A Review Of Mine Plan Implementation And Expansion Planning Of Gare IV/1 Open Cast Coal Mine, Chhattisgarh, India With Special Reference To Integrated Solid Waste Management

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Abstract : Gare IV/1 open cast coal mine was started on virgin land in the year 1998 with a projected coal production of 2 million tonnes per annum (MTPA) in the state of Chhattisgarh, India. This paper traces the implementation of the approved mining plan on ground and identifies the deviations and their causes thereof, with special reference to the over burden management, washery wastes and ash from present sponge iron plant and middling based power station at Raigarh and additional proposed middlings based power station (washery and power station, both at pit head). In 2004, the mine was planned for expansion to 6 MTPA. Simultaneously, for transportation of coal from mine to the consumer (sponge iron plant), a railway line has been envisaged over a distance of 35 km. This paper predicts the impact of the latest planning measures in terms of improvement of the environment as well as economics. Integrated solid waste is proposed for disposal of the ash from Raigarh and pit head thermal power plant to the mine. The railway route will also be useful for transport of ash from existing power stations at consumer end. It is economically and environmentally more sustainable than the road route. This study also tries to establish the potential impact of sub surface hydrogeological flows through the back filled materials and its pollution potential.

Keywords : Mining and mineral wastes, Environmental impacts, Integrated waste management, ash disposal

Introduction

Depending upon the type of mineral and depth at which it is found, the process of its mining may yield zero or substantial solid waste in the form of 'overburden' and 'inter burden'. Solid waste management in mines has attracted a lot of attention from mining engineers, geologists, geotechnical engineers and environmentalists due to the various challenges in overburden and interburden management. Some of the commonly associated problems with solid waste are stabilisation of dumps, erosion, collapse (dump failure), gully formation, pollution etc.

Gare IV/1 open cast coal mine was started in the year 1998 in the state of Chhattisgarh in India by a private sector conglomerate (Refer Fig. 1 for location map). The authors had the opportunity to be involved in the mine planning as well as the environmental management planning of the mine whilst still a greenfield project. In India, the regulations demand that the detailed mining stage plans be prepared for the first five years only, followed by the conceptual plan (end of life) and got approved from the Ministry of Coal. The environment management plan (EMP) is based on the approved mining plan, and hence valid as long as the same mining plan in adhered to for the life of the mine.

The project was started with a humble production of 0.5 million tonnes per annum (MTPA) of coal in the first year. The company was operating a small steel plant and power plant near the city of Raigarh, about 35 km from this mine. The production from this mine was to meet the requirement of the same. However, the steel scenario world over changed to such an extent that post 2000, the steel and power sectors started experiencing a boom and the Government of India aided this further by opening coal mining to private players in a bigger way.

Hence, after five years, in 2004, the authors again had the opportunity to be part of the team involved in preparation of the mining scheme for the subsequent five years. At this juncture the owner company had decided to expand the capacity of the mine from 2.0 MTPA to 6.0 MTPA to meet the increasing demands of sponge iron plant.

During these years, Government of India took out a Notification stating "Every coal or lignite based thermal power plant commissioned subject to environmental clearance conditions stipulating the submission of an action plan for full utilisation of fly ash shall, within a period of nine years from the publication of this Notification, **phase out the dumping and disposal of fly ash on land** in accordance with the plan." (1). With increased coal consumption in the sponge iron plant and thermal power plant, the generation of fly ash would also increase, thereby making it more challenging to adhere to the Government of India Notification.

There are all sorts of methods to manage fly ash such as brick making, tiles making, cement manufacture, road making and reclaiming burrows/ quarries and low lying lands. In US, post the Clean air Act 1990, fly ash beneficiation has also been done.(2) But none of the methods utilizes fly in quantities large enough to make it possible for a thermal power plant to phase out dumping and disposal of fly ash on land.

With the need to revise the mining plan for the mine and to adhere to the above Notification, it was thought to utilize the exhausted mine pit for ash dumping. This would become the first private sector company to undertake such a project at such a large scale considering the typical environmental problems with ash dykes. Ash dykes have been under fire for various reasons such as utilization of enormous water volumes, using large areas of virgin land and causing water pollution.

There are recent instances of using fly ash for stoping in underground mines in India, but so far only in the Government operated mines. For the first time in India, use of pond ash in underground mine stowing in working panel has been successfully demonstrated. Approximately 10000 m^3 pond ash has been stowed in the underground mine PK-I OF Singereni Collieries Company Ltd. (SCCL), Manuguru area from a captive Thermal Power Station of Heavy Water Plant (Department of Atomic Energy) at Manuguru, Andhra Pradesh. Directorate General of Mine Safety is satisfied with the demonstrations and plans are being worked out to take up pond ash stowing on large scale. The project is implemented by Central Mining Research Institute, Dhanbad.
Similar operations are also on at Western Coalfields Ltd. ((WCL) - Chandrapur, where pond ash from Chandrapur Super Thermal Power Station is being stowed in Durgapur Raitwari Colliery, Chandrapur area, Chandrapur, Maharashtra. (3)

Objectives

a) During the mine planning exercise for increased capacity, a study of the solid waste dumping planned for 1998-2004 was done and compared with the actual dumping to find out the deviations and reasons thereof.

b) At the same time, economy of transportation between the mine and the plants was studied for large scale movement of coal and fly ash.

c) Of the various parameters that are affected due to fly ash dumping (Fig 2), the impact assessment of ground water was done.

Methodology

a) For solid waste dumping planned during 1998-2004, the mining plan of the Mine was referred to. This was superimposed by the present surface plan of 2004 to identify the locations and sizes of present dumps vis-à-vis the planned dumps. The records of dumping maintained at the mine were collected and the deviations in permitted dumping quantities and those in actual were identified. Further planning was done by mining engineers for the next five years based on the present status (i.e. 2004) of dumping.

b) The company wanted to economise transportation of coal and waste in view of the increased generation of coal as well as ash. The present transportation system is road based. Hence, a parallel study for establishing a railway line from the mine to the plant was done. The benefits in terms of reduced costs as well as tremendous tangible and intangible environmental benefits were enumerated by the authors based on traditional methods. Air pollutant modeling was done using CALINE.

c) The proposal for fly ash dumping as backfill material in open cast mine was and still is under debate. The foremost concern being the threat to ground water quality due to leaching of heavy metals and other contaminants from fly ash. For this purpose, the revolutionary work carried out at Manuguru, India is drawn upon heavily. Their studies of the water filtered through the barricade gave hope that it is possible to undertake backfilling with limited contamination. Pumping tests were carried out adjoining to the mine to determine aquifer characteristics. Water levels were measured in over 30 locations in the immediate vicinity and the water quality determined in eight ground water and seven surface water samples. This helped establish the present baseline scenario to impact assessment exercise.

Results and Discussion

a) In the approved mining plan two outside dumps were envisaged and are summarized in Table 1 (4). Actually the position of outside dump upto 31st Aug 2003 is as given in Table 2 (5). A perusal of the two tables and study of the records as well as discussions with the mines manager shows that there are two main deviations:

- The dump (D_2) location inside the lease is not the same as was envisaged in Mining Plan. Dumps D_1 and D_3 are located near the colony outside the ML, however no outside dump was envisaged outside the ML. This deviation was due to the reason that the land envisaged for dumping inside the ML could not be acquired in time as the owners were reluctant to sell, hence the dumping was carried out where the land could be acquired inside and outside the ML.

- The volume actually dumped out side 18.17 mil. cum is more than envisaged 14.47 mil. cum. Thus deviation came into play because the lower seams VII T and VII M including VIII could not be extracted in time because of quality management problems (washery could not be commissioned before 2002-2003) explained above. As the lower seams remained unmined, no backfilling could be resorted to till 2002-2003.

b) The existing road freight for carrying coal from mines to the plants is around Indian Ruppees (Rs.) 80 per tonne, which shall come down to Rs. 50 per ton for carrying over the captive railway line. Therefore, the total saving in freight is Rs. 0.330 million per day or Rs. 120.45 million per year. In addition, the proposed line shall also carry 3000-4000 tonnes per day (TPD) of ash and 1500 TPD of SMS slag. As a result, the cost of freight will further come down. These savings will result into reduction in cost of production and have significant positive impact on economy of the company (6).

Each coal train will carry about 1800 T of coal from the mines, which is equivalent to about 180 trucks of 10 T or 30 trucks of 60 T. Further, the railway shortens the distance to about two-third of the road distance. Broad calculations show that the fuel consumption will go down by almost ten times by using rail for carrying the same load compared to road transportation. Thus, significant reduction in traffic and vehicular emission, leading to positive impact in air environment, is envisaged.

The movement of trains will impart impact through increase in levels of SO_2, Nox and CO. However, the emissions are distributed over a length of 35 km, and the total round trips on the line limited to 12, which is equivalent to one train passing any point at an interval of about 90 minutes. Modelling the emissions, its is observed that under the worst conditions scenario, the most affected village enroute will experience CO increase by 11.1 micro grams/m^3, SO_2 by 3.14 micro grams/m^3, and NOx by micro grams/m^3.

c) The ground water in the area generally occurs within the primary porosity of alluvial material or Gondwana sandstone which occurs at shallow depth. The occurrence and movement of groundwater is controlled by prevailing geomorphology. The ground water table in the region varies between 2-10 m below ground level and the seasonal water fluctuation varies between 2-4 m, the average being 2.8 m. The pumping tests revealed that the deeper aquifer has got low permeability (0.5 to 1.0 m/day) (7).

Since the mining void intersects the ground water table, the mine seepage has been calculated and it comes to 4.09 million cubic metres (MCM) annually. Simultaneously, rainwater accumulation in the mine pit is acting as a source of recharge to the tune of 0.226 MCM (7).

Hence, it is inevitable that seepage flows occur through backfills, especially when the depth of the mine will increase and the backfills will also correspondingly become higher.

Fly ash can be backfilled with the overburden in two ways- either as layers alternated with overburden or by mixing thoroughly with overburden. The second option will prove to be more expensive and while considering the overall volume filled and distribution per unit area, the proportion of fly ash and overburden would remain similar.

The studies done at Manuguru reflect that the filtered water through fly ash has heavy metals and other parameters well within the limits specified by the Indian standard IS : 10500 for drinking water. Ash tends to be less reactive based on method of disposal and process of ponding (8). Also, unlike stowing, the water will be even lesser contaminated in backfilling due to its (ash) being mixed with overburden. The typical iron content in the mine bore well was 0.38 mg/l and other heavy metals were below detectable limits.

Conclusion

a) The first deviation was unavoidable since the land can be bought only from willing sellers. However, the second deviation could have been avoided with timely commissioning of washery. The future backfilling programme will leave a void of about 40 mill. cum. spread over an area of about 3.6931 sq. km. Hence, considerable fly ash can easily be accommodated with backfilling

b) It is concluded that the tangible and intangible benefits are manifold such as savings in cost of production of coal at consumer end and savings in expenditure on transportation of fly ash and slag since the same train which would otherwise be going back empty to the mine can carry the ash and slag. Environmental benefits are in terms of long term reduction in fossil fuel consumption and air pollutant emission reduction. Transportation by train would be very advantageous compared to the present system of road transportation. There will be reduction in vehicle density, which in turn will result in reduction in accidents enroute and subsequent blockades by concerned parties.

c) Fly ash dumping with overburden has several risks as well as advantages. The implementation of the proposal will bear clearance from the Ministry of Environment and Forests for ensuring clean environment as well as Director General of Mine Safety for ensuring stability of backfill.

Hence, integrated solid waste management approach for the mine as well as the steel and power plants will a feasible solution for several multi-prongedproblems.

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Table 1

Outside Dump Details As Approved In Mining Plan Period (1998-99 to 2003)

Outside Dump	Outside or inside the ML	Area, sq. km.	Capacity, million cubic metre	Height, m
D_1	Inside	0.0901	0.85	30
D_2	Inside	0.4034	13.62	60
Total		**0.4935**	**14.47**	

Table 2

Actual Overburden (OB) Dumps Created till Aug 2003

Outside Dump	Outside or inside the ML	Area, sq. km	Capacity, million cubic metre	Height, m
D_1	Outside	0.1540	4.64[1]	30
D_2	Inside	0.2216	7.95[1] 0.22[2]	50
D_3	Outside	0.1830	3.36[1]	20
Roads/Bunds	-	-	2.00[1]	-
Total		0.5586	18.17*	

** Comprises 17.95 mcum OB/IB in* D_1 , D_2*, and* D_3 *+ 0.22 M cum TS over* D_2
1 OB/IB
2 TS

FIG 1. : Map Showing Location Of Mine With Respect To Plant And Railway Line

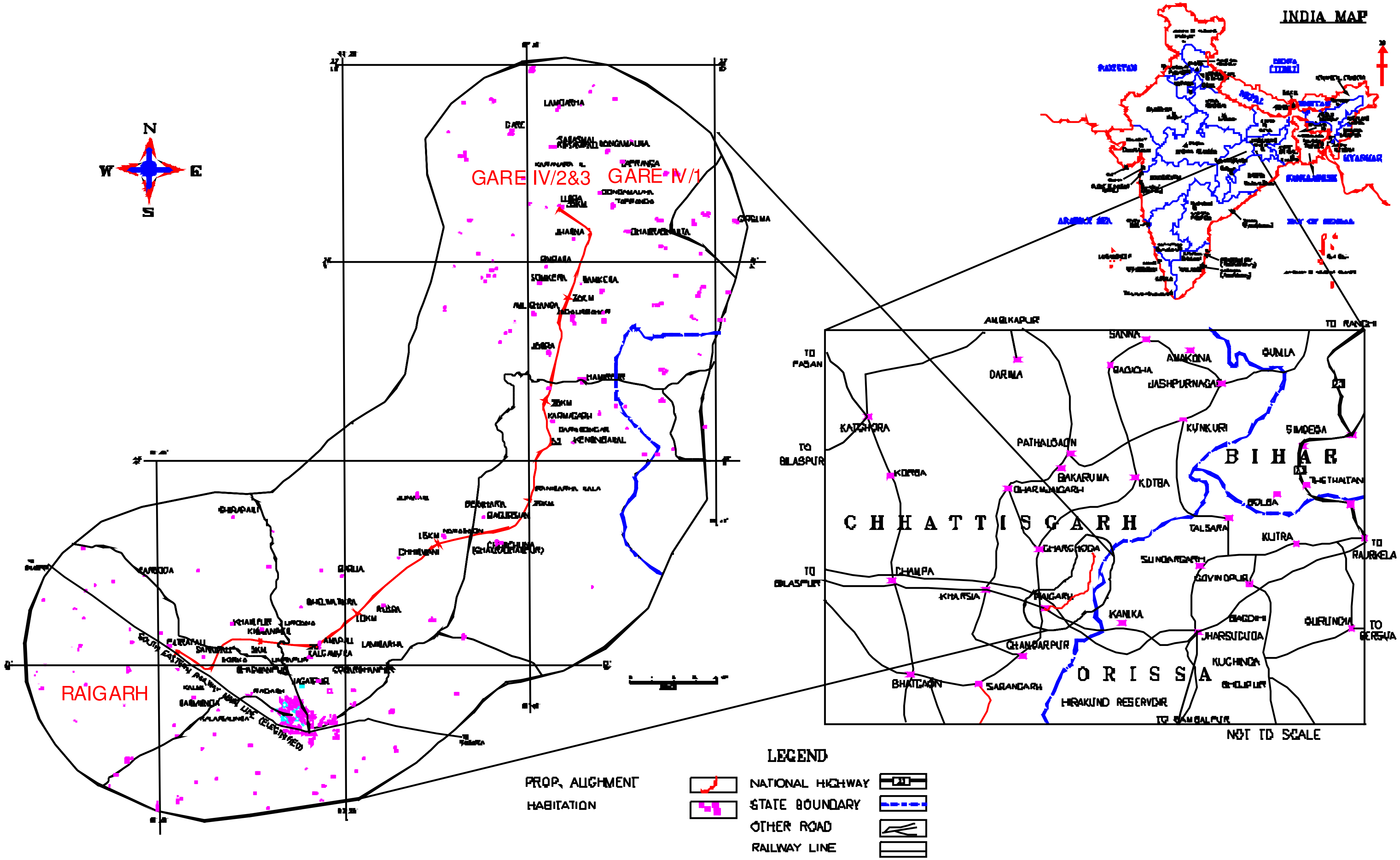
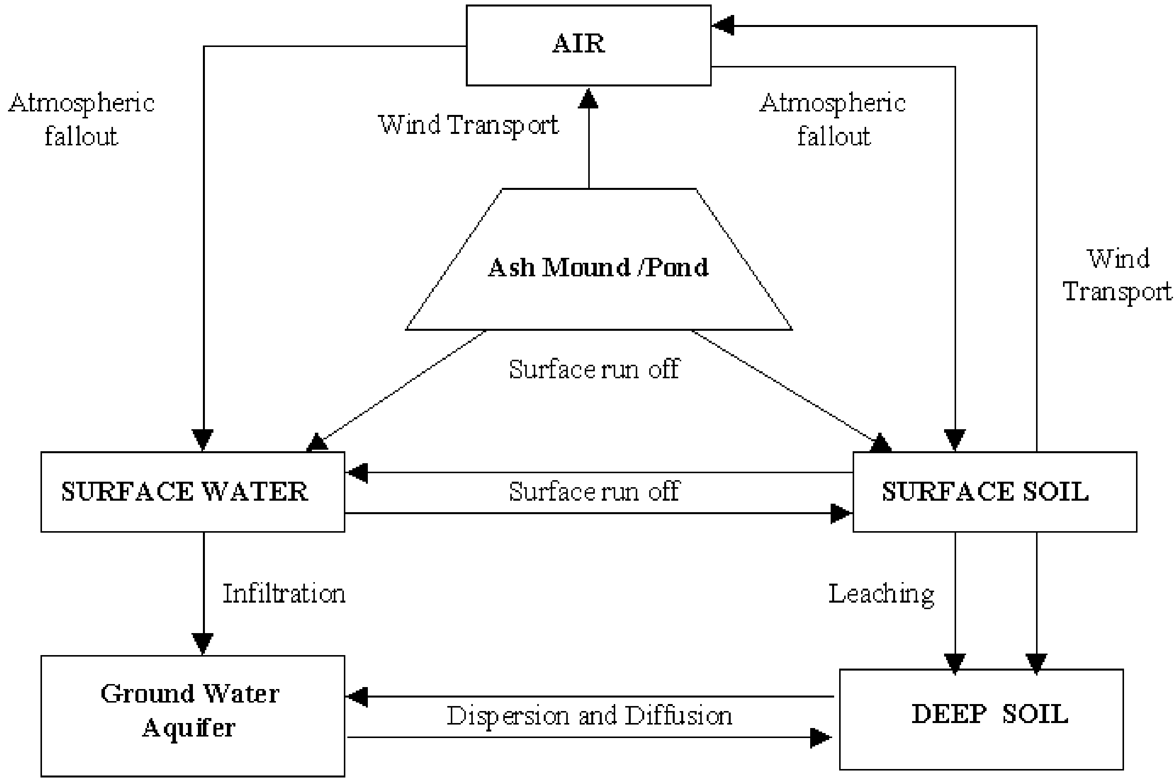


Fig 2. Impact of fly ash dumping



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