RISK ASSESSMENT

HAZARD IDENTIFICATION AND RISK ASSESSMENT METHODOLOGY

All types of industries face certain types of hazards which can disrupt normal activities abruptly. Similar river bed mines also have risks which need to be addressed for which a disaster management plan has been formulated with an aim of taking precautionary steps to avert disasters and also take such action after disaster which limits the damage to minimum. In the sections below, the identification of various hazards, probable risks during the operational phase of the mining, maximum credible accident analysis and consequences analysis are addressed either qualitatively or quantitatively.

Risk assessments will help mine operators to identify high, medium and low risk levels. This is a requirement of the Occupational Health and Safety Act 2000. Risk assessments will help to priorities the risks and provide information on the need to safely control the risks. In this way, mine owners and operators will be able to implement safety improvements. The following natural/industrial problem may be encountered during the mining operation.

- Inundation: Filling of the mine pit due to excessive rains
- Slope failures at the mine faces or stacks
- Accident due to fire (in forested areas)

As per proposal made under the mining plan the area will be developed by means of opencast mining method. Extraction of minerals is to be carried out by semi-mechanized. Water table will not be touched during the mining process. No high risk accidents like landslides, subsidence flood etc have been apprehended.

Risks due to Inundation

Mining will be done during the non-monsoon periods (October-June); therefore problem of inundation is not likely to happen.

Risks Due to Failure of Pit Slope

In order to allay dangers due to open cast slope failure, final pit, slope stability estimations will be made for the existing mines. Determining the factor of safety, the slopes should be monitored at regular intervals to check for any possible failure.

Risks due to Failure of Waste Dumps

During extraction of sand from mining areas silt and clay will also be removed in form of waste materials. The excavated silt and clay will be used for backfilling of the pits. Therefore there is no risk associated with failure of waste dumps.

Risks of Accidents due to Trucks and Dumpers

Identifying the hazards that come along with the presence of vehicles at the workplace (*e.g.* reversing operations, loading) can cause harm if not properly handled. Among some of the factors that may make vehicle accidents more likely are:

- Rough access roads
- Time pressure
- Inadequate brakes (Possibly from lack of maintenance)
- Carelessly parked vehicles (*e.g*. being parked on a slope without being adequately secured)
- Unsafe coupling and uncoupling of trailers, and
- Untrained drivers
- Overturning vehicles

To avoid such instances we will talk to the workers and their representatives and will involve them in the risk assessment process and tell them what to do, to reduce risk. All transportation within the mine lease area should be carried out directly under the supervision and control of management.

- The vehicles will be maintained in good working condition and checked thoroughly at least once a month by the competent person authorized for the purpose by the management.
- Road signs will be provided at each and every turning point up to the main road (wherever required)
- To avoid danger while reversing the vehicles especially at working place/loading points, stopper should be posted to properly guide reversing/spotting operating.
- Only trained drivers will be hired.

DISASTERS AND ITS MANAGEMENT

Mining and allied activities are associated with several potential hazards to both the employees and the public at large. A worker in a mine will be able to work under conditions, which are adequately safe and healthy. At the same time the environmental conditions also will not impair his working efficiency. This is possible only when there is adequate safety in mines. Hence mine safety is one of the most essential aspects of any working mine. The safety of the mine and the employees is taken care of by the Mines Act 1952, which is well defined with laid down procedure to ensure safety and constantly monitored and supervised by Directorate General of Mines Safety and Department of Mines, State Government.

Identification of Hazards

There are various factors, which can create disaster in sand mine. These hazards are as follows:

a) Inundation / Flooding.
b) Quick Sand Condition.
c) Drowning.
d) Accident due to vehicular movement.
e) Accident during sand loading, transporting and dumping.

The mining activity has several disaster prone areas. A check list depicting likely disaster/risk events due to the sand mining activity is presented in **Table 7.2** and identification network for hazards are depicted in **Figure 7.1**. Accidents occur due to negligence, poor workmanship and unskilled persons.

Table 1.: Check List for Likely Risks in Sand Mines

S. No.	Activities	Human Risk			Ecological Risk		
		Probability of Occurrence	Consequence	Risk level	Land	Air	Water
1.	Sand Loading	Possible	Critical	6	0	0	0
2.	Sand Transport	Possible	Critical	6	0	0	0
3.	Sand Dumping and Storage	Possible	Critical	6	0	1	0
4.	Inundation/Flooding	Possible	Minor	3	1	0	0
5.	Quick Sand Condition	Possible	Minor	3	0	0	0
6.	Drowning	Possible	Critical	4	0	0	0
7.	Vehicular Movement	High	Critical	8	1	2	0

Sand Loading

The sand is loaded in the trucks using hand shovels and back-hoe. There are possibilities of injury in the hands during loading with shovels and staying under bucket movement.

i. There are possibilities that the workers standing on the other side of loading may get injury due to over thrown sands with pebbles.
ii. There are possibilities of workers getting injured during opening of side covers of the trucks to facilitate sand loading.
iii. There are possibilities of riverbank collapse due to close proximity of sand extraction.
iv. There are chances of falling of cattle/children into sand pit in river bed-- instances of death due to fall in such pits were reported from other areas to the Department of Mines.
v. Chance of workers getting injured due to improper balancing of truck while loading.

Sand Transport

The sands loaded in 25 Tons trucks are being sent to the collieries through public roads.

i. All possibilities of road accidents are possible.
ii. Accident may also occur during movement in the mine (sand dunes).
iii. There are possibilities that due to overloading, some pebbles or big boulder may injure the passerby public.

Sand Dumping and Storage

i. There are possibilities of the trucks rolling/ sliding down the sand bunker during dumping operation.
ii. The dumper /trucks may cause injury to the workers working near the stowing plant.
iii. Dumping the sand in an empty sand bunker may cause injury to the stowing operator if the bunker chute is in open condition.
iv. Dumping the sand in an empty sand bunker may cause burying the stowing machineries if the bunker chute is in open condition.

Heavy Machinery

Most of the accidents occur during transportation by dumpers, trucks and other heavy vehicles and are often attributable to mechanical failures, in which the factor of human errors cannot be ruled out.

Inundation / Flooding

i. The possibility of inundation/flooding of the sand mines are very high during monsoon or during heavy rains in lean season as the mine area lies over the sand dunes of a riverbed.
ii. There are dangers to the trucks and other machineries due to flooding.
iii. There are dangers to the workers working in the sand dunes. Inundation or flooding is expected and beneficial for these sand mines as during this time only the sand reserve gets replenished.

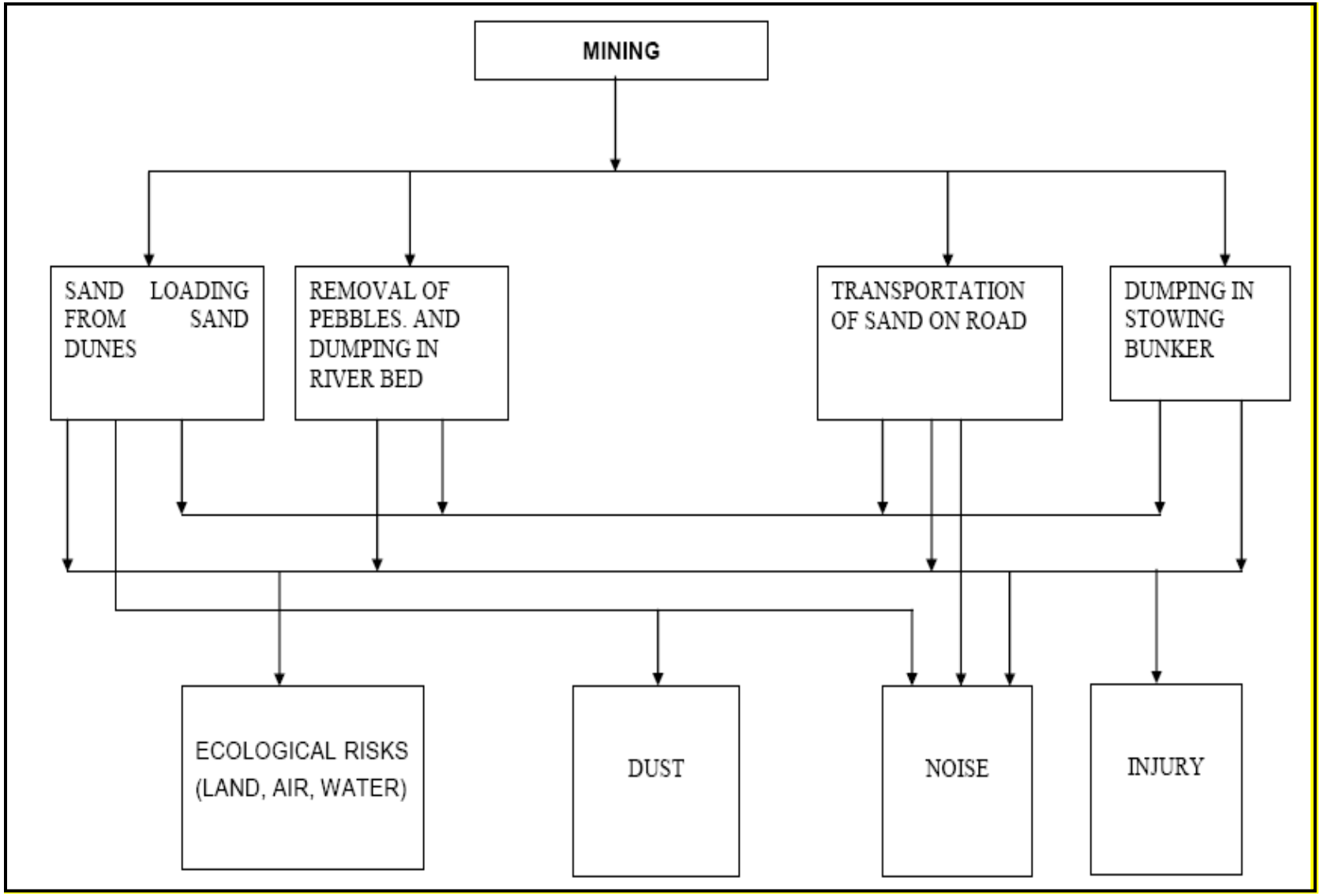

Figure 7.1: Identification of Hazards in Mines

Quick Sand Condition

i. This condition occurs when the working crosses the water table at a certain depth and the permeability of the strata is very high.
ii. This condition occurs when the effective stress in the sand becomes zero due to influx of water i.e., $i = i_{cr} = \Upsilon'/\Upsilon w$; where i = Hydraulic gradient, icr = Critical Hydraulic gradient, Υ = submerged unit weight, Υw = unit weight of water.
iii. This creates danger condition to the trucks and other machineries plying over the sand dunes.

Drowning

There are possibilities of drowning in the deeper part of the river. However safety jackets, floating tube will be kept at the site office to prevent any mishap.

Mitigation of Hazards

Measures to Prevent Accidents during Sand Loading

i. The trucks will be brought to a level so that the sand loading operation suits to the ergonomic condition of the workers and the back-hoe.
ii. The loading will be done from one side of the truck only.
iii. The workers will be provided with gloves and safety shoes during loading.
iv. Opening of the side covers (pattas) will be done carefully and with warning to prevent injury to the loaders.
v. No sand will be collected within 7.5m from bank, especially from outer bank of the meandering river. Safe clearance will be mainly determined by the height of the river bank and thickness of sand to be extracted from the close vicinity of that bank.
vi. Ponding in the river bed shall not be allowed.
vii. Operations during daylight only.
viii. No foreign material (garbage's) will be allowed to remain/spill in river bed and catchment area, or no pits/pockets are allowed to be filled with such material.
ix. Stockpiling of harvested sand on the river bank will be avoided.
x. For particular operations, approaching river bed from both the banks will be avoided.

Measures to Prevent Accidents during Sand Transportation

i. All transportation within the main working will be carried out directly under the supervision and control of the management.
ii. The Vehicles must be maintained in good repairs and checked thoroughly at least once a week by the competent person authorized for the purpose by the Management.
iii. Road signs will be provided at each and every turning point especially for the guidance of the drivers at the evening/night.
iv. To avoid danger while reversing the trackless vehicles especially at the embankment and tipping points, all workers will be removed from all areas for reversing of lorries, and the vehicle will have audio-visual alarm during reversing.
v. A statutory provision of the fences, constant education, training etc. will go along way in reducing the incidents of such accidents.
vi. Generally, overloading will not be permitted. Big boulders will not be loaded. This is unsafe and may damage equipment and stowing bunker.
vii. The truck will be covered and maintained to prevent any spillage.
viii. The maximum permissible speed limit will be ensured.
ix. The truck drivers will have proper driving license.

Safety Features Required in Tippers/Trucks

a) Exhaust/ Retard Brake: Required as per DGMS circular 02 of 2004.
b) Propeller shaft guard: Propeller shaft guard as per DGMS circular 10 of 1999.
c) Tail gate protection: Protection of cabin against collision either by head to head or head to tail.
d) Limiting speed device: To ensure speed limits as decided by management. The device may be Electronic or mechanical type speed governors.
e) Reverse gear for audio-visual alarm: The audio-visual alarm provided for equipments will confirm to DGMS (Tech.) Tests to be carried out on the audio-visual alarm and certificates shall be issued to user industries.
f) Provision of two brakes: One of brakes shall be fail safe and for details refer DGMS circular 09 of 1999.
g) Body lifting position locking arrangement: A hooter along with an indication may be provided to show the body is lifted.
h) Fire suppression System: Semi-automatic fire suppression system. For details refer DGMS circular 10 of 2004. The fire suppression system shall be a factory fitment.
i) Blind spot mirror: Better view of front blind spot by operator.
j) Retro reflective reflectors on all sides: For visibility of truck during night
k) Seat belt reminder: To alert operator for using the seat belt
l) Proximity warning device: To alert operator
m) Rear Vision System: For assisting operator to have back view during reversing
n) Auto dipping System: To reduce glaring of eyes of operator during night
o) Load Indicator and Recorder: Enables management to detect and prevent over loading.
p) Global Positioning system: To prevent illegal transport and selling of sand, restricting short-cut routes other than stipulated routes and computerized monitoring.

It is the responsibility of the Project Proponent to mention these terms and conditions in the tender document.

Measures to Prevent Accidents during Sand Dumping and Storage

i. The Stowing Sand bunkers will be covered by steel grizzly (netting) to prevent inadvertent fall of human being or the vehicles during dumping operation.
ii. The dumping will be done only when the chute of the sand bunker is in closed condition or partially filled.
iii. The vehicles/trucks will not be brought over the grizzly.
iv. There will be a duly constructed berm made up of concrete or other material to prevent the rear wheels come/roll over the grizzly of sand bunker.
v. Dozers are used near the sand bunkers to maintain the safety bern and to push material over the edge as required.
vi. The dumping operation will be done under strict supervision.

Measures to Prevent Accidents due to Trucks/ Dumpers etc.

i. All transportation within applied mining lease working will be carried out directly under the supervision and control of the management.
ii. The vehicles will be maintained in good condition and checked thoroughly at least once a month by the competent person authorized for the purpose by the management.
iii. Road signs will be provided at each and every turning point up to the main road (wherever required).
iv. To avoid danger while reversing the equipment's/ vehicles especially at the working place / loading points, stopper will be posted to properly guide reversing/ spotting operating, otherwise no person will

be there within 10 Km radius of machine.

v. A statutory provision of the fences, constant education, training etc. will go a long way in reducing the incidents of such accidents.
vi. Regular training will be provided to the operators by the Company or the Contractors.

Measures to Prevent Dangerous Incidents during Inundation/Flooding

i. Inundation or flooding is expected and beneficial for these sand mines as during this time only the sand reserve gets replenished.
ii. During monsoon months and heavy rains the sand mining operations are ceased.
iii. The Trucks and other vehicle plying over the dunes will be kept on the river banks beyond HFL.
iv. The workers are not allowed to go over the dunes during heavy rains.
v. There will be mechanism/warning system of heavy rains and discharges from the upstream dams.

Measures to Prevent Quick Sand Condition

i. The only way to avoid quick sand condition is by avoiding sand lifting below water table.
ii. The critical hydraulic gradient (ICR) will be maintained at less than 1 to prevent high artesian pressure in a coarse sand area.
iii. At least 0.5 m sand bed will be left in-situ while harvesting sand from riverbed.

Measures to Prevent Drowning

i. The sand mining will be done under strict supervision.
ii. The workers are not allowed to go to the deeper areas of the rivers.
iii. The workers are not allowed to fish in the river during working hours.
iv. In case it is required to cross the river, it is done under strict supervision and over the shallow area using life lines.
v. Few life jackets, inflated tubes will be kept near the mine site.

Training and Human Resources Development

i. Appointment and delegating qualified and experienced personnel in various disciplines.
ii. Adequate training/refresher training will be provided to the supervisors, workers keeping in view provisions of Mines Vocational Training Rules, 1966; Mine Rules, 1955, Mines Rescue Rules, 1985.
iii. Personnel who have to operate and maintain HEMM, Trucks etc are to be trained under the guidance of the manufacturers and as per provisions of DGMS Circular Technical 1/1989 regarding accidents in opencast mines. Recommendation of Seventh Conference on Safety in Mines on “Safety in Open Cast Mining”, “Traffic Rules and Procedures”, “Mobile equipments and Highway Delivery Vehicles”, “Operations and Operator Training” and other related circulars.
iv. The training of mine personnel shall be provided regularly with respect to environmental protection.
v. Special courses for employees will be arranged for afforestation, re-vegetation, reclamation, health hazards (identification), malaria eradication, HIV prevention etc in the training centre of the company.

OCCUPATIONAL HEALTH HAZARDS

Dry-pit mining by open cast method involves dust generation by excavation, loading and transportation of mineral. At site, during excavation and loading activity, dust is main pollutant which affects the health of workers whereas environmental and climatic conditions also generate the health problems. Addressing the occupational health hazard means gaining an understanding of the source (its location and magnitude or concentration), identifying an exposure pathway (*e.g.* a means to get it in contact

with someone), and determination of likely a receptor (someone receiving the stuff that is migrating). Occupational hazard due to sand mining mainly comes under the physical hazards. Possible physical hazards are as below mention:

Physical Hazards Due To Mining Operations

Following health related hazards were indentified due to riverbed sand mining operations to the workers:

a) **Light:** The workers may be exposed to the risk of poor illumination or excessive brightness. The effects are eye strain, headache, eye pain and lachrymation, congestion around the cornea and eye fatigue.
b) **Heat and Humidity:** The most common physical hazard is heat. The direct effects of heat exposure are burns, heat exhaustion, heat stroke and heat cramps; the indirect effects are decreased efficiency, increased fatigue and enhanced accident rates. Heat and humidity are encountered in hot and humid condition when temperatures and air temperatures increase in summer time up to 480C or above in the river bed mining area.
c) **Eye Irritation:** During the high windy days in summer the sand could be the problems for eyes like itching and watering of eyes.
d) **Respiratory Problems:** Large amounts of dust in air can be a health hazard, exacerbating respiratory disorders such as asthma and irritating the lungs and bronchial passages.
e) **Noise Induced Hearing Loss:** Machinery is the main source of noise pollution at the mine site.

Medical Examination Schedule

To minimize the health impacts PPE like dust masks, ear plugs/ muffs and other equipments will be provided for use by the work personnel. All workers will be subjected to Initial Medical Examination as per Mines Rule 1955 at the time of appointment. Periodical Medical Examination will be conducted at least once in five years. Medical camps will be organized. The detail of health check up and periodical medical examination schedule is given below.

Table 2: Medical Examination Schedule

S. No	Activities	1st Year	2nd Year	3rd Year	4th Year	5th Year
1.	Initial Medical Examination (Mine Workers)					
A.	Physical Check -up		-	-	-	-
B.	Psychological Test		-	-	-	-
C.	Audiometric Test		-	-	-	-
D.	Respiratory Test					
2.	Periodical Medical Examination (Mine Workers)					
A.	Physical Check -up	-				
B.	Audiometric Test	-				
C.	Eye Check -up	-				
D.	Respiratory Test	-				
3.	Medical Camp (Mine Workers and Nearby Villagers	-				
4.	Training (Mine Workers)					

Note: Medical Follow Ups Work force will be divided into three targeted groups age wise as follows:		
Age Group	**PME as per Mine Rule 1955**	**Special Examination**
Less than 25 years	Once in a Three Years	In case of emergencies

Between 25 to 40 Years	Once in a Three Years	In case of emergencies
Above 40 years	Once in a Three Years	In case of emergencies