INTRODUCTION

A. The mining lease over 64.463 Ha in village Kaliapani for chrome ore was executed in favour of M/s Ispat Alloys Ltd (Now known as Balasore Alloys Limited) for 30 years w. e. from 17.07.2000. (Copy of the lease deed is at **Annexure – 1)**.

B. As per CCOM, Circular No 2/2010 and its addendum regarding geo-reference mining lease map and ML boundary pillars is being conducted by ORSAC and shall be intimated to IBM after receiving. Undertaking in this regard is at **Page - ii**.

C. Environmental clearance for the project **(Annexure – 2)** has been received from MoEF, New Delhi with an annual production capacity of 0.6 MTPA of Chrome ore by opencast to opencast and underground including mining of blocked pillars in open pit mines by Drift and Fill mechanized mining method.

D. Consent to operate the mine for opencast and underground mining has been obtained from SPCB Odisha **(Annexure – 3)** for production of 0.60 MTPA per year of Chrome ore.

E. Details of surface right obtained.

Concerned Authority issuing Surface Right	Letter No & Date	Area over which SR is Granted	Annexure
District Collector, Jajpur	3480/2000/31.07.2000	158.44 Ac/64.119 Ha	**4**
District Collector, Jajpur	8273/Mines/03.08.2011	0.85 Ac/0.344 Ha	

F. There are two continuous chrome ore bands running NE – SW dipping northeasterly have been proved in detail so far in the lease area. Band – I of the mining lease is being worked for chrome ore and ROM above threshold limit as communicated by IBM is being produced to the tune of 3.5 lakh tonnes (maximum). Chrome ore above 40% Cr2O3 grade ore is directly dispatched to company's Charge Chrome Plant at Balgopalpur in Balasore District of Odisha. Mineral Rejects with 10 to 40% Cr2O3 is subjected to beneficiation in the 20 tph capacity COBP of the company inside the lease. As far as the record of COBP the output product is about 39% by volume of chrome concentrate with the grade range of 48% to 51% Cr2O3. By product such as middling are recovered to about 50 % by volume and balance 11% by volume waste as tailing is recovered which analyses 9.59 to 9.79 % Cr2O3, which is below threshold limit.

G. The present scheme of mining, approved by IBM expires on 31.03.2015. As per provision in MCDR 1988, the scheme of mining for next 5 years (2015-16 to 2019-20) is submitted for approval of competent authority of IBM.

H. The company does not have any other executed mining lease in the State of Odisha or country as on date. An area over 35.537 Ha to the south of the area under discussion has been granted and approved mining plan, forest & environmental clearance obtained and submitted to State Govt., which is in process for order for execution.

INTRODUCTORY NOTES

1.0	**General**		
	(a)	**Name of applicant**	Sri Sankar Gagopadhyay, Vice President, Balasore Alloys Ltd., Constituted Attorney, on behalf of the lessee M/S Balasore Alloys Ltd. (Enclosed – Resolution by the Board, Identity Proof – **Annexure - 5**
		Rule 45 registration no	IBM/62/2011
		Address	Kaliapani Chrome Mine; Village – Kaliapani and Post - Kaliapani
		District	Jajpur,
		State	Odisha.
		Pin code	755 047
		Phone	-
		Fax	-
		Mobile No	-
		Email id.	mail@balasorealloys.com
	(b)	**Status of applicant/lessee**	Public Limited Company
	(c)	**Mineral(s) which is / are included in the prospecting license (For Fresh grant)**	Not applicable
	(d)	**Mineral(s) which is / are included in the letter of Intent / lease deed**	Not applicable
	(e)	**Mineral(s) which is the applicant / lessee intends to mine**	Chrome Ore

	(f)	**Name of Recognized Person under rule 22C of MCR,1960 or a Person employed under clause (c) of Sub rule (1) of rule 42 of MCDR, 1988 (Applicable for Scheme of Mining only) preparing Mining Plan**	
	(i)	**Name**	Sri Prem Prakash **Annexure -6**
		Address	M/s Balasore Alloys Limited; Fortune Towers, 1st floor, Chandrashekherpur, Bhubaneswar
		District	Khurda
		State	Odisha
		Pin code	751 015
		Phone	-
		Fax	-
		Mobile No	07381095973
		Email id.	p_prakash@balasorealloys.com
		Registration No	RQP/BBS/023/2000/A
		Date of Grant	11.05.2010
		Valid upto	10.05.2020
	(ii)	**Name**	Sri Prem Shankar Acharya, **Annexure -6**
		Address	GEMTECH Consultants Pvt. Ltd,, A/10, HIG, 1st Floor, Baramunda Housing Board Colony, Bhubaneswar
		District	Khurda
		State	Odisha
		Pin code	751003
		Phone	(0674) 2355154
		Fax	**-**
		Mobile No	09437008179
		Email id.	**Gemtech_consultant@yahoo.co.in**
		Registration No	RQP/NGP/027/87/A
		Date of Renewal	10.12.2009
		Valid upto	09.12.2019

	(iii)	**Name**	Sri Sunil Madhab Patro, **Annexure -6**
		Address	GEMTECH Consultants Pvt. Ltd, A/10, HIG, 1st Floor, Baramunda Housing Board Colony, Bhubaneswar - (Odisha)
		District	Khurda
		State	Odisha
		Pin code	751003
		Phone	(0674) 2355154
		Fax	-
		Mobile No	09861093020
		Email id.	Gemtech_consultant@yahoo.co.in
		Registration No	RQP/CAL/175/93/A
		Date of Renewal	19.04.2011
		Valid upto	18.04.2021
2.0	**Location and accessibility**		
	(a)	**Lease Details (Existing Mine)**	
		Name of mine	Kaliapani Chrome Mine
		Lat/long of any boundary point	Pillars A - N21°02'05.8"/ E 85°45'29.24", F - N21°01'40.55"/ E85°46'28.24", D - N21001'33.05"/ E85°46'16.17" and G - N21°02'11.16"/ E 85°46'07.83".
		Date of grant of lease	17.07.2000
		Period/Expiry Date	16.07.2030
		Name of lease holder	Balasore Alloys Ltd.
		Postal Address	Kaliapani Chrome Mine; Village – Kaliapani and Post – Kaliapani, District – Jajpur, Postal Code - 755 047 (Odisha)
		Phone	**-**
		Fax	**-**
		Mobile No	**-**
		Email id	Sukinda_mines@balasorealloys.com & mail@balasorealloys.com

<table>
<tr><td></td><td>(b)</td><td colspan="4">Details of lease area with location map over 64.463 Ha</td></tr>
<tr><td></td><td></td><td>Forest</td><td colspan="3">Non forest</td></tr>
<tr><td></td><td></td><td rowspan="3">Nil</td><td>Non forest (specify)</td><td>Area (Acre)</td><td>Area (Ha)</td></tr>
<tr><td></td><td></td><td>Waste land (Patharbani)</td><td>158.440</td><td>64.119</td></tr>
<tr><td></td><td></td><td>Road (Rasta)</td><td>0.850</td><td>0.344</td></tr>
<tr><td></td><td></td><td>Total lease area</td><td colspan="3">159.290 Acre or 64.463 Ha</td></tr>
<tr><td></td><td></td><td>District & State</td><td colspan="3">Jajpur (Odisha)</td></tr>
<tr><td></td><td></td><td>Taluka</td><td colspan="3">Sukinda</td></tr>
<tr><td></td><td></td><td>Village</td><td colspan="3">Kaliapani</td></tr>
<tr><td></td><td></td><td>Whether the area falls under Coastal Regulation Zone (CRZ)? if yes, details</td><td colspan="3">No</td></tr>
<tr><td></td><td></td><td colspan="4">Existence of public road/railway line, if any nearby and approximate distance</td></tr>
<tr><td></td><td colspan="5">The area lies in the South-Western quadrant of the survey of India topo sheet No. 73 G/16. The Tomka-Mangalpur an all weathered tar road passes almost along the northern lease boundary. This road connects the area with Jajpur- Keonjhar Road, the nearest rail head on the South- Eastern Railways via-Mangalpur as well as Tomka. At Tomka it joins with the express highway (Daitari -Paradeep) and via-Duburi to Jajpur Road the total distance is 57 kms. The distance via- Mangalpur where it joins MDR-25 (Jajpur road-Kamakhyanagar) to Jajpur road is 60.0 kms. (Plate No - 1).</td></tr>
<tr><td></td><td>(c)</td><td colspan="2">Toposheet No. with latitude & longitude of all corner boundary point/pillar</td><td colspan="2">Survey of India Topo Sheet No.-73 G/16.
Pillars A - N21°02’05.8”/ E85°45’29.24”,
Pillar F - N21°01’40.55”/ E85°46’28.24”,
Pillar D - N21°01’33.05”/ E85°46’16.17” and
Pillar G - N21°02’11.16”/E 85°46’07.83”.</td></tr>
<tr><td></td><td>(d)</td><td colspan="2">Attach a general location map showing area and access routes. It is preferred that the area be marked on a Survey of India topographical map or a cadastral map or forest map as the case may be. However, if none of these are available, the area may be shown on an administrative map.</td><td colspan="2">Plate No - 1. Attached</td></tr>
</table>

3.0	**Details of approved mining plan / scheme of mining (if any)**	
3.1	Date and reference of earlier approved mining plan and scheme of mining and their modifications	
(i)	MP for execution with development & production planning for the period of 2000-01 to 2004 – 05 under Rule 22 of MCR-1960	314(3)/9/MCCM/(C)/MP, Dated 20.04.2000 & 13.09.2000
(ii)	Modification to the approved Mining Plan with development & production planning for the period of 2000-01 to 2004 – 05 under Rule 10 of MCDR-1988	314(3)/2003-CCM/(C)/MP-17, dated 10.09.2004
(iii)	Scheme of Mining for period of 2005-06 to 2009-10 under Rule 12 of MCDR-1988	314(3)/2003/MCCM/(C)/MP-17 dated 15. 12.2005
(iv)	Modification of approved scheme of mining for period of 2008-09 to 2009-10 under Rule 10 of MCDR-1988	314(3)/2008-MCCM (Z)/MS-17 dated 25.11.2008.
(v)	Scheme of Mining for period of 2010-11 to 2014-15 under Rule 12 of MCDR 1988	314(3)/2010-CCM(CZ)/MS-02 dated 18.05.2010
(vi)	Modification of approved scheme of mining for period of 2012-13 to 2014-15 under Rule 10 of MCDR 1988	314(3)/2010-CCM(CZ)/MS-11 dated 17.12.2012
(vii)	Modification to approved modified scheme of mining for period of 2013-14 to 2014-15 under Rule 10 of MCDR 1988	MSM/FM/32-ORI/BHU/2013-14, Dated 25.07.2014

3.2 Details of last modification (for previous approved period) of approved mining plan / scheme of mining, indicating the date of approval, reason of modification.

(i) Second scheme of mining for 5 years w. e. from 2010-11 – 2014-15 under rule 12 of MCDR along with review of mining activities for the period of 2005-06 to 2009-10 was approved by IBM on 18.05.2010 which for the first time was modified under rule 10 of MCDR 1988, for the following reason.

- Incorporate underground mining along with opencast mining in the lease area.
- The review of work for 2010-11 and 2011-12 was done in this modification and the same was approved by IBM on 17.12.2012 with the objectives of : -
- Interest in mineral conservation
- Interest of protection of environment and
- Captive use of minerals.

This modification to approved modified scheme was approved on 17.12.2012

(ii) The above modified scheme of mining was again modified under rule 10 of MCDR 1988 and was approved by IBM on 25.07.2014. reasons for modification was as follows.

- Interest in mineral conservation
- Interest of protection of environment and
- Captive use of minerals.

3.3 Review of earlier approved proposal in respect of exploration, excavation, reclamation etc.

Last approved scheme of mining and their modifications was for the period of the scheme period 2010-11 to 2014-15. Proposed exploration, excavation and reclamation etc in different phases that was approved in the scheme of mining, modified in subsequent modifications of the scheme are reviewed para wise as below.

(i) Exploration

Form "J" submitted to IBM at different phases are at **Annexure - 7**. The drill cores have been analyzed and kept in a bound register in the mine office in form "K" and placed at **Annexure -8.** Year-wise borehole proposal and achievement is as follows.

Proposal

Year	Reference Number of BH	Proposed Depth (m)	Location (Coordinate)	Collar (mRL)/ Angle/ Bearing (Degree)
2010-11	No Proposal			
2011-12	No Proposal			
2012-13	PBH/1	370	N (-)850/ E (-)1234	135/130/69
	PBH/2	510	N (-)903/ E (-)1300	141/131/72
	PBH/3	330	N (-)806/ E (-)1068	137/125/62
	PBH/4	370	N (-)866/ E (-)1153	138/130/59
	PBH/5	360	N (-)900/ E (-)1031	144/131/59
2013-14	PBH/6	150	N (-)654/ E (-)1034	135/127/70
	PBH/7	130	N (-)695/ E (-)1104	91/125/67
	PBH/8	120	N (-)723/ E (-)1196	71/129/61
	PBH/9	130	N (-)756/ E (-)1255	87/130/61
	PBH/10	130	N (-)769/ E (-)1329	85/130/61
	PBH/11	420	N (-)694/ E (-)1122	138/127/82
2014-15	PBH/12	127.0	N (-)362/ E (-)1031	163/124/65
	PBH/13	160.0	N (-)453/ E (-)1261	165/124/65
	PBH/14	220.0	N (-)366 / E (-)1030	167/124/80
	PBH/15	360.0	N (-)451/ E (-)1321	176/128/84

Achievement

Year	Reference number of BH	Proposed depth (m)	Location (Coordinate)	Collar (mRL)/ Bearing (Degree)/ Angle
2011-12 2011-12	BH 1 Ore Band I	551.2	N845-E1151	139/130/75
	BH 2 Ore Band I	411.5	N574-E1290	112/310/62
	BH 3 Ore Band I	334.5	N606-E1112	84/310/72
	BH 4 Ore Band I	184.0	N755-E1392	104/150/80
	BH 5 Ore Band I	206.0	N751-E1373	104/150/75
	BH 6 Ore Band I	164.0	N745-E1382	104/150/80
	BH 7 Ore Band II	186.30	N426-E1312	175/125/75
	BH 8 Ore Band II	260.5	N355-E1142	180/130/88
	BH 10 Ore Band I	85.00	N593-E1042	123/235/50
	BH 11 Ore Band I	950.50	N816-E1069	138/140/88
	BH 13 Ore Band II	473.00	N493-E1261	130/143/84
	BH 14 Ore Band I	941.50	N834-E1251	139/139/90
	BH 15 Ore Band II	1040.0	N507-E1137	121/142/90
2012-13	BH16 Ore Band I	513.0	N774-E1064	136.294/125/80
	BH17 Ore Band I	370.0	N823-E1226	137.37/131/69
	BH18 Ore Band I	150.0	N651-E1020	138/130/65
	BH19 Ore Band I	130.0	N671-E1101	88.41/133/67
	BH20 Ore Band I	131.0	N732-E1247	86.25/130/61
	BH21 Ore Band I	428.5	N774-E1235	117.381/130/83
	BH22 Ore Band II	161.4	N328-E1034	73.617/129/61
	BH23 Ore Band II	180.0	N429-E1253	168/129/61
	BH24 Ore Band II	220.0	N328-E1034	169/124/80
	BH25 Ore Band I	120.0	N699-E1188	73.617/129/61
	BH26 Ore Band I	130.00	N745-E1334	82.762/131/59
	BH27 Ore Band I	365.0	N666-E1026	130.121/127/82
	BH28 Ore Band I	330.0	N788-E1091	127.712/125/62
	BH29 Ore Band I	370.0	N843-E1144	137.37/130/59

Year	Reference number of BH	Proposed depth (m)	Location (Coordinate)	Collar (mRL)/ Bearing (Degree)/ Angle
2012-13	BH30 Ore Band I	360.0	N868-E1284	137.864/131/59
	BH31 Ore Band I	510.0	N871-E1284	137.76/131/72
	BH32 Ore Band II	210.0	N426-E1324	168.70/128/86
	BH33 Ore Band II	222.00	N454-E1380	155.107/131/59
	BH34 Ore Band I	90.0	N704-E1226	67.56/80/59
	BH35 Ore Band I	116.0	N715-E1325	67.785/148/80
	BH36 Ore Band I	70	N650-E1205	61.758/329/59
	BH37 Ore Band I	127	N626-E1164	67.97/329/59
2013-14	BH38 Ore Band I	68	N 643- E1125	65.743/245/59
	BH39 Ore Band I	89	N 647- E1122	65.291/270/58
Four holes proposed to be drilled during 2014-15 have been drilled and incorporated in last approved re-modified scheme of mining				

(ii) Mine development

Year-wise mine development proposal and achievement is as follows.

Proposal

Reference	Year	LCuM			
		OC	BPM	Conventional UG	Total
SoM for 2010-11 to 2014-15, approved vide IBM Letter No 314(3)/2010-CCM(CZ)/MS-02 dated 18.05.2010	2010-11	18.579	0.000	0.000	18.579
	2011-12	1.948	0.000	0.000	1.948
Modification of approved SoM 2012-13 to 2014-15 314(3)/2010-CCM(CZ)/MS-11 dated 17.12.2012	2012-13	8.891	0.000	0.134	9.025
	2013-14	13.130	0.381	0.381	13.892
Modification of modified approved SoM 2013-14 to 2014-15 MSM/FM/32-ORI/BHU/2013-14, Dated 25.07.2014	2014-15	9.639	0.313	0.313	10.265
Total		**52.187**	**0.694**	**0.828**	**53.709**

Achievement

Reference	Year	LCuM				
		OC	BPM	Conventional UG	Total	% Achieved
Annual Return	2010-11	7.284	0.000	0.000	7.284	39.21%
Annual Return	2011-12	5.564	0.000	0.000	5.564	285.63%
Annual Return	2012-13	5.046	0.000	0.000	5.046	55.91%
Annual Return	2013-14	6.361	0.000	0.000	6.361	45.79%
Office Record	2014-15 (till 28.02.2015)	8.589	0.000	0.000	8.589	83.67%
Total		**32.844**	**0.000**	**0.000**	**32.844**	**61.15**

Reason for deviation, if any

From the above figures it is seen that every year except the 2nd year of present scheme period there is less development, reason being – Availability of space for OB/waste removal, besides proportionate less ore production, there was deviation in OB/waste removal to the tune of about 39%.

(iii) Production of chrome ore (ROM)

Year-wise production proposal and achievement is as follows.

Reference	Year	Proposal in LT			
		OC	BPM	Conventional UG	Total
SoM for 2010-11 to 2014-15, approved vide IBM Letter No 314(3)/2010-CCM(CZ)/MS-02 dated 18.05.2010	2010-11	5.600	0.000	0.000	5.600
	2011-12	3.600	0.000	0.000	3.600
Modification of approved SoM 2012-13 to 2014-15 314(3)/2010-CCM(CZ)/MS-11 dated 17.12.2012	2012-13	2.223	0.000	0.000	2.223
	2013-14	2.678	0.043	0.043	2.764
Modification of modified approved SoM 2013-14 to 2014-15 MSM/FM/32-ORI/BHU/2013-14, Dated 25.07.2014	2014-15	3.500	2.050	0.100	5.650
Total		**17.601**	**2.093**	**0.143**	**19.837**

Reference	Year	Achievement in LT				
		OC	BPM	Conventional UG	Total	% achieved
Annual Return	2010-11	2.442	0.000	0.000	2.442	43.61%
Annual Return	2011-12	1.665	0.000	0.000	1.665	46.25%
Annual Return	2012-13	1.429	0.000	0.000	1.429	64.28%
Annual Return	2013-14	2.079	0.000	0.000	2.079	75.22%
Office Record	2014-15 (till 28.02.2015)	2.836	0.000	0.000	2.836	50.19%
Total		**10.451**	**0.000**	**0.000**	**10.451**	**52.68%**

Reason for deviation, if any

From the above figures it is seen that every year except the 4th year of present scheme period there is less production of ore to the tune of about 47%. Reason for this was due to slight increase of ore recovery percentage.

3.4 Violations received from IBM authority and compliances

	Violations Received during 2011-12	
2011-12	**IBM Letter reference**	**BAL Reply reference**
	ORI/CR/JJP/MCDR-13/ BBS Dated 05.07.2012 **(Annexure –9A)**	BAL/Mines/311 Dated 16.07.2012 **(Annexure 9B)**
2012-13 & 2013-14	Dr M. K. Somani Sr. Mining Geologist issued a letter No ORI/Cr/JJP/MCDR-13/ BBS dated 17.01.2013 **(Annexure-10 A)** under rule 13 (1), 23 (E) (2) and 29 of MCDR 1988. RCOM issued a letter No ORI/Cr/JJP/ BBS dated 20.05.2013 on the observations from the compliances submitted by BAL dated 20.05.2013. **(Annexure – 10A)**	The compliance to these two letters of IBM Bhubaneswar had been submitted by M/s BAL vide it's Letter dated 04.07.2013 & 17.04.2013 (**Annexure –10 B)**
2014-15	ORI/RECL/BBS-2014/2082 Dated 01.09.2014, Violation of provisions of MCDR,1988 in respect of Kaliapani Chromite Mines over an area of 64.463 ha **(Annexure – 11 A)**	BAL/Mines/286 & 287 Dated 16.09.2014 (**Annexure – 11B)**

3.5 Indicate and give details of any suspension/ closure/ prohibitory order issued by any Government agency under any rule or Court of law:

No suspension / closure / prohibitory orders have been issued by any Government agency during the last scheme period.

3.6 In case the MP/SOM is submitted under rules 9 and 10 of MCDR'88 or under rule 22(6) of the MCR, 1960 for approval of modification, specify reason and justification for modification under these rules:

The Scheme of Mining for the period from 2015-16 to 2019-20 is being submitted under rule 12 of MCDR, 1988 for approval of the authorities.

3.7 Other Information

(i) Detail of boundary Description and Land Schedule as per the executed lease deed is as below.

BOUNDARY DESCRIPTION – Topo sheet No 73 G/16 - Scale 1:50,000

The station 'N' of M/s TISCO Ltd over 406 Ha has been taken as the reference point of the area. The station 'N' is also the starting station 'A' of M/s Ispat Alloys Limited and is situated at a distance of 2111.802 m or 6928.484. it on a F.B of 59° 20'00" from station 'A' of M/s TISCO Ltd over 406 Ha which in turn is situated at distance of 1128.496m or 3702.414 ft on a F.B of 108°36'54" from district boundary pillar No.38 of Jajpur and Dhenkanal district as shown in the plan. From station 'A' the traverse line starts and runs in anti-clock wise direction as follows.

BOUNDARY DESCRIPTION OF LEASE BOUNDARY (Annexure – 1)

Pillar No	Latitude	Longitude
A	N-21 °02' 05.8"	E-85° 45' 29.24"
A1	N-21° 02' 03.55"	E-85° 45' 30.75"
A2	N-21 °01' 57.0"	E-85° 45' 34.3"
B	N-21° 01' 50.69"	E-85° 45' 39.47"
B1	N-21° 01' 53.60"	E-85° 45' 44.29"
B2	N-21° 01' 57.4"	E-85° 45' 50.5"
C	N-21° 02' 01.49"	E-85° 45' 57.09"
C1	N-21° 01' 53.5"	E-85° 46' 02.7"
C2	N-21° 01' 47.74"	E-85° 46' 06.32"
C3	N-21° 01' 40.4"	E-85° 46' 11.9"
D	N-21° 01' 33.05"	E-85° 46' 16.17"
E	N-21° 01' 36.43"	E-85° 46' 21.43"
F	N-21° 01' 40.55"	E-85° 46' 28.24"
F1	N-21° 01' 46.05"	E-85° 46' 24.6"
F2	N-21° 01' 54.7"	E-85° 46' 19.0"
F3	N-21° 02' 03.7"	E-85° 46' 12.8"
G	N-21° 02' 11.16"	E-85° 46' 07.83"
G1	N-21° 02' 07.7"	E-85° 46' 00.9"
G2	N-21° 02' 02.79"	E-85° 45' 53.18"
H	N-21° 01' 57.62"	E-85° 45' 44.11"
H1	N-21° 02' 01.17"	E-85° 45' 41.74"
I	N-21° 02' 09.82"	E-85° 45' 35.91"

LAND SCHEDULE - Revenue Village- Kaliapani (Annexure – 1)

SL	Plot No	Khata No	Tenant	Area in acres	Kissam
1	887(P)	55	Abadajogya Anabadi	1.97	Patharbani
2	888(P)	55	Abadajogya Anabadi	31.68	Patharbani
3	889(P)	55	Abadajogya Anabadi	26.50	Patharbani
4	890(P)	55	Abadajogya Anabadi	1.08	Patharbani
5	892(P)	56	Sarbasadharana	0.85	Road
6	893(P)	55	Abadajogya Anabadi	19.10	Patharbani
7	894(P)	55	Abadajogya Anabadi	78.11	Patharbani

PART - A

1.0 GEOLOGY AND EXPLORATION

(a) Topography, drainage pattern, vegetation, climate and rainfall data of the mining lease area described as follows.

(i) Topography

The Chromite deposits of sukinda ultramafic complex is the 3rd largest in the world coming next only to south Africa and Rhode sin so far as the reserve is concerned. The Balasore Alloys limited has mining leases over 64.463 Ha in this valley which has been shown in the **Plate No - 1**, with reference to Toposheet in 1 : 50000 Scale. The area under consideration is potentially rich in chromite ore. Systematic evaluation of the deposit commenced since 1960 in the chrome valley and the reappraisal of chromite resources was carried out by G.S.I. during 1974-76. Since 2000 after grant and execution of the lease Balasore Alloys Ltd started detailed geological mapping and core drilling in order to assess the resources. The area exhibits a peneplained topography marked by linearly disposed mounds of low relief. The line of subsequent and obsequent slopes are not very well defined. Waxing faces are more prominent than the winning faces. The maximum elevation in the area is 182 mRL whereas the minimum elevation is 121 mRL. The overall slope is from South-East to North-West **(Plate No - 3).**

(ii) Location and accessibility

The area lies in the South-Western quadrant of the survey of India topo sheet No. 73 G/16. The Tomka-Mangalpur all weathered tar road passes almost along the northern lease boundary. This road connects the area with Jajpur- Keonjhar Road, the nearest rail head on the South- Eastern Railways via-Mangalpur as well as Tomka. At Tomka it joins with the express highway (Daitari - Paradeep) and via-Duburi to Jajpur Road the total distance is 57 kms. The distance via-Mangalpur where it joins MDR-25 (Jajpur road-Kamakhyanagar) to Jajpur road is 60.0 kms. **(Plate No - 1).**

(iii) Drainage

The Damsal Nala flowing towards south-west is the main drainage system of the area and is 700 m away from the lease area in N-W direction. It can be categorized in to a stream of 5th order which is seasonally fed by several streamlets and gullies. One perennial stream to the S-E adds as a tributary to damsal nala. The run-off water collected by streamlets and damsal nala finally discharges into the river Bramhani at a distance of about 30 kms.

(iv) Climate

The area experiences a hot humid sub-tropical climate of a greater part of a year. It is quite hot in the summer months whereas considerable cold is felt in the winters. The annual variation of temperature highest of 47°C in summer to a lowest of 8.5°C in the winter. This extremity of warmth and cold is due to the proximity of high hills.

(v) Rainfall

The area receives a maximum rainfall of 465 mm. during the month of august and the minimum rainfall recorded in the month of February is nil mm.

(vi) Vegetation

The area is thinly vegetated. Sal, Mahul, Asan etc. dominate among the species. The other varieties include Dhaura, Katau and few Fruit bearing trees like Mango, Jackfruit, Kendu etc. Atundi dominate among the shrubs.

(b) Brief description of Regional Geology with reference to location of lease area.

(i) The sukinda ultramafic complex forms a part of the unfossiliferous metamorphosed pre-cambrians of peninsular India. It is associated with the sedimentary sequences in parts of Keonjhar, Cuttack and Dhenkanal districts of Orissa studied by G.H.S.V. Prasad rao et al. six sequences separated by unconformities have been deciphered in this region. The sukinda ultramafites come in the second sequence of the succession and occur as instrusives. The succession is given in the following table.

Sixth Sequence	Granite Intrusive Contact Shale, Carbonaceous shale, lava & tuff, Conglomerate, Sandstones
	---------- Unconformity ----------
Fifth Sequence	Gabbro, Ultrabasic and Dyke swarms, Quartzite, Conglomerate
	---------- Unconformity ----------
Fourth Sequence	Manganese bearing Shale Banded Hematite Jasper, Shale
	---------- Unconformity ----------
Third Sequence	Gabbri and ultrabasic (intrusive), Lava and Interbedded Grits, Conglomerate, Grit, Sandstone
	---------- Unconformity ----------
Second Sequence	Granit & Granit Gneiss Granophyre, Gabbro and Ultrabasic with Chrome Load Banded Hematite Quartzite, Banded Hematite Jasper, Conglomerate, Ferruginous Shale and Phyllite
	---------- Unconformity ----------
First Sequence	Metavolcanics, Chlorite Schist, Quartzite, BHQ, Mica Schist, Fuchsite Quartzite

The stratigraphic succession given by K.L. Chakrabarty, T.L. Chakrabarty and tapan mazumdar (1980) fin table-2 has been quoted for comparative study.

Stratigraphic Succession (K.L.Chakraborty, et. Al.)

	Alluvium
	Laterite (Nickeliferous at places)
	Dolerite
	Granite and Granite gneiss
	Orthopyroxenite (enstatites)
	Ultramafic with chromite lode
	Sandstone (Quartzarenite) kolhan Group (?)
	Conglomerate
---------- Unconformity ----------	
Iron ore group	Banded iron formation with inter banded volcanic tuff and alternation product quartzite with intraformational Conglomerate

Basement Not Exposed

The host rocks of ultramafites include contrasted types of metamorphic associations. North of latitude 21°00' in topo sheet 73 G/12 and 16 the ultramafites occur either as concordant emplacements within green schist facies quartzites (e.g. sukinda mass) or as disjointed pendants floating in biotite hornblende granite (e.g. kathpal mass). In contrast the ultramafites occurring south of latitude 20°56' are sporadically distributed within granulite facies assemblages (P.K. Banerjee, 1972). Systematic geological mapping has established that the granulite facies rocks immediately south of latitude 20°56' mark the northern fringe of the Mahanadi valley charnochite-khondalite association in this area while the low grade metamorphites north of latitude 21°00' are the southern outposts of iron ore stage of Bihar and Orissa. Thus the ultramafic cluster is located near the contact between two different stratigraphy-tectonic provinces.

(ii) Lithology

The ultramafic rocks along with the associated chromite ore bodies are intrusive into the lower sequence of rocks. In sukinda area these rocks are extensively lateritised and except for the main pyroxenite band all the rock types lie under a thick cover of lateritic soil.

The ultimafic body is a layered complex composed of alternate bands of chromite. Chromite, dunite, peridotite and orthopyroxenite repeated in a rhvthmic manner.

The dunite and peridotite rocks are almost wholly serpentinised. In dunite skeletal crystal of olivine lies within the ground mass of serpentine variety. In peridotite both skeletal crystal of olivine and pyroxene are present. The orthopyroxene is almost monominerallic and composed mostly of enstatite (P.K. Banerjee) with miner olivine (R.N. Pattanaik)

The presence of numerous chert vein close to the chromite body and the cross cut relations it bear with chromite band and ultramafics is a distinctive feature.

The ultramafics are intruded by dolerite dykes which after weathering altered to montmorillonits. Small exposure of granite- granophyres are seen at southern base of mahagiri intruding in to quartzites.

The hornblende granite exposed to the west of sukinda ultramafic body is medium grained and shows a granophyric texture at places. This also contains innumerable pods and pocket shaped inclusions of ultramafic rocks associated with chromite.

(iii) Structure

In Daitari- Mahagiri area the lower sequence of the iron ore super group has been folded into a broad syncline plunging low (10^{o}-15^{o}) towards WSW. The ultramafic rocks have intruded into this sequence as a laccolith and then subsequently co-folded with them. The whole group of rocks was then affected by two parallel faults coinciding with the southern and northern margins of the ultramafic body. The main ultramafic body along with the sedimentary apron was uplifted while both the side blocks were down thrown. This horst with a continued period of denudation over millions of years has given rise to the present day configuration of the Damsal valley.

These two faults are located at the north of the Mahagiri range and south of Daitari range which trend in ENE-WSW direction. In the proximity of the faults the sedimentary beds are almost vertical sheared, milonitized and silicified. The ultramafic rocks are sheared near these faults and are schistose at places. The chromite bands stretched and separated as boudins. The pod like occurrence of chromite along the southern foothills and base of Mahagiri range evidently represent these boudins.

The northern limb of the fold extends in a linear fashion in WNW-ENE direction from daitari hill in the west to the east of ramchandrapur upto kusari river. The southern limb of the fold is cross folded in a NW-SE axis and extends from Sukinda Pankapal Siaria, Bandhagoda and finally meets the northern limb near Kusai River (R. N. Pattanaik, 1972)

The beds of the northern limb dips towards south the amount of dip varying from 50^{o} to almost vertical. Due to cross folding the amount and direction of dips of the southern limb varies but the general dip is towards north.

(iv) Mineralization

The chrome ore mineralization is strictly confined to the ultramafics and occurs at six different stratigraphic levels Band-I is continuous for a greater distance and is thickest all the chromite lodes. It bears a gradational contact with the wall rock. The ultramafics in the form of veins do occur in many places within the chromite lode.

(c). Detailed description of geology of the lease area such as shape and size of the mineral / ore deposit, disposition of various litho-units indicating structural features if any etc. (Applicable for Mining plan for grant & renewal and not for scheme of Mining / Modification in the approved Mining Plan / Scheme of Mining)

The proposal submitted is for Scheme of Mining for the period of 2015-16 to 2019-20. So, this para is not applicable.

(d) (i)	**Name of prospecting /exploration agency**	In-house Geology Division having 8 geologists, three surveyors, two chemists, headed by Sri Tarini Prasad Mohanty
(ii)	**E mail address**	tarini_mohanty@balasorealloys.com
(iii)	**phone no**	7381096053
(e)	**Details of prospecting/exploration already carried out**	
(i)	**Number of pits and trenches indicating dimensions, spacing etc along and across the strike/foliation with reference to geological plan**	
	No pit and trench have been done in the lease area.	

(ii)	**Number of boreholes indicating type (Core/RC/DTH), diameter, spacing, inclination, Collar level, depth etc with standard borehole logs duly marking on geological plan/sections.**						
No of boreholes	**Ore Band**	**Type of hole**	**Size**	**Spacing (m)**	**Inclination (degree)**	**Collar level (mRL) Max - Min**	**Depth (m) (Min – Max)**
30	BAND-I	Core	PQ, HQ, NQ	50 to 100	Inclined hole	139-84	71.00-941.50 mt.
09	BAND-II	Core	PQ, HQ, NQ	50 – 200	Inclined hole	180-121.20	161.40-1040.00 mt.
02 (PS & SS)	Balance area	Core	PQ, HQ		Vertical hole	177.77-176.71	560-640

(iii)	**Details of samples analysis indicating type of sample (surface/sub-surface from pits/trenches/borehole etc) Complete chemical analysis for entire strata for all radicals may be undertaken for selected samples from a NABL accredited Laboratory or Government laboratory or equivalent. Entire mineralized area may be analyzed meter wise with 10% of check samples. (At least for 10% of total samples may be analyzed in accordance to BIS and reports from NABL accredited/other government laboratory).**

Core drilling is being undertaken through drilling agencies from the start of exploration in the lease area. 41 numbers of holes drilled (Borehole No 01 to 41) till 2014-15 From borehole number (01 to 08 holes) core drilling were done by M/s AOSL. Borehole number 01 to 33 were done by M/s Maheswari Mining (P) Ltd. Subsurface samples from borehole cores for the ore zone and 6 m to either side of the mineralized core are drawn by in house geology division and analyzed in a laboratory accredited by NABL, i.e. SGS Hyderabad. Some samples were analyzed by XRF in the plant laboratory, Balasore. Depending upon lithology and run of the core, samples were drawn after splitting the cores into two equal halves. The core length of each sample varies depending on the lithology. In case the same lithology continues samples are drawn for the entire length of core. In other cases 1 m long samples for ore drawn. Samples are mostly analyzed for the major components i.e. Cr_2O_3, FeO and SiO_2. Assay values of each sample were incorporated in the section plans along the core lines and different bands and ore bodies were demarcated. A total of 41 number of boreholes were drilled till date with running meterage of 12128.70 m. About 1899 numbers of core samples for entire mineralized zone were drawn & 1899 numbers of samples analyzed principally for Cr_2O_3, FeO and SiO_2. Out of this 41 holes have been core drilled during last 5 years of approved scheme period with total cumulative meterage of 12128.70 m. Number of samples drawn is 1899 out of which 124 number of samples are analyzed for Cr_2O_3 in departmental laboratory for Cr_2O_3 etc. 10% of total scheme period samples were check analyzed for confirming the reliability of the results in a NABL accredited Laboratory. In addition 239 samples from core and mineral reject are analyzed for Cr_2O_3, Feo, Al_2O_3, SiO_2,CaO, MgO and LOI. **(Annexure - 12)**. Filled in form "K" is attached as **Annexure - 8.**

(iv) **Expenditure incurred in various prospecting operations.**

A total of 41 numbers of boreholes have been drilled by outside agencies (Borehole number 1 to 41). Details of agencies and cost involved for core drilling in lease area is as below.

Year	Agency engaged for core drilling	Meterage drilled	Core Drilling per m Rate (Rs)
2011	M/s AOS Ltd.	2307.30	3800/- per meter Average
2012	M/s Maheswari Mining (P) Ltd. 21 CLM Lane Raniganj-713347	3670.50	4500/- per meter Average
2013	M/s Maheswari Mining (P) Ltd.21 CLM Lane Raniganj-713347	6150.5	4500/- per meter Average
Total:		**12128.70**	

Copies of work order issued & payment release to drilling agencies are enclosed as **Annexure - 13.**

(f) **The surface plan of the lease area may be prepared on a scale of 1: 1000 or 1: 2000 with contour interval of maximum of 10 m depending upon the topography and size of the area duly marked by grid lines showing all features indicated under Rule 28(1)(a) of MCDR 1988**Based on the topographical survey of the area, surface plan of the lease area has been prepared on 1:2000 scales with contour interval of 5 m and grid lines at 100 m interval. All surface features as indicated under rule 28(1) of MCDR, 1988 have been marked in the Surface plan (**Plate No - 3**).

(g) **For preparation of geological plan, surface plan prepared on a scale of 1: 1000 or 1: 2000 scale specified under para 1.0 (f) of Part A of the format may be taken as the base plan. The details of exploration already carried out along with supporting data for existence of mineral, locations proposed exploration, various litho-units along with structural features, mineralized/ore zone with grade variation if any may be marked on the geological plan along with other features indicated under Rule 28 (1) (b) of MCDR 1988.**

Geological plan of the lease area has been prepared on 1:1000 scale taking the surface plan as the base plan **(Plate- 4)**. The exploration already carried out, proposed exploration to be undertaken, litho units with structural features, ore zone etc have been marked on the geological plan along with other features indicated under rule 28(1) of MCDR, 1988.

Name of the Mineral - CHROMITE								
Sl No	**Name of the Lease & Owner**	**Total Lease Area**	**Chromite Bands**	**Lease area explored as per UNFC norms (in HA) C =D+E+F+G**				**Remarks/Comments including reasons for not carrying out as per UNFC norms**
				G1 Level	**G2 Level**	**G3 Level**	**Other Lease Area/Unexplored area**	
A	**B**	**C**		**D**	**E**	**F**	**G**	**H**
1	Kaliapani Chromite Mines, M/S Balasore Alloys Limited	64.463 Ha	Band-I	Up to (-) 768 mRL	Up to (-) 818 mRL	Up to (-) 868 mRL	NIL	Sukinda Chromite deposits is principally Statiform in nature and as per GSI six Chromitite seams locally known as Bands have been reported from the area. In Kaliapani Chromite Mines Lease area consists of two Bands namely Band-I & Band-II only.
			Band-II	Up to (-) 322 mRL	Up to (-) 900 mRL	Up to (-) 950 mRL	NIL	

(h) Geological sections prepared on natural scale of geological plan at suitable interval across the lease area from boundary to boundary.

07 numbers of geological cross sections of the acquired area within the mining lease have been prepared on 1:2000 scales at every 50 m interval from boundary to boundary. Two longitudinal sections have also been prepared in 1:2000 scales.

(i) Future program of exploration with due justification

Exploration by way of deep boreholes on a regular grid pattern is given in the lease area by which both Band – 1 and band – II have been proved. In ore Band – 1 out of 27 holes 26 holes have proved ore. In ore Band – 2 out of 9 holes 8 holes have proved ore. Area covered by exploration by way of drilling is 36.58 Ha within lease area of 64.463 Ha. Deepest borehole on Band – 1 is 950.50 m and it is 1040 m in band II. So, ultimate level upto which ore has been assessed in Band – 1 and Band – 2 is (-) 768 mRL and (-) 900 mRL respectively. There is no proposal to put borehole from surface in order to proving ore during the proposed scheme period. Only definition drilling shall be carried out to prove the ore body limit after development of underground drives in Band- I & II. However further exploration of Band-II may be carried out in 50 meter grid pattern from (-) 160 & (-) 240 mRL by putting Horizontal bore holes.

PBH No	Location Co-ordinate	Collar mRL	Proposed Drilling Depth in (m)	Drilling to be completed
1	1350/710	(-) 160	270	2018-19
2	1300/700	(-) 160	260	2018-19
3	1250/685	(-) 160	250	2018-19
4	1200/670	(-) 160	270	2018-19
5	1150/650	(-) 160	260	2018-19
6	1100/635	(-) 160	260	2018-19
7	1050/630	(-) 160	230	2018-19
8	1350/700	(-) 240	250	2019-20
9	1300/680	(-) 240	230	2019-20
10	1250/670	(-) 240	230	2019-20
11	1200/650	(-) 240	250	2019-20
12	1150/635	(-) 240	230	2019-20
13	1100/620	(-) 240	230	2019-20
14	1050/610	(-) 240	210	2019-20
Total			**3430**	**2 years**

(j) Reserves and Resources as per UNFC with respect to threshold value notified by IBM (Area explored under different level of exploration may be marked on the geological plan and UNFC code for area considered for different categories of reserve/resources estimation may also be marked on geological cross sections). Feasibility study report along with financial analysis for economic viability of the deposit as specified under the UNFC field guide lines is incorporated.

Reserves Estimated in the last approved modification to last modified scheme of mining under UNFC classification is as below. (As on 01.04.2013 – Refer Para 3.7.11 Page 36 of modified scheme approved on 25.07.2014)

Category of Reserves		Band-I	Band-II	Total	Code
A	**Mineral Reserve in million tonnes**				
1	Proved Mineral Reserve	18.74	4.79	23.53	111
2	Probable Mineral Reserve	0.97	0.27	1.24	122
Total Mineral Reserves A		**19.71**	**5.06**	**24.77**	
B	**Remaining Resources in million tonnes**				
1	Feasibility Mineral Resource	6.35	1.76	8.11	211
2	Prefeasibility Mineral Resource	0.48	0.40	0.88	221
3	Measured Mineral Resource	0	0	0	331
7	Indicated Mineral Resource	0	0	0	332
5	Inferred Mineral Resource	0	0	0	333
6	Reconnaissance Mineral Resource	0	0	0	334
Total Remaining Resources B		**6.83**	**2.16**	**8.99**	
Total of A + B		**26.54**	**7.22**	**33.76**	

Depletion of Reserve

During 2013-14 and 2014-15 (by 28.02.2015) about 0.492 MT chrome ore have been depleted (0.208 MT in 2013-14 and 0.284 MT by 28.02.2015 of 2014-15 have already been depleted. There has been no depletion of reserves from ore Band – II. These are tabulated below. No BPM (a technique of underground mining) or conventional underground mining as was proposed could be started, due to late approval of environmental clearance and non-availability of consent to operate.

Remaining Reserves Category wise updated at the start of Scheme of Mining from 2015-2020 as per UNFC Code

Calculation is based on the reserves as 01.04.2013 (-) reserves depleted during 2013-14 and 2014-15. Total depletion is 0.552 MT from opencast working within proved limitations. So, resource available **as on 01.04.2015** is as below.

Category of Reserves		Band-I	Band-II	Total	Code
A	**Mineral Reserve in million tonnes**				
1	Proved Mineral Reserve	18.188	4.790	22.978	111
2	Probable Mineral Reserve	0.970	0.270	1.240	122
Total Mineral Reserves A		**19.158**	**5.06**	**24.218**	**111 + 122**
B	**Remaining Resources in million tonnes**				
1	Feasibility Mineral Resource	6.350	1.760	8.11	211
2	Prefeasibility Mineral Resource	0.480	0.400	0.88	222
3	Measured Mineral Resource	0	0	0	331
7	Indicated Mineral Resource	0	0	0	332
5	Inferred Mineral Resource	0	0	0	333
6	Reconnaissance Mineral Resource	0	0	0	334
Total Remaining Resources B		**6.830**	**2.160**	**8.990**	**221+222**
Total of A + B		**25.988**	**7.22**	**32.208**	**111 + 122 + 221 + 222**

(k) Detail calculation of Reserves/Resources section wise.

While preparing the modification to the modified scheme of mining which was approved on 25.07.2014, the reserve of Band-I and Band – II was estimated based on the ore body intersection through 37 numbers bore holes **(Refer Para 3.6 Page – 24 modified scheme approved on 25.07.2014)** coupled with data collected from the geological mapping of the quarry. In Band-I two numbers of holes (BH-38 and BH – 39 as shown in geological plan) were drilled which encountered ore. Two holes in the south and east boundary drilled for production and service

shaft resulted with no ore (BH logs of 4 hole **Annexure –14**). In the last scheme of mining complete analyses of all completed holes were not available. In due course of time after approval of last scheme results of complete analyses were received which have been in corporate in the proposed scheme of mining. As such there is additional reserves which have been accounted in resource & reserves estimation considering the complete analyses reports. Accordingly the reserves & resources are up dated. In case of Band-II, it was also proposed in para 3.8 Page – 39 **(Refer modification to modified scheme approved on 25.07.2014)** to drill eight numbers of holes in the year 2014-15 to an aggregate length of 745 m to explore ore band – II. These proposed holes could not be completed till 30.09.2014 because of active mining zone for bench extension. So, there will be no effect on the resources and reserves estimated as on 01.10.2014 **(modification to modified scheme approved on 25.07.2014).** In this case also due to reanalyzes of cores of drill holes ore dissemination in both the sides of band has been accounted in Resource & Reserves estimation.

(l) Mineral Reserves/Resources, estimated based on level of exploration with reference to threshold value of mineral declared by IBM

Level Of Exploration	Band-I		Band-II	
	Number of holes drilled where ore has been intersected	Proved Level (mRL)	Number of holes drilled where ore has been intersected	Proved Level (mRL)
G1	26 (density of drilling 50m x 50 m)	Up to (-) 768	7 (density of drilling 50m x 50 m)	Up to (-) 322 mRL
G2	50 meter Influence Taken below G2 Level	Up to (-) 818	1	(-) 372 mRL
G3	50 meter Influence Taken below G2 Level	Up to (-) 868	50 m Influence Taken below G2 Level	Up to (-) 422 mRL

Resource and Reserves within lease may be arrived after applying results feasibility study and economic evaluation of deposits based on various factors such as

a) Mining method, recovery factors, mining losses etc
b) Cutoff grade, Ultimate pit depth proposed
c) Mineral/Ore blocked due to benches, barriers and pillars.

Updated Resources and Reserves Re-estimated in the leasehold area in different ore patches and categories. Parameters considered for calculation of up dated resources and reserves are as below.

	Parameters considered for calculation of resources and reserves
(a)	As per guidelines of IBM threshold value of iron ore is considered as 10% Cr2O3 and calculation of resources and reserves is done for 10-40% and > 40% as mineral reject and ore are considered respectively.
(b)	The ore zones are re - plotted considering additional disseminated Chrome ore in both sides of the main Chrome ore zone of Band-I & II in completed boreholes. In respective cross sections these are connected to arrive sectional area in sq.m. of mineralized zone. The percentage of recovery for mineral rejects, ore and intermediate burden are calculated to arrive at resources/reserves.
(c)	The sectional area in sq.m. of that particular section multiplied with the influence between 2 conjugative sections (half way on either side of a section) the volume of ROM is arrived in CuM.
(d)	To arrive at the quantity (tonnage) of ROM a factor 3.0 and 3.5 is accounted in ore reserves calculation for friable and Hard ore respectively. Once the reserves are estimated recovery factor of mineral rejects and ore are applied to arrive at quantity of Mineral rejects and ore separately.
With the above parameters the following formula is adopted	

Tonnage	=	SA x d x Sp. Gr.
Where SA	=	Area of cross section (sq.m.)
D	=	Linear distance (i.e. influence of a particular section in m).
Bulk Density	=	3.0/3.5 (CuM to tonnes insitu Chromite) Refer IIT Report **(Annexure-28)**

(a) Band-I

(i) Calculation of Geological Ore Resources updated as on 1.04 2015 (BAND – I) from (+) 2 mRL to (-) 768 mRL (G1 Category)

Friable							**Hard**						
Sec	**Area (sq.m.)**	**Influ (m)**	**Volume (CuM)**	**BD**	**Qty (t)**		**Sec**	**Area (sq.m.)**	**Influ (m)**	**Volume (CuM)**	**BD**	**Qty (t)**
A A'	3966	67	265722	3	797166		A A'	12430	67	832810	3.5	2914835
B B'	4710	61	287310	3	861930		B B'	13573	61	827953	3.5	2897836
C C'	4596	33	151668	3	455004		C C'	16133	33	532389	3.5	1863362
D D'	5816	50	290800	3	872400		D D'	11672	50	583600	3.5	2042600
E E'	7440	57	424080	3	1272240		E E'	12653	57	721221	3.5	2524274
F F'	7914	41	324474	3	973422		F F'	11110	41	455510	3.5	1594285
G G'	13615	96	1307040	3	3921120		G G'	12724	96	1221504	3.5	4275264
Total			**3051094**	**3**	**9153282**		**Total**			**5174987**	**3.5**	**18112456**

(ii) Calculation of Geological Ore Resources updated as on 1.04 2015 (BAND – I) from (-) 768 mRL to (-) 818 mRL (G2 Category)

Sec	Area (sq.m)	Influence (m)	Volume (CuM)	BD	Qty (t)
A A'	973	67	65191	3.5	228169
B B'	1076	61	65636	3.5	229726
C C'	943	33	31119	3.5	108917
D D'	937	50	46850	3.5	163975
E E'	1014	57	57798	3.5	202293
F F'	961	41	39401	3.5	137904
G G'	1227	96	117792	3.5	412272
Total			**423787**	**3.5**	**1483256**

(iii) Calculation of Geological Ore Resources updated as on 1.04 2015 (BAND – I) from (-) 818 mRL to (-) 868 mRL (G3 Category)

Sec	Area (sq.m)	Influence (m)	Volume (CuM)	BD	Qty (t)
A A'	973	67	65191	3.5	228168.5
B B'	1076	61	65636	3.5	229726
C C'	919	33	30327	3.5	106144.5
D D'	937	50	46850	3.5	163975
E E'	1012	57	57684	3.5	201894
F F'	951	41	38991	3.5	136468.5
G G'	1314	96	126144	3.5	441504
Total			**430823**	**3.5**	**1507880.5**

(b) Resources Band - II

(i) Calculation of Geological Ore Resources updated as on 1.04 2015 (BAND – II) from present floor level to (-) 322 mRL (G1 Category)

Friable						Hard					
Sec	Area (sq.m)	Infl (m)	Vol (CuM)	BD	Qty (t)	Sec	Area (sq.m)	Infl (m)	Vol (CuM)	BD	Qty (t)
A A'	3384	67	226728	3	680184	A A'	3722	67	249374	3.5	872809
B B'	4218	61	257298	3	771894	B B'	4639	61	282979	3.5	990426.5
C C'	4218	33	139194	3	417582	C C'	4214	33	139062	3.5	486717
D D'	4218	50	210900	3	632700	D D'	4214	50	210700	3.5	737450
E E'	1765	57	100605	3	301815	E E'	1941	57	110637	3.5	387229.5
F F'	1904	41	78064	3	234192	F F'	2094	41	85854	3.5	300489
G G'	1120	96	107520	3	322560	G G'	1232	96	118272	3.5	413952
Total			**1120309**	**3**	**3360927**	**Total**			**1196878**	**3.5**	**4189073**

(ii) Calculation of Geological Ore Resources as on 1.10 2014 (BAND – II) from present floor level to (-) 322 mRL to (-) 372 mRL (G2 Category)

G 2 (332) Hard Up to (-) 372 mRL					
Sec	**Area (sq.m)**	**Influence (m)**	**Volume (CuM)**	**BD**	**Qty (t)**
A A'	765	67	51255	3.5	179393
B B'	954	61	58194	3.5	203679
C C'	632	33	20856	3.5	72996
D D'	633	50	31650	3.5	110775
E E'	399	57	22743	3.5	79601
F F'	430	41	17630	3.5	61705
G G'	253	96	24288	3.5	85008
Total			**226616**	**3.5**	**793157**

(iii) Calculation of Geological Ore Resources as on 1.10 2014 (BAND – II) (-) 372 mRL to (-) 422 mRL (G3 Category)

Sec	**Area (sq.m)**	**Influence (m)**	**Volume (CuM)**	**BD**	**Qty (t)**
A A'	765	67	51255	3.5	179392.5
B B'	954	61	58194	3.5	203679
C C'	628	33	20724	3.5	72534
D D'	628	50	31400	3.5	109900
E E'	399	57	22743	3.5	79600.5
F F'	430	41	17630	3.5	61705
G G'	253	96	24288	3.5	85008
Total			**226234**	**3.5**	**791819**

(c) Calculation of Blocked Measured Resources in BAND-I by Transverse Section Method out of total Measured Resources within 7.5 meter Safety Zone Boundary.

(i) Blocked measured resources

(a) Friable ore

Band-I (Friable)						**Band-II (Friable)**					
Sec	**Area (sq.m)**	**O.W (m)**	**Vol (CuM)**	**Tf**	**Qty (Tonnes)**	**Sec**	**Area (sq.m)**	**O.W (m)**	**Vol (CuM)**	**Tf**	**Qty (Tonnes)**
Sec-A-A'	2062	43	88666	3	265998	Sec-A-A'	1668	15	25020	3	75060
Sec-G-G'	1228	48	58944	3	176832	Sec-G-G'	1668	5	8340	3	25020
Total			**147610**	**3**	**442830**	**Total**			**33360**	**3**	**100080**

(b) Hard ore

Band-I (Hard)						Band-II (hard)					
Sec	**Area (sq.m)**	**O.W (m)**	**Vol (CuM)**	**Tf**	**Qty (Tonnes)**	**Sec**	**Area (sq.m)**	**O.W (m)**	**Vol (CuM)**	**Tf**	**Qty (Tonnes)**
Sec-A-A'	3938	43	169334	3.5	592669	Sec-A-A'	1797	15	26955	3.5	94342.5
Sec-G-G'	4772	48	229056	3.5	801696	Sec-G-G'	1797	5	8985	3.5	31447.5
Total			**398390**	**3.5**	**1394365**	**Total**			**35940**	**3.5**	**125790**

(ii) Blocked indicated resources

(a) Hard ore

Band-I (Hard)						Band-II (Hard)					
Sec	**Area (sq.m)**	**O.W (m)**	**Vol (CuM)**	**Tf**	**Qty (Tonnes)**	**Sec**	**Area (sq.m)**	**O.W (m)**	**Vol (CuM)**	**Tf**	**Qty (Tonnes)**
Sec-A-A'	380	43	16340	3.5	57190	Sec-A-A'	412	15	6180	3.5	21630
Sec-G-G'	380	48	18240	3.5	63840	Sec-G-G'	412	5	2060	3.5	7210
Total			**34580**	**3.5**	**121030**	**Total**			**8240**	**3.5**	**28840**

(b) Calculation of Blocked Measured Resources in BAND-I and Band – II by Transverse Section Method out of total Measured Resources in Crown Pillar (-) 22 mRL to (-) 60 mRL, (-) 380 mRL to (-) 370 mRL) and Sill Pillar (-) 500 mRL to (-) 520 mRL) for Band-I and Crown Pillar (+) 140 mRL to (+) 120 mRL, (-) 120 mRL to (-) 130 mRL) for Band-II for safety and stability of Underground working.

(i) Blocked measured resources

(a) Friable ore

Band-I (Friable)						Band-II (Friable)					
Sec	**Area (sq.m)**	**Inf (m)**	**Vol (CuM)**	**Tf**	**Qty (Tonnes)**	**Sec**	**Area (sq.m)**	**Inf (m)**	**Vol (CuM)**	**Tf**	**Qty (Tonnes)**
Sec-A-A'	743	67	49781	3	149343	Sec-A-A'	308	67	20636	3	61908
Sec-B-B'	821	61	50081	3	150243	Sec-B-B'	383	61	23363	3	70089
Sec-C-C'	795	33	26235	3	78705	Sec-C-C'	383	33	12639	3	37917
Sec-D-D'	1147	50	57350	3	172050	Sec-D-D'	383	50	19150	3	57450
Sec-E-E'	378	57	21546	3	64638	Sec-E-E'	562	57	32034	3	96102
Sec-F-F'	1284	41	52644	3	157932	Sec-F-F'	160	41	6560	3	19680
Sec-G-G'	1640	96	157440	3	472320	Sec-G-G'	102	96	9792	3	29376
Total			**415077**	**3**	**1245231**	**Total**			**124174**	**3**	**372522**

(b) Friable ore

Band-I (Hard)						Band-II (Had)					
Sec	**Area (sq.m)**	**Inf (m)**	**Vol (CuM)**	**Tf**	**Qty (Tonnes)**	**Sec**	**Area (sq.m)**	**Inf (m)**	**Vol (CuM)**	**Tf**	**Qty (Tonnes)**
Sec-A-A'	586	67	39262	3.5	137417	Sec-A-A'	154	67	10318	3.5	36113
Sec-B-B'	648	61	39528	3.5	138348	Sec-B-B'	192	61	11712	3.5	40992
Sec-C-C'	805	33	26565	3.5	92977.5	Sec-C-C'	192	33	6336	3.5	22176
Sec-D-D'	564	50	28200	3.5	98700	Sec-D-D'	192	50	9600	3.5	33600
Sec-E-E'	666	57	37962	3.5	132867	Sec-E-E'	80	57	4560	3.5	15960
Sec-F-F'	671	41	27511	3.5	96288.5	Sec-F-F'	80	41	3280	3.5	11480
Sec-G-G'	771	96	74016	3.5	259056	Sec-G-G'	50	96	4800	3.5	16800
Total			**273044**	**3.5**	**955654**	**Total**			**50606**	**3.5**	**177121**

(d) Reserves estimation

Mineable reserves estimation is done in the same way out of geological resources estimation deducting the blocked resources. The following table shows mineable reserves after reducing the blocked resources remains within 7.5 wide safety zone area out of geological resources.

(a) Mineable Reserves for Friable ore in Band- I & II under Proved Category (G1)

Band	Geological Resource (tonnes)	Ore Blocked in 7.5 m Boundary (tonnes)	Mineable Ore (tonnes)	Range of Grade in Cr2O3 %
Proved Category				
I	9153282	442830	8710452	10 to 52% Cr2O3
II	3360927	100080	3260847	
Total	**12514209**	**542910**	**11971299**	

(b) Mineable Reserves for Hard ore in Band- I & II under Proved Category (G1)

BAND	Geological Resource (tonnes)	Ore Blocked in 7.5 m Boundary (tonnes)	Mineable Ore (tonnes)	Range of Grade in Cr2O3 %
Proved Category				
I	18112456	1394365	16718091	10 to 52% Cr2O3
II	4189073	125790	4063283	
Total	**22301529**	**1520155**	20781374	

(c) Mineable Reserves for Hard ore in Band- I & II under Probable Category (G2)

BAND	Geological Resource (tonnes)	Ore Blocked in 7.5 m Boundary (tonnes)	Mineable Ore (tonnes)	Range of Grade in Cr2O3 %
Measured Category				
I	1483256	121030	1362226	**10 to 52% Cr2O3**
II	793157	28840	764317	
Total	**2276413**	**149870**	2126543	

(e) Summary of Mineable Reserves in Band- I & II under Proved Category. Geological Resource after deducting ore blocked within 7.5 m lease boundary (-) Ore blocked in Crown and Sill Pillar

(a) Friable Chrome ore

BAND	Geological Resource after deducting ore blocked within 7.5 m lease boundary (t)	Ore blocked in Crown and Sill Pillar (t)	Mineable Ore (t)	Range of Grade in Cr2O3 %
Measured Category				
I	8710452	1245231	7465221	**>10 % Cr2O3**
II	3260847	372522	2888325	
Total	**11971299**	**1617753**	10353546	

(b) Hard Chrome ore

BAND	Geological Resource after deducting ore blocked within 7.5 m lease boundary (t)	Ore blocked in Crown and Sill Pillar (t)	Mineable Ore (t)	Range of Grade in Cr2O3 %
Measured Category				
I	16718091	955654	15762437	**>10 % Cr2O3**
II	4063283	177121	3886162	
Total	**20781374**	**1132775**	19648599	

(f) Summary of Blocked Resources in Band- I & II (updated) in Ore blocked within 7.5 m lease boundary and Ore blocked in Crown and Sill Pillar.

BAND	Category	Ore blocked within 7.5 m lease boundary (MT)		Ore blocked in Crown and Sill Pillar (MT)		Total (MT)	
		Friable	Hard	Friable	Hard	Friable	Hard
I	Measured	0.443	1.394	1.245	0.956	1.688	2.350
	Indicated	0.000	0.121	0.000	0.000	0.000	0.121
	Sub Total	**0.443**	**1.515**	**1.245**	**0.956**	**1.688**	**2.471**
II	Measured	0.100	0.126	0.373	0.177	0.473	0.303
	Indicated	0.000	0.029	0.000	0.000	0.000	0.029
	Sub total	**0.100**	**0.155**	**0.373**	**0.177**	**0.473**	**0.332**
Grand Total		**0.543**	**1.670**	**1.618**	**1.133**	**2.161**	**2.803**

(g) Summary of Geological Resources in Band- I & II (updated)

BAND	Category	Reserves in MT				Total in MT	
		Friable		Hard			
		10% to 40% Cr2O3	>40% Cr2O3	10% to 40% Cr2O3	>40% Cr2O3	10% to 40% Cr2O3	>40% Cr2O3
I	Measured	2.20	6.96	3.08	15.03	5.28	21.99
	Indicated	0.00	0.00	0.25	1.23	0.25	1.23
	Inferred	0.00	0.00	0.26	1.25	0.26	1.25
Sub Total		**2.20**	**6.96**	**3.59**	**17.52**	5.78	24.47
II	Measured	1.69	1.67	2.09	2.09	3.78	3.77
	Indicated	0.00	0.00	0.40	0.40	0.40	0.40
	Inferred	0.00	0.00	0.40	0.40	0.40	0.40
Sub Total		**1.69**	**1.67**	**2.89**	**2.89**	4.58	4.56
Total		**3.89**	**8.63**	**6.47**	**20.40**	10.36	29.03

(h) Summary of Mineable Reserve in Band- I & II (as on 01.04.2015) out of geological resources with due deduction of blocked ore in 7.5 meter boundary and crown & sill pillar

BAND	Category	Reserves in MT				Total in MT	
		Friable		Hard			
		10% to 40% Cr_2O_3	>40% Cr_2O_3	10% to 40% Cr_2O_3	>40% Cr_2O_3	10% to 40% Cr_2O_3	>40% Cr_2O_3
I	Proved	1.79	5.67	2.68	13.08	4.47	18.76
	Probable	0.00	0.00	0.23	1.13	0.23	1.13
Sub Total		**1.79**	**5.67**	**2.91**	**14.21**	4.70	19.89
II	Proved	1.45	1.44	1.94	1.94	3.39	3.38
	Probable	0.00	0.00	0.38	0.38	0.38	0.38
Sub Total		**1.45**	**1.44**	**2.33**	**2.33**	3.78	3.76
Total		**3.24**	**7.11**	**5.24**	**16.54**	8.48	23.65

(i) Grade - wise distribution of Friable & Hard Chrome ore in Band- I & II

The following data has been envisaged based on borehole recovery and chemical analysis of bore hole core samples. It may vary in production stage depending on the structural pattern at different levels. It will also affect the grade of the ore accordingly.

Grade-wise Distribution of Reserves in BAND - I (Friable Chrome ore)						
Category	**10 -40% Cr_2O_3**		**Above 40 % Cr_2O_3**		**Total Reserve in (T)**	**Avg Grade**
	Quantity (T)	**Grade (%)**	**Quantity (T)**	**Grade (%)**		
Measured	1717001	18.62	5748220	51.86	7465221	**44.22**
Total	**1717001**	**18.62**	**5748220**	51.86	**7465221**	

Grade-wise Distribution of Resource in BAND - I (Hard Chrome ore)						
Category	**10 -40% Cr_2O_3**		**Above 40 % Cr_2O_3**		**Total Reserve in (T)**	**Avg Grade**
	Quantity (T)	**Grade (%)**	**Quantity (T)**	**Grade (%)**		
Measured	2679614	27.91	13082823	51.00	15762437	**47.07**
Indicated	231578	27.91	1130648	51.00	1362226	
Total	**2911193**	**27.91**	**14213471**	**50.99**	**17124663**	
Grade-wise Distribution of Resource in BAND - II (Friable Chrome ore)						
Category	**10 -40% Cr_2O_3**		**Above 40 % Cr_2O_3**		**Total Reserve in (T)**	**Average Grade**
	Quantity (T)	**Grade (%)**	**Quantity (T)**	**Grade (%)**		
Measured	1444163	20.05	1444163	50.05	2888326	**35.05**
Total	**1444163**	**20.05**	**1444163**	**50.05**	**2888326**	

Grade-wise Distribution of Resource in BAND - II (Hard Chrome ore)						
Category	**10 -40% Cr2O3**		**Above 40 % Cr2O3**		**Total Reserve in (T)**	**Average Grade**
	Quantity (T)	**Grade (%)**	**Quantity (T)**	**Grade (%)**		
Measured	1943081	14.56	1943081	50.62	3886162	**32.59**
Indicated	382159	14.56	382159	50.62	764318	
Total	**2325240**	**14.56**	**2325240**	**50.62**	**4650480**	

(j) Reserves & Resources

Categorization of reserves & resources		**UNFC Code**	**Quantity in million tonnes**				**Total**		**Grand Total**
			Band I		**Band II**		**Band I & II**		
			>40% Cr2O3	**10 to 40% Cr2O3**	**>40% Cr2O3**	**10 to 40% Cr2O3**	**>40% Cr2O3**	**10 to 40% Cr2O3**	**>10% Cr2O3**
A	**Total Mineral reserve**	**111 + 121**	**19.88**	**4.70**	**3.76**	**2.32**	**23.63**	**7.02**	**30.65**
Proved mineral reserve		111	18.75	0	3.38	0	22.13	0	22.13
Probable Mineral Reserve		121	1.13	4.70	0.38	2.32	1.51	7.02	8.53
B	**Total Remaining Resources**		**3.34**	**0.83**	**0.40**	**1.86**	**3.74**	**2.69**	**6.43**
Feasibility Mineral Reserve		211	0	0	0	0	0	0	0
Prefeasibility Mineral reserve		221 & 222	0	0	0	0	0	0	0
Measured Mineral Resource		331	3.24	0	0.38	0	3.62	0	3.62
Indicated Mineral Resource		332	0.10	0.83	0.02	1.86	0.12	2.69	2.81
Inferred Mineral Resource		333	0	0	0	0	0	0	0
Reconnaissance mineral resource		334	0	0	0	0	0	0	0
Total Reserves (A) + Resources (B)			**23.22**	**5.53**	**4.16**	**4.18**	**27.37**	**9.71**	**37.08**

Note : It may not be possible to quantify grade wise reserves, as normally, there is considerable variation in size and grade distribution within the ore zone, which results variable recovery factor and bulk density. This tonnage arrived are tentative.

(i) Proved Mineral reserves (111)

Classification/ UNFC Code	Economic Axis	Feasibility Axis	Geological Axis
Proved Mineral Reserves (111)	**E1 (Economic)**	**F1 (Feasibility Study)**	**G1 (Detail exploration)**
	1. Exploration is detailed. Mining Scheme for 2010-11 to 2014-15 has been approved. 2. Band – I - Proved Mineral Reserves of 18.75 MT (>40% Cr2O3). For Band - II Proved Mineral Reserves of 3.38 MT (>40% Cr2O3). 3. The mining operation has started since 2000.	1. Geology is detailed. Position and availability of surface as well as ground water has been studied. 2. Feasibility Report is attached **(Annexure - 15).** 3. Land use pattern is detailed in the text. 4. There is no proposal for Reclamation & rehabilitation during Scheme Period. 5 Site services such as office, canteen, rest shelter etc. has been constructed. 6. Provisions under MCR, MCDR and recent Universal format for Mining Plan/Scheme is followed. 7. Mine is being continued economically & profitably.	1. Geological mapping has been done on 1:1000 scale. 2. Geological plan has been prepared showing topographical and geological features, contacts of ore & number of ore zones, location of exploratory holes, quarry etc. 3. Geological sections have been prepared showing the mine developments and exploratory hole data. 4. Measured Mineral Reserves estimated for the ore proved at depth by drilling and considering 50 m grid density. Influence along strike from the sampling points i.e. exploratory hole up to (-) 768 mRL (Band – I). (-) 322 mRL for Band - II 5. 1899 no of core samples analyzed being drawn from all 39 exploratory holes. 1549 samples have been analyzed in a lab **(Annexure - 16).** Accredited by NABL **(SGS Hyderabad Annexure - 16)**

(ii) Probable Mineral Reserves (121)

Classification/ UNFC Code	Economic Axis	Feasibility Axis	Geological Axis
Probable Mineral Reserves (121)	**E1 (Economic)**	**F1 (Feasibility Study)**	**G1 (Detail exploration)**
	1. Exploration is detailed. Mining Scheme for 2010-11 to 2014-15 has been approved. 2. Band – I - Probable Mineral Reserves of 1.13 MT (>40% Cr2O3). 4.70 MT (10 to 40% Cr2O3). For Band - II Probable Mineral Reserves of 0.38 MT (>40% Cr2O3). 2.32 MT (10 to 40% Cr2O3) 3. The mining operation has started since 2000.	1. Geology is detailed. Position and availability of surface as well as ground water has been studied. 2. Feasibility Report is attached **(Annexure - 15).** 3. Land use pattern is detailed in the text. 4. Provisions under MCR, MCDR and recent Universal format for Mining Plan/Scheme is followed. 5. Mine is being continued economically & profitably. Reserves are being beneficiated/upgrade and used in charge chrome facilities.	1. Geological mapping has been done on 1:1000 scale. 2. Geological plan has been prepared showing topographical and geological features, contacts of ore & number of ore zones, location of exploratory holes, quarry etc. 3. Geological sections have been prepared showing the mine developments and exploratory hole data. 4. Measured Mineral Reserves estimated for the ore proved at depth by drilling and considering 50 m grid density. Influence along strike from the sampling points i.e. exploratory hole up to (-) 818 mRL (Band – I). (-) 372 mRL for Band - II 5. 1899 no of core samples analyzed being drawn from all 39 exploratory holes. 1549 samples have been analyzed in a lab **(Annexure-16).** Accredited by NABL **(SGS Hyderabad Annexure -16)**

(iii) Measured Mineral Resources (331)

Classification/ UNFC Code	Economic Axis	Feasibility Axis	Geological Axis
Measured Mineral Resources (331)	**E1 (Economic)**	**F1 (Feasibility Study)**	**G1 (Detail exploration)**
	1. Exploration is detailed. Mining Scheme for 2010-11 to 2014-15 has been approved. 2. Band – I – Measure Resources – geologically, proved not economically extractable. Such resources are 3.24 MT of > 40% Cr2O3. Band – II - Measure Resources – geologically, proved not economically extractable. Such resources are 0.38 MT of > 40% Cr2O3.	1. Geology is detailed. Position and availability of surface as well as ground water has been studied. Economical feasibility of extraction of ore is not there due to safety & stability of UG operation. 2. Feasibility Report is attached **(Annexure - 15).** 3. Land use pattern is detailed in the text. 4. Provisions under MCR, MCDR and recent Universal format for Mining Plan/Scheme is followed.	1. Geological mapping has been done on 1:1000 scale. 2. Geological plan has been prepared showing topographical and geological features, contacts of ore & number of ore zones, location of exploratory holes, quarry etc. 3. Geological sections have been prepared showing the mine developments and exploratory hole data. 4. Measured Mineral Reserves estimated for the ore proved at depth by drilling and considering 50 m grid density. Influence along strike from the sampling points i.e. exploratory hole up to (-) 818 mRL (Band – I). (-) 372 mRL for Band - II 5. 1899 no of core samples analyzed being drawn from all 39 exploratory holes. 1549 samples have been analyzed in a lab **(Annexure -16).** Accredited by NABL (**SGS Hyderabad Annexure - 16)**

(iiv) Indicated Mineral Resources (332)

Classification/ UNFC Code	Economic Axis	Feasibility Axis	Geological Axis
Indicated Mineral Resources (332)	**E1 (Economic)**	**F1 (Feasibility Study)**	**G1 (Detail exploration)**
	1. Exploration is detailed. Mining Scheme for 2010-11 to 2014-15 has been approved. 2. Band – I – Indicated Resources – geologically, indicated but not economically extractable. Such resources are 0.10 MT of >40% Cr2O3 and 0.83 MT 10 to 40% Cr2O3. Band – II - Indicated Resources – geologically, indicated but not economically extractable. Such resources are 0.02 MT of >40% Cr2O3 and 1.86 MT 10 to 40% Cr2O3.	1. Geology is detailed. Position and availability of surface as well as ground water has been studied. Economical feasibility of extraction of ore is not there due to safety & stability of UG operation. 2. Feasibility Report is attached **(Annexure - 15).** 3. Land use pattern is detailed in the text. 4. Provisions under MCR, MCDR and recent Universal format for Mining Plan/Scheme is followed.	1. Geological mapping has been done on 1:1000 scale. 2. Geological plan has been prepared showing topographical and geological features, contacts of ore & number of ore zones, location of exploratory holes, quarry etc. 3. Geological sections have been prepared showing the mine developments and exploratory hole data. 4. Measured Mineral Reserves estimated for the ore proved at depth by drilling and considering 50 m grid density. Influence along dip direction has been considered to be indicated.

2.0 MINING

(a) Briefly describe the existing as well as proposed method for excavation with all design parameters indicating on plans / sections.

Existing

Kaliapani Chromite mine is under active operation since 2000 by opencast mining method. Chrome ore (>10%) is produced from this mine along with overburden. Machines deployed are Wagon Drill Machine, Excavator, Dumper and Dozer etc. Mine development and production of ore is done with the help of Excavator and Dumper combination. Average height of the benches is maintained at 8 m, maintaining the bench slope at around 32°. The ore and overburden zone are being drilled with the help of wagon drill machine. Blasting is normally carried out using Class 2 and Class 6 explosives (Division II & III). The blasted ore are (>40% Cr2O3) transported to company's facilities at Balasore and Mineral Rejects (MR) containing 10 to 40% Cr2O3 is subjected to COBP inside the lease. In blasting NONEL method is being practiced.

Name of Quarry	Average Dimension of the Quarry (Length x Width) (m)	Average Area in Ha	Average Depth of the quarry
Band – 1	470 x 420	17.88	115 m

Proposed

It has been proposed to develop the mine in order to produce chrome by adopting following methods of mining within the lease area.

Regular opencast Mining	
A	Mining towards dip direction of ore body
	Common boundary mining (Joint mining with adjacent lessee JSL)
Underground Mining	
B	Boundary Pillar Mining (BPM)
	Conventional Underground Mining

(i) Mining towards dip direction of ore body by OC mining

Strike of the ore Band – I in the lease area is towards north east, with about 80° easterly dipping. In order to exploit the deep seated ore body development from north side is required more than south side. The detailed slope stability study has been undertaken by Central Institute of Mining & Fuel Research, Dhanbad (CIMFR) **(Annexure - 17)**. According to their recommendation open cast mining is designed and proposed in the scheme period. Further National Institute of Rock Mechanics (NIRM) is being engaged to study of pit slope stability upto 2 mRL **(Annexure – 27).**

(ii) Common boundary mining (Joint mining with adjacent lessee JSL) by OC mining

A MoU has been drawn **(Annexure - 20)** with the adjacent lessee (JSL) to exploit the ore in the western side of the lease boundary block due to statutory barrier. This will enable winning of ore locked up from (+) 148 to (+) 40 mRL and excavation will start after obtaining permission from Director of Mines Safety (DMS) and other statutory bodies.

(iii) Boundary Pillar Mining (BPM) (by UG mining)

AS per recommendation of reputed Global consultants SRK boundary pillar mining is proposed in this Scheme of Mining by adopting a conventional and comparatively inexpensive technology in such a friable ore and weathered wall rocks as those of band I and a special mining method will be adopted named as drift and mining method will be adopted. (for details refer report of SRK placed at **Annexure – 21**).

(iv) Conventional Underground Mining

Underground mining method is selected as per the condition of strata. This aspect was studied by an institute of repute SINOSTEEL MIMR Co Ltd., China **(Annexure – 29)** who suggested a conventional and comparatively inexpensive technology in such a friable ore and highly weathered wall rocks as those of band I & II will be by special mining method called drift and fill mining method. Such friable ore and poor rocks would require development with intensive support and some variant of drift and fill with sand cement mix after stopping operation.

A SLOS (Sub Level Open Stope) & and Filling mining method will be selected for extracting ore between (-) 240mRL and (-) 500mRL in a better condition. Production from Band-I planned below (-) 240mRL till (-) 500 mRL will be by Sub Level Open Stoping methods with backfill, (SLOS&F). The relatively lumpy and hard rock below will be amenable for this method which can achieve higher production levels due to the wider stope widths.

(b) It is proposed to adopt the above methods of mining for winning ore to desired level during proposed 5 years scheme period.

As there is a proposal in the scheme period to go from opencast mining to underground mining, maximum extraction of chrome ore by opencast method is being proposed in the scheme period in the interest of conservation of minerals.

This is a Captive Mine and there is a proposal to enhance the capacity of Ferro Chrome production from 150000 MT to 590000 MT and also to feed the additional requirement of acquired/ merged plants of capacity 99 MVA, 13 MVA & 108 MVA. That requires about 1475000 MT of chrome ore quantities.

Seeing the above captive requirement and conservation of mineral annual production has been proposed in these scheme periods, which are summarized below:

Summary of Ore and OB/waste production from Regular Opencast Mining & Joint Mining with M/S JSL, (Band- I), Boundary Pillar Mining in (Band-I) and Conventional Underground Mining in (Band – I & II) (2015-2016 to 2019-2020)

Year	Regular Opencast Mining & Joint Mining with M/S JSL (Band-I)		Underground Mining				Total Ore (tonnes)	Total OB (CuM)
			Boundary Pillar Mining (Band-I)	Underground Mining conventional (Band-I & II)				
	Ore (tonnes)	OB (CuM)	Ore (tonnes)	Ore in Tonne	Stoping	OB/Waste in CuM		
2015-16	505746	1716031	100935	Nil	Nil	154583	606681	1870614
2016-17	504469	1108750	100639	33210	Nil	120785	638318	1229535
2017-18	518578	837281	110531	166560	Nil	156136	795669	993417
2018-19	253407	900844	102776	567900	Nil	75813	924083	976657
2019-20	106619	458750	186186	481434	918566	86937	1692805	545687
Total	**1888819**	**5021656**	**601067**	**1249104**	**918566**	**594254**	**4657556**	**5615910**

Detailed proposed mining methods are described in subsequent Para -

A. OPEN CAST MINING

Existing method for excavation

Since inception development and ore production from Band – I with deployment of HEMM by opencast method of mining is being carried out and strictly as per the approved mining plan, scheme of mining and their modifications from time to time.

Drilling & blasting in order to loosening of the hard rock is performed by 100 mm dia DTH drills associated with compatible size compressors. Non cap sensitive slurry of 83 mm dia cartridge like nitragel etc as column charge and for secondary blasting, nitragel – 25 explosive cartridge of 25 mm dia is adopted. Height and width of benches are being proposed at 8 m and 8 m respectively, with overall slope of the quarry proposed at about 40°. Ramps are provided for movement of man & machinery. Individual bench slope is kept at about 80° from horizontal. The following machinery is in use in the mines for development and ore production from ore band – I (OC mining).

Sl No	Name	Make	No	Capacity
1	Excavator	Tata 450	2	2.8 CuM
2	Excavator	PC 450	1	2.8 CuM
3	Excavator	PC 300	1	2.1 CuM
4	Excavator	Tata 350	1	2.4 CuM
5	Dumper	MAN	25	25 Tonne
6	Dumper	AMW/Tata Prima	14	25 Tonne
7	Drilling MC	Atlas Co	1	
Sl No	**Name**	**Make**	**No**	**Capacity**
8	Water Tanker		1	12 KL
9	Water Tanker		2	14 KL
10	Disel Tanker		1	9 KL
11	Loader Excavator		1	0.9 CuM
12	JD		1	-
13	Dozer	D 80	2	-
14	Dozer	D 65	1	-

(i) From the mines ore and waste are being transported to their ear-marked sites by 25 t tippers being loaded by 2.1 CuM, 2.4 CuM, 2.8 CuM capacity excavators and 0.5 CuM capacity loader.

(ii) OB/waste is dumped on the selected location in a retreating fashion. Terraces are provided at every 20 m height with retaining wall, garland drain and check dams at the toe of dump. Overall slope of the dumps are kept at 28°. Mine Development and production of ore shall be

continued from 1st year of proposed scheme period i.e. 2015-16 to 5th year i.e. 2019-20. UG mining will be continuing alongwith OC mining from 2015-16. The following paragraphs are detailed for open cast mining only. Co-ordinates of each year of working, top and bottom RLs, height and width of benches developed and no of benches are given in following Tables

(iii) During the scheme period of 2015-16 to 2019-20 it is proposed to develop the mines by joint mining with M/S JSL along with Regular opencast mining in Band - I. Co-ordinates of each year of working, top and bottom RLs, height and width of benches developed and no of benches forms are as below.

Year	Mine working	Description			
		Co-ordinates	Top and Bottom RLs	height of benches	No of benches formed
2015-16	Joint Mining With M/S JSL & Regular opencast mining	985.876E,675.962N	144mRL & 106mRL and 45 mRL to 35 mRL	8mtrs	5 & 24
2016-17	Joint Mining With M/S JSL & Regular opencast mining	985.876E,675.962N	106mRL & 58mRL and 35 mRL to 26 mRL	8mtrs	6 & 25
2017-18	Joint Mining With M/S JSL & Regular opencast mining	985.876E,675.962N	58mRL & 50mRL and 26 mRL to 18 mRL	8mtrs	1 & 26
2018-19	Joint Mining With M/S JSL & Regular opencast mining	985.876E,675.962N	50mRL & 42mRL and 18 mRL to 10 mRL	8mtrs	1 & 27
2019-20	Joint Mining With M/S JSL & Regular opencast mining	985.876E,675.962N	Nil and 10 mRL to 2 mRL	8mtrs	Nil & 28

(b) Year-wise tentative excavation in CuM indicating development, ROM, pit wise is given in the table below

I. Insitu Tentative Excavation

Year	Band-I	Total Excv. Excl. TS (CuM)	Top Soil (CuM)	OB/SB/ IB (CuM)	ROM (CuM)		Mineral Reject (CuM)	ROM/ Waste Ratio
					Ore*	Mineral Reject		
2015-16	Band - 1 Insitu Ore	18,84,613	Nil	1716031	168582	Nil	Nil	1:3.39
2016-17	Band - 1 Insitu Ore	1276906	Nil	1108750	168156	Nil	Nil	1:2.20
2017-18	Band - 1 Insitu Ore	1010140	Nil	837281	172859	Nil	Nil	1:1.61
2018-19	Band - 1 Insitu Ore	985315	Nil	900844	84469	Nil	Nil	1:3.55
2019-20	Band - 1 Insitu Ore	494289	Nil	458750	35539	Nil	Nil	1:4.30
Total	Band - 1 Insitu Ore	3,851,281	Nil	5021656	629605	Nil	Nil	1:2.65

* **Tentative tonnage of the ore may be arrived by computing approximate bulk density and recovery factor as these data are variable and may be established on time series.**

II. Dump handling (for the purpose of recovery of mineral)

Estimated available material (CuM)

Dum identification / No	Year-wise handling (CuM)	Estimated recovery of salable material (CuM)	Reject (CuM)
Not Applicable			

(c) Enclose Individual year wise development plans and sections showing pit layouts, dumps, stacks of mineral reject, if any, etc in case of 'A' category mines.

Individual year wise development plans and sections showing pit layouts, dumps, stacks of mineral reject have been prepared in 1 : 2000 Scale. Refer **Plate No – 6A to 6E**

(d) Describe briefly giving salient features of the proposed method of working indicating category of mine

Open cast fully mechanized (category 'A') system of mining is in practice to mine the chrome ore deposit adopting a system of bench formation with deep hole blasting keeping in mind the quality, cost, safety and conservation of mineral. No change in present method of mining has been envisaged during the proposed scheme period. However There is a proposal to install a in pit conveyor system to evacuate the material from deep open cast mining and same shall be operational after detailed technical study and viability of the project are prepared. Deployment of machinery for development and production from the quarries are calculated as ow.

(i)	**Extent of mechanization**		
	Requirement of machinery in proposed scheme period		
Dozing			
One dozer of 165 HP is now utilized in the mines for construction, leveling and compaction of haul road and waste dump. The same shall be continued in the scheme period.			
Drilling			
Specification of drill machine			
Diameter of drill		**:**	100 mm
Air consumption		**:**	8 to 10 kgf/Sq.m
Pressure supplied up to		**:**	16 kgf/Sq.m.
Drilling parameters			
Dia. of blast hole (D)		**:**	100 mm
Height of the bench		**:**	8 m
Additional drilling required (sub grade)		**:**	0.8 m
Length of the hole (H)		**:**	8.8 m
Burden (B)		**:**	3 m
Spacing (S)		**:**	3 m
Volume of earth to be broken/loosen per hole		**:**	B x S x H = 3 x 3 x 8 = 72 CuM
Meterage of drilling per drill for primary blasting in ore zone			
Maximum volume of material to be excavated (in a year of plan period is 2015-16)		**:**	1884613 CuM
Volume of material require drilling and blasting, as per the nature of the deposit is around 10% of the total excavation as those are soft and Friable in nature)			1884613 × 10%= 188461 CuM
Number of holes to be drilled		**:**	188461 ÷ 72 = 2618 numbers
Number of holes to be drilled per day of 300 days in a year		**:**	2618 ÷ 300 = 8.73 or 9 numbers
Total meterage of drilling/day (length of blast hole = 8.8m)		**:**	9×8.8 = 79.2 m say 79 m
Requirement of drills			
Av. Penetration rate of drill machine		**:**	10 m / hr
Effective drilling meter in two shifts by one drilling machine (8 hrs shift / effective working hrs = 6 hrs / shift)		**:**	10 x 12 =120 m.
Number of drills required		**:**	79 ÷ 120 = 0.66 or 1 numbers.

(ii) Excavation

Hydraulic shovel of 2.1, 2.4 and 2.8 CuM bucket capacity are proposed to be used for excavation and loading.

Excavator (Shovel)	**Unit**			
Bucket capacity (C)	CuM	2.1	2.4	2.8
Bucket fill factor (F)		0.85	0.85	0.85
Time cycle pass at 90° swing (T)	Sec	30	28	26
Swell factor (S)		0.8	0.8	0.8
Production efficiency factor (e)		0.8	0.8	0.8
Job management factor (f)		0.9	0.9	0.9
Time scheduling				
Working days per year	Numbers	300	300	300
Number of working shifts per day	Numbers	3	3	3
Effective working hours per shift	Hrs	6.5	6.5	6.5
Effective working hours per three shift	Hrs	19.5	19.5	19.5
Seconds in hour	Sec	3600	3600	3600
Output /CuM shovel/annum Working days per year [C x F x S x e x f x 3600 x 19.5 x 300] ÷ T	CuM	721768	883798	1110413
Maximum material to be handled in a year i.e first year (2015-16) about 1884613 CuM	CuM	1	1	1

(iii) Transportation

The lead distance of mines to stack yard and OB/waste dump yard has been considered as 4km.

Specification of Dumper	=	**Materials**
Capacity of the dumper	=	25 tonnes (MAN & AMW)/7 CuM
Rate of production of 2.1 CuM shovel per day	=	721768 CuM ÷ 300 = 2406 CuM
Rate of production of 2.5 CuM shovel per day		883798 CuM ÷ 300 = 2946 CuM
Rate of production of 2.8 CuM shovel per day		1110413 CuM ÷ 300 = 3701 CuM
Number of passes required for one dumper attached to shovel (2.1 CuM)	=	Dumper capacity ÷ C x F x S x e = 7 ÷ (2.1 x 0.85 x 0.8 x 0.8) = 6.12 or 6 passes
Number of passes required for one dumper attached to shovel (2.4 CuM)	=	Dumper capacity ÷ C x F x S x e = 7 ÷ (2.5 x 0.85 x 0.8 x 0.8) = 5.14 or 5 passes
Number of passes required for one dumper attached to shovel (2.8 CuM)	=	Dumper capacity ÷ C x F x S x e = 7 ÷ (2.8 x 0.85 x 0.8 x 0.8) = 4.59 or 5 passes
Hauling time for ore stack yard & OB/waste Dump yard	=	Average hauls length to be covered by the loaded dumper (4 km) ÷ Average speed of the dumper (20 km per Hr.) (Loaded + empty) = 12 min

Return time	=	12 min				
Dumper cycle time (ore stack yard and OB/waste dump yard) = Loading time + hauling time + unloading time + return time + spotting time and waiting time	=	3 + 12 + 2 + 12 + 3 = 32 min.				
2.4 CuM Bucket Capacity		2.5+12+2+12+3= 31.5 min				
2.8 CuM Bucket Capacity		2+12+2+12+3= 31 min				
Working time per dumper per day (3 shifts)	=	19.5 Hrs				
Number of trips per dumper per day	=	(19.5 x 60) ÷ 32 = 31.14 or 31				
Attached to 2.4 CuM Bucket Capacity		(19.5 x 60) ÷ 31.5 = 36.56 or 37				
Attached to 2.8 CuM Bucket Capacity		(19.5 x 60) ÷ 31 = 37.74 or 38				
One dumper will handle / day attached to 2.1 Cum Bucket Capacity	=	37 x 7 = 259 CuM				
One dumper will handle / day attached to 2.4 Cum Bucket Capacity	=	37 x 7 = 259 CuM				
One dumper will handle / day attached to 2.8 Cum Bucket Capacity	=	38 x 7 = 266 CuM				
Requirement of Dumpers		**15-16**	**16-17**	**17-18**	**18-19**	**19-20**
Dumper requirement (attached to 2.1 CuM shovel) for handling of Ore and OB/waste @ 2406 CuM/day	=	1	1	1	1	1
Dumper requirement (attached to 2.4 CuM shovel) for handling of Ore and OB/waste @2946 CuM/day	=	1	1	1	1	1
Dumper requirement (attached to 2.8 CuM shovel) for handling of Ore and OB/waste @3701 CuM/day	=	1	1	1	1	1

(iv) Requirement of Machinery for proposed scheme of mining (2015-16 to 2019-20)

Sl No	Name	Make	Capacity	Existing	Additional Requirement
1	Excavator	Tata 450	2.8 CuM	2	-
2	Excavator	PC 450	2.8 CuM	1	-
3	Excavator	PC 300	2.1 CuM	1	-
4	Excavator	Tata 350	2.4 CuM	1	-
5	Dumper	MAN	25 Tonne	24	2
6	Dumper	AMW	25 Tonne	10	-
7	Dumper	TATA Prima	25 Tonne	3	17
8	Drilling MC	Atlas Co		1	1
9	Water Tanker		12 KL	1	-
10	Water Tanker		14 KL	2	-
11	Diesel Tanker		9 KL	1	-
12	Loader Excavator		0.9 CuM	1	-
13	JD			1	-
14	Dozer	D 80		3	-
15	Dozer	D 65		1	-
16	Dozer	D 45		1	-
17	Grader			1	-
18	Rock Breaker			-	1

(v) Maintenance of haul roads

The main haul roads require regular maintenance. One motor grader with tilting facility for maintenance of the main haul roads has been deployed.

(vi) Blasting (Types of explosives to be used)

Non-cap sensitive slurry of 83 mm dia cartridges of Nitrate Mixture like Novaprime, Exoprime and Aquadine, Nitro compound, Safety fuse, detonating fuse, detonator and delay detonator etc are used for column charge and blasting. For secondary blasting the same type of Nitro mixture are used of 25 mm dia cartridge size

(vii) Powder factor

Based on the parameters above and past experience, the powder factor is expected to be 7-8 t of rock / kg of explosives

(viii) Blasting technique

Controlled blasting with 'V' pattern firing is in practice which is much safe and fragmentation is good and throw is within control. Sequential blasting is done by using electric delay detonator or NONEL system of initiation is in use to reduce vibration and fly rock and the same has been

proposed to be continued during the scheme period. Rock breaker shall be in use to avoid secondary blasting. Proper charging, stemming and controlled blasting with NONEL system of initiation is proposed for getting optimum blast results and minimization of hazards while preventive measures like marking of danger zone, arrangement of warning signals by hooting etc shall be adopted. Blasting shelters are provided within the blasting zone. Vibration monitoring at sensitive locations are being carried out scientifically to check adverse effects if any during blasting.

(ix) Meterage of drilling per drill for primary blasting in ore zone

Maximum volume of material to be excavated (in a year of plan period is 2015-16)	**:**	1884613 CuM
Volume of material require drilling and blasting, as per the nature of the deposit is around 10% of the total excavation as those are soft and Friable in nature)		1884613 × 10%= 188461 CuM
Number of holes to be drilled	**:**	188461 ÷ 72 = 2618 numbers
Number of holes to be drilled per day of 300 days in a year	**:**	2618 ÷ 300 = 8.73 or 9 numbers
Total meterage of drilling/day (length of blast hole = 8.8m)	**:**	9×8.8 = 79.2 m say 79 m

(x) Magazine house

Two portable (B & S Type) magazine of 0.8 tonne capacity has been installed within the lease area over 0.107 Ha. Adequate precautionary measure as per regulation has been provided with round the clock security arrangement. Capacity for storing different items of explosive materials is as below

Class	Commercial terms	Quantity
Class – II	Nitrate	800 kg
Class – III (Division – 2)	(PETN/TNT/Boosters)	25 kg
Class – VI (Division – 2)	Detonating fuse	3000 m
Class – VI (Division – 3)	Detonator	4000 numbers
Class – VI (Division – 1)	Safety Fuse	250 m

(xi) Blasting materials are transported to site of blasting from the magazine for which an explosive van has been provided.

	Safety precautions taken during blasting
(i)	Blasting is carried out as per the relevant provisions of MMR 1961
(ii)	Competent person and proper signaling
(iii)	Adequate numbers of blasting shelters are provided within 75 m of the blasting area.

(e)`Layout of mine workings, pit road layout, layout of faces and sites for disposal of overburden/ waste along with ground preparation prior to disposal of waste, rejects etc.

As already discussed in previous paragraphs, the mining operations are confined to Band-I ore body only. Details of operation are as below. Highest production of ROM shall be about 1884613 CuM in 2015-16, whereas the minimum production shall be about 494290 CuM in 2019-20. Mining benches are kept at 8 m height in average. Working bench width is maintained at 8 m invariably but at places those are kept 10 m for stability of side walls/slope. Recommendation of CMRI has been followed

Mine Layout is designed / proposed as per recommendation of CIMFR as below

Hanging Wall Slope		
Particulars	**Factor Of Safety**	**Fig No (Ref Annexure - 17)**
Overall slope height: 125m	1.31	Fig-1
Overall slope angle: 34degree		
Overall slope angle: 34degree		
Maximum inter-ramp height:48m		
Total number oframps:7		
Footwall Wall Slope		
Particulars	**Factor Of Safety**	**Fig No**
Overall slope height: 168m	1.29	Fig-2
Overall slopeangle:29degree		
Top 100m:maximum 31degree		
Bottom 68m:maximum 29degree		
Maximum inter-ramp height: 32m		
Total number of ramps: 10		

100 mm dia meter holes are drilled by operating the Hydraulic drills. Rock breaker is proposed to use for breaking of big boulders. The year wise layout of mine workings with other details UPL is tabulated below with quarries extension, pit road, important installations etc given as below. Year-wise development / excavation are given as below

	Mine Development in 2015-16	
S No	**Description**	**Band –I INSITU Ore**
1	Co-ordinate	North side=1277.7E,907N & South side=1181E,406N
2	RL of quarry floor at the end of the year	35 mRL
3	Sections considered	CC',DD' & EE'
4	Height of bench	8mtrs
5	Individual slope of the bench	80^0
6	Overall slope of the quarry	29^0
7	Volume of excavation of Topsoil (CuM)	Nil
8	Volume of excavation of **OB/SB/ IB** (CuM).	Regular OC mining (1048716 CuM) + Common Boundary Mining with Jindal (667316 CuM) = 1716031 CuM
9	Volume of intermediate burden recovered (CuM)	Nil
10	Volume of excavation of ore zone (RoM) (CuM)	Regular OC mining (59566 CuM) + Common Boundary Mining with Jindal (109016 CuM) = 168582 CuM
11	Number of Ramps connecting from bench to bench for haulage of excavators, tippers, other machinery, vehicles and workers	North side=4nos & South side=8nos

Development - 2015-16 Band - 1 Insitu Ore									
CS	**Area sq.m**	**Infl (m)**	**Total Exv Vol exclude TS & OB CuM**	**OB/SB/ IB CuM**	**TS CuM**	**RF ore**	**Ore Recovery CuM**	**BD**	**Qty ore Tonnage**
A - A'	44.90	15	673.50	253486	NIL	1	673.50	3	2021
B - B'	256.13	40	10245.20	196436	NIL	1	10245.20	3	30736
C - C'	366.83	50	18341.50	197433	NIL	1	18341.50	3	55025
D - D'	378.09	50	18904.50	206080	NIL	1	18904.50	3	56714
E - E'	380.03	30	11400.90	195281	NIL	1	11400.90	3	34203
F - F'	736.18	30	22085.40	217295	NIL	1	22085.40	3	66256
G - G'	1795.09	25	44877.25	232017	NIL	1	44877.25	3	134632
H - H'	2102.69	20	42053.80	218003	NIL	1	42053.80	3	126161
TOTAL			**168582.05**	**1716031**	**NIL**	**1**	**168582.05**	**3**	**505748**

	Mine Development in 2016-17	
S No	**Description**	**Band –I INSITU Ore**
1	Co-ordinate	North side=1277.7E,918N & South side=1181E,406N
2	RL of quarry floor at the end of the year	26mRL
3	Sections considered	CC',DD' & EE'
4	Height of bench	8mtrs
5	Individual slope of the bench	80^0
6	Overall slope of the quarry	30^0
7	Volume of excavation of Topsoil (CuM)	Nil
8	Volume of excavation of **OB/SB/ IB** (CuM)	Regular OC mining (374386 CuM) + Common Boundary Mining with Jindal (734464 CuM) = 118750 CuM
9	Volume of intermediate burden recovered (CuM)	Nil
10	Volume of excavation of ore zone (RoM) (CuM)	Regular OC mining (34320 CuM) + Common Boundary Mining with Jindal (133837 CuM) = 168156 CuM
11	Number of Ramps connecting from bench to bench for haulage of excavators, tippers, other machinery, vehicles and workers	North side=5 nos & South side=8nos

Development - 2016-17 Band - 1 Insitu Ore									
CS	**Area sq.m**	**Infl (m)**	**Total Exv Vol exclud TS & OB CuM**	**OB/SB/ IB CuM**	**TS CuM**	**RF ore**	**Ore Recovery CuM**	**BD**	**Qty ore Tonnage**
A - A'	0.00	0	0.00	57847	0	1	0.00	3	0
B - B'	158.78	35	5557.30	49253	0	1	5557.30	3	16672
C - C'	230.09	50	11504.50	77663	0	1	11504.50	3	34514
D - D'	234.86	50	11743.00	92768	0	1	11743.00	3	35229
E - E'	137.87	40	5514.80	96856	0	1	5514.80	3	16544
F - F'	539.52	45	24278.40	125897	0	1	24278.40	3	72835
G - G'	1571.01	45	70695.45	291113	0	1	70695.45	3	212086
H - H'	1689.69	23	38862.87	317353	0	1	38862.87	3	116589
TOTAL			**168156.32**	**1108750**	**0**	**1**	**168156.32**	**3**	**504469**

	Mine Development in 2017-18	
S No	**Description**	**Band –I INSITU Ore**
1	Co-ordinate	North side=1277.7E,930N & South side=1181E,406N
2	RL of quarry floor at the end of the year	18mRL
3	Sections considered	CC',DD' & EE'
4	Height of bench	8mtrs
5	Individual slope of the bench	80^0
6	Overall slope of the quarry	32^0
7	Volume of excavation of Topsoil (CuM)	Nil
8	Volume of excavation of **OB/SB/ IB** (CuM)	Regular OC mining (524286 CuM) + Common Boundary Mining with Jindal (312995 CuM) = 837281 CuM
9	Volume of intermediate burden recovered (CuM)	Nil
10	Volume of excavation of ore zone (RoM) (CuM)	Regular OC mining (64033 CuM) + Common Boundary Mining with Jindal (108826 CuM) = 172859 CuM
11	Number of Ramps connecting from bench to bench for haulage of excavators, tippers, other machinery, vehicles and workers	North side=7 nos & South side=7nos

Development - 2017-18 Band - 1 Insitu Ore									
CS	**Area sq.m**	**Infl (m)**	**Total Exv Vol exclud TS & OB CuM**	**OB/SB/ IB CuM**	**TS CuM**	**RF ore**	**Ore Recovery CuM**	**BD**	**Qty ore Tonnage**
A - A'	0.00	0	0.00	41722	0	1	0.00	3	0
B - B'	375.06	40	15002.40	107656	0	1	15002.40	3	45007
C - C'	282.09	50	14104.50	128040	0	1	14104.50	3	42314
D - D'	341.35	50	17067.50	131500	0	1	17067.50	3	51203
E - E'	446.46	40	17858.40	115369	0	1	17858.40	3	53575
F - F'	676.72	40	27068.80	98563	0	1	27068.80	3	81206
G - G'	1244.94	40	49797.60	108998	0	1	49797.60	3	149393
H - H'	998.75	32	31960.00	105433	0	1	31960.00	3	95880
TOTAL			**172859.2**	**837281**	**0**	**1**	**172859.2**	**3**	**518578**

	Mine Development in 2018-19	
S No	**Description**	**Band –I INSITU Ore**
1	Co-ordinate	North side=1277.7E,950N & South side=1181E,406N
2	RL of quarry floor at the end of the year	10 mRL
3	Sections considered	CC',DD' & EE'
4	Height of bench	8mtrs
5	Individual slope of the bench	80^0
6	Overall slope of the quarry	32^0
7	Volume of excavation of Topsoil (CuM)	Nil
8	Volume of excavation of **OB/SB/ IB** (CuM)	Regular OC mining (544528 CuM) + Common Boundary Mining with Jindal (356317 CuM) = 900844 CuM
9	Volume of intermediate burden recovered (CuM)	Nil
10	Volume of excavation of ore zone (RoM) (CuM)	Regular OC mining (34320 CuM) + Common Boundary Mining with Jindal (133837 CuM) = 84469 CuM
11	Number of Ramps connecting from bench to bench for haulage of excavators, tippers, other machinery, vehicles and workers	North side=7 nos & South side=7nos

Development - 2018-19 Band - 1 Insitu Ore									
CS	**Area sq.m**	**Infl (m)**	**Total Exv Vol exclud TS & OB CuM**	**OB/SB/ IB CuM**	**TS CuM**	**RF ore**	**Ore Recovery CuM**	**BD**	**Qty ore Tonnage**
A - A'	0.00	0	0.00	70789	0	1	0.00	3	0
B - B'	59.73	40	2389.20	101982	0	1	2389.20	3	7168
C - C'	526.53	50	26326.50	124449	0	1	26326.50	3	78980
D - D'	506.26	50	25313.00	120463	0	1	25313.00	3	75939
E - E'	225.51	45	10147.95	126845	0	1	10147.95	3	30444
F - F'	169.92	50	8496.00	125770	0	1	8496.00	3	25488
G - G'	129.15	45	5811.75	128986	0	1	5811.75	3	17435
H - H'	199.49	30	5984.70	101560	0	1	5984.70	3	17954
TOTAL			**84469.1**	**900844**	**0**	**1**	**84469.1**	**3**	**253408**

	Mine Development in 2019-20	
S No	**Description**	**Band –I INSITU Ore**
1	Co-ordinate	North side=1277.7E,960N & South side=1181E,406N
2	RL of quarry floor at the end of the year	2 mRL
3	Sections considered	CC',DD' & EE'
4	Height of bench	8mtrs
5	Individual slope of the bench	80^0
6	Overall slope of the quarry	33^0
7	Volume of excavation of Topsoil (CuM)	Nil
8	Volume of excavation of **OB/SB/ IB** (CuM)	Regular OC mining (71441 CuM) + Common Boundary Mining with Jindal (187309 CuM) = 458750 CuM
9	Volume of intermediate burden recovered (CuM)	Nil
10	Volume of excavation of ore zone (RoM) (CuM)	Regular OC mining (273110CuM) + Common Boundary Mining with Jindal (8229 CuM) = 35539 CuM
11	Number of Ramps connecting from bench to bench for haulage of excavators, tippers, other machinery, vehicles and workers	North side=7 nos & South side=7nos

Development - 2019-20 Band - 1 Insitu Ore									
CS	**Area sq.m**	**Infl (m)**	**Total Exv Vol exclud TS & OB CuM**	**OB/SB/ IB CuM**	**TS CuM**	**RF ore**	**Ore Recovery CuM**	**BD**	**Qty ore Tonnage**
A - A'	0.00	0	0.00	25259	0	1	0.00	3	0
B - B'	0.00	0	0.00	52065	0	1	0.00	3	0
C - C'	270.28	45	12162.60	59309	0	1	12162.60	3	36488
D - D'	179.88	50	8994.00	65158	0	1	8994.00	3	26982
E - E'	123.08	50	6154.00	69651	0	1	6154.00	3	18462
F - F'	115.96	50	5798.00	68707	0	1	5798.00	3	17394
G - G'	69.46	35	2431.10	69142	0	1	2431.10	3	7293
H - H'	0.00	0	0.00	49459	0	1	0.00	3	0
TOTAL			**35539.7**	**458750**	**0**	**1**	**35539.7**	**3**	**106619**

Waste generation during the scheme period and its management

Year-wise waste development from different mining activities during the proposed scheme period is tabulated below.

Year	Opencast Mining in CuM	Under Ground Mining in CuM	Total in CuM
2015-16	1716031	154583	1870614
2016-17	1108750	120785	1229535
2017-18	837281	156136	993417
2018-19	900844	75813	976657
2019-20	458750	86937	545687
Total	**5021656**	**594254**	**5615910**

About 15% of the waste to be generated i.e.842387 CuM shall be utilized for strengthening of haul road, dump terraces, filling the voids created by rain on the side walls of the dumps, berms on haul road and also in plantation areas for a balance 4773523 CuM of Waste planning for stacking/dumping is proposed in systematic manner in subsequent Paras.

Waste dumping locations

Three waste dumps are there inside the lease areas which were active at the start of scheme period. Present status of these dumps and proposal for further dumping on these dumps in the scheme period of 2015-16 to 2019-20 are described below.

(i) Waste dump – 1

Waste dump – 1 covers an area of 11.892 Ha and has been heighten to 182 mRL as on date. Size of a part of the dump at present is 432 m Long x 212 m wide x 60 m in average and the other part is 385 m x 71 m x 12 m. As on date the dump has accommodated about 2556845 CuM waste, with 3 number of terraces. Considering following suggestions space for 2033465 CuM can be created.

- Thus the height of the dump will go from existing 182 mRL to 202 mRL or the height of the dump will be extended to further 20 m from existing height. For this aspect, technical studies by CIMFR Dhanbad **(Annexure - 17).**
- A Gabion wall from the toe of the waste dump – 1 towards north and west shall be constructed to find more area for accommodating wastes as per suggestions of Z Tech India Pvt. Ltd., New Delhi **(Annexure - 18)**. As per design the evaluated factor of safety is 1.3.

It is proposed to construct a Gabion faced Reinforced earth Retaining wall with Terramesh, and reinforcing the wall with Strip bonded high tenacity Polyester core (Paralink) Geo-grid reinforcement for a length of 346 m & height of 31m with a purpose to retain the existing sloping dump, and also to increase the dump capacity of the chromite mines, to a greater extent. The proposed wall will be constructed at a 6^{o} initial batter at the bottom tier, by placing Galvanized, double twisted PVC coated steel wire mesh (Terramesh) modular units, packed with stone and placing those units, layer by layer, and then reinforcing each layer of the reinforced soil with Paralink reinforcement as per the approved design & drawing. The Terramesh units will be filled with hard, angular to round stones of size 150 to 300 mm. The top layers of the wall will be constructed with an environmental friendly (Green Terra-mesh) modular units to increase stability, as well as aesthetics of the wall. During the construction of the Reinforced wall, both horizontal & vertical Geo-composite drains will be provided in layers at a suitable spacing to prevent pore water pressure in the wall system, and also to prevent reduction in shear strength values of the reinforced fill. Terramesh system is a versatile modular system used for mechanically stabilized earth slopes and predominately used for Industrial, Mining, Road work, River Bank stabilization application areas. This being a "modular" system, most of the units are delivered pre-fabricated to ensure fastest construction.

The stability analysis of the wall has been done with a **MacStARS w – Rel. 4.0** software for Reinforced slopes & Walls. All the stability checks such as Internal, Global & sliding have been analyzed for both the static & seismic conditions for all the 3 Tiers of 10m high. The minimum Global factor of safety considering both the conditions has been evaluated as, F.S **> 1.3.** The design code and analysis have been done in accordance with BS Code 8006-1:2010.

- Further, in-house technical experts have the view for common dumping to join waste dump- 1 and 2 of IMFA on the east & north side and accordingly a MoU with IMFA **(Annexure - 19)** along with approval of DMS **(Annexure - 19)**, has been accorded.

Final conclusion – Considering above technical studied a dump plan and section has been prepared **(Plate No – 7A & 7B)** which shows that the ultimate capacity of waste dump – 1 will be to accommodate a quantum 4590310 CuM. Dump slope also be stabilized with plantation, Coir matting & grass turfing. Overall slope will be kept at 28^{0}. Existing statutory provisions like retaining wall, and garland drain, check dams, terraces and settling tanks those exist at site will be revamped.

(ii) Waste dump – 2

Waste dump – 2 covers an area of 4.875 Ha and has been heighten to 180 mRL as on date. Size of the dump at present is 250 m Long x 195 m wide x 40 High. As on date the dump has accommodated about 812005 CuM waste, with 2 number of terraces. For extending the periphery of the quarry on Band-I towards north about 275000 CuM from 1.0 Ha area from the toe of the dump shall be shifted and will be re-located on waste dump -2 to join with vacant area towards IMFA dump. The vacant area can accommodate additional quantum of 353613 CuM waste. Thus wastes dump – 2 of BAL and dump of IMFA merges. This is under an agreement between both lessee's. At this time size of the dump will be 411 m Long x 126 m wide x 37 High (in average). It has been calculated that the ultimate capacity of the dump after extending towards common boundary to join with wastes of IMFA will cater about 1165618 CuM waste **(Plate No – 7A & 7B).** MoU with IMFA **(Annexure - 19)** along with approval of DMS **(Annexure - 19)**, has been accorded. Dump slope also be stabilized with plantation, Coir matting & grass turfing. Overall slope will be kept at 28^{0}. Existing statutory provisions like retaining wall, and garland drain, check dams, terraces and settling tanks those exist at site will be reconstructed.

(iii) Waste dump – 3

Waste dump – 3 covers an area of 13.28 Ha and has been heighten to 227 mRL as on date. Size of the dump at present is 366 m Long x 380 m wide x 60 High. As on date the dump has accommodated about 5096484 CuM waste, with 3 number of terraces.

To heighten the dump – 3 (for next 10 m thus dump height will be 70 m) from 227 mRL to 235 mRL study was undertaken by IIT Kharagpur. But, now the lessee proposes to keep the dump height at 227 mRL. Instead of 4 terraces at different heights, proposal is there to convert the dump with 3 terraces of 20 m height each. The dumping will with catch drain in the inward slope to connect with the garland drain at the toe of the dump. The dumping will with catch

drain in the inward slope to connect with the garland drain at the toe of the dump.

Western side of waste dump – 3 is proposed to join eastern side dump of JSL upto a height of 225 mRL. A MoU with JSL has already been drawn **(Annexure -20).**

A Gabion wall from the toe of the waste dump – 3 towards east and south shall be constructed to find more area for accommodating wastes.

Final conclusion – Considering above technical studies a dump plan and section has been prepared **(Plate No – 7A & 7B)** which shows that a quantum of 2394185 CuM waste can further be accommodated in waste dump – 3. Finally the waste dump will be having 7490669 CuM waste. Dump slope also be stabilized with plantation, Coir matting & grass turfing. Overall slope will be kept at 28^0. Existing statutory provisions like retaining wall, and garland drain, check dams, terraces and settling tanks those exist at site will be modified.

Summary of waste dumping locations			
Dump No	**Existing Volume**	**Final volume**	**Additional Volume**
Initial waste dump - 1	2556845	4590310	2033465
Common dumping with IMFA	0		
Initial waste dump - 2	812005	1165618	353613
Initial waste dump - 3	5096484	7490669	2394185
Gabbion wall	0		
Terrace heightening	0		
Common dumping with JSL	0		
Total	**8465334**	**13246597**	**4781263**

As described above para under **Waste generation** above space required for accommodation of waste dumping during proposed scheme period is for 4773523 CuM. As above para under Summary of **Waste dumping locations** space for accommodating about 4781263 CuM at different locations is available.

	Land use at the start and end of proposed scheme period		
Sl. No.	**Head**	**Area put on use at start of Scheme of Mining (Ha)**	**land use at the end of the proposed scheme period (Ha)**
1	Area under mining	17.880	22.022
2	Storage for top soil	0	0
3	Waste dump site	33.178	35.173
4	Mineral storage	2.210	2.249
5	Infrastructure (workshop, administrative building, colony etc.	1.219	1.071
6	Roads	1.738	0.686
7	Railways	0	0
8	Tailing pond	0.020	0.020
9	Effluent Treatment Plant	0.240	0.240
10	Mineral Separation Plant	0.800	0.702
11	Township area	0	0
12	Others (to specify) - Area towards south east side of dump – 3 and areas where green belt and garland drain has already been developed.	0	2.300
Grand Total		**57.285**	**64.463**

(f) Conceptual Mine planning upto the end of lease period taking into consideration the present available reserves and resources describing the excavation, recovery of ROM, Disposal of waste, backfilling of voids, reclamation and rehabilitation. Those are shown on a plan with relevant sections.

Life of the mine

Out of the total lease hold area of 64.463 Ha for quarrying and other allied activities excluding safety zone and green belt area of 2.297 Ha by end of scheme period. Quarrying area will be about 26.164 Ha at the end of conceptual period within total surface right area. A mineable ROM of 816569 CuM is available after the end of proposed scheme period or as on 01.04.2020. Beside these, blocked resources of 665481 CuM of Chrome Ore under prevailing mining constraints and pit slopes/ bench formation etc can be mined by Boundary Pillar Mining method. As such about 1482050 CuM mineable ROM is available, which will be mined out in conceptual period at a rate of 600000 CuM per annum. As such life of OC mining & boundary pillar mining will be for about 3 years after the scheme period or upto end of 2022-23.

It has been estimated reserves under G 1, G2 category to the tune of 30.65 million tonne and G3 category of 2.30 million tonne basing on drill hole density. G1 category covers up to 768 mRL in Band-I and 322 mRL in Band-II and proposed mining during the coming 5 years is limited to 2 mRL. AS mentioned in chapter 1.0 that G2 category has gone upto 818 in Band-I and 372 mRL in Band-II and while G3 category upto 868 in Band-I and 422 mRL in Band-II. Balance reserve after the proposed scheme period will be about 25.99 million tonne under G1 and G2 categories. Hence opencast mining upto (-) 22 mRL can be envisaged after detailed techno-economic feasibility study and pit slope stability study by an institute of repute in the interest of mineral conservation, if it is possible in safe & scientific manner. While conducting drilling from Underground the category of G2 and G3 may be enhanced. During proposed scheme period about 4.66 million tonne ore shall be recovered from the lease area leaving a balance of 25.99 million tonne up to 818 mRL in Band-I and 322 mRL in Band-II. Thus the balance reserve by up to 818 and 322 mRL will be 25.99 million tonne. Mining with effect from 1.4.2020 will be continued by Underground mining and shall be continued to another 18 year. Holes to be drilled during these period it is likely that G3 reserves is converted to G2/G1 reserves besides proving additional ore. The mining lease allocated is upto 2030 and reserve balance may require a renewal of the lease for about 20 years, to extract/exploit the ore body till technically feasible depth..

Reclamation & Rehabilitation measures

The open cast mine planning during the conceptual period may be envisaged up to (-) 22 mRL because the existence of chromite has been established up to a level of (-) 818 mRL. The proposed opencast mining below (-) 22 mRL would only be possible after detail slope stability study vis-à-vis economics of mining is undertaken and feasibility is established by based on their recommendation by any institute of repute. Some new techniques may be gathered from different sources of the country and abroad to win the ores. Therefore, it may not be feasible for backfilling of the quarry in view of production of the chromite reserve below the present envisaged level. In case feasibility of mining up to the envisaged depth is not established, the exhausted voids will be reclaimed with available waste materials from Underground Mining. UG mining is not expected to be affected by keeping the voids of OC mining as such, since there is a provision to be about 40 m barrier in after the floor of OC quarry

	Land use at the start and end of conceptual period			
Sl. No.	**Head**	**Area put on use at start of Scheme of Mining (Ha)**	**land use at the end of the proposed scheme period (Ha)**	**land use at the end of the conceptual period (Ha**
1	Area under mining	17.880	22.022	26.164
2	Storage for top soil	0	0	0
3	Waste dump site	33.178	35.173	31.309
4	Mineral storage	2.210	2.249	2.249
5	Infrastructure (workshop, admin building, colony etc.	1.219	1.071	0.801
6	Roads	1.738	0.686	0.678
7	Railways	0	0	0
8	Tailing pond	0.020	0.020	0.020
9	Effluent Treatment Plant	0.240	0.240	0.240
10	Mineral Separation Plant	0.800	0.702	0.702
11	Township area	0	0	0
12	Others (to specify) - Area towards south east side of dump – 3 and areas where green belt and garland drain has already been developed.	0	2.300	2.300
Grand Total		**57.285**	**64.463**	**64.463**

B. Underground Mining

Detailed Project report was made by reputed Global consultants SRK **(Annexure-21)**for boundary pillar mining to excavate the locked up ore in statutory lease boundary and for underground detailed design report is prepared by an institute of Global repute SINOSTEEL MIMR Co Ltd. **(Annexure-29)** for underground development and stoping operation.

Based on above two studies reports all underground design are proposed based on their recommendation, which are described as below:

i) Mode of entry (adit, incline, shaft, ramp / decline).

Briefly describe the reason for choosing the mode of entry and its location with justification. Describe development and stoping method.

Boundary Pillar Mining (BPM)

The cohesive strength of rocks is far below 1 Mpa (about 42 Kpa) and hence the underground drives cross cuts and other excavations may require heavy supporting system. Underground mining, adopting a conventional and comparatively inexpensive technology in such a friable ore

and highly weathered wall rocks as those of band I will require special mining method called drift and fill mining method. Such friable ore and poor rocks would require development with intensive support and some variant of drift and fill with sand cement mix after stopping operation.

Recovering locked up Chromite Ore of Band I in Opencast Benches by Drift & Fill (D & F) method (called Boundary Pillar Mining for blocked ore in boundary pillar) (Annexure –21 by SRK)

Lower Domain: Below ~94 mRL to the ultimate bottom of the open pit mine (+) 2 mRL

- Overhand Transverse Drift and Fill (O/H D&F)
- The improved competency of the chromite ore allows that the excavation can take place by conventional support (bolting, mesh and or reinforced shotcrete) of the roof of each lift.
- This is a low cost and higher production method than the underhand drift and fill.

Access

- ✓ Access for each level will be from the individual bench levels of 8 m high.
- ✓ For the initial lifts the access will be at the bench level. For the subsequent lifts ramps will be constructed from waste material to attain the required entry elevation.

Open cut

- ➢ Since the ore is close to the surface, rather than leaving a crown pillar containing ore, the ore would be removed in an open cut and a reinforced concrete raft would be constructed.
- ➢ This would then form the roof of the initial underhand drift and Fill development and would then negate the requirement for heavily supported drifting.
- ➢ The open cut would subsequently be backfilled to reinstate the surface and allow traffic.

Brief specifications of the Raft / Slab to replace Crown Pillar:

- Concrete strength = 30 N/mm^2
- Steel reinforcement = 500 N/mm^2
- Slab thickness = 1000 mm
- Bottom reinforcement = 25 mm diameter bars at 200 mm centers, in both directions
- Top reinforcement = 25 mm diameter bars at 200 mm center, in both directions

Drift Portals

The crown of the portal will be supported by bolts and mesh and shotcrete as required after specific geotechnical assessment of the ground conditions at each portal site.

Nominally the portal support will comprise 5 m long bolts fully grouted

Main Drifts: FW Access and HW Ventilation Drive

- The main initial drift of 4 m x 4 m size will be formed at the FW contact. This will be the fresh air intake.
- At the same time, a drift of 4 m x 4 m size will be driven on the HW contact. This will be the exhaust ventilation drift.
- Careful consideration will be given to the support of the initial 5m -10m of each drift beyond the portal.
    - Class of support required in this section –
        - Bolts and Steel Fiber reinforced (SFR) shotcrete
        - 1.8m long, 10t bolt per m^2 and 75mm SFR shotcrete
- The FW and HW drifts will be developed to up to 7.5 m of the Boundary with appropriate roof and wall support.
- This completes the main development prior to transverse stoping on the retreat.

Transverse Stoping and Filling

- The transverse stopes are formed by a series of cross-cuts of 3 m x 3 m size between the FW and HW drifts.
- Alternate stopes and pillars are formed with the pillars being the same span as the stopes.
- The sequence of stoping and filling is established such that the filling is maintained closely behind the stoping.
- Filling is by way of cemented sand fill.
    - Ventilation Stopings will be formed at the intersection of the cross-cuts and the Ventilation Drift.
    - Fill will be placed by loader and rammed to the roof or may use the geo foam.
- The Pillars are subsequently mined as secondary stopes and sequentially filled.
- Finally the FW and HW drifts are backfilled.
  The main difference is in the filling of the underhand stopes and the final drifts as follows:
    - Higher strength fill will be placed in the each of the primary and secondary stopes and the FW access and HW ventilation drifts:
    - The fill will be high strength cemented (nom. 10 - 15%) fill with a specially prepared base reinforcing of mesh and geofabric and webbing straps.
        - This will form the stable roof of the subsequent underhand drifts and stopes.

The locked-up ore mining shall be started in the year 2015-16 from (+) 55 mRL upward in the Eastern Boundary (IMFA side) during the scheme period.

Ventilation shall be established initially by auxiliary ventilation system. Later on one main mechanical ventilator of 22 kW capacities shall be installed at the HW drift, which will cater to the requirement of air during stoping for a quantity of 20 cu. m / sec (**Plate – 16).**

Underground Drift & Fill Method of Mining

Underground mining, adopting a conventional and comparatively inexpensive technology in such a friable ore and highly weathered wall rocks as those of band I & II will require special mining method called drift and fill mining method. Such friable ore and poor rocks would require development with intensive support and some variant of drift and fill with sand cement mix after stopping operation.

In view of the above observation, it is proposed to carry out, a Drift and fill stopping method. The sequence of operations will be as follows:

- The Mode of entry to the Underground mining in Friable zone will be by Declines [(herein referred as Decline-1 and Decline-2 with a common portal], which will be excavated from (+) 100 mRL [The coordinates of Decline-1 portal is Easting- 1345.094, Northing - 569.912, Z -100 m mRL] after approaching from shaft in North South direction, then the decline will be drive along East West direction in the Footwall of the ore body.
- Decline will be excavated at 1 in 8 gradients in friable and 1 in 7 in hard zone and supported with rock bolts, shot Crete and steel sets as per requirement of rock strata (Support class 5).
- Once decline reaches (+) 76 m RL, Decline-1 and decline will be connected at +76 mRL, Decline-2 will progress up and down at the same time.
- Access to ore body will be established through an X-Cut and A Footwall drive shall be driven along the Footwall of the Ore body and cross cuts at every Four meter intervals from (-) 240 mRL to (-) 160 mRL in Band-I and 120 mRL to 0 mRL in Band-II by Overhand Drift & Fill method of mining and cross cuts at every Three meter intervals from (-) 160 mRL to (-) 60 mRL in Band-I and 0 mRL to 120 mRL in Band-II Overhand Drift & Fill method of mining.
- These Cross cuts should be supported by strong supporting system (Rock bolting/shotcreting/ steel support) in all sides. Roof & Floor by high grade fill slab/steel support and 1meter RCC pillar/ steel supports for roof & bottom in 4/3 meter intervals. After proper supporting of the cross cuts the ore between the cross cuts will be mined out. Then adequate supporting system will be adopted for safety & stability for further excavations.

While ore development is being carried out on at (-) 160 mRL and (-) 240 mRL decline- 1 excavation will continue downward to exploit the ore. Similarly decline- 2 excavation will continue downward to exploit the ore below “0” mRL.

This method of Mining adopted in band I, will also be applied to band II for Friable ore mining.

There will be overhand D&F Stoping mining method planned to be applied in Friable Zone of Chromite in Kaliapani chromite mine.

Band I

The scope of mining in Band I will be (-) 60mRL~ (-) 500mRL vertically, this will be in a better condition. The overhand D&F mining method will be selected for extract ore between (-) 60mRL and (-) 240mRL in Band I, the same mining method as selected for extracting ore between 0mRL and -120mRL in Band II; A SLOS & and Filling mining method will be selected for extracting ore between (-) 240mRL and (-) 500mRL in a better condition.

Band II

The ore of Band II is friable, so an Overhand D&F mining method will be selected for extract ore between (+) 0mRL and (+) 120mRL and ore between 0mRL and (-) 120mRL.

Overhand D&F Mining Method

(1) Scope of application

Overhand D&F mining method will be applicable only in Block-1 of Band-II (+0m~120mRL).

(2) Parameters of a stope

Block-1 (+0m~120mRL) will be of 120m interval vertically, it will be divided into 3 sub-blocks vertically, a sub-block will be divided into 3 sublevels vertically, a sublevel will be divided into 4 slices vertically, a slice will be of 3m vertically, refer to Fig 5-1. A stope is defined as a slice with a length of 30m horizontally along with strike.

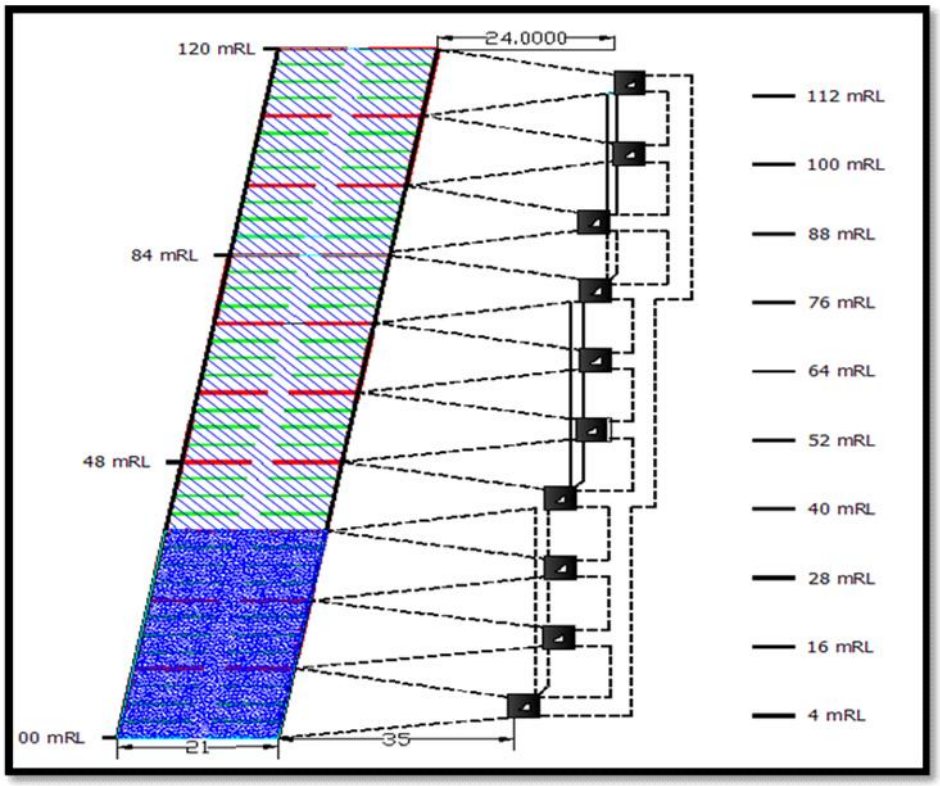


Fig- A Overhand D&F mining method layout in Band II (Block-1)

(3) Cut in Block-1

(1) Drive

Drives will be in waste rock at the footwall of Band II , 24m away from footwall of Band II, they are to be connected to Decline-2 and RAR-2, as well as stepped intake/return air raise for sub-block ventilation, constructed in the period of development. There will be 3 sub-blocks and 4 drives, namely (+) 4 mRL, (+) 40 mRL, (+) 76 mRL, (+) 112 mRL, the maximum vertical interval between drives will be 48m, less than 50m.

(2) Sublevel drive

There will be 2 sublevel drives in sub-block, sublevels will be connected to Decline-2 and stepped intake/return air raise for stope ventilation. Sub-level drives will have the same support as drives.

(3) Staggered return air raise

Ladder equipped return air raises will be for sub-blocks ventilation and second exits. Because RAR-2 will be at eastern side of Lease-1, staggered return air raises also will be at eastern side of block.

(4) Ore pass

As we know, Block-1 will be in bad condition, ore and rock will be very friable; ore passes should be with a small size and supported. The finished diameter of ore pass will 3 m, supported by a steel barrel made of steel plate of 6mm. the space of ore pass will be 60m in Bands II, strike direction, there will be 7 ore passes.

(5) Drift

A drift will be of 3×3m, it will be arranged along with strike of ore body.

(4) Sublevel drive/drift support

Initial sublevel drive/drifts will be supported in class 5, the left sublevel drives/drifts will be supported by beam.

(5) Drilling and blasting

The ore or rock in Block-1 is very friable, there will not be drilling and blasting in Block-1.

(6) Ore drawing

The ore in drifts will be drawn by LHD and unloaded into ore pass.

(7) Stope ventilation

In initial sub-block (+4m~+40mRL), the air flow route will be Decline-1→connector (connection to Decline-1 and Decline-2)→staggered intake air raise→level/sublevel drive→return air raise→RAR2. Auxiliary fan will be adopted for drift ventilation.

(8) Drift filling

Drifts in a stope will be extracted in two phase, initially extracted drifts will be filled in two type of fill placement vertically, the lower part of drift to be filled with a high strength (about 5MPa) fill placement will be 1.0m, the left 2.5m will be filled with a nominal strength (1~2MPa) fill placement. The drifts in phase2 also will be filled in two type of fill placement vertically, the lower part of drift to be filled with a high strength (about 5MPa) fill placement will be 1.0m, the left 2.5m will be filled a fill placement without cement. A high strength (about 5MPa) fill placement requires a 15% of cement, a nominal strength (1~2MPa) fill placement requires a 5 % of cement. The high strength fill placement will be reinforced by steel mesh of Φ18mm and Φ10mm bar in grid of 0.25m×0.25mm, mesh will be 0.2m above a drift floor. Filling with a combination of waste rock may achieve a better effect.

Overhand D&F Mining Method

(1) Scope of application

Overhand D&F mining method will be applicable in Block-2 (0m~-120mRL) in Band II, Block-3 (-60m~-156mRL) in Band I and Block-4 (-156m~-240mRL) in Band I.

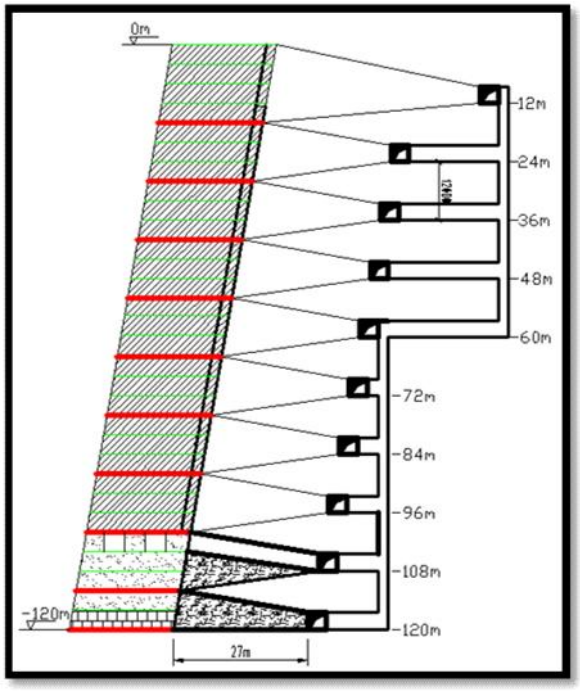


Fig - A overhand D&F mining method layout in Band II (Block-2)

(2) Parameters of a stope

Block-2 (+120m~0mRL) will be of 120m interval vertically, it will be divided into 2 sub-blocks vertically, a sub-block will be divided into 4 or 5 sublevels vertically, a sublevel will be divided into 3 slices vertically, a slice will be of 4m vertically, refer to Fig 5-2. A stope is defined as a slice with a length of 60m horizontally along with strike.

Block-3 (-60m~-156mRL) will be of 96m interval vertically, it will be divided into 2 sub-blocks vertically, a sub-block will be divided into 4 or 2 sublevels vertically, a sublevel will be divided into 3 slices vertically, a slice will be of 4m vertically, refer to Fig 5-3. A stope is defined as a slice with a length of 60m horizontally along with strike.

Block-4 (-156m~-240mRL) will be of 84m interval vertically, it will be divided into 2 sub-blocks vertically, a sub-block will be divided into 4 or 2 sublevels vertically, a sublevel will be divided into 3 slices vertically, a slice will be of 4m vertically, refer to Fig 5-3. A stope is defined as a slice with a length of 60m horizontally along with strike.

(3) Waste Development

(1) Drive

Drives in Block-2 will be in waste rock at the footwall of Band II, 24m away from footwall of Band II, they are to be connected to Decline-2 and RAR-2, as well as stepped intake/return air raise for sub-block ventilation, constructed in the period of development. There will be 2 sub-blocks and 3 drives, namely (-) 12mRL, (-) 60m R, (-) 120m R, the maximum vertical interval between drives will be 60m.

Drives in Block-3 and Block-4 will be at the footwall of Band I, 24m away from footwall of Band I, they are to be connected to Decline-1, RAR1, to stepped intake/return air raise for sub-block ventilation, and to drives at the footwall of Band II drives will be constructed in the period of development.

(2) Sublevel drive

Sublevels will be connected to Decline-1 and Decline-2, and to stepped intake/return air raise for stope ventilation. Sub-level drives will have the same support as drives.

(3) Stepped intake/return air raise

Stepped intake/return air raises will be for sub-blocks ventilation and second exits.

(4) Ore pass

The diameter of ore pass will 3.0m without support, the space of ore pass will be 60m.

(5) Raise for backfill and ventilation

Raise for backfill and ventilation will be in ore at the footwall of ore body with a size of 2.5m×2.5m.

(6) Drift

A drift will be of 4×4m, it will be arranged along with strike of ore body or perpendicularly to strike of ore body.

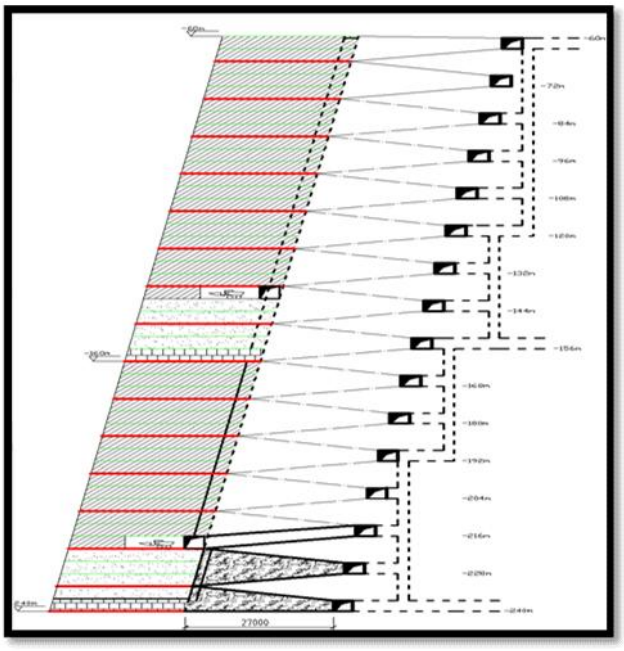


Fig - A overhand D&F mining method layout in Band I (Block-3 and Block-4)

(4) Sublevel drive support

Sublevel drive will be of finished size of 4m (width) × 4m (height). Sublevel drive at below (-) 60mRL will be supported in class 4b; Sublevel drive at (-) 60mRL ~ (-) 120mRL will be supported in class 4a; Sublevel drive at (-) 120m~(-) 240mRL will be supported in class 3.

(5) Drilling and blasting

Weathered ore/rock, fresh ore/rock will occur in zone 0 mRL ~(-) 240mRL, drilling and blasting will be required for mining or excavation. Boomer 281 will be selected for drilling horizontal blasting holes, diameter of blasting holes will be of 42~48mm, depth will be of 3.7m. Chamber will be selected for charging explosive.

(6) Ore drawing

The ore in drifts will be drawn by LHD and unloaded into ore pass.

(7) Stope ventilation

In Block-2 [(-) 120mRL~(-) 60mRL], the air flow route will be Decline-1→air way/drive →stepped intake air raise→level/sublevel drive→return air raise→air way→RAR1/RAR2. Auxiliary fan will be adopted for drift ventilation.

(8) Drift filling

Drifts in a stope will be extracted in two phase, initially extracted drifts will be filled in two type of fill placement vertically, the lower part of drift to be filled with a nominal strength (1~2MPa), fill placement will be 3.5m, the left 0.5m will be filled with a high strength (about 5MPa) fill placement. The drifts in phase2 will be filled in two type of fill placement vertically, the lower part of drift to be filled with a fill placement without cement will be 3.5m, the top of 0.5m will be filled with a high strength (about 5MPa) fill placement.

A high strength (about 5MPa) fill placement requires a 15% of cement, a nominal strength (1~2MPa) fill placement requires a 5 % of cement.

A reinforced high strength fill placement will be required at the bottom of Block-2, Block-3 and Block-4 respectively for the ore mining below, fill placement will be reinforced by steel mesh of Φ12mm and Φ8mm bar in grid of 0.3m×0.3mm, mesh will be 0.2m above a drift floor. Filling with a combination of waste rock may achieve a better effect.

(9) Production capacity of a Block

Production capacity of a Block may be counted by operation cycle time; take a stope in which drifts will be perpendicular to strike of ore body.

(1) Time of blasting hole drilling

Blast hole diameter 48mm, depth 3.7m, effective depth 3.5m, stope width 24m, drift height 4.0m, number of blasting hole 61, total blasting hole 61×3.7m=226m, drilling rate 0.5m/min, drilling time 226m/0.5m/min=452min=7.5h.

(2) Time of explosive charging

Blasting hole will be charged by an explosive truck, charging time 2min per hole, total charging time 61×2 /60=2h.

(3) Time of ventilation soon after blasting

A drift will be ventilated by a local fan, lasting 0.5h.

(4) Time of supporting

It supposed as 4 hours.

(5) Time of ore drawing

Broken ore of one blasting 4×3.5×4×3=168t, LHD rate 70t/h, ore drawing time 168/70=2.4h.

(6) Over sized ore breaking

The rate of oversized ore 5%, 0.25h will be required for a secondary blasting.

Cycle time of is 16.65hrs.

(7) Cycle time of a drift to be mined

A drift will be 25.39m long, cycle time of a drift 25.39m/3.5×16.65= 120.8hrs (6 days) , suppose operating time of 20hrs per day.

(8) Cycle time of a stope to be mined

A stope will consist of 6 drifts, cycle time of a drift 6×6=36d.

(9) Backfill time

Quantity of backfill with cement in a stope 25.39m×16m2×6=2437.44m3, backfill capacity 80m³/h, filling time 2437.44/80=30.47h, operating time per day will be 18h, filling time of a stope will be 1.7d, preparation time for backfill 2d, curing time of backfill placement with cement 14d, waiting time of backfill placement without cement 3d.

Total backfill time will be 1.7+2×2+14+3=22.69d.

(10) Total time of a stope

Total time of a stope will be 37.2+22.69=60d

Underground Mining Operation

Underground mining operation shall be carried out with the following mode of entries.

[1] Decline shaft-I is Common portal for Two Declines, (+) 100 mRL below & Decline - II, (+) 76 mRL down below

[2] Production shaft from (+) 182 mRL & down below

[3] **Return Air Raise-1** from (+) 77 mRL & down below

[4] **Return Air Raise-2** from (+) 182 mRL & down below

Mode of entry to the underground shall be established through Vertical shaft as well as through Declines, which shall serve as main entry to the mine.

[1] The Decline-I collar (+) 100 mRL and decline will be excavated at 1 in 8 gradients up to (-) 500 mRL. The Decline -II will connected from Decline-I at (+) 76 mRL and decline will be excavated at 1 in 8 gradients up to (-) 240 mRL Downward direction and 0 mRL by Upward direction from (+) 76 mRL. This has facility for material handling by means of LHD & LPDT combination and a walk way by means of barricade.

[2] The Vertical Shaft [collar at (+) 182 mRL] of 7.6 m finished diameter will be sunk. It will be started simultaneously at position indicated in the **(Plate No – 12 A to I)** and sunk to a depth of (-) 660 mRL in the Plan period. In the 1st phase Total 3 main levels will be available for first phase of production. The opening of Shaft inset shall be carried out at an interval of 120 meter and 140 meter to carry out man and material winding. One koepe winder with 16 tonne skips will be used for Ore-hoisting

The main level development is to be made at every 120/140m, having connection with Decline and/or vertical shafts from all horizons. However, in vertical shaft the first opening will be at (-) 500 mRL.

It is proposed to access the ore body from the foot wall side by the combination of a Decline and a Vertical Shaft. The size of the Decline shall be of 4.5 m x 4.5 m and will be driven at 1 in 7/8 gradients. The finished diameter of the shaft will be 7.6m. Both the decline and the shaft will be lined as per the condition of the ground through which they would pass.

[3] The Return Air Raise-1 [collar at (+) 77 mRL] of 5m finished diameter will be sunk. The coordinates of RAR-2 collar is E 1366.651, N 669.141, Z (+) 77mRL It will be started simultaneously at position indicated in the **(Plate No – 12 A to I)** and sunk to a depth of (-) 240 mRL in the Plan period. There will be six insets connect to RAR1 i.e.(-)60mRL, (-)120mRL, (-)144mRL, (-)192mRL &(- -240mRL.

[4] The Return Air Raise-2 [collar at (+) 182 mRL] of 4m finished diameter will be sunk. The coordinates of RAR-2 collar is E 1025.000, N 036.970, Z (+) 182mRL. It will be started simultaneously at position indicated in the **(Plate No – 12 A to I)** and sunk to a depth of (-) 240 mRL in the Plan period. There will be 6 insets connect to RAR-2, (+) 112mRL, (+) 76mRL, (+) 40mRL, (+) 4mRL, (-) 60mRL, (-) 120mRL.

There will be one mining method Sub Level Open Stoping (SLOS& and Filling), planned to be applied in Kaliapani chromite mine.

Band I

A SLOS & and Filling mining method will be selected for extracting ore between (-) 240mRL and (-) 500mRL in a better condition.

Production from Band-I planned below (-) 240mRL till (-) 500 mRL will be by Sub Level Open Stoping methods with backfill, (SLOS&F). The relatively lumpy and hard rock below will be amenable for this method which can achieve higher production levels due to the wider stope widths.

SLOS (Sub Level Open Stope) & Filling Mining Method

(1) Scope of application

SLOS & Filling Mining Method will be applicable in Block-5 [(-) 240mRL~(-) 380mRL] in Band I, Block-6 [(-) 380mRL~(-) 500mRL) in Band I.

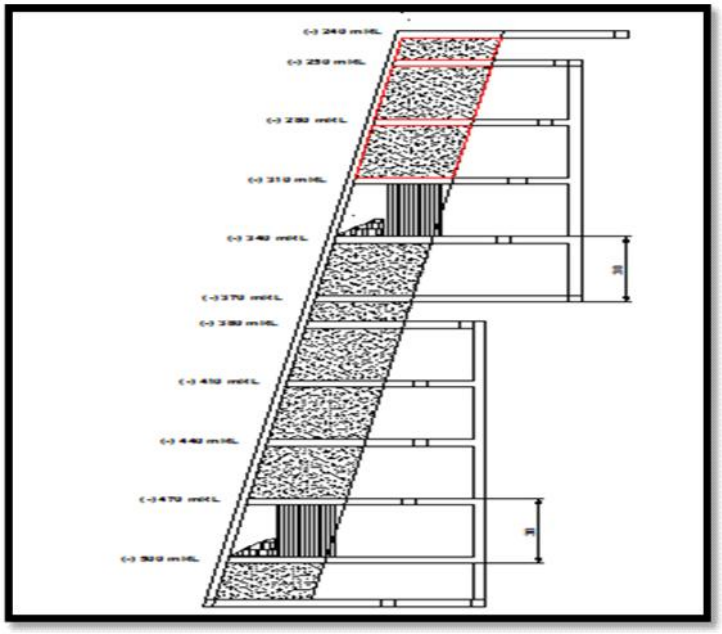


Fig - A SLOS and Filling mining method layout in Band I (Block-5 and Block-6)

(2) Parameters of a stope

Block-5 [(-) 240mRL ~(-) 380mRL] or Block-6 [(-) 380mRL~(-)500mRL) will be of 140m & 120m interval vertically, it will be divided into 8 sublevels vertically at 30 m and 1 Sublevels at 20 m Vertically, first sublevel will be (-)350mRL~(-) 380mRL in Block-5 and (-)500mRL~(-)470mRL in Block-6, Refer to Fig 5-4. A stope is defined as a sublevel with a length of 30m horizontally along with strike.

(3) Waste Development

(1) Drive

Drives in Block-5 and Block-6 will be at the footwall of Band I, about 30m away from footwall of Band I, they are to be connected to Decline-1, to stepped intake/return air raise for sublevel ventilation, and to production shaft. Drives will be constructed in the period of development.

(2) Sublevel drive

Sublevels will be connected to Decline-1 and to stepped intake/return air raise for stope ventilation. Sub-level drives will have the same support as drives. Sublevels will be way for drilling and ore drawing.

(3) Stepped intake/return air raise

Stepped intake/return air raises will be for sublevel ventilation and second exits.

(4) Ore pass

The diameter of ore pass will 3.0m without support, the space of ore pass will be 150~200m. A

(5) Raise for backfill and ventilation

Raise for backfill and ventilation will be in ore at the footwall of ore body with a size of 2.5m×2.5m.

(a) Sublevel drive support

Sublevel drive will be of finished size of 4m (width)×4m(height). Sublevel drive between -240m ~-370mRL will be supported in class2, between -380m~-500mRL in class1.

(6) Drilling and blasting

Block-5 and Block-6 will be in fresh rock zone, drilling and blasting will be required for mining or excavation. Simba 1354 will be selected for drilling up fan-shaped blasting holes, diameter of blasting holes will be of 60~65mm, maximum depth of blasting hole will be of 21m.

(i) Ore drawing

The ore stopes will be drawn by LHD and unloaded into ore pass.

(7) Stope ventilation

Take an example of Block-5 (-240mm~-380 RL), the air flow route will be PS→drive at -380mRL→stepped intake air raise→level/sublevel drive→return air raise→drive at -240mRL→ air way→RAR1/RAR2.

Auxiliary fan will be adopted for drift ventilation.

(8) Stope filling

Stopes will be extracted in two phase, initially extracted drifts will be filled with a nominal strength (1~2MPa), the fill placement will stand 20m high, the stopes in phase2 will be filled with dump waste delivered by pump without cement.

At the top of fill placement will be covered with a layer of 0.5m high strength (about 5MPa) fill placement.

A high strength (about 5MPa) fill placement requires about 15% of cement, a nominal strength (1~2MPa) fill placement requires about 5 % of cement.

A reinforced high strength fill placement will be required at the bottom of Block-5 and Block-6 respectively for the ore mining below, fill placement will be reinforced by steel mesh of Φ12mm and Φ8mm bar in grid of 0.3m×0.3m, mesh will be 0.2m above a drift floor.

Filling with a combination of waste rock may achieve a better effect.

(9) Production capacity of a Block

Production capacity of a Block may be counted by operation cycle time.

(1) Time of blasting hole drilling

Blast hole will have been finished before blasting; there will no time taken into consideration.

(2) Time of explosive charging

Blasting hole will be charged by an explosive truck, charging rate 230kg/h, quantity of explosive in a row (170-20)×3.217=483kg, charging time 483 /230=2.1hrs.

(3) Time of ventilation soon after blasting

A drift will be ventilated by a local fan, lasting 0.5h.

(4) Time of roof treatment

It will be supposed as 2hrs.

Time of ore drawing

Broken ore of one blasting 15×20×1.5×3.5=1575t, LHD rate 100t/h, ore drawing time 1575/100=15.75hrs.

(5) Over sized ore breaking

The rate of oversized ore 5%, 0.5h will be required for a secondary blasting.

Cycle time of ①~⑥ will be 20.85h

(6) Cycle time of a stope to be mined

Thickness of ore body will be 25.39m, cycle time of a drift 25.39m/1.5×20.85=352.9h, suppose time of shift change will be 1h, cycle time of mining in a stope will be 352.9+3×14.7=411.7hrs, amounting to 20.6d.

(7) Backfill time

Quantity of backfill with cement in a stope 25.39m×15m×20m=7617m3, backfill capacity 80m³/h, filling time 7617/80=95.2h, operating time per day 18h, filling time of a stope 95.2/18=5.3d, preparation time for backfill 3d, curing time of backfill placement with cement 28d, waiting time of backfill placement without cement 7d. Total backfill time will be 5.3+3+28=36.3d.

(8) Total time of a stope

Total time of a stope will be 20.6+36.3=57d

Production capacity of a stope:

A Stope will be 30 meter long, reserve shall be 25.39 m (Width) X 30 m (Length) X 30 m(Height)X3.5 (Density)= 79978t, production capacity of stope 79978/57d= 1403.12 t/d, amounting to 0.14 MTPA

The length of Band I is of about 420m, there should be 4 stopes in production, 4 stopes in in preparation, 4 stopes in development, production capacity will achieve 0.45 MTPA in a Block.

(iii) Underground layout

Attach a note briefly describing the underground layout using longitudinal sections / longitudinal vertical projection and level plans where necessary indication;

- Sizes and intervals of levels and raises / winzes with proper reasoning

- proposed year wise level wise extent of development for five years along with the support system

(1) Main level drives

There will be 9 levels to be developed during construction period in project phase1. 6 levels: (+) 112mRL, (+) 76mRL, (-) 60mRL, (-) 120mRL, (-) 160mRL, (-) 240mRL will be in friable zones; 3 levels, (-) 240mRL, (-) 380 mRL and (-) 500mRL will be in hard zones. Every main level drive will be connected to declines.

(2) Dimension of drives

Drives at two levels in strong weathered zone, (+) 112mRL and (+) 76mRL will serve for LHD and mine trucks, with a size of 4×4m mining in this block may be with no blasting;

Drives at five levels (-) 60mRL, (-) 120mRL, (-) 160mRL will serve for Explosive Truck, Mine truck, Boomer281 and LHD moving, of which will be Explosive Truck with the largest dimension of 2.5m (width)×2.6m(height), the size of drives is designed as 4m(width)×4m(height), mining in this block with blasting of horizontal hole drilled by the Boomer281;

Drives at three levels (-) 240mRL, (-)380 mRL, (-) 500mRL will serve for Explosive Truck, Mine truck, Boomer281, Simba1354, Head Roader and LHD moving, of which will be Simba1354 with the largest dimension of 2.43m (width)×3.075m(height), air intake, the size of drives is designed as 4.5m(width)×4.5m(height), mining in this block will be with blasting of fan-shaped hole drilled by Simba1354.

(3) Drives support

Drives for mining in BAND-2 will be supported in 5 classes: (+) 100mRL(portal)~(+) 76mRl in class1, (+) 76mRL~(-) 60mRL in class 4b, (-) 60mRL~(-) 120mRL in class 4a, (-)120mRL~(-)240mRL in class 3, (-) 240mRL~(-) 380mRL in class 2, (-) 380 mRL~(-) 500mRL in class 1; Drives for mining in BAND-1 will be supported in 4 classes: (+) 112mRL~(+) 76mRL in class 5, (+) 76mRL~0mRL in class 4b, 0mRL~(-) 60mRL in class 3, (-) 60mRL~(-) 120mRL in class 2.

The first Level connected from Shaft at (-) 500 mRL, this level shall be considered as Extraction level for first stope block. After that at 30 meter interval (-) 470 mRL one drive shall driven and this level shall considered as drilling levels for first stope block-6. Similarly in Block-5 one Extraction level at (-) 380 mRL and (-) 350 mRL shall be Drilling level of that stope block. The mining methods for Band 1 and Band

2 (Hard Zone) are designed as sublevel stoping and filling. In the drilling level two ore drives shall be carried out in Footwall and Hanging wall to carry out drilling for stopping.

Decline-1 and Decline -2 will be connected to all the levels and sub levels for mobility of Man and Materials.

Support Classes

A simplified Barton's Q chart has been used to define the support. The RMR/ Q values have been used together with the proposed excavation dimensions. Five broad classes of support have been identified which cover the development and stoping excavations. Barton's Tunnelling support chart has been adapted for mining conditions. Cognizance of the Indian conditions and the availability of support materials have been taken into account should alternative materials be proposed going forward these should be assessed for suitability Table below provides details for each support class

Lattice girder arches are preferred over solid steel arches especially for the highly weathered ground, as they are more easily manoeuvrable, are more amenable to shotcreting and can be fabricated to the required specification locally.

Excavation Dimensions and Support

Allowable stope dimensioning for the preferred mining methods has been considered with the knowledge of the ground conditions to hand. The level of support needed to secure the stability of the openings is a function of the stope dimensions (in particular the stope span) and the ground conditions. The following presents the proposed excavation dimensions and support classes for the proposed mining methods. The ESR (Excavation Support Ratio) values which are inherent to the support estimation (see the Table below) are:

Support Classes Roof Support Class	Support Details	Equivalent Reinforcement Categories in Support Chart
Class 1	Systematic Spot Bolting (ut) 1 bolt per 4m2	1,2,3
Class 2	1 bolt per 2m2 (ut) + 25mm shotcrete unreinforced	4
Class 3	1 bolt per 2m2 (ut) + straps + + 25mm shotcrete fiber reinforced	5
Class 4a	1 bolt per 2m2 (ut) + 50mm shotcrete fiber reinforced	6
Class 4b	1 bolt per 2m2 + 75mm shotcrete fiber reinforced	7
Class 5	1 bolt per 1m2 + 100mm shotcrete fiber reinforced, or Lattice Girders + 100mm shotcrete fiber reinforced. or Steel arches/sets at 1.0m centers, tied into the rock and properly braced	8

Support classes of Decline, drive, cross cut, sublevel, air way, etc.

Size	Location	Support class	
		Band 1	Band 2
4.5x4.5m, 4.0x4.0m, 3.0x3.0m,	Above +76mRL	Class 5	Class 5
	+76m~0mRL	Class 4b	Class 4b
	0m~-60mRL	Class 4b	Class 3
	-60m~-120RL	Class 4a	Class 2
	-120m~-240mRL	Class 3	
	-240m~-370mRL	Class 2	
	-370m~-500mRL	Class 1	

Production Drift dimensions and support requirements

production drift	Domain 1	Domain 2	Domain 3	Crown/sill	Rib	boundary
Dimensions	4m×4m	4m×4m	4m×4m	0.5	5	7.5
Support class	3~4	2~3	2~1	RCC M25		

SLOS and Fill Stope dimensions and General Support Requirements

	Domain 3
Dimensions	15m span
Support class	2~1

Underground development proposed in the Plan period.

(I) (a) Underground Mine Working (2015-16)

Production Shaft	Top RL of Shaft	(+) 182 mRL
	Bottom RL of Shaft	(-) 378 mRL
	Meters of Shaft	560 meter
Return Air Raise (RAR-1)	Top RL of Shaft	(+) 77 mRL
	Bottom RL of Shaft	(-) 240 mRL
	Meters of Shaft	317 meter
Return Air Raise (RAR-2)	Top RL of Shaft	(+) 182 mRL
	Bottom RL of Shaft	(-) 120 mRL
	Meters of Shaft	302 meter
Decline-1	Top RL of Decline	(+) 100 mRL
	Bottom RL of Decline	(+) 50 mRL
	Meters of Decline	375 meter
Decline-2	Top RL of Decline	(+) 76 mRL
	Bottom RL of Decline	(+) 63 mRL
	Meters of Decline	124 meter
(+) 76 mRL	Waste Drive	330 meter
(+) 117 mRL	Waste Drive	100 meter
(-) 82 mRL	Waste Drive	80 meter
(-) 120 mRL	Waste Drive	130 meter
(-) 160 mRL	Waste Drive	90 meter
(-) 240 mRL	Waste Drive	20 meter
Total		**2328 meter**

(I) (b) Underground Development & production (2015-16)

Development	Total length in meter	Waste in CuM	Ore in CuM	Ore in MT
Sinking of Production Shaft from (+) 182 mRL to (-) 378 mRL	560 meter	101565	Nil	Nil
Sinking of RAR-1 Shaft from (+) 77 mRL to (-) 240 mRL	317 meter	24885	Nil	Nil
Sinking of RAR-1 Shaft from (+) 182 mRL to (-) 120 mRL	302 meter	15172	Nil	Nil
Decline-1 from (+) 100 mRL to (+) 50 mRL	375 meter	4050	Nil	Nil
Decline-2 from (+) 76 mRL to (+) 63 mRL	124 meter	2511	Nil	Nil
Waste Drives	420 meter	6400	Nil	Nil
Adit/Ore Drive (+) 55 mRL to (+) 95 mRL in Eastern Boundary	3738 meter	0	33645	100935
Total	**5836 meter**	**154583**	**33645**	**100935**

(II) (a) : Underground Mine Working (2016-17)

Production Shaft	Top RL of Shaft	(-) 378 mRL
	Bottom RL of Shaft	(-) 660 mRL
	Meters of Shaft	282 meter
Decline-1	Top RL of Decline	(+) 50 mRL
	Bottom RL of Decline	(-) 17.5 mRL
	Meters of Decline	750 meter
Decline-2 (Upward)	Top RL of Decline	(+) 76 mRL
	Bottom RL of Decline	(+) 117 mRL
	Meters of Decline	402 meter
Decline-2 (Downward)	Top RL of Decline	(+) 63 mRL
	Bottom RL of Decline	(-) 12 mRL
	Meters of Decline	770 meter
(-) 660 mRL	Waste Drive	40 meter
(-) 630 mRL	Waste Drive	20 meter
(-) 580 mRL	Waste Drive	20 meter
(-) 545 mRL	Waste Drive	80 meter
(-) 515 mRL	Waste Drive	80 meter
(-) 500 mRL	Waste Drive	1750 meter
(-) 380 mRL	Waste Drive	15 meter
(+) 0 mRL	Waste Drive	450 meter
(+) 6 mRL	Waste Drive	350 meter
(+) 76 mRL	Waste Drive	440 meter
(-) 100 mRL	Waste Drive	10 meter
(-) 104 mRL	Waste Drive	10 meter
(-) 108 mRL	Waste Drive	10 meter
(-) 112 mRL	Waste Drive	10 meter
(-) 116 mRL	Waste Drive	10 meter
(-) 120 mRL	Waste Drive	160 meter
(-) 160 mRL	Waste Drive	470 meter
(-) 240 mRL	Waste Drive	90 meter
(+) 0 mRL	Ore Drive	1230 meter
Total		**7449 meter**

(II) (b) Underground Development & production (2016-17)

Development	Total length in meter	Waste in CuM	Ore in CuM	Ore in MT
Sinking of Production Shaft from (-) 378 mRL to (-) 660 mRL	282 meter	5711	Nil	Nil
Decline-1 from (+) 50 mRL to (-) 17. 50 mRL	750 meter	15188	Nil	Nil
Decline-2 from (+) 76 mRL to (+) 117 mRL	402 meter	8141	Nil	Nil
Decline-2 from (+) 63 mRL to (-) 12 mRL	770 meter	15593	Nil	Nil
Waste Drives	4015 meter	76152	Nil	Nil
Ore Drives	1230 meter	0	11070	33210
Adit/Ore Drive (+) 37 mRL to (+) 55 mRL in Eastern Boundary	3727 meter	0	33546	100639
Total	**11176 meter**	**120785**	**44616**	**133849**

(III) (a) : Underground Mine Working (2017-18)

Decline-1	Top RL of Decline	(-) 17.5 mRL
	Bottom RL of Decline	(-) 100 mRL
	Meters of Decline	850 meter
Decline-2 (Downward)	Top RL of Decline	(-) 12 mRL
	Bottom RL of Decline	(-) 87 mRL
	Meters of Decline	790 meter
(-) 500 mRL	Waste Drive	1276 meter
(-) 380 mRL	Waste Drive	1408 meter
(-) 240 mRL	Waste Drive	1575 meter
(-) 160 mRL	Waste Drive	425 meter
(-) 120 mRL	Waste Drive	150 meter
(-) 60 mRL	Waste Drive	380 meter
(+) 3 mRL	Waste Drive	20 meter
(+) 3 mRL	Ore Drive	520 meter
(+) 0 mRL	Ore Drive	1400 meter
(-) 120 mRL	Ore Drive	2050 meter
(-) 160 mRL	Ore Drive	340 meter
Raise (-) 380 mRL to (-) 240 mRL	Raise in Waste	140 meter
Raise (-) 380 mRL to (-) 515 mRL	Raise in Waste	135 meter
Raise (-) 500 mRL to (-) 380 mRL	Raise in Waste	600 meter
Total		**12059 meter**

(III) (b) Underground Development & production (2017-18)

Development	**Total length in meter**	**Waste in CuM**	**Ore in CuM**	**Ore in MT**
Decline-1 from (-) 17.50 mRL to (-) 100 mRL	850 meter	17213	Nil	Nil
Decline-2 from (-) 12 mRL to (-) 87 mRL	790 meter	15998	Nil	Nil
Ventilation Raise (-) 500 mRL to (-) 380 mRL	360 meter	10173	Nil	Nil
Ventilation Raise (-) 380 mRL to (-) 240 mRL	140 meter	3956	Nil	Nil
Transfer Raise (-) 500 mRL to (-) 380 mRL	240 meter	6782	Nil	Nil
OT Raise (-) 515 mRL to (-) 380 mRL	135 meter	3815	Nil	Nil
Waste Drives	5234 meter	98199	Nil	Nil
Ore Drives	4310 meter	0	55520	166560
Adit/Ore Drive (+) 21 mRL to (+) 37 mRL in Eastern Boundary	4094 meter	0	36844	110531
Total	**16153 meter**	**156136**	**92364**	**277091**

(IV) (a) : Underground Mine Working (2018-19)

Decline-1	Top RL of Decline	(-) 100 mRL
	Bottom RL of Decline	(-) 175 mRL
	Meters of Decline	830 meter
Decline-2 (Downward)	Top RL of Decline	(-) 87 mRL
	Bottom RL of Decline	(-) 120 mRL
	Meters of Decline	374 meter
(-) 380 mRL	Waste Drive	845 meter
(-) 112 mRL	Waste Drive	300 meter
(-) 160 mRL	Waste Drive	90 meter
(-) 120 mRL	Waste Drive	470 meter
(-) 60 mRL	Waste Drive	360 meter
(+) 3 mRL	Ore Drive	2150 meter
(-) 112 mRL	Ore Drive	3110 meter
(-) 160 mRL	Ore Drive	2700 meter
(-) 240 mRL	Ore Drive	3040 meter
(-) 380 mRL	Ore Drive	600 meter
(-) 500 mRL	Ore Drive	600 meter
Raise (-) 380 mRL to (-) 240 mRL	Raise in Waste	420 meter
Raise (-) 60 mRL to (-) 82 mRL	Raise in Waste	44 meter
Raise (-) 120 mRL to (-) 82 & (-) 160 mRL	Raise in Waste	78 meter
Total		**16011 meter**

(IV) (b) Underground Development & production (2018-19)

Development	**Total length in meter**	**Waste in CuM**	**Ore in CuM**	**Ore in MT**
Decline-1 from (-) 100 mRL to (-) 175 mRL	830 meter	16808	Nil	Nil
Decline-2 from (-) 87 mRL to (-) 120 mRL	374 meter	7573	Nil	Nil
Ventilation Raise (-) 380 mRL to (-) 240 mRL	140 meter	3956	Nil	Nil
Ventilation Raise (-) 120 mRL to (-) 82 & (-) 160 mRL	78 meter	2204	Nil	Nil
OT Raise (-) 380 mRL to (-) 240 mRL	280 meter	7912	Nil	Nil
Waste Drives	2065 meter	37360	Nil	Nil
Ore Drives	12220 meter	0	185250	567900
Adit/Ore Drive (+) 10 mRL to (+) 21 mRL in Eastern Boundary	3807 meter	0	34259	102776
Total	**19794 meter**	**75813**	**219509**	**670676**

(V) (a) : Underground Mine Working (2019-20)

Decline-1	Top RL of Decline	(-) 175 mRL
	Bottom RL of Decline	(-) 250 mRL
	Meters of Decline`	740 meter
(-) 160 mRL	Waste Drive	545 meter
(+) 6 mRL	Waste Drive	825 meter
(-) 104 mRL	Waste Drive	150 meter
(-) 156 mRL	Waste Drive	150 meter
(-) 236 mRL	Waste Drive	150 meter
(-) 240 mRL	Waste Drive	718 meter
(-) 120 mRL	Waste Drive	300 meter
(+) 6 mRL	Ore Drive	2650 meter
(+) 0 mRL	Ore Drive	500 meter
(-) 104 mRL	Ore Drive	2050 meter
(-) 112 mRL	Ore Drive	980 meter
(-) 152 mRL	Ore Drive	400 meter
(-) 156 mRL	Ore Drive	2214 meter
(-) 232 mRL	Ore Drive	400 meter
(-) 236 mRL	Ore Drive	2214 meter
Raise (-) 160 mRL to (-) 120 & (-) 240 mRL	Raise in Waste	280 meter
Raise (-) 120 mRL to (-) 82 mRL	Raise in Waste	38 meter
Raise (-) 240 mRL to (+) 77 & (-) 160 mRL	Raise in Waste	397 meter
(-) 500 mRL to (-) 470 mRL	Stope	215 meter
(-) 380 mRL to (-) 340 mRL	Stope	215 meter
Total		**16131 meter**

(V) (b) Underground Development & production (2019-20)

Development	Total length in meter	Waste in CuM	Ore in CuM	Ore in MT
Decline-1 from (-) 175 mRL to (-) 250 mRL	740 meter	14985	Nil	Nil
Raise (-) 160 mRL to (-) 120 & (-) 240 mRL	280 meter	7912	Nil	Nil
Raise (-) 240 mRL to (+) 77 & (-) 160 mRL	38 meter	770	Nil	Nil
Raise (-) 240 mRL to (+) 77 & (-) 160 mRL	397 meter	11219	Nil	Nil
Waste Drives	2688 meter	52051	Nil	Nil
Ore Drives	11408 meter	0	160478	481434
Stope (-) 500 mRL to (-) 470 & (-) 380 mRL to (-) 340 mRL	350 meter	0	5599	918566
Adit/Ore Drive (+) 10 mRL to (+) 40 mRL in Western Boundary	6896 meter	0	62062	186186
Total	**22797 meter**	**86937**	**228139**	**1586186**

Summary of Underground Mining Ore and OB/waste production from 2015-2016 to 2019-2020

Year	Boundary Pillar Mining		Underground Mining Conventional				Total	
	Ore Dev in Meter	Ore in Tonne	Ore Dev in Meter	OB Dev in Meter	Ore in Tonne	Stoping	OB/Waste in CuM	Ore in Tonnes
2015-16	3738	100935	Nil	2098	Nil	Nil	154583	100935
2016-17	3727	100639	1230	6219	33210	Nil	120785	133849
2017-18	4094	110531	4310	7749	166560	Nil	156136	277091
2018-19	3807	102776	12220	3767	567900	Nil	75813	670676
2019-20	6896	186186	11408	4141	481434	918566	86937	1586186
Total	**22262**	**601067**	**29168**	**23974**	**1249104**	**918566**	**594254**	**2768737**

Summary of Ore production from Regular Opencast Mining (Band- I) & Joint Mining with M/S JSL,, Boundary Pillar Mining and Conventional Underground Mining (2015-2016 to 2019-2020)

Year	Regular Opencast Mining & Joint Mining with M/S JSL (Band-I)	Underground			Total Ore (tonnes)
		Boundary Pillar Mining (Band-I)	Underground Mining Conventional (Band-I & II)		
	Ore (tonnes)	Ore (tonnes)	Ore in Tonne	Stoping	
2015-16	505746	100935	Nil	Nil	606681
2016-17	504469	100639	33210	Nil	638318
2017-18	518578	110531	166560	Nil	795669
2018-19	253407	102776	567900	Nil	924083
2019-20	106619	186186	481434	918566	1692805
Total	**1888819**	**601067**	**1249104**	**918566**	**4657556**

Summary of OB/waste production from Regular Opencast Mining (Band- I) & Joint Mining with M/S JSL, Boundary Pillar Mining and Conventional Underground Mining (2015-2016 to 2019-2020)

Year	Regular Opencast Mining & Joint Mining with M/S JSL (Band-I)	Underground		Total OB (CuM)
		Boundary Pillar Mining (Band-I)	Underground Mining Conventional (Band-I & II)	
	OB (CuM)	OB (CuM)	OB/Waste in CuM	
2015-16	1716031	0	154583	1870614
2016-17	1108750	0	120785	1229535
2017-18	837281	0	156136	993417
2018-19	900844	0	75813	976657
2019-20	458750	0	86937	545687
Total	**5021656**	**0**	**594254**	**5615910**

iii) System of drilling and blasting

Drilling pattern in ore	Wedge Cut pattern Explosive 22.5 Kg,30 Holes.
Drilling pattern in Rock	Wedge Cut pattern Explosive 22.5 Kg,30 Holes.
Drilling pattern in Stopes	Long hole ring drilling pattern. Ring to ring spacing 1.5 m and toe spacing 1.2 m with 57 mm dia hole by simba Machine. Maximum one ring to two rings can be taken in one round.
Maximum number of holes blasted in a round.	It depends on the ring design on the basis of cross section.
Charge per round (Kg)	It also depends on the drilling pattern. about 1.2 Kg explosive comes in one meter of simba hole. The charge pattern will be first hole full charge second hole 2/3 charge and third hole 1/3 of charge so overall explosive charge comes is 65-66% only this is done by taking into account the influence of the explosive.
Charge per hole (kg)	It is differential charging.
Type of explosive	Slurry Explosive
Powder factor (Norms) Rock development, Ore development & Stope	1.3 ton/Kg, 1.2 Ton/Kg, 1.3-1.4, 6-7.5 Ton/Kg
Powder Factor (Actual) Rock development, Ore development & Stope	1.2-1.3,1.1-1.2 & 5.5- 6.5

iv) Method and sequence of stoping

Longitudinal sections indicating broad parameters in the table below. In case it is open stoping attach a Geo technical report from a National Reputed agency on stability of open stopes. In case of filled stopes the detail of filling method to be described with supporting plans and sections. Broader thumb rule in respect of development be considered.

(a) Stope Parameter:

1. Number of Working Stopes.

At present Underground mining is in proposal stage. So No stope working is going on.

2. Size of the panel

Size of the panel is considered for D & F is 20×20 m and for SLOS it is 30 X 30 m

3. Level Interval

In Drift & Fill mining method level intervals are 3m X 3m and 4m X 4m and in SLOS method the level intervals is 30X30m.

4. Thickness of Crown Pillar

The thickness of crown pillar is about 48 meter from (-) 22 mRL to (-) 60 mRL and (-) 380 mRL to (-) 370 mRL) of 10 meter is kept for Band-I and Crown Pillar (+) 140 mRL to (+) 120 mRL, (-) 120 mRL to (-) 130 mRL) for Band-II for safety and stability of Underground working.

5. Thickness of Sill Pillar

The thickness of Sill pillar about 10 meter is kept between (-) 500 mRL to (-) 520 mRL) for Band-I for safety and stability of Underground working.

6. Thickness of Rib Pillar

There is no RIB pillar as per the stope design.

7. Size and Interval of Stope Pillar

Stope pillar of 10 meter kept at interval of 120 meter for safety and stability of Underground working.

8. Size and Shape of Manway

The finished diameter of Manway pass will 3 m dia, supported by a steel barrel made of steel plate of 6mm in soft zone and without support in hard zone.

9. Size/shape of ore pass

The finished diameter of ore pass will 3 m, supported by a steel barrel made of steel plate of 6mm in soft zone and without support in hard zone.

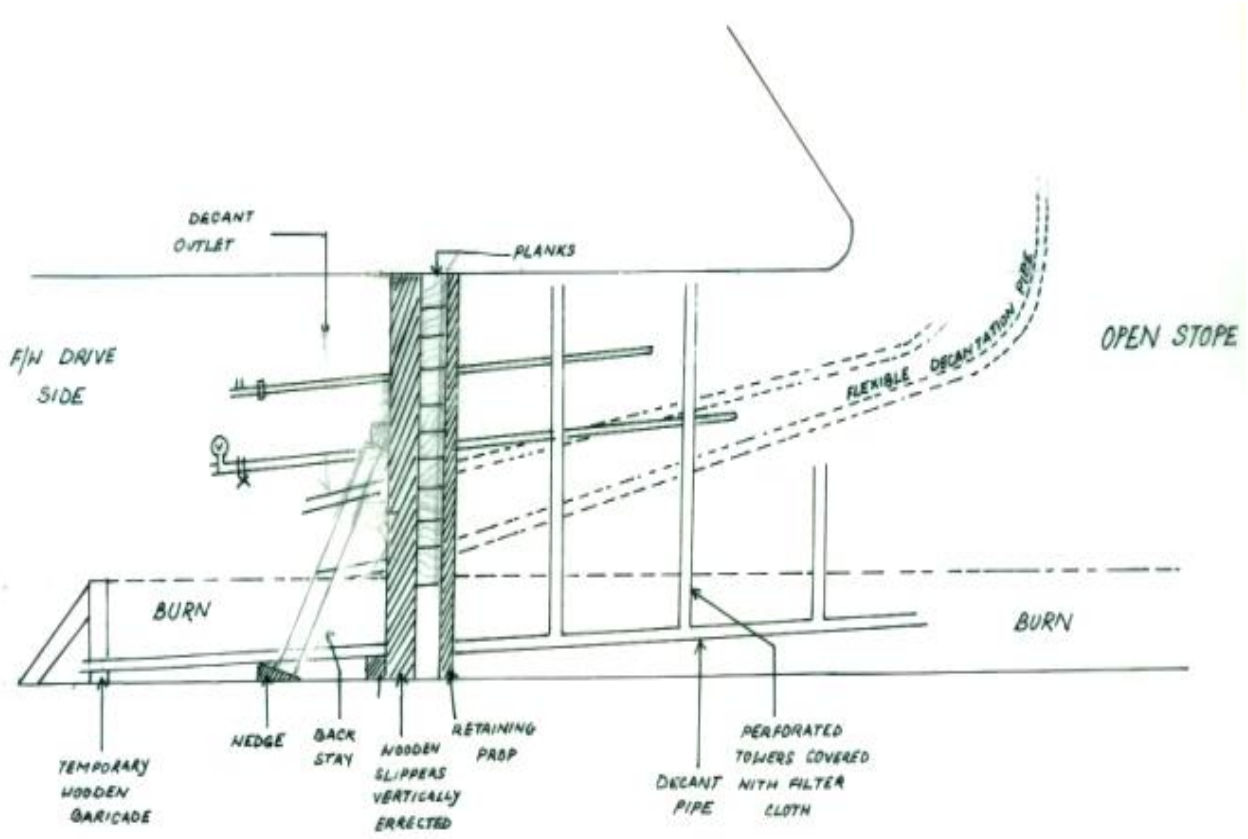
10. Method of stowing/back filling

The final stope excavation is planned to be filled using a hydraulically placed sand and cement mixture according to a sequence that ensures mining proceeds on a continuous basis commencing from the base of a mining block. The base of every main block will be filled with

reinforced high strength fill material. This high strength fill would enable mining lower block up to the base of the upper block. The filled Sub block 1 will work as the working platform for mining of sub block 2, and the stope will progress upward. Details of the backfilling will be presented in a separate, specific backfill section.

11. Method of drainage of stowed water

Find the schematic diagram showing tentative method of water decantation from back filled stope with all the monitoring parameters.



(a) Filling Operation

Average pulp density shall be 1.6 to 1.65. Pulp density should not exceed 1.80 as it may cause pipeline jamming. Measurement of pulp density on continuous basis, recorded in a bound register at every half an hour interval at the fill plant, filling will be suspended if the pulp density falls below 1.60. Pulp density measurement will be carried out at mines near borehole point at surface at every 15 minutes interval by the mine department. Mining mate, superior official in his presence will measure the pulp density fill discharge

place during filling shift at least once and record the same in shift inspection report. Fill size distribution before addition of cement will be maintained such that -400 mesh fines are below 7 %. The testing of cyclone underflow at the fill plant for size distribution is to check the functioning of the cyclones. If the fines (-400 mesh size) exceed 17%, corrective measures will be taken by mill department. Checking the apex valve of the hydro cyclones once in a fortnight to ensure that excess fines are not produced due to wearing of valve, worn out valve will be replaced in time.

(b) Percolation test

Fill samples, collected from FST under flow will be subjected to percolation test by the Civil Department after every 14 days. Percolation rate < 10cm/hr, would be reported by Civil department to the mill and mining department for corrective action. Cemented fill samples will be collected at the fill borehole site at every 15 minutes one composite sample mould will be casted at the site. Curing of sample in moist condition on sand beds and tested for, compressive strength at suitable time interval of 7 days, 14 days, and 28 days by the Civil department. Uniaxial Compressive Strength (UCS) after 28 days of curing period will be not less than 8kg/cm2 for 10% cemented fill.

(c) Water balance measurement through V notch system, erected in the main & adjoining panels.

Ponding not be allowed to exceed 1.50 m height above the settled fill level at any point in the stope. Daily record of the same shall be maintained at the mine in a bound book. The rate of cement, added to fill at the fill plant shall be maintained by the mill department to match the pulp density of the slurry to obtain the right percentage of cement being mixed every hour, as per the requirement of the mines. During the pipe line flushing and during low pressure periods necessary intimations shall be given by the mill to the mine official at the filling point and excess water shall be bypassed at the surface borehole site by mine department. To ensuring quality of cement used at the cement plant by obtaining necessary certificates of its grades and quality from the manufacturers/suppliers. Minimum of 4 decant pipes shall be installed for each filling stage. These will be evenly placed along footwall. The mine official will ensure that fills slurry poring along the footwall during filling operation. The minimum height of fill plug will be 7m above the level. Plug will be given a minimum curing period of 7 days before commencement of filling. The plug will have 10% cemented fill. The height of the plug will be ensured both by fill volume calculation and by direct measurement from upper level. The horizontal

length of plug behind barricade will be not less than 6 m from the brow points. The pressure gauges will be installed to monitor the hydrostatic pressure build up. The main fill barricade will be further reinforced by a mini barricade, of height not less than 1.5m. The fill level RL inside the stope will be measured and recorded once in every week.

v) System of underground transportation:

1. From face to pit bottom or loading point

The ore extracted from face or stope will be transferred by combination of LHD and LPDT trucks via Decline to a crusher. From crusher it will go to skip loading chamber for skip loading.

2. From pit bottom to surface.

Production Shaft (PS) will be a composite shaft of skip and cage, a skip will be for ore hoisting, a cage will be for waste rock hoisting and man winding. All the waste and Ore materials will be hoisted by a skip and cage via the production shaft

3. From surface to end use plant.

The Finished product shall be transfer by trucks to Balasore alloys plant for production of Ferro chrome and other products.

4. Safety features provided on conveyor/ haulage track/ roadway

(a) Conveyor safety:-

All moving part of the conveyor shall be well guarded as per IS 9474 code 1980. The belt conveyor must be installed with pilot control system. The belt conveyor must be with pulling cord system to trip the conveyor in case of emergency from any location along the belt.

(b) Haulage/roadway:-

All the haulages a roadway shall have the provision of man holes in it as per section 95 of MMR 1961. The man hole shall be kept of the correct size mentioned in the regulation to safe guard the travelling persons in it. Also to keep proper clearances in the roadways and haulages as stipulated in the bye laws of moving machines in them. Mine Lighting shall be done as per the provision in the law.

vi) System of winding / hoisting:

Attach a note briefly describing the system and linking with its adequacy for the desired rate of material and man handling,

System of winding / hoisting and ROM Evacuation System.

(a) Decline and Main Shaft

Decline-1 will allow flexible haulage of ore and waste rock up to 1.4 MTPA from Band-I and Band-II. The declines will also provide flexible access for equipment, men and services to all levels. The production capacity at (-) 240m~(-) 500mRL will be 0.9 MTPA, ore extracted will be transferred by trucks via Decline-1 to a crusher, and then will be hoisted by a skip via the production shaft. Parameters of declines are designed depending upon the dimension and moving velocity of mobile equipment.

Production Shaft (PS) will be a composite shaft of skip and cage, a skip will be for ore hoisting, a cage will be for waste rock hoisting and man winding. Tower Type hoisting system was adopted. The detail of Hoisting system is given as under:-

S. No.	Item	Tower-type hoisting
1	Hoisting capacity	Phase1: 1.4MTPA, Phase2: 2.0MTPA
2	Finished Diameter	Φ7.6m (45.34m^2)
3	Depth	Phase1: 842m, phase2: 1314 m
4	Hoisting height	Phase1: 789m, Phase2: 1289 m
5	Hoisting vessel	1. A type of DJD2/3-8 multi-rope bottom- dump, with a volume of 8m^3, defined load (weight-measuring loading) of 16.0t; 2. A type of YMGG multi-rope cage with two layers, and dead load of 13t, max loading of 12t, base plate size of 4,000×1450mm.
6	Type and specifications of a winder and its equipped motor (taking phase 2 into consideration)	1. A set JKM-4×4 III tower-type multi-rope friction winder, with a guide of diameter 4000mm, maximum static tension of 770kN, and maximum static tension difference of 270kN. An AC variable frequency motor of N= 1500kW, n=42.99rpm. The wider will be in use in Phase 2, the motor will be changed. 2. A set of JKM-4×4 III tower-type multi-rope friction winder with a guide of diameter 4000mm, a pulley of diameter 4000mm, and maximum static tension of 770kN, and maximum static tension difference of 270kN. An AC variable frequency motor: N=1200kW, n= 52.548 rpm. The winder will be in use in Phase 2, motor will be changed.
7	Purchase price of a set of winder (motor and electronic control are the same)	A JKM-4.0×4 III tower-type multi-rope friction winder will be RMB 1.7 million yuan cheaper than JKMD-4.0×4 III floor-type multi-rope friction hoist.
8	Quantity of construction	Tower: 5403m^3 RCC; Tower foundation: 1729 m^3 RCC; Total steel in concrete: 232t; Color steel plate: 7123m^2; Wall of bricks: 1973m^3; Steel of shaft equipment: 686t
9	Skip, cage guide type on the operating cost	Skip, cage guide; adopt structural steel guide, having more installation materials, with large work amount and slow construction.

(b) Diameter of production shaft

The diameter of production shaft depends on four aspects as below:

(i) Area taken up by double skips, cage, ladders, pipes, cables, etc., as well as their safety gap, at least 150m gap for hard guide. The diameter of production shaft will be of 7.6m.

(ii) The tower will be 83m high with 11 floors, winders, sheaves, cranes, etc. will be installed on different floors. Area taken up by winder along with attachment, as well as their instalment requirement will demand a shaft diameter of 7.6m.

(iii) Structure of tower requirement will demand a shaft diameter of 7.6m.

(iv) Quantity of intake air will be 348m^3/s (air velocity will be 7.68m/s) on basis of production capacity of 1.4 MTPA.

(c) Shaft Insets

There will be 7 insets connect to PS.

The PS connections to the main production levels will be as follows:

Skip unloading: +209mRL;

Collar: +182 mRL

Band-I: -240mRL, -380mRL, -500mRL

Mining car loading: -515mRL;

Crushing chamber: -545mRL;

Skip loading: -580mRL;

Spillage treatment: -630mRL;

Bottom: -660mRL.

(d) Capacity of Production Shaft

The capacity of PS is designed to cater 1.4 MTPA in First phase and by changing high capacity motor the production capacity shall enhance to 2.0 MTPA in second phase.

(e) Underground Coarse Crushing Equipment

The feeding lumpiness of underground coarse crushing will be 0~650mm, the annual raw ore handling capacity will be 160×104 t/a. This design selects two jaw crushers, whose feeding inlet will be 830×1200mm, each crusher will be of capacity of 0.9MTPA.

The designed coarse crushing will be open circuit crushing, and the handling capacity shall be 320t/h

(f) Underground Coarse Crushing Feeding Equipment

Select 1600×6000 heavy apron feeder.

(g) Surface Crushing Feeding Equipment Selection

Based on the design flow, the ground intermediate crushing adopts open circuit crushing, the maximum feeding granularity of intermediate crushing will be -220mm. This design selects hydraulic cone crusher, coarse crushing cavity (EC type), and the ore discharging port will be 32mm.

During the intermediate open circuit crushing, the crusher's handling capacity shall be 365 t/h. The hoisted ROM to surface dumped into surface bunkers fitted with loading chute to load. From surface bunker, ROM will be transported by means of Stack conveyor to surface stock piles.

vii) Subsidence management

1. **Whether surface areas being monitored are marked on plan? Details of surface features in the subsidence basin**

   The surface area is being monitored are marked in surface plan.

2. **Whether monitoring points have been marked on plan as well as on ground? Depth of the workings from surface (m) where subsidence is being measured.**

   The surface area is being monitored are marked in surface plan as well as in Ground.

3. **Maximum subsidence observed at monitoring points (mm)**

The maximum subsidence observed at points (+/-) 2mm

At what frequency subsidence monitoring is done?

The subsidence monitoring is done in every 15 days frequency.

Whether results of monitoring are being properly recorded?

The subsidence monitoring is recorded and kept in file for reference.

Angle of draw observed on dip and strike side.

There is no angle of draw has observed on dip and strike side.

Whether critical, sub-critical or super-critical area extracted?

There is no critical, sub critical or super- critical area extracted observed.

(vii) Conceptual Mine planning up to the end of lease period taking into consideration the present available reserves and resources describing the ROM excavation, Disposal of waste, stowing/backfilling, surface subsidence, reclamation and rehabilitation showing on a plan with few relevant sections.

It has been forecasted that the underground mining shall continue for more than 30 years assuming the continuity of ore bodies at depth. The conceptual underground workings have been shown in (**Plate No – 17A & B).**

To exploit the ore bodies optimally at depth below (–) 500 mRL a production shaft and two declines have been proposed as shown in (**Plate No – 17A & B). For further details on life of mines refer Chapter 2 (f) at page 59**

viii) Mine ventilation:

Enclose a note outlining the steps to be taken to ensure adequate supply of air in all parts of the mine and prevention of noxious gases produced and excessive rise of temperature or humidity so as to ensure adequate ventilation. Also indicate No. & type of main mechanical ventilators, total air requirement as per statute, total intake / return (cu.m/ sec) etc

(a) Total Quantity of Air

Quantity of Air Required as per Diesel Equipment

According to the requirement of owner BAL, diesel powered mining equipment's are adopted in this preliminary design of the Kaliapani Chromite Mine (KCM), Band – I & Band – II, the quantity of air required for diesel equipment is as follows :

$$Q_0 = q_0 \cdot N$$

Where: Q_0 —Quantity of air required for diesel equipment dilution, m^3/s;

q_0 —Norm of Air, $0.075 m^3/Kw \cdot s$;

N —Used power of all diesel equipments, kW;

$N = N_1K_1 + N_2K_2 + \ldots + N_tK_t$

Where: N_1, N_2, …N_t —Rated power of each diesel equipment, kW;

K_1, K_2, …K_t —usage of time, %.

Quantity of Air Required as per Diesel Equipment

Equipment	No. of units	Rated power (kW)	Usage of time (%)	Used power (kW)
Underground dump truck (capacity 20t)	15	224	90	3024.00
LHD	3	60	80	144.00
LHD	3	45	80	108.00
Fuel truck	1	63	60	37.80
Lift truck	3	63	60	113.40
Bus	3	63	60	113.40
Explosive truck	1	170	80	136.00
Water truck	1	63	50	31.50
Boomer	3			
Simba	2			
Road header	1			
Total		3677.00		3708.10
dilution factor	q0=0.075m3/ kW·s			
Quantity of air required	Q0=0.075×3708.10=278.11m3/s			
Leakage	25%			
Total quantity of air required	Q=232.75×1.25= 348 m3/s			

(b)Quantity of Air required as per Ton output

Quantity of air required will be based on tone output daily.

$Q = k \cdot q1 \cdot T$ m3/s

Where: Q ——Quantity of air required as per ton output, m3/s;

q1 ——Quantity of air required per ton output, 2.5m3/min;

T ——ton output daily, t/d;

k ——Leakage factor, 1.25.

$Q = 1.25 \times (2.5 \div 60) \times (1400000 \div 300)$

$= 243.06$m3/s

(c)Total Quantity of Air

As per Indian regulation, the more quantity of air requirement will be 348m3/s between 7.1.1 and 7.1.2, taken as mine total quantity of air.

(d)Distribution of Total Quantity of Air in the Mine

The mine total quantity of air required will be 348m3/s by diesel equipment. Each block quantity of air required as per diesel equipment is shown in Tab7-2, as per ton output is shown

in Table below after the following table. It is noted that the quantity of air required is much more in Table below than in after the following table, the larger one will be adopted as block quantity of air required.

The total quantity of air of 348 m^3/s will be the basis of ventilator selection and determines the size of shafts, drives, raises, sublevels.

Distribution of Quantity of Air Required to Each Block as per Production Capacity

Block	Rated power (kW)	Used power (kW)	Quantity of air equired (m3/s)
+112m~+76m	157	136.80	12.83
-60m~-120m	351	309.90	29.05
-60m~-156m	396	350.40	32.85
-156m~-240m	441	390.90	36.65
-240m~-380m	896	806.40	75.60
-380m~-500m	896	806.40	75.60
Service equipment	674	432.10	40.51
Added excavation Equipment during production period	538	475.20	44.55
Total	**4349**	**3708.10**	**348**

Distribution of Quantity of Air Required to Each Block as per Production Capacity

Block	Total quantity of air required (m^3/s)
	Production of 1.4 MTPA
+112m~+76m	16.70
-60m~-120m	40.66
-60m~-156m	44.46
-156m~-240m	48.26
-240m~-380m	98.96
-380m~-500m	98.96
Total	**348**

(e) Excavation Size Required for Ventilation

The excavation size required for ventilation on basis of 1.1MTPA and 1.4 MTPA is shown in following tables.

Excavation size required for ventilation on basis of 1.4 MTPA

Shaft/raise /drive	Collar	Bottom	Depth	Finished diameter	Amount (㎡)	Air flow Velocity (m/s)	Air quantity (m³/s)
Production shaft	+182	-500m	682m	Φ7.6m	45.34	5.470	248
RAR1	+77M	-240m	317m	5.0m	19.63	11.717	230
RAR2	+182M	-120M	302m	4.0m	12.56	9.395	118
Decline	+100 M	-500M			18.56	5.388	100
Return air way	+112M (Band-II)			3.0×3.0m	8.37	1.995	16.70
	-60M (Band-I)			4.0×4.0m	14.57	5.842	85.12
	-60M (Band-II)			3.0×3.0m	8.37	/	/
	-120M (Band-II)			3.0×3.0m	8.37	/	/
	-120M (Band-I)			3.0×3.0m	8.37	/	/
	-156M (Band-I)			3.0×3.0m	8.37	5.766	48.26
	-240M (Band-II)			4.5×4.5m	18.56	10.664	197.92
	-380M (Band-I)			4.5×4.5m	18.56	5.332	98.96
Sublevel	+112M (Band-II)			4.0×4.0m	14.57	1.146	16.70
	+76M (Band-II)			4.0×4.0m	14.57	1.146	16.70
	-60M (Band-I)			4.0×4.0m	14.57	3.051	44.46
	-60M (Band-II)			4.0×4.0m	14.57	3.051	44.46
	-120M (Band-I)			4.0×4.0m	14.57	2.791	40.66
	-120M (Band-II)			4.0×4.0m	14.57	2.791	40.66
	-156M (Band-I)			4.0×4.0m	14.57	0.824	12.00
	-240M (Band-I)			4.5×4.5m	18.56	1.030	15.00
Drive	-240M (Band-II)			4.0×4.0m	14.57	3.312	48.26
	-380M (Band-I)			4.5×4.5m	18.56	5.332	98.96
	-500M (Band-I)			4.5×4.5m	18.56	5.332	98.96
Return air raise	+112M	+76M	36m	Φ3.0m	7.07	5.751	40.66
Intake air raise	-60M	-120M	60m	Φ3.0m	7.07	5.751	40.66
Return air raise	-60M	-120M	60m	Φ3.0m	7.07	5.751	40.66
Intake air raise	-60M	-156M	96m	Φ3.0m	7.07	6.289	44.46
Return air raise	-60M	-156M	96m	Φ3.0m	7.07	6.289	44.46
Intake air raise	-156M	-240M	84m	Φ3.5m	9.62	9.638	92.97
Return air raise	-156M	-240M	84m	Φ3.0m	7.07	6.826	48.26
Intake air raise	-240M	-380M	130m	Φ3.5m	9.62	10.287	98.96
Return air raise	-240M	-380M	130m	Φ5.0m	19.63	10.083	197.92
Intake air raise	-380M	-500M	130m	Φ4.0m	12.56	7.879	98.96
Return air raise	-380M	-500M	130m	Φ4.0m	12.56	7.879	98.96

(f)Ventilation System

A multi-stage (3 stages) ventilation mode will be adopted in this design.

(1) **Air intake:** production shaft **(PS)** of Φ7.6m finished diameter (location and function by SRK) and decline of finished size 4.5m×4.5m;

(2) **Air return:** return air raise1 (**RAR1**) and return air raise2 (**RAR2**) (location and function of **RAR1 and RAR2** finalized by SRK).

(3) **Ventilation for Blocks:**

- Ventilation for sub-block in Block-1 (Band Ⅱ):Decline-1→connector at +76mRL→Decline-2 →sublevels→stepped air return raise→return air way at +112mRL→RAR2;
- Ventilation for sub-block in Block-2 (Band Ⅱ) : Decline-1→connector at -120mRL→stepped air intake raise→sublevels→stepped air return raise→return air way at 0mRL→RAR2;
- Ventilation for Block-3 (Band Ⅰ) : Decline-1→connector at -156mRL→stepped air intake raise→sublevels→stepped air return raise→return air way at -60mRL→RAR2;
- Ventilation for Block-4 (Band Ⅰ) : PS→connector at -240mRL→stepped air intake raise→sublevels→stepped air return raise→return air way at -156mRL→RAR1;
- Ventilation for Block-5 (Band Ⅰ) : PS→connector at -380mRL→stepped air intake raise→sublevels→stepped air return raise→return air way at -240mRL→RAR1;
- Ventilation for Block-6 (Band Ⅰ) : PS→connector at -500mRL→stepped air intake raise→sublevels→stepped air return raise→return air way at -380mRL→RAR1.

(4) Auxiliary ventilation:

Auxiliary fans will be located in air return air ways at sublevels as per mining operation requirement.

(5) Crushing chamber ventilation:

PS→crushing chamber→dust suppression→return raise(-630mRL~-500mRL)→drive at -500mRL.

(6) Skip loading chamber ventilation

PS→skip loading chamber→dust suppression→return raise(-630mRL~-500mRL)→drive at -500mRL.

(7) Spillage Treatment chamber ventilation

PS→spillage treatment chamber→return raise(-630mRL~-500mRL)→drive at -500mRL.

7.5 Ventilator Chamber

There are 6 ventilator chambers. 4 of which will be underground and 2 of which will be on surface; three of which for air intake, other three for air return.

Chamber 1 : for air return, located on surface in close proximity of RAR1;

Chamber 2 : for air return, located on surface in close proximity of RAR2;

Chamber 3 : for air return, located in return air way at (-) 60mRL drive in close

proximity of return air raise between (-) 60mRL and -120mRL;

Chamber 4 : for air intake, located in intake air way at (-) 240mRL in close proximity of air intake raise between (-) 240mRL and -156mRL;

Chamber 5 : for air intake, located at (-) 380mRL in close proximity of air intake raise between (-) 380 mRL (-) and (-) 240 mRL;

Chamber6 : for air intake, located at (-) 500mRL in close proximity of air intake raise between (-) 500m R and (-) 378 mRL.

The parameter of ventilator is shown in following tables; numbers of ventilators in chambers are shown in table following the table below.

As per Indian regulation, one more motor of 90kW, 132kW, 250kW will be required respectively for standby; one more set of vanes of ventilator №23, №23, №23 will be required respectively for standby.

Parameters of Main Ventilators

S. No	Ventilator	Power (kW)	Air output (m^3/s)	Air pressure (Pa)
1	FBCDZ(A)-12№34	2×450	72.9~247.9	1342~4337
2	K45-6№20	250	70.3~132.3	1019~1956
3	K40-8№20	75	34.3~74.7	170~787
4	K40-8№23	132	52.2~113.6	225~1041
5	K40-8№24	160	59.3~129.1	245~1133
6	K40-8№24	160	59.3~129.1	245~1133

Parameters of Auxiliary Ventilators

S. No	Ventilator	Power (kW)	No	Air output (m3/s)	Air pressure (Pa)	Air duct
1	K40-6№12	15	10	9.9~21.7	111~510	No wall, α=32° No air duct
2	JK58-1№4.5	11	5	3.1～5.0	2092~1295	air duct Φ=450mm L=150m
3	JK58-1№3.5	3	10	1.5～2.4	1263~752	air duct Φ=350mm L=300m

Ventilators and Chambers of Ventilation System

Chamber	Function	Location	Ventilator	No	Vane angle	Motor
1	Return	On surface	FBCDZ(A)-12№34	1	50°	2×450kW
2	Return	On surface	K45-6№20	1	40°	250 kW
3	Return	-60mRL	K40-8№20	1	29°	75 kW
4	Intake	-240mRL	K40-8№23	1	32°	132 kW
5	Intake	-380mRL	K40-8№24	2	32°	160 kW
6	Intake	-500mRL	K40-8№24	2	32°	160 kW
Total						**1677kW**

(g)Ventilation Structure

The ventilation structures include doors as walls as adjusting doors, walls, as below

Ventilation Structures

S.No	Location	Structure	No
1	Crosscut to RAR2 at +112mRL	Air adjusting door	1
2	Crosscut to RAR2 at +76mRL	Air door	2
3	Crosscut to RAR1 (Band-I) at -60mRL	Ventilation wall	1
4	Crosscut to Decline-1 (Band-I) at -60mRL	Air door	1
5	Crosscut to Decline-2 (Band-II) at -60mRL	Air door	1
6	Crosscut to RAR1 (Band-I) at -120mRL	Air door	2
7	Crosscut to RAR2 (Band-II) at -120mRL	Air door	2
8	Crosscut to RAR1 (Band-I) at -156mRL	Air adjusting door	2
9	Crosscut to RAR1 at -240mRL	Air adjusting door	1
10	Crosscut to intake air raise at -240mRL	Air door	1
11	Crosscut to intake air raise at -380mRL	Air door	1

(h)Ventilation Network Solution

Ventilation network solution is a very complicated matter, because there are so many nodes and branches in a ventilation network. By means of ventilation software, ventilation in a mine can be simulated to solute air distribution and resistance as well as power consumption, etc.. After comparing the result form its own ventilation software with that from ventilation software Vent Sim designated by owner, design institute fond the solution was different. The input information required by its own software is more detailed than that required by software Vent Sim, so design institute revised the input port of Vent Sim to have got the solution in Table below.

63 nodes, 97 branches and 6 ventilators are in designed ventilation network of Kaliapani Chromite mine, the solution is shown in tables below, total quantity of air, total used power and

duty of each ventilator meet the ventilation requirement in Kaliapani Chromite mine (**Refer Plate No 16).**

Ventilation System Solution

Total rated Power (kW)	Total quantity of air (m^3/s)	Total used power (kW)	Total resistance (Pa)	Efficiency of ventilators (%)
1677	358.40	1461.1	3498	79.38

Ventilator Duty

Chamber	Ventilator	Unit rated Power (kW)	Unit used Power (kW)	Air discharge (m^3/s)	Air Pressure (Pa)	Efficiency (%)
1	FBCDZ(A)-12№34	2×450	875.20	248.59	2479.3	70.4
2	K45-6№20	250	235.80	109.81	1841.2	88.9
3	K40-8№20	75	47.40	51.17	697.5	75.2
4	K40-8№23	132	38.60	68.31	468.0	81.9
5	K40-8№24	160	132.50	103.70	1018.8	79.7
6	K40-8№24	160	131.60	104.25	1011.8	80.2

Total Quantity of Intake Air and Return Air

Intake air (m^3/s)				Return air (m^3/s)			
Production shaft	Air velocity	Decline-1	Air velocity	RAR1	Air velocity	RAR2	Air velocity
259.71		98.69		248.5		109.81	
358.40				358.40			

ix) Extent of mechanization

Describe briefly with calculation for adequacy and type of machinery and equipment proposed to be used in different activities of drilling, material handling in development and stope, hauling, hoisting to surface, surface transportation and any other operation.

A fully mechanized mining method is planned. The primary mining equipment comprises of short hole drilling jumbo for development and drifting and LHD in conjunction with low profile dump truck for loading and hauling. The loading the trucks would ideally be conducted within the ore zone or at the intersection of the cross cut and the ore drive to limit LHD tramming distance, so the excavation size would need to be suitably increased at the loading points. For the purposes of the stoping diesel powered LHD unit in conjunction with low profile underground dump truck have been proposed. The primary drilling equipment would be

electro-hydraulic single-boom jumbo equipped with diesel engine for tramming operation and electric motor for drilling operation.

MINING EQUPMENTS FOR DRIFT AND FILL MINING FOR BOUNDARY PILLAR MINING

Sl No	Equipment	No of Units
1	Single Boom Jumbo	2
2	Loader or Scoop-tram	2
3	Shotcrete Machine	3
4	45 KW Fans	5
5	20 KW Pumps	3
6	Compressor	2
7	Hand held drill	10
Total		**27**

MINING EQUPMENTS FOR DRIFT AND FILL MINING FOR UNDERGROUND CONVENTIONAL MINING

Sl No	Equipment	No. of units
1	Underground dump truck (capacity 20t)	15
2	LHD	3
3	LHD	3
4	Fuel truck	1
5	Lift truck	3
6	Bus	3
7	Explosive truck	1
8	Water truck	1
9	Boomer	3
10	Simba	2
11	Road header	1
Total		**36**

3.0 MINE DRAINAGE

(a) Minimum and maximum depth of water table based on observations from nearby wells and water bodies

The altitude within the lease area ranges between 120m to 182m above mean sea level. The area represents an undulating topography, sloping towards the west. The bottom and top RL of the hillock in the central portion of the lease area are 135m and 182 m respectively. There are no streams, nullahs perennial or seasonal observed within the lease area. The ground water table in the mining lease area is 100 m AMSL There are no streams, nala or rivulets observed within the area of 64.463 hectares. However, a number of streams, nala are observed in the neighbouring leases and these drain into the Damsal nala which is about 2 to 3 km away NE of the area. There are two bore wells within the mining lease area which provides water for domestic & industrial use.

(b) Maximum and minimum depth of Workings

At present the quarry has attained 50 mRL in Band-I. Top of the Band- I is 140 mRL in Hang wall side and 182 mRL in Foot wall side. By end of scheme period it is proposed that the deepest level of the quarry in Band-I will be at (+) 2 mRL.

(c) Quantity and quality of water likely to be encountered, the pumping arrangements and places where the mine water is finally proposed to be discharged

(i) The primary sources of water infiltration into the mining pit are direct rainfall and groundwater seepage. It is essential that the mining operation be properly dewatered to minimize the impact on the operation.

(ii) Dewatering in the Mine Area

By the open cast mining process, it was observed that during the rainy seasons and for the next few months in the post monsoon season, very negligible amount of seepage was occurring in the mine pit. This amount was however, hardly perceptible, even on a local scale. In the pre monsoon season, there was no visible or perceptible seepage at all. However, detailed study on slope stability of pits suggested that a considerable amount of water pressure is building up inside the pits due to which the chances of pit walls collapse was imminent. In order to prevent these precarious emergencies, it was suggested by experts to go for horizontal boring in the pit walls to drain out the water present in the pores / fractures and thereby reducing the pore pressure buildup in them. This was the only measure available for ensuring safety and stability of the mine pit.

On expert advice, six numbers of horizontal bore wells of approximately 40 – 50 m length with perforated casings were constructed in the bottom most part of the pits to drain out the water. The discharge from all these horizontal bores is drained to the pit sumps from where they are being pumped to be used for reuse in COB plant and for dust suppression purpose only.

(iii) A test report on quality of water **(Annexure – 25)** and dewatering of mine water during January 2014 to Feb 2015 was undertaken and details of de-watering pump and their Performance is as below.

Month	Elec Pump 425 HP-1	Elec Pump 425 HP-2	Elec Pump 425 HP-3	Diesel Pump 310 HP	Diesel Pump 231 HP	Elec Pump 170 HP	Design Vol of water 425-1	Design Vol of water 425-2	Design Vol of water 425-3	Design Vol of water-310	Design Vol of water-231	Design Vol of water-170	Total Vol /Month	Volume handled @70% efficiency CuM	Volume handled per Day CuM	Remarks
Rate of Discharge per Hr (CUM/HR)	**300**	**300**	**300**	**300**	**200**	**200**										
Jan-14	0	0	0	210	0	82.15	0	0	0	63000	0	16430	79430	55601	1794	PM
Feb-14	0	0	0	191	0	39.3	0	0	0	57300	0	7860	65160	45612	1629	
Mar-14	0	0	0	260	0	133.35	0	0	0	78000	0	26670	104670	73269	2364	
Apr-14	0	0	0	35	93	175.05	0	0	0	10500	18600	35010	64110	44877	1496	
May-14	0	0	0	0	384	0	0	0	0	0	76800	0	76800	53760	1734	
Jun-14	48.55	47.45	0	0	239	0	14565	14235	0	0	47800	0	76600	53620	1787	M
Jul-14	229.10	70.25	0	126	0	0	68730	21075	0	37800	0	0	127605	89324	2881	
Aug-14	175.53	57.21	193.47	0	13	0	52659	17163	58041	0	2600	0	130463	91324	2946	
Sep-14	210.15	1.05	207.55	0	213	0	63045	315	62265	0	42600	0	168225	117758	3925	
Oct-14	161.05	1.10	218.55	0	231	0	48315	330	65565	0	46200	0	160410	112287	3622	
Nov-14	22.55	0	280.50	0	0	0	6765	0	84150	0	0	0	90915	63641	2121	L-47 mRL
Dec-14	0	0	307.35	5	0	0	0	0	92205	1500	0	0	93705	65594	2116	
Jan-15	111.40	105.10	119.15	85	0	0	33420	31530	35745	25500	0	0	126195	88337	2850	
Feb-15	257.30	91.40	0	27.40	0	0	77190	27420	0	8220	0	0	112830	78981	2821	
Total	1215.6	373.56	1326.5	939.4	1173.00	429.85	364689	112068	397971	281820	234600	85970	1477118	1033983	34086	

During Pre - Monsoon period (from Jan 14 to May 14) volume of water handled ranging between 1600 to 2400 CuM per day.

During Monsoon period (from June 14 to October 14) volume of water handled ranging between 1800 to 4000 CuM per day.

During Post - Monsoon period (from Nov 14 to Feb 15) volume of water handled ranging between 2100 to 3000 CuM per day.

(d) Describe regional and local drainage pattern. Also indicate annual rain fall, catchments area, and likely quantity of rain water to flow through the lease area, arrangement for arresting solid wash off etc.

The Damsal Nala flowing towards south-west is the main drainage system of the area and is 700 m away from the lease area in N-W direction. It can be categorized in to a stream of 5th order which is seasonally fed by several streamlets and qullies. One perennial stream to the S-E adds as a tributary to damsal nala. The run-off water collected by streamlets and Damsal nala finally discharges into the river Bramhani at a distance of about 30 kms.

The make of water during average rainy season rainfall as well as under rare conditions of maximum rainfall occurring within 24 hours has been calculated below based on mine area under excavation (there is no backfilling).

Active pit areas, depth and precipitation water accumulation under average rainy season rainfall conditions

Particulars	Start of 2015-16	End of 2020-21
Excavated Pit area	17.88	22.022
Internal dumped area (Ha)	0	0
Area not backfilled (Ha)	17.88	22.022
Mine depth (m) (135m SRL to 55m RRL of quarry bottom level)	95	138
Maximum daily rainfall within 24 hours (m)	0.0092	0.0092
Rain water falling within the pit on the day of maximum rainfall, cum (Pit area in sqm*rainfall in m), cum	1644.960	2026.024
Balance accumulated in pit after considering 30% seepage to ground and 20% evaporation, cum	822.480	1013.012
Daily av based on 3 days pumping	**294.2#**	**306.25**
Assuming dewatering in18 hr/day pumping, the hourly pumping capacity required, cum/hr	16.34	17.01
Pumping capacity required, LPS	4.54	4.72
Pumping capacity required, GPM	59.96	62.42
***# Hydrogeological report Page 54*. However, the volume will increase by ratio of the pit area**		

Active pit areas, depth and precipitation water accumulation under extreme rainfall conditions

Particulars	2014-15	2020-21
Excavated Pit area	17.88	22.022
Internal dumped area (Ha)	0.00	0.00
Area not backfilled (Ha)	17.88	22.022
Mine depth (m) (135m SRL to 55m RRL of quarry bottom level)	95	138
Maximum daily rainfall within 24 hours (m)	0.2517	0.2517
Rain water falling within the pit on the day of maximum rainfall, cum (Pit area in sqm*rainfall in m), cum	45004	55429
Balance accumulated in pit after considering 30% seepage to ground and 20% evaporation, cum	22502	27715
Assuming dewatering in 5 days @ 18 hr/day pumping, the hourly pumping capacity required, cum/hr	258	360
Pumping capacity required, LPS	76	94
Pumping capacity required, GPM	1009	1245

Existing pumping arrangements

Sl No.	Particulars of existing equipment	Specifications
1	Slurry Pump	60 m^3/hrs, MODHM 75
2	Submersible Pump (Mines)	2H.P/1.5K.W,HEAD:70M
3	Slurry Pump	60 m^3/hrs, HEAD20 MTRS, MKMETSO, MOD
4	Slurry pump	60 m^3/hrs, HEAD20 MTRS, MKMETSO, MOD

4.0 STACKING OF MINERAL REJECT / SUB GRADE MATERIAL AND DISPOSAL OF WASTE

(a) Nature and quantity of topsoil, OB/waste and of MR (10% to 40% Cr_2O_3)

(i) Topsoil

There is no topsoil in the area which will require handling.

(ii) Waste (OB/SB/IB)

Recovery of waste from mines (OC & UG) during proposed scheme period and their place of dumping are as below.

The waste materials are consisting of dark brown colored lateritic soil & yellow to brownish limonite etc. During proposed scheme period of five years (2015-16 to 2019-20) about 56.15 LCuM waste have been calculated to be generated from OC and UG. Summary of waste development proposed during the scheme period of 2015-16 to 2019-20 is tabulated below.

Year	Opencast Mining in CuM	Under Ground Mining in CuM	Total in CuM
2015-16	1716031	154583	1870614
2016-17	1108750	120785	1229535
2017-18	837281	156136	993417
2018-19	900844	75813	976657
2019-20	458750	86937	545687
Total	**5021656**	**594254**	**5615910**

15% of the waste to be generated i.e.842387 CuM (5625910 CuM x 15%)shall be utilized for strengthening of haul road, terraces, filling in voids created by rain on side walls of dumps, berm on the sides of road and terraces and plantation areas, leaving a balance of 4773523 CuM for which space is required elsewhere.

(iii) The following table shows details about topsoil, waste and MR available in the lease area, proposed generation in proposed scheme period, their utilization and storage etc.

Topsoil and Waste

Year	Top Soil (CuM)		OB/SB/IB dump (CuM)			
	Re use/spreading	Storage	Total waste generated	Back filling	Utilized for stength. of haul road, berms, plantation areas and terraces etc	Balance stored in diff. locations
2015-16	0	0	1870614	0	280592	1590022
2016-17	0	0	1229535	0	184430	1045105
2017-18	0	0	993417	0	149013	844404
2018-19	0	0	976657	0	146499	830158
2019-20	0	0	545687	0	81853	463834
Total	0	0	**5615910**	**0**	**842387**	**4773523**

Mineral Reject

Year	MR Stack at present (CuM)	Generation (CuM)	Total (CuM)	To be utilized in COBP (CuM)	To be utilized in COBP (CuM) of M/s Rohit	Balance stored (CuM)
2015-16	69943	40106	110049	46000	0	64049
2016-17	64049	53574	117623	46000	46000	25623
2017-18	25623	85815	111437	46000	46000	19437
2018-19	19437	121479	140916	46000	46000	48916
2019-20	48916	117373	166290	46000	46000	74290
Total		**418347**	**702082**	**230000**	**184000**	**230000**

(b) The proposed dumping ground within the lease area proved absence of mineral

(i) Waste dump – 1

covers an area of 11.892 Ha and has been heighten to 182 mRL as on date. Size of a part of the dump at present is 432 m Long x 212 m wide x 60 m in average and the other part is 385 m x 71 m x 12 m. As on date the dump has accommodated about 2556845 CuM waste, with 3 number of terraces. Considering following suggestions space for 2033465 CuM can be created.

(ii) Waste dump – 2

Waste dump – 2 covers an area of 4.875 Ha and has been heighten to 180 mRL as on date. Size of the dump at present is 250 m Long x 195 m wide x 40 High. As on date the dump has accommodated about 812005 CuM waste, with 2 number of terraces. For extending the periphery of the quarry on Band-I towards north about 275000 CuM from 1.0 Ha area from the toe of the dump shall be shifted and will be re-located on waste dump -2 to join with vacant area towards IMFA dump. The vacant area can accommodate additional quantum of 353613 CuM waste. Thus wastes dump – 2 of BAL and dump of IMFA merges. This is under an agreement between both lessee's. At this time size of the dump will be 411 m Long x 126 m wide x 37 High (in average). It has been calculated that the ultimate capacity of the dump after extending towards common boundary to join with wastes of IMFA will cater about 1165618 CuM waste **(Plate No – 7A & 7B).** MoU with IMFA **(Annexure - 19)** along with approval of DMS **(Annexure - 19)**, has been accorded. Dump slope also be stabilized with plantation, Coir matting & grass turfing. Overall slope will be kept at 28^{0}. Existing statutory provisions like retaining wall, and garland drain, check dams, terraces and settling tanks those exist at site will be reconstructed.

(iii) Waste dump – 3

Waste dump – 3 covers an area of 13.28 Ha and has been heighten to 227 mRL as on date. Size of the dump at present is 366 m Long x 380 m wide x 60 High. As on date the dump has accommodated about 5096484 CuM waste, with 3 number of terraces.

To heighten the dump – 3 (for next 10 m thus dump height will be 70 m) from 227 mRL to 235 mRL study was undertaken by IIT Kharagpur. But, now the lessee proposes to keep the dump height at 227 mRL. Instead of 4 terraces at different heights, proposal is there to convert the dump with 3 terraces of 20 m height each. The dumping will with catch drain in the inward slope to connect with the garland drain at the toe of the dump. The dumping will with catch drain in the inward slope to connect with the garland drain at the toe of the dump.

Western side of waste dump – 3 is proposed to join eastern side dump of JSL upto a height of 225 mRL. A MoU with JSL has already been drawn **(Annexure -20)** will start after obtaining permission from Director of Mines Safety (DMS) and other statutory bodies.

A Gabion wall from the toe of the waste dump – 3 towards east and south shall be constructed to find more area for accommodating wastes.

Final conclusion – Considering above technical studies a dump plan and section has been prepared **(Plate No – 7A & 7B)** which shows that a quantum of 2394185 CuM waste can further be accommodated in waste dump – 3. Finally the waste dump will be having 7490669 CuM waste. Dump slope also be stabilized with plantation, Coir matting & grass turfing. Overall slope will be kept at 28^0. Existing statutory provisions like retaining wall, and garland drain, check dams, terraces and settling tanks those exist at site will be modified.

Summary of waste dumping locations			
Dump No	**Existing Volume**	**Final volume**	**Additional Volume**
Initial waste dump - 1	2556845	4590310	2033465
Office & other infrastructure area	0		
Common dumping with IMFA	0		
Initial waste dump - 2	812005	1165618	353613
Initial waste dump - 3	5096484	7490669	2394185
Gabbion wall	0		
Terrace heightening	0		
Common dumping with JSL	0		
Total	**8465334**	**13246597**	**4781263**

The following table shows year wise built up of dumped in the proposed scheme period.

Year	Dump No	Build up of dumps in mRL	
		From	To
2015-16	Dump – 1	182	202
	Dump – 2	145	162
	Dump - 3	163	227
2016-17	Dump – 1	124	182
	Dump – 2	162	165
	Dump - 3	177	227
2017-18	Dump – 1	182	202
	Dump – 2	165	167
	Dump - 3	166	185
2018-19	Dump – 1	-	-
	Dump – 2	167	177
	Dump - 3	185	205
2019-20	Dump – 1	-	-
	Dump – 2	167	177
	Dump - 3	205	225

Protective measure by constructing dump terraces with garland drains towards inner slope and putting half concrete hume pipes to collect water and channelized to the bottom of the dump alongwith a collecting drain all along the bottom periphery, retaining wall at the toe of the dump, check dam for arresting wastes/sediments and settling tanks to collect water from garland drain for treatment through ETP have already been constructed. By changing the re-orientation / dimension of dumps some area of the constructed measures is to be dismantled and reconstructed. The following table's shows already constructed and further to be constructed retaining wall, garland drain etc.

Completed

Particulars	2010-11	2011-12	2012-13	2013-14	2014-15
Retaining wall (CuM)	125	157	157	195	301
Garland Drain (m)	2000	2200	2200	742	353
De silting of settling ponds (CuM)	200	250	300	300	350
Afforestation on dumps (Area/Nos)	11115	9975	8400	9900	18565
Dump terracing (Ha)	-	-	-	-	-
Construction of check dam (Number)	3	3	3	3	4

To be constructed

Particulars	2015-16	2016-17	2017-18	2018-19	2019-20
Retaining wall (m))	1000	1000	1130	1130	1472
Garland Drain (m)	1000	1000	1150	1150	1480
De silting of settling ponds (CuM)			121	360	360
Afforestation on dumps (Area/Nos)	-	-	1.03	7.26	8.40
Dump terracing (Ha)	5.09	6.39	6.39	8.23	8.60
Construction of check dam (Number)	3	3	3	3	5

Recommendation of CIMFR to avoid Dump slope failure

There should not be water stagnation between the dump toe and drain at the lower most ground level. Discontinuous dumping could be avoided to check water accumulation between heaps. Attempt should be made a proper gradient along the benches Top and Floor of the dump. The drain should be effectively maintained by proper gradient t and de silting to divert the drain water away from dumps. Regular updating the Geo Technical parameters should be taken up.

In addition to above practice environment protective measures, a gabion wall around Dump 1 & 3 has been proposed as per study carried out and recommended by Z-Tech a reputed consultant, details of this has been described in page-56.

(iv) As described above para under **Waste generation** above space required for accommodation of waste dumping during proposed scheme period is for 4773523 CuM. As above para under Summary of **Waste dumping locations** space for accommodating about 4781263 CuM at different locations is available.

(c) Details of the existing stack of Mineral Rejects (10% to 40% Cr2O3)

(i) About 72454.710 CuM mineral rejects presently is available inside the lease area.

Stack No	Area (Ha)	Location (Co-ordinate)	Height of the stack (m)	Volume in CuM	Av. Gr (Cr2O3%)
1	2.07	1073N-1116N/1289E-1402E	6 m	72454.710	10% to 45% Cr2O3

(ii) Details of the proposed quantum of Mineral Rejects during the proposed scheme period

During proposed scheme period about 4.40 LCuM from OC working and 8.15 LCuM from UG working has been proposed to be recovered. The company is having its own COBP inside the lease area with a intake capacity of 138000 t (46000 CuM) / year , which is running to full capacity, now. Besides,

(d) Area chosen for dumping of 10% to 40% Cr_2O_3 mineral rejects to be recovered during proposed scheme period (2015-16 to 2019-20) from OC and UG working.

An area over 2.07 Ha is ear marked for MR stacking will be shifted to an area having co-ordinates **1073N-1116N/1289E-1402E** for utilization of storing of mineral rejects during proposed scheme period. Materials will be shifted to COBP on daily basis and there will be no shortage of space.

(i) Management of mineral reject dump

The dimension of the existing MR stack is 200 m long x 84 m wide x 20 m high. The same shall be totally replaced by waste and gradually alongwith otr production shall be re-located at as many as 3 places which are depicted on year-wise development plan **(Plate No – 6A to 6E)**. Side walls of the MR dump shall be as per the angle of reposed. Very frequently material shall be shifted to COBP. Garland drain, retaining wall, check dams and settling tanks shall be constructed and maintained. Water from these garland drains is discharged to COBP inside the lease through ETP. No plantation is done on the mineral reject stack.

5.0 USE OF MINERAL AND MINERAL REJECT

(a) Brief requirement of end use industry specifically in terms of physical & chemical composition

Chrome ore of this lease area is of fine-grained, brownish black colour to black color friable ore. The associated gangue minerals are magnesite, serpentine, magnetite and limonite. Grain size of Chrome crystals varies between 0.1mm to 1.5mm. Hardness 2 to 4, sp gravity 1.6 to 3.0 and non-magnetic to feebly magnetic in nature.

The cut-off grade of Chrome ore production is fixed at 10% Cr_2O_3. The usable grade of chrome ore in ferro alloys industry of the company is +40% Cr_2O_3 minimum with Cr/Fe ratio 2.0 - maximum. These are produced from the mines is being consumed in the captive plant of the lessee situated at Balasore in Odisha for production of ferro chrome. Whatever ore having less than 40% Cr_2O_3 produced is being kept as sub grade mineral stock for beneficiation and regularly fed to COBP of the company located in the lease hold area. The capacity of the COBP is 20 tph (46000 CuM/138000 t / annum). The location of the plant is within the mines as shown in the surface plan **(Plate No -3)**.

M/s BAL has gone with a Business Transfer agreement (BTA) **(Annexure - 22)** with M/s Rohit Ferro Alloys who has a Ferro chrome plant and COBP at Duburi of Odisha, on way from Kaliapani Chromite Mines and Ferro alloys plant of the lessee company. The capacity of the COBP is 20 tph (138000 t /46000 CuM) / year) and BAL shall use this facility from 2016-17 onwards for beneficiating the mineral rejects of the mines.

(b) Brief requirement of intermediate industries involved in up-gradation of mineral before its end-use.

Proposal for beneficiations of mineral rejects is contemplated during the proposed scheme period. Lessee's COBP and newly acquired COBP of M/s Rohit Ferro Alloys shall fed with mineral rejects for its up gradation. The following table shows year-wise quantum of MR to be fed to both the COBPs in proposed scheme period.

Year	MR Stack at present (CuM)	Generation (CuM)	Total (CuM)	To be utilized in COBP (CuM)	To be utilized in COBP (CuM) of M/s Rohit	Balance stored (CuM)
2015-16	69943	40106	110049	46000	0	64049
2016-17	64049	53574	117623	46000	46000	25623
2017-18	25623	85815	111437	46000	46000	19437
2018-19	19437	121479	140916	46000	46000	48916
2019-20	48916	117373	166290	46000	46000	74290
Total		**418347**	**702082**	**230000**	**184000**	**230000**

(c) Detail requirements for other industries, captive consumption, export associated industrial use etc.

The chrome ore raised from the mine is entirely for captive use and the specifications required for the plant are already discussed in para 5.a. Beside the mineral rejects raised are subjected to beneficiation as described in chapter - 6. A detailed study has been made on different sub-grade chrome ore at National Metallurgical Laboratory, Jamshedpur; for construction of full-fledged chrome ore beneficiation plant consisting of screening, two stage grinding, cyclone and spirals. It was observed that about 13% Cr2O3 middling are generated during beneficiation process.

(d) Physical & Chemical specifications stipulated by buyers. - Not applicable

(e) Process adopted to up grade the ROM to suite the user requirements

ROM ore raised from the mines are sent to the ferro alloys plant at Balasore. This consists of both fines, lumps and large boulder. Total ROM are subjected in different compartments and made to final (-) 1.5 mm size which is fed to the furnace.

5.1 Result of beneficiation done in COB Plant during last scheme period of 2010-11 to 2014-15.

Year	Quantity fed to COBP (tons)	Grade (Cr2O3%)	Concentrate recovery (tons)	Grade (Cr2O3%)	By product (tons)	Grade (+10%Cr2O3)	Tailing recovery (tons)	Grade (-10%Cr2O3%)
2010-11	99547	30.48	46490	50.41	14794	21.36	38263.000	9.79
2011-12	92549	25.47	37100	48.47	55448	10.12	Nil	Nil
2012-13	86403	25.67	32369	49.50	46113	11.71	7920.580	9.59
2013-14	89148	26.86	30554	49.61	58595	15.17	Nil	Nil

2014-15	43005	26.37	14978	50.98	28026	13.22	Nil	Nil
Total	**410652**	**27.17**	**161491**	**49.68**	**202976**	**13.18**	**46183.58**	**Nil**
	100.00% by volume	**27.17% by grade**	**39.32% by volume**	**49.68% by grade**	**49.42% by Weight**	**13.18% by grade**	**11.24% by Weight**	**9.75% by grade**

5.2 Proposal for beneficiation to be done in COB Plant during the scheme period of 2015-16 to 2019-20.

Year	Quantity fed to COBP (CuM)	Grade (Cr_2O_3%)	Expected concentrate recovery (CuM)	Grade (Cr_2O_3%)	Expected by product (CuM)	Grade (Cr_2O_3%)	Tailing recovery (CuM)	Grade (Cr_2O_3%)
2015-16	46000	Up to 28% Cr_2O_3	16079	>50% Cr_2O_3	20903	13 % Cr_2O_3	8958	<8% Cr_2O_3
2016-17	92000		16100		20930		8970	
2017-18	92000		16100		20930		8970	
2018-19	92000		16100		20930		8970	
2019-20	92000		16100		20930		8970	
Total	**92000**		**80479**		**104623**		**44838**	
Recovery	100%		35%		45%		20%	

5.3 Tailing Disposal

The tailing of the COB plant are being collected in 2 numbers ponds of size 20m x 20m x 4m made up of RCC floor and walls. No leakage of water from the pond both in vertical and horizontal is observed. The tailings are removed from the pond by hydraulic excavator and kept outside for drying. After drying, the tailings are being shifted through tipper and excavator combination to the earmarked tailing disposal area on the overburden dump in the southern side of the lease area. Further improvement to reduce tailings loss shall be adopted after getting the suggestions from internal & external academic institutions in course of time. The Flow Sheet of COBP with grade and quantity of feed material, percent recovery of concentrate with grade and percent of reject generated is placed at **Annexure - 23**

6.0 PROCESSING OF ROM & MINERAL REJECT

Chrome ore of this lease area is of fine-grained, brownish black colour to black color friable ore. The associated gangue minerals are magnesite, serpentine, magnetite and limonite. Grain size of Chrome crystals varies between 0.1mm to 1.5mm. Hardness 2 to 4,sp gravity 1.6 to 3.0 and non-magnetic to feebly magnetic in nature.

(a) If processing / beneficiation of the ROM or Mineral Reject is planned to be conducted, briefly describe nature of processing / beneficiation. This may indicate size and grade of feed material and concentrate (finished marketable product), recovery etc.

Beneficiation of mineral rejects is being continued in the company's own facility inside the lease which has a capacity to beneficiate about 64000 CuM/year. A detailed study has been made on different sub-grade chrome ore at National Metallurgical Laboratory, Jamshedpur; for construction of full-fledged chrome ore beneficiation plant consisting of screening, two stage grinding, cyclone and spirals. It was observed that about 13% Cr2O3 middling are generated during beneficiation process.

To reduce Cr2O3 content in the middling's and increase the recovery of chrome content a detailed study has been made by IMMT Bhubaneswar and a new process-flow sheet developed for middling processing. Approval from IBM is there to add the circuit to the existing Plant which is added by October 2012.

(b) Give a material balance chart with a flow sheet or schematic diagram of the processing procedure indicating feed, product, recovery, and its grade at each stage of processing.
Material balance chart is at **Annexure -23.**

(c) Explain the disposal method for tailings or reject from the processing plant. - **Refer Para 5.7**

(d) Quantity and quality of tailings /reject proposed to be disposed, size and capacity of tailing pond, toxic effect of such tailings, if any, with process adopted to neutralize any such effect before their disposal and dealing of excess water from the tailings dam.
As mentioned in Para 5.5 above tailing recovery was 11.24% by weight with 9.75% Cr2O3. As at Para 5.6 during proposed scheme period tailing recovery will be about 20% of feed with 8% Cr2O3.

(e) Specify quantity and type of chemicals if any to be used in the processing plant.
No chemical shall be used in the processing plant

(f) Specify quantity and type of chemicals to be stored on site / plant.
Not applicable

(g) Indicate quantity (cum per day) of water required for mining and processing and sources of supply of water, disposal of water and extent of recycling. Water balance chart may be given.
Water balance chart is attached at **Annexure - 24.**

7.0 OTHERS

7.1 Site services

The different site services such as office, explosive magazine, first aid centre, store room, crèche, V.T. Centre, Bachelor Hostel, rest sheds, blasting sheds, canteen for staff and executives are already existing within the lease area. Besides, provision of staff bus and ambulance etc. for the staff members is already there. These services will be continued during the future mining operations.

7.2 Employment potential

The Management and supervisory personnel already employed in the mine and the proposed personnel required during future mining operations are given below.

Sl. No	Personnel	Qualification	Existing
1	Mines Manager	Degree/Diploma in Mining Engineering with first class certificate of competency (with more than 10 years' experience).	1
2	Asst Manager	Second Class Mines Managers Certificate Holder	6
3	Mining Engineer	Degree in Mining Engineering (with more than 10 years' experience).	1
4	Geologist	M. Sc in Geology (two geologists are with more than 10 years' experience.	10
5	Surveyor	Mine's surveyor's certificate of competency	3
6	Mines Foreman	Foreman certificate of competency	12
7	Mining mate	Mate certificate of competency	18
Total			**51**

Employment placement	Location and nature of work	Total
Departmental (Regular)	Mines	232
Departmental (DRM)	Mines	39
Departmental	Bhubaneswar office	14
Contractual Workers	Supply Worker	32
	Loading	265
	Processing	32
	Processing	41
	Equipment Hire	5
	Vehicle Hire	1
	Security	33
	Mining	356
Total		**1050**

8.0 PROGRESSIVE MINE CLOSURE PLAN UNDER RULE 23 OF MCDR'1988

8.1 Environment Base line information

(i) The study of land environment forms the prime study since the changes brought in over this are permanent in nature and make visual effects which are easy to identify and recollect. For collecting the information over the land under reference detailed study of topographical maps and village maps available over an area of about 64.463 Ha, about 300 sq.kms buffer area surrounding in the precincts of the mine and reconnaissance survey was undertaken. Information obtained from bore hole data were also correlated wherever necessary. From the above detailed studies, the following lead features have been recorded about the lease hold area in reference.

(ii) The mining lease area is roughly a strip of land measuring approximately 1250 m in length and 420 in wide in average. Existing mining operations are concentrated on ore Band – I, approximately middle of the lease covering about 17.880 Ha area.

(iii) The surrounding area is having mining leases of other companies and all are actively operated now. General topography of the lease area represents a plain undulating terrain covered with reddish brown alluvium soil and laterite.

8.1.1 Existing land use pattern indicating the area already degraded due to mining, roads, processing plant, workshop, township etc in a tabular form.

Sl. No.	Head	Area put on use at start of Scheme of Mining (Ha)
1	Area under mining	17.880

2	Storage for top soil	0
3	Waste dump site	33.178
4	Mineral storage	2.210
5	Infrastructure (workshop, administrative building, colony etc.	1.219
6	Roads	1.738
7	Railways	0
8	Tailing pond	0.020
9	Effluent Treatment Plant	0.240
10	Mineral Separation Plant	0.800
11	Township area	0
12	Others (to specify)	0
Grand Total		**57.285**

8.1.2 Water regime, quality of air, ambient noise level, flora, climatic conditions

(a) Water regime

(i) The Sukinda valley runs generally in a NE to SW direction closing towards east and fanning towards west. It is flanked by Daitari range on the North and Mahagiri range on the south. The altitude within the lease area ranges between 120 m to 182 m above mean sea level. The area represents an undulating topography, sloping towards the west. The bottom and top RL of the hillock in the central portion of the lease area are 135 m and 182 m respectively. There are no streams, perennial Nalas or seasonal nalas observed within the lease area. The land within the lease area is mostly covered with lateritic and wasteland with no settlements. The nearest habitation is the mine colony of TISCO on the west and Chirigunia camp of OMC on the north. Both are approximately 1.0 km away from the lease boundary. The major drainage system of the region is located NNW of lease area named as Damsal nala which originates from Eastern part of Tungaisuri hill range, flows towards West in Sukinda Valley and then turns towards South and finally joins with Brahmani river. There is another seasonal major nala named as Kurchamula nala flows towards South from Daitari hill range and ultimately joins with Damsal nala through Kharkari Reservoir. Besides few more seasonal nalas named as Nadiabaroa nala, Langalakanta nala and Petapeti nala flows from North to South and ultimately joins with Damsal nala. There are so many seasonal nalas originating from Daitari hills and flow towards South and those seasonal nalas originated from Mahagiri hills flow towards North and ultimately join with Damsal nala. There are 2nos. perennial nalas in the South Western part of buffer zone and known as Pandara nala and Dharainala originated from Mahagiri hills and flow towards South. Due to very gentle slope, there is no perennial or seasonal nala in the lease hold

area. Damsal nala is the nearest water body at 1.0 km in NNW direction from the mining lease area. Garland drains have been constructed around waste dump and quarries for draining rain water. The working RL of the mine lease area being considered at 139 m AMSL. Twelve bore holes were drilled inside the lease area for mineral exploration purpose mainly. Water was struck at various depths within these bore holes. The water levels in these bore holes were measured regularly and the perusal of the periodical monitoring data shows that the depth to pre monsoon water level is around 33 mbgl which in the post monsoon period is around 27 – 29 mbgl. (Analyses Report **Annexure – 25)**

(ii) From the above, it can be inferred that the ground water table is at 100 mRL.

(iii) Both the surface and seepage water accumulated in the mine pits are discharged through pumps which are installed inside pits. The pumped out water passed through an ETP.

(b) Air quality

There is no dearth of fresh and free air in this region because of very scanty population, cattle breed etc. After the start of the mines, pollution would have started to some extent, but due to the measures taken to suppress dust in the activity area does not pose much of a problem on this score. Air pollution is normally defined as the presence in the atmosphere of substances or conditions which adversely affect living organism or habitats. The condition of air is normally disturbed due to gaseous emanations from machineries, dust generated during drilling, blasting, movement of vehicles, loading and crushing operations in the mines. Effective control measures are taken to minimize the pollution due to this effect. Regular air monitoring are being carried out and existing level of air pollution in the area is below the permissible limits (National Ambient Air Quality norms) as it is revealed from the monitoring data generated. The details analysis are enclosed in **Annexure - 25**

(c) Ambient noise level

The source of noise for the area was mainly from drills, compressors, tippers & excavators. There is no habitation in the vicinity of the area. Therefore, impact in this respect has been felt negligible. Regular monitoring of noise levels at different points in the mines is being carried out, the noise monitoring data is enclosed. **(Annexure - 25)**

(d) Climatic condition

The climate of the study area is humid and tropical. It is characterized by a hot and dry pre-monsoon from March to May, a monsoon or rainy season from June to September and a cool winter from October to February.

Temperature

The annual maximum daily mean temperature is 33.30C, while the absolute maximum temperature is 47.20C. Similarly, the annual minimum daily mean temperature is 20.70C and the absolute minimum temperature is 11/3.90C. In general, May is the hottest month and January is the coldest. Extreme temperatures prevail in the area.

Relative Humidity

Humidity is fairly high through the major part of the year and it rises above 80% in the months of July, August and September. The driest months are March and April. The average relative humidity is around 53%.

Rainfall

The average annual rainfall is 1598.36 mm and there are on the average, 97 rainy days in a year. Rainfall peaks during July and August with the four months (June to September) recording 65% of the total rainfall.

Comparison Between IMD Rainfall Data & Internal Rainfall Data In Yearly

Year	IMD Rainfall Data	Internal Rainfall Data	Diffrence Between IMD & Internal	Remarks
1999	0.00	2018.00	0.00	-
2000	0.00	1588.30	0.00	-
2001	0.00	1969.20	0.00	-
2002	0.00	1406.10	0.00	-
2003	0.00	2000.20	0.00	-
2004	1265.50	1137.47	128.03	IMD
2005	1531.90	1841.45	309.55	Internal
2006	1804.80	1735.70	69.10	IMD
2007	1758.50	1635.23	123.27	IMD
2008	1688.60	1438.86	249.74	IMD
2009	1673.10	1580.99	92.11	IMD
2010	1282.70	1093.13	189.57	IMD
2011	1683.00	1613.01	69.99	IMD
2012	1185.40	1426.41	241.01	Internal
2013	0.00	1491.30	0.00	-

Wind Speed

The maximum mean monthly wind velocity is 1.5 m/s and the maximum wind velocity is 4.7

Wind Direction

The predominant wind directions in the study region are from NE and NW followed by South easterlies in Winter season but in later winter some winds from SW & SE is also found. In the

Summer season predominant winds are from SE and NW. In the Monsoon season predominant winds are from NE & SE. The post monsoon season has predominant winds from the NE and SE besides NW at times.

8.1.3 Human settlements

There are no settlements and human habitation within the lease area and the project dose not envisage shifting of even a single person.

8.1.4 Public buildings, places of worship and monuments

There are no public buildings, places of worship and monuments within the lease area.

8.1.5 Indicate any sanctuary is located in the vicinity of leasehold

Natural park, wildlife sanctuary, forest, national monument or tourist interest do not exist in the lease area as well as in buffer zone also. Outside of the mining lease area few places of worship like church and temples are exist which does not interfere with the present mining activity.

8.2 Impact Assessment

Advanced technological innovations and improvements have been brought in the exploration and exploitation of minerals in quick successions, on need base. However, the improve methods made available for the environmental preservation is rather slow. The environmental impact is defined as an alteration of environmental conditions or creation of environmental parameters those may upgrade or degrade the environ especially the land, water and air region of the area. The other connected aspects like noise, vibration and impacts on socio- economic considerations have also to be studied. A comprehensive analysis of the different environmental impacts was due to mining is to be understood well. The physical, chemical and bio-logical effects and their influences on national, social, cultural and aesthetic domains of the region should be considered. A careful evaluation of the impact will not only help in preventing unnecessary/unwanted damage to eco system but will also lead to planning and management of adopting proper environment restoration programs.

8.2.1 Land area indicating the area likely to be degraded

(a) The lease area (64.463 Ha) is non-forest land. Activity wise land requirement has been shown in the following Table following Para 8.1.1 above.

(b) Land utilization break ups (at proposed 5 yearly stages) has been studied and data for which are furnished in Table following 8.2.1 (g) below. The table conclusively shows that the mining project will have effect on the topography of the area only.

(c) Mining will be extended in the Non forest area and the quarry area is going to

increase by 4.142 Ha by end of proposed scheme period.

(d) Afforestation has been planned in over the overburden dumps.

(e) The planned afforestation shall provide a better forest density than the existing scrubby forest. The afforestation has been planned in a manner which will actually increase the bio-diversity of the local ecosystem. The roads may be used by Govt.

(f) After cessation of the mining, roads and buildings will be utilized by the local inhabitants. These facilities shall benefit the site as the roads will form a much better communication link with the outside compared to the existing jeep tracks and existing built up areas may be of use for rural development purpose. During mine closure areas occupied by topsoil bank, storage of machinery and mineral storage area shall be afforestated

(g) Land area indicating the area likely to be degraded due to quarrying, dumping, roads, workshop, processing plant, tailing pond/dam, township etc.

Sl. No.	Head	Area put on use at start of Scheme of Mining (Ha)	land use at the end of the proposed scheme period (Ha)
1	Area under mining	17.880	22.022
2	Storage for top soil	0	0
3	Waste dump site	33.178	35.173
4	Mineral storage	2.210	2.249
5	Infrastructure (workshop, admin building, colony etc.	1.219	1.071
6	Roads	1.738	0.686
7	Railways	0	0
8	Tailing pond	0.020	0.020
9	Effluent Treatment Plant	0.240	0.240
10	Mineral Separation Plant	0.800	0.702
11	Township area	0	0
12	Others (to specify) - Area towards south east side of dump – 3 and areas where green belt and garland drain has already been developed.	0	2.300
Grand Total		**57.285**	**64.463**

8.2.2 Air quality

In mechanized opencast mine, mining operations such as mining extraction, loading and unloading, movement of dumpers on haul roads and external dumping and sizing of ore etc are expected to generate airborne fugitive dusts. Existing level of SO_2 and NO_x in the core zone area is almost less in all the readings and it is not expected to increase in future with the enhanced production. Comparatively higher level of SPM and RPM are expected due to fine particles, which becomes easily airborne after blasting and in haul roads. Due to coarse grained structure, compact nature and not friable, raising of dusts shall not be much. But excavated wastes shall raise the airborne dust level to some extent**.** As the fugitive pollution is localized, pollution transport from mining area to the villages shall be low. Further, dust generated, if any, in excavation area shall be suppressed through water sprinkling**.** While transporting chrome ore from mine to charge chrome plant, as the ore is soft and friable in nature, substantial fugitive dust during transportation is expected. So, precautionary measures like covering the compartment containing ore.

8.2.3 Water quality

Mining is a physical process where water is mainly used for dust suppression and washing of heavy earth moving machines. Since no chemical transformation takes place and the ore is naturally occurring, there is no possibility of any chemical contamination in this waste water except an increase in suspended solids comprising ore particles, clay etc. During oil changes in equipment & other machinery in garage, the oil is mostly drained into containers and being sent to our General Stores for onward disposal to authorized re-processors. All the used filters are being destroyed in identified pit in store premises. Water contaminated with spilled oil & grease from service area is handled through oil separation system. Effluents from garage and workshop are carried to oil separation system and the oil free water is recycled. Thus there will be no discharge going out of the lease area and to any water body. From above it can therefore be concluded that no adverse effect is expected in water quality.

8.2.4 Noise levels

The existing noise level in the area closed to the mine site, as measured at work zone is 70 db (A) during day time and 64 dB (A) at night (Leq. values calculated). The noise level is regularly monitored in the respective area and data thus generated are recorded and maintained for effective control measures which has been dealt in subsequent paragraph.

8.2.5 Vibration levels (due to blasting)

The problem of ground vibration is associated with operations like drilling, blasting, loading, crushing and that of running machineries. But the most prominent one are the factors associated with blasting operations. To control the ground vibration due to blasting, Nonel is being used and multi delay in a hole is in practice to minimize noise, ground vibration and to restrict fly rock.

8.2.6 Water regime

During the course of mining, no nallah/streams has been diverted. The rain water and seepage water is collected in the deep sumps, is being pumped off. The pumped out water passes through settlings tanks & long drainage system within the mining area where the suspended particulate matter, if any, gets settled and the clean water goes to the neighbouring agricultural land and are utilized for the cultivation purpose. Waste water & sanitary sewage from domestic use in the colony is being discharged to septic tank and soak pit and in no circumstances discharged to any water body. As estimated, the source of water for futuristic operations of the project shall be from quarry accumulated water and dug well. Maximum water demand to satisfy the project requirement is 295 CuM/day (in peak summer). Out of 295 CuM, only 25 CuM water is drawn from ground water. The population is also low. As because water demand for industrial, domestic and irrigation is very low, drawl of 25 CuM/day (maximum) of water from the surface and ground source shall not cause any water deficit in the area. Moreover, a number of streams join after the water drawl point are acting as surface recharge sources and sufficiently compensating the drawl quantity.

8.2.7 Acid mine drainage : Not applicable

8.2.8 Surface subsidence : Not applicable

8.2.9 Socio-economics

The location of operational area under reference with respect to the villages or other human settlement and the scale of mining activities contemplated are observed not to cause any damage to the property. There are no amenities of any type, existing in and around the area to get affected by the mining operation. There are no major displacement of village and rehabilitation of land for bustees involved except in the danger zone of blasting , which is almost complete. This does not affect the basic life style, livelihood or culture. The continuance of mining has improved the socio-economic conditions of the people living around. Various direct and indirect benefits given to the mine employees are also extended to the villagers and the facilities are -

- Direct employment in the mines at much higher wages;

- Improved transport and communication facilities;
- Additional educational and medical facilities;
- Post office, bank and market facilities;
- Additional security measures adopted by company;
- Electricity and lighting facilities in the nearby villages; and
- Recreational facilities like club, sports and pastime, T.V., cinema etc., as entertainment facilities.

8.2.10 Historical monuments etc.

As explained in earlier paragraph, no natural park, wildlife sanctuary, forest, national monument or tourist interest do not exist in the lease area as well as in buffer zone also. Hence, impact assessment on this account does not required.

8.3 Progressive reclamation Plan

8.3.1 No reclamation of mined out land is proposed during the proposed scheme period.

8.3.2 Environmental aspects

(a) Efforts are being taken to restrict/ reduce the degradation of land in the coming years by limiting the activities by depth ward extension of mining. However, during the coming years of mining in the lease hold area, it has been projected that an additional area of 4.142 hectares of land will be degraded for systematic development of the quarry during the period 2015-2016 to 2019-20 and by end of conceptual period, a total area of 26.164 Ha of land will be degraded.

(b) The plantation program during the coming years is shown in the Conceptual Plan **Plate No. 08 (A)**. Continuous agaves or similar plantation will be done at the waste dumps and mined out areas.

(c) Environmental monitoring with respect to air, water, noise, etc will be continued as per norms and guidelines.

8.3.3 Land use pattern :

The existing land use shall be changed during the scheme period and conceptual period since the quarries are to be extended and some fresh areas shall be utilized for mining and other activities. The present land use pattern vis a vis that in scheme period and conceptual period are tabulated below:

	Land use at the start and end of conceptual period			
Sl. No.	**Head**	**Area put on use at start of Scheme of Mining (Ha)**	**land use at the end of the proposed scheme period (Ha)**	**land use at the end of the conceptual period (Ha**
1	Area under mining	17.880	22.022	26.164
2	Storage for top soil	0	0	0
3	Waste dump site	33.178	35.173	31.309
4	Mineral storage	2.210	2.249	2.249
5	Infrastructure (workshop, admin building, colony etc.	1.219	1.071	0.801
6	Roads	1.738	0.686	0.678
7	Railways	0	0	0
8	Tailing pond	0.020	0.020	0.020
9	Effluent Treatment Plant	0.240	0.240	0.240
10	Mineral Separation Plant	0.800	0.702	0.702
11	Township area	0	0	0
12	Others (to specify) - Area towards south east side of dump – 3 and areas where green belt has already been developed.	0	2.300	2.300
Grand Total		**57.285**	**64.463**	**64.463**

8.3.4 Topsoil Management

No topsoil is there which may require management.

8.3.5 Tailings Dam Management

The steps to be taken for protection and stability of tailing dam, stabilization of tailing material and its utilization, periodic desilting measures to prevent water pollution from tailings etc, arrangement for surplus water overflow along with detail design, structural stability studies, the embankment seepage loss into the receiving environment and ground water contaminant if any may be described.

8.3.6 Acid mine drainage, if any and its mitigative measures. - Not applicable

8.3.7 Surface subsidence mitigation measures through backfilling of mine voids or by any other means and its monitoring mechanism.

The information on protective measures for reclamation and rehabilitation works year wise may be provided as per the following table.

Items	Details	Cumulative as on date	Proposed (Year)				
			1st	2nd	3rd	4th	5th
Dump management	Area afforested (Ha)	13.0	-	-	1.03	7.583	8.4
	No of saplings planted	88468	-	-	1580	11570	14560
	Cumulative no of plants	75213	75213	75213	77793	88363	102923
	Cost including watch and care during the year (Lakhs)	-	-	-	-	-	-
Management of worked out benches	Area available for rehabilitation (ha)	Nil	Nil	Nil	Nil	Nil	Nil
	Afforestation done(ha)	Nil	Nil	Nil	Nil	Nil	Nil
	No of saplings planted in the year	Nil	Nil	Nil	Nil	Nil	Nil
	Cumulative no of plants	Nil	Nil	Nil	Nil	Nil	Nil
	Any other method of rehabilitation (specify)	Nil	Nil	Nil	Nil	Nil	Nil
	Cost including watch and care during the year (L)	Nil	Nil	Nil	Nil	Nil	Nil
Reclamation and Rehabili- tation by backfilling	Void available for Backfilling (L x B x D) pit wise /stope wise	Nil	Nil	Nil	Nil	Nil	Nil
	Void filled by waste /tailings	Nil	Nil	Nil	Nil	Nil	Nil
	Afforestaion on the backfilled area	Nil	Nil	Nil	Nil	Nil	Nil
	Rehabilitation by making water reservoir	Nil	Nil	Nil	Nil	Nil	Nil
	Any other means (specify)	Nil	Nil	Nil	Nil	Nil	Nil
Rehabili-tation of waste land within lease	Area available (ha)	Nil	Nil	Nil	Nil	Nil	Nil
	Area rehabilitated	Nil	Nil	Nil	Nil	Nil	Nil
	Method of rehabilitation	Nil	Nil	Nil	Nil	Nil	Nil
Others (specify)	Besides, retaining wall, garland drain, settling tank etc have been constructed and shall be re-constructed. Details are as follows.						

8.3.8 Disaster Management and Risk Assessment

As far as the nature of deposit and method of mining (opencast) is concerned, there is no possibility of landslide, subsidence, flood, inundation, fire, seismic activity and tailing dam failure etc.

8.3.9 Measures taken for controlling any unforeseen disaster and risk etc

(i) Ultimate slope of the quarry is kept at very safe depending on formation condition

(ii) The nearest river controls the drainage system and receives the entire rain & run-off water is Baitarani at a distance of 45 km from the mine towards west. There were no floods in the past & not expected in future too, as the area is located in high altitudes.

(iii) Though earthquake is felt several times in Orissa, damage to man & material has been severe till date.

(iv) 2 no's explosives magazines with total capacity of 0.8 tonnes have been constructed on the non movable part of waste dump – 2 on 0.107 Ha area for storage of explosives. Handling of explosives and blasting operations are done by qualified blasters and

blaster helpers under the supervision of an Asst. Manager. The Asst. Manger is assisted with a qualified foreman to have effective supervision. To control fly rock fragments during blasting in creating problems to nearby men and machinery precautionary measures are being adopted and shall be continued in future which are as below.

- Proper blast design results in lower ground vibrations and avoids the fly rock.
- Controlled blasting technique with SME/SMS (Nonel system of initiation).
- Drill holes will be located in weaker planes.
- No loose materials will be kept on the bench floors during blasting.
- Optimum stemming length and stemming material will be chosen.
- Safe ratio (stemming length to burden of hole) shall be kept at more than 0.6.
- Proper compaction of the stemming material will be undertaken before blasting.

(v) Safety Precautions are being practiced and area also proposed Boards displaying (in Odiya & English) blasting time will be kept at the places where required. Blasting time will be fixed and intimated to all concerned. At the time of blasting, security guards will be deployed in order to block the vehicle movement on the public road. In order to indicate the blasting operation, red flags will be kept where ever required. A Siren will be blown at the beginning and end of the blasting operation.

(vi) Small-scale fire may occur, which will be extinguished by fire extinguisher. Sufficient quantity of sand and water are kept in the magazine premises.

(vii) Area under reference has no proposal of beneficiation / washing plant. Therefore, tailing dam is not necessarily required and the question of failure of tailing dam does not arise.

8.4 Care and Maintenance during Temporary Discontinuance

Temporary discontinuance may happen due to various causes such as

- Court order
- Natural calamities
- Accident (mine related)
- Slope failure
- Failure in fulfillment of statutory requirement or
- Local issues
- Any other unforeseen circumstances

Since it is a temporary discontinuance, the following measures can be undertaken partly/fully depending upon the causes

- Intimation to local mine & legal administrative authorities regarding the discontinuance.
- Listing of the machines & materials
- Care and maintenance of machinery as per the machine operating manuals.
- Tightening of the security to keep the machine and materials safe & secured.
- Preparation of plan & sections at the time of discontinuance.

- Repair & maintenance of haul road
- Regular monitoring of air, water, noise etc in the permitted area.

An emergency plan for the situation of temporary discontinuance due to court order or due to statutory requirements or any other unforeseen circumstances may indicate measures of care, maintenance and monitoring of status of discontinued mining operations expected to re-open in near future.

(a) During temporary discontinuance due to unforeseen reasons such as court order, natural calamity, mine related accident, any type of failure in fulfillment of statutory requirement or local issues or any other unforeseen circumstances, slope failure etc shall have to be implemented forthwith.

(b) **Emergency plan to be taken up, which will include the followings**

- Intimation to local mine and legal administrative authorities concerned (IBM, DGMS, Directorate of Mines, Circle Mining Office & others) regarding the temporary discontinuance.
- Explanation to the local community, on the cause of temporary discontinuance and possibility of reopening of mine in future.
- Listing and proper storing of machines, materials, assets and documents.
- Care and maintenance of machinery as per machine operating manuals.
- Tightening of security to keep the machine and materials safe & secured.
- Monitoring of status of unplanned discontinued mining operation in respect of bench height, width, individual bench slope angle, over hang, under cut, misfire or any other parameters, whose levels either in form of higher side or lower side, is dangerous for further mine working.
- Repair & maintenance of haul road.
- Regular monitoring of air, water, noise & others in the permitted area.

(c) Necessary plan & section at the time of discontinuance of mines are to be prepared and kept ready. Those are

- Projection of benches, in the plan and sections, which is safe for future working:
- Management of misfire. Fly rock movement, maintenance of machinery & others which are risk free and not dangerous for further working.
- Intimation to concerned authorities for reopening, once the mine is risk free.

8.5 Financial Assurance

Table indicating break-up of the areas within the lease for calculation of Financial Assurance. The amount calculated for the purpose of Financial Assurance is based on the CCOM's Circular no. 4 dated 2006 as below.

Sl. No.	Head	Area put on use at start of Scheme of Mining (Ha)	Additional requir during Plan period (Ha)	Total Area (Ha)	Area considered as fully recla & rehabd (Ha)	Net area considered for calculation (Ha)
1	Area under mining	17.880	4.142	22.022	0	22.022
2	Storage for top soil	0	0	0	0	0
3	Waste dump site	33.178	1.995	35.173	0	35.173
4	Mineral storage	2.210	0.039	2.249	0	2.249
5	Infrastructure (workshop, admin build, colony etc).	1.219	(-) 0.148	1.071	0	1.071
6	Roads	1.738	(-) 1.052	0.686	0	0.686
7	Railways	0	0	0	0	0
8	Tailing pond	0.020	0	0.020	0	0.020
9	Effluent Treatment Plant	0.240	0	0.240	0	0.240
10	Mineral Separation Plant	0.800	(-) 0.098	0.702	0	0.702
11	Township area	0	0	0	0	0
12	Others (to specify) - Area towards south east side of dump – 3 and areas where green belt and garland drain has already been developed.	0	2.300	2.300	0	2.300
Grand Total		**57.285**	**7.178**	**64.463**	**0**	**64.463**

This being a Category "A" mine, financial assurance for 64.463 Ha is calculated at the rate of 25000.00 per Ha. This amounts to Rs 1611575/-. The lessee shall submit a financial surety in shape of Bank Guarantee for the amount to the Regional Controller of Mines of Indian Bureau of Mines, Bhubaneswar Region, Bhubaneswar.

PART-B

9.0 : Certificates/Undertakings/Consents – Submitted at the start of the document (Page - i to iii).

10.0 : List of Plans and sections submitted – Submitted at the start of the document (Page – vii to viii).

11.0 : List of documents to be annexed – Submitted at the start of the document (Page - v to vi).