONA	B-7 : PANEL DEPIllARING BAL.	DEP.	0.25	0.42		
			B-8 : PANEL DEVElOPMENT	DEV.	0.12			
			B-8 : PANEL DEPIllARING	DEP.	0.05			
	CM-3	LWS	L-11 : PANEL DEVElOPMENT BAL.	DEV.	0.21	0.42		
L-11 : PANEL DEPIllARING			DEP.	0.21				
Year : 12	CM-1	LWS	L-10 : PANEL DEPIllARING BAL.	DEP.	0.02	0.42	1.26	
			L-12 : PANEL DEVElOPMENT	DEV.	0.08			
			L-12 : PANEL DEPIllARING	DEP.	0.13			
			L-MD4 : PANEL DEPIllARING	DEP.	0.06			

Year : 13	CM-2	BAGDON A	L-15 : PANEL DEVELOPMENT	DEV.	0.14	0.42	1.26	
			B-8 : PANEL DEPILLARING BAL.	DEP.	0.27			
			B-MD5 : DEPILLARING OF PANEL	DEP.	0.14			
			B-9 : PANEL DEVELOPMENT	DEV.	0.01			
	CM-3	LWS	L-11 : PANEL DEPILLARING BAL.	DEP.	0.14	0.42		
			L-13 : PANEL DEVELOPMENT	DEV.	0.28			
	CM-1	LWS	L-15 : PANEL DEVELOPMENT BAL.	DEV.	0.13	0.42		
			L-15 : PANEL DEPILLARING	DEP.	0.27			
			L-17 : PANEL DEVELOPMENT	DEV.	0.02			
	CM-2	BAGD ONA	B-9 : PANEL DEVELOPMENT BAL	DEV.	0.22	0.42		
			B-9 : PANEL DEPILLARING	DEP.	0.20			
	CM-3	LWS	L-13 : PANEL DEVELOPMENT BAL.	DEV.	0.05	0.42		
L-13 : PANEL DEPILLARING			DEP.	0.37				
Year : 14	CM-1	LWS	L-17 : PANEL DEVELOPMENT BAL.	DEV.	0.42	1.26		
	CM-2	BAGDON A	B-9 : PANEL DEPILLARING BAL.	DEP.	0.11		0.42	
			B-10 : PANEL DEVELOPMENT	DEV.	0.13			
			B-10 : PANEL DEPILLARING	DEP.	0.18			
	CM-3	LWS	L-13 : PANEL DEPILLARING BAL.	DEP.	0.08		0.42	
			L-14 : PANEL DEVELOPMENT	DEV.	0.28			
			L-14 : PANEL DEPILLARING	DEP.	0.06			
Year : 15	CM-1	LWS	L-17 : PANEL DEVELOPMENT BAL.	DEV.	0.06	1.26		
			L-17 : PANEL DEPILLARING	DEP.	0.36			
	CM-2	BAGD ONA	B-10 : PANEL DEPILLARING BAL	DEP.	0.15		0.42	
			B-11 : PANEL DEVELOPMENT	DEV.	0.27			
	CM-3	LWS	L-14 : PANEL DEPILLARING BAL	DEP.	0.37		0.42	
L-16 : PANEL DEVELOPMENT			DEV.	0.05				
Year : 16	CM-1	LWS	L-17 : PANEL DEPILLARING BAL	DEP.	0.42	1.26		
	CM-2	BAGDONA	B-11 : PANEL DEVELOPMENT BAL.	DEV.	0.03		0.42	
			B-11 : PANEL DEPILLARING	DEP.	0.39			
	CM-3	LWS	L-16 : PANEL DEVELOPMENT BAL.	DEV.	0.22		0.42	
			L-16 : PANEL DEPILLARING	DEP.	0.20			

Liquidation Plan- Contd.....

Y R	M/C	SE AM	PARTICULARS	DEVT. / DEP.	PRODN. (Mt)	M/C (Mt)	TOTAL (Mt)	REMARKS
Year : 17	CM-1	LWS	L-17 : PANEL DEPILLARING BAL	DEP.	0.05	0.42	1.26	
			L-MD3 : PANEL DEPILLARING	DEP.	0.17			
			L-19 : PANEL DEVELOPMENT	DEV.	0.09			
			L-19 : PANEL DEPILLARING	DEP.	0.11			
	CM-2	BAGDONA	B-11 : PANEL DEPILLARING BAL	DEP.	0.13	0.42		
			B-12 : PANEL DEVELOPMENT .	DEV.	0.07			
			B-12 : PANEL DEPILLARING	DEP.	0.16			
			B-MD4 : PANEL DEPILLARING	DEP.	0.05			
			B-13 : PANEL DEVELOPMENT	DEV.	0.01			
	CM-3	LWS	L-16 : PANEL DEPILLARING BAL.	DEP.	0.20	0.42		
L-18 : PANEL DEVELOPMENT			DEV.	0.13				

Year : 18	CM-1	LWS	L-18 : PANEL DEPIILLARING	DEP.	0.09	0.42	1.26				
			L-19 : PANEL DEPIILLARING BAL.	DEP.	0.03						
			L-21 : PANEL DEVELOPMENT	DEV.	0.12						
			L-21 : PANEL DEPIILLARING	DEP.	0.13						
	CM-2	BAGDON A	B-13 : PANEL DEVELOPMENT BAL.	DEV.	0.25	0.42					
			B-13 : PANEL DEPIILLARING	DEP.	0.17						
	CM-3	LWS	L-18 : PANEL DEPIILLARING BAL.	DEP.	0.11	0.42					
			L-20 : PANEL DEVELOPMENT	DEV.	0.15						
			L-20 : PANEL DEPIILLARING	DEP.	0.14						
			L-22 : PANEL DEVELOPMENT	DEV.	0.02						
	Year : 19	CM-1	LWS	L-23 : PANEL DEVELOPMENT BAL	DEV.	0.07			0.42	1.26	
				L-23 : PANEL DEPIILLARING	DEP.	0.22					
L-25 : PANEL DEVELOPMENT				DEV.	0.13						
CM-3		LWS	B-13 : PANEL DEPIILLARING BAL	DEP.	0.42	0.42					
			L-22 : PANEL DEVELOPMENT BAL.	DEV.	0.11						
			L-22 : PANEL DEPIILLARING	DEP.	0.12						
			L-24 : PANEL DEVELOPMENT	DEV.	0.06						
			L-24 : PANEL DEPIILLARING	DEP.	0.06						
			L-26 : PANEL DEVELOPMENT	DEV.	0.07						
Year : 20	CM-1	LWS	L-25 : PANEL DEPIILLARING	DEP.	0.13	0.42	1.26	CM-3 SHIFTING TO BAGDONA SEAM (FROM LWS)			
			L-MD2 : PANEL DEPIILLARING	DEP.	0.15						
			L-27 : PANEL DEVELOPMENT	DEV.	0.11						
			L-27 : PANEL DEPIILLARING	DEP.	0.04						
	CM-2	BAGDON A	B-13 : PANEL DEPIILLARING BAL	DEP.	0.02	0.42					
			B-14 : PANEL DEVELOPMENT	DEV.	0.16						
			B-14 : PANEL DEPIILLARING	DEP.	0.24						
	CM-3	LWS	L-26 : PANEL DEVELOPMENT BAL.	DEV.	0.03	0.42					
			BAGDON A	B-15 : PANEL DEVELOPMENT	DEV.				0.17		
				B-15 : PANEL DEPIILLARING	DEP.				0.22		

Liquidation Plan- Contd.....

Y R	M/ C	SEAM	PARTICULARS	DEVT. / DEP.	PROD N. (Mt)	M/C (Mt)	TOTAL (Mt)	REMARKS
Year : 21	CM-1	LWS	L-27 : PANEL DEPIILLARING BAL	DEP.	0.07	0.42	1.26	CM-1 SHIFTING FROM LWS TO IA SEAM
		IA SEAM	IA-MD1 : PANEL DEVELOPMENT	DEV.	0.03			
			(THE 3 Nos OF MAIN-DIP HEADINGS FROM IA-MD1 TO IA-MD2 BY CROSSING THE DYKE WOULD HAVE BEEN COMPLETED IMMEDIATELY AFTER TOUCHING THE IA SEAM FLOOR BY THE INCLINES )					
			IA-MD-2 & MD-3 : DEVELOPMENT	DEV.	0.11			
			If any delay in making Drifts for entering MD-4 from MD-3 by crossing fault F-16, CM-3 package can be deployed for development of Panel IA-11 for the time being.					
			IA-MD4 : PANEL DEVELOPMENT	DEV.	0.03			

Year : 22	CM-2	BAGDONA	If any delay in making drifts for crossing dyke, CM-3 package can be deployed for devt of Panel IA-5. Once IA-MD4 development is completed, development headings in panel IA-8 may be commenced up to the point where 3 drifts are to be made to cross Dyke -II in panel-IA-8.			1.26			
			IA-MD5 : PANEL DEVELOPMENT	DEV.	0.05				
			During IA-MD5 development, the 3 drifts to enter IA-2 panel by crossing Dyke-I will be done.						
			IA-4 : PANEL DEVELOPMENT	DEV.	0.06				
			IA-3 : PANEL DEVELOPMENT	DEV.	0.07				
	CM-3	BAGDONA	B-14 : PANEL DEPILLARING BAL	DEP.	0.16			0.42	
			B-MD3 : PANEL DEPILLARING	DEP.	0.09				
			B-16 : PANEL DEVELOPMENT	DEV.	0.11				
			B-16 : PANEL DEPILLARING	DEP.	0.06				
	CM-1	IA SEAM	B-15 : PANEL DEPILLARING BAL	DEP.	0.15			0.42	
			B-17 : PANEL DEVELOPMENT	DEV.	0.12				
			B-17 : PANEL DEPILLARING	DEP.	0.15				
	CM-1	IA SEAM	IA-3 : PANEL DEVELOPMENT BAL	DEV.	0.08			0.42	
			3 Nos of drifts to enter Panel IA-2 from IA-3 will be made						
			IA-2 : PANEL DEVELOPMENT	DEV.	0.10				
			Once panel IA-3 is entered, initially the devt. may be done up to the location of the drifts which connects panels IA-3 with IA-2. After entering IA-2, the development will be done along north west part of this panel. With this, the location of the 2 drifts (between IA-2 to IA-3)in panel IA-2 can be accessed and can start drift drivages. After this, the remaining portions in IA-3 & IA-2 can be developed till the completion of 2 drifts to panel IA-1 from IA-2.						
			IA-1 : PANEL DEVELOPMENT	DEV.	0.05				
			IA-1 : PANEL DEPILLARING	DEP.	0.13				
			IA-2 : PANEL DEPILLARING	DEP.	0.06				
	CM-2	BAGDONA	B-16 : PANEL DEPILLARING BAL	DEP.	0.09			0.42	
B-18 : PANEL DEVELOPMENT			DEV.	0.11					
B-18 : PANEL DEPILLARING			DEP.	0.17					
B-20 : PANEL DEVELOPMENT			DEV.	0.04					
B-20 : PANEL DEPILLARING			DEP.	0.01					
CM-3	BAGDONA	B-17 : PANEL DEPILLARING BAL	DEP.	0.05	0.42				
		B-19 : PANEL DEVELOPMENT	DEV.	0.15					
		B-19 : PANEL DEPILLARING	DEP.	0.22					

Liquidation Plan- Contd.....

Y R	CM	SEAM	PARTICULARS	DEVT. / DEP.	PROD N. (Mt)	M/C (Mt)	TOTAL (Mt)	REMARKS
Year : 23	CM-1	IA SEAM	IA-2 : PANEL DEPILLARING BAL.	DEP.	0.21	0.42	1.26	SHIFTED TO IA FROM BAGDONA.
			IA-3 : PANEL DEPILLARING	DEP.	0.21			
	CM-2	BAGDONA	B-20 : PANEL DEPILLARING BAL	DEP.	0.05	0.42		
			B-MD2 : PANEL DEPILLARING	DEP.	0.15			
			B-22 : PANEL DEVELOPMENT	DEV.	0.08			
	CM-3	IA / BAG.	IA-4 : PANEL DEPILLARING	DEP.	0.14	0.42		
			B-19 : PANEL DEPILLARING BAL	DEP.	0.03			
			B-21 : PANEL DEVELOPMENT	DEV.	0.11			
			B-21 : PANEL DEPILLARING	DEP.	0.19			
			B-23 : PANEL DEVELOPMENT	DEV.	0.06			

Year : 24	CM-1	IA SEAM	B-23 : PANEL DEPIILLARING	DEP.	0.03	0.42	1.26	
			IA-3 : PANEL DEPIILLARING BAL	DEP.	0.12			
			IA-5 : PANEL DEVELOPMENT	DEV.	0.28			
	CM-2	IA SEAM	IA-5 : PANEL DEPIILLARING	DEP.	0.02	0.42		
			IA-6 : PANEL DEVELOPMENT	DEV.	0.08			
			IA-6 : PANEL DEPIILLARING	DEP.	0.21			
	CM-3	IA SEAM	IA-MD5 : PANEL DEPIILLARING	DEP.	0.13	0.42		
			B-23 : PANEL DEPIILLARING BAL	DEP.	0.08			
			IA-7 : PANEL DEVELOPMENT	DEV.	0.31			
Year : 25	CM-1	IA SEAM	IA-9 : PANEL DEVELOPMENT	DEV.	0.03	0.42	1.26	
			IA-7 : PANEL DEPIILLARING BAL.	DEP.	0.32			
	CM-2	IA SEAM	IA-7 : PANEL DEPIILLARING	DEP.	0.10	0.42		
			IA-8 : PANEL DEVELOPMENT	DEV.	0.09			
			IA-8 : PANEL DEPIILLARING	DEP.	0.23			
	CM-3	IA SEAM	IA-10 : PANEL DEVELOPMENT	DEV.	0.10	0.42		
			IA-9 : PANEL DEVELOPMENT BAL	DEV.	0.21			
			IA-11 : PANEL DEVELOPMENT	DEV.	0.18			
	Year : 26	CM-1	IA SEAM	IA-12 : PANEL DEVELOPMENT	DEV.	0.03		
IA-7 : PANEL DEPIILLARING BAL.				DEP.	0.41			
CM-2		IA SEAM	IA-MD4 : PANEL DEPIILLARING	DEP.	0.01	0.42		
			IA-10 : PANEL DEPIILLARING	DEP.	0.26			
			IA-19 : PANEL DEVELOPMENT	DEV.	0.08			
CM-3		IA SEAM	IA-19 : PANEL DEPIILLARING	DEP.	0.08	0.42		
			IA-12 : PANEL DEVELOPMENT BAL	DEV.	0.09			
			IA-14 : PANEL DEVELOPMENT	DEV.	0.09			
			IA-15 : PANEL DEVELOPMENT	DEV.	0.04			
CM-3	IA SEAM	IA-18 : PANEL DEVELOPMENT	DEV.	0.09	0.42			
		IA-13 : PANEL DEVELOPMENT	DEV.	0.11				
		IA-13 : PANEL DEVELOPMENT	DEV.	0.11				

Liquidation Plan- Contd.....

YR	M/C	SEAM	PARTICULARS	DEVT / DEP.	PROD N. (Mt)	M/C (Mt)	TOTAL (Mt)	REMA RKS
Year : 27	CM-1	IA SEAM	IA-MD4 : PANEL DEPIILLARING BAL	DEP.	0.07	0.42	1.23	CM-2 IS WITHDRAWN
			IA-9 : PANEL DEPIILLARING	DEP.	0.35			
	CM-2	IA SEAM	IA-19 : PANEL DEPIILLARING	DEP.	0.24	0.39		
			IA-18 : PANEL DEPIILLARING	DEP.	0.15			
	CM-3	IA SEAM	IA-13 : PANEL DEVELOPMENT BAL	DEV.	0.03	0.42		
			IA-13 : PANEL DEPIILLARING	DEP.	0.23			
IA-16 : PANEL DEVELOPMENT	DEV.	0.16						
Year : 28	CM-1	IA SEAM	IA-9 : PANEL DEPIILLARING BAL.	DEP.	0.20	0.42	0.84	
			IA-11 : PANEL DEPIILLARING	DEP.	0.22			
	CM-3	IA SEAM	IA-16 : PANEL DEVELOPMENT BAL	DEV.	0.01	0.42		



			IA-17 : PANEL DEVELOPMENT	DEV.	0.12			
			IA-17 : PANEL DEPILLARING	DEP.	0.21			
			IA-12 : PANEL DEPILLARING	DEP.	0.08			
Year : 29	CM-1	IA SEAM	IA-11 : PANEL DEPILLARING BAL.	DEP.	0.18	0.42	0.70	CM-2 IS WITHDRAWN
			IA-MD3 : PANEL DEPILLARING	DEP.	0.10			
			IA-MD2 : PANEL DEPILLARING	DEP.	0.14			
	CM-3	IA SEAM	IA-12 : PANEL DEPILLARING BAL	DEP.	0.09	0.28		
			IA-14 : PANEL DEPILLARING	DEP.	0.14			
			IA-15 : PANEL DEPILLARING	DEP.	0.05			
Year : 30	CM-1	IA SEAM	IA-MD2 : PANEL DEPILLARING BAL..	DEP.	0.03	0.42	0.42	
			IA-MD1 : PANEL DEPILLARING BAL..	DEP.	0.07			
		BAGDO NA	B-MD1 : PANEL DEPILLARING	DEP.	0.07			
			B-22 : PANEL DEPILLARING	DEP.	0.15			
		LWS	L-MD1 : PANEL DEPILLARING	DEP.	0.09			
			L-26 : PANEL DEPILLARING	DEP.	0.01			
Year : 31	CM-1	LWS	L-26 : PANEL DEPILLARING BAL	DEP.	0.10	0.10	0.10	
<b>TOTAL</b>							<b>30.67</b>	

The total extractable reserves in Gandhigram UG mine is 30.67 Mt. Initial 2 years will be for acquisition of land for surface infrastructures like Inclines, air-shafts etc. Drivage of inclines and air-shafts will commence from 3<sup>rd</sup> year Coal production starts from 4<sup>th</sup> year onwards (0.30 Mty). Target production will be achieved during 7<sup>th</sup> year which will continue up to 26<sup>th</sup> year. Production tapering starts from 27<sup>th</sup> year till the end of mine life-ie 31<sup>st</sup> year.

<b>YEARWISE SCHEDULING OF MACHINES FOR PRODUCTION (WITH QUALITY)</b>						
Year	COAL PRODUCTION SCHEDULE (Mt)				GCV- K.Cal/Kg	Grade
	CM-1	CM-2	CM-3	Total		
Year 1-4	LAND ACQUISITION				-	
Year 3	INCLINE/AIR-SHAFT DRIVAGES ETC				-	
Year 4	0.30			0.30	5536	G-6
Year 5	0.38	0.30		0.68	5593	G-6
Year 6	0.42	0.42	0.36	1.20	5564	G-6
Year 7	0.42	0.42	0.42	1.26	5543	G-6
Year 8	0.42	0.42	0.42	1.26	5633	G-6
Year 9	0.42	0.42	0.42	1.26	5697	G-6

Year 10	0.42	0.42	0.42	1.26	5549	G-6
Year 11	0.42	0.42	0.42	1.26	5310	G-7
Year 12	0.42	0.42	0.42	1.26	5347	G-7
Year 13	0.42	0.42	0.42	1.26	5094	G-8
Year 14	0.42	0.42	0.42	1.26	5638	G-6
Year 15	0.42	0.42	0.42	1.26	5623	G-6
Year 16	0.42	0.42	0.42	1.26	5622	G-6
Year 17	0.42	0.42	0.42	1.26	5525	G-6
Year 18	0.42	0.42	0.42	1.26	5565	G-6
Year 19	0.42	0.42	0.42	1.26	5635	G-6
Year 20	0.42	0.42	0.42	1.26	5684	G-6
Year 21	0.42	0.42	0.42	1.26	5778	G-6
Year 22	0.42	0.42	0.42	1.26	5701	G-6
Year 23	0.42	0.42	0.42	1.26	5786	G-6
Year 24	0.42	0.42	0.42	1.26	5820	G-5
Year 25	0.42	0.42	0.42	1.26	5766	G-6
Year 26	0.42	0.42	0.42	1.26	5718	G-6
Year 27	0.42	0.39	0.42	1.23	5862	G-5
Year 28	0.42		0.42	0.84	5841	G-5
Year 29	0.42		0.28	0.70	5614	G-6
Year 30	0.42			0.42	5747	G-6
Year 31	0.10			0.10	5930	G-5
<b>Total</b>	<b>11.28</b>	<b>9.51</b>	<b>9.88</b>	<b>30.67</b>	<b>5620</b>	<b>G-6</b>

## 9.2 SCHEDULE OF EQUIPMENT PROCUREMENT

The schedule of equipment procurement is detailed for Departmental and Partial Hiring Options along with the phasing of quantity and capital requirement. The population of important mining equipments for 3 Continuous Miner packages (for 3 CM-districts) is tabulated as under. Each CM package will be introduced during 4<sup>th</sup> year, 5<sup>th</sup> year & 6<sup>th</sup> year of mine operation.

Sl.No	Equipment Particulars	Nos. (Dept. Option)	Nos. (P.H Option)
1	Continuous Miner, operating range: 1.5m to 3.5m, cutting width: 3.30m, cutting power: 2 x	3	

	170 kW, total power of CM: 590 kW, 1100 V		Will be procured by the Contractor (Hiring)
2	Shuttle Car (Electric), capacity: 10.19 m <sup>3</sup> , power: 141 kW, 1100 V	6	
3	Feeder Breaker, capacity: 500 tph, power: 112 kW, 1100 V	3	
4	Twin Boom Roof bolter, operating height: 1.5m to 3.5m, electro-hydraulic, tyre mounted, drilling length: 7.5m, POWER: 2X37 kW	6	
5	Electricals for CM Package / spares	3 sets	

3 Nos of Continuous Miner districts are envisaged in this Report. 1<sup>st</sup> set of CM package (CM-1) will be introduced in 4<sup>th</sup> year for main-dips development in LWS. 2<sup>nd</sup> CM set (CM-2) will be introduced in 5<sup>th</sup> year in Bagdonga Seam . The 3<sup>rd</sup> CM package (CM-3) will be introduced in 6<sup>th</sup> year in LWS with CM-1.

Besides these equipment's, some ancillary/safety equipment or installation is also required in the mine, prominent of them are listed below:

1. Auxiliary fans (12 cum/s capacity) - 6 Nos.
2. Hand held Coal Drills (FLP) - 1 Nos.
3. Hydraulic Roof Bolter - 1 No.
4. Panel Belt/Gate Belt conveyor
5. Electrical sub-stations/installations
6. UG Safety Boring machine
7. Continuous Gas monitoring System
8. Chair-lift Man riding system
9. Firefighting system
10. Ventilation appliances
11. Multi Utility Vehicles (LHD)

### 9.3 SUPPORT SYSTEM

It is proposed to install resin encapsulated roof bolts in the continuous cutting machine district. Since the unsupported cut-out distance is likely to be about 10 m for Gandhigram U/G Mine, the time lag in supporting the freshly exposed roof has to be minimized by installing a bolting system, which sets faster and has high bond strength. The specifications of the proposed bolting consumables are as under:

**Bolt:** Diameter 22mm & length 2.4 m .The bolt should be made of TMT steel with required strength properties like ultimate tensile strength (<500 N/mm<sup>2</sup>).

**Thread:** The thread should be at least 150 mm long. Nut should be fitted to end of the bolt with a shear pin arrangement that has a break-out facility works within a torque range of 125-150 Nm.

Resin Capsule: The resin should be in 24 mm diameter capsules of sufficiently low viscosity to enable the bolter to spin the 2.4m long bolt through resin and mix it in less than the gel setting time of the resin (20 sec.). UCS of resin should be greater than 80 MPa.

### 9.3.1 Support System during Development Stage.

The height of extraction of development panels in trunk roads will be 3.0m only. For all other working panels, the development height will be the thickness of seam or 4.6m whichever is lesser. The support system during development stage will be designed based on the RMR of immediate 2.0 m roof strata & the guidelines for design of support system laid down by DGMS in its circulars which will be finalized after the approval of DGMS.

It is expected that the RMR of seams in Gandhigram UG mines would be about 60 (good category). 4 nos. resin encapsulated bolts of 2.4 m length are proposed in a row at 1.2 m spacing for a gallery width of 4.8 m in the freshly exposed area. The spacing between the adjacent rows will be 1.2 m. The geologically disturbed zones will be additionally supported.

### 9.3.2 Support system during Extraction stage.

During extraction stage, the splits are proposed to be supported by 4 nos. resin encapsulated roof bolts, 2.4m length with W-Strap of length 4.4m, in a row at 1.2m spacing. The spacing between the rows will also be 1.2m. At the goaf edges, the bolting density will be increased with additional number of rows of bolts. The increased density at the goaf edges will serve as breaker-line support. The above mentioned specifications along with support system are only indicative and will be governed by the approved SSR. At the goaf edges, the bolting density will be increased with additional number of rows of bolts. The increased density at the goaf edges will serve as breaker-line support.

To test the efficacy of installed support system and necessity of installing additional supports, etc. mine management will carry out routine monitoring through dual height Tell Tales. To ensure specified quality and consistency of roof bolting consumables and installation procedures, "short encapsulation pull test" shall be carried out by the mine management. The roof bolt-resin-strata system should have an average bond strength of 140 KN/300 mm of full encapsulation.

## 10.0 TRANSPORT

### 10.1 PROPOSED COAL TRANSPORT SYSTEM

Two inclines (Incline-I & II) are proposed in this Recast P.R for Gandhigram

U/G Mine. Incline-I will be used for coal transport from underground to surface by belt conveyors. Incline-II will be equipped with haulage installations for material transport.

In this Report, it is envisaged to work 3 nos of CM districts . With a coal production of about 1400 tpd from each CM district, the total production expected from Gandhigram UG mine is about 4200 tpd (1.26 Mty).

#### 10.1.1 FACE & GATE TRANSPORT

The coal cut by the Continuous Miner will be loaded onto the shuttle car bucket by the gathering arms and in-built chain conveyor. Coal from the shuttle car bucket will be discharged into the receiving hopper of the feeder breaker. The bigger lumps of coal will be crushed to - 200 mm size in feeder breaker.. The feeder breaker (mobile type) will transfer coal onto the gate belt conveyor and then to the out-bye conveyor system. A set of 1000 mm wide, 250 tph capacity gate belt conveyors is proposed to be installed in the gate roads. These gate belt conveyors will transfer coal onto a series of trunk belt conveyors.

Gate belt conveyors are designed to transport about 200 tph. of coal with an installed drive motor of 90 kW capacity.

#### 10.1.2 TRUNK TRANSPORT

Coal from gate belt conveyors will be fed onto a set of Trunk belt conveyors which is having a width of 1200 mm and coal transport capacity of 400 tph. (Powered with 2 x 90 kW motors). During initial years, 2 CM districts will be deployed in LWS & 1 CM district in Bagdona seam. Trunk belt conveyors TB4 to TB8 will be provided in main dip of LWS to receive coal from Gate belts and discharge to incline trunk belts and trunk belt conveyors TB9 to TB13 will be provided in main dip of Bagdona seam to receive coal from Gate belts and discharge to incline trunk belts.

TB1 will be installed in incline No. 1 for transport coal from underground to surface which will discharge coal on to the secondary crusher of CHP (400 tph capacity) where coal will be further sized to (-) 100 mm. This sized coal will be fed onto overhead 2x100t twin bunkers. An electronic belt weigher (continuous type) will be provided on trunk belt conveyor TB1 near incline no.1 (on surface). TB1 will receive coal from TB3 through TB2 . All these trunk belt conveyors are installed along Incline-I with a 1200 mm belt in series. Trunk belt conveyors will receive coal from gate belt conveyors from the working faces.

The coal from Gandhigram UG mine is proposed to be transported to Satpura TPS at Sarni through the proposed Coal Transport & route which will be detailed later in para 13.2 "Integrated Coal Transport Arrangement" .

## 10.2 MEN & MATERIAL TRANSPORT

A chair-lift man riding system of 75kW capacity is proposed along Incline-II (length 925 m) for transport of men. A direct haulage of 150 kW will also be provided along Incline-II for material transport from surface to incline bottom .

A man riding chair lift system of 150 kW each will be provided in main dips of LWS and Bagdona seam for further movement of workmen along trunk route of each seam. The length of this man riding system would be 2.5 km each.

At any point of time, maximum 2 nos of seams will be under working. Since coal extraction with caving method is proposed , the order of working of seams will be from top to bottom . Once LWS is exhausted, the entire working will be shifted to IA seam including man riding system. For transport of material along trunk route (main-dips), direct haulages of 90 kW will be provided parallel to man riding chair lift systems in a separate trunk road in each seam.

Along gate roads , men will travel by the side the belt conveyors. 4 nos. of endless haulages each of 37 kW power will be used for transport of material in gate route to Continuous Miner districts in each seams.

## 11.0 VENTILATION

### 11.1 GENERAL

Exhaust ventilation system has been proposed for Gandhigram UG mine. The main mechanical ventilator will be installed at the fan drift of return air-shaft with properly constructed airlock arrangement at the top of the shaft.

### 11.2 VENTILATION SYSTEM DESIGN

It is anticipated that the coal seams in the proposed Gandhigram U/G Mine will also fall in Degree-II category of gassiness as similar coal seams in the adjacent & nearby mines in Pathakhera area fall in Degree-II category of gassiness. It is advised that proper gas surveys should be carried out as per statute to ascertain the actual degree of gassiness. All ventilation provisions with respect to Degree-II category of gassiness have to be complied and maintained throughout the life of the mine.

As per CMR 1957, 2.5 m<sup>3</sup>/min of air per tonne of daily output should reach the last ventilation connection (LVC) of the districts. There will be 3 CM panels in operation at a time for a total production target of 1.26 Mty (ie 4200 tpd - ie 1400 tpd from each CM district). Hence the minimum air quantity requirement at the LVC of the 3 working districts together works out to 175 m<sup>3</sup>/sec. However, in highly mechanized mines with high production levels (using continuous cutting technology like mechanized Longwall , CM technology

etc), air quantity requirement based on production becomes very high and it is not practicable also to provide this much of air quantity in the mine. Hence exemption from DGMS is sought in such mass production technology mines.

As per international standards, each mechanized district should be provided with an air quantity of 25 cum/sec at LVC. With 3 CM districts under operation at a time, the total air quantity at the LVC of the 3 panels together works out to 75 cum/sec. With an additional 10 cum/sec of air quantity to ventilate service areas below ground, the total air quantity requirement works out to 85 cum/sec. The ventilation system of the mine has been designed considering overall V.E.Q. of 50%. Thus the air-quantity requirement in the main mechanical ventilator to deliver 85 m<sup>3</sup>/sec airflow in the LVC of three districts works out to 170 m<sup>3</sup>/sec.

With 2 numbers of inclines proposed in Gandhigram UG mine (intake airways with cross sectional dimension of 4.8mx3m each), maximum air quantity that can be carried to the mine within permissible velocity of 4m/s for belt conveyor roads is 115 m<sup>3</sup>/sec. Hence a third intake airway is required. Hence an air-shaft (AS-I) with 5.0m diameter has been proposed as intake airway in addition to the 2 inclines. Based on the resistance of the 2 reverse inclines and the intake air-shaft, it is anticipated that the 2 inclines will carry an air quantity of 40 m<sup>3</sup>/sec each and the remaining 90 m<sup>3</sup>/sec air quantity will be carried by the intake airshaft (AS-I).

### 11.3 VENTILATION SIMULATION STUDY

A ventilation simulation study has been done for Gandhigram U/G Mine to assess the ventilation requirements of this mine. It is estimated that during 22<sup>nd</sup> year of mine operation, the ventilation requirements are expected to be maximum. During this period, CM-1 district will be working in panel IA-1 (IA seam) while CM-2 & CM-3 districts will be working in panels B-18 & B-19 (both in Bagdona seam) respectively. The farthest working panel being IA-1, the simulation study is done for ventilation network for panel IA-1.

The air quantity and pressure along the ventilation network is shown in a tabular format below-

Sl.No	Location	Length (m)	Resistance (gaul)	Air-Qnty (m <sup>3</sup> /sec)	Pressure (Pa)
1	INCLINE-1 (Surf. to BAG. Floor)	760	0.152	38	219.48
2	INCLINE-1 (Bag. Floor to IA Floor)	162	0.0324	35	39.69
3	IA-MD1 to IA-MD2(DRIFT)	30	0.006	33	6.534
4	IA-MD2 & IA-MD3	870	0.174	19.5	66.16
5	IA-MD3 to IA-MD4(DRIFT)	160	0.032	26.25	22.05
6	IA-MD4	290	0.058	16.5	15.79
7	IA-MD4 to IA-MD5(DRIFT)	25	0.005	24	2.88

8	IA-MD5	360	0.072	15	16.2
9	IA-MD5 to IA-2	800	0.16	20	64
10	IA-2 to IA-1(DRIFT)	200	0.04	35	49
11	IA-1(PANEL)	300	0.06	15	13.5
12	L.V.C OF PANEL IA-1	96	0.0192	25	12
13	IA-1(PANEL)	300	0.06	15	13.5
14	IA-1 to IA-2 (DRIFT)	200	0.04	35	49
15	IA-2 to IA-MD5	800	0.16	20	64
16	IA-MD5	360	0.072	15	16.2
17	IA-MD5 to IA-MD4(DRIFT)	25	0.005	25	3.125
18	IA-MD4	290	0.058	16.6	15.98
19	IA-MD4 to IA-MD3(DRIFT)	160	0.032	26.3	22.13
20	IA-MD3 & L-MD2	870	0.174	19.5	66.16
21	IA-MD2 to IA-MD1(DRIFT)	30	0.006	33	6.53
22	ALONG IA -18 (UPTO R-A.S)	300	0.06	35	73.5
23	AIRSHAFT (IA-MD1 to BAG-FLOOR.)	40	0.0016	71	8.06
24	AIRSHAFT/FAN DRIFT (BAG-FLOOR to SURFACE.)	176	0.00704	167	196.33
<b>Total</b>					<b>1061.84</b>

#### 11.4 FAN SPECIFICATION

The requirement of the ventilation system for Gandhigram UG mine to produce 1.20 Mty of coal is described below.

Air quantity requirement (Q)	-	170 m <sup>3</sup> /sec
Air Pressure (P)	-	1061.84 Pa ( 108 mm of WG)
Mine Resistance (R)	-	0.037 gaul (P/Q <sup>2</sup> )
Air kW	-	181 Kw (PxQ/1000)
Fan Motor Power	-	278 kW (65 % overall efficiency)
		Say <b>275 kW</b> )

The main mechanical ventilator (exhaust type) should be capable of delivering the following air quantities at desired pressure during the entire life of mine by changing the fan blade angle or RPM of fan motor.

#### 12.0 WATER MANAGEMENT & PUMPING

The production proposed from Gandhigram U/G Project is 1.26 Mty from 3 nos of Continuous Miner districts to work 3 seams-ie LWS, Bagdonga Seam & IA Seam . The total mining area of Gandhigram UG is about 7.2 sq.km. The source of water in the UG mine is mainly due to seepage from strata because of rainfall. The total rainfall in the adjacent mines are about 1400 mm. The other sources are seepage due to ground water & water from CM package, Twin Boom roof bolter, feeder breaker etc.

#### 12.1 CLEAN WATER SUPPLY ARRANGEMENT FOR C. M. DISTRICT



Clean water with neutral pH and minimum suspended solids is required at the rate of about 250 litres per minute at 200 kPa pressure for cooling motors, drilling and dust suppression for each Continuous Miner. The clean water shall be supplied by means of a 100 mm diameter pipe range installed in the conveyor drive. Near the gate belt tail end, a manifold distributes the clean water to the equipment through flexible trailing pipes. A manifold will be installed near each feeder breaker for the supplying of clean water to Continuous Miners, Roof Bolters & Feeder Breakers through fire resistant armoured hose. The pipe range shall be extended along with the extension of each gate belt conveyor. Clean water is required for operation of Twin Boom roof bolter & Feeder breaker in CM district. The total clean water requirement for these machines expected to be about 2000 litres/minute.

## 12.2 MAKE OF WATER

It is anticipated that the main sources of water in Gandhigram UG mine are mainly due to seepage from strata because of rainfall, Seepage due to ground water & Water accumulation by water supply to Continuous Miner system and water spraying system. As per the data available from Hydro-geological Department of CMPDI, the make of water estimated during incline drivage of nearby Tawa and Sarni blocks was 15 LPS. During construction of drivages between above two properties and development of the mine, the inflow of water may go up to 55 LPS and during caving condition the flow may be 70 LPS. The final stabilized flow may be around 35 LPS. Pumping capacity from the main sump to surface has been calculated and shown below-

Sl.No	Particulars	Calculated Data
1	Maximum make of water during development of mine as per hydro-geological data supplied/ day	3.3 cum/min
2	Pump operating period per day	18 hrs
3	Pumping capacity	$3.3 \times 1.1 \times 24/18$ = 4.84 cum/min

Total working hours for pumping has been taken as 18 Hrs. in day and average 650 LPM water assumed for water supply to Continuous Miner for total working hours in a day.

Sl.No	PARTICULARS	Calculated Data
1	Water accumulated from each C.M. district/day	650 LPM x 18 Hrs.
2	Required pumping capacity to pump out in 18 hrs	10.83 LPS
3	Required pumping capacity for the water accumulated in operation of two Continuous Miners in 18 hrs	$3 \times 10.83 = 32.49$ LPS
6	Required pumping capacity for three dist.	32.49 LPS
7	Total pumping capacity to pump out in 18 Hrs.	$80.67+32.49$

		=113.16(say 114 lps)
8	No. of pump of 80 LPS capacity	01
9	No. of pump of 38 LPS capacity	01

Water of the whole project collected in the main sump at Gandhigram UG mine (near the incline bottom of LWS) will be pumped out to surface through proposed two delivery lines. Among them one of 219mm diameter pipe will be for discharge to surface through main incline and the other of 150mm diameter pipe through mine incline. The capacity of main sump is estimated as 5760 m<sup>3</sup>. Water from all auxiliary sumps as said earlier will be collected in the main sump for further discharge to surface. The capital provision for pumps, pipes, pipe fittings including installation and foundation cost etc are estimated and provided for this project.

### 13.0 COAL HANDLING PLANT

#### 13.1 CHP & SURFACE DISPATCH ARRANGEMENT

A small coal handling plant for Gandhigram UG mine has been proposed near belt incline no. 1 to handle the entire production of coal from mine-ie 1.26 Mty. The CHP will have facilities like secondary crushing (>100mm size), twin storage bunkers(100T each), weighment facility for coal etc.

Coal from underground will be brought to surface by trunk belt conveyor TB1 of 1200 mm wide through incline no. 1. TB1 will discharge coal into a single roll crusher which will crush the ROM coal to (-)100mm size. (-) 100mm size coal will be collected by CHP belt conveyor C1 of 1200mm wide. Conveyor C1 will discharge coal into twin overhead hopper of 2 x100t capacity. Coal from this overhead hoppers will be reclaimed with the help of hydraulic sector gate provided below twin hoppers and loaded directly into tripping trucks for transporting to Satpura TPS at Sarni or misc. customers through road.

An electronic road weighbridge of 100t. capacity will be provided at a convenient location near the CHP and used for the weighment of empty and loaded trucks. The weighbridge will have printing facility for keeping records and for preparation of bills

#### 13.2 INTEGRATED COAL TRANSPORT ARRANGEMENT

The coal from the 2 future UG projects of Pathakhera Area (Gandhigram & Tawa-III) are proposed to be transported through the proposed "Integrated coal transport route" – ie from pit top of each mine to Satpura TPS at Sarni or miscellaneous customers through a 5.5 km long road proposed along the northern & western side boundary of Tawa/Tawa extn blocks as shown in Plate-VII. This road will also cater as approach road to Gandhigram UG mine as well as incoming power supply route from STPS at Sarni..

The target coal production capacity of the proposed Gandhigram & Tawa-III

UG mines are 1.26 Mty & 0.48 Mty respectively (total about 1.74 Mty) . The coal is proposed to be transported along this road to Satpura Thermal Power Station at Sarni through Tawa bridge. Double line road (7.5m wide) has been proposed and sufficient capital provision has been given in this Report.

The coal from these 2 mines may be taken directly to Satpura Thermal Power Station at Sarni by trucks through road. Other option is taking this coal up to the Shobhapur Bunker by road and from there to STPS at Sarni through the existing belt conveyor system.

## **14.0 WORKSHOP, STORES & MAGAZINE**

### **14.1 WORKSHOP**

The Unit Workshop at mine-level will provide basic engineering support in the form of repairs, maintenance, replacement of minor spare parts etc. The facilities and manpower provided in this Workshop would be sufficient enough to cater to the routine needs of various underground mining machines operating in the project. Washing, greasing, and checking of brake system, hydraulic system etc. would also be undertaken in the Unit Workshop. Washing, cleaning & repair of LMVs, assemblies, defective parts etc. is also envisaged. The Unit Workshop would have the facilities of

- a) Machine shop
- b) U/G Mining Equipment Repair shop
- c) Electrical Equipment Repair shop
- d) Carpentry shop ,Smithy shop
- e) Light Motor Vehicle shop
- f) Washing Ramp & platform etc

Jobs that shall be carried out in the unit workshop shall be in the form of unit replacement of assemblies or replacement of defective parts. Major and capital repairs, overhauls, manufacture of critical spares, reconditioning of assemblies and sub-assemblies and other works of capital nature would be carried out at Regional Workshop of the Area or Central Workshop at Tadali as per the requirement. As such, unit workshop has been provided with those plant and machineries adequate to support the daily repair and maintenance needs of the project only.

### **14.2 STORES**

A small but independent unit stores has been envisaged to cater to the routine needs of consumables, spares, POL, etc. of the mine. Unit store shall have the backing of the Area Store and Central Store for its smooth functioning.

### **14.3 MAGAZINE**

Since Continuous Cutting technology is proposed in this project, provision for Magazine is not required as this is blasting free method of coal exploitation.

However, provision for a mini explosive carrier/Van has been given in this Recast PR for the purpose of drift drivages etc.

## 15.0 POWER SUPPLY AND ILLUMINATION

### 15.1 SOURCE OF POWER SUPPLY

Gandhigram UG Mine is located approximately 10 km from existing Tawa-II Underground Mine in Pathakhera Area of WCL. The mine is being planned for a target production of 4200 tpd (1.26 Mty) with 3 nos of C.M districts. Two future UG projects namely Gandhigram & Tawa-III are expected to come in Pathakhera area of WCL which are in close proximity to each other. Considering this, an “Integrative approach” for power supply for all these 2 mines have been considered in this Recast Project Report.

In Madhya Pradesh state, MPSEDCL generally allow to transmit/provide up to only 10 MVA power at 33 kV voltage level. Beyond this, they ask to go for higher voltage i.e. 220/132 kV as per availability. The target coal production & estimated maximum power demand for these 2 mines will be as follows :-

Sl. No.	UG MINE	Target Coal Prodn.	Est. Max. Demand
1	Gandhigram UG mine	1.26 Mty	6 to 7 MVA
2	Tawa III UG	0.48 Mty	3 to 4 MVA
	TOTAL	1.74 Mty	9 to 11 MVA

Hence, from the above table it is seen that for both the mines, the total MVA demand shall be in the range of 9-11 MVA, which may increase/ decrease subject to the variation in the coal production, various stage of mine life, deployment of different technology etc.

Presently, the nearest power source of all the mines of Pathakhera area is Sarni MPSETCL substation having capacity 220 /132 /33 kV , 60 MVA. The power is fed to all the mines of Pathakhera area through two numbers of 33 kV feeder namely NCDC Feeder and Shobhapur feeder.

The total contract demand taken through these feeders is 19880 kVA and maximum demand is 17908 kVA. It was pointed out that both the MPSETCL Feeders are very old and giving frequent power outage due to the heavy load attached with these feeders. After discussions with Pathakhera Area officials, it is proposed to erect a separate 33 kV double feeder O/H line from Sarni MPSETCL Sub-station to Gandhigram UG Mine. The route of the above line is envisaged which is approximately 16 kms, which requires a detailed survey as the proposed route of the line will pass through MPSETCL Lands (from STPS to Tawa Dam site-about 9km long), forest land (Tawa dam to Tawa

bridge-about 1km long) & Tenancy land (Tawa bridge to Gandhigram UG mine site along the approach road/coal transport road –about 5.5 km long). This line will cater the power requirement of Gandhigram UG Mine as well as Tawa III UG Mine. The entire capital requirement for the “Integrated Power & Transport Route” has been loaded in Gandhigram UG Report only.

## 15.2 CONNECTED LOAD & MAXIMUM DEMAND

The details of Connected Load and Maximum Demand of the proposed Gandhigram U/G Mine and Township (though provision of quarters is not given but the electric load of quarters for the proposed manpower residing in the nearby townships is considered) for both departmental as well as partial hiring options are as given below:

Sl.No.	ITEM HEAD	Dept. option	P.H option
1.	CONNECTED LOAD:		
	a) Only mine	10697 kW	7301 kW
	b) Only township	920 kW	592 kW
	c) Total	11617 kW	7893 kW
2.	LOAD IN OPERATION:		
	a) Only mine	10423kW	7027 kW
	b) Only township	920 kW	592 kW
	c) Total	11343 kW	7619 kW
3.	PROJECTED MAX. DEMAND:		
	a) Only mine	6313 kVA	4084 kVA
	b) Only township	673 kVA	434kVA
	c) Total	6986 kVA	4518 kVA

## 15.3 SALIENT FEATURES OF ELECTRICAL PARAMETERS

The salient features of electrical parameters of the proposed Gandhigram U/G Mine for Departmental and Partial Hiring Options are given below:

Sl. No.	Particulars	Dept. option	P.H option
1.	Specific Energy Consumption (Including Township)	25.07 kWh / t	19.33 kWh / t
2.	Specific Power Cost (Incl. Township)	Rs. 255.73/t	Rs. 192.13/t
3.	Fixed Percentage of Power Cost	34.5 %	38.56 %
4.	Variable Percentage of Power Cost	65.95 %	61.44 %
5.	Specific Demand	5.544 MVA/Mt.	3.586MVA/Mt.
6.	Capacitor Bank Provided (Incl. Township)	4400 kVAR	2600 kVAR

7.	Target Coal production	1.26 Mty	1.26 Mty
8.	Average cost of purchased power	Rs. 10.20/ kWh	Rs. 9.94 / kWh

#### 15.4 COMMUNICATION SYSTEM

The communication systems like Intrinsically safe signaling bells, Intrinsically safe Auto-CDS system , Electronic telephone exchange (EPABX- 400 Lines) have been proposed considering the various requirements of the mine with respect to telecommunications, safety electronics and industrial electronics. DoT Communication will be done for communication between Mine & Area Office / HQ etc.

### 16.0 CIVIL CONSTRUCTION

#### 16.1 SERVICE BUILDINGS & RESIDENTIAL BUILDINGS

The total life and revenue life of Gandhigram UG project is about 31 years and 28 years respectively, therefore all civil works have been envisaged on permanent specifications. The Building Cost Index for the M. P. Region has been worked out to 511 in 2016 (2nd half) taking the prevalent rates of materials and labour. This Building Cost Index is with reference to base 100 in Nagpur as on 1.1.1992.

Keeping in view the needs and requirements of this mine, provision for service buildings such as Project office / Manager office, Unit workshop, Unit Stores, Sub-station, statutory buildings, community buildings and other welfare buildings have been provided.

#### 16.2 PROVISION OF QUARTERS

No additional residential quarters have been proposed for Gandhigram U/G Mine. The existing residential quarters in Pathakhera and Shobhapur townships shall cater to the residential needs of Gandhigram U/G Mine.

The total manpower requirement in departmental option is 603. Capital provision for renovation of 322 quarters (overall housing satisfaction of 53.40%) has been made since these quarters are quite old.

The quarters which are to be renovated shall be identified by WCL authorities at the time of actual deployment of manpower at this U/G Mine. In partial Hiring option, 217 quarters will be renovated with an overall housing satisfaction of 55.36% with the total manpower requirement of 392.

#### 16.3 PROVISION OF ROADS & CULVERTS AND WATER SUPPLY & SEWAGE

For reaching the mine site, an approach road has been proposed in this PR. This road will be about 5.5 km long (7.5 m wide with 2.0 m cycle track) starting from the incline site of this mine Mine to the existing road near Tawa bridge. The alignment of the road will follow the northern & western

boundaries of Tawa & Tawa extn blocks mostly on tenancy land. The same road will also serve as route for coal dispatch from mine site to STPS and incoming double feeder 33kV power supply from Satpura Thermal Power Station.

Service roads for reaching to the sites of air shafts and other service buildings/surface infrastructures are also proposed in this report (length about 1.0 km).

The industrial water demand for departmental option is 2110 KLD, which includes water demand of 1800KLD for Continues miner. The provision for water supply & sewerage arrangement has been kept in the Recast P.R.

## 17.0 MANPOWER, PRODUCTIVITY & TRAINING

The manpower requirement for the proposed Gandhigram U/G Mine has been assessed keeping in view the location of the mine, work culture and work load norms prevalent in nearby mines of the Area. The manpower assessment for CM panels is based on the deployment pattern in mines of Coal India Ltd where similar technology is in operation.

### 17.1 MANPOWER, OMS & MANPOWER PHASING

The proposed manpower, production and productivity for a target capacity of 1.26 Mty for Departmental and P.H Options are tabulated as below:

Sl. No.	Group Name	Departmental Option				Partial Hiring Option			
		Including Welfare		Excluding Welfare		Including Welfare		Excluding Welfare	
		Strength (Nos.)	OMS (t)	Strength (Nos.)	OMS (t)	Strength (Nos.)	OMS (t)	Strength (Nos.)	OMS (t)
1	U/G	485	9.949	485	9.949	274	17.605	274	17.605
2	Surface	118	40.447	103	46.337	118	40.447	103	46.337
	Total	603	7.985	588	8.191	392	12.266	377	12.758

The manpower phasing in the initial years to achieve 1.26 Mty of target production in Departmental & Partial Hiring options of Gandhigram UG mine is tabulated below-

#### Departmental option

Particulars	Yr-1	Yr-2	Yr-3	Yr-4	Yr-5	Yr-6	Yr-7
Manpower (nos)	5	10	40	440	520	603	603

Coal Prodn. (Mt)	-	-	-	0.30	0.68	1.20	1.26
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**Partial Hiring option**

Particulars	Yr-1	Yr-2	Yr-3	Yr-4	Yr-5	Yr-6	Yr-7
Manpower (nos)	5	10	40	330	360	392	392
Coal Prodn. (Mt)	-	-	-	0.30	0.68	1.20	1.26

In partial hiring option, operations in all the 3 CM districts like continuous miner / shuttle car/ feeder breaker/ twin boom roof bolters etc will be done on hiring. Coal transport up to the gate belt, mine ventilation arrangements including installation/shifting of devices also come under the purview of hiring.

**17.2 TRAINING:**

Since mechanization with CM technology has been proposed, training should be imparted either by machine manufacturer or at other mines of WCL /CIL, where this technology is in operation.

For other jobs, services of nearest VTC will have to be utilized. Supervisory training may be imparted at Supervisory Training Institute, Chhindwara.

**17.3 TRANSPORT OF PERSONNEL**

No residential accommodation is proposed near the inclines. The work force will continue to reside in the townships of Pathakhera and Shobhapur. Since the distance of these townships from the inclines of Gandhigram U/G mine will be nearly 15 kms, 3 buses have been proposed for transport of workforce.

An approach road to the incline site (about 5.50 km long) has also been proposed for access to the mine site from the existing road near Tawa bridge.

**18.0 SAFETY & CONSERVATION****18.1 DEGREE OF GASSINESS**

The coal seams in the proposed Gandhigram U/G mine are expected to be 'Degree-II' gassy seams. It is necessary that gassiness of the seams should be ascertained just after touching coal seams. Regular gas survey should be carried out as per statute. Adequate provision of chemical type self generating oxygen self rescuers has been made to enable everybody to carry it underground. Provision has been made in the report for methanometer &



other appliances related with mine environment for regular monitoring of methane in the mine. Provision of 3 sets of Continuous Gas Monitoring Systems for parameters such as CH<sub>4</sub>, CO, other noxious gases, airflow, O<sub>2</sub>, etc. has been made in this report. Stone dust barriers have to be provided as per statute.

Development should be done using auxiliary fans for providing adequate quantity of air up to the faces. Interlocking of auxiliary fans with face machinery should be practiced. All possible precautions should be taken while working near dyke affected zones so that accumulation of inflammable gas does not take place in the working faces.

## 18.2 INUNDATION

Dagdaga nalla forms the western boundary of the proposed mine. This nalla flows in spate during the monsoon season. The HFL along the course of Dagdaga nalla in the block has not been recorded anywhere. The inclines of Gandhigram U/G mine have been positioned at 445.0 m RL which is far away from the nalla and there fore no danger to the mine entries from this nalla is perceived. Detailed survey of the incline site is not done so far. Hence it is suggested that a detailed survey of the locality be carried out before fixing the site of inclines. If necessary the direction of inclines may be changed to suit the local topography. Development in all coal seams shall be restricted to safe distance from the eastern bank of Dagdaga nalla as per the provisions of related Regulations & Circulars . During extraction stage, the developed pillars falling within safe distance from the nalla shall be left intact.

A careful assessment of the danger of inundation from surface water should be made before the onset of every rainy season and adequate precautions against such danger should be clearly laid down and implemented. The seams shall be extracted in descending order after ensuring that the caved goaves of upper seam(s) are free from any water accumulation. When work is being done in lower seam under the settled goaf of upper seam, all useful information including the position, extent and depth shall be acquired and kept recorded and a scheme of working designed to prevent irruption of water shall be prepared and put into operation.

## 18.3 DUST SUPPRESSION

Dust suppression spray is an integral part of Continuous Miners. Most Continuous Miners use water for the cooling of electric motors. This water is discharged at the cutting head and coal loading "spade", as a fine spray to further suppress dust from cuttings. Clean water should be provided to the Continuous Miner through separate pipes. Continuous Miner should be equipped with Dust Scrubber to remove as much dust as possible.

## 18.4 FIRE & SPONTANEOUS HEATING

The incubation period of coal seams in the operating mines of the Area has been assessed as 18 months. No instance of spontaneous heating in belowground has been reported in any mine in Pathakhera Area so far. The average thickness of the 3 seams are less than 2.5m in this block. Entire seam thickness shall be extracted. The extraction of pillars would commence from the dip most side panel (north end) and proceed towards the rise side panels (south side) of each seam. Preparatory stoppings shall be kept ready in the devt. headings at the out-bye end of the sub-panel so that in case of outbreak of any U/G fire, the sub-panel can be abandoned and sealed-off by constructing fire stoppings in the minimum possible time.

Since extraction of coal by caving has been proposed, cracks may appear on the surface. Cracks have to be sealed with non-carbonaceous debris so that air and water does not enter in the goaf through these cracks. It is also proposed to continuously monitor the environment inside the goaved out areas especially near the isolation stoppings and working areas with the help of continuous environment monitoring system. This will help to keep track of temperature, CO, CO/O<sub>2</sub> ratio, etc., so that appropriate steps to control spontaneous heating/eruption of fire can be taken.

#### 18.5 ROOF CONTROL

Resin encapsulated bolting has been proposed for the CM panels for improving the factor of safety of the bolting system. Dedicated roof bolting machines (Twin boom roof bolters) have been provided for supporting of roof along both main-dips and other panels. Once the main-dips development is complete, the dip most panels in each seam will be developed first and then depillared with Continuous Miner. The average parting thickness between LWS -Bagdona seam -IA seam is from 36m to 52 m. Due to this, subsidence & tensile strain levels would be lesser. The support system (SSR) to be adopted for development and extraction stage shall be based on scientific analysis and approved by DGMS before implementation. While implementation, this approved system shall be strictly adhered to. It is suggested that monitoring of roof movement should be carried out regularly and based on the analysis of roof movement data, the roof bolting pattern would change.

#### 18.6 SUBSIDENCE

The surface topography is hilly in nature and entire area is overlain by Asir Reserve Forest. Subsidence Prediction Studies and Subsidence Management will be of vital importance during implementation to ensure minimum damage to surface. It is anticipated that the forest may not be considerably affected by subsidence due to higher depth. Only the trees falling on the edges of subsidence zones and surface cracks may get tilted or dislodged in the area

where the depth is 200m or less. In order to protect Dagdaga nalla, Gandhigram village from the adverse impact of subsidence, it is proposed to leave a safety barrier in the form of developed pillars below and within safe distance of these surface features.

#### 18.7 GENERAL PRECAUTIONS

Trailing cables of mobile equipment like continuous miner, shuttle car, roof bolter, etc. get cut quite frequently due to various reasons. The cable joints have to be vulcanized. Continuity of insulation of the cable, after every vulcanization should be tested and the insulation resistance recorded.

The efficacy of the twin boom roof bolter is dependent upon using both the bolting rigs simultaneously. The support density envisaged in this report is within the capability of the roof bolters. Quality of roof bolting consumables plays a critical role in the efficacy of roof bolting. Quality control must be exercised at the mine level by carrying out short encapsulation tests etc.

All equipment in the continuous miner package are electro-hydraulically operated. All provisions and guidelines stated in "DGMS Tech. Circular No.1 of 1996 regarding use of high pressure hydraulic hoses in UG coal mines" should be strictly followed.

A Safety Management Plan should be prepared by the Mine Management taking into account the risk involved in various operations and the control measures to be adopted to obviate the risk. While implementation, this plan has to be strictly adhered to.

#### 18.8 CONSERVATION OF COAL

The panels in the proposed Gandhigram U/G mine have been so designed that most of the faults lie along the barrier pillars. Thus these faults act as barriers between panels and minimize loss of coal in panel barriers are expected. Partial extraction methods can be adopted for pillars which are falling within the limits of safety barriers with due permission from DGMS for further conservation of coal. The working panels/pillars have been designed as per the available geological data of Gandhigram geological block. In case of any change in this , these panels/pillars location may also change.

#### 18.9 EXEMPTIONS / RELAXATIONS REQUIRED FROM DGMS

Introduction of high productive continuous cutting technology will require exemptions from certain provisions of Coal Mines Regulation from DGMS. Some of the exemptions specific to the continuous cutting technology are as follows:

- i) As per CMR of 1957, the quantity of air to be provided at LVC of each working panel would be 2.5 cum/min with respect to daily tonne output

of coal . However, the air quantity requirement based on production becomes very high and it is not practicable also to provide this much of air quantity in the mine. As per international standards, each mechanized district should be provided with an air quantity of 25 cum/sec at LVC. Hence exemption from DGMS is sought in such mass production technology mines.

- ii) Working in slices of pillars by Continuous Miner without support.
- iii) Extraction of pillars without installing breaker-line supports in the form of chocks at the goaf edge.
- iv) Corners of the pillars to be rounded to allow easier vehicular access.
- v) Use of two or more number of auxiliary ventilators in a district.
- vi) Permission to deploy lesser number of statutory personnel like Surveyors , Under Managers etc with respect to the production levels as per CMR.

Other exemptions may also be required to get approval for the machinery, equipment, mining system etc.

#### 18.10 SCIENTIFIC STUDIES

It is necessary to undertake the following scientific studies for proper implementation of Gandhigram UG mine Report:

- To undertake Subsidence Prediction Studies to determine the Maximum Subsidence and Maximum Tensile Strain below Forest, Tenancy and Govt. Lands (studies have been done in 2013 on the basis of the earlier Recast PR approved in October-2011
- To undertake the Physico-Mechanical Properties of rocks for designing the support system & to know the caving characteristics of the roof strata. It will be necessary to determine 'Rock Mass Rating' for preparing the Support Plan so that Systematic Support Rules can be framed. This also helps in deciding Cut-out Distance during working.
- To undertake Gas Survey for ascertaining the actual degree of gassiness of the coal seams.
- To undertake Hydro-geological Studies for quantifying ground water and to assess the impact of caving on existing ground water regime.

#### 19.0 ENVIRONMENT MANAGEMENT

Proposed Gandhigram U/G Mine is located in Pathakhera Area of WCL. This is a greenfield project where activities have yet to be initiated. The Ambient Air Quality, Water quality, Noise levels, Flora & Fauna Micrometeorological Data and Socio-Economic status in core and buffer zone will be determined on the basis of Base line data generation for this UG mine.

##### 19.1 IMPACT ON AIR

It is anticipated that levels of various air pollutants will be well under limits.

However, only potential air pollutant will be SPM / Dust. During day to day operations at the mine and coal dispatch road, adequate control measures like water spraying, green belt development, regular cleaning and water sprinkling of coal transportation road, etc. will be adopted so as to minimize generation and propagation of dust.

## 19.2 IMPACT ON LAND USE

The total land base required for the project is 718.073 Ha out of which majority of the mine area is covered by Forest land (628.067 Ha). The remaining land area constitutes 62.496 Ha of Tenancy land & 27.510 Ha of Govt. land. Out of total 718.073 Ha mine area, 622.897 Ha is considered under mining rights. The remaining land area is proposed to be acquired under surface right / all right. The plantation is likely to be carried out along the coal transportation route and no much change is anticipated in the post mining land use pattern.

## 19.3 SUBSIDENCE EFFECTS

Coal extraction with caving has been proposed in Gandhigram U/G Mine. A Subsidence Prediction Study has been conducted for this project in April 2013 (on the basis of the earlier Recast PR approved in October-2011) to assess the nature of subsidence at surface due to mining operation. As per the study, the anticipated maximum subsidence at surface due to working of LWS, Bagdona seam & IA seam were 1.13m, 0.84m & 1.26m respectively. The anticipated max. subsidence over the mining area at the end of 10<sup>th</sup>, 20<sup>th</sup> & 30<sup>th</sup> year of mine operation were 0.9m , 1.13m & 2.63 m. During the end of mine working, the maximum subsidence would be 2.63m which falls under forest area. It is anticipated that, for a surface terrain like Gandhigram block, this level of subsidence may not affect the drainage pattern in the area much. The max.subsidence above tenancy land is likely to be 1.20m with 7.74 mm/m slope and 3.87 mm/m tensile strain. This may reduce the crop yield and water retention capacity of the sub-soil. Gandhigram village as well as Dagdaga nalla are not likely to be affected due to the barrier pillars which are left out.

A fresh subsidence study is to be conducted with the present mine liquidation plan & panel lay-out plan and sufficient capital provisioning is done for that.

## 19.4 CAPITAL REQUIREMENT FOR ENV. PROTECTION MEASURES

Sl. No	Particulars	Amount in Rs (Lacs)
1.	Settling Tank for Mine Discharge	30 .00
2.	Base Line Data Generation	10.00
3.	Land use Mapping by Remote Sensing	8.00
4	Effluent Treatment Plant	10.00

5	Sub-Total	58.00
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In addition to this, a capital requirement of Rs 60.00 lacs is proposed for Continuous Air Quality Monitoring Stations (CAQMS) including land base. Hence, total capital required for the mitigation of environmental impacts due to the mining operations in Gandhigram UG mine works out to 118.00 Lacs.

In addition to the Capital cost , Rs 6.00/ t under revenue head has been kept to cater for Plantation & Green belt development, Environmental Monitoring, Social development , Miscellaneous Pollution control measures etc.

## 20.0 MINE CLOSURE PLANNING

As directed through memorandum No. 55011-01-2009-CPAM of Government of India, Ministry of Coal, Shastri Bhawan, New Delhi dated 27/08/2009, Mine Closure Plan has to be enclosed with all PRs / EMPs. In the Annexure to this memorandum, guidelines for preparing the Mine Closure Plan and assessing the capital cost of mine closure have been specified.

The mine closure activities will include subsidence survey for a period of 3 years after mine closure, filling of subsidence cracks, fencing of caved out area and post-project monitoring for a period of 3 years after mine closure.

The Mine Closure Cost for this Report works out to Rs. 7.84/t. The detailed calculations are tabulated as under:

Total Area of the Gandhigram UG Mine (Ha)	718.073
WPI value as on August 2009 (Base WPI)	129.6
WPI value of current available month (Aug. 2016 -Provisional)	183.1
Ratio of WPI (August 2016 : Aug. 2009)	1.4128
Amount to be considered for underground (Rs. / ha)	100000
<b>Total Mine Closure Corpus Fund (Rs. lacs)</b>	<b>1014.4997</b>
Total life of this mine (excluding land acquisition in years)	29
Annual Mine Closure Corpus Fund as on Aug- 2016 (Rs.lacs)	34.98
Annual Mine Closure Fund at the start of construction activity (Rs lacs)	38.57

Year-wise mine closure cost for Gandhigram UG mine is tabulated below.

Year	Production (Mt)	Amount/Yr (Rs. lacs)	Annual Cost (Rs/t)
Year-1	-	-	-
Year-2	-	-	-
Year-3	-	38.57	-
Year-4	0.30	40.5	13.50
Year-5	0.68	42.52	6.25
Year-6	1.20	44.65	3.72

Year-7	1.26	46.88	3.72
Year-8	1.26	49.22	3.91
Year-9	1.26	51.68	4.10
Year-10	1.26	54.27	4.31
Year-11	1.26	56.98	4.52
Year-12	1.26	59.83	4.75
Year-13	1.26	62.82	4.99
Year-14	1.26	65.96	5.24
Year-15	1.26	69.26	5.50
Year-16	1.26	72.72	5.77
Year-17	1.26	76.36	6.06
Year-18	1.26	80.18	6.36
Year-19	1.26	84.19	6.68
Year-20	1.26	88.4	7.02
Year-21	1.26	92.82	7.37
Year-22	1.26	97.46	7.73
Year-23	1.26	102.33	8.12
Year-24	1.26	107.45	8.53
Year-25	1.26	112.82	8.95
Year-26	1.26	118.46	9.40
Year-27	1.23	124.38	10.11
Year-28	0.84	130.6	15.55
Year-29	0.70	137.13	19.59
Year-30	0.42	143.99	34.28
Year-31	0.10	151.19	151.19
	<b>30.67</b>	<b>2403.60</b>	<b>7.84 (Avg.)</b>

From the above table, it can be seen that the Total Amount of Mine Closure Cost Corpus Fund works out to Rs. 24.0360 Crores .The average mine closure cost will be Rs 7.84/t.

This mine closure cost will be utilized for different activities of Mine Closure of Gandhigram UG mine which includes

- a) Dismantling of structures (Service Buildings, Residential Buildings ,Industrial Structures like CHP, Workshop, Field Substation, Cap lamp room, Haulage, Fan Installation etc).
- b) Permanent sealing of mine entries (inclines mouth and air shafts):
- c) Subsidence Management & Landscaping.
- d) Plantation over the cleared area obtained after dismantling and on other Barren Spaces.
- e) Monitoring / Testing of parameters for three years: Air / Water Quality.

- f) Entrepreneurship development (Vocational / Skill Development ) Training for sustainable income of affected people etc.

## 21.0 LAND REQUIREMENT, R&R PACKAGE & PROJECT IMPLEMENTATION

### 21.1 LAND REQUIREMENT

The total land base required for this project is 718.073 Ha out of which majority of the area is covered by forest land (628.067 Ha). The remaining land area constitutes to 62.496 Ha of Tenancy land & 27.510 Ha of Govt. land. The break-up of land requirement is shown in a tabular form below-

Sl. No.	Particulars	Type of Land	Rights	Area(Ha)
A.	For Infrastructures			
1	Land required for 2 Inclines (Mine Entries), Surface Infrastructure etc	Tenancy	Surface Rights	7.470
2	Land required to protect both the Inclines (50 m from the inclines on both sides outside mining area).	Rev. Forest	Surface Rights	4.170
3	Land required for 2 Airshafts & approach road to these airshafts.	Rev. Forest	All Rights	1.000
Sub-total: A (Area in Ha)				12.640
B.	For Mining Operation			
4	a). Land required for u/g mining operations	Tenancy	All Rights	55.026
	b). Land required for u/g mining operations	Govt.	All Rights	27.510
	c). Land required for u/g mining operations.	Forest	Mining Rights	622.897
Sub-total: B (Area in Ha)				705.433
<b>Total Land Requirement : A+B (Area in Ha)</b>				<b>718.073</b>

The entire Govt. & Tenancy lands falling within the mining area is proposed to be acquired under all rights. However, the forest land has been proposed under mining right only. It is proposed to carry out a subsidence study for the proposed mine area and based on the result of this study, if required, the effected forest land (if any) may be acquired under all rights.

The breakup of total land requirement (718.073 Ha) based on their rights is summarized below-

Type of Rights	Govt. Land (Ha)	Tenancy Land (Ha)	Forest Land (Ha)	Total (Ha)
All Rights	27.51	55.026	1.00	83.536
Surface Rights	-	7.47	4.17	11.64
Mining Rights	-	-	622.897	622.897
<b>Total</b>	<b>27.51</b>	<b>62.496</b>	<b>628.067</b>	<b>718.073</b>



## 21.2 TIME FRAME FOR LAND ACQUISITION & ITS CAPITAL PROVISION

The land required for incline site/surface infrastructures will be completed in first 2 years & inclines/air-shafts drivage etc can be started in 3<sup>rd</sup> year. It is proposed to complete the total land acquisition process in first 4 years .

A capital provision of Rs. 52.3067 Cr has been made for acquisition of land for Gandhigram UG mine as per the Revised R&R Act of 2013. This includes cost of land (Tenancy & Govt.) , one time monetary compensation to the Tenancy land losers (for 50% of total tenancy land) and NPV for Forest Land (including compensatory afforestation charges) etc. The base land rates (Forest land) for proposed Gandhigram UG mine has been taken based on the letter received from Area General Manger, Pathakhera Area (letter no-WCL/PKD/AGM/PLAN/350 dated 12.10.2015. For Tenancy & Govt lands, the land rates considered is based the letter with ref. no. WCL/GM/L&R/949 dated 22.12.2014 by G.M (L&R),WCL. (Enclosed as Annexure-3a & 3b).

The mining operation in this project may not affect the existing Gandhigram village due to higher depth of workings (minimum depth is about 200m). Only development of pillars is proposed beneath this village. In the absence of exact number of families living within the mine area, it has been presumed that the number families is equal to the number of tenancy land plots-which is about 92 numbers. All rehabilitation measures like one resettlement, transportation cost for displaced families, construction of cattle sheds ,one time monetary compensation etc are calculated based on the number of families within the mine area.

One time monetary compensation for the tenancy land losers has been considered for 50% of total families (50% of 92 families -ie 46 families) @ Rs 5.00 lacs /Ha in lieu of employment. For the balance land, WCL may consider to offer employment in lieu of monetary compensation if the land losers are not willing to accept monetary compensation subject to provisions of New Land Acquisition, Rehabilitation & Resettlement Act-2013. The capital for land required for “Integrated Transport & Power Route” has been considered in Mine Developmental activities and detailed in App. A.8.1.

## 21.3 PROJECT IMPLEMENTATION SCHEDULE

### 21.3.1 MAJOR ACTIVITIES LEADING TO ACHIEVEMENT OF CAPACITY

Once the Recast Project Report is approved, the authorities should take up the following major activities leading to the achievement of target production:

- a) EC / FC clearance is to be obtained.
- b) A new EMP may have to be prepared & get approval as per the Recast PR for this Mine for a target capacity of 1.26 Mty (peak capacity of 1.575 Mty) with a total land requirement of 718.073 Ha.
- c) Land Acquisition for Incline /air-shaft site, approach roads etc.

- d) Construction of Approach Road up to Mine Entries Site.
- e) Temporary and Permanent Water & Power Supply Arrangement
- f) Surveying, Locating and Fixing up the Site for Mine Entries.
- g) Tender and Work Award for 2 Inclines and 2 Airshafts.
- h) Drivage of Inclines and Sinking of Airshaft. Installation of belt / haulage along inclines.
- i) Construction of Fan Drift, Fan House and Installation of Main Fan.
- j) Establishing ventilation connection between the Inclines and Airshafts and Commissioning of Main Mechanical Ventilator.
- m) Once the Inclines touch the floor of LWS during the end of 3<sup>rd</sup> year , all the mine developmental activities will be followed as described in this report earlier- at 7.5 “MINE DEVELOPMENT STRATEGY”.

The detailed Liquidation plan including other developmental activities are given in tabular form in para 9.1 “Mining Schedule”. The time frame for the major activities leading to achievement of target capacity is shown in the Harmonogram (Plate No-VIII).

The average advance rate for drivage of inclines, open cutting and drifting etc is considered as 55-60m/month . For sinking of airshafts , the rate of advance considered would be about 20 m/month.

### 21.3.2 PRODUCTION SCHEDULE

Considering that the proposed Recast PR for Gandhigram UG Mine will be approved by WCL in 2016-17, the 1<sup>st</sup> year of this Project will be 2017-18. The gestation period of the mine has been assessed as 3 years- ie from 2017-18 to 2019-20. This period will be devoted to land acquisition, EMP Approval and other preparatory jobs like incline/airshaft drivages.

The coal production starts during 4<sup>th</sup> year (2020-21) with 1 set of CM package in LWS. Second CM district will be introduced during 5<sup>th</sup> year in Bagdona Seam. 3<sup>rd</sup> CM district will be introduced during 6<sup>th</sup> year in LWS. The target coal production will be achieved during 7<sup>th</sup> year & this production level will continue till 26<sup>th</sup> year of mine operation. Production tapering starts from 27<sup>th</sup> year till 31<sup>th</sup> year (life of mine).

## 22.0 FINANCIAL EVALUATION

### 22.1 GENERAL

- a) The Recast Project Report for Gandhigram U/G Mine proposes to work by Mechanized Bord & Pillar method using Continuous Cutting Technology with caving method. The target capacity of the mine has been envisaged as 1.26 Mty (about 4200 tpd) from 3 Continuous Miner districts .
- b) Yearly avg. grade of coal in Gandhigram UG project has been assessed as ‘G-5 to G-8’ in different years of mine life considering all in-seam bands

irrespective of thickness and nature. The weighted avg. grade of coal during the entire life of the mine works out to G-6 (5620 K.Cal/Kg).

- c) The economics has been worked out on two options namely Departmental Option and Partial Hiring Option in this report.

## 22.2 ACTIVITIES PROPOSED FOR HIRING IN PARTIAL HIRING OPTION

The following main activities related to production from a continuous cutting machine package proposed to operate in a district to produce 1.26 Mty have been envisaged for Outsourcing / Hiring in Partial Hiring Option. This is in addition to the development and extraction of main-dips/trunk headings with Continuous Cutting technology including coal production, coal loading onto belt conveyor , roof supporting, extension of ventilation appliances etc.

- (1) Procurement, supply, operation and maintenance of 3 sets of Continuous Cutting Machine package and indigenous equipment in the district including supply of spares, consumables and lubricants.

Each set of Continuous Cutting Machine package includes 1 low height Cutting Machine, 2 Shuttle Cars, 1 Feeder Breaker, 2 Twin Boom Roof Bolters, Electrical Equipment for the same including 3.3/1.1 kV FLP Transformer, Trailing Cables, DAC Communication, Spares Parts etc.

- (2) Coal preparation by continuous cutting, loading and transport of coal up to the gate belt in panels except main-trunks/main-dip.
- (3) Roof support using resin encapsulated roof bolts with W-straps as per the approved support system and supply of roof bolting consumables including drill rods and bits for the bolter as per the quality and quantity requirement.
- (4) Extension of ventilation ducting and cleaning of path of shuttle cars and loading and un-loading points. Coordination with the Mine Management regarding extension of gate belt, cables, etc. and operation and maintenance of equipment as per the permissions granted by DGMS or any other Competent Authority. All operations in the district shall be carried out under the control and supervision of the Mine Management.
- (5) Supply of electricity from the 3.3/1.1 kV transformer and 3.3 kV/ 550 V transformer to various equipment operating in the district..
- (6) Supply of clean water from near gate belt tail end to the point of use.
- (7) DGMS permission has to be obtained for the proposed equipment, proposed method of mining and any other required permissions.
- (8) Construction of ventilation and isolation stoppings etc.
- (9) Supply, operation and maintenance of face pumps etc.
- (10) Any Scientific Investigations if required by DGMS.
- (11) Coal Production as per the Proposed Target.

(12) Any other activities required to be fulfilled by the bidder.

### 22.3 CAPITAL INVESTMENT

The economics of the mine has been worked out on two options namely Departmental and Partial Hiring Options.

The following table shows the Total Capital Investment under the major heads in Departmental and Partial Hiring Options in Recast Project Report for Gandhigram U/G Mine prepared in September-2016:

A/C Head	Particulars	Capital Investment (Rs. Lacs)	
		Dept. Option	P.H. Option
01	Land	5230.67	5230.67
02	Buildings:		
	a) Service Buildings	700.35	700.35
	b) Residential Buildings	424.00	305.00
03	Plant & Machinery	47790.54	14670.34
04	Furniture & Fittings	25.00	25.00
05	Railway Siding	-	-
06	Vehicles	11.68	11.68
07	Prospecting & Boring	736.33	736.33
08.1	Capital outlay in mines	8728.56	8724.74
08.2	Roads & Culverts	720.15	720.15
08.3	Water Supply & Sewerage	943.48	943.48
08.4	EMP & PR Preparation Cost	383.12	383.12
08.4 (A)	Env. Pollution Control Measures	118.00	118.00
08.5	Scientific Research Costs	200.00	200.00
09	Net Rev. Expenditure. Capitalized during development period	1171.21	1184.68
	<b>Additional Capital Investment</b>	<b>67183.09</b>	<b>33953.54</b>

The total Capital requirement in Departmental & Partial Hiring options of the proposed Recast PR for Gandhigram UG Mine works out to Rs 671.8309 Cr & Rs 339.5354 Cr respectively.

### 22.4 FOREIGN CAPITAL

The total foreign exchange requirement including customs duty, port handling cost, inland transportation, etc. for the imported equipment of 3 sets of Continuous Cutting Machine Package in Departmental Option works out to Rs. 314.0022 crores considering exchange rate of 1 US \$ = Rs. 67.09, which was the ruling rate as on 25.08.2016.

There is no foreign capital provision involved in this report in Partial Hiring Option as the package equipment is to be brought and operated by a contractor to produce the target coal production.

## 22.5 BASIS OF PRICES OF P&M & CIVIL WORKS

The pricing of Plant and Machinery is based on the Standard Price List of June 2015 (escalated up to September: 2016) circulated by the Underground Mining Division of CMPDI (HQ), Ranchi. The cost of Civil Works has been estimated on the basis of Civil Cost Index 511 for Madhya Pradesh in 2<sup>nd</sup> half of 2016.

## 22.6 ESTIMATION OF HIRING COST IN PARTIAL HIRING OPTION

Continuous cutting machine is not being operated departmentally in any of the underground mines of Coal India Ltd. till now. Either the Continuous cutting machine package has been operated in CIL mines on Risk / Gain Sharing Basis or on Hiring Basis. Till now, norms with respect to productivity and elements of cost of production to operate Continuous Cutting Machine Package on hiring basis are not available.

The matter regarding the methodology of estimating Outsourcing Cost to operate Continuous Cutting Machine Package on Hiring was discussed at CMPDI (HQ) for a project. In absence of break-up of all the elements of hiring rate for recently awarded mines to estimate the hiring rate for deployment of Continuous Cutting Technology on hiring basis, it was advised to consider the latest Outsourcing / Hiring Cost of Continuous Cutting Machine Package operating at Pinoura U/G Mine / Vindhya U/G Mine of Johila Area, SECL with due Escalation / Updation. The Pinoura Contract involved the support cost during depillaring including withdrawal of already installed Bolts as the panels offered to the contractor are already developed with B&P method of mining.

However, the hiring cost of Rs 1489.00/t has been considered to operate CM package in the proposed Gandhigram UG mine. This rate is based on the Letter of Intent issued for introduction of CM package on hiring basis at Kairaha UG mine of SECL for Rs 1489.00/t. The same hiring cost has been quoted recently for Global Bid document for introduction of CM package at Tawa-II UG mine of WCL .

## 22.7 OPENING OF REVENUE ACCOUNT

The norms for bringing Coal Projects into Revenue Account, as decided in the meeting held under the chairmanship of JS & FA on 9/6/04 are as follows:

- 1) Revenue Expenditure to be capitalized should be net of Sales Receipts of Coal produced during the construction period.

- 2) The period of construction has to be defined, to determine the Commercial Readiness of the Project to yield on a sustainable basis.
- 3) In case of Opencast Projects, the volume of OB removal and in case of UG Projects, the completion of required developmental activities during the above period of construction have to be clearly defined.
- 4) Based on the above, the capitalization of revenue expenses / opening of revenue account will be decided.

Accordingly, a definition of the term “ Commercial Readiness “ of a project has been drafted and based on this, a norm for capitalization of revenue expense / opening of revenue expenditure of a project has been suggested as under:

#### COMMERCIAL READINESS:

An underground project will be treated to have reached the stage of commercial readiness to yield production on sustainable basis from the year when all the following criteria have been achieved:

- i) Minimum essential mine development works like drivage of main inclines / adits / drifts / shafts etc., installation of winding arrangements & ventilation arrangement, pit top and pit bottom transport arrangements as required for attaining targeted coal production as per project report have been constructed and commissioned.
- ii) In case of projects with B&P method of mining, underground workings have adequately progressed and adequate number of main mining equipment have been commissioned to enable opening of the first development panel.
- iii) Construction of CHP and railway siding has been completed or adequate alternative arrangement for sizing and dispatch of coal have been commissioned for the project.
- iv) The land required for the project (up to target year) has been acquired.

All the required approvals, land acquisition, drivage of inclines and sinking of airshaft for proposed Gandhigram U/G Mine will take 3 years time to bring the proposed mine into commercial readiness for production on sustainable basis. Most of the infrastructural facilities like Approach Road, CHP, Workshop, Service Buildings, Power Supply, Water Supply and other developmental activities required for mine operation are likely to be completed by then. Therefore, Gandhigram U/G Mine will have cash surplus in the first year of touching coal, i.e., 4<sup>th</sup> year of mine operation and the mine is proposed to come into Revenue from 4<sup>th</sup> Year.

## 22.8 COMPLETION CAPITAL

The expected completion capital for Gandhigram U/G Mine works out to Rs. 731.0968 Crores in Departmental option and Rs. 387.4162 Crores in Partial Hiring option.

## 22.9 MANPOWER & O.M.S.

The manpower requirement of the mine in Departmental Option works out to 603 & 508 including and excluding the welfare manpower respectively. In Partial Hiring option, the manpower requirement of the mine including the welfare manpower works out to 392 and 377 excluding the welfare manpower.

The overall OMS of the mine in Departmental option works out to 7.985 t (including the welfare manpower) & 8.191 t (excluding the welfare manpower).

The overall OMS of the mine in Partial Hiring option works out to 12.266 t (with welfare manpower) & 12.758 t (without welfare manpower).

#### 22.10 E.M.S.

The EMS calculated as per CMPDI norms for Departmental & P.H options works out to Rs. 2561.49 and Rs. 2652.88 respectively for September-2016, which are considered for determining economics in this report.

#### 22.11 UNIT COST OF PRODUCTION

The following table shows the Cost of Production of both the options:

Sl. No.	Particulars	Cost of Production at 100%	
		Departmental Option (Rs./t)	Partial Hiring Option (Rs./t)
1	Salaries and Wages	333.39	226.53
2	Stores	304.81	77.91
3	Power	261.06	196.67
4	Environment Pollution Control	6.00	6.00
5	Miscellaneous Expenses (incl. W/D)	76.40	65.99
6	Mine Closure Cost	7.84	7.84
7	Administrative Overhead	187.22	187.22
8	Hiring / Outsourcing Cost	-	1489.00
9	Depreciation	461.32	175.28
10	Interest on Working Capital @ 14.50%	48.64	100.86
11	Interest on Loan Capital @ 11.50%	66.00	33.00
	<b>Total Cost of Production</b>	<b>1752.68</b>	<b>2566.30</b>

The Cost of Production in Departmental Option at 100% and 85% levels of capacity utilization works out to Rs. 1752.68/t and Rs. 2001.14/t respectively. The Cost of Production in Partial Hiring Option at 100% and 85% levels of capacity utilization works out to Rs. 2566.30/t and Rs. 2707.96/t respectively.

In Stores Cost given in the above table, the Repair and Maintenance Cost consists of two parts namely (i) Face and transport equipment, i.e., direct plant & machinery and (ii) Other P&M such as Electrical equipment,

Workshop, CHP, Stowing, Pumping and Miscellaneous equipment. In Partial Hiring Option, the Repair & Maintenance Cost has been worked out excluding the capital provision for Continuous Cutting Technology Packages.

The Repairs & Maintenance Cost has been treated as 60% fixed cost and 40% variable cost and is determined on the following norms:

- i) 20% of annual depreciation of direct P&M, i.e., equipment required for coal preparation, loading, support, ventilation, safety and transport of coal up to the incline mouth and material up to the working face.
- ii) 2% of capital cost of other equipment, i.e., equipment deployed in CHP, Workshop, Pumps & Pipe Fittings, Electrical & Communication and Miscellaneous equipment.

During the Technical Sub-Committee Meeting held for Project Report of Tawa-II Expansion U/G Mine on 28-05-2010, it was directed by the committee mainly to include Maintenance Service Rate (on MARC pattern) in Departmental Option as WCL has no expertise in operating Continuous Miner departmentally. But, recently a meeting was held in the chamber of Director (Tech) (P&P), WCL on 18.09.2015 in which it was decided to work out economics of U/G Mines on Departmental Option considering operation and maintenance of C.M. Package by WCL on its own as this technology is no longer new for WCL/CIL. (See Annexure IV).

Accordingly, the store cost for Recast P.R. for Gandhigram U/G Mine (September-2016) has been worked out with Repair & Maintenance Cost of all P&M including C.M. Package departmentally and considered in the cost of production. The store cost for this project works out to Rs 304.81/t & Rs 77.91/t for departmental & partial hiring options respectively.

## 22.12 GRADE OF COAL & WEIGHTED AVERAGE SELLING PRICE

The annual grade of coal dispatch during its total life of the mine varies from grade 'G-5' to 'G-8' as per GCV depending upon the location of working panels and seams. During the initial years, coal grade is mainly G-6. The weighted average grade of coal during the entire life of mine works out to 'G-6' (with GCV of 5620 K.Cal/Kg). The weighted average sale value considering 98.5% of the year-wise grade of coal and Rs. 79/t as processing charge for dispatching (–) 100 mm size coal works out to Rs. 2285.36/t and Rs. 2703.30/t for Power Sector and Non-Power Sector respectively.

## 22.13 CAPITAL INVESTMENT, PROFITABILITY & IRR

The Total Capital Investment, Cost of Production, Profitability, IRR and Desired Selling Price to yield 12% IRR at 100% and 85% target capacity in Departmental and P.H Options (September-2016) is tabulated below:



Sl. No.	Parameters	Departmental Option		Partial Hiring Option	
		100%	85%	100%	85%
1	Total Capital Investment ( Rs Cr.)	671.8309		339.5354	
2	Total Cost of Production (Rs./t)	1752.68	2001.14	2566.30	2707.96
3	Average Selling Price (Power)	2285.36			
4	Profit / Loss for Power Sectors	(+) 532.68	(+) 284.22	(-) 280.94	(-) 422.60
5	I.R.R. for Power Sector (%)	(+) 18.99	<b>(+) 12.55</b>	(-) ve	(-) ve

## 22.14 CONCLUSION

In this Recast Project Report for Gandhigram U/G Mine, the Financial Evaluation has been worked out on two options namely Departmental and Partial Hiring Options as on September-2016, which is enumerated below:

### 22.14.1 DEPARTMENTAL OPTION

Total capital requirement estimated for Gandhigram UG Mine estimated to Rs. 671.8309 Crores in Dept. option. The Cost of Production works out to Rs. 1752.68/t & Rs. 2001.14/t at 100% & 85% target capacities respectively.

With an average sale price of Rs. 2285.36/t for Power Utilities, Fertilizer & Defence Sectors etc the mine is expected to make a profit of Rs 532.68/t & Rs 284.22/t at 100% & 85 % target capacities respectively.

The I.R.R. at 100% & 85 % target capacity are (+) 18.99% and (+) 12.55% respectively for Power Sector in this option.

This project is achieving more than 12% IRR at 85% target capacity for Power Sector in Departmental option. Hence the Recast P.R for Gandhigram UG Mine (including Mining Plan) may be approved by the competent authority for a target production capacity of 1.26 Mty (with Peak production capacity of 1.60 Mty for EMP/E.C) and with a capital investment of Rs 671.8309 Cr in Departmental option.

### 22.14.2 PARTIAL HIRING OPTION

Total capital requirement estimated for Gandhigram UG Mine estimated to Rs. 339.5354 Crores in Partial Hiring option. The Cost of Production works out to Rs. 2566.30/t & Rs. 2707.96/t at 100% & 85% target capacities respectively.

Power Sector

With an average sale price of Rs. 2285.36/t for Power Utilities, Fertilizer & Defence Sectors etc , the mine is expected to make a loss of Rs 280.94/t & Rs 422.60/t at 100% & 85 % target capacities respectively.

The Desired Selling Price to yield 12% IRR at 100% and 85% target capacity in P.H Option works out to Rs. 2609.03/t and Rs. 2758.23/t respectively. The I.R.R. at 100% & 85 % target capacities are (-) ve in this option.

Non-Power Sector

With an average sale price of Rs. 2703.30/t for Non-Power Sector, the mine is expected to make a profit of Rs 137.00/t at 100 % target capacity & a loss of Rs 4.66/t at 85 % target capacity.

The Desired Selling Price to yield 12% IRR at 100% and 85% target capacity in P.H Option works out to Rs. 2609.03/t and Rs. 2758.23/t respectively. The I.R.R. at 100% & 85 % target capacities are (+) 15.32 % & (+) 9.74% respectively.

The project is not achieving 12% IRR at 85% target capacity for both Power as well as Non-Power Sectors in Partial Hiring option.

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