ENVIRONMENTAL IMPACT ASSESSMENT STUDY FOR THE DEVELOPMENT OF ALL-WEATHER MULTI CARGO CAPTIVE JETTY IN A GREENFIELD SITE AT VILLAGE NANDGAON, MAHARASHTRA

JSW INFRASTRUCTURE LIMITED, MUMBAI

लघु रत्न - MINI RATNA

WAPCOS INDIA LIMITED

(A GOVT. OF INDIA UNDERTAKING)

PLOT No. 76-C, SECTOR 18, GURGAON-122 015, HARYANA

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1 INTRODUCTION

1.1 Back ground & Need of the Project

The state of Maharashtra is bestowed with a long coastline of about 720 km, of which Greater Mumbai district has approximately 114 km, Thane district 127 km, Raigad district 122 km, Ratnagiri district 237 km and Sindhudurg district 120 km. There are 48 Intermediate & Non-Major Ports and 35 creeks on this coastline. The creeks have shallow water Jetties for use of the fisherman and local boats.

About 60 % of the Nation's container is handled at Jawaharlal Nehru Port Trust (JNPT). However, of late increased congestions at the berth as well as in the connectivity (especially road) its share is falling over the years. In addition, the falling usability of the Mumbai Port due to siltation and reduction in the navigable depths have made it incumbent on the Maharashtra Maritime Board (MMB) to scout suitable alternative locations in the immediate environs of Mumbai for port development. Consistent with this policy, MMB signed a lease agreement with M/s JSW Infrastructures Limited for development of a Captive port to handle captive cargo of the JSW. The deed was further modified to development of the captive jetty, in view of the order granted by the Hon'ble Minister for Ports. When fully operational the facility is envisaged to serve the captive needs of the JSW steel and power plants in the immediate hinterland (Tarapur, Vasind and Dlovi). Besides, as further perspective the facility has a capacity for serving the ever increasing need of the Industries located in the nearby Maharashtra Industrial Development Corporation (MIDC) area at Tarapur and the Vapi Industrial area in Gujarat.

The location advantage of the selected site is immense from the point of accessibility, proximity and over all development potential. The easy accessibility could be gauged from the fact that the location is well connected to the NH 8, located about 23 km away by a 2 lane state highway (Boisar Road). This road is a two lane black topped road, which connects NH8 to the MIDC area. This may be further widened after the development of port facility currently being proposed in order to handle the additional traffic. The MIDC area has 4 lane roads with dividers. The MIDC roads stop short of the proposed location by about 2 km, for which the new roads need to be constructed.

In addition, the site is located barely 8 km from the Delhi- Mumbai trunk rail route. The proposed Dedicated Freight Corridor (DFC) planned on the west of the existing rail line, is about 9 km away.

The site also draws advantage due to its location proximity to major industrial centres and business hubs.

The development potential of the site would be discussed in detail in the later chapters. For the present it could be stated that the assured captive cargo of JSW would help the port to stabilise at the beginning of its operation.

The location of the proposed port is shown in Figure 1.1.

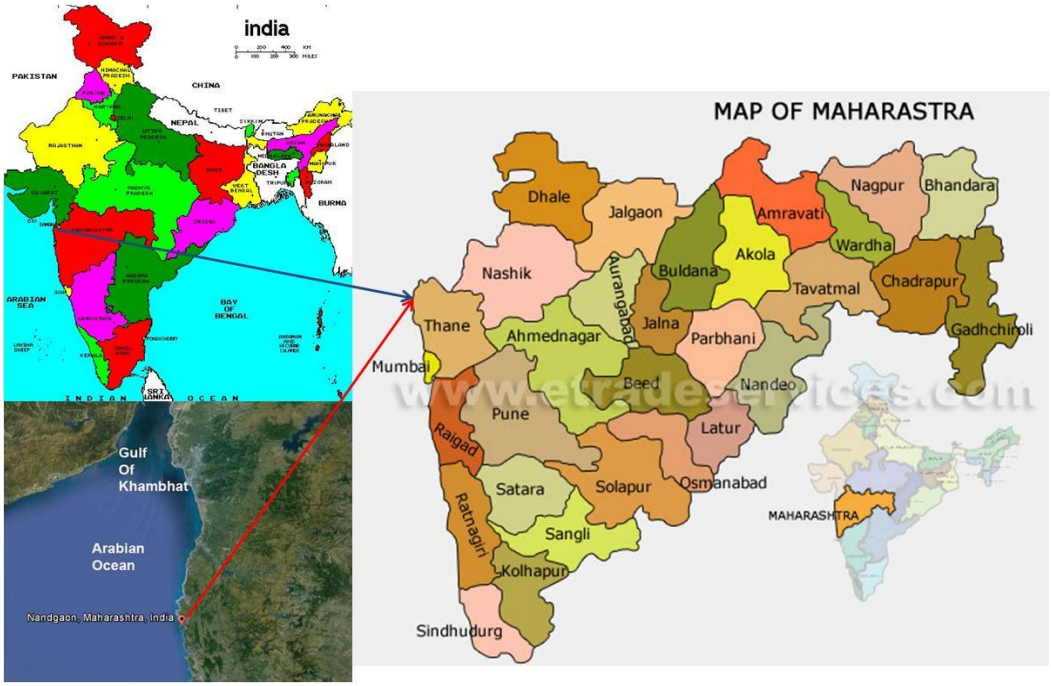


Figure 1.1: Proposed location of the Port Facility on the West Coast of India

1.2 Profile of the JSW Group

JSW Group is one of the fastest growing business conglomerates with a strong presence in the core economic sector. This enterprise has grown from a steel rolling mill in 1982 to a multi business conglomerate worth US $ 9.0 billion within a short span of time.

As part of the US $ 16.5 billion O. P. Jindal Group, JSW Group has diversified interests in Steel, Energy, Minerals and Mining, Aluminum, Infrastructure, Cement and Information Technology.

JSW Steel Limited (JSWSL) the flag ship company of JSW group is one of the largest steel producers of the Country. The company has manufacturing facilities located at Vijayanagar in Karnataka, Salem in Tamil Nadu Vasind, Tarapur and Dolvi, Kalmeshwar in Maharashtra. JSW Steel has present capacity to produce steel of 14.3 million tonnes per annum (MTPA). JSWSL currently imports more than 16 MTPA coal, coke, lime stone, dolomite and other cargoes and exports 4 MTPA through various ports of the country. The group presently engaged in the fields of steel, cement and aluminum production, power generation and Infrastructure development.

JSW Steel at Vijaynagar is one of the India's largest integrated steel companies with sales of Rs. 15,179 Crores in the financial year ended on 31st March 2011. With an annual capacity of about 14.3 MTPA the company has manufacturing facilities located at Vijayanagar in Karnataka, Salem in Tamil Nadu, Vasind, Tarapur and Dolvi in Maharashtra. The product range includes Pellets, Slabs, HRC, HR Plates / Sheets, CR Coils, GP/GC and Colour Coated Coils/Sheets, Bars, Rounds & Reinforcement bars.

JSW Energy Ltd. (JSWEL) is the first Independent Power Producer (IPP) to be set up in the state of Karnataka. The company has set up 2 units of 130 MW each and two units of 300 MW each and all these units are generating power using Corex gas and coal. JSWEL supply power to JSW Steel Ltd., and to Power Trading Corporation. JSWEL will import 4 MTPA of coal for its 1200 MW power plant at Vijaynagar.

JSWEL commenced its commercial operation on 18th January 2000 and has achieved Plant Load Factor (PLF) of more than 95% consistently. The company follows strict environmental standards and its Environmental Management system (EMS) has been certified as ISO 14001 compliant by BVQI. JSWEL is also ISO 9001-2000 and ISO 18001 certified company.

Another subsidiary, JSW Energy (Ratnagiri) Ltd, is operating a 1200 MW Coal fired power plant at Jaigad, Ratnagiri Dist, Maharashtra. Another unit is functional at Barmer, Rajsthan producing about 1080 MW lignite fired power.

The JSW Infrastructure Ltd (JSWIL) is a JSW Group company which is presently into development of ports, rail/road and inland water connectivity, development of port based SEZ and other related infrastructure developments works along with terminal handling operations and port management.

Buoyed by the Group's cargo support, experience in marine infrastructure development and operations, JSW Infrastructure Ltd. ventured into development of Greenfield ports across the coast of India.

South West Port Ltd, a JSWIL group company, has developed two berths, namely berth no. 5A & 6A in Murmugao Port, Goa on BOOT basis and has successfully handled more than 25 million tonne cargoes to date.

As part of the growth plan of the company, JSW Infrastructure entered into 50 year concession agreement with Maharashtra Maritime Board for developing a Greenfield all weather Port facility at Jaigarh in Ratnagiri Dist. The port was developed by JSW Jaigarh Port Ltd, a subsidiary of JSW Infrastructure Ltd., as an All-Weather multi-commodity Greenfield port, capable of handling vessels up to 1,05,000 DWT. The Port is now equipped to service two vessels simultaneously with 550 m quay length and 14.3 m draft.

In the initial Phase, the Port has an installed capacity of about 10 MTPA of dry and liquid cargo, with a proposal to increase in the annual capacity to 20 MTPA by deploying additional environmental friendly mechanized bulk cargo handling systems on the Berths.

JSWJPL is currently meeting the coal requirements of the operational 1200 MW power plant of JSW Energy. In the second phase expansion, the port is planning to handle other cargoes like bauxite, raw sugar, fly ash, cement, iron ore, fertilizers, fertilizer raw materials, edible oil, molasses and completely / semi knocked down kits, containerized cargoes, POL and LNG. These cargos would be handled from 6 additional berths to be constructed in this phase, for which the environmental clearance was obtained in 2007. The DPR dealing with the storage, handling and the conveyance mechanisms for the various cargos has been approved by the MMB, and now awaits environmental nod.

In this phase, the total quay length will be increased to about 2700 m (from existing 550 m). The additional berths along with the associated back up area and modern and environment friendly handling equipment would take the capacity of the port to about 50 MTPA or beyond. Rail, road and inland waterway connectivity projects for the port are also being taken up simultaneously to propel the growth further by connecting the port seamlessly with the hinterland. On 22nd September 2009, JSW Jaigarh Port Ltd. has been formally inaugurated by the Honourable Minister for Industries & Ports, Government of Maharashtra.

Presently the raw materials for the plants at Tarapore MIDC and Vasind, are being handled at various places on a make shift basis and therefore bringing in uncertainties in supply and increase in the cost. Hence, JSW is desirous of consolidating its group cargo and develop a new generation all weather multi-cargo port at a Greenfield location for its group cargoes as well as cargoes of other industries in the hinterland in a phased manner.

1.3 Project Profile

The jetty is located about 30 km to the south of the Wadhvan point and about 7 km from the Tarapur point as shown in Figure 1.2, near Nandgaon village. The coastline of the area lies between the geographical co-ordinates 19^0 45' 44" N; 72^0 41' 12" E and 19^0 47' 03" N; 72^0 41' 18" E. Rocky outcrops could be seen at low tides occurring in the S-SW direction from the shore. The length of the area covered these rocky outcrops which mostly gets exposed at low tides is about 1.5 km. A narrow sandy beach could be seen along the coast line.

Figure 1.2: Proposed locations on west coast of India to the south of Tarapur Point

1.4 Need for the EIA Study

The purpose of the Environmental Impact Assessment Study (EIA) is to assist in the decision making process and to ensure that the project options under consideration are environmentally sound and sustainable. EIA identifies ways of improving project environmentally by preventing, minimizing, mitigating or compensating for various adverse impacts likely to accrue as a result of the proposed jetty. In addition an EIA study also leads to the delineation of long-term environmental monitoring requirements.

The EIA study is a pre-requisite for getting the Environmental Clearance as well as the CRZ clearance from Ministry of Environment & Forests, Government of India (MoEF) and No Objection Certificate (NOC) / CTE from the State Pollution Control Board (SPCB). Accordingly, based on the Terms of Reference issued by the Environmental Assessment Committee of the Ministry of Environmental and Forest, this report is prepared.

The key aspect of an EIA study includes:

- Assessment of the existing status of physico-chemical, ecological and socio-economic aspects of the environment.
- Identification of potential impacts on various environmental components due to activities envisaged during construction and operation phases of the proposed project.
- Prediction of significant impacts on major aspects of environment.
- Delineation of EMP outlining measures to minimize adverse impacts during construction and operation phases of the proposed project.
- Formulation of environmental quality monitoring programme for implementation during construction and operation phases.

1.5 Outline of the Report

The contents of the EIA report are arranged as follows:

- **Chapter 1**: The chapter gives an overview of the need for the project, objectives, need for EIA study, etc.
- **Chapter 2:** The chapter presents a brief description of the project and related appurtenances.

- **Chapter 3:** Baseline environmental conditions including physical and biological have been described in this chapter. Before the start of the project, it is essential to ascertain the baseline conditions of appropriate environmental parameters which could be significantly affected by the implementation of the project.

- **Chapter 4:** Baseline environmental conditions for socio-economic aspects have been described in this chapter.

- **Chapter 5:** Anticipated positive and negative impacts as a result of the construction and operation of the proposed jetty project are assessed in the chapter. An attempt has been made to predict future environmental conditions quantitatively to the extent possible. But for certain parameters, which cannot be quantified, the general approach such intangible impacts in qualitative terms so that planners and decision-makers are aware of their existence as well as their possible implications, is addressed.

- **Chapter 6:** This chapter deals with the Environmental Management plan (EMP) and the mitigation measures for amelioration of anticipated adverse impacts likely to accrue as a result of the proposed project. The approach for formulation of mitigation means has been to maximize the positive environmental impacts and minimize the negative ones.

- **Chapter 7:** Outlines the Disaster Management Plan (DMP).

- **Chapter 8:** Environmental Monitoring Programme for implementation during project construction and operation phases has been delineated in this chapter. The objective is to assess the adequacy of various environmental safeguards and to compare the predicted and actual scenario during construction and operation phases to suggest remedial measures not foreseen during the planning stage but arising during these phases and to generate data for further use.

- **Chapter 9:** Cost required for implementation of Environmental Management Plan and Environmental Monitoring Programme is summarized in this Chapter.

- **Chapter 10:** Corporate Social Responsible (CSR) Plan

- **Chapter 11:** Delineates the Disclosure of Consultants involved in the study.

2 PROJECT DESCRIPTION

2.1 Introduction

The sub-urban region of Mumbai and its surrounding is developing industrially due to large scale and varied economic activities in the private as well as in the public sector. By virtue of its location and connectivity to the hinterland, JNPT remains the first choice for container handling in the country, though of late part of the container traffic is taken over by the Gujarat Ports. But still JNPT remains the largest container port, accounting for more than 55 % of the country's container traffic. Despite low draft of around 13.5 m, handling of this volume of traffic is possible because of excellent road and rail connectivity the port enjoys. However, with the volume of the total container traffic of the country growing keeping pace with the GDP, (NMDP pegs the twelfth plan traffic for containers at 436 million tons) the total volume in the absolute terms are in the upswing even at the JNPT port, though the traffic share in the percentage terms are on the decline. However, of late, long pre-berthing delays, congestion of the road traffic is making this port increasingly unattractive. Therefore there is a need for an additional port in the region to share the traffic and take the burdens off the JNPT. In addition this would help to ease the road and rail traffic in a big way and provide efficient, safe and environmentally sustainable alternative. Keeping these aspects in mind various alternative locations were examined before deciding on the location of the proposed jetty as discussed in the following paragraphs.

2.2 Selection of Project Site - Evaluation of the Alternatives

The proposed jetty is expected to handle about 8.4 million tonnes of cargo in year 5 rising to about 16.7 million tonnes in year 10. The cargo to be handled in the first phase would mainly consist of solid cargo such as coal, coking coal, fertiliser, cement and clinker, iron and steel, containers, automobiles, misc. cargo such as food grains, sulphur, sugar, pulp, newsprint, scrap and liquid cargo such as LNG/FSRU, POL and chemicals. There would be six berths for handling solid cargo during Phase-I, with a quay length of about 1500 m. In addition, one berth exclusively for coal, one for LNG and 3 berths for chemicals and other liquid cargo shall be constructed. Many alternative sites were examined in the hinterland of the industries requiring this jetty. As explained earlier, this jetty is envisioned to act as an alternative to the existing jetties in the Mumbai Region. Accordingly coast line from the Mumbai in the south to the Gujarat border in the south was studied. Various sites such as Umbergaon and Phansa in Gujarat and sites in Maharashtra both on the south as well as in the North were also studied. However, the choice got limited to the Maharashtra coastline

considering the distance from Mumbai and the concession terms from the Maharashtra Maritime Board. Of the various alternatives examined along this coastline only three options (refer Figure-2.1) were considered for the final evaluation of the site.

- Development within lagoon Harbour near Wadhvan Point - (Lagoon Harbour) (19^0 56' N, 72^0 42' E)
- Development off shore - Outer Harbour to the North of the Virar Creek (19^0 31' N, 72^0 44' E)
- Development off shore – Outer Harbour at Nandgaon (19^o 46' 23" N; 72^o 41' 14" E)

Figure 2.1: Location of the Alternative sites considered for the Jetty Development

2.2.1 Lagoon Harbour at Wadhvan Point

Wadhvan Point with Geographical Coordinates of 19^0 56' N, 72^0 42' E is located about 150 km from the city of Mumbai. It is close to the Dahanu BSES Thermal Power Plant. The fore shore is lined with coconut orchards and single crop cultivated lands. The shoreline is marked by exposed rocks of Basaltic Origin.

Earlier studies carried out by M/s CGR, of Australia for P&O Australia, indicated existence of hard rocks in the surface as well in the subsurface region. CGR have recommended a Lagoon harbour created by excavation of rocks by blasting under dry conditions, since

dredging of hard rock would be expensive. This appears to be a prudent choice looking at the site conditions and the prohibitively high cost of dredging of hard rock. Therefore harbour basin, inner channel and turning basin was supposed to be created by dry blasting of rocks. CGR recommended creation of dry with a series of coffer dams. Any port proposed at this location would have to necessarily adopt similar methodology. With banning of rock dredging in the eco-sensitive area of Dahanu which is barely 7 km from the site, almost put paid to any proposal for port development at this location.

The existing rail track is about 11 km away and the National Highway is about 28 km away. The conceptual plan of the harbour at the Wadhvan point is shown in Figure 2.2.

The major drawbacks of the location are the following:

1. Rocky soil conditions would pose problems in creating the Harbour basin and the approach channel, except by dry blasting which is prohibited close to the sensitive area.
2. Proximity to the Dahanu Eco-sensitive zone (7 km)
3. Land acquisition for development of Harbour as well as the backup storage area

Major advantages are;

1. No breakwater construction
2. Good founding soil condition will reduce the cost of foundation

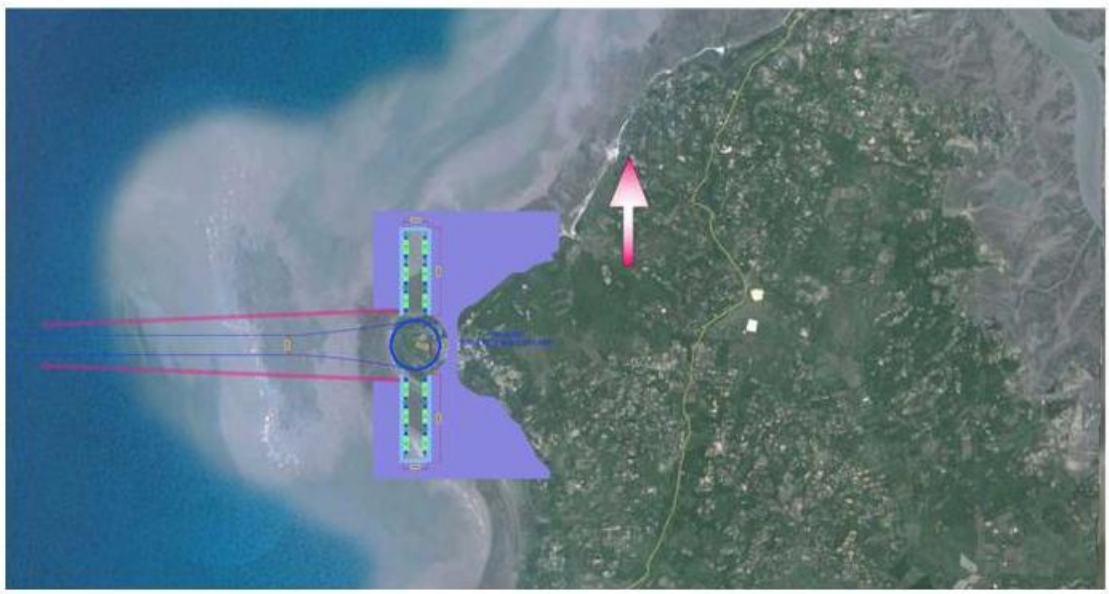


Figure 2.2: Conceptual layout of the facility at Wadhvan Point

2.2.2 Outer Harbour Offshore Outer Harbour to the North of the Virar Creek

The site north of the Virar Creek was another location for which site reconnaissance and other data examination was carried out. The biggest advantage of the location is its closeness to the Mumbai which is barely 60 km away from the site. The development plan studied around the Geographical Coordinates of 19^0 32' N and 72^0 44' E is dotted with coconut orchards and vast government land is available for the backup facilities. . The shoreline is marked by narrow sandy/clayey beaches.

An outer harbour has been planned in this area. The existing railway line and road are about 10 km and 22 km respectively from the proposed project site.

The main drawbacks of the site are;

1. The site is too close to the Sanjay Gandhi National Park.
2. Being located too close to the Mumbai Metropolitan region same problems (with regard to the road traffic) of JNPT may arise at a later date.
3. Siltation rates may be higher due to the fresh water discharge of the creek

The major advantages are;

1. No exposed rocks in the region suggest soft strata, which could be dredged easily.
2. Deeper depths in the near shore region.

The layout assessed under the alternative is shown in Figure 2.3.

Figure 2.3: Conceptual layout of the facility to the North of Virar Creek

2.2.3 Outer Harbour at Nandgaon

The site near village Nandgaon which was investigated for the proposed jetty is located around 7 km south of the Tarapur point and about 22 km south of the Wadhwan point. The geographic coordinate of the site is 19^0 46' 23" N and 72^0 41' 14" E. The shoreline forms an embayment with two creeks on either extremity. The near shore area is shallow and rocky. Vast intertidal area is one of the specialties, which can be taken advantage of by locating the harbour in deeper waters and using the near shore areas as back up space. This would reduce the land acquisition on the fore shore area, thereby, reducing the rehabilitation and resettlement issues to bare minimum. Land being an emotive issue, and the main cause of shelving of many projects around the country, this single advantage could turn the table in its favour.

The conceptual layout of the proposed jetty is shown as Figure 2.4.

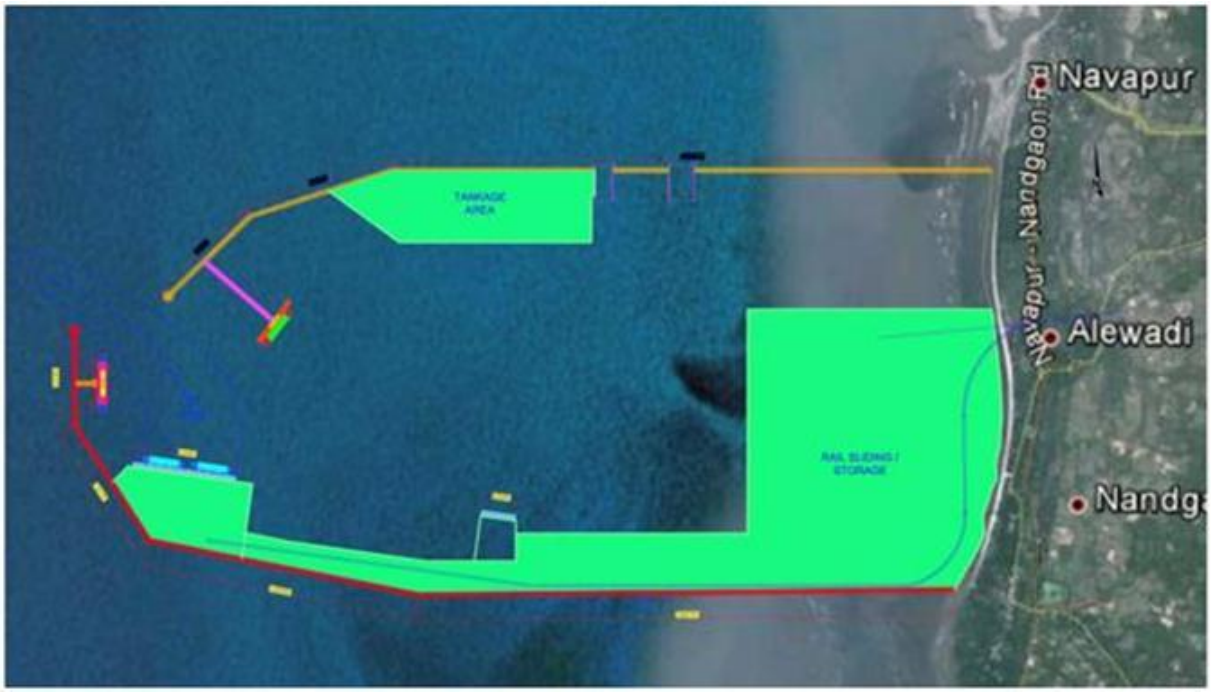


Figure 2.4: Conceptual layout of the jetty at Nandgaon

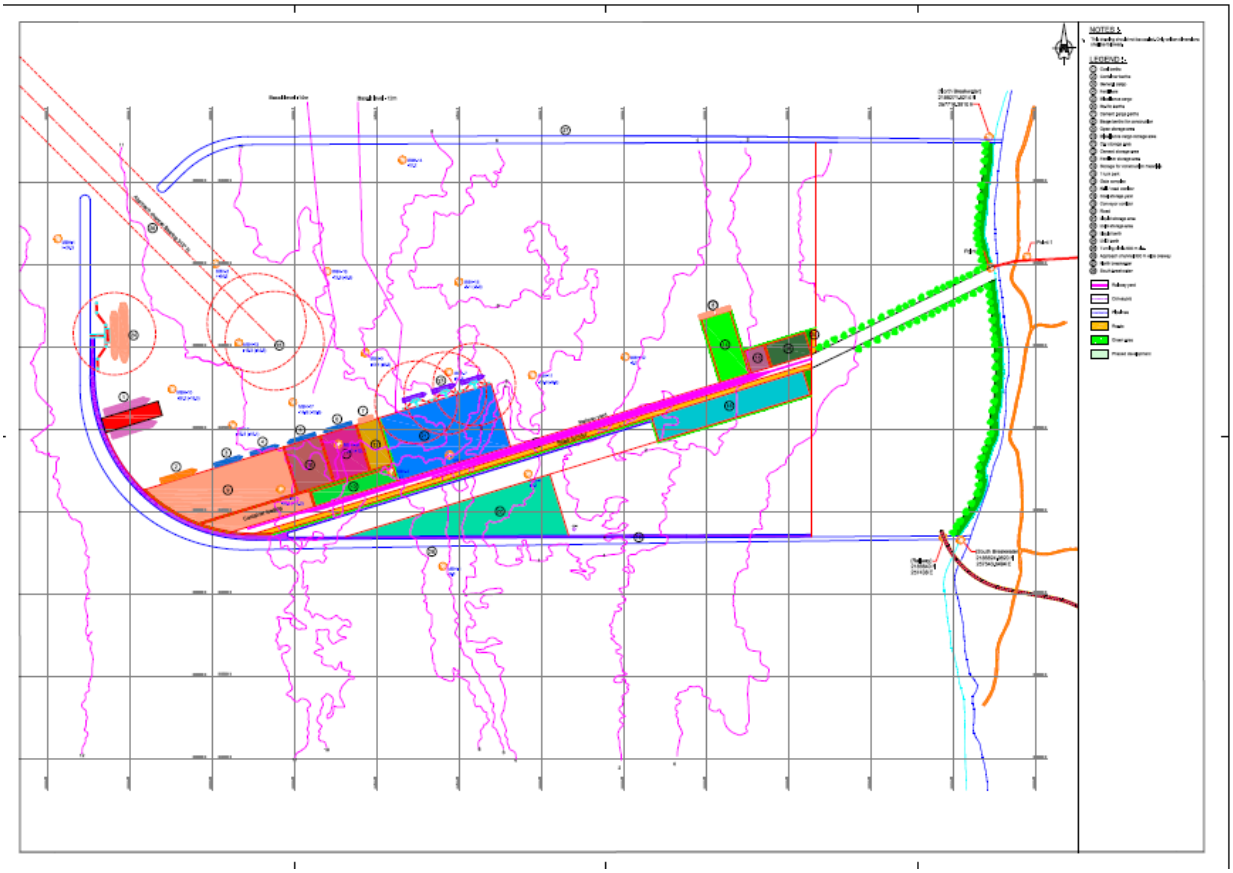


Figure 2.4a: Conceptual layout of the jetty at Nandgaon after model studies

The Layout was further refined at the DPR stage and the berths were arranged more scientifically, aligned to the predominant wind direction. The alignment and the location of the breakwaters were largely left unaltered. The berth layout was changed owing to the fact that higher wind on the beam will stress the moorings. Accordingly, the main berth is oriented to the pre dominant wind direction (255^0 N). In addition, in order to reduce the cargo mixing, the coal stack yard is located on the south eastern corner. The modified layout is shown in Figure 2.4a.

As could be seen from the Figure 2.4/2.4a, the jetty is carved out entirely on the reclaimed land. The road (National Highway 8) and the rail network (Trunk route between Mumbai and Delhi) located to the west of the proposed jetty at a distance of 23 km and 8 km respectively. In the initial Phases only road network up to the MIDC would be developed. However in the latter phase, the connectivity to the NH 8 and the Rail network including the DFC shall be established.

Land would be required for the road and rail corridor of the jetty. The alignment for the road and rail corridor was studied in details and the proposed alignment is shown as Figure 2.5. As could be seen from the Figure 2.5, the first phase road would connect the MIDC and in

the subsequent phase the connectivity to the existing road (NH 8) and rail networks (Central Railway and DFC) would be provided. The private land for the road and rail corridor would be purchased from the land owners directly through negotiations paying suitable compensation. Since land (private) requirement is less, no appreciable rehabilitation and resettlement issues are envisaged.

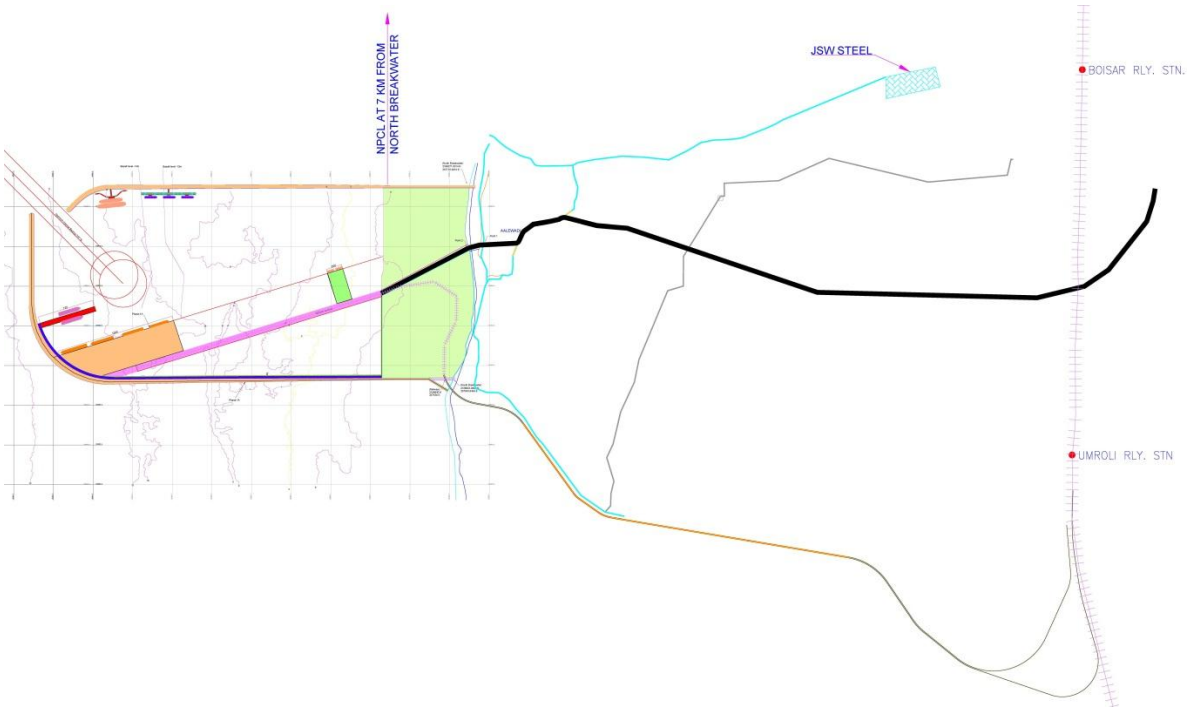


Figure 2.5: The road and rail connectivity to the jetty

2.2.4 Selection of the Site

A comparison of the alternatives was made in the following paragraphs, based on various parameters:

- Channel length
- Capital dredging
- Maintenance dredging
- Breakwaters/Groynes
- Reclamation
- Land area available
- Construction difficulty
- Rail and road accessibility
- Environmental impact
- Impact on existing operations/ facilities

- Resettlement/ rehabilitation
- Future Expansion and Cost
- Existence of Mangroves
- Fish landing Centers
- Effect on Water bodies and Bathymetry

Channel Length & Capital Dredging

Dredging and breakwater protection are the two main capital intensive activities in any jetty development, apart from their impact on the environment. Therefore length of the channel not only determines the economics, but has great environmental significance as well. In the three site evaluated for locating the harbour, the channel length will be least in case of the Nandgaon jetty. Though the Wadhwan Point has good depths comparatively near shore, the port could only be developed as a lagoon harbour due to the existence of hard rock on the bed. The cost of dredging would be least for the Nandgaon case. The other advantage of this site is the requirement of dredged materials for reclamation. For other sites the dredged material would have to be dumped in the sea and create adverse environmental effects. In addition the dredging of fresh rock at the Wadhvan Point location would be very expensive besides requirement of blasting.

Maintenance Dredging

The maintenance dredging of the Virar Creek location would be maximum followed by the Wadhvan Point Lagoon Harbour. This is due to the fact that the locations are nearer to bigger creeks which discharges large amount of sediment in the ocean. The Nandgaon location is the best, since the sediment flow along the shoreline is the least. The model studies shows an annual sedimentation of about 0.6 million m^3 for Nandgaon.

Breakwater & Groynes

As far as the requirement of breakwater and groynes are concerned, the Wadhvan point location requires the smallest and the Nandgaon site the longest. This is due to the shallow depths near shore at the Nandgaon Location.

Reclamation and Land availability

Land is a scarce and valuable commodity. Therefore, creation of land in sea through reclamation is a preferred option, if the shore line and the zonal morphology permit the same. The Nandgaon is located in the embayment where the sediment movement is limited. In addition the nearshore bathymetry is rocky and not hospitable for fishes. On the contrary the Virar site is more productive ecologically. Therefore the Nandgaon site is more

suitable for reclamation. As far as Wadhvan Point is concerned, the port would have to be located on acquired land.

Construction Difficulty

The Lagoon harbour near the Wadhvan point has to be carved out of land by blasting of fresh basaltic rock. Hence this would pose the maximum difficulty. It would also pose difficulty in creating the breakwater protections for the Nandgaon and Virar harbour. But these would have lesser environmental impact than the blasting that is intended to be involved in the rock blasting.

Rail & Road Connectivity

The distances of the nearest road/rail network are given above. This indicates that the Nandgaon location is the closest to these networks. Adequate land for the connectivity to the jetty is also available.

Environmental Impact

Impact of the ports on the ambient environmental conditions was examined in detail. It was noticed that while the Wadhvan point is located about 7 km away from the Dahanu Eco-sensitive area, the Virar location is close to the Sanjay Gandhi National park. Hence the Nandgaon Site scores more on this account**.**

Impact on Existing Operations and Activities

The Virar location is very close to the Mumbai Metropolitan Region. Hence it will add to the existing traffic due to JNPT. The other sites are though is close proximity to the Mumbai is not too close to affect the traffic movement and congestion.

Resettlement & Rehabilitation

The Nandgaon jetty has the least resettlement and rehabilitation problems since the entire facility is created on reclaimed land. Only the connectivity would need land acquisition. For other options land is needed for port development.

Future Expansion & Cost

The scope of future expansion in the Wadhvan Point option is very limited. Since all the facilities would have to be created in the first phase itself. In the other two options scope for expansion does exist, to various degrees.

Mangroves

There are no mangroves near the Wadhvan point and the Nandgaon Site. However, for the other option mangrove can be seen in the vicinity about 500 m away.

Fish landing Centre

There is a fish landing centre at Dahanu and Virar. Fish landing centre at Satpati near Nandgaon is about 7 to 8 km away.

Effect on Water Bodies

The effect on the water bodies are very important, due to the rich eco-system it possess. The effect of the proposed development on the creeks near Nandgaon was studied in a model and the effect was found to be negligible. For the other two sites though quantified effects are not available, on examination it could be seen that there will be only marginal effects.

A matrix for the three alternatives (lagoon harbour and outer harbours) was formed by giving marking from 1 to 5 to various parameters on the following basis. The grading results of evaluation of various sites are given in Table 2.1.

1 : Poor
2 : Fair
3 : Good
4 : Very Good and
5 : Excellent

Table 2.1: Evaluation of various sites considered for the Nandgaon jetty

S. No.	***Parameters***	***Lagoon Harbour***	***Outer Harbour near Virar Creek***	***Outer Harbour at Nandgaon***
1	*Capital dredging*	*1*	*4*	*5*
2	*Maintenance dredging*	*3*	*1*	*4*
3	*Breakwaters/Groynes*	*5*	*2*	*3*
4	*Reclamation*	*5*	*3*	*4*
5	*Land area available*	*1*	*3*	*5*
6	*Navigation*	*3*	*3*	*5*
7	*Construction difficulty*	*4*	*5*	*5*
8	*Rail accessibility*	*4*	*2*	*5*
9	*Road accessibility*	*4*	*4*	*5*
10	*Environmental impact*	*3*	*1*	*5*
11	*Impact on existing operations/ facilities*	*3*	*3*	*5*

12	*Resettlement/ rehabilitation*	*3*	*4*	*5*
13	*Future Expansion* *Horizontal (Plan area)* *Vertical (Deepening)*	 *3* *2*	 *3* *4*	 *4* *4*
14	*Cost*	*3*	*3*	*4*
15	*Mangroves*	*4*	*2*	*4*
16	*Fish Landing Centres*	*4*	*4*	*4*
17	*Effect on Water bodies*	*3*	*2*	*4*
18	*Bathymetry*	*3*	*3*	*3*
Total		***61***	***56***	***82***

From the analysis presented above (nature of material to be dredged, costs, environmental/ social aspects, future expansion and the matrix referred above), the jetty site Nandgaon site is preferred for the development of the proposed multi-cargo jetty.

2.3 Development Plans for Jetty and Berth Layout

2.3.1 Planning of Facilities

The planning for a harbour calls for consideration of a number of inter-connected factors, such as:

- Characteristics and quantum of cargoes to be handled
- Ship sizes and characteristics
- Marine environmental conditions
- Cargo type and average shipment/parcel size
- Methodology of loading/unloading and equipment type for each cargo
- Access from the land side
- Scope for expansion

Cargo Handling

The rate of mechanised handling of cargo will be commensurate with probable average ship sizes and the envisaged annual quantum of throughput per berth per annum keeping the average ship waiting time (demurrages) at the jetty within acceptable limit. Handling rates will be provided in view of the maritime trade practices of present and future. At the initial stage limited mechanization is planned and the extent of mechanization would increase keeping pace with the increment in cargo volume.

Jetty and Berth Layout

Tranquillity conditions at berths will be such as to permit unhindered operations for the longest possible time (at least for 330 days per annum). But in the initial stage reduced number of days may be acceptable.

Dredged Depths

In order to keep the capital and maintenance dredging cost to the minimum the access channel and turning basin will have depths and dimensions to permit movement of Aframax (105,000 DWT) bulkers and equivalent size container ships (6000 TEU), at all stages of the tide, while larger vessels, if any, will have to take advantage of tides. However, berthing areas will have depths and dimensions to permit the largest vessels up to (180,000 DWT – Cape size coal carriers) to remain at berth during all states of tide.

Adequate Storage

Storage facilities will be commensurate with ship sizes likely to be handled at various berths, annual throughput and the rate and mode of despatch of cargo to the shore-based Power Plant(s) and hinterland.

Smooth Traffic Flow

Road and rail links to the jetty or close to the jetty and suitable transhipment facilities will be provided to ensure smooth flow of traffic to and fro the jetty.

Supporting Services

Ancillary facilities such as maintenance shops, administrative and operational centres, and stores, berthing facilities for port craft and navigational aids, and all other services required for the functioning of the jetty will be provided.

Navigation channel

The geometric characteristics of the approach waterway for the jetty of Nandgaon (dimensions and alignment) and the navigation requirements would be based on the Guide lines laid down by the PIANC-IAPH, working Group No. 30. The design and details of the channel dimensions are as follows,

Outer Channel:	*Width = 180 m Depth = (-)*	*18 m CD*
Inner Channel (straight section):	*Width = 200 m Depth = (-)*	*16 m CD*

However planning the dredging of the approach channel for the MLWS condition, the dredged depths in the inner channel will be 14.8 m and the outer channel 16.8 m CD.

2.3.2 Berth requirement

The required number of berths depends mainly on the cargo volumes and the handling rates. While various general cargos including some low volumes of dry bulk can be handled

at the same (multi-purpose) berth, major bulk cargo would require dedicated facilities. Other factors that influence the number of berths are:

- Types and Volumes of Cargo to be handled
- Vessel sizes and parcel sizes
- Operational time with respect to number of operational days per year and number of working hours per day
- Allowable berth occupancy
- Types and Volumes of Cargo to be handled

The traffic expected to be handled at the jetty has been summarized in the Table 2.2.

Table 2.2: Traffic to be considered for the planning of facilities

Cargoes	***Projected Traffic in million tones***			
	Year 5	***Year 10***	***Year 15***	***Year 30***
Break Bulk and Coal	*4.0*	*5.6*	*7.8*	*15*
General cargo/Chemicals	*0.9*	*1.1*	*1.4*	*2.5*
Cement	*0.5*	*1.0*	*1.5*	*2.0*
POL and Other Liquid Cargo	*-*	*4.0*	*10*	*20*
Fertilizers	*1*	*1.5*	*1.5*	*2*
Total (1)	***6.4***	***13.2***	***22.2***	***41.5***
Containers in million TEU *(In million tons)* ***(2)***	*0.17* *(2.0)*	*0.29* *(3.5)*	*0.51* *(6.16)*	*2.80* *(33.6)*
Grand Total (1) + (2)	***8.4***	***16.7***	***28.36***	***75.1***

2.3.3 Ships Sizes Expected at the Facility

The average ship sizes for the initial years at the jetty are given in the Table 2.3.

Table 2.3: General Ship sizes considered in planning

Type	***DWT***	***LOA***	***B***	***D***
Bulk Carriers	*105,000*	*268.0 m*	*43.5 m*	*14.0 m*
Multipurpose Carriers	*80,000*	*240.0 m*	*36.5 m*	*14.0 m*
Crude Oil Tankers	*85,000*	*260.0 m*	*40.0 m*	*14.0 m*
Liquid Gas Carriers	*60,000*	*265.0 m*	*42.2 m*	*13.5 m*
Container ships	*80,000*	*290.0 m*	*42.5 m*	*14.0 m*
Ro-Ro vessels	*50,000*	*287.0 m*	*32.2 m*	*12.4 m*
General cargo vessels	*40,000*	*209.0 m*	*30.0 m*	*12.5 m*
Car carriers	*30,000*	*193.0 m*	*32.2 m*	*11.7 m*
Ferries	*25,000*	*197.0 m*	*30.6 m*	*7.1 m*
Passenger cruise ships	*80,000 (GT)*	*272.0 m*	*35.0 m*	*8.0 m*
Maximum sizes	*105,000*	*290.0 m*	*43.5 m*	*14.0 m*

2.3.4 Area requirement at Jetty

Norms adopted for Storage / Stock pile / Infrastructure areas

The norms adopted to arrive at the area provisions for storage/ stack pile, rail siding, service and main roads, administrative and other offices / dwellings, safety systems, green belt etc., are detailed in the Tables 2.4 and 2.5.

Table 2.4: Norms adopted for provision of area for various cargo

Storage area commodities	***Norm (Whichever is higher)***
Liquid bulk	*4 x ship size; one month throughput for each type norm is repetitive*
POL & Chemical	*4 x ship size; one month throughput for each type norm is repetitive*
Solid Bulk	
Iron – ore *Coal* *FRM* *Lime Stone* *Cement & Clinker*	*6 times ship size or 1 month throughput whichever is higher*
Containers	*15 days storage or 6 times max. Ship size*
General Cargo	*15 days storage or 8 times parcel size*

Table 2.5: Norms for Provision of Area for various activities in a jetty

Infrastructure	***Provision***
Rail 4 line main entry siding with ½ km loop	*4 entering lines : 12 x 500m* *4 Exit : 12 x 500m* *2 Establishing lines: 6 x 760m* *2 Engine escape : 6 x 760m* *1 Sick line : 3 x 760m* *2 Crossing gap : 10 x 1000 m* *2 Washing lines : 6 x 760m*
Roads	*Main highway approach into* jetty *20 km long x 24m*
Service Utilities	*Fire Station.* *Staff Building : 50 x 100m* *20 no. Tender parking : 24 x 20m* *Water Tankage, over ground : 350m^2* *Foam storage : 50 x 20m* *Dedicated fire tender exist roads 5 no. X 6m x 500m: 15000m^2*
Power Sub-Station	*132 KV / 33 KV : 150 x 150* *33/11 KV Switch yard and load dispatch : 100 x 50m* *5 unit sub-station for 11 KV/3.3KV and 11 KV /415V* *5no. X 50 x 20m* *Fenced area and approach.: 3 x 4000m*
ADM Buildings, Office complex, Staff quarters.	*4 storeys main jetty office shipping cos stevedores office:* *10 cubicles* *Customs offices* *3 Bank counters* *10 Cargo agents offices* *Canteen for staff & officers* *Staff Quarters for 500; (2 storey units), Park, green belts , car parks at each office units : 1000 x 500m*

Infrastructure	*Provision*
	Industrial Potable Garden Service
Water Supply	*Water treatment plant, pump rooms 100 x 100 m*
Green belt	*In* jetty*: 6 corridors each 7000m x 10m* *Out* jetty *: 6 corridors each 2000m x 5m*

Adopting the above norms / basis of provisions the areas required have been worked out. General uncertainty allocation of 20% is accounted for area evaluation.

Storage / stock pile areas for commodities area within the jetty operational boundaries and infrastructure and support system are outside the jetty operational boundary. The area thus calculated is given in the Table 2.6.

Table 2.6: Jetty Land requirement

Commodity	***Throughput and Area***			
	5 years	***Area (Ha)***	***30 years***	***Area (Ha)***
Break bulk and Coal	*4.0*	*20*	*15.0*	*60*
Cement	*0.5*	*3*	*2.0*	*5*
Container in million tons	*2.0*	*30*	*33.6*	*150*
General Cargo	*0.9*	*20*	*2.5*	*25*
Fertilizer	*1.0*	*5*	*2.0*	*10*
POL, LNG/LPG, Chemicals	*-*	*-*	*20.0*	*80*
Road and Rail siding and network	*-*	*5*	*-*	*60*
Total area cargo related	***7.9***	***83***	***75.1***	***390***

In addition to the above areas required for the jetty, provision has to be made for rail and road connectivity, which would be estimated after a topographic survey of the area. Hence, considering the above, the total requirements of the land in the jetty could be calculated as, 1.2x83 = 99.6 ha in the phase – I and 470 Ha in the final phase.

2.3.5 Water Front Planning

Harbour Layout

The *raison-d'etre* of the Harbour proposal is the extensive rocky sea bed which extends approximately 1.5 to 2.5 km offshore from the coastline that would provide adequate area for reclamation on which the port facility could be conveniently planned without any private land and consequent displacement. In-other-words the jetty back up facilities, the logistics

area, the transit sheds and the trunk and rail handling bays, all would be accommodated on the reclamation area located in this coastal shallow rocky areas. In addition, the embayment between the Satpati Creek in the South to the Ucheli Creek in the North does provide calmer littoral movement climate. The rocky out crops with the embayment makes the area devoid of any sand movement on the coastal region. The apparent absence of littoral activity ensures that the reclamation near shore would not have any adverse impacts on the coastline. About 260 acres of land would be reclaimed in this phase for the proposed developments, which would require about 12 million cubic meter of material. Out of which about 10 million will be obtained from dredging and the balance quantity would be burrowed from the approved quarries.

Mathematical Model Studies

In order to evaluate and compute the changes in the shoreline, sediment pattern and effect of development on the creek mouths, the following model (mathematical) studies were carried out at the Central Water and Power Station (CWPRS), Pune.

1. Flow Hydrodynamics
2. Sediment Movement and Morphology
3. Littoral Drift and Shoreline Evolution

From the model studies the following could be summarised;

1. The flow fields at each hour tidal conditions were recorded for the proposed developments and a typical flow during various stages of tides are shown in Fig.12 (A) to Fig.12 (D). The magnitude and direction of flow and flow pattern were observed. The length of the vectors in the flow field shows the magnitude of the velocity to the scale shown and arrow head shows the direction of flow with respect to north. The magnitude of currents varied in the range of 0.2 to 0.33 m/sec indicating that the currents are weak inside the harbor basin which is attributed to the protection given by the breakwaters. But in the offshore region particularly at the tip of the breakwater near approach channel entrance the flow velocities have increased marginally and magnitude of currents varied in the range 0.8 to 1.0 m/s.

2. Sediment transport studies were carried out for the existing condition (minus developments); by considering neap and spring tidal conditions. The sedimentation during different phases of the tide was observed. A typical siltation pattern over a period of one month during non-monsoon period covering Neap and Spring tide was carried out. No significant area of erosion or accretion was observed.

3. The model was then operated for predicting the siltation pattern with the proposed developments. A typical siltation pattern over a period during non-monsoon period covering neap and spring tidal conditions with the layout of proposed development was carried out. During neap tidal condition it could be seen that the zone of deposition (Very slight deposition) is mainly in the approach channel extending up to -15m contour, specifically after the tip of the proposed breakwater and towards the offshore region (about 1000m towards offshore), this may be attributed to the sudden change in depth of the channel when compared to the adjacent contours. Inside the Harbor there is a tendency of sediment deposition over the shadow region of the basin. It is also noticed that there is a trend of sediments entering the harbor basin through the openings provided in the northern breakwater. In the offshore region it is seen that there is not much impact as variation in depth is gradual. It is observed that the average depth of sediment deposition in the approach channel varies from 15 to 30 cm over a period of six months covering monsoon season. Similar trend is observed with spring tidal condition except that there is no trend of deposition in the approach channel. The estimated annual sedimentation in the entire harbor region including approach channel and turning circle works out to be of the order of 0.09 M Cu m which is based on the model study and literature survey of ports along west coast.

4. The model was further operated for predicting the siltation pattern with the modified layout. A typical siltation pattern with modified layout over a period during non-monsoon period covering neap and spring tidal conditions with the layout of proposed development. During neap tidal condition it could be seen that the zone of deposition (very slight deposition) is mainly in the approach channel extending up to -15 m contour, specifically after the tip of the proposed breakwater and towards the offshore region (about 1000m towards offshore), this may be attributed to the sudden change in depth of the channel when compared to the adjacent contours. Inside the Harbor there is a tendency of low sediment deposition over the shadow region of the basin including turning circle and increasing tendency at the jetty entrance as compared to the original proposal. In the offshore region it is seen that there is not much impact as variation in depth is gradual. It is observed that the average depth of sediment deposition in the approach channel varies from 15 to 20 cm over a period of six months covering monsoon season. Similar trend is observed with spring tidal condition except that there is no trend of deposition in the approach channel. The estimated annual sedimentation in the entire harbor region including

approach channel and turning circle works out to be of the order of 0.60 M Cum which is based on the model study and literature survey of ports along west coast.

5. In was also observed that largely the creek mouths are remaining clean due to the higher velocities at these locations. No change in the sediment pattern inside the creeks also was noticed due to the developed. It was primarily due to the fact that the flow velocities at the creek mouths largely remain same, even after the development.
6. In addition 1-Dimensional Littoral Drift modeling was carried out for a period of 20 years, in order to evaluate the long term shoreline evolution in the area. It was noted that project area has equal up and down drift of about 0.72 million cum and therefore the net transport is zero and consequently the shoreline is largely stable.
7. The creek mouth was examined in the model extensively and it was noted that the net sediment transport near the area is near zero. There is a stable equilibrium at the creek mouths, often gets disturbed by the sand mining. Now that the sand mining has been completely banned in the area, the zonal morphology is stable and is in equilibrium.

The water depths in the area vary with 10 m contour located about 5.5 km from the shoreline. Therefore the shallow and rocky near shore areas are earmarked for reclamation and locating the backup facilities, the harbour basin would necessarily have to be shifted to the deeper waters offshore. Extensive geotechnical investigations have indicated that in the near shore region the rock levels near the bed is sedimentary sand stone followed by weathered rock of Basaltic origin which extends about 3 to 4m. This layer is underlain by basaltic hard basalts. Intermittently, the inter-trapien sedimentary rocks also are discovered.

Planning process of the jetty enabling handling of about 17 million tons annually, in a time horizon of 10 years, is given in the Detailed Project Report (DPR). Vessel size analysis carried in the DPR designates a container vessel of 290 m long and 14.5 m draft as the design vessel. The entry has been planned at MLWN which is 1.20 m CD. The approach channel design and the resulting dredging calculation is based on the accepted codal provisions and guidelines lay down by international bodies like PIANC.

Since the major investments in the harbour facilities goes in to construction of breakwater and dredging of the approach channel and the dock basin, the optimisation process for the harbour would involve them for maximisation of resources. Therefore, the objective could be achieved in two distinct ways. In the first way, locate the approach channel at the

required depth with minimum dredging and make the breakwater protection expensive. Alternatively, the breakwater could be made smaller and dredging could be increased by moving the harbour basin shoreward. This is a techno-economic process and in most cases than not, a compromise is arrived in order to make the optimal use of the resources. Since the near shore area is strewn with rocky outcrops, dredging would be highly expensive, due to the fact that dredging in soft soil and hard soil differs by a factor of 10. Accordingly, it was decided to take advantage of the shallow near shore area and construct a longer breakwater and locate the harbour basin in deeper waters.

Since the harbour itself as well as the approach channel will have to be dredged, the back-up land, for harbour operations, could be easily reclaimed. The geo-technical investigations in the area have indicated that the dredged material will provide only a part of the material for filling/reclamation. Hence, materials from the approved burrow areas are required to be transported and used. However, one of the main advantages of the location is the availability of fill material in the near vicinity. The main perceived advantage of the location of this harbour is the relative remoteness and wide separation of the activities connected with unloading and handling and storage of cargo such as LNG, from existing settlements and fishing areas.

Dredging

Therefore in the Phase – I expensive rock dredging would be avoided. Only limited quantity of disintegrated solidified sediments/rocks would be taken out. The total dredging quantity for the approach channel and the harbour basin including the turning circle works out to about 10 million m^3 which would contain about 8.5 million cubic meters of soft material and balance hard material. All the material obtained from dredging would be used for reclamation and therefore would be contained inside a containment embankment. In the future phases, based on requirement, more dredging may be carried out for locating the berths and the stacking area for the cargo. No sea dumping of dredged sediments is envisaged.

Breakwater

The harbour would require protection by breakwaters in order to provide the necessary tranquillity at the berths. Therefore the layout of breakwaters in this proposal must take this into account the need to provide the desired degree of tranquillity for enabling handling of coal, container, Fertilizers, General Cargo, Steel Products, Cement, POL, Chemicals and other liquid bulk cargo such as LNG (or FSRU) in the first phase. At the same time it is

prudent to take advantage of the natural features to minimize the dredging requirements as well as the breakwater costs.

The harbour would require protection from hostile wave climate in form of breakwaters for providing necessary tranquillity at the berths. Detailed analysis of wave data obtained from the UKMO (British Meteorological Office) for 12 years was carried out using MIKE 21 SW mathematical model and it was noted that the jetty with only the southern breakwater can operate for about 240 days. However since the depending industries would need uninterrupted supplies for 365 days a year, a down time of 125 days would not be acceptable. Therefore, the jetty facility with two breakwaters (one in the south and one in the north) was tested in the mathematical model at the CWPRS. The model results indicated that with both the breakwaters the jetty will be operable for about 345 days or more. Hence, based on the findings of the mathematical study the proposed multi-cargo jetty at Nandgaon would have two breakwaters for offering safe and efficient cargo handling. The south breakwater is approximately 6.5 km long and the north breakwater is approximately 5.2 km. The root of south breakwater is at Lat. 19^0 45' 44" N, north breakwater is at Lat. 19^0 47' 03" N: and Long. 72^0 41' 10" E.

Reclamation

In the first phase about 260 acres of land only shall be reclaimed using the material from the dredging of the harbour basin and the approach channel. In the subsequent phases the reclamation will be progressively carried out based on requirement. The initial phase requirement would need about 12 million m^3 of material of which 10 million cubic meters would be obtained from dredging. The balanced material would be sourced from the various approved quarries in the vicinity.

The Layout of the Phase I development of the Jetty is shown as Figure 2.4a. The backup area for storage is located in the shallow area reclaimed using the dredged sand obtained by dredging the harbour area. Additional areas have been earmarked to reclaim progressively using the maintenance dredging material and other material obtained from periodic capital dredging.

2.4 Infrastructure Facilities

The berthing, cargo handling and transfer facilities created would not be adequate to serve the overall purpose unless backed up by well-planned infrastructure facilities for receipt and dispatch of projected cargo taking into account the future expansion of the jetty. The infrastructure facilities include roads, rail lines and pipelines, and within the jetty, water and

power supply and distribution, sewage treatment and drainage, bunkering, craft, navigation, fire fighting systems, safety and control systems, EDI/computerisation systems and communications, office buildings and residential accommodation.

2.4.1 Railways

A jetty is only a part of the multi-modal chain between the origin and destination of the cargo, and should therefore be well connected to the existing national network of roads and railways.

The Mumbai-New Delhi rail corridor are very close (about 8km) from the proposed site. In addition the proposed DFC corridor is also about 9 km from the proposed jetty location. In the phase – I there is no immediate requirement of the railway corridor. But when the traffic picks up the requirement would be felt. A dedicated rail corridor is proposed to be constructed from the jetty to the nearest Rail takeoff point. The details of the railway connections would be dealt at the DPR stage. However, a brief on the rail access is given in the following paragraphs.

Rail Access

The Western Railway line from Mumbai to Delhi via Valsad, Surat and Vadodara passes closest to the sea coast at Boisar station (about 9 km from the coast). The other station which may be a little closer (around 8 km) is the Umroli station. This is a small block station. In addition the Dedicated Freight Corridor (DFC) runs passes almost parallel to the existing trunk route to the west. This route also would be of interest to the jetty for transportation of containers and bulk cargo.

Rail Linkage

The jetty traffic will be mostly import, consisting mainly of coal, chemicals and containers. The coal traffic may initially serve only the immediate hinterland of MIDC and Vapi, whereas in due course it would extend into the primary hinterland of Nasik, Bhusaval and North Maharashtra. The container traffic would however move towards/from the secondary hinterland to the land-locked north of the country, i.e. Rajasthan, Delhi, Haryana, Punjab, J&K, and Uttar Pradesh. The general cargo traffic, which will also be primarily import, with some export cargo, would be expected to cater only to the immediate hinterland. The cement traffic will really be a coastal traffic, bringing in cargo from the production areas in vessels of 5000 to 1000 DWT and distributed by road to the immediate hinterland to the south of the jetty. The rail traffic will thus be predominantly towards or from the Delhi side.

The immediate need for the rail connection to the jetty may not be there and the rail linkage would be taken up subsequently if the container traffic materialises as proposed.

2.4.2 Roads

Road Access

In the first Phase, only road transport is envisaged. The road traffic from the jetty to the MIDC area would be created by the port. The road alignment would be planned in a manner so as to involve minimum possible private land. Mostly the Government land would be used for this purpose. The private land for the road connectivity would be acquired, through private negotiations and would be paid at prevailing market prices. Suitable rehabilitation and resettlement policies would be put in place.

As indicated above, in the first phase, road traffic is envisaged to and from the MIDC area. In the later phases, a unified road and rail corridor would be planned using the same cardinal principle of maximising the use of Government land and minimising acquisition of private land. The crossing of the existing roads would be provided with suitable under passes or over bridges so as to cause minimum interruption of the existing traffic on account of jetty development. The proposed road network in the Phase – I is shown in the Figure 2.5.

The MIDC roads are 4 lane roads with dividers and have the adequate capacity to accommodate the additional traffic. The MIDC roads would help in distribution in the MIDC area as well as leading to the Boisar road, which connects the NH 8, located about 23 km away from the coast line. In the subsequent phases, a combined road and rail corridor would be developed in consultation with the local authorities for connectivity to the NH8 and the DFC.

Within the terminal the 50 m wide arterial roads are planned. The feeder roads would be of 15 m width and service roads 10 m wide. The approach roads to the container terminal and the service roads within the terminal area are designed taking into consideration the density of traffic and wheel pressure of the tractor trailers used to trans-containers to the CFS area. All other roads are designed for normal vehicular traffic with 30 T road trucks.

2.4.3 Navigation Aids

The terms Aids to Navigation, Nav-aids and Navigational aids used interchangeably, are all meant to convey marks, including floating marks, such as buoys and beacons, transit and clearing marks as well as signalling systems, radio aids and communications, electronic

systems, radar etc. Which are installed on land or in water for guidance to all ships for safe and regulated navigation in the channels, anchorages, berths, docks etc. It is envisaged that navigation will be carried out throughout the year, by day and night except during times of high wind speeds and low visibility.

Buoyage

The most commonly used navigational aid in any port is a system of floating markers known as Buoyage system. There are several buoyage systems in vogue at various ports around the world. However, International organizations have been able to, by and large, standardize these systems. For the proposed project and its approaches the Uniform International Lateral Buoyage System is envisaged. Starting from seaward, a "Landfall Buoy" may be laid in deep i.e. about 20 m depth of water. This buoy should be large, lighted and provided with radar reflectors or more advanced fittings to make it visible and/or discernible from a distance of not less than 3 to 5 nautical miles in clear visibility. Ships intending to call at the port may head for this buoy. Embarkation of Pilots too may be done off this Landfall Buoy.

A channel will be dredged from a seaward point where the natural depth is more than 15 m below Chart Datum to the Turning Circle inside the port. This channel will ultimately have a bottom width of 300 m and a depth of 20 m below CD. Both edges of the channel will have side slopes of around 1:5. For convenience, the passage confined between the outer edges of the side slopes, is termed as the Fairway. The entire Fairway will have to be properly marked by laying jetty hand and starboard hand channel marker buoys of the appropriate shape, colour, top-mark and light characteristics on both edges of the channel. However, a Fairway Buoy may be laid a short distance seaward of the beginning (seaward end) of the dredged channel. It is proposed that a gated pattern – in which port and starboard buoys are laid in pairs on the respective sides of the channel opposite one another – may be used for positioning the channel buoys so as to provide clear guidance to the pilots. Buoys may be laid on the outer edges of the fairway so that vessels will not be hindered by buoys in using the full 300m width of the dredged channel. Gated pairs of buoys may be laid at intervals of 1.5 to 2.0 km in the straight sectors of the channel. In the case of a bend in the channel extra buoys may have to be laid at the start and end of the bend. This scheme of Buoyage may be extended only a short distance beyond the harbour entrance. Thereafter, channel marking may have to depend partly or entirely on transit marks so as not to impede ship movements in an already restricted area.

The details of buoys proposed in the Nandgaon jetty are given in the Table 2.7.

Table 2.7: Details of Buoys proposed in Nandgaon jetty

Types of Buoys	***Numbers***
Hand Buoys	*3*
Starboard Hand Buoys	*3*
Fairway Buoys	*1*
Landfall Buoys	*1*

Ship-to-Shore Communications

Efficient and reliable ship-to-shore communication is a basic need for smooth operations. In the past this was achieved through visual means such as Semaphore and Flags hoisted on ship and shore signal masts. These systems still cater to dire emergencies and during failures of all modern systems, which depend on electric power. Accordingly, a Signal Mast complete with yard and halyards may be erected at a prominent location visible from ships in sight of the jetty. Full sets of flags and other types of hoists and visual storm and other signal shapes should be provided in suitable storages.

The Jetty Signal Station or communication centre shall be equipped with modern, multi-channel radio communication systems for voice and signal communications with ships at, near or relatively distant from the port. The centre should be manned by qualified operating and maintenance staff. A proper E.T.A Reporting system for ships, intending to call at the Jetty should be promulgated and enforced.

2.4.4 Portable Water Supply

An underground water tank of 1800 m^3 capacity will be provided to meet an approximate daily demand of 1.5 million litres with 300 m^3 as reserve. A closed loop grid system with necessary cross connections and valve stations will be provided inside the jetty premises. Water supply will be provided to all berths by running a pipeline with 600 lpm discharge capacity. Two outlet points at each berth will be provided for supply of potable water to ships. A pump house will be provided with necessary pumps and controls to maintain water supply.

During construction phase, about 375 m^3/day of water will be required. The requirement for domestic purposes is 75 m^3/day, while 300 m^3/day of water will be required for various construction activities.

In addition bunkering of potable water to ships will also be provided as per their needs; water pipelines will be laid to the individual jetties for this purpose. Provisions for Supply of ballast water requirements of the container ships and Water sprinkling of coal stacks also

would be provided. In the operation phase, about 500 m^3/day water would be needed in order to take care of the complete need of the jetty operations. This requirement also includes the water required for sprinkling the coal stacks. The water would be sourced from the Maharashtra Industrial Development Corporation, who has the adequate capacity to meet this additional demand.

2.4.5 Storm Water Drainage

Storm water run-off from the container area is collected using a network of catch-basins and inter connecting pipes. One catch basin is envisaged to cater to around 4000 sq. Metres of area. The runoff will be led to the waterway behind berths using multiple discharge points. For the bulk handling facilities area, a system of open drains will be provided to discharge the collected runoff into the waterway, through a settling and purification pond.

2.4.6 Sewerage System

Sewerage system will be designed to integrate with the overall sewage disposal system being planned for the project. A system of interconnecting sewer lines will be laid both in the port so as to be connected to the main sewer lines at suitable locations. The sanitary sewage discharge from berthed ships will be pumped into the sewer system in the port area which would be discharged into the sea after treatment. The sewage treatment would be carried out using Fluidised Aerobic Bio-Reactor (FAB) Reactor based treatment system. The 50 m^3/day capacity STP is proposed. The FAB consists of a tank filled with specially developed media. These media is made of special material of suitable density that can be fluidised using an aeration device through diffusers. A bio film develops on the media which along with the effluent in the reactor. The movement inside the reactor is generated by providing aeration by putting diffusers at the bottom of the reactor. The thin bio-film enables the bacteria to act upon the bio-degradable matter in the effluent and reduces the BOD/COD content in the presence of oxygen from air used for the fluidisation. The main advantage of this type of STP is as follows;

1. Required less area
2. No sludge recycles, monitoring of F/M ratio etc., hence easy to operate.
3. Minimal moving parts thus lesser maintenance requirements
4. Flexibility to correct the performance by just adding the media in reactor or increasing the air quality
5. No expensive replacements

The treated water shall be reused in horticulture and sprinkling etc.

2.4.7 Electric System

The electrical demand for ultimate stage would be around 10 MVA. Power supply has to be arranged from the nearest recommended substation (Take of point) of Maharashtra State Electricity Board (MSEB) from a suitable point in their distribution system.

No special difficulty is anticipated in getting the required amount of power supply from MSEB in Phase I and/or JSW power plant inside the MIDC area. As the power demand is not heavy in first phase, power supply can be taken at 33/66 KV, with the receiving station being as close to the harbour as possible, at a convenient location. To meet the emergency power requirement, D.G. Sets with suitable capacity will be installed in each substation. Power back-up will be considered for essential lighting and power requirement for control systems & communication facilities

2.4.8 Fire Fighting System

The fire fighting facilities will be provided for all the jetty areas and activities, viz. for coal, cement, container, etc. The system will comprise water lines to draw water from sea, and a pump house with pumps and a closed loop with hydrants for the needed locations. The water drawing facilities would be located on the jetty.

The system will consist of a closed loop grid and fire hydrants with single/multiple heads located in such a manner that hose lines can effectively reach any part of the area.

Sea water will be used for fire fighting purpose. Electrical pumps of adequate capacity will be provided with diesel standbys.

A centralized fire station will also be provided for attending to all calls. This station will house Mobile Fire Tenders / Foam Tenders. Further special firefighting equipment such as foam and carbon dioxide extinguishers will also be provided for chemical and electrical fires.

Fire detection and warning system will be provided, in all vulnerable area of the port.

2.4.9 Buildings

The buildings would mainly consist of the following

- Administration Buildings
- Operational Buildings

- Storage Buildings
- Maintenance Buildings
- Electrical Buildings
- Gate Complex
- Port Users' Complex for stevedores companies, shipping companies, cargo agents, surveyors, Customs, freight forwarders, banks, post office, canteen, etc.

The administration buildings would consist of administration, finance & traffic department, planning and environmental department, canteen, dispensary, etc.

The operational buildings would consist of plant office building, Terminal control tower, Security building, Fuelling station, etc.

Maintenance buildings would consist of workshop, services facilities for mechanical/ electrical equipment, spare part warehouse, fire station, etc.

2.5 Cost Estimates

A Capex report with indicative Book of Quantities and rough Cost estimates was carried out and was estimated as Rs. 11750 million. The preliminary cost estimate is presented in the Table 2.8.

Table 2.8: Cost Estimate of the Nandgaon Jetty (Phase – I)

Item Description	***Unit***	***Rate in Rs.***	***Qty***	***Amt in Rs. Million***
Land				
Land Purchase & Development for Phase-1	*{Acres}*	*7,500,000*	*12*	*90.00*
Private Land	*{Acres}*	*4,000,000*	*120*	*480.00*
Govt. Land	*{Acres}*	*500,000*	*80*	*40.00*
Dredging & Reclamation				
Soft	*{Mil.Cu.M}*	*250*	*2.8*	*700.00*
Hard	*{Mil.Cu.M}*	*1,500*	*0.9*	*1,350.00*
Creek Dredging	*{Mil.Cu.M}*	*150*	*2*	*300.00*
Break Water				
Stone Supply	*{MT}*	*250*	*6,000,000*	*1,500.00*
Sectioning	*{MT}*	*125*	*6,000,000*	*750.00*
9Cu.M Accropode Costing & Placing	*{Nos}*	*23,477*	*60,000*	*1,408.62*
Reclamation Bund incl. Intermediate Embankments	*[MT}*	*325*	*1,686,600*	*548.15*
Approach Embankment	*{MT}*	*325*	*494,640*	*160.76*

Item Description	Unit	Rate in Rs.	Qty	Amt in Rs. Million
Jetty (650m x 35)	{Sq.M}	22,750	65000	1,478.75
Block Jetty	{Cu.M}	12,500	11600	145.00
Civil Works & Buildings	{LS}			200.00
Internal Roads	{RMT}	5,000	12000	60.00
External Road (bituminous)	{RMT}	5,000	40000	
2 Lane Road Bridge	{Nos}	100,000,000	1	100.00
Ware Houses	{Sq.M}	10,000	20000	200.00
Harbour Mobile Cranes & Container Cranes	{Nos}	200,000,000	2	400.00
Container Cranes	{No}	400,000,000	2	800.00
Electrical	{LS}			90.00
PMC & Consultancy etc.	{LS}			300.00
IDC				648.97
TOTAL COST				**11,750.25**

3 ENVIRONMENTAL BASELINE STATUS

3.1 General

Before the start of the project it is desirable to measure the levels of the appropriate environmental parameters which could be significantly affected as a result of implementation of the proposed project. This Chapter outlines the information on baseline setting of the study area. The baseline data were collected through field investigations and collection of available secondary data, review of existing documents/publication pertaining to this area. The baseline data collection for different environmental components viz. Meteorology, ambient air quality, noise, marine water quality, land use, ecology, sediments and socio-economic was carried out by WAPCOS through a well-developed field studies covering data collection from primary as well as secondary sources i.e. area within 10 km radius of the proposed Project at Nandgaon, Maharashtra. The study area map is shown in the Figure 3.1.

The project site is located near Nandgaon village, which is about 10 km west of Tarapur Industrial area in Thane district of Maharashtra. As a part of the EIA study, the Baseline Status has been ascertained for the following aspects:

- Meteorology
- Waves
- Tides
- Currents
- Cyclones
- Geology
- Land use pattern
- Ambient air quality
- Noise environment
- Terrestrial ecology
- Marine water quality
- Sediments
- Marine Ecology
- Fisheries
- Littoral Drift

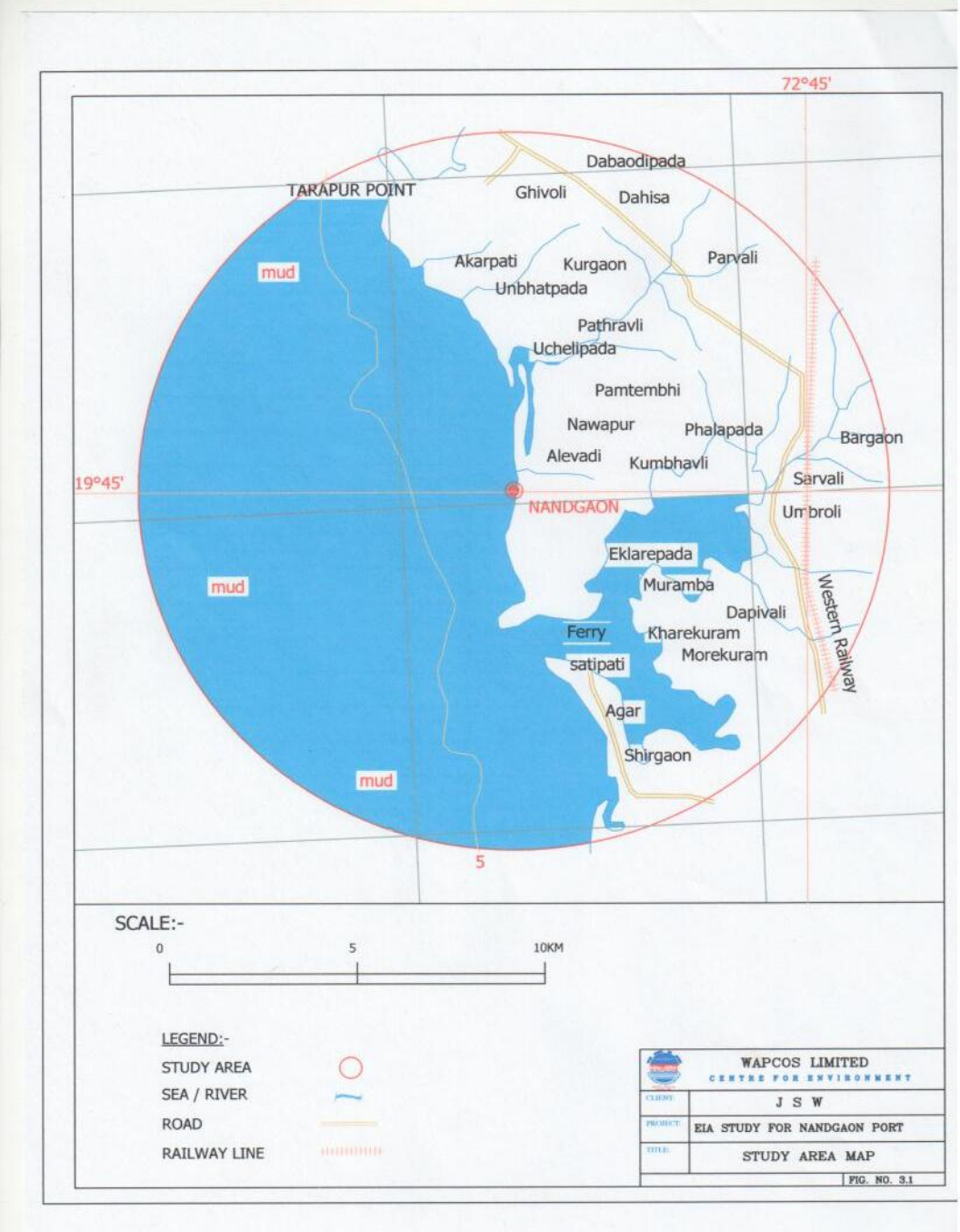


Figure 3.1: Study Area Map

3.2 Meteorological and Oceanographic Conditions

3.2.1 Temperature

The mean of the highest air temperature recorded in Tarapur MIDC is 35^0 C in the months of March, April and May while the mean lowest is 16^0 C recorded in the month of January. Mean daily maximum and minimum temperatures are 31^0 C and 24^0 C respectively.

3.2.2 Rainfall

The south-west monsoon normally enters into the state in the first week of June and prevails till last week of September. The average yearly rainfall in the study area is about 2098 mm, of which 1965 mm (93.66%) is received during June to September under the influence of south-west monsoons. Usually maximum average monthly rainfall of 709 mm occurs in July. January and February are generally the driest month of the year. There is practically no rainfall from December to April.

3.2.3 Relative Humidity

The relative humidity was observed to be high during the monsoon months from July to September. Mean yearly relative humidity at 0830 hours is 77% while the same at 1730 hours is 71%. The monthly average is lowest in February (62%) and highest in July to September (85%).

3.2.4 Fog

Reportedly the region has zero foggy days and as such no affect to navigation on this count.

3.2.5 Wind

Ship observed offshore wind data for a period of 30 years from 1976 to 2005 were obtained from India Meteorological Department (IMD) and analyzed for the grid covering Lat. 18^{o} – 20^{o} N and Long 71^{o} – 73^{o} E, which centres the area of interest. The distribution of wind speed and direction is presented in Figure 3.2. The observations represent measurements taken at sea level for every 3 minutes. It may be seen from Figure 3.2, that west is the predominant wind direction and that the wind speed is less than 10 m/s for 88% of the time as shown in the Figure 3.3.

The results are also presented in the form of monthly wind roses. It may be seen that the predominant wind is NE-N-NW in January. It gradually shifts towards west and by May it becomes NW to SW. During the months of June, July and August, the wind blows from W to SW. From September the wind direction starts changing and by December, again the predominant sector becomes NE-N-NW.

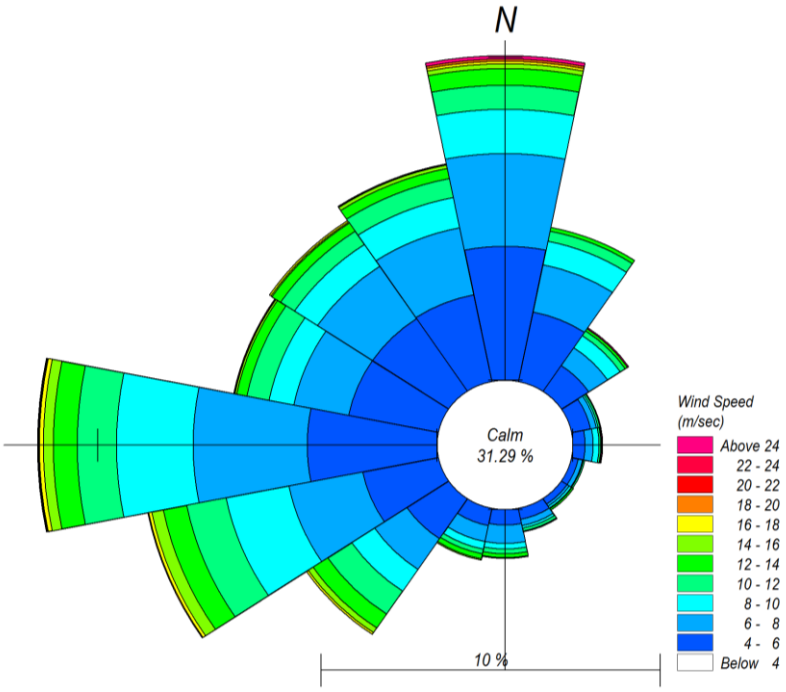


Figure 3.2: Wind rose diagram (Source: IMD, 1976 – 2005)

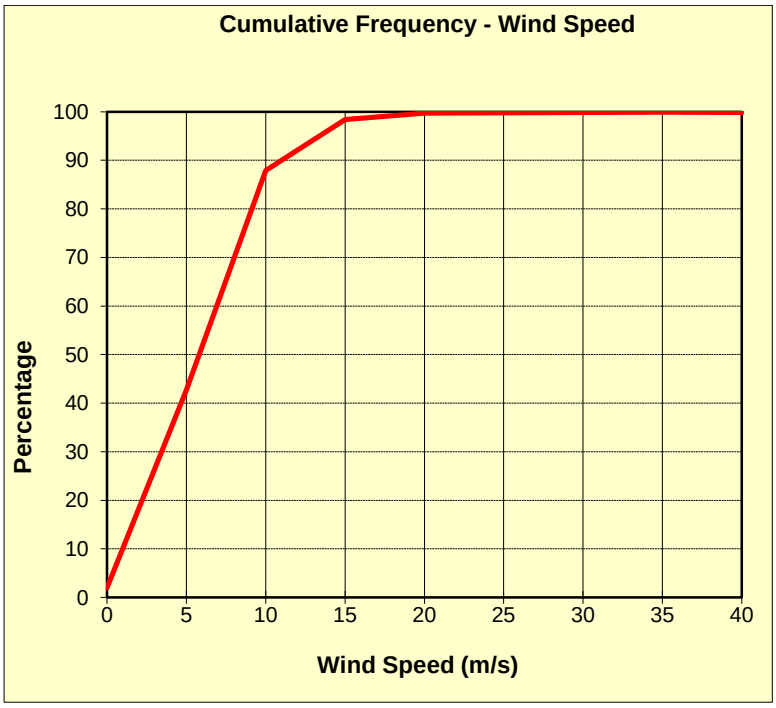


Figure 3.3: Cumulative frequency graph for wind speed (Source: IMD, 1976-2005)

It may be observed that during the fair weather season viz. October to May, the wind speed is less than 6 m/s for about 91% of the time. However, during the monsoon season (June to September), the wind speed is less than 8 m/s knots for only 62% of the time. It may

also be seen that during the peak monsoon period (July and August), wind speed of 6 to 13 m/s occurs for about 29% of the time. Wind speed of 13 m/s is seldom exceeded. However a maximum wind speed of 22.7 m/s has been reported, under normal conditions.

3.3 Waves

The ship observed wave data were collected from the India Meteorological Department (IMD) for the quadrant bounded by Latitudes 18^o to 20^o N and Longitudes 71^o to 73^o E, between 1976 and 2005. The annual distribution of wave heights is given in the form of wave rose diagrams in Figures 3.4. It may be seen that the predominant directions of waves in the deep sea are from SW to NW. It can also be seen that waves are less than 1 m, 2 m and 3 m in height for 77, 94 and 98% of the time respectively as may be observed from the cumulative frequency curve given as Figure 3.5. The Figure 3.6 shows the wave rose for the wave period.

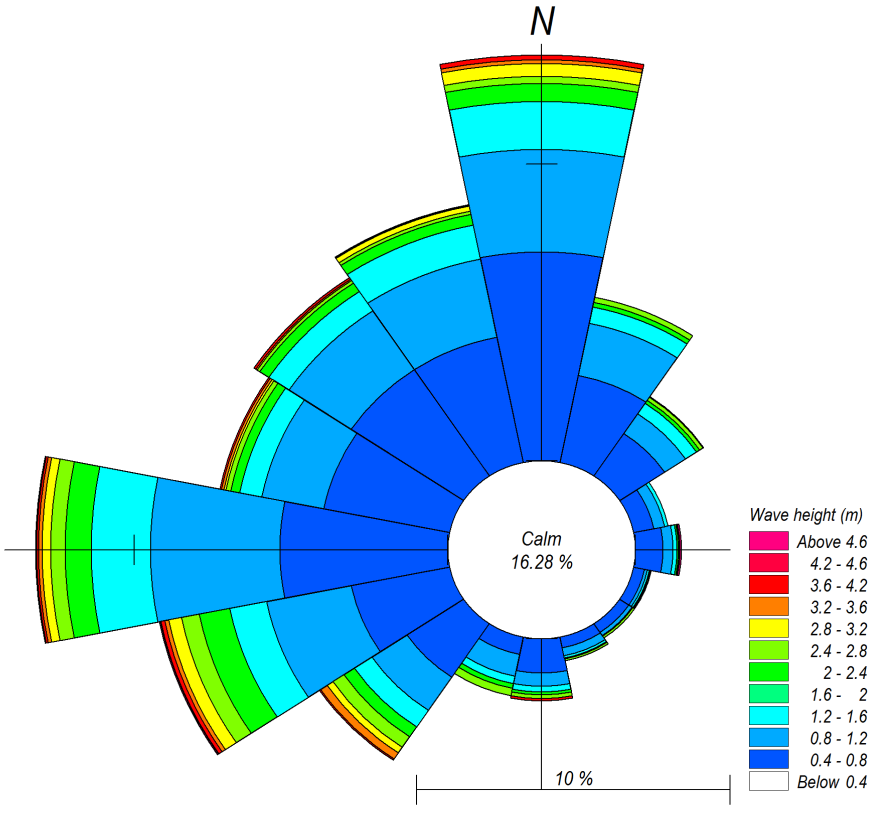


Figure 3.4: Wave height rose diagram (Source: IMD, 1976 – 2005)

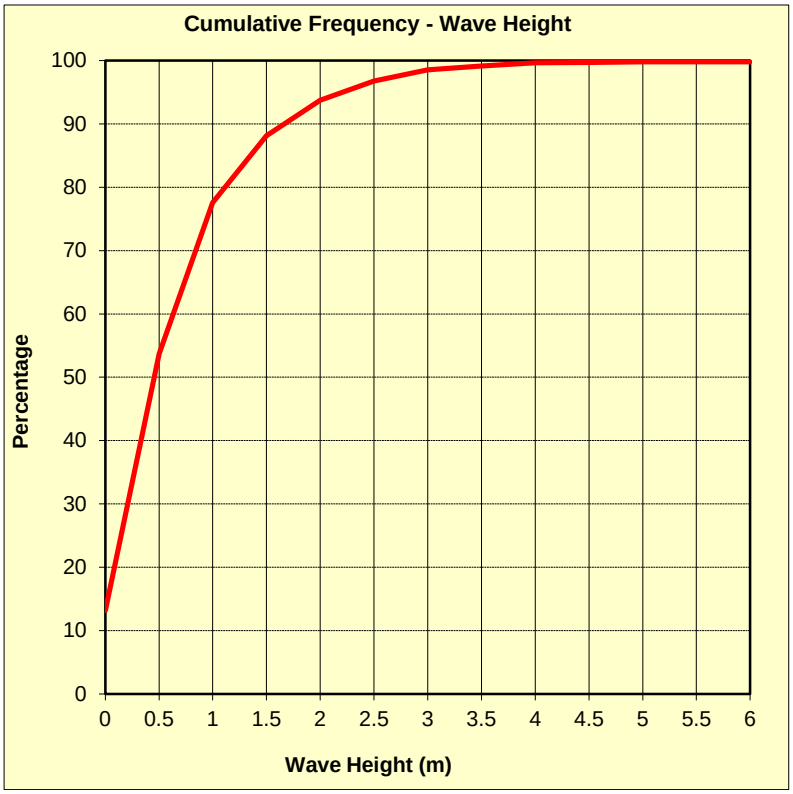


Figure 3.5: Cumulative frequency graphs for wave height (Source: IMD, 1976 – 2005)

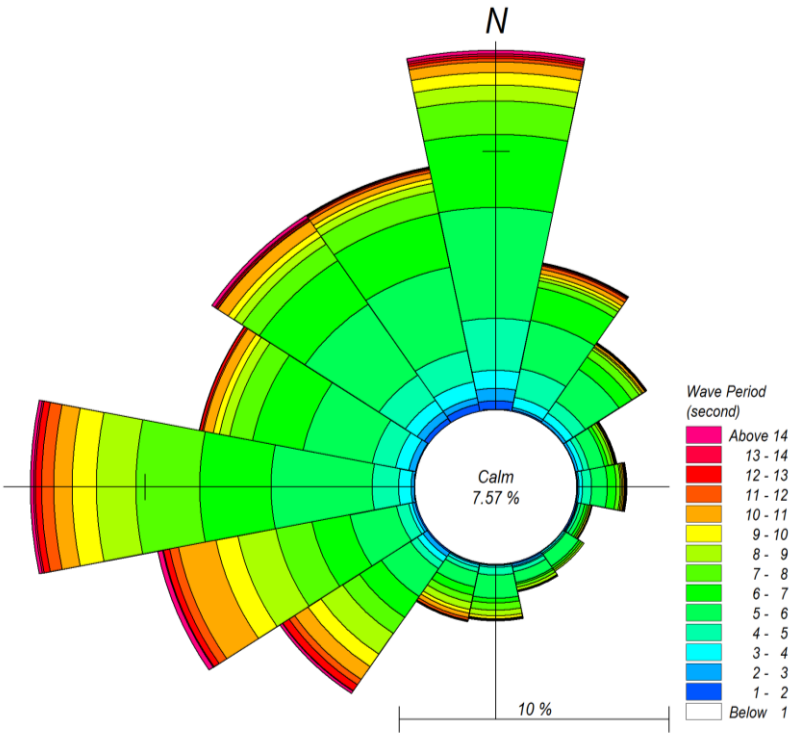


Figure 3.6: Wave period rose (Source: IMD, 1976 – 2005)

During the pre-monsoon period (January to May) over 92.93% of waves are less than 3 m in height. During the monsoon period (June to September) wave heights are less than 2 m for 85% and less than 3 m for 97% of the time. During the post monsoon period (October to December) wave heights are more than 3 m for 0.9% of the time. The predominant wave directions are in the NW quadrant for pre-monsoon period, from W to SW during the southwest monsoon and from NE to NW in the post-monsoon period. These wave heights applicable for the offshore conditions and wave are completely attenuated as they enter the well-protected creek.

It may be mentioned that the tidal levels mentioned above get modified, albeit to a minor extent, by coastal geometry and configuration at the proposed jettysite. Hence site-specific tidal observations are necessary for design purposes, which are discussed in the next chapter.

3.4 Tides

The tides in the Mumbai region are of the semi-diurnal type, i.e. characterized by occurrence of two high and two low waters every day. There is a marked inequality in the levels of the two low waters in a day. The important tidal datum planes with respect to Chart Datum at Satpati and Tarapur point as per the Naval Hydrographic Chart 210 are as follows;

Tidal Stage	Satpati	Tarapur Point
MHWS	+ 4.9 m	+4.8 m
MHWN	+ 3.9 m	+3.7 m
MSL	+ 3.1 m	+2.8 m
MLWN	+ 2.3 m	+2.0 m
MLWS	+ 1.2 m	+0.9 m

3.5 Current Pattern

The currents in the region are mainly of monsoon origin and sets in south-westerly and north-easterly direction with a strength of about 2.5 knots (1.25 m/s).

3.6 Cyclones

In general the west coast of India is less prone to cyclonic storms compared to the east coast. From the information reported by India Meteorological Department (IMD) a total of 1034 disturbances occurred in the Bay of Bengal during the period 1891 to 2010 of which 363 intensified to cyclonic storms, the rest being ‘depressions’. On an average the number

of cyclonic disturbances per year during this period was about 13. However, if the data is updated to 2010, the number of cyclonic events per annum works out to be 18, varying from a minimum of 9 to a maximum of 21.

The above cyclones may be divided into two broad categories. The first group consists of cyclones that originate in the Bay of Bengal and cross the East coast at certain locations. These storms pass over the Indian landmass and lose their strength before crossing the West coast. The second group consists of cyclones that cross over to the Arabian Sea at the southern tip of the Indian Peninsula and veer northwards towards Saurashtra. These cyclones are much stronger and more dangerous for the west coast and normally occur during the transition months of May and November. Tracks of the cyclones in the Arabian Sea from 1877 to 1992 are presented in Figure 3.7. It may be seen there from that only 10 storms endangering the Mumbai coast have occurred in the above said period that is at a frequency of once in 12 years.

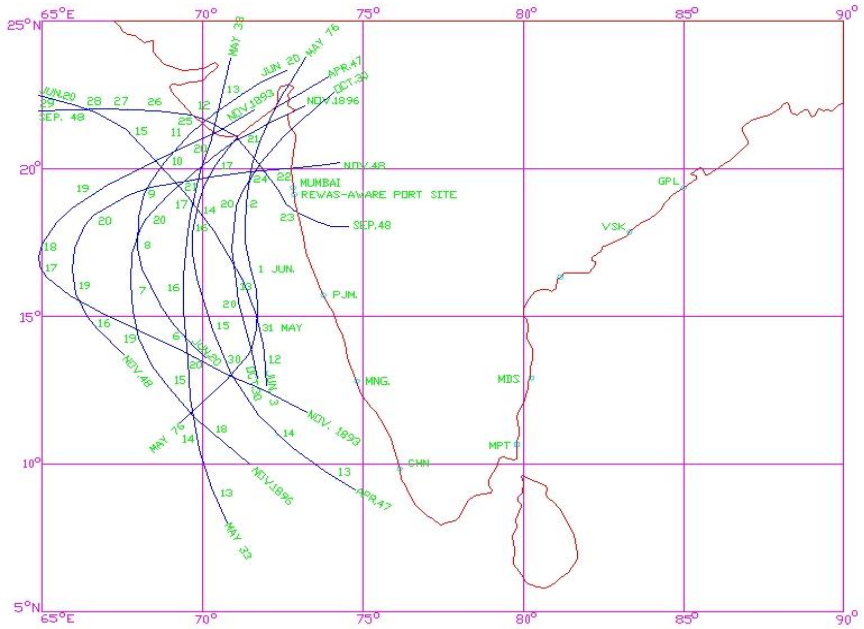


Figure 3.7: Storm tracks applicable for the region

3.7 Geology

A historical review of the changes in the shoreline of the area is being carried out by the Institute of Ocean Management, Chennai and as per the study report the shoreline is mostly stable with occasional low erosion and accretion areas. The small creeks on the north and south of the proposed site are also stable. Hence at the present moment the shoreline and the estuaries are in stable equilibrium, though temporal instabilities are introduced by sand mining at the entrance. Further it is important to point out that:

3.8 Land use Pattern

As a part of the EIA study, digital satellite data (IRS P-6, LISS-IV MX) was procured from National Remote Sensing Services Agency (NRSA) Hyderabad. Land use classification of the study area was prepared using the satellite imagery. Ground truth studies were conducted in the area to validate various signals in the satellite images and correlate them with different land use domains. This satellite image was then classified using the prominent signatures extracted based on ground truth studies and past experience.

The False Colour Composite (FCC) imagery of the study area is given in Figures 3.8. The supervised land use classification map of the study area is given in Figure 3.9. The land use pattern of the study area as per the satellite data is given in Table 3.1.

Table 3.1: Land use pattern of the study area

Category	***Area (ha)***	***Percentage of the total study area***
Water body	*17750*	*56.50*
Vegetation	*2921*	*9.30*
Grass/Scrubs	*2478*	*7.89*
Agricultural Land	*5527*	*17.59*
Salt Pans	*23*	*0.07*
Built up area/Settlements	*924*	*2.94*
Mangroves	*46*	*0.15*
Intertidal Area	*1748*	*5.56*
Total	***31416***	***100.00***

As the project is proposed on sea cost major portion of land use categories in the study area is water body, which accounts for about 56.5%. Agriculture land is the second dominant land use category with 17.59 %. Vegetation constitutes about 9.30 % area. Grass land occupies 7.89% of the study area.

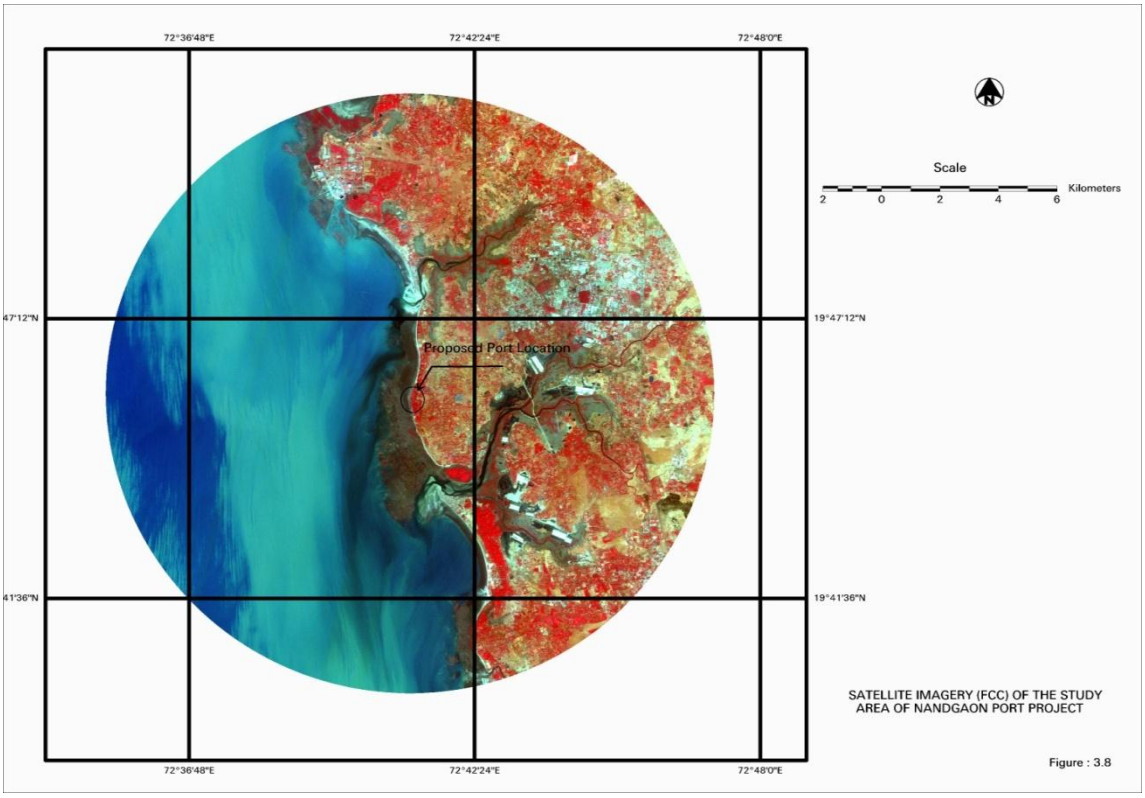


Figure 3.8: FCC of the Study Area

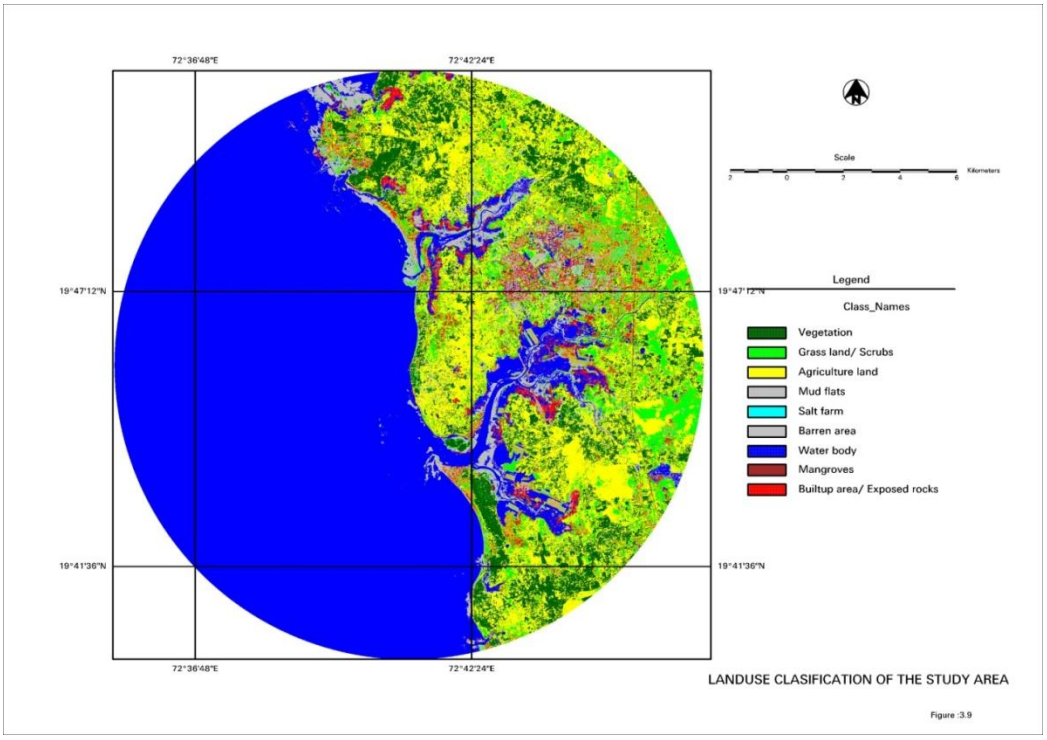


Figure 3.9: Classified Imagery of the Study Area

3.9 Shoreline Change Study

To understand the stability of the shoreline and the erosion/accretion status in the area, satellite imageries for the past 39 years were examined and the shoreline characteristics are determined. The study of the shoreline evolution, using satellite imagery data have indicated almost a stable and very insignificant low eroding shoreline (carried out by Institute for Ocean Management, Anna University, Chennai). The same was validated by the morphological studies carried out using mathematical model studies which indicated that the proposed developments would have negligible effect on the coastline and creek mouths. The shoreline change study shall be presented in a separate report.

3.10 Ambient Air Quality

In order to establish the baseline status with respect to ambient air quality, four air quality sampling stations were established as a part of the EIA study for the proposed project. The ambient air quality survey was conducted for the three consecutive seasons of the year. The frequency of monitoring was twice a week at each station for 12 consecutive weeks. The parameters monitored were Particulate Matter less than 10 microns (PM_{10}), Particulate Matter less than 2.5 microns ($PM_{2.5}$), Sulphur Dioxide (SO_2) and Oxides of Nitrogen (NO_2). The monitoring period for different seasons is as below:

- Winter season : 7^{th} Nov. 2011 to 28^{th} Jan. 2012
- Pre-monsoon season : 2^{nd} March 2012 to 22^{nd} May 2012
- Post-monsoon season : 17^{th} Sept. 2012 to 7^{th} Dec. 2012

The methodology adopted for the analyses of various air quality parameters is given in the following Table 3.2.

Table 3.2: Techniques used for the Ambient Air Quality Monitoring

Parameter	***Technique***	***Technical Protocol***
Particulate Matter less that 10 microns (PM_{10})	*Gravimetric method*	*IS-5182 (Pt-23)*
Particulate Matter less than 2.5 microns ($PM_{2.5}$)	*Gravimetric method*	*EPA Guidelines*
Sulphur Dioxide (SO_2)	*Modified West and Gaeke method*	*IS-5182 (Part-II)*
Nitrogen Dioxide (NO_2)	*Sodium Arsenite method*	*IS-5182 (Part-IV)*

The sampling locations of the ambient air quality monitoring are as follows which is shown in the Figure 3.10. These locations were selected based on the following criteria;

1. Located in the Study area of 10 km radius
2. Populated villages where the effect could be noticed
3. On the windward side

Location 1 - Nandgaon
Location 2 - Alewadi
Location 3 - Murbe
Location 4 - Kumbhavali

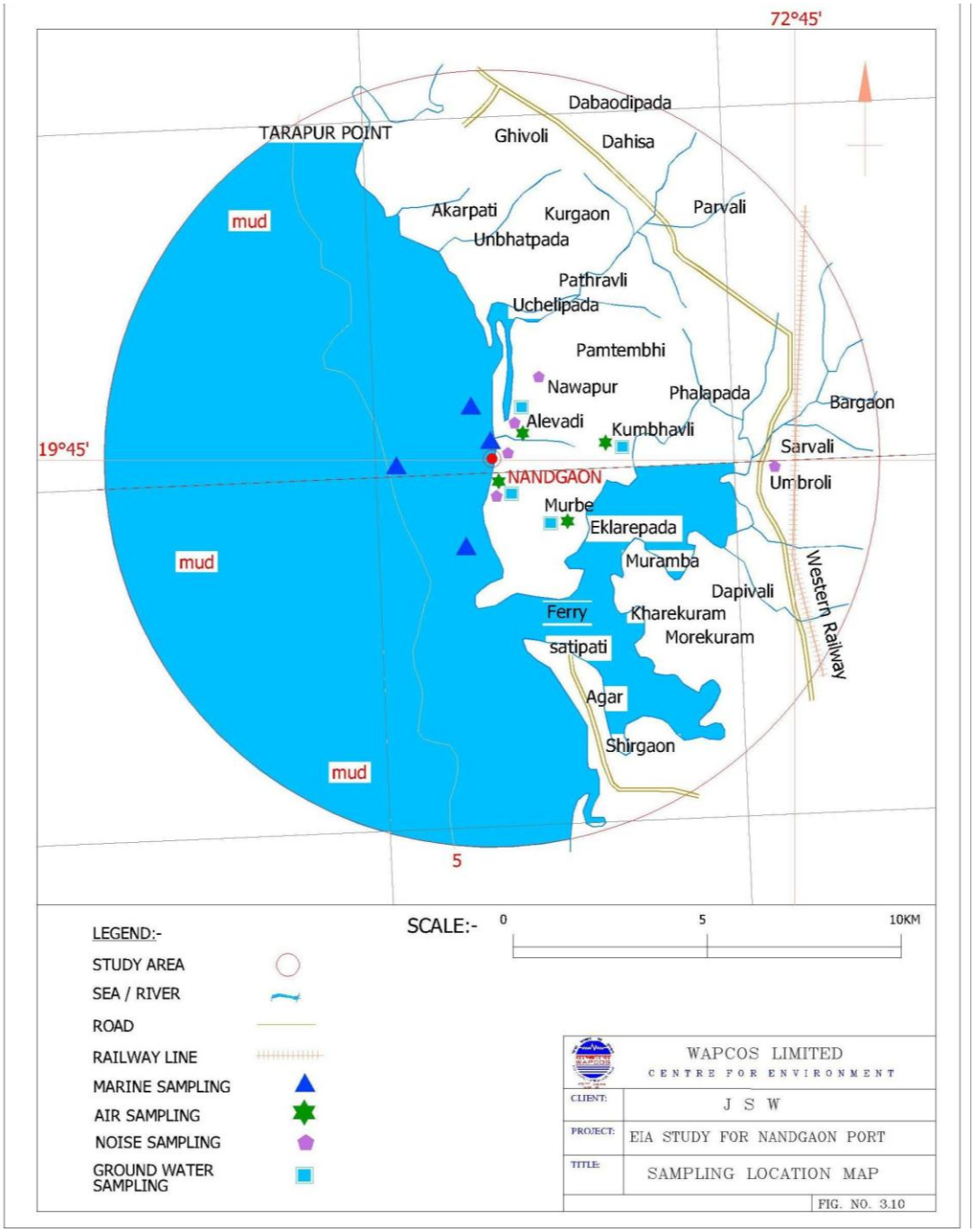


Figure 3.10: Sampling location map

The National ambient air quality standards specified in the notification issued by the Ministry of Environment and Forest (MoEF) on 16th November, 2009 under the provisions of Environment (Protection) Rules, 2009 are presented as Annexure-I.

The results of ambient air quality monitoring observed during the study period are summarized in the Tables 3.3-3.5.

Table 3.3: Summary of ambient air quality status during winter season

(Unit: µg/m^3)

Location	***Maximum***	***Minimum***	***Average***
Particulate Matter less than 10 microns (PM_{10})			
Nandgaon	*81*	*60*	*71.25*
Alewadi	*85*	*70*	*77.83*
Murbe	*89*	*75*	*83.08*
Kumbhavali	*89*	*76*	*82.92*
Particulate Matter less than 2.5 microns ($PM_{2.5}$)			
Nandgaon	*43*	*32*	*38.71*
Alewadi	*52*	*39*	*46.67*
Murbe	*53*	*42*	*48.54*
Kumbhavali	*52*	*44*	*48.42*
Sulphur Dioxide (SO_2)			
Nandgaon	*18*	*10*	*13.54*
Alewadi	*25*	*16*	*19.04*
Murbe	*21*	*12*	*18.71*
Kumbhavali	*26*	*20*	*23.08*
Nitrogen Dioxide (NO_2)			
Nandgaon	*27*	*13*	*19.75*
Alewadi	*35*	*23*	*27.63*
Murbe	*36*	*17*	*26.75*
Kumbhavali	*37*	*26*	*31.08*

Table 3.4: Summary of ambient air quality status during pre-monsoon

(Unit: µg/m^3)

Location	***Maximum***	***Minimum***	***Average***
Particulate Matter less than 10 microns (PM_{10})			
Nandgaon	*84*	*67*	*74.42*
Alewadi	*90*	*75*	*81.10*
Murbe	*92*	*80*	*85.71*
Kumbhavali	*92*	*80*	*85.63*
Particulate Matter less than 2.5 microns ($PM_{2.5}$)			
Nandgaon	*45*	*38*	*40.87*
Alewadi	*54*	*44*	*48.17*
Murbe	*55*	*48*	*50.38*

Kumbhavali	*54*	*47*	*49.71*
Sulphur Dioxide (SO_2)			
Nandgaon	*17*	*8*	*12.50*
Alewadi	*21*	*15*	*17.67*
Murbe	*20*	*15*	*17.92*
Kumbhavali	*24*	*18*	*21.08*
Nitrogen Dioxide (NO_2)			
Nandgaon	*25*	*14*	*18.79*
Alewadi	*32*	*22*	*26.38*
Murbe	*32*	*20*	*25.29*
Kumbhavali	*34*	*24*	*28.92*

Table 3.5: Summary of ambient air quality status during post-monsoon

(Unit: µg/m^3)

Location	***Maximum***	***Minimum***	***Average***
Particulate Matter less than 10 microns (PM_{10})			
Nandgaon	*83*	*62*	*73.02*
Alewadi	*85*	*72*	*78.85*
Murbe	*87*	*74*	*81.55*
Kumbhavali	*88*	*75*	*82.06*
Particulate Matter less than 2.5 microns ($PM_{2.5}$)			
Nandgaon	*45*	*34*	*40.42*
Alewadi	*50*	*38*	*45.15*
Murbe	*52*	*40*	*47.28*
Kumbhavali	*52*	*42*	*47.75*
Sulphur Dioxide (SO_2)			
Nandgaon	*20*	*12*	*14.75*
Alewadi	*22*	*13*	*18.52*
Murbe	*24*	*17*	*20.58*
Kumbhavali	*25*	*20*	*22.75*
Nitrogen Dioxide (NO_2)			
Nandgaon	*30*	*10*	*20.52*
Alewadi	*33*	*21*	*27.22*
Murbe	*35*	*20*	*28.25*
Kumbhavali	*35*	*25*	*30.54*

3.10.1 Observation PM_{10} Levels

It is observed from the Table 3.3 to 3.5 that the average concentration of PM_{10} at various stations ranged from 71.25 to 83.08 µg/m^3 during winter season, 74.42 to 85.71 µg/m^3 during pre-monsoon, and 73.02 to 82.06 µg/m^3 in post-monsoon season. The maximum concentration of PM_{10} was recorded at the Murbe and Kumbhavali. However, the average

PM_{10} levels were lower than the prescribed limits of *100 $\mu g/m^3$* specified for the industrial, residential, rural and other areas. The concentration levels of PM_{10} at various sampling locations in the study area during the observation period are shown in the Figures 3.11-3.13.

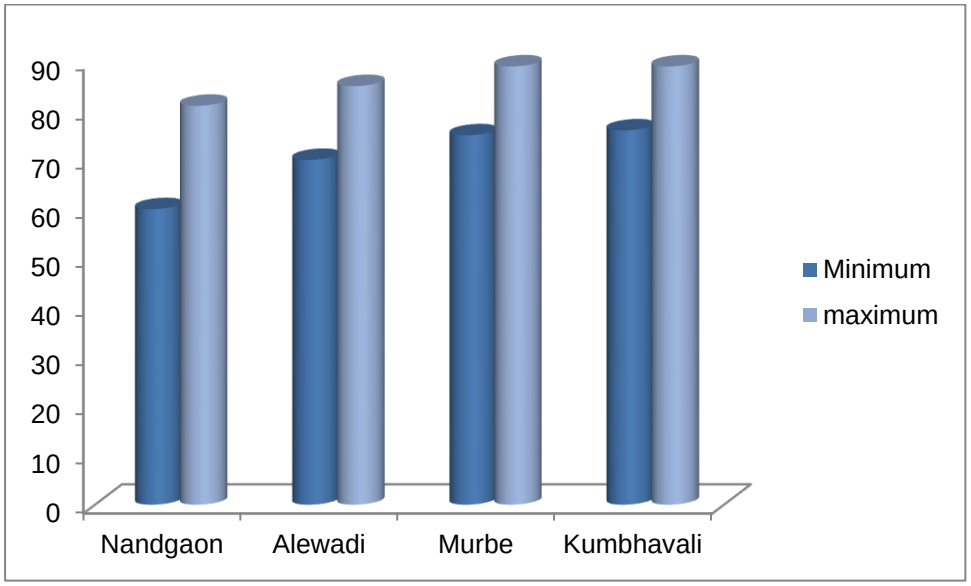


Figure 3.11: Concentration level of PM_{10} during winter season

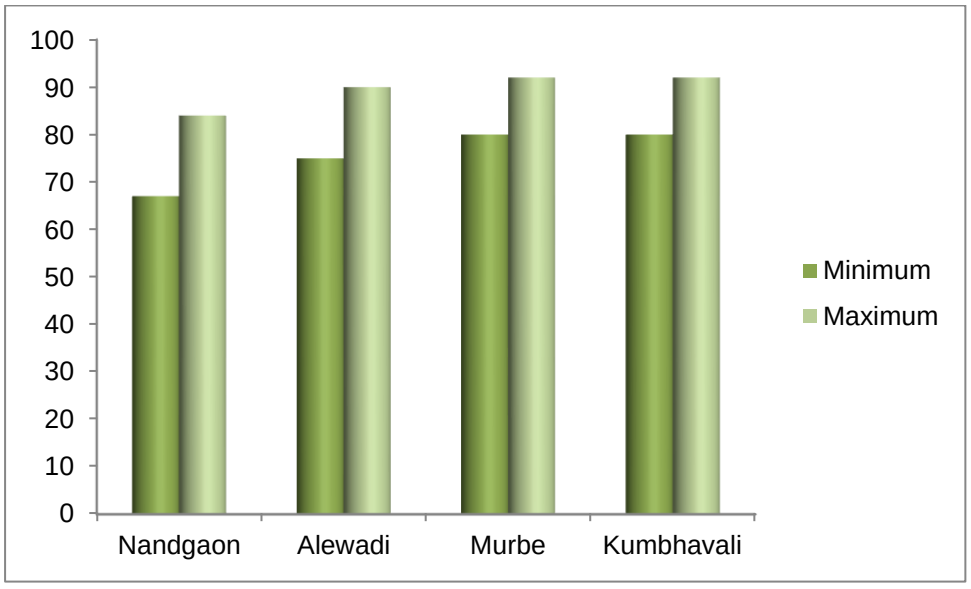


Figure 3.12: Concentration level of PM_{10} during pre-monsoon

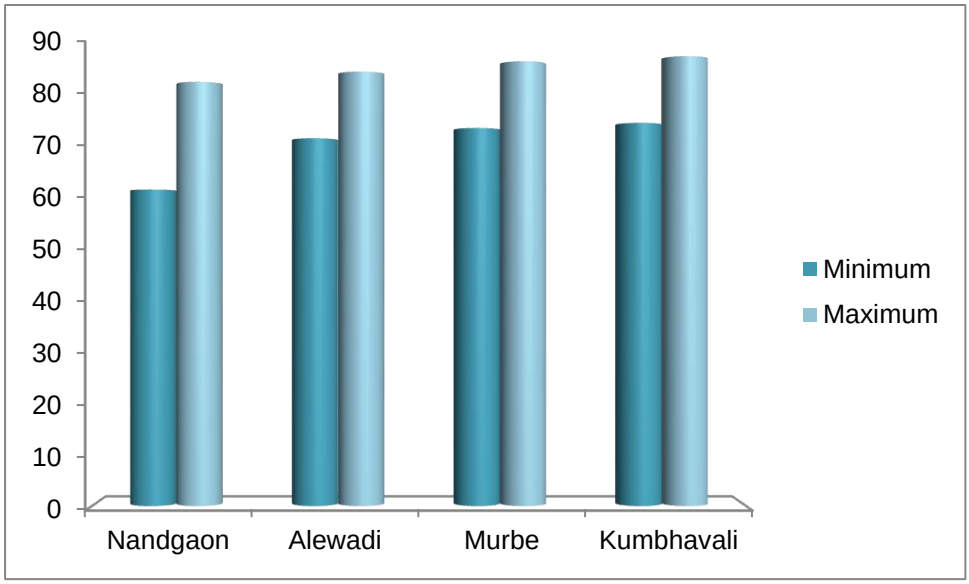


Figure 3.13: Concentration level of PM_{10} during post-monsoon

3.10.2 Observation $PM_{2.5}$ Levels

The average concentration of $PM_{2.5}$ at various stations ranged from 38.71 to 48.54 μg/m^3 in winter season, 40.87 to 50.38 μg/m^3 in pre-monsoon, and 40.42 to 47.75 μg/m^3 during post-monsoon season. The maximum concentration of $PM_{2.5}$ was recorded at Alewadi and Kumbhavali locations. However, the average values of $PM_{2.5}$ were lower than the prescribed limits of *60 μg/m^3* specified for the industrial, residential, rural and other areas. The concentration levels at various sampling locations during the study are shown in the Figures 3.14 - 3.16.

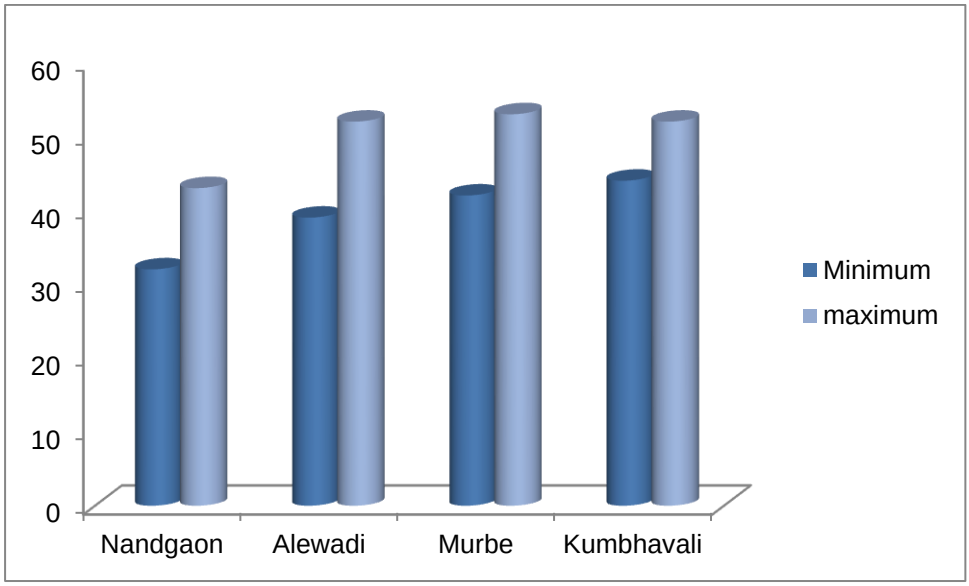


Figure 3.14: Concentration level of $PM_{2.5}$ during winter season

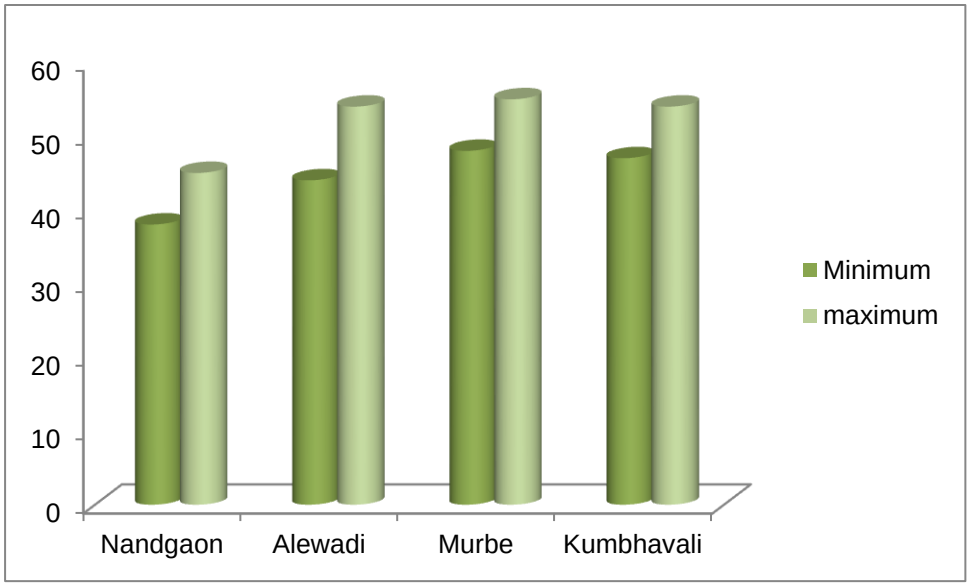


Figure 3.15: Concentration level of $PM_{2.5}$ during pre-monsoon

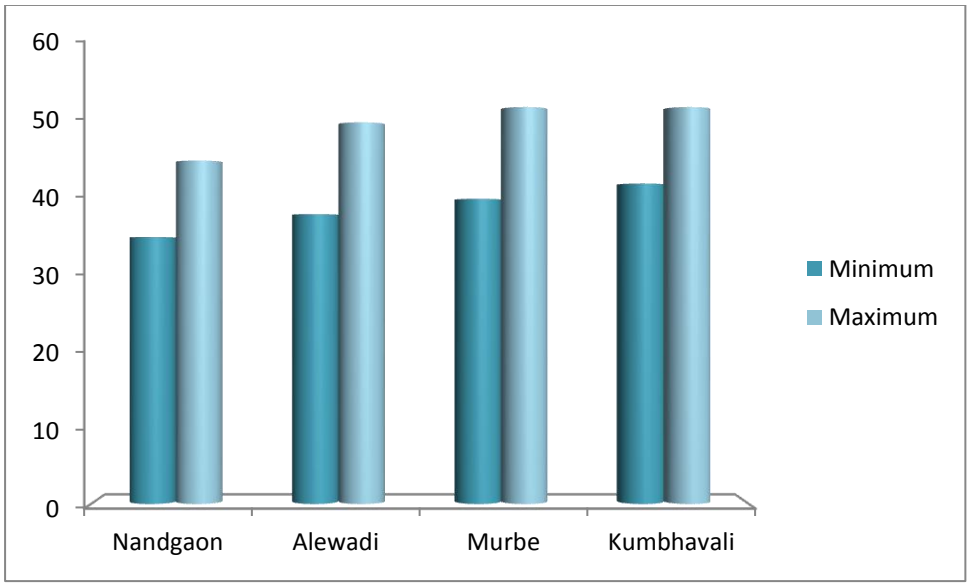


Figure 3.16: Concentration level of $PM_{2.5}$ during post-monsoon

3.10.3 Observation SO_2 Levels

The average concentration of SO_2 at various stations ranged from 13.54 to 23.08 μg/m^3 in winter season, 12.50 to 21.08 μg/m^3 in pre-monsoon, 14.75 to 22.75 μg/m^3 in post-monsoon season. The average concentration of SO_2 at various stations in the study area were well below the prescribed limits of *80 μg/m^3* specified for the industrial, residential, rural and other areas. The highest SO_2 concentration of 26 μg/m^3 was observed at location

Kumbhavali. The concentration levels of SO_2 at various sampling locations during the study period are shown in the Figures 3.17-3.19.

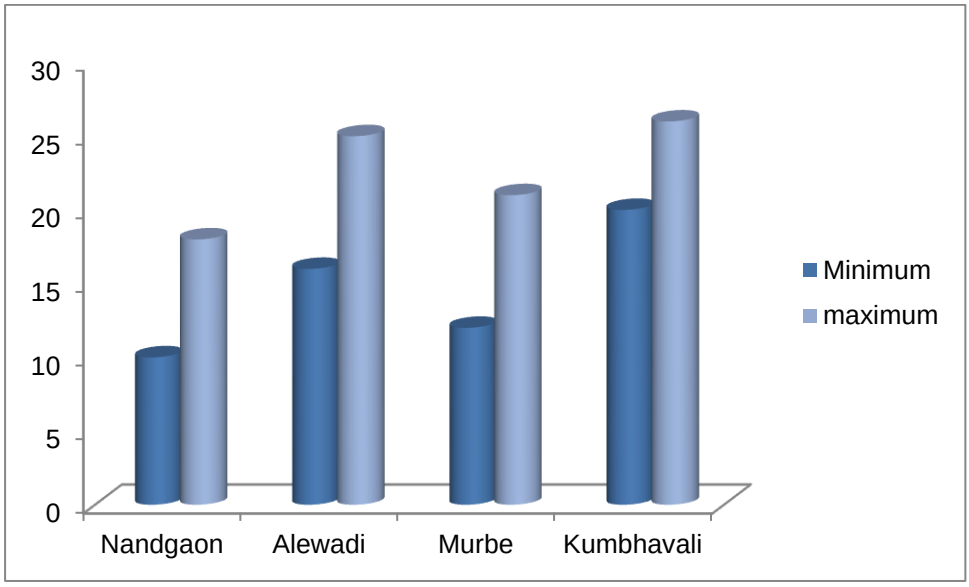


Figure 3.17: Concentration level of SO_2 during winter season

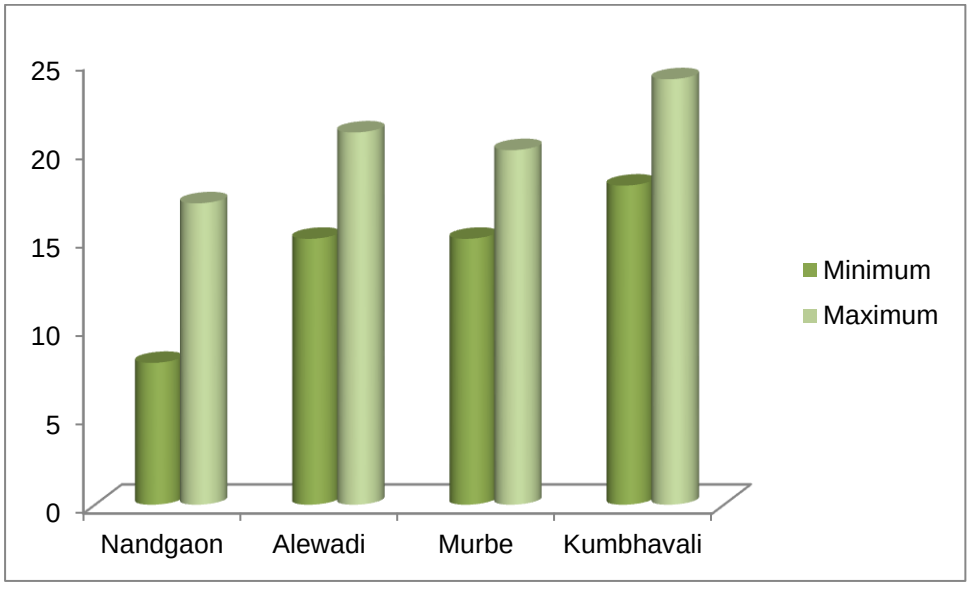


Figure 3.18: Concentration level of SO_2 during pre-monsoon

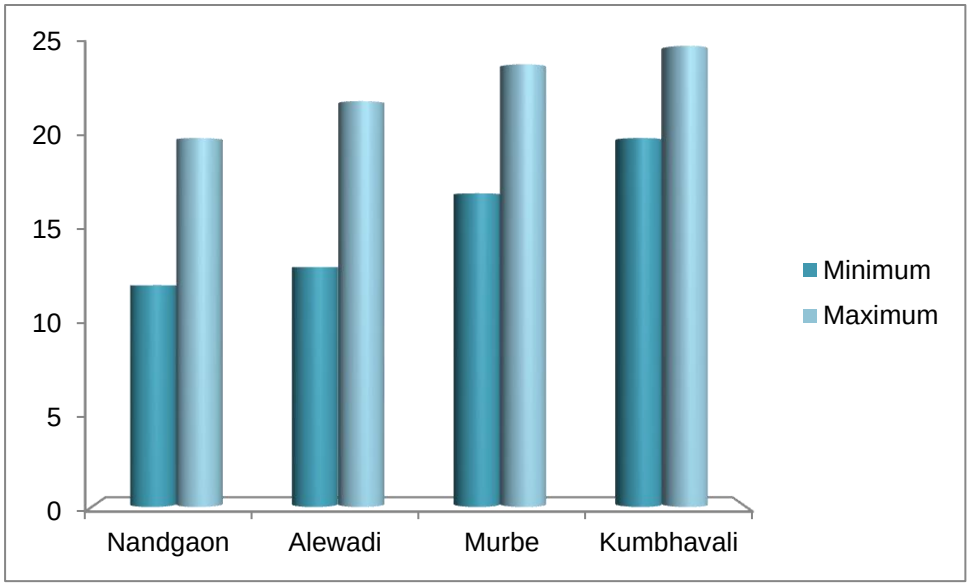


Figure 3.19: Concentration level of SO_2 during post-monsoon

3.10.4 Observation NO_2 Levels

The average concentration of NO_2 at various stations ranged from 19.75 to 31.08 μg/m^3 in winter season and 18.79 to 28.92 μg/m^3 in pre-monsoon, and 20.52 to 30.54 μg/m^3 in post-monsoon season. The NO_2 concentration at all the sampling stations were well below the prescribed limit of *80 μg/m^3* specified for the industrial, residential, rural and other areas. The highest NO_2 concentration was observed at Kumbhavali. The concentrations of NO_2 at various sampling locations during the study period are shown in the Figures 3.20-3.22.

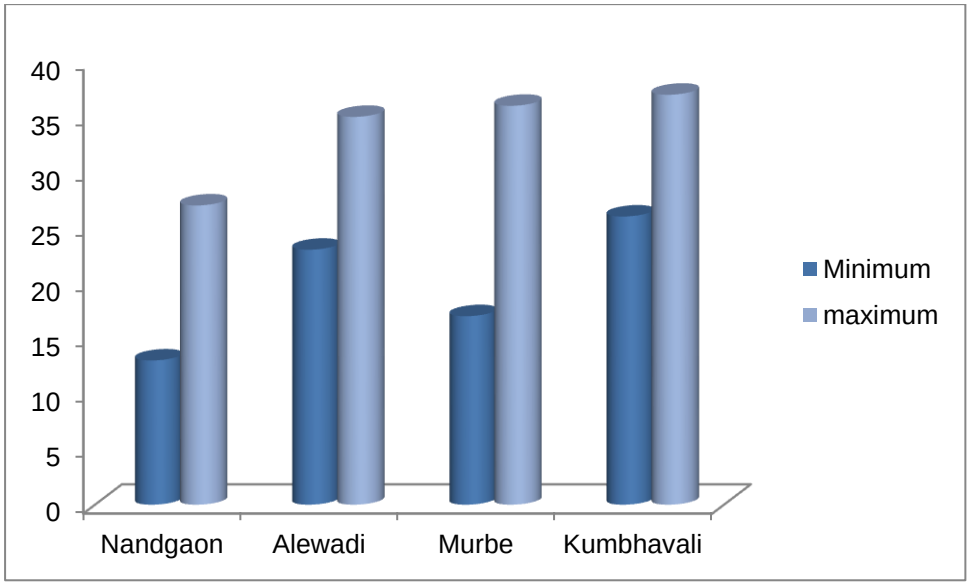


Figure 3.20: Concentration level of NO_2 during winter season

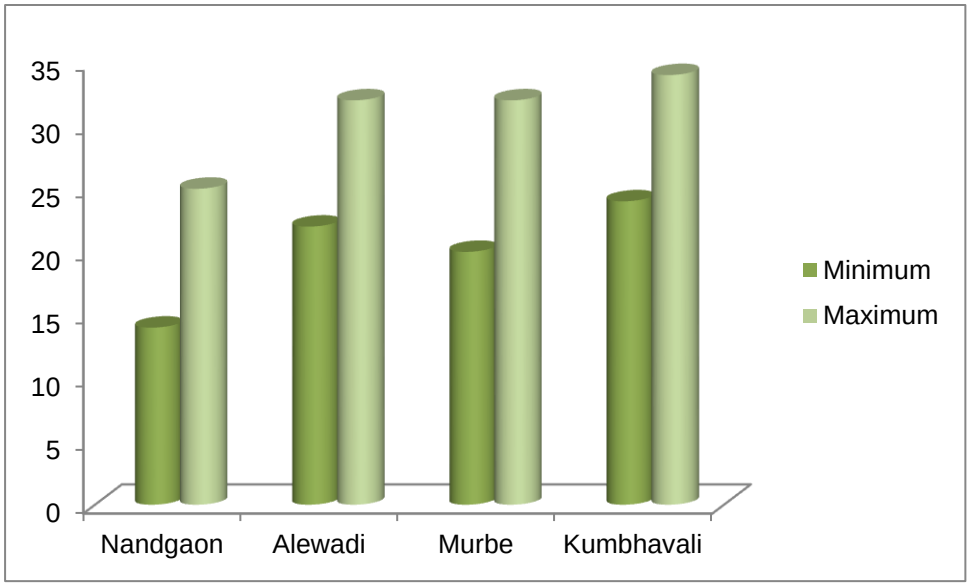


Figure 3.21: Concentration level of NO_2 during pre-monsoon

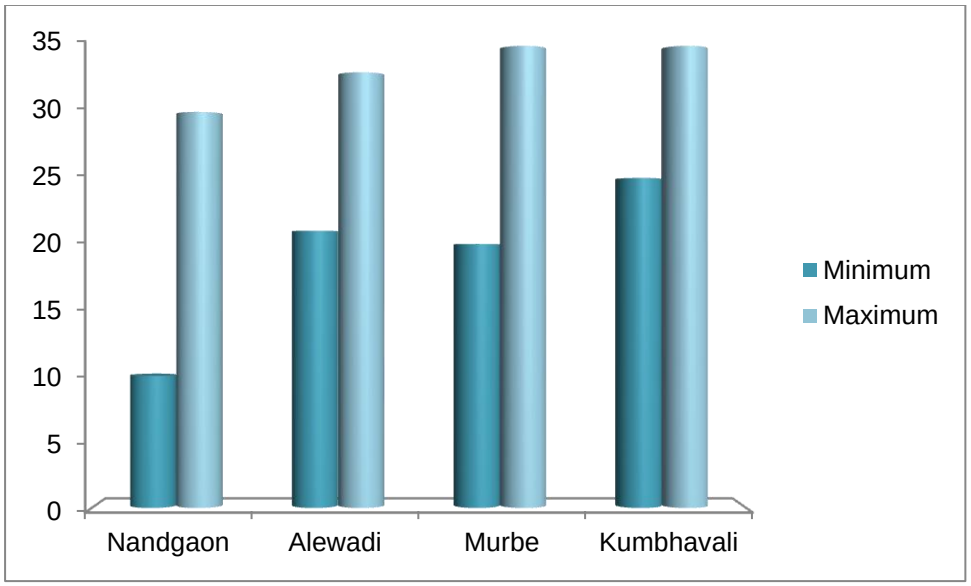


Figure 3.22: Concentration level of NO_2 during post-monsoon

3.11 Noise Environment

Baseline noise data has been measured using a weighted sound pressure level meter. The survey was carried out in calm surroundings. Sound Pressure Level (SPL) measurement in the outside environment was made using sound pressure level meter. Hourly noise meter readings were taken at each site, and equivalent day time and night time noise levels were estimated. The location of various ambient noise level monitoring stations are shown in the

Figure 3.10. The day time and night time Equivalent noise levels during the study period are presented in the Table 3.6. The ambient noise standards are enclosed as Annexure-II.

Table 3.6: Equivalent noise levels in the study area during the observation period

[Unit: dB(A)]

Locations	***Leq($_{day}$)***	***Leq($_{night}$)***
Winter Season		
Proposed site	*52.4*	*45.7*
Nandgaon village	*51.7*	*45.5*
Alewadi village	*51.5*	*46.3*
Navapur village	*51.9*	*45.6*
Umroli village	*51.4*	*45.0*
Pre-monsoon		
Proposed site	*52.7*	*45.5*
Nandgaon village	*52.0*	*45.7*
Alewadi village	*51.8*	*45.3*
Navapur village	*52.2*	*44.7*
Umroli village	*49.6*	*41.8*
Post-Monsoon		
Proposed site	*50.2*	*42.6*
Nandgaon village	*52.3*	*45.1*
Alewadi village	*51.2*	*45.8*
Navapur village	*52.8*	*46.4*
Umroli village	*52.7*	*46.2*

It may be seen from the Table 3.6, that during winter season, day time equivalent noise level ranged from a minimum of 51.4 dB(A) to a maximum of 52.4 dB(A). Likewise, in night time equivalent noise level ranged from a minimum of 45.0 dB(A) to a maximum of 46.3 dB(A). During pre-monsoon, the day time equivalent noise level ranged from a minimum of 49.6 dB(A) to a maximum of 52.7 dB(A). In night time equivalent noise level ranged from a minimum of 41.8 dB(A) to a maximum of 45.7 dB(A). Whereas, during post-monsoon the day time equivalent noise level ranged from 50.2 dB(A) to 52.8 dB(A), and in night time equivalent noise levels ranged from 42.6 dB(A) to a maximum of 46.4 dB(A).

The day and night time equivalent noise level at various sites located close to the residential areas were compared with Ambient Noise Standards (Refer Annexure-II) and were observed to be well below the permissible limit of *75 dB(A) and 70 dB(A*) specified for the industrial area respectively.

3.12 Terrestrial Ecology

3.12.1 Flora

Proposed project is located on the western coast near Tarapur industrial area. The forest types as per Champion & Seth (1968) classification in the study area can be grouped under the following types:

Group 3: Tropical moist deciduous forests

Sub-group 3B. South Indian moist deciduous forests

Moist teak bearing forests (3B/C1)

Southern moist mixed deciduous forests (3B/C2)

Group 4. Littoral and swamp forests

Sub-group 4B. Tidal swamp forests

Mangrove scrub forests (4B/TS1)

Group 8. Subtropical broadleaved forests

Sub-group 8A. Southern subtropical broadleaved hill forests

Western subtropical hill forests (8A/C2)

Moist teak bearing forests (3B/C1): Major part of the forests comprises of this type. Within this main type considerable local variations in composition and quality of crop are observed. These variations are due to the edaphic factor in some cases but in majority of them, the other factor like topography, biotic influences, and past treatment are responsible for such variations. This association is mostly found in the Bhatane Palghar range on the foothills of the Western Ghats. The soil is shallow and poor in humus content. The Ain (*Terminalia tomentosa*) and Bonda (*Lagerstroemia parviflora*) are the most common species in these forests in the study area. The other species associated are Kakad (*Garuga pinnata*), Kuda (*Holarrhena antidysentrica*) and Takala (*Cassia tora*) but their proposition is not much. Undergrowth is sparse, while climbers are rare.

Southern moist mixed deciduous forests (3B/C2): The evergreen vegetation is usually larger than in case of the teak-bearing forests. Teak is occasionally recorded and may be an indicator of secondary succession. Grasses are generally less. The Common species are *Terminelia bellerica*, *Dalbergia latifolia*, etc.

Western subtropical hill forests (8A/C2): This type is found on the higher slopes of the Western Ghats on the Gambhirgad hills in Udhava. The area is exposed to strong winds with the result that the height growth of the trees is poor except in the valleys. It is a semi evergreen type of forest with many evergreen species in the over wood and with Underwood and under growth almost exclusively of evergreen species. The floristries are

as under. Common species observed in the project area includes Mango (*Mangifera Indica*), Karanj (*Pongania pinnata*), Kokam (*Garcinia indica*), Jambul (*Syzygium cumini*), Shisham (*Dalbergia latifolia*), Asana (*Bridelia retusa*), Hirda (*Terminalia chebula*), Beheda (*Terminalia bellerica*), Bher (*Zizyphus* species) etc;

Five local types may be distinguished for the purposes of description of the forest and its management. The following forest types are observed in the study area.

- Teak forests
- Ain forests
- Mixed forests
- Babul Forests
- Casuarina Forests

The poorest quality of forests is found adjacent or in proximity of villages and developing large townships. Forests in such areas have been subjected to great pressure by surrounding populations. Some hillocks which are very near to the townships have become barren lands and denuded of vegetation completely. Where the forests have been subjected to the heavy pressure of tahal lopping, non-teak species have disappeared. There is almost pure Teak in such areas but of very poor quality owing to the constant exposure of soil and lack of humus. In areas where grazing is heavy and such is the case of the entire accessible tract, natural regeneration and advance growth are absent.

Teak Forest: The forests having more than 20% of Teak in over wood are called as Teak forests. On deep, rich and well-drained soil, most valuable species economically i.e. the teak occur and forms about 20 to 30 % of the crop. On poorer sites with shallow soils and particularly in areas which are subjected to frequent fires and severe damages due to hacking etc., the proportion of teak is more than 50 % but the growth is not so good. Almost pure teak forests are confined to Teak plantations, but most of them have been cut on account illegal tree felling. On better sites, the associates of teak are valuable timber species like Ain, Khair Hed, Kalam, Bibla etc. are found. However, in poorer sites, associates are drier species like Dhavada, Kakad, Shemal etc.

Ain Forest: The forests having more than 50 % of Ain over wood are called as 'Ain forests'. In part of the areas, Ain accounts are more than 50 % of the crop. This forest type is very common in woodland or even in reserve forest where areas have been largely used for cultivation. This type occurs, on almost all malki land near woodlands and reserve forest. The occurrence of the species in cultivated area and encroachments indicates that the species has capability of surviving against the injuries or increased pressure, probably

owing to its high coppicing power in the earlier stages and its suitability to the edaphic, climatic and other ecological or environmental conditions existing in this tract.

Mixed Forest: The forests with less than 20 % teak and none of the species being more than 50 % would be called as mixed forest. This type of the forest has low proportion of teak in the crop. It occurs in the areas which have not been subjected to adverse effects of biotic factors like fires, grazing, over grazing, hacking etc. This forest occurs in the more moist areas like nalla banks and shaded valleys.

Casuarina Forest: This forest type consists of the plantations of *Casuarina equisetifolia* (Suru) along the sea coast in Palghar, Dahanu and Bordi Ranges of the Division. These are pure Suru plantations and have no Underwood or undergrowth, whereas, older plantations are very successful and have been harvested in the past. These forests are also important from aesthetic point of view as they form good shelterbelts on the coast.

Babul Forest: This type occurs in narrow strip along the Vaitarna River. Babul was raised artificially by sowing of seeds. The area is flat and has deep loamy soil. Almost pure crop of Babul was reported to be occurring as a result of regeneration efforts in the distant past. The crop is reported to have been regularly harvested. However, at present most of the areas under this forest type are blank and efforts for regeneration have not been made. List of commonly recorded plant species in the study area is given in the Table 3.7.

Table 3.7: List of common plants recorded from the project area

Common Name	**Scientific Name**
Trees	
Ain	*Terminalia tomentosa*
Alu	*Meyna laxiflora*
Ashi	*Morinda tinctoria*
Amba	*Mangiferia indica*
Amati (Wavding)	*Embelia robusta*
Apta	*Bauhinia racemosa*
Asana	*Bridelia retusa*
Arjunsadada	*Terminalia arjuna*
Athroon (Kakar-Bhekal)	*Flacourtia ramontchi*
Avali	*Emblica officinalis*
Babul	*Acacia arabica*
Bel	*Aegle marmelos*
Bakula	*Mimusops elengi*
Bava (Bhava)	*Cassia fistula*
Beheda	*Terminalia bellerica*
Bhendi	*Thespesia populnea*

Common Name	Scientific Name
Bhokar (Shelute)	*Cordia dichotoma*
Bhutkesh (Lawsat)	*Mussaenda frondosa*
Bhitia (Alan or Bhutaksha)	*Elaeodendron glaucum*
Biba	*Semecarpus anacardium*
Bibla	*Pterocarpus marsupium*
Bondara	*Lagerstroemia parviflora*
Bor	*Ziziphus jujube*
Chambuli	*Bauhinia vahlii*
Chera	*Erinocarpus nimmonii*
Chinch	*Tamarindus indica*
Dandoshi	*Dalbergia lanceolaria*
Daiwas (Dahivel)	*Cordia macleodii*
Datir	*Ficus heterophylla*
Dhaman	*Grewia tiliaefolia*
Dhavada	*Anogeissus latifolia*
Gela	*Randia dumatorum*
Gol	*Trema orientalis*
Hed	*Adina cordifolia*
Hirda	*Terminalia chebula*
Humb	*Saccopetalum tomentosum*
Jambul	*Syzgium cuminii*
Kalamb	*Stephegyne parvifolia*
Kadvai	*Hymenodictyon excelsum*
Suru	*Casuarina equisetifolia*
Katekumbhal	*Sideroxylon tomentosum*
Kavath	*Limmonia acidissima*
Khair	*Acacia catechu*
Karanj	*Pongamia pinnata*
Kokam	*Garcinia indica*
Shisam	*Dalbergia latifolia*
Khavas	*Sterculia colorata*
Kinhai	*Albizzia procera*
Kirmira	*Casearia tomentosa*
SHRUBS	
Adulsa	*Adhatoda zeylanica*
Dhaiti	*Woodfordia floribunda*
Ghaneri	*Lantana camara*
Ghaypat	*Agave americana*
Gultata	*Lantana alba*
Kanfuti	*Flemingia strobilifera*
Kaladhotra	*Datura fastuosa*
Karvandi	*Carrissa carandas*
HERBS	
Anantmul (Upalasari or Indian sarsaparilla)	*Hemidesmus indicus*
Bhigguli	*Indigofera enneaphylla*

Common Name	Scientific Name
Burada	*Blumea lacera*
Chikata	*Desmodium pulchellum*
Dinda	*Leea macrophylla*
Litchi (Van-bhendi)	*Urena lobata*
Papadi	*Pavetta tomentosa*
Rankel	*Musa superb*
Ranhalad or sholi	*Curcuma aromatic*
Rankanda	*Scilla indica*
Sarp mukha	*Tephrosia purpurea*
Sonki	*Senecio graham*
Tarota or Takala	*Cassia tora*
Vikhara talimkhana	*Hygrophila auriculata*
CLIMBERS	
Alai/Alsi	*Dalbergia volubilis*
Bhuikohala	*Ipomea digitata*
Chilhari	*Caesalpinia sepiaria*
Gunj	*Abrus precatorius*
Gulvel (Amarvel)	*Tinospora cordifolia*
Kanguni	*Celastrus paniculata*
Kantjaruel	*Capparis sepiara*
Kuhili	*Mucuna pruriens*
Phulsun	*Spatholobus roxburghii*
Sakalvel	*Ventilago madraspatana*
Ukshi	*Calycopteris floribunda*
Valbiwala	*Milletia racemosa*
Watvel	*Cocculus macrocarpus*
Wagati	*Wagatea spicata*
Wag, Govinsi	*Capparis zeylanica*
BAMBOOS	
Bundhi or cher	*Oxytenanthera monostigma*
Manvel	*Dendrocalamus strictus*
Padhai or katas	*Bambusa arundianacea*
GRASSES	
Ber	*Ischaemum rugosum*
Bhale Kusal	*Heteropogon triticus*
Bhongrut (Phuleraphul)	*Themeda quadrivalvis*
Bhuri	*Aristida paniculata*
Boru	*Andropogon species*
Chirika	*Eragrostis tremula*
Dongari gavat	*Chrysopogon fulvus*
Ghanya	*Bothriochloa pertusa*
Gondvel	*Andropogon pumilis*
Harali (Durva)	*Cynodon dactylon*
Kunda	*Ischaemum pilosum*
Kothar	*Woodrowia diandra*

Common Name	Scientific Name
Kusali	*Heteropogon contortus*
Lavhala	*Mnesithea laevis*
Marvel	*Dichanthium annulatum*
Pavnya	*Sehima sulcatum*
Phool	*Themeda triandra*
Rosha	*Cymbopogon schoenanthus*
Sheda	*Sehima nervosum*

The project is being proposed on sea coast and there is no acquisition of private or forest land. There is no National Park or Wild Life Sanctuary in the study area. The nearest Sanjay Gandhi National Park is nearly 65 km away from the project site through the aerial distance, and about 100 km away by the road distance. There is no mangrove vegetation near the proposed project site, which is about 4.5 km away towards south of the project site near Satpati creek.

3.12.2 Fauna

Proposed project is located on the western coast near Tarapur industrial area, which forms part of the Dahanu Forest Division. The wild life population in the Dahanu Forest Division is dwindling due to increased biotic pressure on their habitat. The major wild life species reported in the project area is given in the Table 3.8.

Table 3.8: Major wild life species observed in the project area

Common Name	Scientific Name	IUCN Red List Status
Mammals		
Barking Deer	*Muntiacus muntjak*	Least Concern
Common Langur	*Presbytis entellus*	-
Mouse Deer	*Tragulus meminna*	Least Concern
Wild Boar	*Sus scrofa*	Least Concern
Raptiles		
Indian Crocodile	*Crocodilus Pallustris*	-
Common Garden Lizard	*Calotes versicolor*	-
Common Indian Monitor	*Varanus bengalensisis*	-
Common Wolf Snake	*Lycodon aulicus*	-
Common Red Snake	*Ptyas mucosus*	-
Common Indian Krait	*Bungarus caeruleus*	-
Indian Cobra	*Naja naja*	Least Concern
Russell's Viper	*Daboia russellia*	-
Avi Fauna		
Litle Grebe	*Tachybaptus rujicollis*	-
Little Cormorant	*Phalacrocorax niger*	Least Concern
Purple Heron	*Ardea purpurea*	Least Concern
Smaller Egret	*Egretta inrermedia,*	-
Lesser Whisting Teal	*Dendrocygna javanica*	Least Concern

Common Name	Scientific Name	IUCN Red List Status
Common Pochard	*Aythya arina*	-
Pariah Kite	*Milvus niigrans*	
Shikra	*Accipiter badius*	Least Concern
Grey Jungle Fowl	*Gallus sonneratti*	-
White breasted Waterhen	*Atnaurornis phoenicurus*	-
Pheasanttailed Jacana	*Hydrophasianus chirurgus*	Least Concern
Redwattled Lapwing	*Vanellus indicus*	Least Concern
Common Greenshank	*Tringa nebularia*	Least Concern
Blue Rock Pigeon	*Columba livia*	Least Concern
Indian Ring Dove	*Streptopelia decaocto*	Least Concern
Spotted Dove	*Streptopelia chonensis*	-
Emerald Dove	*Chalcophaps indica*	Least Concern
Roseringed Parakeet	*Psittacula krameri*	Least Concern
Blossom headed Parakeet	*Psittacula cyanocephala*	Least Concern

3.13 Water and Soil Environment

3.13.1 Sampling and Analysis

Marine water samples were collected using Universal water sampler from sub-surface and bottom, and transferred to the pre-cleaned polypropylene and glass containers. Sediment samples were collected using a Peterson Grab, transferred to clean polythene bags and transported to the laboratory. The sediment samples were air-dried. The plant root and other debris from the sample were removed and stored for further analysis. Similar sampling procedure was adopted for the surface and ground water, and soil sampling.

3.13.2 Water Analysis

In-situ Analysis

The physical parameters like pH, temperature and salinity were measured i*n-situ* in field condition. The subsurface temperature was measured with a mercury thermometer having ± 0.02 °C accuracy. The physico-chemical parameters like pH, Salinity, Turbidity, TDS, Total Alkalinity and Electrical Conductivity were measured *in-situ* in the field using a pre-calibrated TKK-DOA water quality-monitoring probe WQC–24. Water samples for dissolved oxygen (DO) were collected carefully to the glass stoppered air-tight bottles. The DO in the water sample was fixed immediately and brought to the laboratory for further analysis.

Preservation and Laboratory Analysis

After collection, all samples were immediately cooled to 4°C and then brought to the laboratory in an insulated thermo cool box. For dissolved heavy metals, the water sample was acidified immediately after the collection. In the laboratory, water samples were filtered

through Whatman GF/C filter paper and further analysed. All the analyses were carried out as per internationally adopted standard procedures for samples of aquatic origin.

The Winkler's method described by Strickland and Parsons (1972) was adopted for the estimation of dissolved oxygen fixed at the field. The BOD was computed simply as the difference between the 1st day DO and 5th day DO after incubation at 20 °C. The values were expressed in mg/l. The COD was measured adopting the open flux method followed by the standard methods for the examination of water and wastewater manual APHA, 2006 and expressed as mg/l.

The nutrient parameter like Phosphate, Nitrate, and Ammoniacal Nitrogen were analyzed spectrophotometrically by following the standard manual for water quality analysis by Grasshoff et al (1999). The PHc was determined using a Spectrofluorometer after solvent extraction.

For the determination of dissolved heavy metals, the acidified water sample was solvent extracted using the APDC-MIBK solution. Hexavalent Chromium (Cr^{6+}) was anlysed after extraction with APDC-NaDDC solution. The solution extracts were analysed through Atomic Absorption Spectrophotometer (Perkin Elmer 4100). Mercury was analysed through Cold Vapor Technique using AAS. The major ions like calcium, magnesium, sodium, potassium were analyzed using Flame Photometer by following the standard methods for the examination of water and wastewater manual APHA, 2006. Similarly, the Chloride and Fluoride were also analysed titrametrically by following the manual APHA, 2006.

3.13.3 Sediment Analysis

For the analysis pH, conductivity the sediment samples were used as such. For all other analyses of organic matter, nutrients and heavy metals, sediment samples were dried in an oven at 110 °C to constant weight and ground to fine powder.

The estimation of organic matter in sediment was performed by adopting the method of El Wakeel and Riley (1956). The procedure involves chromic acid digestion and subsequent titration with ferrous ammonium sulphate solution in the presence of 1, 10 phenanthroline indicator.

The nutrients were determined spectrophotometrically by adopting the acid digestion procedure followed by Murphy and Rilley (1962). TKN was determined following the Kjeldahl digestion method of Anderson and Ingram (1993). The soil PHc was determined after extraction using Spectrofluorometer.

For the determination of heavy metals, the samples were digested using aqua regia. Approximately 0.5 gm of each sample was digested with aqua-regia (1: 3 HCl: HNO3) in a Teflon bomb for 2h at 120 ^{o}C. After cooling, the digested samples were filtered and kept in plastic bottles before the analysis. Mercury in the soil/sediment was analysed through Cold Vapour Technique. The sample solution were then analysed for metals through Atomic Absorption Spectrometer (Perkin Elmer 4100). The major ions (Na, P, K) were determined by the measurement of exchangeable cations using ammonium acetate.

3.14 Ground Water Quality

As a part of the EIA study, ground water samples were collected during winter season (December, 2011), pre-monsoon (April, 2012), and post-monsoon (September, 2012) season from four locations in the study area. The surface and ground water samples were analyzed for three seasons and the results are shown in the Tables 3.9-3.11. The sampling locations are shown in the Figure 3.10. The water samples were collected from the Lake, and open/bore well from the following locations;

1. Alewadi SW I
2. Nandgaon GW II
3. Murbe GW III
4. Kumbhavali GW IV

The proposed project is located near Tarapur industrial area (also called the Tarapur MIDC area) on the Arabian Sea Coast in Thane District of Maharashtra State. Four surface and ground water samples were collected from the dug wells and bore wells in the study area for physico-chemical analyses. The analyses show that the area in general is good except high TDS and high conductivity at few places. High chloride concentration was also noticed at two locations, possibly due to its proximity, and hydraulic connection with the sea. Although the potability of groundwater is questionable in certain areas, it is good enough for irrigation purposes at present. There are evidences of seawater intrusion in ground water in the area and around the creeks. The proposed project is not anticipated to have adverse impacts on ground water quality.

Table 3.9: Physico-chemical properties of ground water during winter season

Parameters	SW I	GW II	GW III	GW IV	Desirable Limits- IS10500	Permissible Limits- IS10500
pH	7.3	7.7	7.8	7.3	6.5-8.5	-
TDS (mg/l)	212	646	680	258	500	2000

Parameters	SW I	GW II	GW III	GW IV	Desirable Limits- IS10500	Permissible Limits- IS10500
EC (µS/cm)	290	910	988	340	-	-
Calcium (mg/l)	13	28	42	17	75	200
Magnesium (mg/l)	7.2	21	19	9.0	30	100
Alkalinity (mg/l)	126	322	342	172	200	600
Chloride (mg/l)	22	105	91	28	250	1000
Fluoride (mg/l)	0.03	0.16	0.06	0.41	1	1.5
Sulphate (mg/l)	2.0	13	38	3.0	200	400
Phosphate (mg/l)	0.004	0.02	0.04	0.01	-	-
Nitrate (mg/l)	0.9	2.2	1.6	2.6	45	100
Copper (mg/l)	BDL	0.002	0.004	0.001	0.05	1.5
Zinc (mg/l)	0.001	0.005	0.007	0.009	5	15
Lead (mg/l)	BDL	BDL	BDL	0.008	0.05	-
Cadmium (mg/l)	0.001	BDL	BDL	0.002	0.01	-
Chromium as Cr^{6+} (mg/l)	BDL	BDL	BDL	BDL	0.05	-
Arsenic (mg/l)	BDL	BDL	BDL	BDL	0.05	-
Mercury (mg/l)	BDL	BDL	BDL	BDL	0.001	-

Table 3.10: Physico-chemical properties of ground water during pre-monsoon

Parameters	SW I	GW II	GW III	GW IV	Desirable Limits- IS10500	Permissible Limits- IS10500
pH	7.4	7.9	7.7	7.2	6.5-8.5	-
TDS (mg/l)	236	670	694	260	500	2000
EC (µS/cm)	310	960	926	370	-	-
Calcium (mg/l)	18	27	43	20	75	200
Magnesium (mg/l)	8	19	16	9	30	100
Alkalinity (mg/l)	132	312	350	181	200	600
Chloride (mg/l)	16	95	82	25	250	1000
Fluoride (mg/l)	0.04	0.16	0.15	0.33	1	1.5
Sulphate (mg/l)	3.0	19	41	5.0	200	400
Phosphate (mg/l)	0.002	0.03	0.03	0.02	-	-
Nitrate (mg/l)	1.0	2.8	2.2	3.1	45	100
Copper (mg/l)	BDL	0.005	0.007	0.005	0.05	1.5
Zinc (mg/l)	0.003	0.007	0.010	0.011	5	15
Lead (mg/l)	BDL	BDL	BDL	BDL	0.05	-
Cadmium (mg/l)	0.001	BDL	BDL	BDL	0.01	-
Chromium as Cr^{6+} (mg/l)	BDL	BDL	BDL	BDL	0.05	-
Arsenic (mg/l)	BDL	BDL	BDL	BDL	0.05	-
Mercury (mg/l)	BDL	BDL	BDL	BDL	0.001	-

Table 3.11: Physico-chemical properties of ground water during post-monsoon

Parameters	SW I	GW II	GW III	GW IV	Desirable Limits- IS10500	Permissible Limits- IS10500
pH	6.8	7.5	7.3	7.2	6.5-8.5	-
TDS (mg/l)	192	590	610	226	500	2000
EC (µS/cm)	262	824	830	294	-	-
Calcium (mg/l)	14	32	38	16	75	200
Magnesium (mg/l)	6.4	18	16	8.2	30	100
Alkalinity (mg/l)	116	294	316	158	200	600
Chloride (mg/l)	12	96	72	34	250	1000
Fluoride (mg/l)	0.08	0.09	0.07	0.39	1	1.5
Sulphate (mg/l)	2.2	15	24	2.0	200	400
Phosphate (mg/l)	0.002	0.015	0.028	0.005	-	-
Nitrate (mg/l)	0.06	1.8	1.2	1.8	45	100
Copper (mg/l)	BDL	0.002	0.002	BDL	0.05	1.5
Zinc (mg/l)	BDL	0.005	0.005	0.007	5	15
Lead (mg/l)	BDL	BDL	BDL	0.006	0.05	-
Cadmium (mg/l)	BDL	BDL	BDL	0.004	0.01	-
Chromium as Cr^{6+} (mg/l)	BDL	BDL	BDL	BDL	0.05	-
Arsenic (mg/l)	BDL	BDL	BDL	BDL	0.05	-
Mercury (mg/l)	BDL	BDL	BDL	BDL	0.001	-

During study period, the pH values recorded at various locations were in the range of 6.8 to 7.9. The total dissolved solids (TDS) ranges from 192 to 680 mg/l. TDS concentration is between the desirable and maximum permissible limit of BIS drinking water standards indicating that the ground water at location 1 and 4 may be suitable for drinking and other domestic purposes, while station 2 and 3 have high TDS concentrations. Chlorides values ranged from minimum 12 to a maximum value of 105 mg/l seasonally. Fluoride level ranged from 0.03 to 0.41 mg /l. The heavy metals were at the lower concentration level except copper and zinc however, most of the metals were below the detectable limit at various locations in the study area.

3.15 Soil Quality

Soil samples were collected from four locations in the study area close to the ground water sampling location. The samples were collected during winter season (December, 2011), pre-monsoon (April, 2012), and post-monsoon (September, 2012) season. The results of the soil quality analysed from the study area is given in the Tables 3.12-3.14. The result shows, that the soil is slightly alkaline with high chloride content. The soil has lower level of potassium, sodium and organic matter which indicates it may be less productive. The soil

has slightly elevated concentration level of heavy metals like copper, and zinc at few locations of the study area during the sampling period.

Table 3.12: Soil quality in the study area during winter season

Parameters	Alewadi	Nandgaon	Murbe	Kumbhavali
pH	7.93	8.12	8.01	7.85
Conductivity (mS/cm)	0.19	0.21	0.19	0.17
Sodium (mg/kg)	16.9	18.2	20.1	17.6
Potassium (mg/kg)	33.6	42.2	28.5	37.3
Sulphate (mg/kg)	270	200	206	212
Phosphate (mg/kg)	0.88	0.42	0.45	0.51
Nitrate (mg/kg)	0.59	0.33	0.46	0.39
Organic matter (%)	3.31	2.20	1.79	3.68
Copper (mg/kg)	71	89	78	107
Zinc (mg/kg)	59	98	102	118
Lead (mg/kg)	BDL	5.5	6.2	9.1
Cadmium (mg/kg)	BDL	BDL	BDL	0.03
Chromium as Cr^{6+} (mg/kg)	BDL	2.8	1.3	5.3
Mercury (mg/kg)	BDL	BDL	BDL	0.008

Table 3.13: Soil quality in the study area during pre-monsoon

Parameters	Alewadi	Nandgaon	Murbe	Kumbhavali
pH	8.20	8.22	8.14	8.03
Conductivity (mS/cm)	0.23	0.20	0.20	0.18
Sodium (mg/kg)	20.2	19.6	18.6	16.8
Potassium (mg/kg)	50.8	47.8	44.6	40.2
Sulphate (mg/kg)	320	280	262	248
Phosphate (mg/kg)	0.46	0.58	0.52	0.65
Nitrate (mg/kg)	0.62	0.64	0.38	0.27
Organic matter (%)	2.36	3.20	3.28	3.12
Copper (mg/kg)	84	132	94	146
Zinc (mg/kg)	72	142	46	168
Lead (mg/kg)	BDL	7.4	BDL	8.2
Cadmium (mg/kg)	BDL	BDL	BDL	BDL
Chromium as Cr^{6+} (mg/kg)	BDL	4.7	BDL	6.8
Mercury (mg/kg)	BDL	BDL	BDL	BDL

Table 3.14: Soil quality in the study area during post-monsoon

Parameters	Alewadi	Nandgaon	Murbe	Kumbhavali
pH	7.08	7.82	7.60	7.34
Conductivity (mS/cm)	0.14	0.20	0.17	0.11
Sodium (mg/kg)	15.8	18.0	19.2	17.0
Potassium (mg/kg)	30.0	45.0	38.2	30.4
Sulphate (mg/kg)	252	220	228	194
Phosphate (mg/kg)	0.92	0.51	0.47	0.48
Nitrate (mg/kg)	0.47	0.38	0.52	0.33
Organic matter (%)	2.94	2.72	3.10	3.26
Copper (mg/kg)	77	85	82	132
Zinc (mg/kg)	61	105	120	144
Lead (mg/kg)	BDL	4.8	5.4	10.2
Cadmium (mg/kg)	BDL	BDL	BDL	0.01
Chromium as Cr^{6+} (mg/kg)	BDL	3.2	1.8	4.4
Mercury (mg/kg)	BDL	BDL	BDL	0.003

3.16 Marine Water Quality

Detailed marine ecological survey was conducted to establish the existing status of the marine water around the proposed project site. The field studies were conducted during winter season (December, 2011), pre-monsoon (April, 2012), and post-monsoon (September, 2012) season. The study covered data collection and analysis of physico-chemical and biological characteristics of marine water and sediment samples, collection of mangrove samples for detailed analysis, interaction with fisheries department and local fishermen. Marine water and sediment sampling was done at four representative locations.

As a part of this study, the sampling was conducted at the following sites and the locations are shown in the Figure 3.10.

Station – I Near proposed site
Station – II About 500 meters north of Jetty
Station – III About 1500 m south of the proposed Jetty
Station – IV About 4 km east of the proposed Jetty

The results of the various physico-chemical parameters, and heavy metals analysed during the study period are given in the Tables 3.15 - 3.17.

Table 3.15: Physico-chemical characteristics of marine water during winter season

Parameter	SW I	SW II	SW III	SW IV	BW I	BW II	BW III	BW IV	WQ Criteria Class SW-IV
Temperature ^{o}C	26.9	27.0	26.5	26.7	26.1	26.3	25.8	26.0	NA
pH	8.0	8.0	7.7	7.8	8.0	7.9	7.7	7.9	6.5-9.0
EC (mS/cm)	53.8	53.6	54.0	54.0	53.2	53.4	53.8	53.8	NA
Turbidity (NTU)	28	29	25	25	28	30	35	32	NA
Salinity	34.8	34.3	34.7	35.0	34.5	34.7	34.7	34.9	NA
Chloride (mg/l)	20,300	19,850	20,150	20,450	19,800	20,150	20,200	20,350	NA
Dissolved Oxygen (mg/l)	5.60	5.38	4.92	5.18	5.50	5.30	5.05	5.20	3.0 or 40% sat. value
BOD (mg/l)	3.00	2.88	1.72	1.50	3.10	2.50	1.60	1.60	5.0
COD (mg/l)	12.6	13.0	8.60	7.80	12.4	11.6	8.20	8.00	NA
Phosphate as PO_4 (mg/l)	0.028	0.022	0.022	0.012	0.032	0.026	0.025	0.011	NA
Nitrate as NO_3 (mg/l)	0.51	0.45	0.30	0.24	0.54	0.40	0.40	0.27	NA
Ammonical Nitrogen (mg/l)	0.59	0.50	0.40	0.27	0.58	0.45	0.30	0.30	NA
TKN (mg/l)	15	15	11	10	15	16	12	12	NA
Sulphate (mg/l)	2,780	2,502	2,608	2,128	2,850	2,520	2,538	2,012	NA
Calcium (mg/l)	510	504	512	522	502	514	518	518	NA
Magnesium (mg/l)	1748	1710	1784	1818	1720	1730	1778	1796	NA
Sodium (mg/l)	10,720	10,622	10,768	10,792	10,568	10,665	10,762	10,764	NA
Potassium (mg/l)	410	418	425	435	410	425	430	430	NA
PHc (µg/l)	12.0	13.0	10.0	8.0	11.0	12.0	9.0	9.0	NA
Copper (µg/l)	6.8	9.4	BDL	BDL	6.4	10.2	3.6	BDL	NA
Zinc (µg/l)	6.2	7.4	4.6	BDL	7.0	8.3	3.2	BDL	NA
Lead (µg/l)	0.8	1.2	BDL	BDL	1.0	1.4	BDL	BDL	NA
Cadmium (µg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NA
Chromium as Cr^{6+} (µg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NA
Mercury (µg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NA

Table 3.16: Physico-chemical characteristics of marine water during pre-monsoon

Parameter	SW I	SW II	SW III	SW IV	BW I	BW II	BW III	BW IV	WQ Criteria Class SW-IV
Temperature ^{o}C	33.1	32.9	32.7	31.7	32.2	31.9	31.8	30.9	NA
pH	8.2	8.0	8.1	8.3	8.2	8.1	8.0	8.1	6.5-9.0
EC (mS/cm)	54.6	54.4	54.5	54.4	54.1	54.4	54.4	54.4	NA

Parameter	SW I	SW II	SW III	SW IV	BW I	BW II	BW III	BW IV	WQ Criteria Class SW-IV
Turbidity (NTU)	13	15	19	19	15	17	25	22	NA
Salinity	34.8	35.0	35.2	35.4	34.7	34.8	35.0	35.4	NA
Chloride (mg/l)	20,250	20,400	20,500	20,550	20,200	20,250	20,350	20,600	NA
Dissolved Oxygen (mg/l)	5.82	5.44	5.90	5.74	5.46	5.20	5.52	5.38	3.0 or 40% sat. value
BOD (mg/l)	1.86	1.64	2.20	1.92	1.72	1.68	1.84	1.38	5.0
COD (mg/l)	9.12	8.20	10.4	9.22	8.32	8.40	8.82	7.18	NA
Phosphate as PO_4 (mg/l)	0.017	0.024	0.023	0.020	0.021	0.023	0.026	0.021	NA
Nitrate as NO_3 (mg/l)	0.20	0.19	0.21	0.25	0.21	0.28	0.29	0.26	NA
Ammonical Nitrogen (mg/l)	0.26	0.27	0.28	0.25	0.26	0.28	0.27	0.28	NA
TKN (mg/l)	18	15	19	16	17	16	18	18	NA
Sulphate (mg/l)	2,360	2,808	2,800	2,582	2,655	2,434	2,434	2,286	NA
Calcium (mg/l)	520	524	525	540	525	530	530	535	NA
Magnesium (mg/l)	1778	1802	1838	1768	1862	1850	1864	1886	NA
Sodium (mg/l)	11,125	11,100	10,950	11,050	11,125	10,875	10,725	11,050	NA
Potassium (mg/l)	450	450	450	425	425	425	425	450	NA
PHc (mg/l)	16.0	17.0	14.0	14.0	-	-	-	-	NA
Copper (µg/l)	13.2	10.0	BDL	BDL	15.8	12.6	BDL	BDL	NA
Zinc (µg/l)	6.6	5.0	BDL	BDL	6.2	5.0	BDL	BDL	NA
Lead (µg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NA
Cadmium (µg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NA
Chromium as Cr^{6+} (µg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NA
Mercury (µg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NA

Table 3.17: Physico-chemical characteristics of marine water during post-monsoon

Parameter	SW I	SW II	SW III	SW IV	BW I	BW II	BW III	BW IV	WQ Criteria Class SW-IV
Temperature ^oC	28.5	28.4	28.6	29.1	27.8	28.0	28.2	28.7	NA
pH	7.7	7.4	7.6	8.0	7.5	7.3	7.6	7.9	6.5-9.0
EC (mS/cm)	52.8	52.2	53.4	53.8	52.4	52.0	53.0	53.6	NA
Turbidity (NTU)	35	42	38	30	40	45	45	32	NA
Salinity	32.8	32.5	32.7	33.2	32.7	32.5	32.5	33.0	NA
Chloride (mg/l)	19,230	19,080	19,204	19,650	19,210	19,054	19,188	19,570	NA
Dissolved Oxygen (mg/l)	5.08	4.95	5.52	5.70	5.05	4.82	5.38	5.64	3.0 or 40% sat. value

Parameter	SW I	SW II	SW III	SW IV	BW I	BW II	BW III	BW IV	WQ Criteria Class SW-IV
BOD (mg/l)	2.26	2.50	1.78	1.84	2.30	2.72	1.88	1.80	5.0
COD (mg/l)	11.4	12.4	8.72	8.64	11.4	12.8	8.60	8.52	NA
Phosphate as PO_4 (mg/l)	0.022	0.032	0.017	0.014	0.02	0.036	0.015	0.012	NA
Nitrate as NO_3 (mg/l)	0.42	0.63	0.29	0.22	0.47	0.62	0.30	0.21	NA
Ammonical Nitrogen (mg/l)	0.48	0.60	0.44	0.35	0.53	0.72	0.47	0.33	NA
TKN (mg/l)	18	21	17	13	19	26	19	14	NA
Sulphate (mg/l)	2,530	2,820	2,322	2,028	2,460	2,770	2,284	2,014	NA
Calcium (mg/l)	492	470	484	506	486	472	478	498	NA
Magnesium (mg/l)	1652	1620	1648	1726	1640	1630	1638	1712	NA
Sodium (mg/l)	10,322	10,274	10,316	10,366	10,292	10,286	10,290	10,334	NA
Potassium (mg/l)	404	396	402	418	408	402	402	410	NA
PHc (µg/l)	14.0	15.0	12.0	10.0	12.0	15.0	10.0	8.0	NA
Copper (µg/l)	7.4	8.8	5.2	BDL	7.6	8.0	4.6	BDL	NA
Zinc (µg/l)	6.4	7.6	3.4	BDL	6.8	7.8	2.4	BDL	NA
Lead (µg/l)	0.4	1.0	BDL	BDL	0.6	1.2	BDL	BDL	NA
Cadmium (µg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NA
Chromium as Cr^{6+} (µg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NA
Mercury (µg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	NA

BDL – Below Detectable Limit, **SW** – Surface Water, **BW** – Bottom Water, **NA**- Not Available

3.16.1 Temperature

The temperature was measured both in surface and bottom water at different locations of the study area. There was marginal difference in the water temperature at different locations which can be attributed to the different time of observations. Surface water temperature ranged between 26.5 to 27 ^{o}C during winter season, 32.2 ^{o}C and 33.1 ^{o}C in pre-monsoon, and 28.4 to 29.1 ^{o}C in post-monsoon season. The bottom water temperature was found to be slightly lower than the surface water temperature in all the locations during the study period. The bottom water temperature ranged from 25.8 to 26.3 ^{o}C during winter season, 31.0 to 32.2 ^{o}C during pre-monsoon, and 27.8 to 28.7 ^{o}C in post-monsoon season.

3.16.2 pH

The pH concentration varied uniformly during the study period. During winter season, it varied from 7.7 to 8.0 in both the surface and bottom water. While during pre-monsoon, it

varied from 8.0 to 8.3, and in post-monsoon it varied from 7.3 to 8.0 in both the surface and bottom water. Overall, the pH level during pre-monsoon is higher than the winter and post monsoon season.

3.16.3 Electrical Conductivity (EC)

The electrical conductivity varied from 53.2 to 54.0 mS/cm during winter season, 54.0 to 54.6 mS/cm during pre-monsoon and 52.0 to 53.8 mS/cm during post-monsoon season in the water column.

3.16.4 Turbidity

The turbidity levels were high during post-monsoon and winter season, and ranged from 30 to 45 NTU, while during pre-monsoon the values were in the range of 13 to 25 NTU at different locations of the study area. Also, turbidity in the bottom water was slightly higher than the surface water.

3.16.5 Salinity

The salinity values varied from 34.3 to 35.0 in winter season to 34.8 to 35.4 during pre-monsoon and 32.5 to 33.2 during post-monsoon in the surface water. There is a marginal variation in the salinity level from surface to bottom water. Also, there is an increasing trend in salinity level towards the sea mostly during pre-monsoon in absence of the fresh water flow from the creeks.

3.16.6 Chlorides

The chloride content in the surface water was found to be in the range of 19,850 to 20,450 mg/l during winter season, 20,250 to 20,550 mg/l during pre-monsoon and 19,080 to 19,650 mg/l during post-monsoon season. In the bottom water chloride level ranged between 19,054 to 20,600 mg/l in between the seasons. No significant variation in their concentration level in the water column.

3.16.7 Dissolved Oxygen

Dissolved Oxygen (DO) content of the surface water at different locations ranged from 4.92 to 5.60 mg/l during winter season, 5.44 to 5.90 mg/l during pre-monsoon and 4.95 to 5.70 mg/l during post-monsoon season. In the bottom water, it varied from 5.20 to 5.50 mg/l during winter season, 5.20 to 5.52 mg/l in pre-monsoon and 4.82 to 5.64 mg/l during the post-monsoon season.

3.16.8 Biological Oxygen Demand

The biological oxygen demand (BOD) level in the surface water varied from 1.50 to 3.00 mg/l during winter season, 1.64 to 2.20 mg/l in pre-monsoon season and 1.78 to 2.50 mg/l during post-monsoon season. While in bottom water it varied from 1.60 to 3.10 mg/l in winter season, 1.38 to 1.84 mg/l in pre-monsoon and 1.80 to 2.72 mg/l in the post-monsoon season.

3.16.9 Chemical Oxygen Demand

Unlike BOD, the chemical oxygen demand (COD) level also varied in the water column during the study period. Seasonally, the concentration level varied from 7.80 to 13.0 mg/l in the surface water, while in the bottom water it varied from 7.18 to 12.4 mg/l at different locations of the study area.

3.16.10 Nutrients

The phosphate content varied from 0.011 mg/l to 0.032 mg/l during winter season, 0.017 to 0.026 mg/l during pre-monsoon and 0.012 mg/l to 0.036 mg/l in post-monsoon season. In general, the phosphate content was more or less uniform in the water column in all the locations during the study period.

The nitrate content during winter season varied from 0.27 to 0.54 mg/l, 0.19 to 0.29 mg/l during pre-monsoon and 0.21 to 0.63 mg/l in post-monsoon season. Nitrate values of the bottom water were slightly higher than the surface water. Also, the concentration level was slightly higher during post-monsoon and winter season than the pre-monsoon season in the study area.

The Total Kjeldahl Nitrogen (TKN) concentration during the winter season varied from 10 to 16 mg/l, and in pre-monsoon it varied from 15 to 19 mg/l. While during post-monsoon it varied from 13 to 26 mg/l.

3.16.11 Major Ions

The calcium level in the surface and bottom water samples ranged from 502 to 522 mg/l during winter season, 520 to 540 mg/l during pre-monsoon and 470 to 506 mg/l during post-monsoon season. No significant variation was observed in the surface and bottom water concentration of the calcium level.

The magnesium level in the water column ranged from 1710 to 1818 mg/l during winter season, 1778 to 1886 mg/l during pre-monsoon and 1620 to 1726 mg/l during post-

monsoon. Unlike calcium, the variation of magnesium in the surface and bottom water values was negligible.

The sodium level in the water column levels ranged from 10,568 to 10,792 mg/l during winter season, from 10,725 to 11,125 mg/l during pre-monsoon, whereas during post-monsoon it varied from 10,274 to 10,366 mg/l.

The minimum and maximum potassium values in surface and bottom water samples were 410 to 435 mg/l during winter season, 425 and 450 mg/l during pre-monsoon and 396 to 410 mg/l during post-monsoon. There is no significant variation in their concentration level in the water column.

The sulphate concentration in the surface water varied from 2128 to 2780 mg/l during winter season, 2380 to 2808 mg/l during pre-monsoon and 2,028 to 2,820 mg/l during post-monsoon. While in bottom water it varied from 2012 to 2850 mg/l during winter season, 2286 to 2655 mg/l during pre-monsoon and 2,014 to 2,770 mg/l during post-monsoon season.

3.16.12 Petroleum Hydrocarbon

The PHc concentrations in the water column varied from 8.0 to 13 mg/l during post monsoon, 14 to 17 mg/l during pre-monsoon and 8.0 to 15 mg/l during post-monsoon. Although, there is no such significant variation in their concentration level in the water column, however it is slightly higher during pre-monsoon than the post-monsoon and winter season.

3.16.13 Heavy Metals

Heavy metals such as Copper (Cu), Zinc (Zn), Lead (Pb), Cadmium (Cd), Mercury (Hg) and Hexavalent chromium (Cr^{6+}) in the marine system in the project site for both surface and bottom water was determined during the study period along with the physico-chemical characteristics of the water.

In the present study, the concentrations of Cu varied from 3.6 to 10.2 µg/l during winter season, 10.0 to 15.8 mg/l during pre-monsoon, and 4.6 to 8.8 µg/l during post-monsoon season. The concentration was higher towards the coast, while it is below the detectable limit towards the marine site. The Zn level in the water column varied from 3.2 to 8.3 µg/l during the winter season, and 5.0 to 6.6 µg/l during pre-monsoon and 2.4 to 7.8 µg/l during post- monsoon. Unlike Cu, the spatial variation of Zn is significant, and mostly below the detectable limit in few locations. The Pb concentration during the winter season ranged from 0.8 to 1.4 µg/l, 0.4 to 1.2 µg/l during post-monsoon in few of the locations, and below

detectable limit during pre-monsoon season. Metals like Cd, Hg and Chromium (Cr^{6+}) are below the detectable limit in the water column during the observation period.

3.17 Sediment Quality

In an aquatic system, there is a close relationship between the type of sediments with physico-chemical and biological characteristics of water. Similarly, the activities in the system have a profound effect on the sediment characteristics. Hence, an understanding of the physico-chemical and biological characteristics of the sediments in the aquatic ecosystem is essential. With this view, the sediment samples from various marine water sampling stations were also collected and their physico-chemical and biological characteristics were analysed. The sediment samples were collected and analysed during the winter season (December, 2011), pre-monsoon (April, 2012), and post-monsoon (September, 2012) season and the results are summarized in the Tables 3.18-3.20.

Table 3.18: Sediment quality during winter season

Parameters	Locations			
	I	II	III	IV
pH	8.2	8.1	8.1	8.0
Total volatile solids (mg/g)	48	51	98	97
Chloride (mg/g)	840	920	1848	1982
Sodium (mg/g)	4.9	5.4	9.7	10.0
Potassium (mg/g)	0.32	0.40	0.70	0.72
Phosphate (mg/g)	0.0002	0.0002	0.0001	0.0001
Nitrate (mg/g)	0.051	0.052	0.042	0.040
Total Kjeldahl Nitrogen (mg/g)	120	92	80	68
Sulphate (mg/g)	2.0	4.8	5.2	1.8
*PHc (µg/g)	0.6	0.8	0.5	0.4
Copper (µg/g)	63.2	80.2	50.5	65.0
Zinc (µg/g)	124	128	104	61.0
Lead (µg/g)	10.2	13.2	8.4	7.7
Cadmium (µg/g)	0.12	0.14	BDL	BDL
Mercury (µg/g)	0.01	0.02	BDL	BDL
Arsenic (µg/g)	BDL	2.2	BDL	BDL
Chromium as Cr^{6+} (µg/g)	3.2	4.6	BDL	BDL
Organic matter (%)	1.0	1.2	0.7	0.5

**in wet wt. and all are in dry wt.*

Table 3.19: Sediment quality during pre-monsoon season

Parameters	Locations			
	I	II	III	IV
pH	8.9	8.7	8.6	8.5
Total volatile solids (mg/g)	61	73	107	106
Chloride (mg/g)	1040	520	1944	2320
Sodium (mg/g)	3.4	6.0	10.8	11.0
Potassium (mg/g)	0.2	0.35	0.5	0.85
Phosphate (mg/g)	0.0001	0.0002	0.0003	0.0002
Nitrate (mg/g)	0.06	0.059	0.052	0.042
Total Kjeldahl Nitrogen (mg/g)	160	121	88	73
Sulphate (mg/g)	6.5	2.0	4.2	1.4
*PHc (µg/g)	1.2	1.0	0.6	0.6
Copper (µg/g)	125	64.5	119	14.2
Zinc (µg/g)	73.6	31.1	58.0	42.0
Lead (µg/g)	16.1	9.20	12.2	8.4
Cadmium (µg/g)	BDL	BDL	BDL	BDL
Mercury (µg/g)	BDL	BDL	BDL	BDL
Arsenic (µg/g)	2.8	5.0	BDL	BDL
Chromium as Cr^{6+} (µg/g)	3.7	5.5	2.8	BDL
Organic matter (%)	0.77	0.45	0.55	0.62

**in wet wt. and all are in dry wt.*

Table 3.20: Sediment quality during post-monsoon season

Parameters	Locations			
	I	II	III	IV
pH	8.0	7.8	8.1	8.2
Total volatile solids (mg/g)	54	45	89	93
Chloride (mg/g)	850	810	1732	1754
Sodium (mg/g)	5.2	4.7	8.8	9.4
Potassium (mg/g)	0.42	0.36	0.64	0.78
Phosphate (mg/g)	0.0003	0.0004	0.0002	0.0002
Nitrate (mg/g)	0.058	0.065	0.052	0.034
Total Kjeldahl Nitrogen (mg/g)	114	132	92	76
Sulphate (mg/g)	4.0	4.4	3.2	2.2
*PHc (µg/g)	0.9	1.0	0.9	0.6
Copper (µg/g)	82.2	90.0	70.8	52.0
Zinc (µg/g)	96.0	114	92.0	66.0
Lead (µg/g)	12.0	15.2	10.4	7.2
Cadmium (µg/g)	0.08	0.10	BDL	BDL
Mercury (µg/g)	0.02	0.02	BDL	BDL

Parameters	Locations			
	I	II	III	IV
Arsenic (µg/g)	1.6	3.0	BDL	BDL
Chromium as Cr^{6+} (µg/g)	4.5	5.2	BDL	BDL
Organic matter (%)	1.4	1.4	1.2	0.8

**in wet wt. and all are in dry wt.*

pH

The pH in the sediments varied from 8.0 to 8.2 during winter season, 8.5 to 8.9 during pre-monsoon and 7.8 to 8.2 during post-monsoon season. The pH concentration is slightly higher during pre-monsoon season than the rest of the observation period.

Total volatile solids

The TVS value of the sediment samples varied from 48 to 98 mg/l during winter season and 61 to 107 mg/g during pre-monsoon and 45 to 93 mg/g during post-monsoon. The highest value was observed towards the marine site and the lowest value was observed near the coast.

Nutrients

The TKN values observed at all locations were in the range from 68 to 120 mg/l during winter season, 73 to 160 mg/g during pre-monsoon and 76 to 132 during post-monsoon season. The nitrate concentration varied from 0.04 to 0.052 mg/g during winter season, 0.042 to 0.06 mg/g during pre-monsoon and 0.034 to 0.065 mg/g during post-monsoon season. As compared to Nitrogen, phosphate concentration is significantly lower and varied from 0.0001 to 0.0002 mg/g during winter season, 0.0001 to 0.0003 mg/g during pre-monsoon and 0.0002 to 0.0004 mg/g during post-monsoon season.

Sulphate

The Sulphate content of the sediment samples ranged from 1.8 to 5.2 mg/kg during winter season, 1.4 to 6.5 mg/kg during pre-monsoon season and 2.2 to 4.4 mg/kg during the post-monsoon season.

PHc

The PHc concentration was varied from 0.4 to 0.8 µg/g during winter season, 0.6 to 1.2 µg/g during pre-monsoon and 0.6 to 1.0 µg/g during the post-monsoon season.

Heavy metals

Heavy metals like Copper (Cu), Zinc (Zn), Lead (Pb), Cadmium (Cd), Mercury (Hg), Arsenic (As), and Hexavalent Chromium (Cr^{6+}) were analysed as a part of the study.

Among these heavy metals, the concentration like Cu, Zn, and Pb are slightly higher, however within the oceanic range. Other metals like Cd, Hg, Cr^{6+} and As are low concentration level, and mostly below the detectable limit in most of the locations.

Organic matter

The organic matter of the sediment samples varied from 0.5 to 1.2 % during winter season, 0.45 to 0.77 % during pre-monsoon and 0.8 to 1.4 % during post-monsoon season. The concentration level generally decreases towards the sea site from the coastal region.

3.18 Marine Ecology

Biological characteristics of a water body are very important, since they determine the productivity of the aquatic ecosystem. Primary productivity is the most important biological phenomenon in nature on which the entire diverse array of life depends either directly or indirectly. It involves trapping of the radiant energy of the sun and its transformation into high potential biochemical energy through the process of photosynthetic activities using inorganic materials of low potential energy. It also helps in measuring the ability of an area to support a biological population and sustain a level of growth and respiration. Fish production is dependent on zooplanktons, which in turn are dependent on the phytoplankton. As a part of the EIA study, a detailed marine ecological survey was conducted in the project area. The survey involved the collection and analysis of marine water and sediment samples for the biological parameters like chlorophyll pigments, primary productivity, zooplanktons, phytoplankton and benthic fauna of the project area.

3.18.1 Chlorophyll *a* and Phaeophytin

Chlorophyll *a* is the photosynthetic pigment. The productivity of a water body depends on the Chlorophyll *a* content. The chlorophyll *a* concentration varied from 2.90 to 5.56 µg/l in surface water and 2.32 to 4.50 µg/l in bottom water during the winter season. In pre-monsoon, the concentration in surface water varied from 2.36 to 3.38 µg/l and in bottom water varied from 1.12 to 2.16 µg/l. While in post-monsoon, the concentration in surface water varied from 1.16 to 4.76 µg/l and in bottom water varied from 0.88 to 3.81 µg/l. The Phaeophytin conc. varied from 0.97 to 3.52 µg/l and 0.95 to 2.72 µg/l in the surface and bottom water respectively during winter season. In pre-monsoon, it varied from 1.60 to 2.62 µg/l and 0.75 to 1.08 µg/l in surface and bottom water respectively. Whereas, in post-monsoon the concentration varied from 1.08 to 2.80 µg/l and 0.82 to 2.68 µg/l in the surface and bottom water respectively. The concentrations are given in Tables 3.21-3.23.

For the determination of Chlorophyll pigments, the samples were filtered through Whatman GF/C filter papers and the chlorophyll was extracted into 90% acetone. The resulting colored acetone extract was measured in a spectrophotometer at different wavelengths and the same acetone extracts were acidified and measured for the phaeophytin.

Table 3.21: Chlorophyll a and Phaeophytin concentration in winter season

Strata	Location	Chlorophyll a (µg/l)	Phaeophytin (µg/l)
Surface Water	SW I	5.56	2.52
	SW II	4.44	2.32
	SW III	2.90	1.04
	SW IV	2.97	0.97
Bottom Water	BW I	4.50	2.72
	BW II	3.00	1.62
	BW III	2.32	0.95
	BW IV	2.40	0.98

Table 3.22: Chlorophyll a and Phaeophytin concentration in pre-monsoon

Strata	Station	Chlorophyll a (µg/l)	Phaeophytin (µg/l)
Surface Water	SW I	2.36	1.65
	SW II	3.72	2.24
	SW III	2.87	1.60
	SW IV	3.38	2.62
Bottom Water	BW I	2.02	1.04
	BW II	2.10	1.00
	BW III	1.12	0.75
	BW IV	2.16	1.08

Table 3.23: Chlorophyll a and Phaeophytin concentration in post-monsoon

Strata	Station	Chlorophyll a (µg/l)	Phaeophytin (µg/l)
Surface Water	SW I	3.41	2.21
	SW II	1.16	1.08
	SW III	4.76	2.80
	SW IV	2.83	2.14
Bottom Water	BW I	2.42	2.14
	BW II	0.88	0.82
	BW III	3.81	2.68
	BW IV	1.92	1.61

3.18.2 Primary productivity

The primary productivity in the study area was estimated following the dark and light bottle method (Strickland and Parsons, 1972). The dissolved oxygen concentration during the experiment was determined by following Winkler's method.

Primary productivity is the rate at which new organic matter is added to the phytoplankton standing crop. Primary productivity depends on the chlorophyll pigments, which absorbs light and produces energy through the process of photosynthesis. Therefore, the estimation of these pigments is very much important to ascertain the productivity of the aquatic environment. The primary productivity observed at various sampling locations during the study period is given in the following Tables 3.24 to 3.26.

Table 3.24: Primary productivity during winter season

(Unit: mg C/m^3/day)

Sl. No.	Location	Gross primary production	Community respiration	Net primary production
1	SW I	5.54	2.95	2.59
2	SW II	4.95	2.58	2.37
3	SW III	2.88	1.25	1.63
4	SW IV	3.08	1.41	1.67

Table 3.25: Primary productivity during pre-monsoon

(Unit: mg C/m^3/day)

Sl. No.	Location	Gross primary production	Community respiration	Net primary production
1	SW I	3.40	2.46	0.94
2	SW II	4.10	1.98	2.12
3	SW III	3.00	1.24	1.76
4	SW IV	3.46	1.38	2.08

Table 3.26: Primary productivity during post-monsoon

(Unit: mg C/m^3/day)

Sl. No.	Location	Gross primary production	Community respiration	Net primary production
1	SW I	3.30	1.12	2.28
2	SW II	2.16	0.84	1.32
3	SW III	4.62	2.06	2.56
4	SW IV	3.58	1.24	2.34

3.18.3 Phytoplankton

Phytoplankton is the chlorophyll bearing microscopic organisms which produce organic carbon through photosynthesis. The density and abundance of phytoplankton can be used as an indicator of the primary productivity of an aquatic ecosystem. Phytoplankton is very

sensitive to pollution and responds quickly to environmental changes. The abundance and density of phytoplankton depends on the level of nutrient and light penetration. The zooplanktons feed on phytoplankton and their survival is also directly dependent on the standing crop of the phytoplankton. Zooplankton in turn is fed by the larvae juveniles and fishes and other benthic organisms in aquatic ecosystems.

Phytoplankton samples were collected from the surface waters of the study areas by towing a plankton net (mouth diameter 0.35 m) made of bolting silk (No.25 mesh size 48 µm) for half an hour. These samples were preserved in 5% neutralized formalin and used for qualitative analysis. For the quantitative analysis of phytoplankton, the settling method described by Sukhanovo (1978) was adopted. Numerical plankton analysis was carried out using Utermohl's inverted plankton microscope.

Phytoplankton was identified using the standard works of Hustedt (1930-1966), Venkataraman (1939), Cupp (1943), Subramanian (1946), Prescott (1954), Desikachary (1959 and 1987), Hendey (1964), Steidinger and Williams (1970) and Taylor (1976) and Anand et al. (1986)

The detailed list of phytoplankton species and its density observed at different locations during the study period is given in the Tables 3.27 to 3.29. About 32 species of phytoplankton species are recorded from the study area.

The phytoplankton density during winter season varied from 75400 to 207300 No./m^3. The maximum value was observed at location I and the minimum at location III. The dominant species at various sampling locations are *Astermophalus sp, Chaetoceros decipens*, *Cyclotella sp., Peridinium sp., Streptotheca thamensi, and Thalassiosira sp.* The density during pre-monsoon varied from 62700 to 133900 No./m^3. The maximum value was observed at location II and minimum at location III. The dominant species at various sampling locations are *Cyclotella sp., Leptocylindrus danicus, Navicula sp., Peridinium sp., Thalassionema nitzschioides, and Thalassiosira sp.* During post-monsoon, the density varied from 108000 to 187000 No./m^3, and dominant species recorded are *Chaetoceros* sp., *Coscinodiscus centralis, Nitzschia sp., Pleurosigma sp., and Triceratium favus etc.*

Table 3.27: Abundance and density of phytoplankton during winter season

(Unit: No./m^3)

Name of Species	Location I	Location II	Location III	Location IV
Astermophalus sp.	46500	23400	300	0
Bacteriastrum sp.	200	2600	2600	5600

Name of Species	Location I	Location II	Location III	Location IV
Biddulphia sp.	200	1300	1200	1200
Chaetoceros decipens	2000	1300	600	10500
Corethron sp.	0	0	600	600
Coscinodiscus sp.	2000	2200	1900	1200
Cyclotella sp.	12200	6000	1600	1600
Cymbella sp.	200	700	0	0
Diploneis sp.	0	0	600	0
Distephanus sp.	0	0	0	800
Ditylium bringhtwellii	0	0	600	1300
Eucampia sp.	0	900	900	0
Fragillaria oceanic	200	900	0	1000
Guinardia flaccid	200	4300	3600	7000
Gyrosigma balticum	200	1000	900	100
Hemiaulus sp.	200	0	0	0
Hyalodiscus sp.	200	300	0	0
Melosira sp.	0	0	500	0
Navicula sp.	4000	2100	600	5000
Nitzschia sp.	18000	2600	1200	1300
Oscillatoria sp.	0	900	900	1300
Peridinium sp.	11600	33900	29900	4500
Pleurosigma sp.	4000	1200	1200	1900
Prorocentrum sp.	0	0	300	1700
Rabdonema sp.	200	200	0	0
Rhizosolenia sp.	0	0	300	1500
Streptotheca thamensis	56200	23000	2000	0
Surirella sp.	600	1500	1200	0
Thalassionema nitzschioides	200	1300	1200	4500
Thalassiosira sp.	47800	36600	19500	42700
Thalassiothrix subtilis	400	800	600	800
Triceratium reticulum	0	600	600	0
Total	**207300**	**149600**	**75400**	**96100**

Table 3.28: Abundance and density of phytoplankton during pre-monsoon

(Unit: No./m^3)

Name of Species	Location I	Location II	Location III	Location IV
Bacteriastrum sp.	0	1200	400	800
Biddulphia sp.	0	2200	400	1200
Campyloneis sp.	400	600	200	400
Ceratium sp.	0	200	800	0
Ceratoulina sp.	2400	3400	1000	1200

Name of Species	Location I	Location II	Location III	Location IV
Chaetoceros decipens	0	0	400	200
Coscinodiscus sp.	4600	2800	1600	2000
Cyclotella sp.	0	17400	8100	9100
Diploneis sp.	4000	500	0	200
Ditylium bringhtwellii	0	1200	800	1000
Dityocha sp.	200	0	200	0
Eucampia sp.	200	0	400	0
Fragillaria oceanic	200	0	1200	200
Guinardia flaccida	0	500	200	200
Gramatophora sp.	0	600	200	200
Gyrosigma balticum	0	0	200	400
Leptocylindrus danicus	3800	10800	3700	7400
Navicula sp.	1400	18600	900	7500
Nitzschia sp.	800	1800	900	1400
Peridinium sp.	2200	11300	8400	11800
Pleurosigma sp.	400	1200	4400	4400
Pinnularia sp.	0	200	200	0
Prorocentrum sp.	200	0	200	400
Rhizosolenia sp.	1400	200	0	0
Skeletonema costatum	0	0	5800	5300
Streptotheca thamensis	200	500	0	200
Surirella sp.	400	500	900	1000
Thalassionema nitzschioides	600	10200	2200	5700
Thalassiosira sp.	56600	44000	17400	31800
Thalassiothrix subtilis	600	4000	1600	2900
Total	**80600**	**133900**	**62700**	**96900**

Table 3.29: Abundance and density of phytoplankton during post-monsoon

(Unit: No./m^3)

Name of Species	Station I	Station II	Station III	Station IV
Chaetoceros decipiens	0	0	9000	14000
Chaetoceros sp.	24000	14000	0	0
Ceratium sp.	0	0	18000	18000
Coscinodiscus centralis	19000	0	44000	0
Coscinodiscus ecentricus	0	0	0	14000
Coscinodiscus granii	5000	14000	0	9000
Coscinodiscus radiates	0	0	3000	9000
Corethron sp.	5000	0	0	0
Diatoma anceps	0	0	9000	0
Ditylum brightwellii	0	0	4000	5000

Name of Species	Station I	Station II	Station III	Station IV
Melosira sp.	7000	0	0	0
Navicula sp.	5000	0	0	0
Nitzschia longissima	14000	5000	13000	9000
Nitzschia seriata	10000	4000	0	0
Nitzschia sp.	4000	9000	0	0
Odentella aurita	5000	5000	13000	0
Odontella mobiliensis	0	0	9000	3000
Odontella sinensis	0	0	0	5000
Pediastrum simplex	0	0	0	3000
Pleurosigma directum	10000	3000	0	14000
Pleurosigma elongatum	0	5000	0	5000
Pleurosigma longisima	2000	14000	0	0
Pleurosigma normanii	0	0	18000	5000
Pleurosigma sp.	5000	0	0	0
Planktosphaeria gelatinosa	2000	9000	6000	0
Pseudonitzschia inflatula	10000	3000	0	0
Rhizosolenia aurita	0	0	0	5000
Rhizosolenia sp.	0	0	0	9000
Skeletonema costatum	3000	5000	2000	0
Synedra utermohlii	3000	0	0	0
Thalassionema nitzschioides	0	0	0	7000
Thalassiothrix frauenfeldii	0	0	13000	0
Triceratium favus	5000	18000	13000	5000
Triceratium retigulatum	0	0	13000	5000
Total	**138000**	**108000**	**187000**	**140000**

3.18.4 Zooplankton

Zooplankton is microscopic free floating organisms which constitute an important link between primary producer and consumer of higher order in the aquatic food chain. Therefore, the population dynamics of zooplankton represent the physico-chemical and biological characteristics of water.

Zooplankton samples were collected from the surface waters of the study areas by horizontal towing of a plankton net with mouth diameter of 0.35 m, made of bolting silk (No. mesh size 33 mm) for half an hour. These samples were preserved in 5% neutralized formalin and used for quantitative analysis. The zooplankton was identified using the classical works of Dakin and Colefax (1940), Davis (1955), Kasthurirangan (1963) and Wickstead (1965) and Damodara Naidu (1981). For the quantitative analysis of

zooplankton, a known quantity of water (100 l) was filtered through a bag net (0.33 mm mesh size) and filtrate was made up to 1 l in a wide mouthed enumerated using Utermohl's inverted plankton microscope. The plankton density is expressed as number of organisms/m^3.

The detailed list of zooplankton species and its density observed at different locations in the study area during the sampling period is given in the Tables 3.30 to 3.32. The density of zooplankton species varied from 3350 to 5800 No./m^3 during winter season, 3050 to 4800 No./m^3 during pre-monsoon, and 2200 to 3475 No./m^3 during the post-monsoon season. The dominant species found in the sampling locations during the study period are *Copepod sp.*, *Calanoida sp*., *Lamellibranchs, Decapod larvae, and Polychaetes* etc.

Table 3.30: Abundance and density of zooplankton during winter season

(Unit: No./m^3)

Name of Species	Location I	Location II	Location III	Location IV
Foraminiferans	275	350	250	0
Siphonophores	0	0	125	200
Medusae	300	450	250	200
Chaetognaths	0	200	250	350
Polychaetes	450	450	250	200
Copepods	2500	1250	500	500
Cumaceans	200	0	0	0
Mysids	125	0	0	0
Lucifer sp.	0	300	125	200
Decapod larvae	300	400	200	350
Gastropods	150	300	200	325
Lamellibranchs	500	275	250	350
Appendicularians	125	125	200	200
Fish eggs	250	225	250	250
Fish Larvae	225	150	250	300
Isopods	400	250	250	400
Total	**5800**	**4725**	**3350**	**3825**

Table 3.31: Abundance and density of zooplanktons in pre-monsoon

(Unit: No./m^3)

Name of Species	Location I	Location II	Location III	Location IV
Sprirotricha	300	200	200	200
Foraminiferans	100	250	0	0
Medusae	0	300	0	100
Copepods	1150	600	900	900
Mysids	350	250	350	350

Name of Species	Location I	Location II	Location III	Location IV
Chaetognaths	0	450	600	500
Lucifer sp.	0	300	0	550
Polychaetes	550	450	250	750
Cladocerans	125	250	150	250
Lamellibranchs	300	200	250	200
Fish eggs / larvae	500	150	150	200
Phyllosoma larvae	0	300	0	100
Bippinaria larvae	0	150	0	100
Echinoderm larvae	150	150	0	0
Gastropods	125	500	0	0
Others	250	300	200	300
Total	**3900**	**4800**	**3050**	**4500**

Table 3.32: Abundance and density of zooplanktons in post-monsoon

(Unit: No./m^3)

Name of Species	Location I	Location II	Location III	Location IV
Sprirotricha	0	0	375	625
Foraminiferans	375	500	0	250
Medusae	0	50	100	0
Copepods	375	250	250	0
Mysids	100	0	0	50
Chaetognaths	0	50	100	50
Calanoida	750	375	1000	375
Cyclopoida	250	500	375	250
Polychaetes	500	375	375	250
Harpacticoida	375	625	250	0
Gastropods	0	0	375	0
Lamellibranchs	50	0	0	0
Barnacle naupili	250	0	0	0
Bivalve veliger	0	0	0	250
Crustacean naupili	0	0	125	0
others	50	100	150	100
Total	**3075**	**2825**	**3475**	**2200**

3.18.5 Benthic Fauna

Benthos is a collective term referred to the organisms lying in or associated with aquatic sediment comprising bacteria, plants and animals from almost all phyla. Benthic fauna have been found to play a significant role in the trophic network, as they utilise all forms of food material available in the sea-bed or estuarine base and form an important link in the

transfer of energy. Another important aspect of the benthic studies is the effect of the pollution on the standing crop and productivity. Abiotic relationship of benthos especially with the sedimentological features has explained most of the fluctuations in benthic abundance.

For studying the benthic organisms, sediment samples were collected using a Petersen grab. The wet sediment was sieved with varying mesh sizes for segregating the organisms. The sieved organisms were stains with Rose Bengal and sorted to different groups. The number of organisms in each grab sample was expressed in number per meter square. According to size, benthic animals are divided into three groups. (i) macrobenthos (ii) meiobenthos and (iii) microbenthos (Mare, 1942). Macrobenthos are organisms which are retained in the sieve having mesh size between 0.5 and 1 mm. For Meiobenthos, the lowest size attributed is 63 µm and the upper limit depends upon the mesh size of the sieve used for separating macrobenthos from meiobenthos. The macro-benthos and meio-benthos observed in the surficial sediments at various sampling locations during the study period are given in the following Table 3.33 and 3.34.

Table 3.33: Abundance and density of Macro-benthos during the study period

(Unit: No./m^2)

Group/Species	Location I	Location II	Location III	Location IV
Winter Season				
Foraminiferans	0	75	200	200
Gastropods	275	275	325	100
Pelecypods	75	50	0	0
Polychaetes	550	575	450	600
Amphipods	100	0	0	0
Cumaceans	75	50	25	25
Total	***1075***	***1025***	***1000***	***900***
Pre-monsoon				
Gastropods	625	325	150	150
Polychaetes	325	300	275	350
Bivalves	150	625	325	250
Cirripedia	150	75	0	50
Amphipods	100	75	50	50
Total	***1350***	***1400***	***800***	***850***
Post-monsoon				
Gastropods	375	500	575	325
Polychaetes	550	500	575	750
Bivalves	125	100	150	150
Amphipods	150	275	250	325

Group/Species	Location I	Location II	Location III	Location IV
Isopods	50	75	25	0
Cumaceans	200	150	0	150
Total	**1050**	**1100**	**1300**	**1225**

Table 3.34: Abundance and density of Meio-benthos during the study period

(Unit: No./10 cm^2)

Group/Species	***Station I***	***Station II***	***Station III***	***Station IV***
Winter Season				
Nematodes	158	136	116	165
Cumaceans	2	6	2	2
Foraminiferans	63	50	48	30
Gastrotricha	12	10	10	8
Harpacticoids	24	42	10	35
Ostrocodes	26	32	30	23
Tanaidacea	34	26	35	38
Total	**319**	**302**	**251**	**301**
Pre-monsoon				
Nematodes	139	169	150	110
Cumaceans	6	9	4	8
Foraminiferans	84	94	50	103
Gastrotricha	6	3	2	4
Harpacticoids	16	23	16	16
Ostrocodes	24	16	10	15
Tanaidacea	13	15	23	25
Total	**288**	**329**	**255**	**281**
Post-monsoon				
Nematodes	178	183	164	199
Cumaceans	3	13	4	3
Foraminiferans	96	109	97	85
Gastrotricha	2	2	3	1
Harpacticoids	16	16	14	17
Ostrocodes	9	6	9	10
Tanaidacea	28	25	30	25
Total	***332***	***354***	***321***	***340***

3.19 Fisheries

The prevailing fishery status of the region around the project area was evaluated based on the data collected from the Department of Fisheries, Government of Maharashtra. The project area has mainly two fish landing zones i.e. Popharan Dandi (Zone II) and Satpati (Zone III). Data on marine fish Production from Popharan Dandi and Satpati fishing zone

were analysed for 5 years from 2007 to 2012. The details of the Mechanized and Non-mechanized boats at Pophran Dandi and Satpati for the year 2007-08 and 2011-12 are summarized in the Table 3.35. The marine fish production at various FLCs in the fishing zones for the period from 2007- 08 to 2011-12 are given in the Table 3.36.

Table 3.35: Boat details at various Fish Landing Centres (FLCs)

S. No.	Name of fish landing centre	Mechanised Boats		Non-Mechanised Boats	
		2007-08	2011-12	2007-08	2011-12
Popharan Dandi- Zone II					
1	Ghivali	30	31	-	-
2	Uchheli/Dandi	85	130	8	-
3	Navapur	23	37	11	7
4	Murbe	62	87	10	10
Satpati- Zone III					
1	Satpati (N)	136	166	7	21
2	Satpati (M)/(S)	145	187	7	13
3	Shirgaon	-	18	-	3

Table 3.36: Marine fish production at various Fish Landing Centres (FLCs)

S. No.	Name of fish landing centre	Fish Production in Tonnes				
		2007-08	2008-09	2009-10	2010-11	2011-12
Popharan Dandi- Zone II						
1	Ghivali	2524	2975	3491	3547	1553
2	Uchheli/Dandi	8835	10990	11516	12520	5717
3	Navapur	1852	1935	2721	2605	1328
4	Murbe	6230	6463	6550	7679	3326
	Total	**19441**	**22363**	**24278**	**26351**	**11924**
Satpati- Zone III						
1	Satpati (N)	2919	4043	4153	5618	6248
2	Satpati (M)/(S)	4866	6791	3460	6248	9742
3	Shirgaon	-	-	92	872	254
	Total	**7785**	**10834**	**7705**	**12738**	**16244**

(Source: *Fish Production Report, Dept. of Fishery, Govt. of Maharashtra*)

From the Table 3.35, it is observed that there is a remarkably increase in the no. of mechanized boats from 2007-08 to 2011-12, while no such variations in the no. of non-mechanised boats in the Zone-II, and remarkably higher in the Zone-III. The marine fish production in the fish landing centre are varying inconsistently during the last 5 years. Although there was an increase in fish production in the FLCs of Zone-II, it has decreased substantially in the recent period. While in FLCs of Zone-III, there was observed a marginal

increase in fish production in the last 5 years. The year wise fish productions at various fish landing centres of the fishing zones are shown in Figure 3.23. The common fish species found in the fish landing centres are given in the Table 3.37.

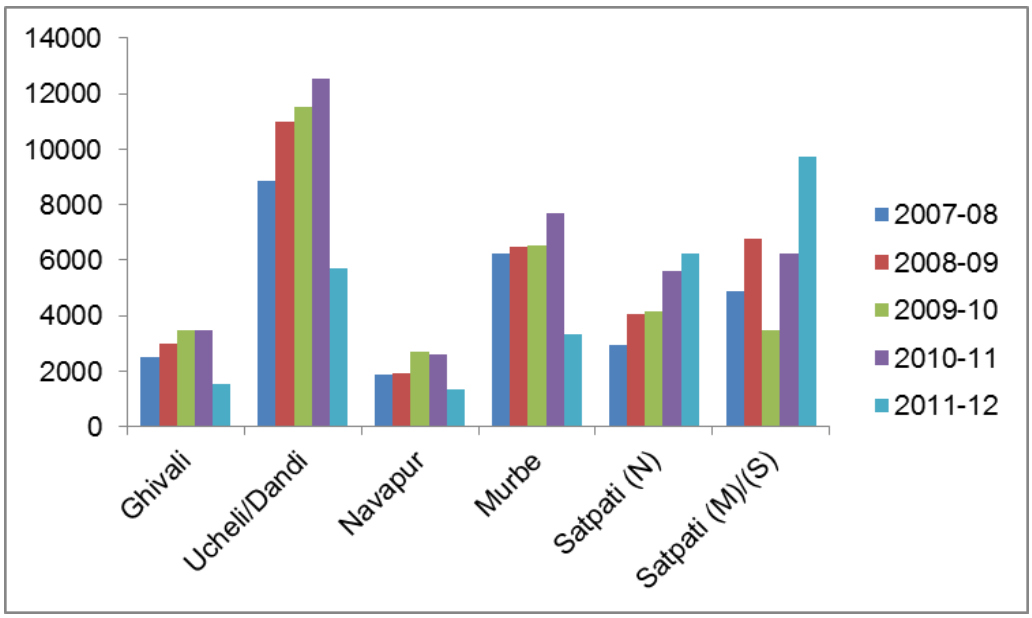


Figure 3.23: Year wise Fish Production (*in Tonnes*) at various FLCs

Table 3.37: Common fish species found in the Fish Landing Centres (FLCs)

S. No.	***English Name***	***Local name***
1	*Elasmobranchs*	*Mushi, Mori, Shinavale*
2	*Eels*	*Ali*
3	*Cat Fish*	*Shingala*
4	*Chirocentrus*	*Datali, Karli*
5	*Hilsa Ilisha*	*Palla, Pedi*
6	*Ancheviella*	*Velli*
7	*Thrissocles*	*kati*
8	*Harpodon Nehereus*	*Bombil, Sinhala*
9	*Polynemids*	*Dara, Darha*
10	*Sciaenids*	*Koth, Ghol*
11	*Otolithes sp.*	*Dhoma*
12	*Ribbon fish*	*Bala, Wagti*
13	*Caranx*	*Kala Bangada*
14	*Pomfrets*	*Saranga, Pomplet*
15	*Mackeral*	*Bangada*
16	*Seer Fish*	*Surmai*
17	*Penaeid Prawns*	*Kolabi, Kalambi*
18	*Non- Penaeid Prawns*	*Ambadi, Karadi*

3.20 Littoral Drift

Maharashtra coast shows relatively low annual net transport (0.1 x 10^6 m^3). Coasts near Malvan, Dabhol, Murud and Tarapur appear to be nodal drift points with equal volume of transport in either direction annually. The historic measurements at these locations are given in the Table 3.38.

Table 3.38: Annual Long Shore Transport in 10^6 m^3/year

Places	***Northerly***	***Southerly***
Bombay	*1.313*	*0.540*
Tarapur	*0.712*	*0.700*
Umbergaon	*1.523*	*0.386*

The shoreline near the project location is rocky and no appreciable movement of littoral sand is possible, due to the lack of sand supply. The LITPACK model showed no changes in the shoreline configuration even after 20 years post development.

4 SOCIO-ECONOMIC ASPECTS

4.1 Introduction

The description of Environmental Baseline Status is an integral part of any Environmental Impact Assessment (EIA) study. This Chapter outlines the information about the baseline status of the study area for socio-economic aspects. The study covered as a part of the EIA study is the area within 10 km of the project site. The study area map is enclosed as Figure 3.10 in previous chapter. There is no private land acquisition in the project; hence, there will be no project affected families.

4.2 Socio-Economic Profile of the Villages in the Study Area

As already mentioned earlier, the proposed project is located at Nandgaon in Tehsil Palghar in district Thane. The study area of 10 km radius around the proposed project area was demarcated as per the guidelines of the MoEF.

4.2.1 Demographic Profile

The study area comprises of 27 villages, 3 Census Towns and 1 Municipal Council located in Taluka Palghar in district Thane. The demographic profile of study area villages is given in Table 4.1 and Figure 4.1. The total population of the study area as per 2001 census is about 160965. About 13.2% of the total population comprises of children below the age of 6 years. The total male and female population comprises of about 53.8% and 46.2% respectively of the total population in the study area.

The overall sex ratio, i.e. number of females per 1000 males is 858. Although there are about six villages in which the female population is more than 1000, the remaining villages it is below 980. However, in a few villages, the sex ratio is alarmingly low (ranging between 700 – 500 females/1000 males). A probable reason could be attributed to the fact that the Tarapur Power Station is located in the vicinity and male members from the study area villages are employed in their power station and have migrants from the village. The average family size in the study area is about 5.

Table 4.1: Population details of study area villages

S. No.	Study Area Village/ Town	No. of Households	Total Population	Male Population	Female Population	Population < yrs	Sex Ratio	Family size
1	Ghivali	525	2493	1322	1171	299	886	4.7
2	Dahisar T. Tarapur	364	1639	851	788	190	926	4.5
3	Parnali	247	1049	572	477	161	834	4.2
4	Akkarpatti	233	945	597	348	99	583	4.1
5	Unbhat	260	1145	585	560	125	957	4.4
6	Pathrali	113	405	208	197	32	947	3.6
7	Kurgaon	775	3070	1745	1325	427	759	4.0
8	Uchchheli	316	1568	776	792	221	1021	5.0
9	Nawapur	889	4120	2114	2006	554	949	4.6
10	Pam Tembhi	520	1909	1093	816	247	747	3.7
11	Kumbhavali	554	2083	1232	851	217	691	3.8
12	Alewadi	216	923	474	449	101	947	4.3
13	Nandgaon T. Tarapur	535	2482	1205	1277	275	1060	4.6
14	Kharekuran	476	2241	1120	1121	304	1001	4.7
15	Morekuran	179	703	370	333	89	900	3.9
16	Shigaon	694	3466	1757	1709	672	973	5.0
17	Khutad	117	835	463	372	111	803	7.1
18	Mahagaon	337	1627	802	825	313	1029	4.8
19	Saravali	1360	5503	3020	2483	892	822	4.0
20	Betegaon	420	1817	966	851	245	881	4.3
21	Man	404	1665	880	785	314	892	4.1
22	Padghe	388	2133	1150	983	376	855	5.5
23	Satpati	3160	17613	9617	7996	1952	831	5.6
24	Shirgaon	1037	5059	2573	2486	592	966	4.9
25	Nandore	441	2330	1231	1099	352	893	5.3
26	Khatali	20	87	37	50	11	1351	4.4
27	Agarwadi	373	1494	728	766	169	1052	4.0
28	Boisar (Census Town)	3506	14685	8329	6356	2179	763	4.2
29	Pasthal (Census Town)	4080	16185	8634	7551	2037	875	4.0
30	Tarapur (Census Town)	1406	7014	3538	3476	817	982	5.0
31	Palghar (Municipal Council)	11779	52677	28645	24032	6933	839	4.5
	Total	**35724**	**160965**	**86634**	**74331**	**21306**	**858**	**4.5**

Source: Census of India, 2001

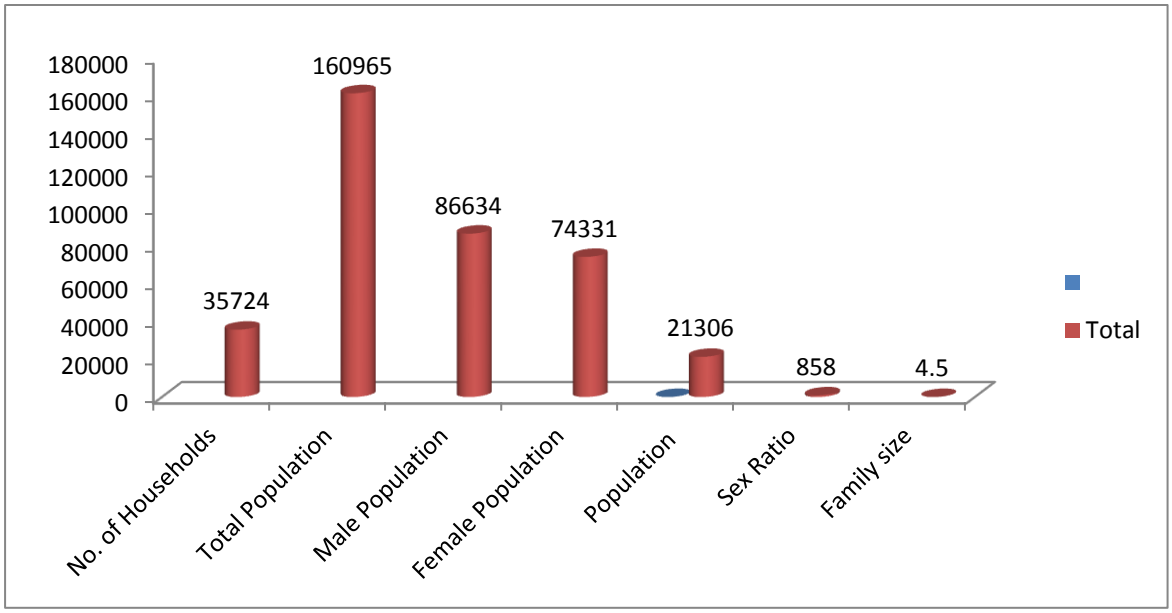


Figure 4.1: Population details of study area villages

4.2.2 Caste Profile

The total population residing in the study area is of the order of 160965 persons. The village-wise details of population on the basis of caste are outlined in Table 4.2 and in Figure 4.2.

It is observed that the General Caste category is the dominant caste group in the study area and they constitute about 79.5% of the total population. The Scheduled Tribe (ST) population accounts for about 16.9% of the total population. The Scheduled Caste (SC) population comprises of only 3.6% of the total population

Table 4.2: Village-wise caste profile in the study area

S. No.	Study Area Village/ Town	Total Population	Population General Caste	Population Scheduled Caste	Population Scheduled Tribe
1	Ghivili	2493	2175	143	175
2	Dahisar T. Tarapur	1639	794	166	679
3	Parnali	1049	656	9	384
4	Akkarpatti	945	852	2	91
5	Unbhat	1145	1031	0	114
6	Pathrali	405	325	42	38
7	Kurgaon	3070	2207	151	712
8	Uchchheli	1568	1416	5	147
9	Nawapur	4120	3860	3	257
10	Pam Tembhi	1909	1747	109	53
11	Kumbhavali	2083	2003	6	74

S. No.	Study Area Village/ Town	Total Population	Population General Caste	Population Scheduled Caste	Population Scheduled Tribe
12	Alewadi	923	829	1	93
13	Nandgaon T. Tarapur	2482	2329	19	134
14	Kharekuran	2241	2051	11	179
15	Morekuran	703	437	4	262
16	Shigaon	3466	309	0	3157
17	Khutad	835	28	11	796
18	Mahagaon	1627	196	0	1431
19	Saravali	5503	5044	145	314
20	Betegaon	1817	1124	0	693
21	Man	1665	895	5	765
22	Padghe	2133	217	44	1872
23	Satpati	17613	15498	43	2072
24	Shirgaon	5059	3868	170	1021
25	Nandore	2330	334	3	1993
26	Khatali	87	86	0	1
27	Agarwadi	1494	1376	59	59
28	Boisar (Census Town)	14685	13758	799	128
29	Pasthal (Census Town)	16185	14112	1290	783
30	Tarapur (Census Town)	7014	5499	665	850
31	Palghar (Municipal Council)	52677	42847	1897	7933
	Total	**160965**	**127903**	**5802**	**27260**

Source: Census of India, 2001

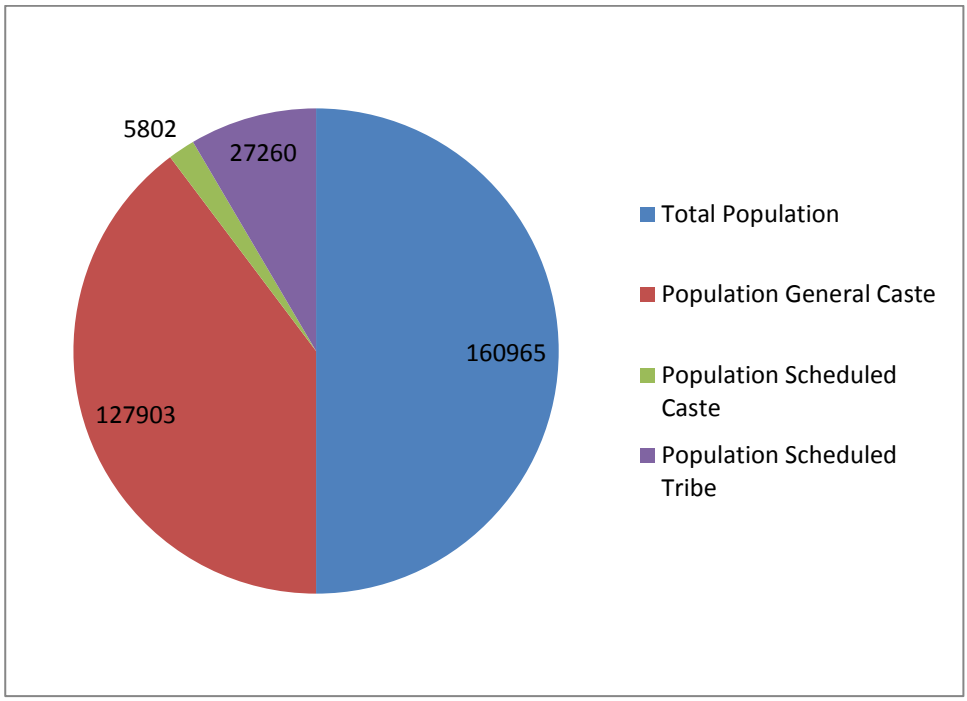


Figure 4.2:Village-wise caste profile in the study area

4.2.3 Literacy Rate

The details of literate and illiterate population are depicted in Table- 4.3 and Figure- 4.3. Out of the total population in the study area, about 72.0% are literate while about 28.0% are illiterate. Amongst the literate population, male and females constitute about 57.6% and 42.4% of the literate population. The overall literacy rate in the study area is 72.0%. The male and female literacy rates are 77.0% and 66.1% respectively.

Table 4.3: Literacy levels in study area villages

S. No.	Study Area Village/ Town	Total Population	Population Literate	Population Illiterate
1	Ghivali	2493	1839	654
2	Dahisar T. Tarapur	1639	1203	436
3	Parnali	1049	703	346
4	Akkarpatti	945	690	255
5	Unbhat	1145	896	249
6	Pathrali	405	282	123
7	Kurgaon	3070	2217	853
8	Uchchheli	1568	1244	324
9	Nawapur	4120	3057	1063
10	Pam Tembhi	1909	1485	424
11	Kumbhavali	2083	1560	523
12	Alewadi	923	723	200
13	Nandgaon T. Tarapur	2482	1971	511
14	Kharekuran	2241	1471	770
15	Morekuran	703	491	212
16	Shigaon	3466	990	2476
17	Khutad	835	542	293
18	Mahagaon	1627	666	961
19	Saravali	5503	4141	1362
20	Betegaon	1817	1188	629
21	Man	1665	913	752
22	Padghe	2133	936	1197
23	Satpati	17613	12437	5176
24	Shirgaon	5059	3846	1213
25	Nandore	2330	1273	1057
26	Khatali	87	67	20
27	Agarwadi	1494	1161	333
28	Boisar (Census Town)	14685	11261	3424
29	Pasthal (Census Town)	16185	13252	2933
30	Tarapur (Census Town)	7014	5440	1574
31	Palghar (Municipal Council)	52677	37985	14692
	Total	**160965**	**115930**	**45035**

Source: Census of India, 2001

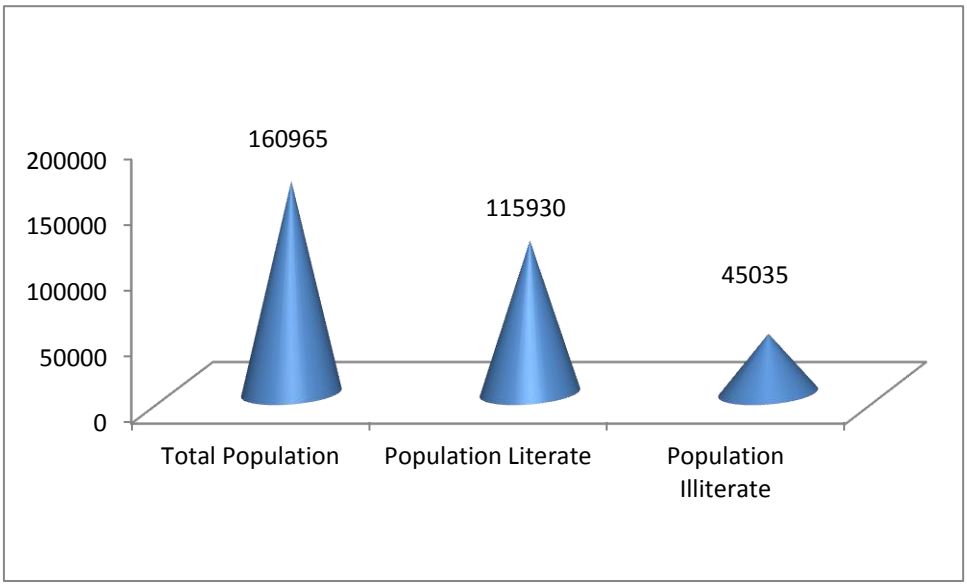


Figure 4.3: Literacy levels in the study area villages

4.2.4 Occupational profile

The details on occupational profile within the study area are given in Table 4.4 and Figure 4.4. Out of the total population, about 39.9% are engaged in economically productive activities and hence have been designated as “main workers” by the census. The remaining 60.1% are designated as “non-working” population. Amongst the working population, males and females constitute 77.1% and 22.9% of the working population respectively. Among the working population, about 82.7% are main workers while 17.3% are marginal workers.

Table 4.4: Occupational profile of study area villages

S. No.	Study Area Village/ Town	Total Population	Total Working Population	Main Workers	Marginal Workers	Non-Working Population
1	Ghivali	2493	1173	769	404	1320
2	Dahisar T. Tarapur	1639	878	554	324	761
3	Parnali	1049	384	301	83	665
4	Akkarpatti	945	483	455	28	462
5	Unbhat	1145	446	158	288	699
6	Pathrali	405	156	91	65	249
7	Kurgaon	3070	1308	986	322	1762
8	Uchchheli	1568	616	371	245	952
9	Nawapur	4120	1198	1065	133	2922
10	Pam Tembhi	1909	847	715	132	1062
11	Kumbhavali	2083	1180	1036	144	903
12	Alewadi	923	387	243	144	536

S. No.	Study Area Village/ Town	Total Population	Total Working Population	Main Workers	Marginal Workers	Non-Working Population
13	Nandgaon T. Tarapur	2482	1170	844	326	1312
14	Kharekuran	2241	1274	754	520	967
15	Morekuran	703	399	241	158	304
16	Shigaon	3466	1763	1023	740	1703
17	Khutad	835	178	164	14	657
18	Mahagaon	1627	879	291	588	748
19	Saravali	5503	1990	1702	288	3513
20	Betegaon	1817	1054	591	463	763
21	Man	1665	730	478	252	935
22	Padghe	2133	907	641	266	1226
23	Satpati	17613	7386	6446	940	10227
24	Shirgaon	5059	1835	1076	759	3224
25	Nandore	2330	1120	677	443	1210
26	Khatali	87	56	45	11	31
27	Agarwadi	1494	602	509	93	892
28	Boisar (Census Town)	14685	5199	4976	223	9486
29	Pasthal (Census Town)	16185	5728	5337	391	10457
30	Tarapur (Census Town)	7014	2592	2257	335	4422
31	Palghar (Municipal Council)	52677	20233	18278	1955	32444
	Total	160965	64151	53074	11077	96814

Source: Census of India, 2001

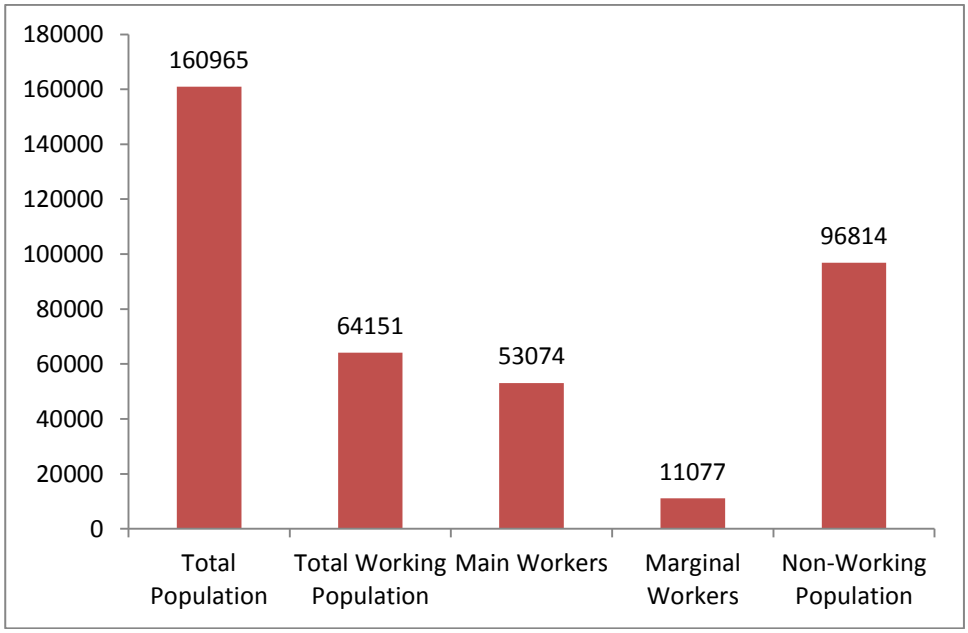


Figure 4.4: Occupational profile of study area villages

5 ASSESSMENT OF IMPACTS

5.1 Introduction

Based on the project details and the baseline environmental status, potential impacts that are expected to accrue as a result of the proposed project have been identified. The assessment for quite a few disciplines is subjective in nature and cannot be quantified. Wherever possible, the impacts have been quantified. However, for non-tangible impacts, a qualitative assessment has been done so as to formulate appropriate management measures for them as well. This Chapter deals with anticipated positive as well as negative impacts due to the construction and operation of the proposed jetty at Nandgaon. As a part of the study, impacts on various aspects of environment have been assessed. The impacts have been categorised for construction as well as operation phases.

5.2 Impact during Construction Phase

5.2.1 Impacts due to quarrying operation

The major part of the jetty will be developed over reclaimed area. A part of the material required for reclamation would be met by dredging. However, major quantum of material for reclamation shall be imported. The construction material is proposed to be excavated from local and existing quarries or borrow pits. These quarries as such have been cleared by the authorities and they follow the environmental norms prescribed by the MoEF from time to time. The project proponents would not operate any quarry.

5.2.2 Impacts due to construction activities

The main impact on land environment is on account of acquisition of land. Pre-construction activities generally do not cause significant damage to environment. Preparatory activities like the use of existing access road, construction of storage sheds, staff quarters, etc. being spread over a large area, would have no further significant impact once the land is acquired and its existing use changes. Clearing, stripping and levelling the sites, construction of bunds for protection from flooding, earth filling and excavation for foundations, will lead to some improvement of the habitat.

5.2.3 Impacts due to effluents from labour camps

During construction phase, about 1000 workers are likely to work for the project site. Of these, only about 10% (100) of the migrated labours would be staying near the construction

site for which a small labour camp/colony would be constructed. Considering family size as 5 on an average, the migrated labour is expected to be of the order of 500. Rest 90% (900) of the labour involved in the construction phase are local and would come from the nearby villages. Accordingly, the total water requirement for the workers during the construction phase is estimated at 75 m^3/day. The details are given in the Table 5.1.

Table 5.1: Domestic water requirements at labour camps

Category	***Per capita water requirement (lpd)***	***Population***	***Total water requirement (m^3/day)***
Migrated labour at the labour camp	*70*	*500*	*35.00*
Local labour	*45*	*900**	*40.05*
Total			***75.05 say 75 m^3/day***

** Total workers excluding labours residing in the camp.*

The sewage generated is normally taken as 80% of the total water requirement. Thus, the sewage generated would be of the order of (0.8 x 75) 60 m^3/day.

The typical composition of untreated sewage is given in Table 5.2.

Table 5.2: Typical composition of untreated sewage

Parameters	***Concentration***
Total Solids, mg/l	*720*
Total Dissolved Solids, mg/l	*500*
Total Suspended Solids, mg/l	*220*
BOD mg/l	*220*
Oil and grease, mg/l	*100*
Alkalinity (as $CaCO_3$), mg/l	*100*
Total Phosphorus, mg/l	*80*
Total Nitrates, mg/l	*40*
Bicarbonates, mg/l	*100*
Carbonates, mg/l	*10*
Nitrates, mg/l	*40*
Phosphates, mg/l	*40*
Chlorides, mg/l	*50*
Sulphates, mg/l	*30*
Calcium, mg/l	*40*
Magnesium, mg/l	*40*
Potassium, mg/l	*15*
Sodium, mg/l	*70*

It is clear from Table 5.2 that the BOD is the major pollutant, as far as sewage is concerned. Normally untreated sewage would find its way to natural drainage system which ultimately confluences into the sea. However, these natural drains are seasonal in nature

and are likely to remain dry in the non-monsoon months. During this period, the flow of untreated sewage from the labour colonies in these drains can lead to development of anaerobic conditions, with associated odour problems. It is proposed to treat the sewage from labour camps before disposal. The details of the treatment methodology are outlined as a part of Environmental Management Plan (EMP) outlined in Chapter-6 of this Report.

5.2.4 Effluent from other sources

Substantial quantities of water would be used in the construction activities. With regard to water quality, waste water from construction activities and runoff from construction site would mostly contain suspended impurities. Adequate care should be taken so that excess suspended solids in the wastewater are removed before discharge into water body. The effluent is proposed to be treated by collecting the waste water and runoff from construction sites and treating the same in settling tanks.

5.2.5 Impacts due to Dredging

The potential environmental effects of dredging can be categorized as impacts due to dredging process itself and those due to disposal of the dredged material. During the dredging process, impacts are anticipated on account of excavation of bed sediments, loss of material during transport to the surface, overflow from the dredger whilst loading and loss of material from the dredger and/or pipelines during transport.

The evaluation of the environmental effects of dredging and disposal must take account of both the short-term and long-term effects that may occur both at the site of dredging or disposal (near field) and the surrounding area (far field). Near field effects are simply defined as ‘phenomena occurring within the geographic bounds of the activity, or less than approx. 1 km from the activity’, and far field effects as ‘occurring more than approximately 1 km from the activity'.

Impacts on Suspended sediments and turbidity levels

During the construction phase a large quantity of construction material like stones, pebbles, gravel and sand would be needed for reclamation. All the reclamation material available in the sea/creek bed would be used. It is proposed to extract reclamation material from borrow areas in the sea/creek bed. The extraction of these materials may affect the marine water quality due to increase in the turbidity levels. This is mainly because the dredged material gets released during one or all the operations mentioned below:

- Dredging of material from the Sea/creek bed.

- Loss of material during transport to the surface.
- Overflow from the dredger while loading/pumping
- Loss of material from the dredger during transportation.

The cumulative impact of all the above operations is increase in turbidity levels. Good dredging practices can however, minimize turbidity. It has also been observed that at times slope collapse is the major factor responsible for increase in the turbidity levels. If the depth of cut is too high, there is possibility of slope collapse, which releases a sediment cloud. This will further move outside the suction radius of dredged head. In order to avoid this typical situation, the depth of cut is to be restricted to:

$$\gamma H/C < 5.5$$

Where, γ - Unit weight of the soil

H - Depth of soil

C - Cohesive strength of soil (which depends on the slope of the cut)

The dredging and deposition of dredged material may affect the survival and propagation of benthic organisms. The macro-benthic life which remains attached to the stones, boulders etc. gets dislodged and is carried away downstream by turbulent flow. The area from where construction material is excavated, benthic fauna gets destroyed. In due course of time, however, the area gets recolonized, with fresh benthic fauna. The density and diversity of benthic fauna will however, be less as compared with the pre-dredging levels.

When dredging and disposing of non-contaminated sediments, the key impacts are the increase in suspended sediments and turbidity levels. Any dredging method releases suspended sediments into the water column, during excavation itself and during the flow of sediments from hoppers and barges. In many cases, locally increased suspended sediments and turbidity associated with dredging and disposal is obvious from the turbidity 'plumes' which may be seen trailing behind dredgers or disposal sites.

Increase in suspended sediments and turbidity levels from dredging and disposal operations may under certain conditions have adverse effects on marine animals and plants by reducing light penetration into the water column and by physical disturbance.

Increased suspended sediments can affect young fish, if suspended sediments become trapped in their gills increased fatalities of young fish have been observed in highly turbid water. Adult fish are likely to move away from or avoid areas of high suspended solids,

such as dredging sites, unless food supplies are increased as a result of increases in organic material. The increase in turbidity could marginally affect the fisheries in the area.

The increase in turbidity results in a decrease in the depth that light is able to penetrate the water column which may affect submerged plants, by temporarily reducing productivity and growth rates. Since, benthic fauna is not well developed in the areas, hence impacts on this account is not expected to be significant. The degree of re-suspension of sediments and turbidity during dredging and disposal depends on:

- Sediments being dredged (size, density and quality of the material)
- Method of dredging (and disposal)
- Hydrodynamic regime in the dredging and disposal area (current direction and speed, mixing rate, tidal state) and
- Existing water quality and characteristics (background suspended sediment and turbidity levels).

In most cases, sediment re-suspension is only likely to present a potential problem if it is moved out of the immediate dredging location by tidal processes. In general, the effects of suspended sediments and turbidity are generally short term (<1 week after activity) and near-field (<1km from activity). These are of concern only, if sensitive species are located in the vicinity of the maintained channel. Since, no sensitive species are observed in the areas to be dredged, hence, no adverse impacts are anticipated. In addition no sea dumping of material is envisaged. All materials would be dumped inside a properly constructed containment embankment (to be used as stacking area), thereby reducing the turbidity levels in the open sea area.

Impacts on marine water quality

Redox potential (eH) and pH are two variables that control the characteristics of chemicals and heavy metals in water and sediment. As long as the pH remains around 8 and eH < 150 mV, most of the chemicals and metals will remain bound to the solid phase without being released into the surrounding water. Only anoxic conditions reduce the eH below this level and hence if dissolved oxygen level is normal no leaching of chemicals and heavy metals will occur.

In the present survey sites pH was 8.0 to 8.2 and dissolved oxygen was 5.3 to 5.9 mg/l which is ideal for a marine ecosystem. Dissolved oxygen levels are not reduced to anoxic conditions. Under these circumstances, there is no possibility of any of the chemicals or metals being leached into the water. Moreover, sediment samples collected from all the

sites were uncontaminated. As such no adverse impact due to dredging or dumping on the chemical characteristics of water or sediment is expected.

Impacts due to dredging and disposal of organic matter and nutrients

The release of organic rich sediments during dredging or disposal can result in the localized removal of oxygen from the surrounding water. Depending on the location and timing of dredging, this may lead to the suffocation of marine animals and plants within the localized area or may deter migratory fish or mammals from passing through. However, removal of oxygen from the water is only temporary, as tidal exchange would quickly replenish the oxygen supply. Therefore, in most cases where dredging and disposal is taking place in open coastal waters, this localized removal of oxygen has little, if any, effect on marine life.

Impacts due to contaminated sediments

Another possible impact is the release of toxicants from the sediment if the sediment is contaminated. In the case of contaminated sediment acute toxicity, chronic toxicity and bioaccumulation are the possible effects. But all these are short term and insignificant and no serious effects have been reported from any earlier instances or experimental studies.

In various sampling locations covered as a part of the study, sediment samples analyzed did not show the presence of any appreciable levels of contamination and hence may not pose any such problems.

5.2.6 Noise due to operation of construction equipment

The major sources of noise during construction phase are due to operation of various construction equipment. The noise levels generated by various construction equipment are given in Table 5.3.

Table 5.3: Average noise levels generated by the operation of various construction equipment

Equipment	***Noise level (dB(A))***
Floating pontoon with mixer machine and crane	*70*
Winch machine	*80*
Transit mixer	*75*
Dumpers	*75*
Generators	*85*
Batching plant	*90*
Dredger	*85*
Booster pumps	*85*

Under the worst case scenario, considered for prediction of noise levels during construction phase, it has been assumed that equipment required during construction phase is operating at a common point. Likewise, to predict the worst case scenario, attenuation due to various factors too has not been considered during noise modelling.

Modelling studies were conducted to assess the increase in noise level due to operation of various construction equipments, and the results of this exercise are given in Table 5.4.

Table 5.4: Predicted noise levels due to the operation of various construction equipment

Distance (m)	***Ambient noise level (dB(A))***	***Increase in noise level due to construction activities (dB(A))***	***Noise level due to construction activities (dB(A))***	***Increase in ambient noise level due to construction activities (dB(A))***
30	*45*	*70*	*70*	*25*
50	*45*	*66*	*66*	*21*
100	*45*	*60*	*60*	*15*
200	*45*	*54*	*54*	*4*
500	*45*	*46*	*48*	*3*
1000	*45*	*36*	*40*	*1*

It is clear from Table 5.4, that at a distance of 1 km from the construction site, the increase in noise levels will be only 1 dB(A). The nearest residential areas are at a distance of more than 1 km from the proposed project site. Hence, no major adverse impacts are anticipated on ambient noise levels during construction phase of the proposed project.

It would be worthwhile to mention here that in absence of the data on actual location of various construction equipments, all the equipment have been assumed to operate at a common point. This assumption leads to over-estimation of the increase in noise levels. Also, it is a known fact that there is a reduction in noise level as the sound wave passes through a barrier.

Walls of various houses or other structure will attenuate at least 30 dB(A) of noise. In addition there is noise attenuation due to the following factors.

- Air absorption
- Rain
- Atmospheric in-homogeneities
- Vegetal cover

Thus, no increases in noise levels are anticipated as a result of various activities, during the project construction phase due to the following:

- Assumption that all equipment are operating from a common point leads to over-estimation of increase in noise level
- Attenuation of 30 dB(A) of noise by wall of any structure
- Noise attenuation due to various factors.

5.2.7 Noise due to increased vehicular movement

During construction phase, there will be significant increase in vehicular movement for transportation of construction material. At present, there is no vehicular movement near the barrage site. During construction phase, the increase in vehicular movement is expected to increase up to a maximum of 5 to 6 trucks/hour.

As a part of EIA study, impact on noise level due to increased vehicular movement was studied using Federal Highway Administration model. The results of modelling are outlined in the Table 5.5.

Table 5.5: Increase in noise levels due to increased vehicular movement

Distance (m)	***Ambient noise level dB(A)***	***Increase in noise level due to increased vehicular movement dB(A)***	***Noise levels due to increased vehicular movement dB(A)***	***Increase in ambient noise level due to increased vehicular movement dB(A)***
10	*45*	*72*	*72*	*27*
20	*45*	*67*	*67*	*22*
50	*45*	*61*	*61*	*16*
100	*45*	*57*	*57*	*12*
200	*45*	*52*	*52.5*	*7.5*
500	*45*	*46*	*48*	*3*
1000	*45*	*42*	*46*	*1*

As mentioned earlier, there will be significant attenuation due to various factors, e.g. absorption by construction material, air absorption, atmospheric inhomogeneties, and vegetal cover. Thus, no significant impact on this account is anticipated. Appropriate measures have been suggested as a part of Environmental Management Plan (EMP) report to minimize impacts on wildlife.

5.2.8 Noise generated due to drilling

The noise levels monitored at a 10 m distance from the source and operator's cabin is given in the Table 5.6.

Table 5.6: Noise generated due to drilling

Equipment	***Noise level at source dB(A)***
Standing idle (inside cabin)	*70-72*
Standing idle (10 m radius)	*72-74*
On load (inside cabin)	*78-80*
On load (10 m radius)	*82-84*

The noise levels during various construction activities have been compared to various standards prescribed by Occupational Safety and Health Administration (OSHA), which are being implemented in our country through rules framed under Factories Act. It can be observed (Refer Table 5.6) that for an 8 hour duration, equivalent noise level exposure should be less than 90 dB(A).

5.2.9 Impacts of noise on labour

The effect of high noise levels on the operating personnel has to be considered as this may be particularly harmful. It is known that continuous exposures to high noise levels above 90 dB(A) affects the hearing acuity of the workers/operators and hence, should be avoided. To prevent these effects, it has been recommended by Occupational Safety and Health Administration (OSHA) that the exposure period of affected persons is limited (Table 5.7).

Table 5.7: Maximum Exposure Periods specified by OSHA

Maximum equivalent continuous Noise level dB(A)	***Unprotected exposure period per day for 8 hrs/day and 5 days/week***
90	*8*
95	*4*
100	*2*
105	*1*
110	*½*
115	*¼*
120	*No exposure permitted at or above this level*

5.2.10 Impacts on cultural/religious/historical monuments

No monuments of cultural, religious, historical or archaeological importance are reported in the project area. Thus, no impact on such structures is envisaged.

5.2.11 Impacts on air quality due to construction activities

The major pollutant in the construction phase is SPM being air-borne due to various construction activities. The vehicular movement generates pollutants such as NOx, CO and HC. But, the vehicular pollution is not expected to lead to any major impacts. The fugitive

emissions due to vehicular movement will be 8 to 12 kg/km travelled by the vehicle. The soils in the project area are sandy in texture, and are likely to generate substantial quantities of dust. However, the fugitive emissions generated due to vehicular movement are not expected to travel beyond a distance of 200 to 300 m. The windblown dust is also likely to be substantial, especially during the summer months. Since, there is no habitation in the vicinity of the site the major impact on air environment during the construction phase is not expected to be significant as far as air pollution is concerned. The combustion of diesel in various construction equipment could be one of the possible sources of incremental air pollution during the construction phase. The fuel utilisation rates of various equipment expected to be in operation during construction phase is given in the Table 5.8. Under the worst case scenario, it has been considered that equipment used for construction of berth and earthwork at each site, are operating at a common point.

Table 5.8: Fuel combustion during construction phase

S. No.	***Equipment***	***Fuel consumption rate (lph)***	***No. of units***	***Total fuel consumption (l)***
1.	*Floating pontoon with mixer machine and crane*	*40*	*2*	*80*
2.	*Winch machines*	*25*	*6*	*150*
3.	*Transit mixers*	*20*	*2*	*40*
4.	*Dumpers*	*30*	*6*	*180*
5.	*Generators*	*30*	*2*	*60*
6.	*Batching plant*	*40*	*1*	*40*
7.	*Dumpers*	*20*	*60*	*1200*
8.	*Loaders and Unloaders*	*25*	*3*	*75*
9.	*Excavators*	*25*	*2*	*50*
10.	*Dozers*	*20*	*3*	*60*
11.	*Sheep foot roller*	*20*	*3*	*60*
12.	*Motor grader*	*20*	*3*	*60*
	Total			***2055***

The short-term increase in concentration has been predicted using Gaussian plume dispersion model. The maximum short-term increase in SO_2 is observed as 0.00119 $\mu g/m^3$, which is at a distance of 200 m from the emission source. The maximum SPM concentration was 1.15 $\mu g/m^3$ which is at a distance of 400 m from the emission source. The incremental concentration is so low that it does not need any specific control measure. Thus, the operation of construction equipment is not expected to have any major impact on the ambient air quality as a result of the project.

5.2.12 Transportation of construction material

Vehicular movement from the transportation of construction material in the area is likely to increase temporarily during the construction period. However in the operation phase, the increased traffic will have very little impact due to the improved infrastructure and road network.

During construction phase, there will be increased vehicular movement. Lot of construction material like sand, fine aggregate are stored at various sites, during the project construction phase. Normally, due to blowing of winds, especially when the environment is dry, some of the stored material can get entrained in the atmosphere. However, such impacts are visible only in and around the storage sites. The impacts on this account are generally, insignificant in nature.

5.2.13 Pollution due to increased vehicular movement

During construction phase, there will be increased vehicular movement for transportation of various construction materials to the project site. Similarly, these will be increased traffic movement on account of disposal of muck or construction waste at the dumping site. The maximum increase in vehicle is expected to 50 vehicles per hour. Large quantity of dust is likely to be entrained due to the movement of trucks and other heavy vehicles. Similarly, marginal increase in Hydrocarbons, SO_2 and NO_2 levels are anticipated for a short duration. Modelling studies for hydrocarbon emissions were conducted and the results are given in Table 5.9.

Table 5.9: Increase in hydrocarbon concentration due to vehicular movement

Distance (m)	***Increase in HC concentration (µg/m^3)***
10	*5*
20	*2.50*
30	*1.67*
40	*1.25*
50	*1.00*
60	*0.83*
70	*0.71*
80	*0.63*
90	*0.56*
100	*0.50*

The increase in vehicular density is not expected to significant. In addition, these ground level emissions do not travel for long distances. Thus, no major adverse impacts are anticipated on this account.

5.2.14 Impacts on marine ecology

For the land reclamation and to increase the width and depth of the navigation channel dredging would be carried out in the project site. As a result of the dredging, impacts on marine ecology are anticipated. In the areas to be dredged, the existing marine life would be adversely affected. The area to be dredged would, however, small recolonize in short duration after the cessation of dredging activities. However, these areas would have regular ship traffic, which leads to significant disturbance as compared to the pre-project status. This means that though the dredged stretches are likely to get recolonized, the ecology is not expected to develop upto the pre-project levels.

There are very few studies on the impact of aquatic noise on the marine animals. The marine animals can sense the noise in the infrasonic range between 5 and 35 cycles/sec which is much different from the human audible range (20-20,000 cycles/second). Most of the work on noise pollution has been done in the audible frequencies. However, US Navy has done some work on the detection of submarines through the movement of Dolphins and fish species. However, most of the data is classified. It is more or less certain that quite a few of the aquatic animals, especially Dolphins, communicate amongst themselves in the infrasonic range. The articulation of fishes, sharks, etc. have not been much studied but it is likely that some of them can communicate in the same range. Noise generated by ship movement may interfere with their communication lines. It has been reported that ship movement may scare some of the fishes and their immediate reaction is restricted to avoid the area. However, as soon as the ship passes that area, they return. Therefore, it is apparent that the impact of ship movement on noise levels is purely temporary and may cause only marginal impact on the marine fauna especially fish. Quantification of such impact is not possible mainly because of our lack of knowledge on the effect of noise on fishes and the noise level measurement is carried out in the audible and ultrasonic range.

Impacts on benthic organisms

During dredging operations, the removal of material from the sea bed also removes the animals living on and in the sediments (benthic animals). With the exception of some deep burrowing animals or mobile surface animals that may survive a dredging event through avoidance, dredging may initially result in the complete removal of animals from the excavation site.

In areas to be covered under maintenance dredging well-developed benthic communities are not expected to occur in or around the area. Since, the significant macro-and meio-

fauna is not developed in the area, hence dredging is not expected to lead to significant adverse impacts.

Total seven groups of Meio-fauna were present in the sediment samples collected from the project site. Meio-fauna was dominated by *Nematodes, Foraminiferans*, and *Tanaidacea* having moderate conc. Eight groups of macro-fauna are present in the sediments. The *Gastropoda, Polychaetes, and Bivalves* are the dominant species. None of the Macro and Meio-faunal species are rare, endangered or threatened species. All are common benthic organisms found in the marine ecosystem.

The recovery of disturbed habitats following dredging ultimately depends upon the nature of the new sediment at the dredge site, sources and types of re-colonising animals, and the extent of the disturbance. In soft sediment environments recovery of animal communities generally occurs relatively quickly and a more rapid recovery of communities has been observed in areas exposed to periodic disturbances, such as maintained channels. Thus, in area under maintenance dredging in subsequent years, the recovery of benthic organisms is not expected to be significant.

A review of dredging works in coastal areas world-wide showed that the rates of recovery of benthic communities following dredging in various habitats varied greatly and the details are given in Table 5.10.

Table 5.10: Rates of recovery of benthic communities in various coastal areas

Location	***Habitat type***	***Recovery time***
Coos Bay, Oregon	*Disturbed Muds*	*4 weeks*
Gulf of Cagaliari, Sardinia	*Channel muds*	*6 months*
Mobile Bay, Alabama	*Channel muds*	*6 months*
Goose Creek, Long Island	*Lagoon muds*	*>11 months*
Klaver Bank, North Sea	*Sands-gravels*	*1-2 years*
Chesapeake Bay	*Muds-sands*	*18 months*
Lowestoft, Norfolk	*Gravels*	*>2 years*
Dutch coastal waters	*Sands*	*3 years*
Boca Ciega Bay, Florida	*Shells-sands*	*10 years*

Recovery rates were most rapid in highly disturbed sediments in estuaries that are dominated by opportunistic species. In general, recovery times increase in stable gravel and sand habitats dominated by long-lived components with complex biological interactions controlling community structure. Thus, in the dredging sites of the proposed project, texture of the sediments is mainly clayey; hence, recovery time is expected to be relatively quick.

Impacts due to settlement of suspended sediments

Sediments dispersed during maintenance dredging and disposal may resettle over the seabed and the animals and plants that live on and within it. This blanketing or smothering of benthic animals and plants may cause stress, reduced rates of growth or reproduction and in the worse cases the effects may be fatal. Generally sediments settle within the vicinity of the dredged area, where they are likely to have little effect on the recently disturbed communities, particularly in areas where dredging is a well-established activity. Hence, impacts on this account are not expected to be significant in areas to be covered under maintenance dredging. However, in other areas to be dredged, too, settlement of suspended sediments will be just after they have been freshly disturbed hence; adverse impacts on this account are not anticipated.

Impact on phytoplankton and primary productivity

Biomass of phytoplankton depends mainly on the availability of light in nutrient rich waters. Dredging and disposal may lead to increased turbidity and consequent reduction of light penetration for short periods. This may affect primary productivity and plankton biomass. However, turbidity due to dredging and dumping will be observed only in a localised area and only for a very short duration. Hence these impacts are not of any concern.

Impacts on benthos

The dredging and dumping generally affect the benthos. These are related to removal of the benthic organisms from the dredging site and burial of benthic organisms at the dumping site. The dredged material takes away most of the benthos along with it and while dumping it most of the organisms present are buried under the deposited material. This will result in reduced number and diversity of benthic organisms at the dumping site. However, earlier studies show that the dredged site and dumping sites will be colonized by benthic organisms within a very short time. Moreover biomass and diversity of benthos will also be restored to the earlier level within a very short time.

Benthic fauna did not contain any rare or endangered species and consisted of common species only. It can be expected that these species will colonize within a short time from dislodging.

Impacts on fisheries

The most important impact on fishes may be suspended solid load or changes in the food chain. The high turbidity due to heavy suspended solid load during dredging or disposal of dredged materials results in clogging of gills of fishes thereby causing asphyxiation. But

since fishes are free swimming they very well avoid such areas and move to safer areas. Once the turbidity disperses due to current and wave disturbances, they come back to the area. Due to this capability of the fishes there is virtually no impact on fishes and fisheries by dredging and disposal.

5.2.15 Impacts on Land use Pattern of the Area

The construction and operation of the project will provide an impetus to the industrialization and urbanization in the area. Thus, some of the agricultural lands are likely to be put to non-agricultural use. Jetty area would require lot of ancillary developments like shops, restaurant, repair shops, etc. in and around the jetty area. This will lead to conversion of barren land into commercial use. In some areas, even agricultural land could also be diverted by the locals to avail greater economic opportunities presented as a result of the jetty development.

5.2.16 Impacts on Socio-Economic Environment

The role of any industrial development is to be evaluated not only by its impact on the ecosystem but also by its contribution to the improvement in the quality of life. Economic benefits of a jetty are manifold. Both negative and positive impacts are expected during construction phase of the proposed project.

Impacts due to labour camps

The construction phase of the jetty is likely to expand over a period 3-4 years and will require good amount of labour force. There might be pressure on the local resources and other infrastructure facility due to the migrants. Though majority of population would be recruited locally but in case of labourers with specific skills, from outside the region is recruited, it would be in limited number. Therefore no significant pressure on local infrastructure is envisaged.

Impact on local economy

The construction phase would lead to generation of temporary employment opportunities such as requirement of manpower/vessels to trans-ship the materials, ground clearing, road laying works etc. These activities would temporarily increase the income levels of the local population.

5.3 Impacts during Project Operation Phase

5.3.1 Entrainment of fugitive emissions

The following additional solid cargo is proposed to be handled at the jetty in bulk. These bulk cargos could be further subdivided in to, clean cargo, which has no fugitive emissions and others with emissions to various degrees.

- Iron ore
- Coal
- Limestone
- Fertilizer
- Cement and Clinker
- Construction cargo

The handling details of various cargoes in the proposed jetty are given in the following paragraphs:

Iron Ore, Coal and Lime Stone

- Handling Equipment: Mechanised Grab Unloader
- Conveying Equipment: Closed/open Conveyors
- Reclaiming: Stacker/ Reclaimers
- Storage and stacking: Open storage. Stack height: 10m initially going up to 14m
- Provided with dust suppression, wind shields, green belt and water sprays
- Despatch through Trucks/Rakes

Fertilizer

- Handling Equipment: Mechanised Grab Unloaders
- Conveying Equipment: Closed/open Conveyors (overhead tippler type)
- Reclaiming: By reclaimers conveyor with 4 hoppers
- Storage and stacking: Covered storage
- Despatch: Bagged fertilizer through rakes/road

Cement and Clinker

- Handling: Cement with pneumatic unloaders
- Conveying: Special conveyors/pipe conveyors
- Storage and Stacking: Cement is silos/ Clinker in covered storages (filter for dust suppression)
- Despatch: Bags and on in specially made vehicles with no dust emissions

Containers

- Handling: Fully mechanised loader/unloaders
- Conveying: Tractor-trailers/RTGC
- Storage and Stacking: Open
- Despatch: Rakes/Road/Ship

The cargoes e.g. Iron Ore, Coal, Limestone, fertilizer will be handled in bulk form. For such cargoes, fugitive emissions are not generated. Cement and clinker would be handled in piped conveyors and would be bagged for despatch. The entire operation would be handled in dry state is closed conveyor system. Thus, no air pollution is envisaged.

The various cargoes to be handled at the jetty in the project operation phase include Coal, iron ore, coal, limestone, cement/clinker, Bauxite etc. The cargoes to be handled at the jettywill be conveyed by a closed conveyor system. Thus, no solid waste is expected to be generated. However, at the point of the transfer of cargo like coal, Bauxite, Iron ore and limestone through the conveyor belt to the stock yard, dust may fly and finally get deposited on the ground. The dust could be higher in case of coal. The quantum of coal likely to be entrained was calculated using standard formulae for estimation of fugitive emissions, during loading and unloading operations. The fugitive emissions are expected to be of the order of 0.004 kg/tonne of material transferred.

The coal dust needs to be cleaned regularly from coal stack pile areas using water sprays. The water can be channelled from various locations and brought to a common point for treatment prior to disposal.

Containers

The handling of container cargo will not lead to entrainment of any emissions, as the nature of cargo does not lead to any air pollution.

Liquid Bulk Cargo

POL, LNG/LPG is expected to be handled at the jetty. POL would be imported in Oil tankers and handled through unloading arms. Except for spillage there will be no other impacts on the environment. The spillage will be controlled through better handling and in case of any spillage; oil booms would be installed in consultation with the coast guard.

LNG would be received in the liquid form. LNG is not a hazardous cargo per-se. However, spillage of the cargo would generate gas clouds. The impacts on the immediate environment are not significant except for the fire hazards at a particular air mix; this is discussed in the chapter on risk analysis later in the report.

5.3.2 Impacts on Land Use Pattern of the Area

The construction and operation of the project will provide an impetus to the industrialization and urbanization in the area. Thus, some of the agricultural lands are likely to be put to

non-agricultural use. Jetty area would require lot of ancillary developments like shops, restaurant, repair shops, etc. in and around the jetty area. This will lead to conversion of barren land into commercial use. In some areas, even agricultural land could also be diverted by the locals to avail greater economic opportunities presented as a result of the jetty development.

5.3.3 Generation of Garbage at Jetty

The other problem envisaged during operation phase could be the disposal of garbage. This could comprise floating materials, packaging, polythene or plastic materials. Garbage accumulated on the deck is also problematic and should be suitably disposed.

The solid waste in the proposed project could also be generated mainly from three sources viz. institutional/ office waste, domestic waste and waste from cargo handling etc.

The office waste in the proposed project could be in the form of packing material, cardboard, etc. which is not expected to be significant. The same is proposed to be routinely collected and disposed as per the prescribed Municipal Solid Waste (MSW) Rules.

5.3.4 Air pollution due to coal handling

Coal will be stored at coal storage yard in coal stock piles with an approximate maximum height of 4 m, with side slope of 35^{o}. During unloading and storage at coal stockyard, the following sources/activities could lead to air pollution:

- Dust caused by displacement of air
- Dust blown out by the wind
- Wind erosion from disposal sites

The above sources are described in the following paragraphs;

Dust caused by displacement of air

As the coal is loaded, it displaces air of quantum equal to its volume, which leads to entrainment of dust. As the air enters the environment at the location, where the coal is released at the stack yard, the air entrains the coal dust along with it and leads to entrainment of fugitive dust.

Dust generated by the Impact

The falling product has a certain velocity and the moment it hits the foregoing product that has already been loaded into the truck. This velocity represents a certain amount of kinetic

energy that causes breakage of the product and therefore generates dust at the point of impact.

Dust blown out by the wind

As soon as the product leaves the spout, the wind can blow through the falling stream of product and will blow out the smaller and lighter particles.

Wind erosion from coal piles on the deck

The coal dust gets entrained in the atmosphere due to wind action. The emissions are greatest during periods of material movement, high winds and dry periods.

The fugitive emissions can be calculated as per the following equations:

1. Vehicular traffic around piles = 3.574×10^{-5} Ks D_2
2. Wind erosion = 7.096×10^{-8} s D_2 f D_1
3. Load out from coal piles = $1.529 \times 10^{-3} \frac{sUK}{M^2 Y}$
4. Load in onto coal piles = $1.946 \times 10^{-4} \frac{sUK}{M^2 Y}$

where, Emission factors are kg/ton of material stored

K = Correction factor for vehicular traffic in the area
S = Silt content (%)
D_1 = duration of material storage (days)
D_2 = number of dry days per year
f = percentage of time wind exceeds 20 kmph
U = mean wind speed (kmph)
M = moisture content (%)
Y = loader bucket capacity (m^3)

Loading and unloading

The receivable and disposal of dusty materials, releases the dust which is mechanically agitated by the movement of the excavating equipment and the turbulent air eddies created during the process. The amount of dust generated depends on particle size, wind velocity and the material moisture content.

The emission rates during loading can be estimated as follows:

$E_{LS} = 1.946 \times 10^{-4} \frac{sU}{M^2}$

where,

E_{LS} = load in emission rate (kg/ton of material loaded)
s = silt content (%)
U = wind speed (kmph)
M = moisture content (%)

Erosion from unpaved roads

Particulate emissions occur whenever a vehicle travels over an unpaved surface. The fugitive emissions are much higher in unpaved road. The fugitive emission from unpaved roads is calculated as per the following equation:

$E = 5.0 \times 10^{-5} sV (365-w)$

where,

E - kg of fugitive emission/vehicle miles travelled
s - silt content (%)
V - average vehicle speed (kmph)
W - number of rainy days in a year.

The fugitive emissions generated through various sources are given in Table 5.11.

Table 5.11: Fugitive emissions generated by various sources

S. No.	***Source***	***Quantum (kg/tonne of material handled)***
1.	*Wind erosion from disposal sites* • *Vehicular traffic around piles* • *Wind erosion* • *Load out from piles* • *Load in onto piles*	 *0.17* *0.0144* *1.84×10^{-4}* *2.34×10^{-5}*
2.	*Loading and unloading*	*6.98×10^{-5}*

The water requirements for suppression of coal dust from stockyard area have been estimated as 50 m^3/hr. The details are given as below:

- Stock pile area (Coal area only) : 25ha
- No. of spray guns : 50
- Water consumption/gun : 15 m^3/hr
- Total water requirement/hour : 75 m^3/hr

Net water requirement assuming 50% is recycled : 37.5 m^3/hr

Water requirement at transfer point @ 25% of net water requirement : 20 m^3/hr

Total water requirement : 50 m^3/hr, requirement/day = 600 m^3

5.3.5 Generation of waste water

It is estimated that a total of 800 m^3 of water will be required for the jetty activities during the operational period. The break up for the water consumption during operation phase is presented in the Table 5.12. The source of water would be from the MIDC.

The domestic sewage generated by the use of service water by the employees in the project operation phase is one of the major sources of waste water. The total water

required for landscaping and greenbelt development is 52 m^3/day. Domestic water consumption will be 48 m^3/day, and the generated waste water which is estimated to be 33.6 m^3/day.

Table 5.12: Water requirement during operational period

S. No.	***Purpose***	***Total Consumption (m^3/day)***
1	*Consumption (Jetty area, office canteen etc.)*	*48*
2	*Mist Sprinkler (Coal stock yard)*	*600*
3	*Water requirement for landscaping*	*52*
4	*Fire Fighting (Lumpsum)*	*100*
	Total	***800***

The potable water demand is proposed to be obtained from Maharashtra Industrial Development Corporation (MIDC). The underground and overhead tanks of adequate capacity are proposed to be provided within the premises.

As a part of EMP, appropriate measures for treatment of effluent have been suggested in Chapter-6 of this Report.

5.3.6 Environmental Impact from Ship Traffic

During the operational phase with additional facilities there will be increased activities of ship movement in the region. All these activities may have impacts on marine lives. Possible sources of such impacts on marine environment would be from;

- Accidental Oil Spill from the calling ships
- Ballast water
- Illegal tank washing
- Ship grounding, physical damage of bottom community
- Anchoring
- Discharges of sewage from vessels
- Discharge from solid waste

Ship traffic poses a risk of oil pollution from the following sources:

- Small spills caused by the accidental or international release of oil-contaminated bilge water from freights
- Minor spills caused by release of bunker oil during terminal operations
- Major spills caused by the rupture of a bunker oil tank in a bulk/cargo vessel collision, shipwreck of a bulk/cargo vessel

Marine environmental implications during routine operations at the harbour could be due to the following cases.

- Escapement of cargo during loading/unloading operations
- Release of wastes generated from the ships including garbage, solid waste, oily ballast and bilge water as well as swage
- Wastes generated at the jetty such as domestic wastewater, effluent from the grit/oil separator and garbage

5.3.7 Material handling

Solid bulk cargoes will be handled at the bulk berths. Though adequate precautions in form of anti-spillage mechanisms are in place, minor spillages are expected. In case of an unlikely event of spillage, the material lumps and dust may increase the local turbidity temporarily. The likely effect would be negligible and momentary. It is not documented clearly whether the coal particles adversely affect the planktonic and nektonic forms but it is likely that they may affect the sessile forms by clogging of coal dust in the gills of fish and molluscs if the concentration reaches critical levels. Coal is a fossilized fuel shall be detrimental to marine life and ecology as these ecosystems do not have appropriate assimilative and biodegrading capabilities for fossilized fuels. However, chances of such eventualities are very meagre since the jetty assures efficient handling of coal without spillage into the environment. Fishing activities in a working jetty is also very less. The details of the mechanical equipment and their capacities are given in the Detailed Project Report, which is an accompanied document.

5.3.8 Impacts due to noise on marine ecology

No adverse impacts on noise environment are anticipated due to the proposed project. During construction phase, there could be high noise levels due to operation of various construction equipment. Fitting of exhaust mufflers and intake mufflers could reduce the noise from air compressors. It is very useful for reducing the low frequency noise levels. Chassis and engine structural vibration noise can be dealt with by isolating the engine from the chassis and by the fitting of covers over various sections of engines.

During project operation phase also, the major source of noise could be due to operation of various equipment. Apart from the above mentioned steps, as a part of the environment protection activities, trees and ornamental horticultural trees and shrubs would be developed around the project area, which will attenuate noise levels to a certain extent. It is

recommended that workers operating various equipments during project construction and operation phases are provided with ear plugs.

There are very few studies on the impact of aquatic noise on the marine animals. The marine animals can sense the noise in the infrasonic range between 5 and 35 cycles/sec. which is much different from the human audible range (20-20,000 cycles/second). Most of the work on noise pollution has been done in the audible frequencies. However, US Navy has done some work on the detection of submarines through the movement of Dolphins and fish species. However, most of the data is classified. It is more or less certain that quite a few of the aquatic animals, especially Dolphins, communicate amongst themselves in the infrasonic range. The articulation of fishes, sharks, etc. have not been much studied but it is likely that some of them can communicate in the same range. Noise generated by ship movement may interfere with their communication lines. It has been reported that ship movement may scare some of the fishes and their immediate reaction is restricted to avoid the area. However, as soon as the ship passes that area, they return. Therefore, it is apparent that the impact of ship movement on noise levels is purely temporary and may cause only marginal impact on the marine fauna especially fish. Quantification of such impact is not possible mainly because of our lack of knowledge on the effect of noise on fishes and the noise level measurement is carried out in the audible and ultrasonic range.

5.3.9 Impacts due to spillage of liquid cargo

During project operation phase, there is a possibility of leaching of various types of spilled and waste compounds, e.g., oil, paints, grease, etc. Efforts will be made to ensure that these spillages/leakages are near zero.

5.3.10 Escapement of solid cargo

The impact of accidental release of solid cargo, particularly during rough weather, though could be serious to the personnel on board or on berth; it would have limited impact on the environment. However, the jetty operations may be hampered if the ship is damaged or the cargo goes overboard that could risk navigation.

The escapement of bulks such as coal, limestone etc during unloading has high potential to cause dust pollution. These materials are non-toxic and their spillage in water of the jetty which is inherently turbid would not have serious impact on ecology though there would be temporary and minor impact on benthos.

5.3.11 Escapement of petroleum

Mechanical loading arms are considered safe and spills in the marine environment are unlikely. Though very rare, bulk releases of petroleum product / fuel could result due to accidents such as ship collision, ship grounding, onboard fire etc. Majority of such accidents have occurred when the ships approach / leave the jetty through the navigational channel. It has been well established that the human factor remains to be the cause of about 90 % of accidents leading to petroleum spills. Small and large spills (50-10000 t) could however result if a loaded bulker went aground or collided with another ship, partially rupturing oil holds.

The failure frequency of loading arms equipped with safety devices is as low as 0.03 per 106 h operation and even if a spill occurs in the event of activation of Powered Emergency Release Coupling (PERC), the volume spilled is small (a few litres) and the spill is collected in the tray below the PERC.

If spill occurs, it would negatively impact the local biota since petroleum products are toxic to marine organisms depending on their composition and volume spilled.

Spilled petroleum undergoes weathering through processes such as spreading, evaporation, dispersion, emulsification, dissolution, oxidation, sedimentation and biodegradation. A lighter product such as naphtha or Motor Spirit (MS) would soon evaporate under tropical conditions while heavy product such as FO would persist in the marine environment for a prolonged period. Thus the impact of a spill on marine biota of the project area would critically depend on the nature of the product, volume spilled and the area affected.

An increase in concentrations of dissolved PHC in water subsequent to a spill could lead to plankton kills. The recovery of plankton would be however quick through repopulation of the community by fresh recruits from adjacent areas not affected by oil. Eggs and larvae of fishes, crustaceans and molluscs in the spill area would be killed. However, it is unlikely that any localised losses of fish eggs and larvae caused by a spill would have discernible effect on the size or health of future adult populations. The productivity at the primary and secondary levels of the proposed project site is low. Hence, large scale implication to the fishery of the region is not expected.

5.3.12 Escapement of LNG

Unlike other liquid petroleum products LNG reacts vigorously with water and vaporises very fast (leaving nothing behind) posing minimum risk for the marine life. However, LNG reacts violently with water and may cause explosion due to Rapid Phase Transition (RPT).

As indicated before, LNG is imported in cryogenic form and then stored either in the liquid or in the gaseous form. The supply however is mostly in the gaseous form. LNG contains more than 80% methane which is a flammable gas. Before deciding on the handling and terminal facilities for LNG, the properties of LNG is of paramount importance and therefore is given below.

LNG Density: 424.49 kg/m^3 (hence it is lighter than water)

LNG boiling point: -161^0 C (-259^0 F)

Natural gas has a density of 0.8 kg/m^3, at 20^0 C under one bar pressure

Flammability limits Lower Flammability Limit (LFL) : 5%,

Upper Flammability Limit (UFL) : 15%

1 m^3 LNG = 600 m^3 of gas at 20°C

Properties of LNG that have safety implications include auto-ignition temperature, low temperature, heat of vaporisation, flammability limits, heta transfer rate of boiling liquid and specific gravity. The figure 4.1 shows the flammability limits of LNG are depicted in the Figure 5.1.

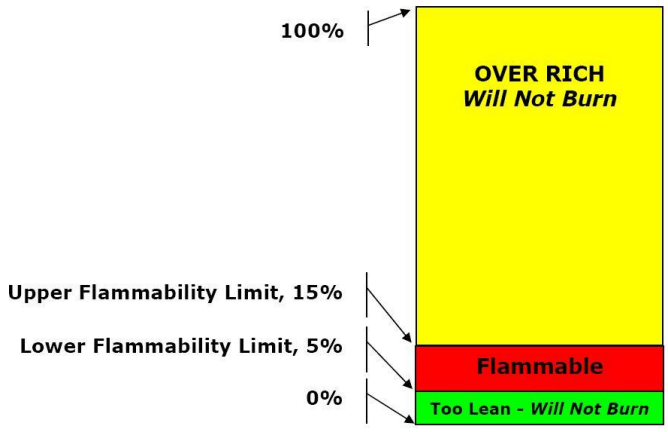


Figure 5.1: Flammability limits of LNG

The average auto ignition temperature of pure methane at atmospheric pressure is 5370 C, which is quite high. The lower and upper flammability limit of methane in air is 5% & 15% by volume respectively as shown in Figure 5.1.

In a closed tank, the percentage of methane is 100%, thus it cannot ignite. Methane leaking from a tank in a well – ventilated area is likely to rapidly dissipate to less than 5%, thus it is relatively safer as compared to other fuels.

The LNG vapours disperses rapidly and depends on the direction and the intensity of the wind as show in Figure 5.2 and 5.3.

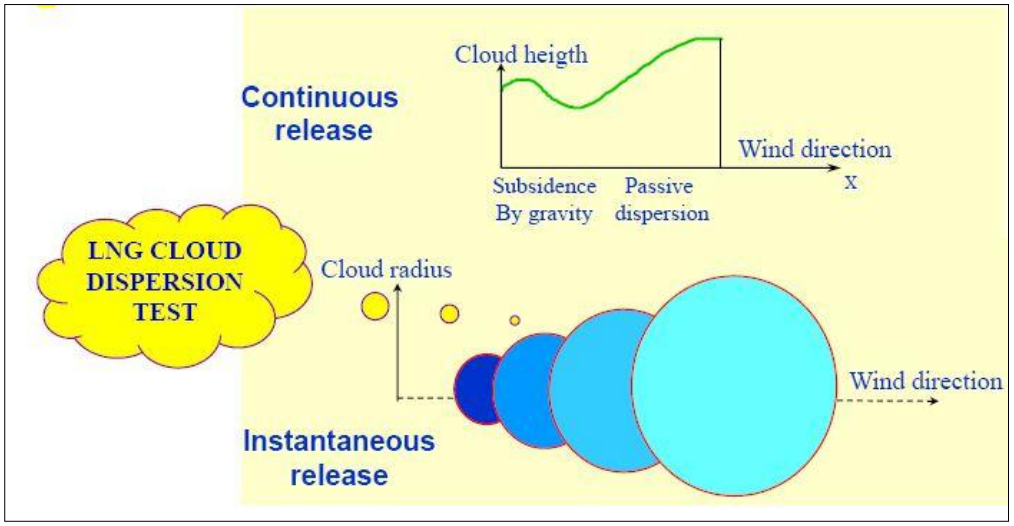


Figure 5.2: Dispersion of LNG vapours by wind

Figure 5.3: Dispersion of LNG vapours by wind on field

There are various myths that surround LNG. These myths are mostly exaggerated and not true. For example, it is said that 'Catastrophic release of LNG creates a BLEVE (Boiling Liquid Expansion Vapour Explosion'. However, in the laboratories as well as in the open ocean tests no BLEVE condition was ever found. Similarly, it is often said that, 'An LNG tanker is a floating Bomb'. Again over the years Liquefied Natural Gas (LNG) tankers have run aground, have experienced loss of containment, suffered weather damage, been subjected to low temperature embrittlement and cargo spillage, suffered engine room fires, and been involved in collision with other cargo carriers, but no cargo explosions have ever been reported.

5.3.13 Ships generated wastes

The four basic categories of wastes generated by ships are as follows:

- Oily waste which usually consists of some oil mixed with larger quantities of sea water, but also fuel residues and sludge.
- Remains of noxious liquid substances carried in bulk in parcel tankers, dry bulk carriers or in portable containers.
- Sewage generated by crew.
- Garbage originating from the crew, the maintenance of the ship, cargo etc.

The International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 (MARPOL 73/78) prohibit all ships from discharging wastes at sea which could result in pollution of the marine environment. MARPOL 73/78 applies to oil tankers, cruise ships, general cargo and container vessels, tugs, ferries, yachts and small pleasure craft.

MARPOL 73/78 requires that ships retain all the wastes on board until reaching facility. However, certain wastes can be discharged under certain conditions such as the distance from shore, the type of waste and the condition of the waste (e.g., ground foodstuffs). Plastics of any kind cannot be discharged anywhere. The vessels must be equipped with dedicated holding tanks for sewage and oily wastes and have the capacity to compact and store garbage.

6 ENVIRONMENTAL MANAGEMENT PLAN

6.1 General

The aim of the Environmental Management Plan (EMP) is to ensure that the stress/load on the ecosystem is within its carrying capacity. The most reliable way to achieve the above objective is to incorporate the management plan into the overall planning and implementation of the project. The Environmental Management Plan (EMP) for the proposed Jetty project is classified into the following categories:

- EMP During project construction phase
- EMP during project operation phase

6.2 EMP for Construction Phase

6.2.1 Land Environment

On completion of construction activities, it should be made mandatory for the contractor to annihilate all signs of haul roads, storage areas, temporary structures, labour colonies, etc. Extraneous material and objects should be removed from the site. These aspects will be made mandatory as a part of the contract agreement.

The major impacts on land environment are expected during construction phase only. The borrow pit areas are generally left untreated. During the monsoon months these untreated borrow areas get filled up with water and these can serve as potential breeding sites for mosquitoes. As a part of the Environmental Plan, the borrow pits would be properly levelled, so that no isolated pools or puddles are left over, once the water dries up. A proper system to drain out the rainwater must be installed. The surface roads, which are proposed to be utilised during construction should be black topped. Adequate provisions should be made for their timely repairs. On completion of construction activities, the roads should be resurfaced completely. Material excavated during construction will be used for refilling and reclamation purpose or suitably disposed.

The major construction materials include coarse aggregate, cement and steel for various other concrete structures. It is proposed to use existing approved quarries to the extent possible. If any new quarry needs to be opened for the project, then management of quarry will be done by the quarry owner. He shall be responsible for implementation of various environmental measures for the quarry, operation & maintenance, closure, etc. Thus, the project proponents are not expected to get involved in the quarry reclamation process, as these will be the approved quarries.

As far as reclamation work is concerned, direct dumping of burrowed material either burrowed or dredged will create turbidity. Hence a reclamation embankment would be constructed before the reclamation and all the reclamation material shall be dumped inside the embankment so that no general turbidity in the area is created.

6.2.2 Water Environment

The major source of water pollution in the construction and operation phases is the sewage generated by the workers and employees. During construction phase about 63 m^3/day of sewage is expected to be generated. It is proposed to construct 30 community toilets within labour camps.

An aerated lagoon is proposed to be provided for treatment of effluent from domestic sources. The effluent from aerated lagoon will be settled in a settling tank. The treated effluent will have a BOD less than 30 mg/l and hence can be disposed in marine water. The settled sludge will be dried in sludge drying beds and then used as manure by the locals. The manure shall be distributed to locals free of cost.

A provision of Rs. 3.0 million has been earmarked for commissioning of the Effluent Treatment Plant. These facilities can be used in the project operation phase as well. The total cost required will be Rs.4.50 million. The details are given in Table 6.1.

Table 6.1: Cost estimates for sanitary facilities for labour camps

S. No.	***Item***	***Rate (Rs./unit)***	***Number***	***Total cost (Rs. million)***
1.	*Community toilets*	*50,000*	*30*	*1.50*
2.	*Effluent treatment plant*			*3.00*
	Total			***4.50***

Aerated lagoon

L = 36.0 m

B = 18.0 m

D = 3.5 m (including Free Board)

Power requirement - 30 hp

Settling tank

Diameter - 5.0 m

Depth - 2.3 m (Including free board)

Effluent from coal stockyard

The effluent generated by washing from coal stockyard will contain high suspended solids. It is proposed to be treated in a settling tank. The sludge so produced will be mainly coal dust, which can be dried on sludge drying beds. During monsoon months, the sludge can be stored separately, in a structure with adequate storage capacity.

The dimensions of settling tank are given as below:

L = 8.5 m

B = 4.0 m

D = 2.0 m (including Free Board)

A provision of Rs. 3.0 million can be earmarked for this construction of settling tank, sludge drying beds and storage structures.

Effluent from workshops, oil storage etc.

The effluent from workshops, oil storage, etc. will contain oil and grease particles which shall be treated in an oil skimmer and suitably disposed after treatment or will be sold to registered recyclers.. The collected oily matter is stored in cans, etc. and disposed at landfill sites designated by the district administration. An amount of Rs. 1.0 million has been earmarked for this purpose.

6.2.3 Air Environment

Control of Emissions

Minor air quality impacts will be caused by emissions from construction vehicles, equipment and DG sets, and emissions from transportation traffic. Frequent truck trips will be required during the construction period for removal of excavated material and delivery of select concrete and other equipment and materials. The following measures are recommended to control air pollution:

- The contractor will be responsible for maintaining properly functioning construction equipment to minimize exhaust.
- Construction equipment and vehicles will be turned off when not used for extended periods of time.
- Unnecessary idling of construction vehicles to be prohibited.
- Effective traffic management to be undertaken to avoid significant delays in and around the project area.
- Road damage caused by sub-project activities will be promptly attended to with proper road repair and maintenance work.

- Transportation of construction materials and cargoes shall be in covered trucks.

Air Pollution control due to DG sets

The Central Pollution Control Board (CPCB) has issued emission limits for generators up to 800 KW. The same are outlined in Table 6.2, and are recommended to be followed.

Table 6.2: Emission limits for DG sets prescribed by CPCB

Parameter	***Emission limits (gm/kw hr)***
NOx	*9.2*
HC	*1.3*
CO	*2.5*
PM	*0.3*
*Smoke limit**	*0.7*

*Note: * Light absorption coefficient at full load (m^{-1})*

The above standard needs to follow by the contractor operating the DG sets.

The other measures are recommended as below:

- Location of DG sets and other emission generating equipment should be decided keeping in view the predominant wind direction so that emissions do not effect nearby residential areas.
- Stack height of DG sets to be kept in accordance with CPCB norms, which prescribes the minimum height of stack to be provided with each generator set to be calculated using the following formula:

$$H = h+0.2x \sqrt{KVA}$$

Where,

H = Total height of stack in metre

h = Height of the building in metres where the generator set is installed

KVA = Total generator capacity of the set in KVA

Dust Control

The project authorities will work closely with representatives from the community living in the vicinity of project area to identify areas of concern and to mitigate dust-related impacts effectively (e.g., through direct meetings, utilization of construction management and inspection program, and/or through the complaint response program). To minimize issues related to the generation of dust during the construction phase of the project, the following measures have been identified:

- Identification of construction limits (minimal area required for construction activities).
- When practical, excavated spoils will be removed as the contractor proceeds along the length of the activity.

- When necessary, stockpiling of excavated material will be covered or staged offsite location with muck being delivered as needed during the course of construction.
- Excessive soil on paved areas will be sprayed (wet) and/or swept and unpaved areas will be sprayed and/or mulched. The use of petroleum products or similar products for such activities will be strictly prohibited.
- Contractors will be required to cover stockpiled soils and trucks hauling soil, sand, and other loose materials (or require trucks to maintain at least two feet of freeboard).
- Contractor shall ensure that there is effective traffic management at site. The number of trucks/vehicles to move at various construction sites to be fixed.
- Dust sweeping - The construction area and vicinity (access roads, and working areas) shall be swept with water sweepers on a daily basis or as necessary to ensure there is no visible dust.
- Various management measures needs to be implemented for Control of air pollution control need to be included in the Tender Document for the Contractor involved in construction activities. The same shall be monitored on a regular basis by the project proponents.
- Water shall be sprinkled for dust suppression. Green belt shall be developed for dust attenuation.

6.2.4 Noise Control Measures

The contractors will be required to maintain properly functioning equipment and comply with occupational safety and health standards. The construction equipment will be required to use available noise suppression devices and properly maintained mufflers.

- Construction equipments shall be properly maintained. They will be provided with mufflers.
- Staging of construction equipment and unnecessary idling of equipment within noise sensitive areas to be avoided whenever possible.
- Notification will be given to residents within 100 m of major noise generating activities. The notification will describe the noise abatement measures that will be implemented.
- Monitoring of noise levels will be conducted during the construction phase of the project. In case of exceeding of pre-determined acceptable noise levels by the machinery will require the contractor(s) to stop work and remedy the situation prior to continuing construction.

The following Noise Standards for DG sets are recommended for the running of DG sets during the construction:

- The maximum permissible sound pressure level for new diesel generator sets with rated capacity up to 1000 KVA shall be 75 dB(A) at 1 m from the enclosure surface.
- Noise from the DG set should be controlled by providing an acoustic enclosure or by treating the enclosure acoustically.
- The Acoustic Enclosure should be made of CRCA sheets of appropriate thickness and structural/ sheet metal base. The walls of the enclosure should be insulated with fire retardant foam so as to comply with the 75 dBA at 1m sound levels specified by CPCB, Ministry of Environment & Forests.
- The acoustic enclosure/acoustic treatment of the room should be designed for minimum 25 dB(A) Insertion Loss or for meeting the ambient noise standards, whichever is on the higher side.
- The DG set should also be provided with proper exhaust muffler.
- Proper efforts to be made to bring down the noise levels due to the DG set, outside its premises, within the ambient noise requirements by proper sitting and control measures.
- A proper routine and preventive maintenance procedure for the DG set should be set and followed in consultation with the DG set manufacturer which would help prevent noise levels of the DG set from deteriorating with use.

It is known that continuous exposure to noise levels above 90 dB(A) affects the hearing of the workers/operators and hence has to be avoided. Other physiological and psychological effects have also been reported in literature, but the effect on hearing acuity has been specially stressed. To prevent these effects, it has been recommended by international specialist organizations that the exposure period of affected persons be limited as specified in Table 6.3.

Table 6.3: Maximum Exposure Periods specified by OSHA

Maximum equivalent continuous Noise level dB(A)	***Unprotected exposure period per day for 8 hrs/day and 5 days/week***
90	*8*
95	*4*
100	*2*
105	*1*

110	*½*
115	*¼*
120	*No exposure permitted at or above this level*

6.2.5 Marine Ecology

In this proposed development, about 3.8 million m^3 of dredging would be involved for the land reclamation purpose. Hence, it is necessary to evolve an environment friendly Dredging Plan, where the depth of cut is engineered on sound scientific principles and steps taken to minimise the turbidity cloud in the vicinity of the drag/cutter head.

The following recommendations are made which require to be adopted for amelioration of adverse impacts of dredging to the extent possible:

- Dredger operators should follow proper safety procedures to avoid accidents and spills.
- Authorities should ensure that all the ships moving in proximity to the area to be dredged or disposal sites do not affect such activities or vice-versa.
- To reduce the potential errors on the part of the contractor, endeavor should be made to regularly monitor the activities during dredging and disposal activities.
- The timing of dredging and disposal activities could be planned, where ever practicable, to avoid and reduce any adverse impacts on sensitive marine flora and fauna. Measures could be planned in terms of the local hydro dynamics for minimizing sediment suspension and extent of the area affected.

6.2.6 Provision of Free Fuel

As a part of EMP, the following measures are proposed:

- Make a clause mandatory in the contract of every contractor involved in project construction to provide supply of fuel to their labourers, so that trees are not cut for meeting their fuel demands.
- Provide LPG to run community kitchens.

The Jetty in association with the state government shall make necessary arrangements for distribution of LPG. These fuels would be supplied at subsidized rates to the local/contract labourers for which provision should be kept in the cost estimate. The total cost required for provisions of fuel works out to Rs. 33.20 million. The details are given in the Table 6.4.

Table 6.4: Cost estimate for LPG distribution

Year	***No. of Employees***	***Annual requirement @ 1 cylinder per family per month (No. of cylinders)***	***Total Cost @ Rs. 600/ cylinder (Rs. million)***
I	*1000*	*12000*	*7.20*
II	*1000*	*12000*	*7.92*
III	*1000*	*12000*	*8.61*
IV	*1000*	*12000*	*9.47*
	Total		***33.20***

6.2.7 Solid Waste Management

During construction phase, about 1,000 labour and technical staff is likely to congregate. The increase in population is expected to be order of about 1400 including the family members of the individuals. The solid waste likely to be generated from labour camps shall be of the order of 0.3 tonnes/day. The chemical characteristics of solid waste generated are given in the following Table 6.5.

Table 6.5: Chemical characteristics of municipal waste

Component	***Percentage by weight***
Moisture	*19.52*
Organic matter	*25.14*
Nitrogen (as Total Nitrogen)	*0.66*
Phosphorous (as P_2O_S)	*0.56*
Potassium (as K_2O)	*0.69*

The composition of various waste materials in the municipal refuse is detailed is given in the Table 6.6.

Table 6.6: Composition of waste material in municipal refuse

Ingredient	***Percentage by weight (%)***
Paper	*4.71*
Rubber, Leather and synthetics	*0.71*
Glass	*0.46*
Metals	*0.49*
Total compostable matter	*38.95*
Inert matter	*44.73*
Others/ plastic	*9.95*
Total	***100***

Adequate facilities for collection, conveyance and disposal of solid waste will be developed. The solid waste will be disposed at the designated landfill sites.

The landfill shall have impervious clay at the bottom most layers. The second layer shall be impervious liner (Geo-membrane) third layer will be of sand, after that well compacted solid waste is to be put over the sand, then again a layer of clay, finally a layer of soil. Vegetation shall be grown on the top most layers. It will give a good aesthetic view of landfill.

Various aspects of solid waste management include:

- Reuse/Recycling
- Refuse storage
- Collection and Transportation
- Disposal

Reuse/Recycling

In order to reduce quantum of waste generated, project will reuse significant quantity Muck (generated due to excavations) for backfilling, form work (in civil work) wherever possible and will also reuse the packing materials received with packages etc.

Project proponent will explore opportunity to recycle the waste generated at the project site, in this context project will identify authorized vendors and send used batteries, used oil, and used oil filters for recycling.

Bio- degradable waste will be disposed by composting and the manure generated will be given to local community for cultivating vegetables and flowers.

Refuse storage

In the proposed project, labour camps are proposed to be located at three locations. In each of the labour colony, provisions shall be made to separately store the degradable and non-degradable solid waste.

Two different coloured bins may be supplied to each labour family, who will segregate the waste generated by their family. Green and Biodegradable waste is to be deposited in one container and non-biodegradable waste in another container. In case of canteens, kitchens also, two different coloured dust-bins suitable to deposit the Biodegradable and non-biodegradable waste generated in their unit shall be provided. A sustained awareness programme will be conducted to educate workers about the segregation of degradable and bio-degradable wastes.

Collection of house-hold Waste

Every day the tractor mounted trolleys will collect the waste at the door of each unit of labour camp and colonies. Two workers and one Tractor Driver will attend for collection of waste. The trolleys will be provided with two compartments for depositing segregated waste separately. Each worker will be allotted at a fixed area. The collection will be on regular pre-informed timings and the arrival will be informed through blowing a whistle/horn. The solid waste so collected shall be disposed at a common storage point. Two trucks will be commissioned to collect the solid waste and dispose the same at sites designated for disposal of solid waste.

Disposal

Degradable component

The degradable portion of the solid waste would be disposed of by composting. The degradable portion is taken as about 38.9%. Thus, (0.389*0.3) about 0.12 t/day of degradable portion of solid waste will be generated. In composting the process takes around 60 days to mature. Thus the total capacity of pits required would be = 78 cu m.

A pit of 2m x 1.5m x 1.3m deep (0.3m freeboard) size can take 3.0 cu m of compostable waste. Thus the no. of pits required shall be 3. The total area will be almost three times the pit area as some area in between pits will be required for transportation and stacking of waste. Hence, total area required will be about 10 m^2. The pits will be covered with GI sheets. Additional 100 m^2 would be kept for storage for compost plus screening and other activities.

The pits to be constructed will have around 25 cm of bottom lining consisting of about 5 cm thick stone grit over which 15 cm thick coarse sand followed by 15 cm thick earth lining will be done. The refuse along with animal dung will have to be laid in layers of 5 to 10 cm thickness. The pit will be then watered on alternate days. Thereafter waste is laid in 5 to 10 cm thick layers twice in a week till the whole pit is filled up. Every week the waste will need to be turned up and water will have to be sprinkled every day to keep adequate moisture. The process will take around 45 to 60 days where after the composted waste from the pit is taken out and after drying it is screened with screens having 2 mm dia holes. The screened compost would be filled in plastic bags and used as good manure especially for cultivation of vegetables and flowers.

Non-Degradable component

The non- degradable portion (about 0.18 t/day) such as plastic bottles, cans, etc. shall be segregated and disposed off at separate sites identified by the district administration.

The details of landfill site are given as below:

- Waste Generation 0.18 tonnes per day
- Design Life 4 years (construction phase)
- Total Waste Generation in 4 Years 262.8 tonnes
- Length 25 m
- Width 12 m
- Depth of fill 5 m

A provision of 15% of the total area, for accommodating infrastructure facilities will be included while working out requirement of space. The liner system will comprise of the following layers below the waste:

- 0.30 m thick drainage layer comprising of coarse sand or gravel (stone dust with no fines)
- 0.2 m thick protective layer of sandy silt
- 1.50 mm thick HDPE Geo-membrane
- 1.0 m thick clay layer/amended soil layer, amended soil layer comprising of local soil + bentonite is to be provided).

The total cost required for solid waste management is estimated Rs. 10.88 million. The details are given in Table 6.7.

Table 6.7: Cost required for implementation of Solid Waste Management Plan

S. No.	***Item***	***Cost (Rs. million)***
1.	*Cost of land*	*0.50*
2	*Reclamation and stabilization cost of landfill and composting sites*	*3.00*
3	*One covered trucks for conveyance of solid waste to landfill site*	*3.00*
4.	*Manpower cost for 10 persons @ Rs. 10000/ month for 4 years including 10% escalation/year*	*2.23*
5.	*01 tractor with trolley*	*0.50*
6.	*Awareness programme*	*0.50*
7.	*Water facility & Toilet facility*	*0.10*
8.	*Tools & Implements*	*0.50*
9.	*Yard lighting maintenance store room lighting, Monitoring station @5000/ fixture x 10*	*0.05*
10.	*Periodical Training & Medical Checkup*	*0.10*
	Total	***10.88***

6.2.8 Control of Pollution due to increased vehicles

The movement of vehicles is likely to increase during construction phase and later in the operation phase of the project. Thus, as a control measure, vehicles emitting pollutants above the prescribed standards will not be allowed to ply either in the project construction or in the operation phases. Vehicles and construction equipment will be fitted with internal devices i.e. catalytic converters to reduce CO and HC emissions.

The rail and road connectivity of the jetty in order to handle the expansion plan of the connecting rail as well as the All the roads in the vicinity of the project site and the roads connecting the quarry sites to the construction site are paved or black topped to minimize the entrainment of fugitive emissions. If any of the road stretches cannot be blacktopped or paved due to some reason or the other, then adequate arrangements will be made to spray water on such stretches of the road.

6.3 EMP for Implementation during Operation Phase

6.3.1 Air Environment

Coal, Iron ore and Limestone

During project operation phase, one the major activity would be handling of the bulk cargoes such as, coal, coke, iron ore, lime stone and Bauxite. These cargos are potential sources of dust and would contribute to fugitive dust emissions. Another source of air pollution in the proposed project is due to the increased vehicular movement in the project construction and operation phases. The following management plan would reduce the impact of such emissions on the general environment.

The impacts due to dust emissions could be substantially managed by containment and reduction of emissions. The reduction in the emissions is achieved by continuous spraying of water so that the surface remains moist and the dust gets suppressed. In materials where the water spray would change the characteristics of the material by making it muddy and slushy, foam cover has been successfully used elsewhere in the world. Accordingly at the present facility, both water sprays and foam suppressants shall be used.

It is proposed to install mechanised handling system and the other associated equipments such as hoppers, belt conveyors, stacker cum reclaimers along with integrated dust suppression systems.

Detail plan of the dust suppression at the proposed Jetty at Nandgaon are as follows:

- Imported coal from Indonesia, Australia and Africa are generally having high moisture contents, often times exceeding 20%, Thus, handling of such coal at the port would result in lesser dust emission.
- Dust suppression systems will be provided at the hopper and at the point of discharge on the berth conveyor as well as the feeder underneath hopper at the ship unloader (Figure 6.1 and 6.2). Mist and fog sprayers will be used for this purpose.
- Dust suppression systems will be provided at all transfer points in the conveying and transfer systems to limit residual dust in the discharge area (Figure 6.2). Nozzles with capacity to atomise 2-6 rpm of water at 4-8 kg/cm^2 pressure has been envisaged for this purpose. With all the above-mentioned measures, no emission is anticipated from the main length of the conveyors.
- No conveyors will be crossing the inhabited areas. All conveyors will be provided with removable type belt hood as well.
- Stack yard will be provided with water spraying system (Figure 6.3). The sprinkler system would consist of pressurised high through sprinklers jets of capacity 4 – 5 rpm at pressure up to 12 kg kg/cm^2, which will operate at an inclination of 30 – 40 degree with respect to the horizontal. Each sprinkler will have a throw range of 25 m and will be installed at 30 m intervals all along the stockpiles.
- For wind generated dust generation, a windshield with a wire mesh fencing with fast growing creepers up to a height of 14 m around the coal/other bulk stack yard has been proposed (Figure 6.4).
- Even the wagon loading system would be complying with the zero emission standards as shown in Figure 6.5.
- In addition to all the above measures, a 15 m wide greenbelt will be developed for dust arresting proposes. Detail on greenbelt development program is discussed in section 6.3.12.

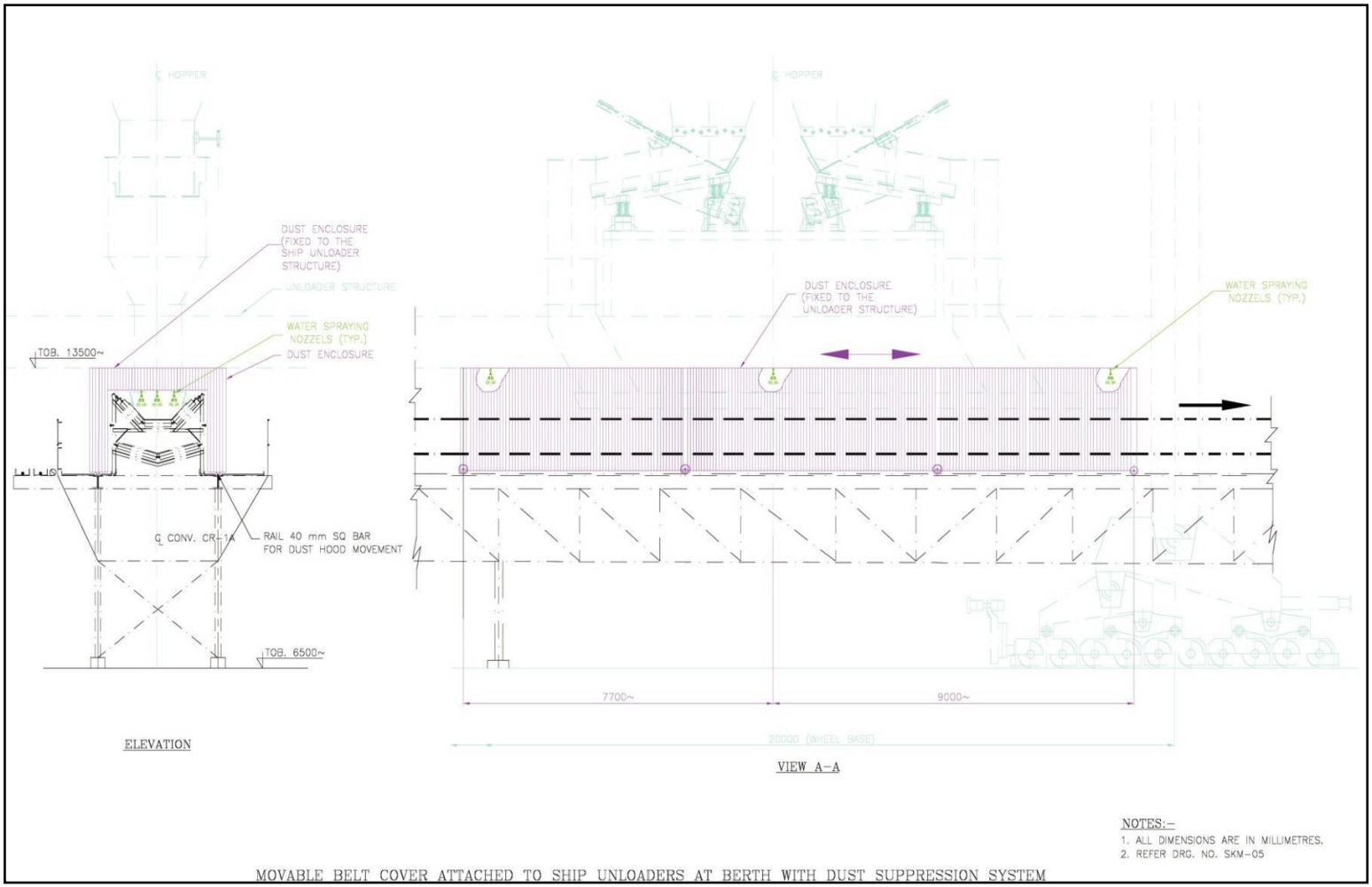


Figure 6.1: Water sprinkler system at ship unloader facility

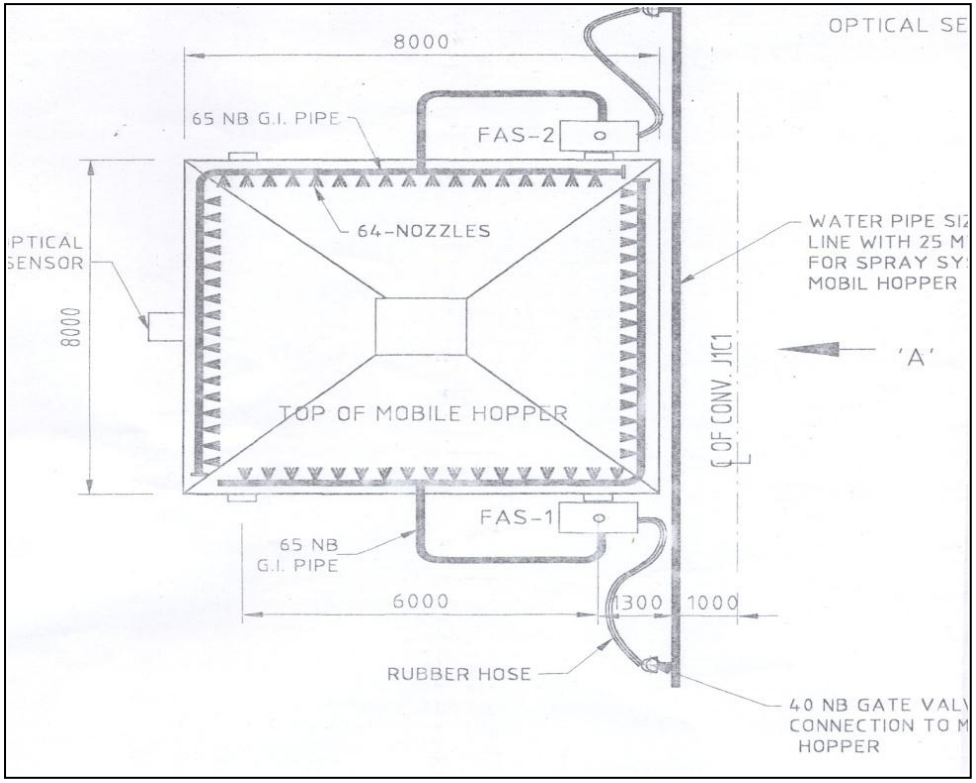


Figure 6.2 A: The water spray/mist system in the berth hopper for dust suppression

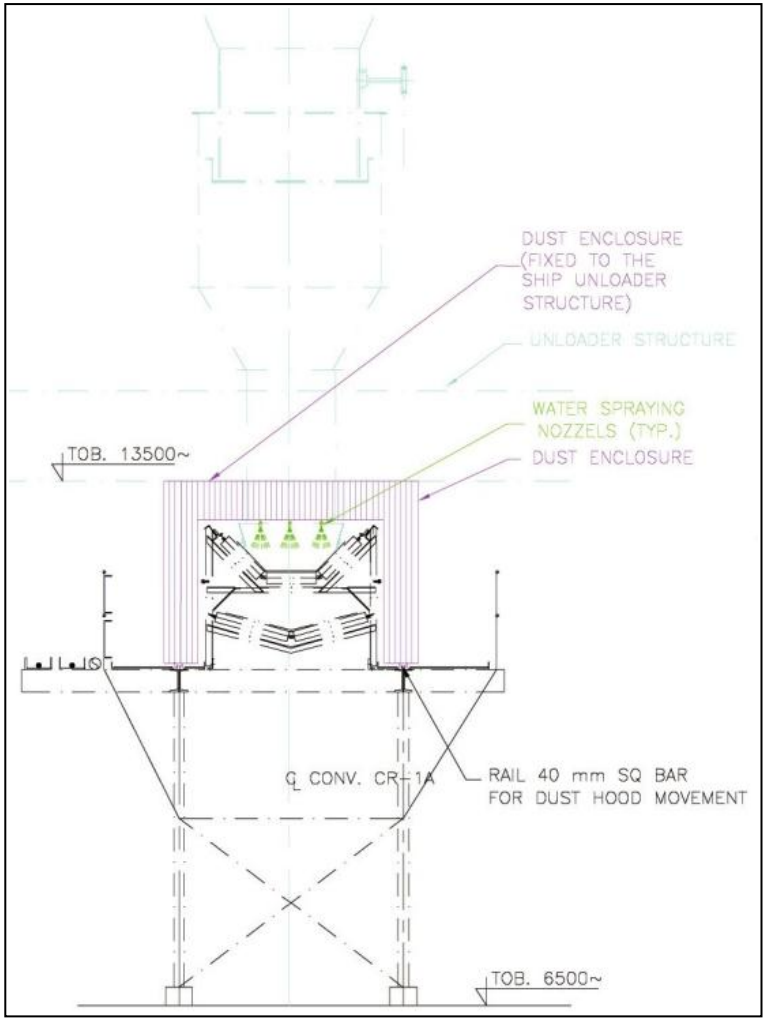


Figure 6.2 B: The water spray arrangement on the berth conveyor with the dust hood

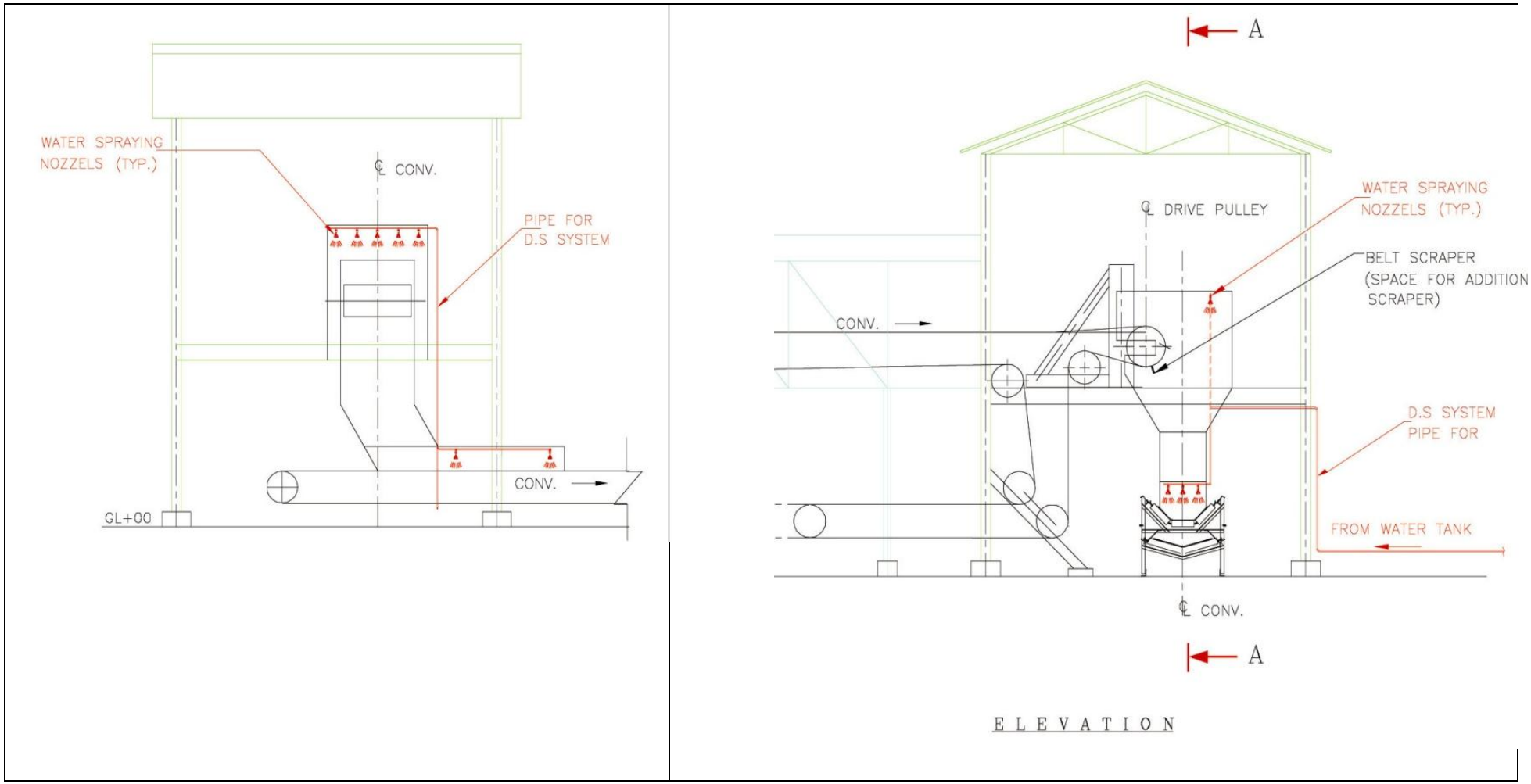


Figure 6.2 C: Water spray system at the transfer towers and conveyor systems

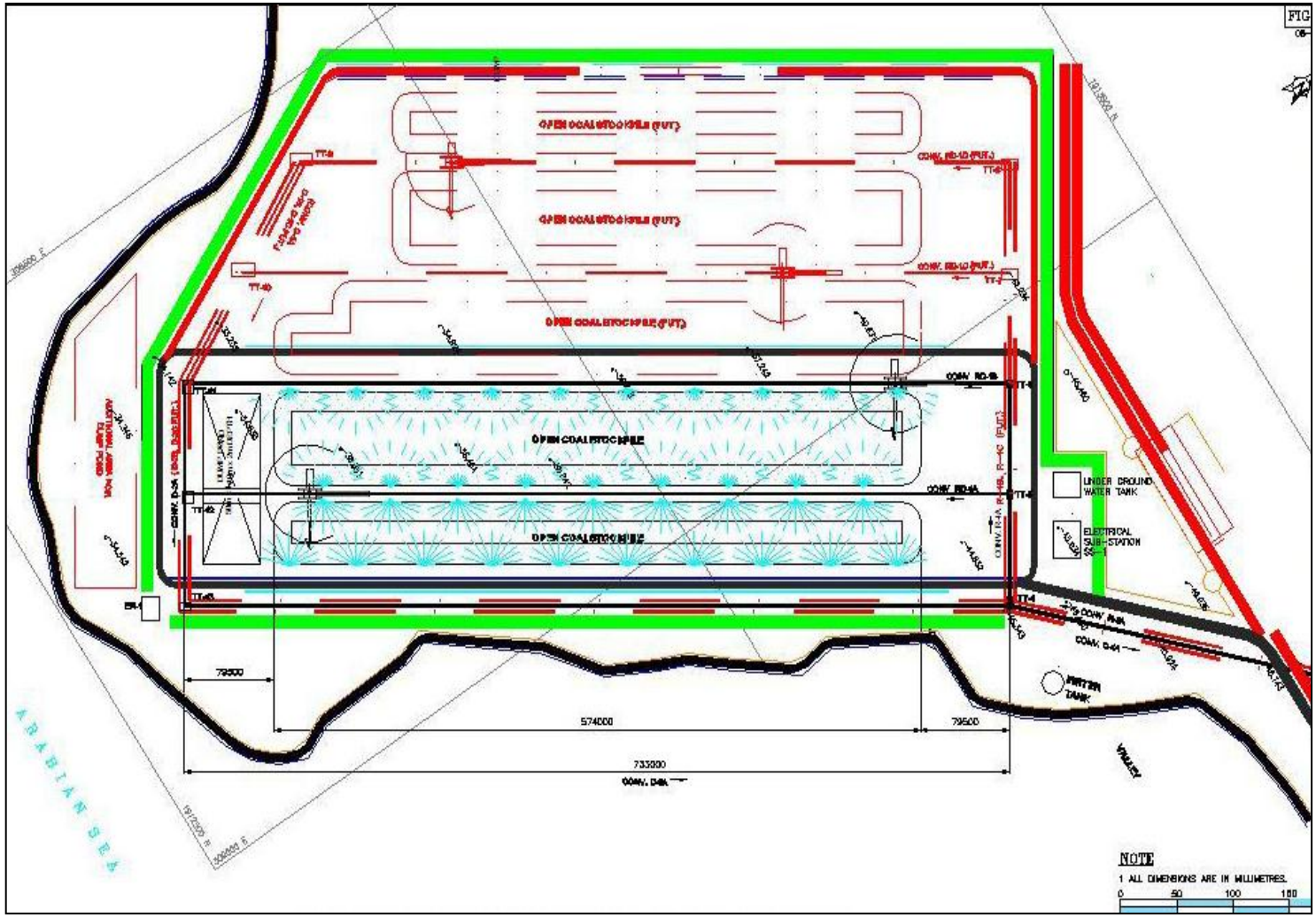


Figure 6.3: Layout showing sprinkler system for open stack yards

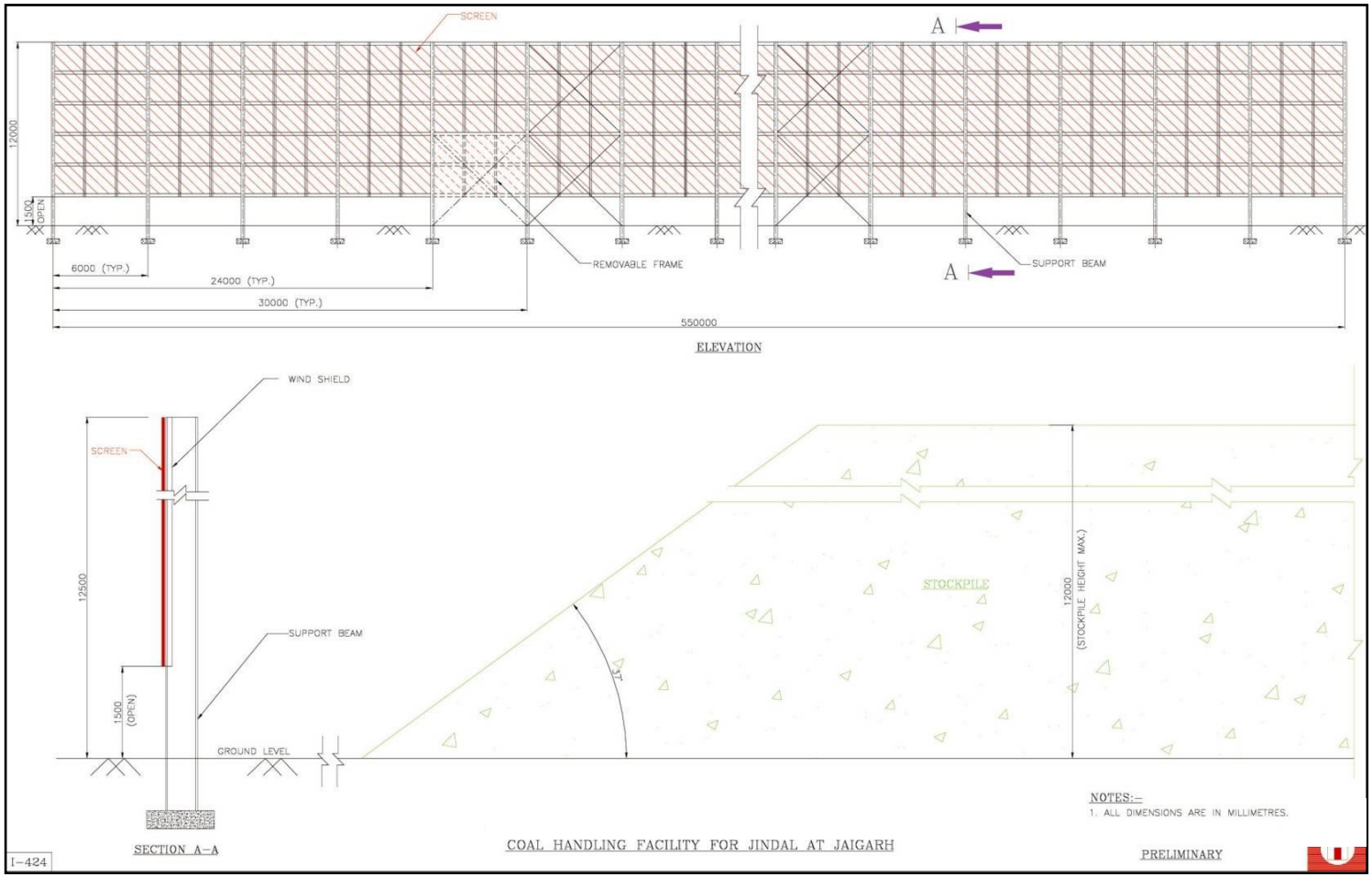


Figure 6.4: Windshield arrangement at open stack yard to control wind generated dust suspension

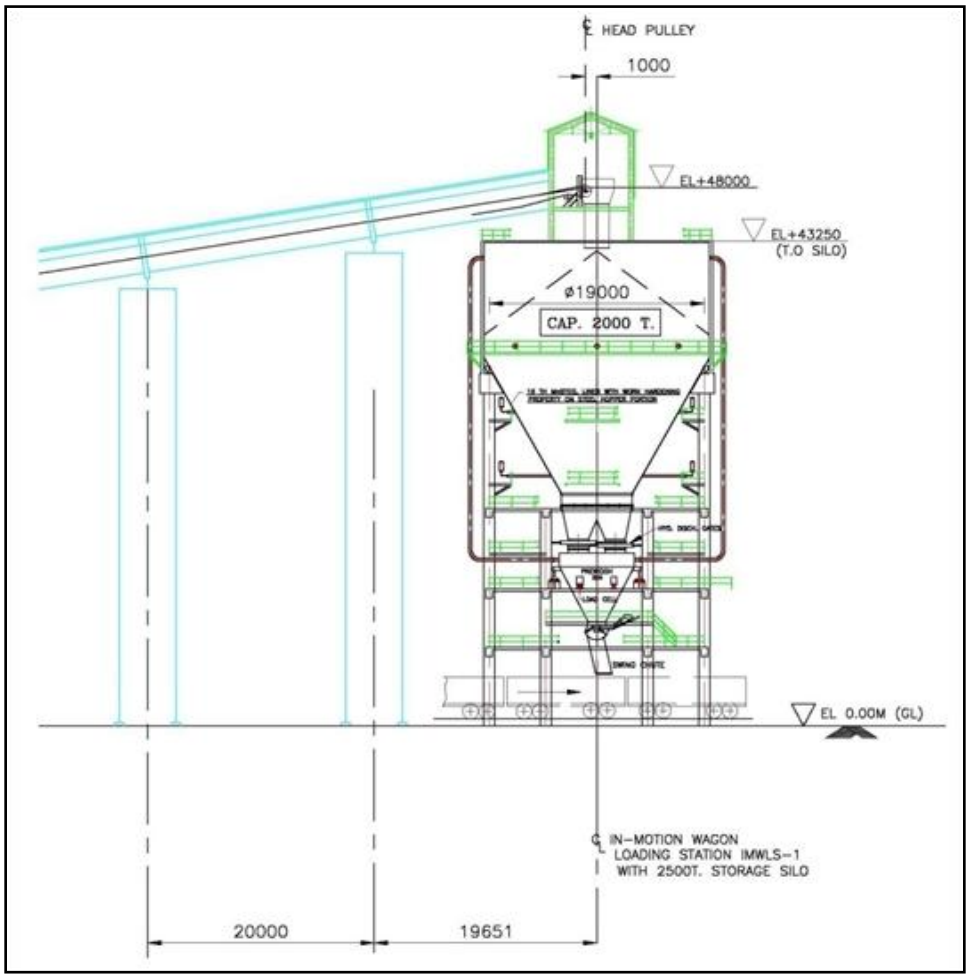


Figure 6.5: The Wagon Loading System

Fertilizer

The fertilizer will be unloaded by automated unloaders shall be transported by covered conveyors in to a covered storage as is shown in the Figure 6.6. The storage stack would be serviced from the top through tipper conveyor. The emission if any shall be totally and completely controlled inside the closed shed. The stack itself shall be placed on a raised platform so that, the spillage if any would be easily collected and fed back in to the system. Collection of spilled fertiliser can be carried out using mechanical sweeps and scrappers. Manual cleaning may also be resorted in case of any left over.

The fertilizer from the storage stack yard shall be moved through completely covered conveyors and hence the emissions shall be near zero, to the bagging plant for bagging before

despatch. The dispatch through rakes or road shall be solely in form of bags and no bulk transportation shall be undertaken. Figure 6.7 shows the arrangements at the despatch yard.

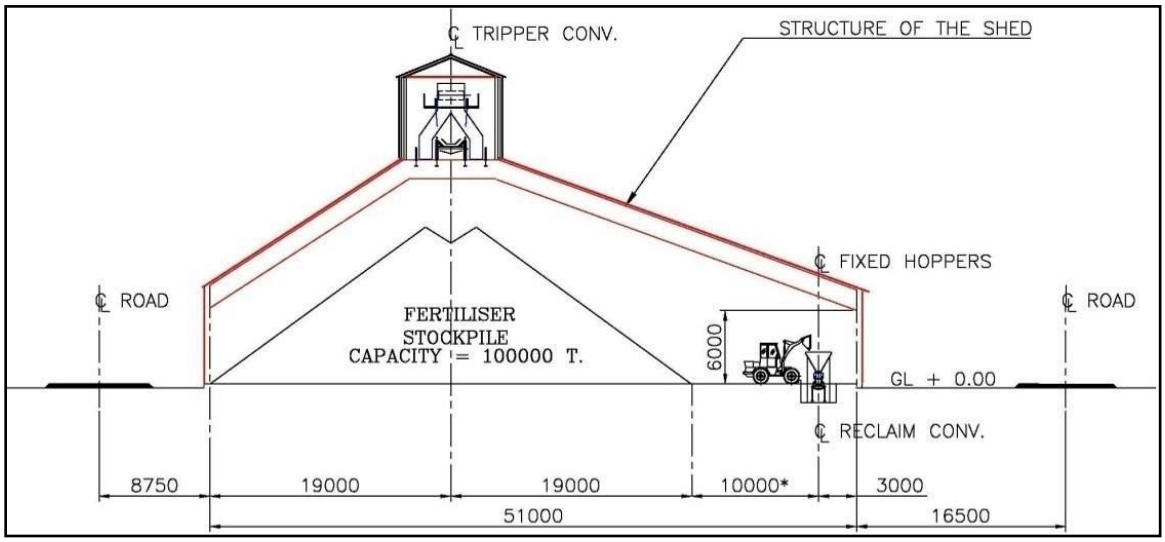


Figure 6.6 Layout showing covered and enclosed storage for fertilizer

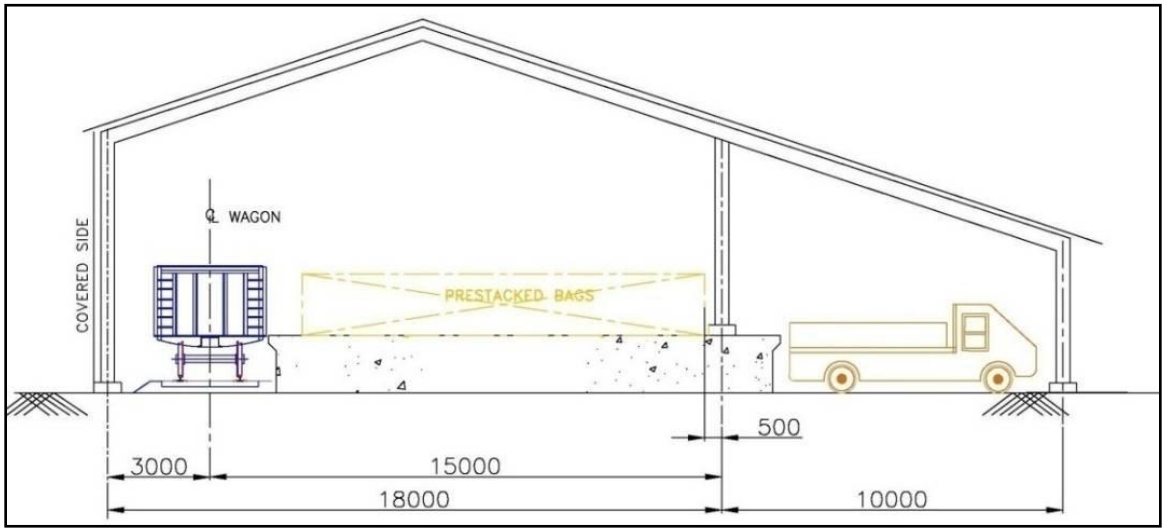


Figure 6.7 Layout showing the dispatch yard for the fertilizer bags

Cement and Clinker

Clinker is not likely to contribute to dust emission. Cement would be handled at the facility through Vacuum un-loaders conveyed through pipe conveyors, reducing the dust emission to

zero. The cement would be stored in a closed silo fitted with filters and dust suppressors. The bagging plants shall be fully enclosed and no emission at this point is also envisaged.

6.3.2 Water Environment

There are two sources of wastewater generation in the port project. One is the water collected from the stockyard area after being used for dust suppression and second is the domestic wastewater. Both of these waste streams will be treated appropriately. Apart from these two regular sources of effluents, plans for leaks at workshops and marine oil spills also are proposed.

Effluent from coal and other bulk cargo stack yard

Effluent from stack yard will contain mainly fine particles. Thus, it is proposed to be treated in a settling tank. In the stockpile area embedded perforated PVC pipes will be used for collection of sprayed water (for dust suppression) and storm water runoff. The pipe network at the stockyard will be connected to the dump pond or settling pond at the South-West end of the stockyard. The pond will be segregated in two chambers. The dump pond will be 140 m long x 50 m wide x 2 m deep with two days of retention period to allow settling of most of the particles. Additional area for dump pond, as shown in the site map, has been earmarked in the Master Plan for unforeseen circumstances and future expansion.

When one chamber is being cleared of the settled solids after draining of the clear water from the top, the other chamber will be utilised for collection of run-off water. Clean over flow after dust settlement can be collected and recycled for dust suppression and excess overflow will be discharged into outfall drain. The sludge so produced will be mainly coal dust, which will be put back in the stack yard.

The effluent form coal stack yard will contain high suspended solids. It is proposed to be treated in a settling tank. The sludge so produced will be mainly coal dust, which can be dried on sludge drying beds. The dried sludge, which has fuel value, can then be distributed amongst the villagers. During monsoon months, the sludge can be stored separately, in a structure with adequate storage capacity. The collected water can be reused sprinkling on coal stockyard. It would reduce the water demand for sprinkling.

6.3.3 Control of Water Pollution from oil spill

The other major source of water pollution is oil spills which may occur during bunkering operations. To combat oil pollution near the port, portable oil skimmers should be available at the berth. A clean sweep oil recovery unit consisting of a power pack and the recovery unit mounted on a system can be utilized for this purpose. The recovery unit generally consists of a recovery drum, collecting trough, screw conveyor, discharge housing and wiper assembly. In addition, the berths should have chemical dispersants with spray pumps, catamarans for collection of debris and recovery of oil and tanker carriers of 5 kl capacity for recovering sludge/bilge water. A provision of Rs.10.0 million has been earmarked for this purpose.

The International Convention for the Prevention of Pollution from Ships, 1973, as modified by the protocol of 1978 (MARPOL, 73/78), has issued guidelines for prevention of Marine Pollution. These are listed in subsequent paragraphs and should be strictly adhered to for prevention of marine pollution.

- Ships are prohibited to discharge oil or oily water such as oily bilge water containing more than 15 ppm of oil within 19 km (12 miles) of land.
- Chemicals are evaluated for environmental hazard which may cause environmental hazards if discharged into the sea (categories A, B, C and D). Discharge into the sea of the most harmful chemicals (category A) is prohibited. Tank washings and other residues of less harmful substances (categories B, C and D) may only be discharged keeping in mind certain conditions e.g. total quantity of discharge, distance from the shore, depth of water prescribed depending on the hazards. There are no restrictions on substances such as water, wine, acetone, etc.
- Harmful substances in the packaged form should not be disposed into the sea.
- Sewage generated at the ship should not be disposed off into the sea, unless it is treated or it is disposed off at a certain distance from land.
- Garbage produced on ship must be kept on board and discharged either ashore or into the sea under certain conditions, such as distance from the land; discharge of all plastics is prohibited.

6.3.4 Oil spill response plan

The Response plan should describe the recommended procedures for responding to an oil spill with essential information. The format of the operational plan should be as follows:

Reporting oil spill incidence

Immediately upon notice of an oil spill, incidence reporting will be done in the prescribed format to: the Internal within organization, Indian Coast Guard, Oil Industry Safety Directorate, Directorate General of Hydrocarbon (DGH), Concerned Port and Harbour Authorities and Mutual Aid Partners.

Details of Notification information

- Date and time of observation (24 hour clock).
- Position (preferably Lat. /Long., and/or description using recognized names).
- Source and cause of spill.
- Estimate of amount spilled and continued spillage rate.
- Description of the slick size.
- Type of oil spilled and characteristics
- Tide, weather and sea conditions.
- Owners of oil and carrier.
- Clean-up organization in place/responsible – name and contact details of on-Scene Commander.
- Action, both taken and intended, to combat pollution and prevent further spillage.
- Statutory local environmental bodies and contact details.
- Name, occupation and contact details of initial observers.

Surveillance and tracking of oil at sea

Immediately after the spillage, carry out the surveillance for assessing the quantity of spilled oil:

- Identification of sensitive areas.
- Identify the sensitive areas and inform the parties.
- Protect the sensitive areas as per the priorities.

Development of site specific response plan

- On-scene coordinator will identify the facilities required and sources from where the resources are mobilized.
- Operations planning and mobilization procedures.
- Mobilization procedures are required only in case the spill is likely to affect the coastline and damage the marine sensitive areas.

Control of operations

- Establish a management team with experts and advisors
- Update information (sea/wind/weather forecast, aerial surveillance, beach report)
- Review and plan operations accordingly
- Obtain additional equipment, supplies and man power if required
- Prepare daily incident log and management reports
- Prepare operations accounting and financing reports
- Prepare releases for public and press conferences
- Brief local and government officials including Coast Guard

Termination of operations

- Standing-down equipment for cleaning, maintaining and replacing
- Prepare formal detail report
- Review plans and procedures from lessons learnt.

Management of oil spills

Majority of spills at terminals result from routine operations such as valve leakages, improper couplings, pipeline leaks etc. These operational spills are generally small with over 90 % involving quantities of a few litres to a few tonnes. Rare but large accidental spills can occur when a ship gets involved in an accident such as collision or grounding. Hence, response at several levels is necessary for combating oil spills of such variable quantity.

The National Oil Spill Disaster Contingency Plan (NOS-DCP) describes the responsibilities of ports handling petroleum and its products. Indian Coast Guard is the Central Coordinating Agency for marine response. NOS-DCP considers response at 3 Tiers for combating oil spills. The Plan makes port authorities responsible to respond to accidents within the port limits

(Tier-1 response) though they can seek additional assistance through the regional communication / operational centre of the Coast Guard.

6.3.5 Escapement of chemicals

The port will be fully prepared and geared-up to meet emergencies such as fire due to leakages of these highly inflammable chemicals.

Emergency responders will be properly trained and equipped in accordance with OSHA standards on emergency response and emergency fire protection. The plan for responding to an emergency situation will prioritize the priorities for response. The first priority will be the safety of emergency personnel, employees and the surrounding community. The second priority will be minimizing damage to the critical equipment and machinery followed by the third priority of conserving or protecting the property and the environment.

Personnel at the liquid berth will be trained in proper handling and safety as per applicable international regulations. Respiratory protection will be available at the berth. OSHA's standard for these chemicals requires engineering controls and work practices that comply with the OSHA PELs (Personal Exposure Levels). Similarly, the Chemical Protective Clothing (CPC) to prevent contact with chemicals will be available at the terminal. The level of protection selected will be based on the potential ethylene / butadiene concentration and likelihood of contact.

Clear and unambiguous SOPs for unloading and handling these petrochemicals will be developed based on the site layout and all appropriate regulations and standards. It will be ensured that the product handling facilities used for unloading are compatible with the vessel design and product operating conditions.

6.3.6 Oil Spill Contingency Plan (OSCP)

To successfully combat an oil spill, the manpower needs to be thoroughly trained since quick and efficient response is the primary factor deciding the efficiency of the operation. It is also vital that all equipment is routinely inspected and regular mocks are held. The following issues will be earnestly addressed.

In view of handling of increased volume of petroleum products when the port is expanded the OSCP will be re-examined and modified if required in consultation with the Indian Coast Guard.

SOPs will be developed for every facet of operational OSCP that will include notification; strategy for combating depending on oil type, quantity involved and area of spill impact; deployment of booms to contain and to protect sensitive habitats, mainly mangroves; deployment of skimmers; on board and shore storage of recovered oil; strategy for shoreline cleaning and storage of oil contaminated sediment; use of dispersants; final disposal of recovered oil and contaminated sediment; closure of operation; dissemination of information to public and media etc.

The oil spill combating equipment will be stored in the vicinity of the oil berth and a suitable vessel will be always kept stand by for quick response during loading / unloading operations of petroleum and while providing bunker.

Mock drills involving deployment of critical oil spill containment and recovery equipment will be held at least once in 3 months.

Manpower responsible for responding to oil spills will be thoroughly trained in all facets of oil spill response.

The oil spill combating equipment will be inspected regularly as recommended by the manufacturers and records of inspection will be maintained. Prompt action will be taken to attend to deficiencies, if identified during inspection.

6.3.7 Control of Water Pollution from Marine Transportation

The other major source of water pollution is oil spills which may occur during bunkering operations. To combat oil pollution near the port, portable oil skimmers should be available at the berth. A clean sweep oil recovery unit consisting of a power pack and the recovery unit mounted on a system can be utilized for this purpose. The recovery unit generally consists of a recovery drum, collecting trough, screw conveyor, discharge housing and wiper assembly. In addition, the berths should have chemical dispersants with spray pumps, catamarans for collection of debris and recovery of oil and tanker carriers of 5 kl capacity for recovering sludge/bilge water.

The International Convention for the Prevention of Pollution from Ships, 1973, as modified by the protocol of 1978 (MARPOL, 73/78), has issued guidelines for prevention of Marine

Pollution. These are listed in subsequent paragraphs and should be strictly adhered to for prevention of marine pollution.

- Ships are prohibited to discharge oil or oily water such as oily bilge water containing more than 15 ppm of oil within 19 km (12 miles) of land.
- Chemicals are evaluated for environmental hazard which may cause environmental hazards if discharged into the sea (categories A, B, C and D). Discharge into the sea of the most harmful chemicals (category A) is prohibited. Tank washings and other residues of less harmful substances (categories B, C and D) may only be discharged keeping in mind certain conditions e.g. total quantity of discharge, distance from the shore, depth of water prescribed depending on the hazards. There are no restrictions on substances such as water, wine, acetone, etc.
- Harmful substances in the packaged form should not be disposed into the sea;
- Sewage generated at the ship should not be disposed off into the sea, unless it is treated or it is disposed off at a certain distance from land.
- Garbage produced on ship must be kept on board and discharged either ashore or into the sea under certain conditions, such as distance from the land; discharge of all plastics is prohibited.

6.3.8 Escapement of solid cargo

Comprehensive and easy to implement Standard Operating Procedure (SOP) will be made for each category of cargo in order to avoid spillages. SOPs will address safe conditions of wind, tide, visibility etc under which operations would be permissible. The operating staff at the berth will be trained in such operations and also to handle emergencies.

Transfer of bulks to the stack yards will be through closed conveyors. Water sprinkling will be done at stack yards prone to generate wind-blown dust.

6.3.9 Escapement of petroleum

Even with the loading arm spillages of petroleum while loading/unloading cannot be totally ruled out in spite of a number of safeguards are built in the design and adequate precautions and safety measures are taken during operation. Hence, appropriate spill response scheme should be in place to minimise impacts on marine environment should a spill occur.

Design considerations

For improved environmental safety and leak prevention, loading arms will be equipped with the following accessories:

- Hydraulic Coupler which allows rapid connection and disconnection of the arm to the tanker / pipeline flange.
- Powered Emergency Release Coupling (PERC) installed between two disco valves to allow quick disconnection from the tanker / pipeline without draining of the arm.
- Limit switches that define 3D working envelope giving alarm at three stages.
- Emergency Shut Down (ESD).

6.3.10 Berth related wastes

The wastes generated at berths in normal operations include domestic effluent, garbage and solid wastes (debris, leftover plastic items, boxes, containers etc).

Sufficient number of toilets and bathrooms will be provided to the operational staff. The sewage will be disposed in soak pits and domestic wastewater will be treated in a wastewater treatment plant and used for greenbelt development.

A site in the vicinity of berths will be cordoned and mark as solid waste collection site. Solid and hazardous wastes will be segregated at this site and stored separately. Biodegradable waste will be disposed as municipal sewage while hazardous waste will be given to the MPCB approved recyclers.

6.3.11 Terrestrial Ecology

As discussed earlier, no significant impact is envisaged on terrestrial ecology in the area due to the proposed project. However, there will be some fugitive emissions during the construction and operation phases of the proposed project. But the impacts due to these emissions will be insignificant. However, tree plantation programme along the roads in and around the project area will be taken up. In addition, ornamental trees and shrubs will also be grown at the proposed site to not only improve the bio-aesthetics but to contribute to a healthy state of terrestrial ecology in the area. An amount of Rs.1.0 million is proposed to be earmarked for these activities.

6.3.12 Green Belt Development

It is proposed to develop greenbelt around various project appurtenances, which will go a long way to achieve environmental protection and mitigation of pollution levels in the area.

Depending upon the topo-climatological conditions and regional ecological status, selection of the appropriate plant species has been made. The various criteria adopted for selecting the species for greenbelt development are:

- Plants should be fast growing;
- Preferably perennial and evergreen;
- Indigenous;
- Resistant to SPM pollution, and
- Should maintain the ecological and hydrological balance of the region.

The general considerations involved while developing the greenbelt are:

- Trees growing up to 10 m or above in height with perennial foliage should be planted around the perimeter of the proposed project area and on both sites of the conveyor belt.
- Planting of trees should be undertaken in appropriate encircling rows around the project site.
- Trees should also be planted along the roadside.
- Generally fast growing trees should be planted.
- Since, the tree trunk area is normally devoid of foliage upto a height of 3 m, it may be useful to have shrubbery in front of the trees so as to give coverage to this portion.

Taking into consideration the above parameters, the greenbelt development plan has been evolved for the proposed alternatives to reduce the pollution levels to the maximum possible extent. The plantation will be at a spacing of 2.5 x 2.5 m, and width of the greenbelt will be 15m. About 1,600 trees per hectare will be planted. The project proponents will also do the maintenance of the plantation area. The cost of plantation per hectare is estimated at Rs.50, 000. About 8 ha of land are proposed to be afforested as a part of Greenbelt Development Plan in either of the project alternatives. The total cost of afforestation works out to Rs.0.40 million. The species recommended for greenbelt development are listed in the Table 6.8.

Table 6.8: Recommended species for greenbelt development

Common Name	***Botanical Name***
Peepal	*Ficus religiosa*
Arjuna	*Terminalia arjuna*
Mango	*Mangifera indica*
Suru	*Casuarina equisetifolia*
Undi	*Mamea logifolia*
Amla	*Embelica officinalis*
Arjun	*Terminalis arjuna*

6.4 Environment Management Cell

It is proposed to develop Environment management team as a part of Environmental Management Cell (EMC) who will be responsible for the management of the environment of all environment retreated activities. The team will be headed by a senior management executive and will constitute environmental engineers, chemists and horticulture supervisors. The Organizational Structure of Environment Management Cell (EMC) is presented in Figure 6.8.

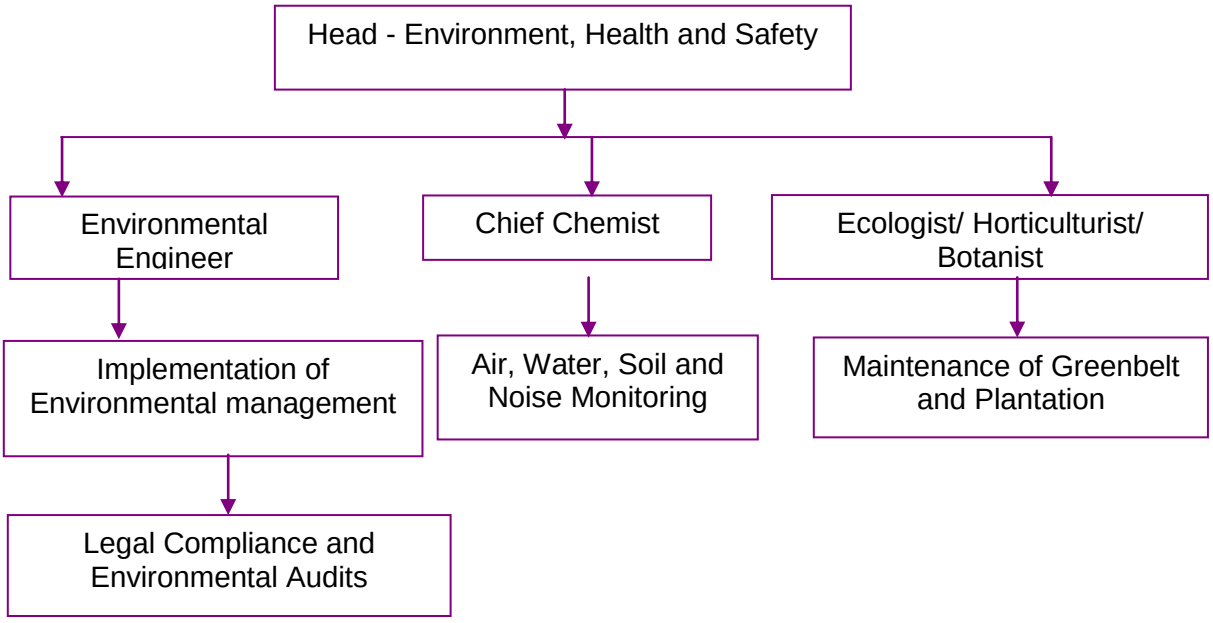


Figure 6.8: Organization structure for Environment Management Cell (EMC)

The Head (Environment) will be responsible for Environmental Management Activities in the proposed project. Basically, this department will supervise the monitoring of environmental pollution levels viz. source emission monitoring, ambient air quality, water and effluent quality, noise level either departmentally or by appointing external agencies wherever necessary. In case the monitored results of environmental monitoring are found to exceed the allowable limits, the Environmental Management Cell will suggest remedial action and get these suggestions implemented through the operation group.

The EMC will also coordinate all the related activities such as collection of statistics of health of workers and population of the region, afforestation and greenbelt development. This will be supported by a fully equipped laboratory to carry out the analysis.

7 RISK ANALYSIS AND DISASTER MANAGEMENT PLAN

7.1 Statutory Requirement, Coverage of the Risk Assessment

The RA covers operations of the port for hazardous inventories, solid, liquid and refrigerated liquids present in stockpiles, godowns, tanks and pipelines within the boundary of the port. Chemicals qualifying as '*Hazardous*' by virtue of listing in the Schedule 1, Part I and/or II of the Manufacturing Storage and handling of Hazardous Chemicals Rules, 1989 (amended 2000), (MSIHC Rules) have been considered for consequence analysis for RA.

Following typical hydrocarbon products proposed to be handled on oil jetties of ports have been considered for the RA:

a. Naphtha
b. Motor Spirit
c. Superior Kerosene Oil/Aviation Turbine Fuel
d. High Speed Diesel
e. Heavy/fuel oils

Following non-hydrocarbon bulk liquid cargo have been considered for RA, though their annual shipment volumes may be lesser than the hydrocarbon liquids:

a. Acitic Acid
b. Aniline
c. Benzene
d. Caustic Lye
e. Ethyl alcohol
f. Ethylene Di-Chloride
g. Hexane
h. Liquor ammonia
i. Methanol
j. Mono Ethylene Glycol
k. Styrene
l. Toulene
m. Xylene

The port proposes an 08 MMTPA LNG import terminal/3.5 MMTPA FSRU in addition to liquid cargo jetties. The LNG terminal may be on-shore storage-gasification-send out type, or a moored, along-side berthing FSU based LNG storage with on-jetty-deck open rack vaporisers.

The project *inter alia* attracts application and compliances under following statutes relevant to port and personnel safety:

1. Factories Act, 1948, Maharashtra Factory Rules, 1953
2. Manufacture, Storage and Import of Hazardous Chemicals (Amended) Rules, 2000
3. Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996
4. Petroleum Act, 1934, Petroleum Rules, 2002

The RA also discusses risks due to vessel collision and grounding and risks due to fire and explosion of hazardous cargo in the vessels within the notified port limit/administrative limit of the proposed port.

The DMP covers emergency response of the port during natural hazards and hazards due to release and compound consequences of hazardous chemicals.

7.2 Site Meteorology

Meteorology of a site plays an important part in its natural hazard vulnerability and dispersal characteristics in case of loss of containment of any hazardous material. The consequences of released toxic or flammable material are largely dependent on the prevailing weather conditions. For the consequence analysis of major scenarios the most important meteorological parameters are wind speed, atmospheric stability and temperature as they directly affect the atmospheric dispersion of the escaping material. Rainfall does not have any direct bearing on the results of the consequence analysis; however, it can have beneficial effects by absorption/washout of released materials. Actual behaviour of any release would largely depend on prevailing weather condition at the time of release.

Wind Speed

Ship observed offshore wind data for a period of 30 years from 1976 to 2005 were obtained from India Meteorological Department (IMD) and analyzed for the grid covering Lat. 18^o – 20^o N and Long 71^o – 73^o E, which centres the area of interest. Wind observations point that west is the predominant wind direction and that the wind speed is less than 10 m/s for 88% of the time. During fair weather season viz. October to May, the wind speed is less than 6 m/s for about 91% of the time. However, during the monsoon season (June to September), the wind speed is less than 8 m/s knots for only 62% of the time. During the peak monsoon period (July and August), wind speed of 6 to 13 m/s occurs for about 29% of the time. Wind speed of 13 m/s knots is seldom exceeded. However a maximum wind speed of 22.7 m/s has been reported, under normal conditions.

Atmospheric Stability

Stability of atmosphere is its tendency to resist vertical motion or to suppress existing turbulence. This tendency directly influences the ability of atmosphere to disperse pollutants emitted into it from the facilities. In most dispersion scenarios, the relevant atmospheric layer is that nearest to the ground, varying in thickness from a few meters to a few thousand meters. Turbulence induced by buoyancy forces in the atmosphere is closely related to the vertical temperature gradient.

Temperature normally decreases with increasing height in the atmosphere. The rate at which the temperature of air decreases with height is called Environmental Lapse Rate (ELR). It will vary from time to time and from place to place. The atmosphere is said to be stable, neutral or unstable according to ELR is less than, equal to or greater than Dry Adiabatic Lapse Rate (DALR), which is a constant value of 0.98°C/100 meters.

Pasquill stability parameter, based on Pasquill – Gifford categorization, is such a meteorological parameter, which describes the stability of atmosphere, i.e., the degree of convective turbulence. Pasquill has defined six stability classes ranging from `A' (extremely unstable) to `F' (moderately stable). Wind speeds, intensity of solar radiation (daytime insulation) and night time sky cover have been identified as prime factors defining these stability categories. Table-7.1 indicates the various Pasquill stability classes.

Table-7.1 Pasquill Stability Classes

Surface Wind Speed (m/s)	***Day time Solar Radiation***			***Night time Cloud Cover***		
	Strong	*Medium*	*Slight*	*Thin <3/8*	*Medium 3/8*	*Overcast >4/5*
< 2	*A*	*A – B*	*B*	*-*	*-*	*D*
2 - 3	*A – B*	*B*	*C*	*E*	*F*	*D*
3 – 5	*B*	*B – C*	*C*	*D*	*E*	*D*
5 – 6	*C*	*C - D*	*D*	*D*	*D*	*D*
> 6	*C*	*D*	*D*	*D*	*E*	*D*

Legend: A = Very unstable, B = Unstable, C = Moderately unstable, D = Neutral, E = Moderately stable, F = stable

As the D Neutral and F Stable states of the atmospheres pose greatest hindrance to dispersal of any chemical by advection by natural atmospheric dynamic processes, these stability classes are assumed for consequence analysis for the purpose of conservativeness. These stability classes are expected to be present with moderate frequency on a coastal site such as Nandgaon owing to high wind speeds and generally overcast skies.

7.3 Vulnerability Profile of the Nandgaon Port

Following aspects of the port may create threat to safety and wellbeing of the port infrastructure and life of the people working in the port and those residing in the vicinity of the port. A qualitative scoping assessment of the hazards has been presented in the Table-7.2.

Table-7.2 Vulnerability Profile of the Port

S. No.	***Hazard***	***Cause***	***Effect***	***Response Measure***
1.	*Earthquake*	*Geo-tectonic*	*Building and marine structure failures - Onsite effects, low casualty potential*	*a. Construction in accordance with applicable Codes* *b. DMP*
2.	*Wildfire*	*Causative factor not present*		
3.	*Tsunami*	*Geo-tectonic, Oceanographic*	*Marine structure failures, inundations, loss of hazardous cargo, offsite impacts, high casualty potential*	*a. Construction in accordance with applicable Codes* *b. DMP*

S. No.	Hazard	Cause	Effect	Response Measure
4.	Mud/landslide	Causative factor not present		
5.	Dam failure	Causative factor not present		
6.	Riverine Floods	No large river or river basin present in the zone of influence/discharging trough the Port site		
7.	Cyclone	Meteorological	Blow away of structures, cargoes and secondary losses, low casualty potential	a. Construction in accordance with applicable Codes b. DMP
8.	Flash Floods	Not likely		
9.	Thunderstorm and lightening	Not likely		
10.	Volcano	Causative factor not present		
11.	Extreme weather conditions	Out of purview of Port Intervention		
12.	Major Industrial accident/industrial disaster/nuclear disaster	Causative factor not present , out of purview of Port Intervention		
13.	Fires	Spot fire in coal stockpile	Localized effect, economic loss, no casualty potential	a. Sprinkling of water b. Fire fighting system c. SOP d. DMP
		Fire in POL/Hazardous cargo (due to pipeline failures)	Localized effect, economic loss, no casualty potential	a. Design engineering b. Fire fighting system c. SOP d. DMP
		Fire in bulker fuel	Localized effect, no casualty potential	a. SOP b. DMP
		Fire in Fertilizer/FRM	Localized effect, economic loss, no casualty potential	a. SOP b. DMP
		Fire in LNG operations	Localized effect, economic loss, low to moderate casualty potential	a. Design engineering b. High reliability detection and control systems c. Fire fighting system d. SOP e. DMP
14.	Explosion	Dust explosion in coal	Localized effect	a. Design engineering b. SOP
15.	Toxic release	Liquid Chemical cargo	Localized to medium spread	a. Design engineering

S. No.	Hazard	Cause	Effect	Response Measure
			(onsite) effect, casualty potential low	*b. SOP* *c. DMP*
15.	*Terrorist/disruptive activity*	*Low likelihood*		*Port security*

7.3.1 Vulnerability Profile of the Site with respect to Natural Disasters

Sea ports are vulnerable to natural hazards of ocean geo-tectonic and meteorological origins by being the first to bear their brunt. Ports absorb the forces of nature and act as shield for population immediately in their landward shadow, though facing losses due to damage of infrastructure and cargo, disrupted operations and other commercial losses.

Natural Hazard classification of the project has been carried out in accordance with the Munich Re database of natural hazards. Munich Reinsurance Company Limited (Munich Re) is a leading International Reinsurer which has collected and analysed precise natural disaster data of about two centuries in addition to credible historic records of natural disasters for classification of the world into hazard proneness and exposure ratings. The authoritative database is used by insurance companies worldwide to assess natural hazard risks of projects in specific geographical locations and decide upon the insurance premium amount.

Following natural hazards relevant to the proposed port have been ranked on the scale of respective severity for the Mumbai-Nandgaon region:

A. Earthquake
B. Storm/Cyclone
C. Lightening
D. Flood
E. Tsunami

Natural hazard classification of the Project site can be seen in Figure-8.1.

A. Earthquake

According to Munich Re Earthquake classification, Nandgaon falls in the Zone 1 – MM VI which is rated medium. The location falls in earthquake zone II as per IS 1893.

The port construction will take into account structural stability of the onshore and offshore structures so that they may withstand a high intensity earthquake during construction phase. Port structures will be designed in accordance with IS 1893: Part 1 2002 - Criteria for Earthquake Resistance Design of Structures. Construction activities will be based on technically evaluated and certified plans by established and authorised consultants. Action to be taken during an earthquake has been spelt out in Disaster Management Plan.

B. Storms/Cyclones

According to Munich Re classification, Nandgaon falls in Zone 3 – SS 3 (178-209 KM/hr wind speed). All port units will be designed to withstand wind loads in accordance with the applicable IS code - IS 15498:2004 'Guidelines for improving the cyclonic resistance of low rise houses and other buildings/structures' for wind resistance.

Although cyclones affect the entire coast of India, the East Coast is more prone compared to the West Coast. Only 25 percent of the cyclones that develop over the Arabian Sea approach the west coast. In the pre-monsoon season, corresponding figures are 25 percent over the Arabian Sea and 30 percent over the Bay of Bengal. There are 13 Coastal States and UTs in the country, with about 84 coastal districts affected by tropical cyclones. Four States (Tamil Nadu, Andhra Pradesh, Orissa and West Bengal) and one UT (Puducherry) on the East Coast and one State (Gujarat) on the West Coast are the States that are more vulnerable to cyclone disasters. Nandgaon is not a Cyclone prone area.

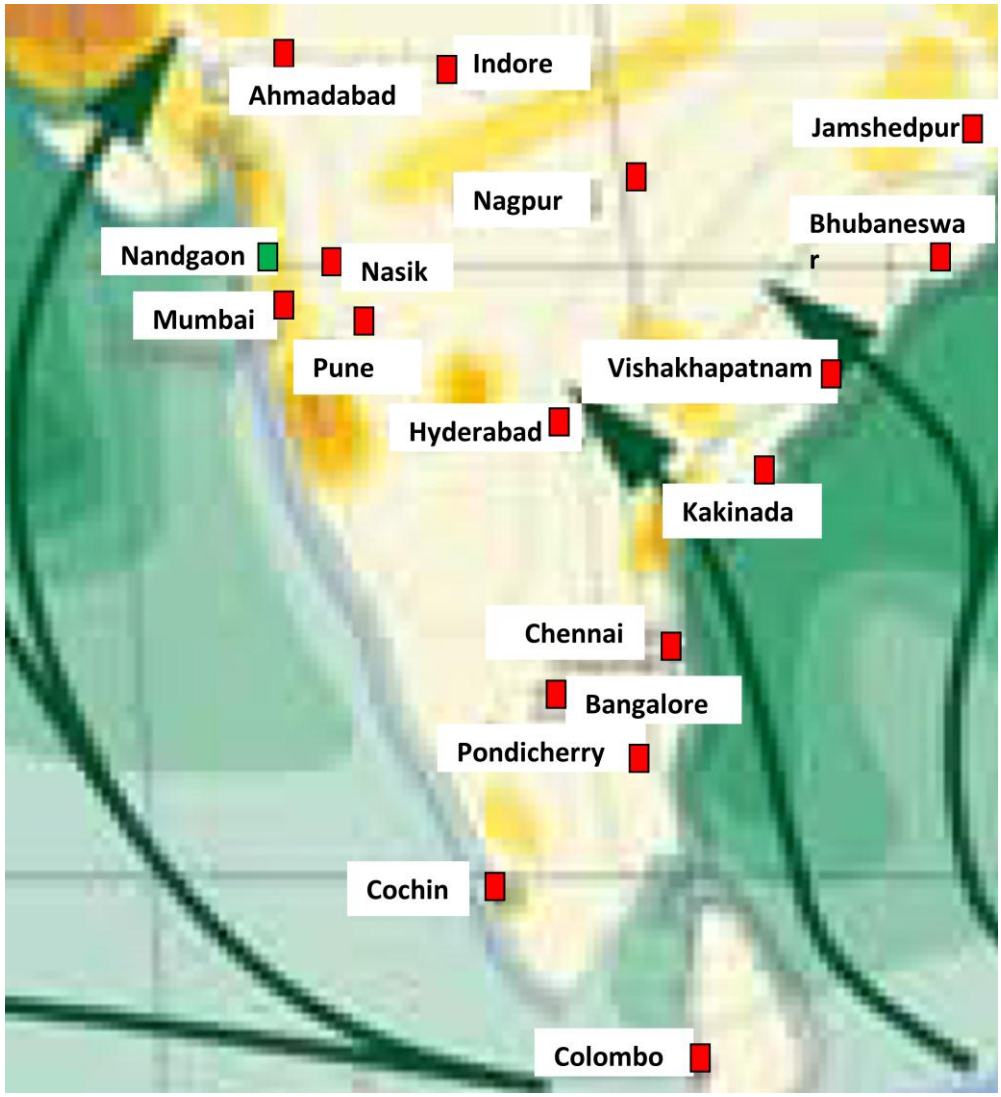


Figure-7.1 Natural Hazards at Project Site

Cyclones are classified in various categories depending up on the wind velocity, as stated in Table-7.3.

Table-7.3 Classification of Cyclones based on Intensity

S. No.	***Name***	***Wind Velocity (km/hr)***
1.	*Low Pressure Area*	*Up to 30*
2.	*Depression*	*30 – 50*
3.	*Deep Depression*	*50 – 60*
4.	*Cyclonic storm (Moderate)*	*60 – 85*
5.	*Severe Cyclonic storm*	*85 – 115*
6	*Severe Cyclonic storm with a core of hurricane winds*	*115 and above*

For Storms and Cyclones in the Arabian Sea, early warning of IMD is available 24-48 hrs prior to the onset. Hence cyclone precautions can be taken before it actually strikes. Action to be taken during a storm/cyclone is indicated in the Disaster Management Plan. As there are no large rivers in the proximity of the Port site, no significant risk of inundation from river spill over exists from the landward side.

C. Tsunami

Tsunam may occur in the Arabian sea due to presence of Makran subduction zone north of Arabian Sea, however likelihood of its occurrence is only 5% compared to tusnami events in Bay of Bengal due to proximity of tsunamigenic zone of Andaman-Nicobar-Sumatra island arc. Absence of volcanoes in the geological region also limits possibility of tsunamis near Nandgaon.

In case of an earthquake near northern Sri Lanka, the tsunami may take about 6 hour to reach Nandgaon with dissipated, feeble wave energy. For earthquakes in Indonesia the tsunami travel time may vary between 100 to 140 minutes. Figure-8.2 taken from the 'Tsunami Travel Time Atlas for the Indian Ocean' published by Indian Institute of Technology, Kharagpur shows the travel time of tsunami waves likely at Nandgaon area.

Tsunami warning by the IMD may be very short, in the range of one to four hours.

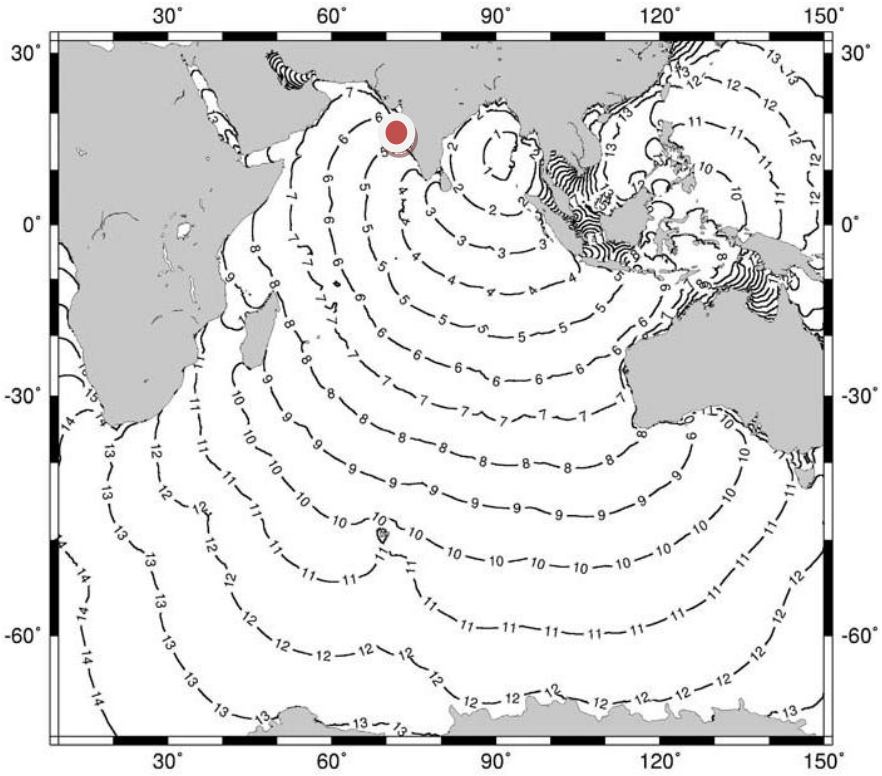


Figure-7.2 Tsunami Time Travel Chart for Andaman Sea

D. Lightning

According to Munich Re, chances of lightning exposure at Nandgan are low. All Port structures will be protected from lightening by providing lightening arresters erected as per IS Codes (IS 2309:1989).

7.4. Risks due to handling of Solid Bulk/break Bulk Hazardous Material

A common user port needs to create capability, both in terms of protective hardware as well as systems to handle emergencies arising out of hazardous consequences related to handling of hazardous cargoes. The hazard responses will be specific to the nature of cargo, mode of handling and storage and likely modes in which there could be loss of containments and hazardous consequences. Cargoes which may cause damage due to inappropriate handling have been studied for their damage potential; suggested Standard Operating Procedures have been suggested for their handling and storage.

Hazards due to storage and handling of combustible or mildly toxic material in solid form are discussed in the following sections in the chapter. Bulk cargoes such as coal and the Fertilizers/FRMs are not hazardous per definition of the term in the MSIHC Rules, 1996 (listing in the Schedule 1, Part I and/or II of the Rules). Following the instruction for handling of these materials in their MSDS and good storage practices are generally adequate to eliminate any undesirable consequences in mass handling of the material.

a. Coal Fire

Coal is classified according to their carbon content. Common coal types handled on Ports may be Anthracite (80-96% carbon), Bituminous (35-80% carbon), Lignite (25-35% carbon) and Peat (less than 25% carbon); however international or coastal shipping of low grades of coal such as lignite or peat are rare.

Coal is not categorized as 'hazardous substance material' per MSIHC Rules, 1989. Coal, being flammable, basically poses following hazards.

1. Coal fire hazard in coal storage
2. Coal dust explosion hazard in handling of coal in confined spaces

Fire in bulk stored coal stockpile is a very common occurrence. The risk of fire exists wherever significant amount of coal is stored or used. Coal, being combustible, is susceptible to a variety of causes of ignition. However, the most common reason for fire in a coal stockpile is spontaneous combustion, i.e. combustion without contact by any external ignition source.

Spontaneous combustion depends on many complex and different factors such as:

1. Type of coal
2. Age of coal
3. Composition of coal
4. Method of storage
5. Moisture content
6. Final use

Spontaneous combustion fires usually begin as "hot spots" deep within the reserve of coal. The hot spots appear when coal absorbs oxygen from the air. Heat generated by the oxidation then initiates the fire. Such fires can be very stubborn to extinguish because of the amount of coal that is involved and the difficulty of getting to the seat of the problem. Moreover, coal in either the smouldering or flaming stage may produce copious amounts of methane and carbon monoxide gases. In addition to their toxicity, these gases are highly explosive in certain concentrations, and can further complicate efforts to fight this type of coal fire.

The fire fighting efforts must be concentrated on extinguishing the fire rather than on wetting the whole of coal stockpile. It is advisable that water be applied from a safe distance. It helps if a proper plan is first made as and when fire is detected and information about the extent of the fire spread is available, then the fire can be extinguished efficiently, completely and safely.

In case of coal fire, the coal fire spreads at a very slow rate that allows sufficient time to mount an adequate fire-fighting strategy depending on the type and the quantity of coal on fire.

Hazards commonly associated with coal fire are burn injuries to the workers and fire fighters. These can be avoided with proper fire fighting techniques and personal protective equipment.

b. Coal Dust Explosion

A dust explosion is defined as rapid burning of combustible particulate within a confined area that result in the generation of shock wave and intense heat. The pressure rise due to any explosion in a confined space needs to be vented adequately by proper design of explosion flaps in order to prevent damage to the confining structure and its surroundings. Absence of persons is ruled out in such functional enclosures due to high dust concentration.

The areas where dust explosion is likely in the proposed port are as follows:

1. Transfer towers in the conveyor streams

2. Sections of conveyor galleries
3. Wagon Loader

Good design of coal conveyors, dust control provisions, preventive maintenance, and regular maintenance of dust control devices such as bag dust collectors, common spark exclusion measures and provision of explosion vents/flaps are generally adequate to avoid and mitigate occasional explosions in the coal transfer stream. As the coal in the Port will be handled in pre-sprinkled condition and in lump form, likelihood of coal dust explosion will be reduced significantly.

c. Hazards in Fertilizer and FRM handling

Fertilizer and Fertilizer raw material may pose handling and storage problems due to huge variety in the properties of Fertilizer and FRM. Table-7.4 lists the precautions to be taken while handling Fertilizer and FRM in the Port.

Table-7.4 Handling Precautions for Fertilizer and FRM

Transportation of goods	• *Cover any loads of fertilizer products whilst in transit*
Drift of dust from storage areas and/or facilities	• *Keep fertilizer products covered and/or sealed* • *Clean up spillages promptly* • *Personnel responsible for storage areas and/or facilities to will ensure that the drift of dust beyond the perimeter is kept to a minimum.*
Storage areas - Floors	• *Keep floor surfaces swept clean of fertilizer to prevent tracking by people and/or vehicles beyond the perimeter.* • *Sweep up and dispose of spillages in a timely and appropriate manner*
Cross contamination of product	• *Keep each fertiliser product will in a separate storage container and/or position within the facility and/or area.*
Confusion of Product	• *Maintain an accurate storage manifest/register.* • *Ensure all storage bays and bins are clearly labelled.* • *Ensure all storage, loading and blending plant and equipment is cleaned from all residues when changing from one product to another.* • *Do not store product in bags that are not correctly stamped*
Personal Protective Equipment	• *Personnel must be provided with appropriate PPE when using fertiliser products.*
Appropriate warning safety signage and information	• *Managers must ensure that appropriate safety warning signs and/or information is displayed/available regarding nature of hazards and risk control measures.*
Housekeeping and/or routine maintenance	• *All personnel are responsible for implementing sound housekeeping practices in storage areas and arranging regular routine maintenance for all equipment used.*

Plant & equipment	• *Conduct regular inspection & testing of equipment and infrastructure to identify maintenance requirements*
Training	• *Personnel will undergo appropriate training.*
Appropriate records &/or documentation	• *All relevant records and documentation to be kept and maintained e.g. training records, risk assessments, maintenance schedules, MSDS's etc.*
General Storage Guidelines	• *Keep fertilizer/FRM covered to avoid unnecessary expose to open air.* • *Do not store dry urea with dry ammonium nitrate.* • *Ensure that the storage facility is appropriately secured,* • *Fertilizer/FRM materials are not to be stored in contact with ground surfaces,* • *Storage areas/facilities are to weather-proofed and able to exclude runoff from other areas,* • *Do not store in close proximity to heat sources such as open flames, steam pipes, radiators or other combustible materials such as flammable liquids,* • *In case of fire flood the area with water,* • *If augers are used to move the material ensure that any residue(s) in the immediate area is cleaned up, and* • *Dispose of empty bags in the appropriate manner.*

MSDS of all the Fertilizers/ FRM should be sought from the supplier fifteen days in advance of the handling schedule to help arrange appropriate handling appurtenances and storage space.

Summary chemical properties of seven major fertilizers and FRMs handled on Indian ports are presented below, also indicating precautions to be taken while handling them. The summary given below will be supplemented by information given in MSDS available with the port operations team at the time of handling.

Iron Sulphate
Physical *Iron sulphate is a liquid that is grey in colour. It is fully soluble in water.* *Fire* *It may not catch fire by itself. Wear full protective suit and Self Contained Breathing Apparatus (SCBA) for fire fighting as oxides of sulphur may get emitted due to fire. Use water spray and carbon dioxide to extinguish fire.* *Health* *It may enter human body through inhalation of spray fumes and exposed skin.* *Eyes: Flush immediately with plenty of water for 15 minutes, if condition persists, consult doctor.* *Skin: Wash thoroughly with water, if condition persists, consult doctor.* *Ingestion: Do NOT induce vomiting, give large quantities of water, if condition persists, consult doctor.* *Toxicological Information*

No data is available
General Precautions:
Use good personal hygiene practices
Environmental Information
It undergoes ionic dissociation
It may be toxic to aquatic life
Do not contaminate land and water with concentrate
Reactivity/ Materials to avoid
Extremes of temperatures should be avoided
Salts of Barium and strontium and highly alkaline substances and reagents should be avoided

Calcium Ammonium Nitrate

Physical
It is in powder form. It's soluble in water to an extent of 140 g/100 ml.
Fire
It may not catch fire by itself, but it may catch fire when in contact with combustible materials. In case the surrounding material catches fire, due to possibility of release of toxic and corrosive nitrous vapours, Self-Contained Breathing Apparatus may be used. All types of extinguishing media can be used for surrounding fires.
Health
Eyes: Irritating to eyes, flush immediately with plenty of water for 15 minutes, if condition persists, consult doctor.
Skin: Wash thoroughly with water, if condition persists, consult doctor.
Ingestion: Give large quantities of water, if condition persists, consult doctor.
Inhalation: Move victim to fresh air; maintain adequate airway & respiration, if breathing problems develop or unconscious, consult doctor
Toxicological Information
Acute Oral Toxicity: LD_{50} (rat) found to be 2000 mg/kg, not acutely toxic.
General Precautions:
Use good personal hygiene practices
Remove contaminated clothing immediately
Clean contaminated clothing
Environmental Information
Do not contaminate land, water or sewerage with concentrate
Reactivity/ Materials to avoid
Hygroscopic conditions should be avoided
Keep away from reducing materials and organic materials

Muriate of Potash

Physical
It is a colourless or whitish in granules or powder form fertiliser. It's slightly soluble in water to an extent of 11 g/100 ml.
Fire
It may not catch fire by itself, but it may catch fire when in contact with combustible materials. The product may reach melting point & decompose to release NH_3, SO_X, PO_X or CN. In case the surrounding material catches fire, use suitable media to extinguish source of fire, Self-Contained Breathing Apparatus may be used.
Health
Eyes: Flush immediately with plenty of water for 15 minutes, if condition persists, consult doctor.
Skin: Wash thoroughly with soap & water, if condition persists, consult doctor.

Ingestion: If large amount is ingested, give 2-3 glasses of water, induce vomiting, and consult doctor.

Inhalation: Move victim to fresh air; maintain adequate airway & respiration, if breathing problems develop or unconscious, consult doctor

Toxicological Information

Acute Oral Toxicity: LD_{50} (rat) found to be 1500-2600 mg/kg, not acutely toxic.

General Precautions:

Use good personal hygiene practices

Environmental Information

Do not contaminate land, water or sewerage with concentrate

Reactivity/ Materials to avoid

Hygroscopic conditions should be avoided

Keep away from strong oxidising agents as prolonged contact may cause oxidation of unprotected metals.

Phosphoric Acid, 28 % P_2O_5

Physical

It is green viscous liquid fertiliser. It's odourless when cold and pungent when hot. It reacts with water to produce heat. It's completely soluble in water.

Fire

It may not catch fire by itself, but it may catch fire when in contact with combustible materials. The product on reaching very high temperatures may produce phosphoric acid mists. Self-Contained Breathing Apparatus may be used for fire fighting purposes. In case the surrounding material catches fire, use suitable media to extinguish source of fire,

Health

Eyes: It will cause severe irritation; prolonged contact may result in burn to eye causing permanent damage. Consult doctor immediately.

Skin: May produce mild to severe irritation, prolonged contact may result in chemical burns. Consult doctor immediately.

Ingestion: May result in burning of mucous membrane and/or gastrointestinal tract. Consult doctor immediately.

Inhalation: Acid mists may produce mild to severe irritation of respiratory tract. Consult doctor immediately.

Toxicological Information

Acute Oral Toxicity: LD_{50} (rat) found to be 1530 mg/kg, not acutely toxic.

Acute Dermal Toxicity: LD_{50} (rabbit) > 3160 mg/kg, not acutely toxic

Acute Inhalation Toxicity: LC_{50} (guinea pig, mouse, rabbit) found to be 61-1689 mg/m^3, not acutely toxic.

General Precautions:

Use good personal hygiene practices

When unloading, open vent valve on top of container before opening and leave for adequate time for chlorine gas to diffuse in atmosphere

Environmental Information

Do not contaminate land, water or sewerage with concentrate

Reactivity/ Materials to avoid

Keep away from strong alkaline agents or metal other than stainless steel.

It reacts strongly with strong alkalis to produce heat.

Phosphoric Acid, 28 % P_2O_5

Physical

It is white solid fertiliser. It's odourless when cold and pungent when hot. It reacts with water to produce heat. It's soluble in water to an extent of 31 g/100 ml.

Fire

It may not catch fire by itself, but it may catch fire when in contact with combustible materials. The product on reaching very high temperatures may decompose to from hazardous gaseous oxides of nitrogen. Remove containers from fire area, if possible. Self-Contained Breathing Apparatus may be used for fire fighting purposes. Use water to extinguish fire. Do not use dry chemicals, CO_2 or halogenated agents to extinguish fire.

Health

Eyes: It will cause discomfort, Flush immediately with plenty of water for 15 minutes, if condition persists, consult doctor.

Skin: It will cause discomfort, Wash thoroughly with soap & water, if condition persists, consult doctor.

Ingestion: Mau cause diarrhoea, vomiting or convulsions, Consult doctor.

Inhalation: May cause discomfort, Move victim to fresh air, maintain adequate airway & respiration, if breathing problems develop or unconscious, consult doctor

Toxicological Information

Acute Oral Toxicity: LD_{50} (rat) found to be 1900-3750 mg/kg, not acutely toxic.

Acute Dermal Toxicity: LD_{50} (rat) > 5000 mg/kg, not acutely toxic

General Precautions:

Use good personal hygiene practices

Environmental Information

Do not contaminate land, water or sewerage with concentrate

Reactivity/ Materials to avoid

It is an oxidiser and may burn vigorously or explode when mixed with combustible materials or ignited.

Rock Phosphate, Ground

Physical

It is a light brown to dark brown or black rock. It's soluble in water.

Fire

It will not catch fire by itself. The product may decompose at high temperatures to release PO_X & SiF_4 gases. Use suitable media to extinguish source of fire.

Health

Eyes: Flush immediately with plenty of water for 15 minutes, if condition persists, consult doctor.

Skin: Wash thoroughly with soap & water, if condition persists, consult doctor.

Ingestion: If large amount is ingested, give 2-3 glasses of water, induce vomiting, and consult doctor.

Inhalation: Move victim to fresh air; maintain adequate airway & respiration, if breathing problems develop or unconscious, consult doctor

Toxicological Information

No information available

General Precautions:

Use good personal hygiene practices

Environmental Information

Do not contaminate land, water or sewerage with concentrate

Reactivity/ Materials to avoid

Keep away from strong acids.

Urea

Physical

It is in white powderish or white crystalline form having ammonia like odour. It's soluble in water.

Fire

It will not catch fire by itself. Reactions with incompatible material may cause explosion hazard. Use full protective clothing and Self Contained Breathing Apparatus for fire fighting. Use suitable media to extinguish source of fire.

Health

Eyes: Flush immediately with plenty of water for 15 minutes, if condition persists, consult doctor.

Skin: Wash thoroughly with soap & water, if condition persists, consult doctor.

Ingestion: Induce vomiting immediately, consult doctor.

Inhalation: Move victim to fresh air; maintain adequate airway & respiration, if breathing problems develop or unconscious, consult doctor

Toxicological Information

Acute Oral Toxicity: LD_{50} (rat) found to be 8471 mg/kg, investigated as reproductive effector.

General Precautions:

Use good personal hygiene practices

Environmental Information

Do not contaminate land, water or sewerage with concentrate

Reactivity/ Materials to avoid

Urea reacts with calcium hypochlorite or sodium hypochlorite to form the explosive nitrogen trichloride.

It is incompatible with sodium nitrite, gallium perchlorate, strong oxidizing agents (permanganate, dichromate, nitrate, chlorine), phosphorus pentachloride, nitrosyl perchlorate, and titanium tetrachloride and chromyl chloride.

Zinc Sulphate

Physical

It is a colourless hazy liquid with little odour. It's completely soluble in water

Fire

It may not catch fire by itself. The product may evolve oxides of sulphur on reaching high temperatures. Use water sprays and/or CO_2 to extinguish fire. Use full protective suit.

Health

Eyes: Flush immediately with plenty of water for 15 minutes, if condition persists, consult doctor.

Skin: Wash thoroughly with water, if condition persists, consult doctor.

Ingestion: If conscious, give large amount of water, do NOT induce vomiting, if condition persists or unconscious, Consult doctor.

Toxicological Information

No information available.

General Precautions:

Use good personal hygiene practices

Environmental Information

Do not contaminate land, water or sewerage with concentrate

Reactivity/ Materials to avoid

High temperatures should be avoided.

Lead, calcium, powered metals such as aluminium and magnesium, strontium salts and strong alkalies & borax should be avoided.

7.5 Risks due to handling of Liquid Hazardous Material

7.5.1 Hazardous Material proposed to be handled on the Port

Handling of POL cargo for retail customers is one of the prime mandates of the proposed port. The POL and chemicals will be handled on three liquid berths.

The RA specifically covers consequences from loss of containment of following typical and representative hazardous material proposed to be handled by the port, listed in Table-7.5. Screening of chemicals for hazardous property have been carried out on the basis of Schedule 1 Part II of the MSIHC Rules, 2000 based on the hazard criteria of Toxicity (LD_{50}/LC_{50}), Flammability (flash point) and Explosively (pyrotechnic properties). Hazardous nature of the material has been substantiated from the NFPA 704 'Fire Diamond' classification.

Table-7.5 Identified Hazardous Chemicals

S. No.	***Cargo***	***Property of Concern***	***Reference Schedule 1, MSIHC Rules, 1989***	***NFPA 704 classification (Toxicity, Flammability, Reactivity, Special)***
1	*Naphtha*	*Highly flammable*	*Schedule 1, Part I*	*2,3,0*
2	*Motor Spirit*	*Highly flammable*	*Schedule 1, Part I*	*1,3,0*
3.	*SKO/ATF*	*Flammable*	*Schedule 1, Part I*	*2,2,0*
4.	*HSD*	*Flammable*	*Schedule 1, Part I*	*0,2,0*
5.	*Heavy fuel oils*	*Flammable*	*Schedule 1, Part I*	*0,1,0*
6.	*Acitic acid*	*Corrosive*	*Schedule 1, Part II, 02*	*3,2,1*
7.	*Aniline*	*Toxic*	*Schedule 1, Part II, 37*	*3,2,0*
8.	*Benzene*	*Toxic*	*Schedule 1, Part II, 56*	*2,3,0*
9.	*Caustic lye*	*Corrosive*	*Schedule 1, Part II, 571*	*3,0,1*
10.	*Ethyl alchohol*	*Highly flammable*	*Schedule 1, Part II, 248*	*2,3,0*
11.	*Ethylene Di Chloride*	*Highly flammable, Toxic*	*Schedule 1, Part II, 271*	*3,3,0*
12.	*Hexane*	*Highly flammable*	*Schedule 1, Part II, 306*	*1,3,0*
13.	*Methanol*	*Highly flammable*	*Schedule 1, Part II, 377*	*1,3,0*
14.	*Mono Ethylene Glycol*	*Toxic*	*Schedule 1, Part II, 267*	*2,1,1*
15.	*Styrene*	*Highly flammable*	*Schedule 1, Part II, 583*	*2,3,2*
16.	*Toluene*	*Highly flammable*	*Schedule 1, Part II, 628*	*2,3,0*
17.	*Xylene*	*Highly flammable*	*Schedule 1, Part II, 442*	*2,3,0*

7.5.2 Handling of Liquid Cargo

Liquids will be handled in the specially designed, dedicated liquid cargo berth. The liquid berths are planned on the northern breakwater, closer to the point of entry of the channel into the basin. The berths will comprise working platforms, bresting and mooring dolphins and interconnecting walkways on steel trestles. Alongside depth of -17 m CD will be maintained which will be capable of berthing liquid cargo vessels of 85,000 DWT.

The working platforms will be equipped with loading arms for liquid cargoes, water, and bunker fuel. Instrumented loading arms will be supplied with quick detach couplings for rapid spill and risk response. The loading arms will be set to operate within a safe articulation window to allow for three dimensional vessel movements due to variation in mooring forces and tidal fluctuations. When moving out of the window, the arms will raise a visual and annunciation alarm at the operating platform and also on the panel of the MCR. In case of any malfunction of the articulation window alarms, or any sudden inadvertent movement of the vessel while the arm is connected to her, shearing of the arms may take place. Quick shut down valves will be fitted on to the arms to limit the volume of spill to arm hold-up.

Bresting dolphins will be equipped with cell fenders. Quick release type mooring capstans, and mooring line load measuring system will be installed on the berths, hooked to the Liquid cargo PLC system.

Approach to the working platform will be provided through a pile supported trestle from the breakwater side. The bridge will also carry pipelines from the breakwater pipeline bank to the operating platform. Hydraulic operated, telescopic gangway will be installed to maintain safer vessel access from the platform and to accommodate tidal variation. In addition, a 1.5 T pedestal crane is also proposed to carry a person from one of the mooring dolphins to the vessel in case on emergency and for transfer of mooring hooks, lines, and supplies.

The liquid berths will be equipped with remote operated fire water monitors erected on the mooring dolphins. The fire monitors will have facility to remotely switch to foam as the firefighting medium. The monitors will be fed marine water from the pump room proposed

to be located near the root of the southern breakwater. The operating platform will be additionally serviced with a water curtain system to effectively mitigate any spill and consequent fire near the splicing point of the loading arm and the vessel.

A range of pipe sizes and MOCs have been considered as part of basic specification of the liquid berths. The pipelines will be replaced with higher diameter pipelines when the cargo volumes go up. Pipes of following sizes are likely to be laid in the Port for liquid material conveyance.

- POL cargo (Naphtha, MS, SKO/ATF, HSD) – 18" CS
- Ethanol/Anilline – 8" SS 304
- All other liquid chemicals – 12" CS

The liquid berths will be connected to a Port terminal by a bank of pipelines laid out on grade level over sleepers-pedestals or as a bank in steel truss framework in a well designated pipeline corridor on the southern breakwater. Pipes will be operated about 10 kg/cm^2 for POL cargo with a discharge rate of 3000 to 3500 KL/hr, while for other chemicals, lower pressures of 7 kg/cm^2 and discharge rates of 2000 kl/hr may be sufficient. A distance of 3 m from the outer edge of the outermost pipeline will form battery limit of the pipe corridor, and shall be access-prevented from sides by laying a chain link fence. All motor vehicles plying on the breakwater road will be fitted with spark arresters mufflers on the gate at the root of the breakwater. The pipe corridor will be patrolled every three hours when transfer of MS, Naphtha or a highly flammable chemical will be going on. The pipeline will be laid per applicable API, ASTM, IS and OISD 114 standards.

The pipelines will terminate in a pump house cum manifold station on the Port backup which will form the battery limit of the Port for liquid cargo. Outbound liquid cargo will be propelled and/or on-line boosted by the Pump House as required, whereas inbound cargo will be propelled by the prime movers of the vessels. The pump house will be a spark exclusion zone and will be designed and operated per IP 65 standard. The pump house will be equipped with LEL meters, fire detectors and water curtains/high douse sprinkler systems as firefighting system. All pipelines will be provided with pigging facility to

eliminate contamination and hold up. The pump house will function as a sectionizing valve and will help in limiting spillage quantity in the Port battery limit to the residual pressure and hold up contained in the line. Master-slave override control of the in-line pumps will be given to the control room of the refinery during outbound transfer of POL products to the vessels.

All berth and material transfer controls will be carried out from the Marine Control Room. The MCR will comprise Radio Room, Traffic Room, VHF receiver, Navtex receiver and Automatic Weather Recording Station, The MCR will be protected by an automatic CO_2 flooding system as its mainstay fire protection system.

7.5.3 Identification of Hazard Scenarios

Based on the property of cargo and inventory in the pipeline at the time of loss of containment following hazard scenarios for Worst Case (WC) and Maximum Credible Loss Scenario (MCLS) were scoped for the consequence analysis of the identified chemicals. Common failure modes/sites of failure considered as candidate for the selection of WC and MCLS are shown in Table-7.6. Scenarios selected for MCLS and WC are shown in the Table-7.7.

Table-7.6 Common Failure Modes for Consequence Analysis

S.No.	Failure Case	Failure Mode	Consequence	Possibility
1.	*Guillotine rupture of the 8" SS 304, 12" and 18" CS pipeline.*	*Random failure*	*Dispersion, pool fire, toxic release*	*Non-credible*
2.	*1" leak in the pipeline section*		*Pool fire and Toxic release*	*Credible*
3.	*POL and chemical pump mechanical seal failure.*	*Mechanical seal failure*	*Pool fire and Toxic release*	*Credible*
4.	*Flange/Gasket failure.*	*Gasket failure*	*Pool fire and Toxic release*	*Credible*
5.	*Loading Arm Failure.*	*Random Failure*	*Pool fire and Toxic release*	*Credible*

Table-7.7 Identification of Hazed Scenarios for Consequence Analysis

Sr.	Consequence Code	Chemical	Condition of Loss of Containment	Consequence type
1.	WC01	Naphtha	Guillotine rupture of 18" pipeline	Pool fire
2.	MC01	Naphtha	1" leak on the 18" pipeline	Pool fire
3.	MC02	Naphtha	Guillotine rupture of loading arm on the 18" line	Pool fire
4.	WC03	Motor Spirit	Guillotine rupture of 18" pipeline	Pool fire
5.	MC03	Motor Spirit	1" leak on the 18" pipeline	Pool fire
6.	MC04	Motor Spirit	Guillotine rupture of loading arm on the 18" line	Pool fire
7.	MC05	SKO/ATF	1" leak on the 18" pipeline	Pool fire
8.	MC06	SKO/ATF	Guillotine rupture of loading arm on the 18" line	Pool fire
9.	MC07	HSD	1" leak on the 18" pipeline	Pool fire
10.	-	Heavy Fuel Oil	Low combustible value. Forced burn not assumed.	-
11.	MC08	Acetic Acid	Guillotine rupture of loading arm on the 12" line	Toxic release
12.	MC09	Aniline	Guillotine rupture of loading arm on the 8" SS 304 line	Toxic release
13.	MC10	Benzene	Guillotine rupture of loading arm on the 12" line	Toxic release
14.	MC11	Benzene	Guillotine rupture of loading arm on the 12" line	Pool fire
15.	-	Caustic lye	Dispersal and consequence modeling not indicated for corrosive chemicals.	-
16.	MC12	Ethyl alchohol	Guillotine rupture of loading arm on the 8" SS 304 line	Pool fire
17.	MC13	Ethylene Di Chloride	Guillotine rupture of loading arm on the 12" line	Toxic release
18.	MC14	Ethylene Di Chloride	Guillotine rupture of loading arm on the 12" line	Pool fire
19.	MC15	Hexane	Guillotine rupture of loading arm on the 12" line	Pool fire
20.	MC16	Methanol	Guillotine rupture of loading arm on the 12" line	Pool fire
21.	MC17	Mono Ethylene Glycol	Guillotine rupture of loading arm on the 12" line	Toxic release
22.	MC18	Styrene	Guillotine rupture of loading arm on the 12" line	Pool fire
23.	MC19	Toluene	Guillotine rupture of loading arm on the 12" line	Pool fire
24.	MC20	Xylene	Guillotine rupture of loading arm on the 12" line	Pool fire

In a realistic release scenario, failure of mechanical seal on the pump and the flange/gasket failure will cause to release similar volumes of flammable/toxic inventory in a pressurized pipeline. Thus for consequence analysis, guillotine rupture of the 18" pipelines carrying naphtha or MS has been assumed as the WC failure, and 1" pipeline leak and loading arm failures of flammable and toxic inventory has been assumed as the MCLS for other liquids.

7.5.4 Consequence Analysis of Liquid Cargo

Consequence analysis footprints for the various cargoes for the selected MCLS and WC release scenarios are given in the following section.

a. Naphtha

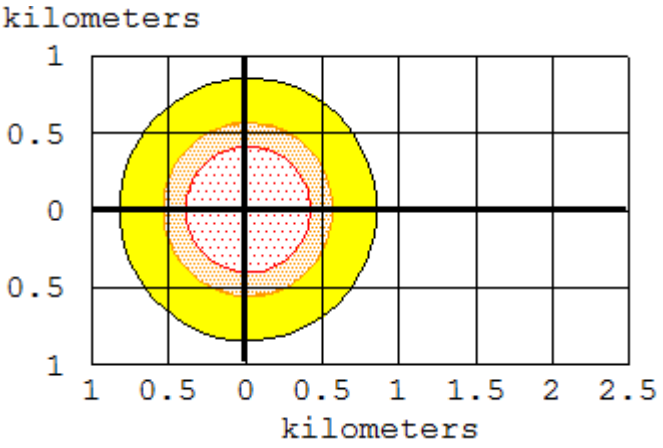
Naphtha is a color less to reddish-brown volatile aromatic liquid, very similar to gasoline. Straight run naphtha (light naphtha) coming out of the primary distillation of crude is a valuable feedstock which is generally captive-consumed. Naphtha of blended origin (or heavy naphtha) is used as fuel in GT based power plants, however its usage for energy is declining worldwide.

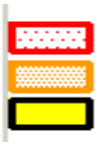
Naphtha has a boiling range between 30 °C and 200 °C. It consists of a complex mixture of hydrocarbon molecules generally having between 5 and 12 carbon atoms. Naphtha is used primarily as feedstock for producing high octane gasoline (via the catalytic reforming process). It is also used in the bitumen mining industry as a diluent, the petrochemical industry for producing olefins in steam crackers, and the chemical industry for solvent(cleaning) applications.

Naphtha Scenario WC01: Complete loss of containment of the 18" pipeline from a guillotine rupture, formation of a pool of evaporating flammable inventory on the 35^0 C concrete pipeline trench, meeting with a source of igniting after 5 minutes of the holdup is drained, resulting in a pool fire, lasting for 13 minutes. Stability Class D.

Thermal radiation from pool fire:

- Flame length 144 m
- 433 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)
- 583 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)
- 871 meters --- (2.0 kW/(sq m) = pain within 60 sec)





>=10.0 Kw/(sq. m) = potentially lethal within 60 seconds

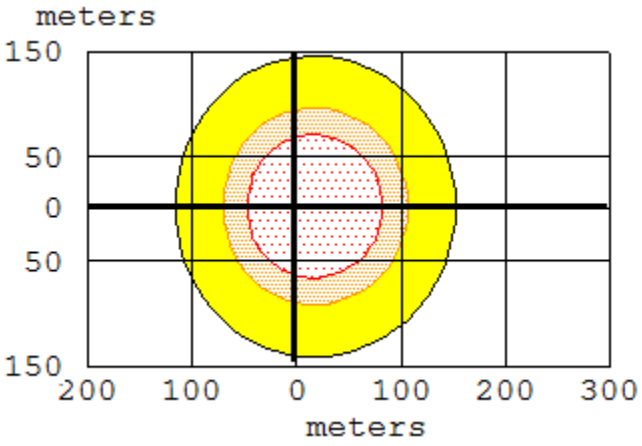
>=5.0 Kw/(sq. m) = second degree burns within 60 seconds

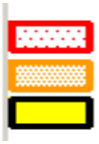
>=2.0 Kw/(sq. m) = pain within 60 seconds

Naphtha Scenario MC01: 1" leak of the 18" pipeline, formation of a pool of evaporating flammable inventory on the 35^0 C concrete pipeline trench, meeting with a source of igniting after 5 minutes of the holdup is drained, resulting in a pool fire, lasting for 2 minutes. Stability Class D.

Thermal radiation from pool fire:

- Flame length 38 m
- 84 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)
- 108 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)
- 154 meters --- (2.0 kW/(sq m) = pain within 60 sec)



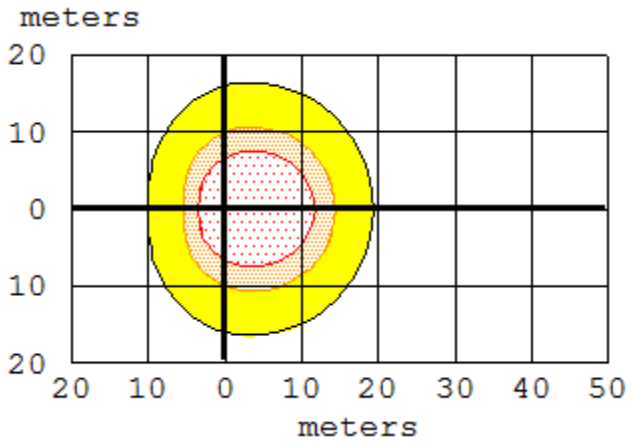


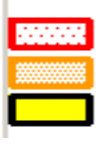
>=10.0 Kw/(sq. m) = potentially lethal within 60 seconds
>=5.0 Kw/(sq. m) = second degree burns within 60 seconds
>=2.0 Kw/(sq. m) = pain within 60 seconds

Naphtha Scenario MC02: Guillotine shear of the loading arm on the 18" pipeline, formation of a pool of evaporating flammable inventory on the 35^0 C concrete working platforms, meeting with a source of igniting after 5 minutes of the holdup is drained, resulting in a pool fire, lasting for less than a minute. Stability Class D.

Thermal radiation from pool fire:

- Flame length 7 m
- 12 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)
- 15 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)
- 19 meters --- (2.0 kW/(sq m) = pain within 60 sec)





>=10.0 Kw/(sq. m) = potentially lethal within 60 seconds
>=5.0 Kw/(sq. m) = second degree burns within 60 seconds
>=2.0 Kw/(sq. m) = pain within 60 seconds

b. Motor Spirit

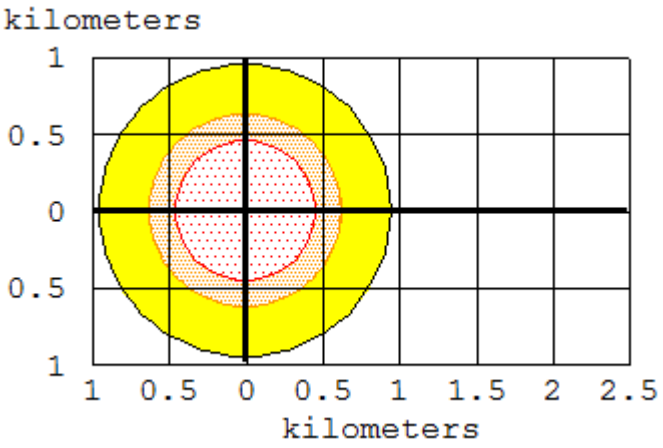
Motor Spirit is a transparent petroleum derived liquid with a low flash point (about 35^0 C) that is primarily used as a fuel in spark ignition internal combustion engines. It consists mostly of organic compounds obtained by the fractional distillation of petroleum, enhanced

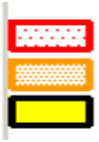
with a variety of additives to regulate its knocking property. Properties of MS in India is governed by IS 2796:2008.

MS Scenario WC02: Complete loss of containment of the 18" pipeline from a guillotine rupture, formation of a pool of evaporating flammable inventory on the 35^0 C concrete pipeline trench, meeting with a source of igniting after 5 minutes of the holdup is drained, resulting in a pool fire, lasting for 13 minutes. Stability Class D.

Thermal radiation from pool fire:

- Flame length 165 m
- 450 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)
- 620 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)
- 945 meters --- (2.0 kW/(sq m) = pain within 60 sec)





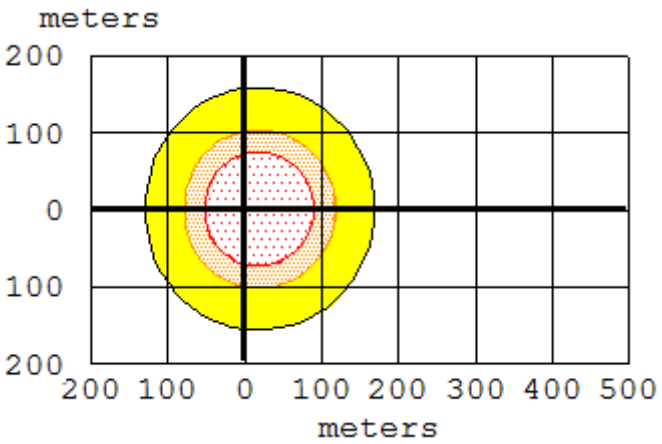
>=10.0 Kw/(sq. m) = potentially lethal within 60 seconds
>=5.0 Kw/(sq. m) = second degree burns within 60 seconds
>=2.0 Kw/(sq. m) = pain within 60 seconds

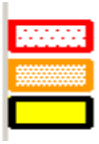
MS Scenario MC03: 1" leak of the 18" pipeline, formation of a pool of evaporating flammable inventory on the 35^0 C concrete pipeline trench, meeting with a source of igniting after 5 minutes of the holdup is drained, resulting in a pool fire. Stability Class D.

Thermal radiation from pool fire:

- Flame length 43 m

- 93 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)
- 120 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)
- 172 meters --- (2.0 kW/(sq m) = pain within 60 sec)



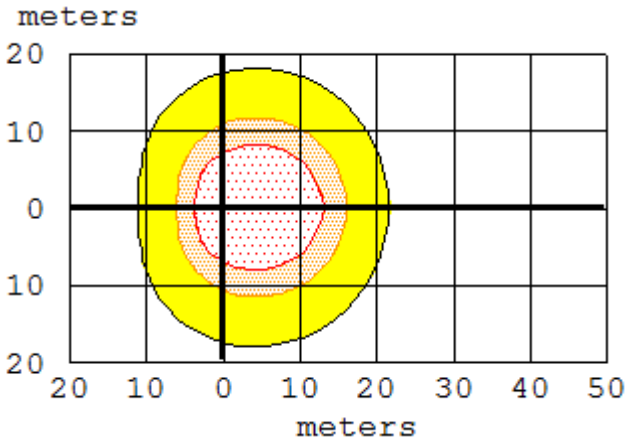


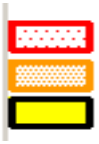
>=10.0 Kw/(sq. m) = potentially lethal within 60 seconds
>=5.0 Kw/(sq. m) = second degree burns within 60 seconds
>=2.0 Kw/(sq. m) = pain within 60 seconds

MS Scenario MC04: Guillotine shear of the loading arm on the 18" pipeline, formation of a pool of evaporating flammable inventory on the 35^0 C concrete working platform, meeting with a source of igniting after 5 minutes of the holdup is drained, resulting in a pool fire, lasting for less than a minute. Stability Class D.

Thermal radiation from pool fire:

- Flame length 9 m
- 13 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)
- 16 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)
- 22 meters --- (2.0 kW/(sq m) = pain within 60 sec)





>=10.0 Kw/(sq. m) = potentially lethal within 60 seconds

>=5.0 Kw/(sq. m) = second degree burns within 60 seconds

>=2.0 Kw/(sq. m) = pain within 60 seconds

c. Superior Kerosene Oil/Aviation Turbine Fuel

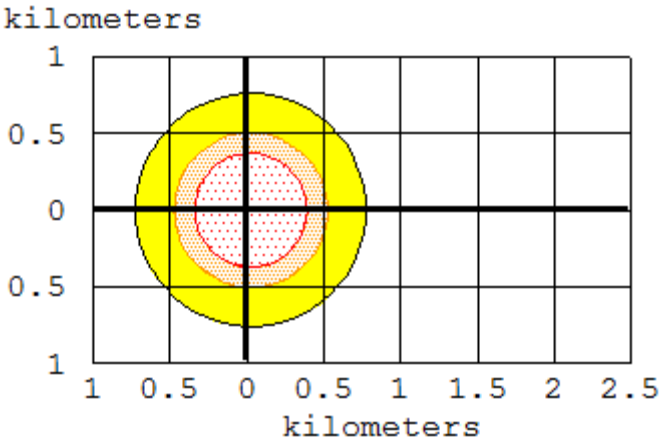
Kerosene are distillate fractions of crude oil in the boiling range of 150-250°C. They are treated mainly for reducing aromatic content to increase their smoke point (height of a smokeless flame) and hydrofining to reduce sulphur content and to improve odour, colour & burning qualities (char value). The Indian Standard governing the properties of kerosene are IS 1459:1974 (2nd Rev).

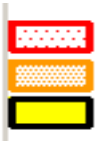
Kerosene is a thin, clear liquid formed from hydrocarbons, with a density of 0.78 –0.81 g/cm$^{3.}$ It is obtained from the fractional distillation of petroleum between 150 °C and 275 °C, resulting in a mixture of carbon chains that typically contain between six and 16 carbon atoms per molecule. Flash point of kerosene is between 37 and 65 °C (100 and 150 °F), and its auto ignition temperature is 220 °C (428 °F).

SKO/ATF Scenario MC05: 1" leak of the 18" pipeline, formation of a pool of evaporating flammable inventory on the 35^{0} C concrete pipeline trench, meeting with a source of igniting after 5 minutes of the holdup is drained, resulting in a pool fire, burning for 16 minutes. The vapour cloud formed in the available ambient conditions is below flash point of SKO and unlikely to catch fire, however a forced burn has been assumed. Stability Class D.

Thermal radiation from pool fire:

- Flame length 125 m
- 398 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)
- 530 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)
- 786 meters --- (2.0 kW/(sq m) = pain within 60 sec)





>=10.0 Kw/(sq. m) = potentially lethal within 60 seconds

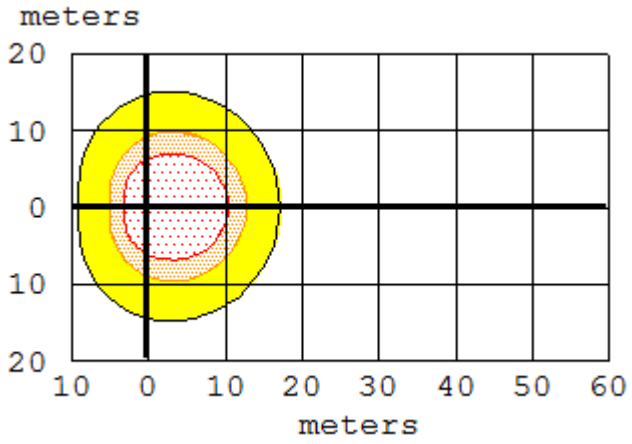
>=5.0 Kw/(sq. m) = second degree burns within 60 seconds

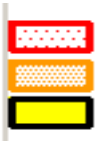
>=2.0 Kw/(sq. m) = pain within 60 seconds

SKO/ATF Scenario MC06: Guillotine shear of the loading arm on the 18" pipeline, formation of a pool of evaporating flammable inventory on the 35^0 C concrete working platform, meeting with a source of igniting after 5 minutes of the holdup is drained, resulting in a pool fire. The vapour cloud formed in the available ambient conditions is below flash point of SKO and unlikely to catch fire, however a forced burn has been assumed. Stability Class D.

Thermal radiation from pool fire:

- Flame length 6 m
- 11 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)
- 13 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)
- 17 meters --- (2.0 kW/(sq m) = pain within 60 sec)





>=10.0 Kw/(sq. m) = potentially lethal within 60 seconds
>=5.0 Kw/(sq. m) = second degree burns within 60 seconds
>=2.0 Kw/(sq. m) = pain within 60 seconds

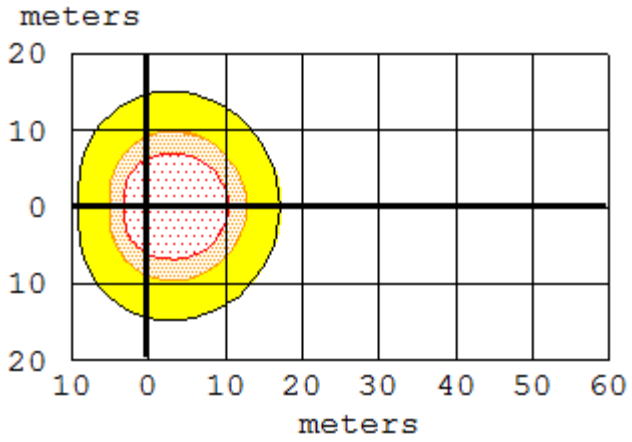
d. High Speed Diesel

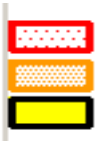
High Speed Diesel is produced from the fractional distillation of crude oil between 200 °C and 350 °C at atmospheric pressure, resulting in a mixture of carbon chains that typically contain between 8 and 21 carbon atoms per molecule. Flash point of HSD is about 66^0 C, and summer time pour point of 15^0 C. Properties of HSD in India is governed by IS 1460:2005.

HSD Scenario MC07: Guillotine shear of the loading arm on the 18" pipeline, formation of a pool of evaporating flammable inventory on the 35^0 C concrete working platform, meeting with a source of igniting after 5 minutes of the holdup is drained, resulting in a pool fire. The vapour cloud formed in the available ambient conditions is below flash point of HSD and unlikely to catch fire, however a forced burn has been assumed. Stability Class D.

Thermal radiation from pool fire:

- Flame length 6 m
- 11 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)
- 13 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)
- 17 meters --- (2.0 kW/(sq m) = pain within 60 sec)





>=10.0 Kw/(sq. m) = potentially lethal within 60 seconds
>=5.0 Kw/(sq. m) = second degree burns within 60 seconds
>=2.0 Kw/(sq. m) = pain within 60 seconds

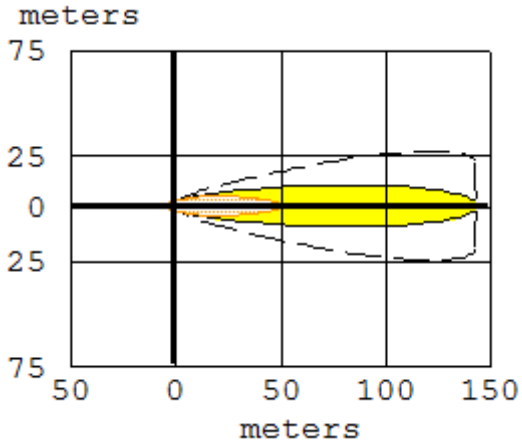
e. Acetic Acid

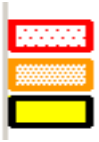
Acetic acid, glacial is a clear colorless liquid with a strong odour of vinegar. It is combustible and has a flash point of 40 deg. C, is soluble in water with release of heat, and is corrosive to metals and tissue. It weighs 1.054 kg/l. Acetic acid is used to make other chemicals, as a food additive, and in petroleum production.

Acetic acid Scenario MC08: Guillotine shear of the loading arm on the 12" pipeline, formation of a pool of toxic vapour cloud on the 35^0 C concrete working platform. Stability Class D.

Toxic vapour from spill:

- 12 meters --- (250 ppm = ERPG-3)
- 50 meters --- (35 ppm = ERPG-2)
- 144 meters --- (5 ppm = ERPG-1)





Greater than 250 ppm (EPRG -3)

Greater than 35 ppm (EPRG -2)

Greater than 5 ppm (EPRG -1)

f. Aniline

Aniline is an organic compound with the formula $C_6H_5NH_2$. Consisting of a phenyl group attached to an amino group, aniline is the prototypical aromatic amine. Being a precursor to many industrial chemicals, its main use is in the manufacture of precursors to polyurethane. Like most volatile amines, it possesses the somewhat unpleasant odour of rotten fish. Aniline is colorless, but it slowly oxidizes and resinifies in air, giving a red-brown tint to aged samples. Aniline is a weak base. The largest application of aniline is for the preparation of methylene diphenyl diisocyanate (MDI); other major applications being rubber processing chemicals, herbicides, and dyes and pigments.

Aniline Scenario MC09: Guillotine shear of the loading arm on the 8" SS 304 pipeline, formation of a pool of toxic vapour cloud on the 35^0 C concrete working platform. Stability Class D.

Toxic vapour from spill:

- less than 10 meters --- (20 ppm = AEGL-3 (60 min)
- 12 meters --- (12 ppm = AEGL-2 (60 min))
- 17 meters --- (8 ppm = AEGL-1 (60 min))

Threat zone was not drawn because effects of near-field patchiness make dispersion predictions less reliable for short distances.

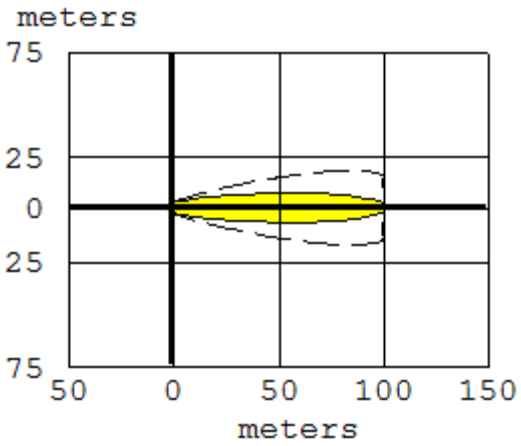
g. Benzene

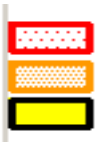
Benzene is an organic chemical compound composed of 6 carbon atoms in a ring, with the molecular formula C_6H_6. Benzene is a natural constituent of crude oil, and is one of the most basic petrochemicals. It is a colorless and highly flammable liquid with a sweet smell. It is mainly used as a precursor to heavy chemicals, such as ethylbenzene and cumene, which are produced on a billion kilogram scale. Because it has a high octane number, it is an important component of gasoline, comprising a few percent. Its carcinogenicity has limited most non-industrial applications.

Benzene Scenario MC10: Guillotine shear of the loading arm on the 12" pipeline, formation of a pool of toxic vapour cloud on the 35^0 C concrete working platform. Stability Class D.

Toxic vapour from spill:

- less than 10 meters(10.9 yards) --- (4000 ppm = AEGL-3 (60 min))
- 20 meters --- (800 ppm = AEGL-2 (60 min))
- 102 meters --- (52 ppm = AEGL-1 (60 min))





Greater than 4000 ppm (AEGL-3)

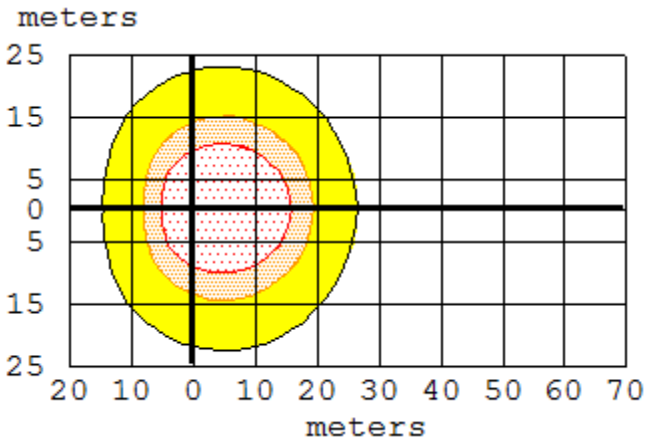
Greater than 800 ppm (AEGL-2)

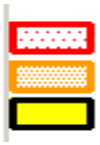
Greater than 52 ppm (AEGL-1)

Benzene Scenario MC11: Guillotine shear of the loading arm on the 12" pipeline, formation of a pool of flammable vapour cloud on the 35^0 C concrete working platform, meeting with a source of igniting after 5 minutes of the holdup is drained, resulting in a pool fire, burning for 52 minutes. Stability Class D.

Thermal radiation from pool fire:

- Flame length 10 m
- 16 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)
- 20 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)
- 27 meters --- (2.0 kW/(sq m) = pain within 60 sec)





>=10.0 Kw/(sq. m) = potentially lethal within 60 seconds
>=5.0 Kw/(sq. m) = second degree burns within 60 seconds
>=2.0 Kw/(sq. m) = pain within 60 seconds

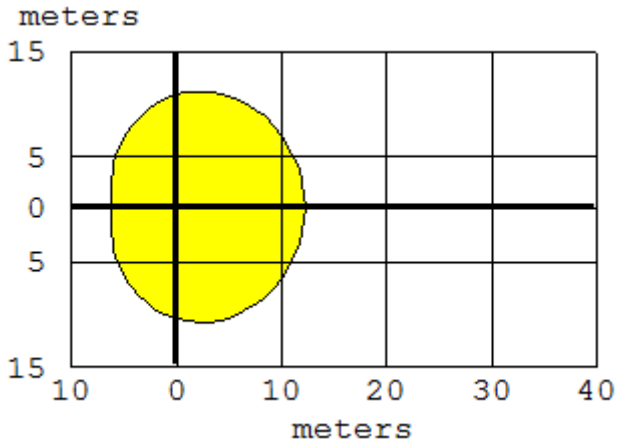
h. Ethyl Alcohol

Ethanol is a 2-carbon alcohol with the molecular formula CH_3CH_2OH. Its empirical formula isC_2H_6O. Ethanol has widespread use as a solvent of substances intended for human contact or consumption, including scents, flavorings, colorings, and medicines. Ethanol is a volatile, colorless liquid that has a slight odor. It burns with a smokeless blue flame that is not always visible in normal light.

Ethyl Alcohol Scenario MC12: Guillotine shear of the loading arm on the 8" SS 304 pipeline, formation of a pool of evaporating flammable inventory on the 35^0 C concrete working platform, meeting with a source of igniting after 5 minutes of the holdup is drained, resulting in a pool fire. Stability Class D.

Thermal radiation from pool fire:

- Flame length 4 m
- less than 10 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)
- less than 10 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)
- 12 meters --- (2.0 kW/(sq m) = pain within 60 sec)



i. Ethylene di chloride

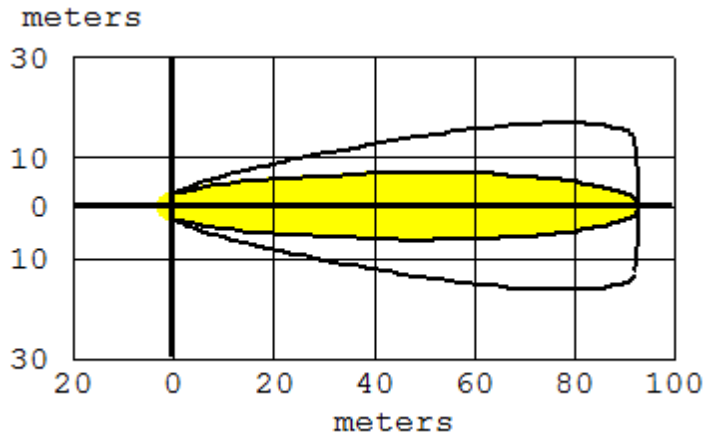
Ethylene dichloride is a chlorinated hydrocarbon, mainly used to produce vinyl chloride monomer (VCM, chloroethene), the major precursor for PVC production. It is a colourless liquid with chloroform-like odour. 1,2-Dichloroethane is also used generally as an intermediate for otherorganic chemical compounds and as a solvent. It forms azeotropes with many other solvents, including water and other chlorocarbons.

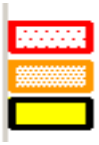
Ethylene di chloride scenario MC13: Guillotine shear of the loading arm on the 12" pipeline, formation of a pool of toxic vapour cloud on the 35^0 C concrete working platform. Stability Class D.

Toxic vapour from spill:

- 34 meters --- (300 ppm = ERPG-3)

- 44 meters --- (200 ppm = ERPG-2)
- 93 meters --- (50 ppm = ERPG-1)





Greater than 300 ppm (EPRG -3)
Greater than 200 ppm (EPRG -2)
Greater than 50 ppm (EPRG -1)

Ethylene di chloride scenario MC14: Guillotine shear of the loading arm on the 12" pipeline, formation of a pool of evaporating flammable inventory on the 35^0 C concrete working platform, meeting with a source of igniting after 5 minutes of the holdup is drained, resulting in a pool fire. Stability Class D.

Thermal radiation from pool fire:

- Flame length 5 m
- less than 10 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)
- less than 10 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)
- less than 10 meters --- (2.0 kW/(sq m) = pain within 60 sec)

Threat zone was not drawn because effects of near-field patchiness make dispersion predictions less reliable for short distances.

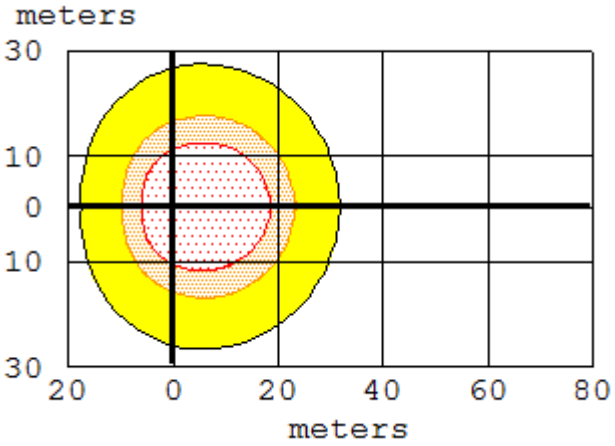
j. Hexane

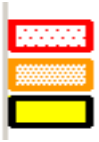
Hexane is a hydrocarbon with the chemical formula $C_6H_{14.}$ Hexanes are significant constituents of gasoline. They are all colorless liquids at room temperature, with boiling points between 50 and 70 °C, with gasoline-like odor. They are widely used as cheap, relatively safe, largely unreactive, and easily evaporated non-polar solvents.

Hexane scenario MC15: Guillotine shear of the loading arm on the 12" pipeline, formation of a pool of evaporating flammable inventory on the 35^0 C concrete working platform, meeting with a source of igniting after 5 minutes of the holdup is drained, resulting in a pool fire, burning for 30 minutes. Stability Class D.

Thermal radiation from pool fire:

- Flame length 12 m
- 19 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)
- 24 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)
- 32 meters --- (2.0 kW/(sq m) = pain within 60 sec)





>=10.0 Kw/(sq. m) = potentially lethal within 60 seconds

>=5.0 Kw/(sq. m) = second degree burns within 60 seconds

>=2.0 Kw/(sq. m) = pain within 60 seconds

k. Methanol

Methanol, the simplest alcohol, is a light, volatile, colorless, flammable liquid with a distinctive odor very similar to, but slightly sweeter than, ethanol (drinking alcohol). At room temperature, it is a polar liquid, and is used as an antifreeze, solvent, fuel, and as a denaturant for ethanol. It is also used for producing biodiesel via trans esterification reaction. Methanol is one of the most heavily traded chemical commodities in the world, with an estimated global demand of around 27 to 29 million metric tons.

Methanol scenario MC16: Guillotine shear of the loading arm on the 12" pipeline, formation of a pool of evaporating flammable inventory on the 35^0 C concrete working platform, meeting with a source of igniting after 5 minutes of the holdup is drained, resulting in a pool fire, burning for 30 minutes. Stability Class D.

Thermal radiation from pool fire:

- Flame length 3 m
- less than 10 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)
- less than 10 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)
- less than 10 meters --- (2.0 kW/(sq m) = pain within 60 sec)

Threat zone was not drawn because effects of near-field patchiness make dispersion predictions less reliable for short distances.

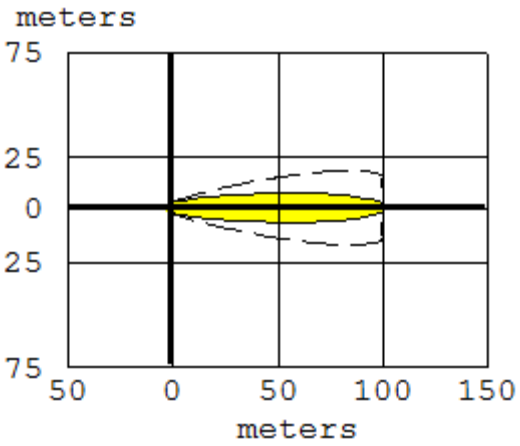
l. Mono ethylene glycol

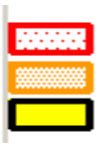
Ethylene glycol is an organic compound widely used as an automotive antifreeze and a precursor to polymers. In its pure form, it is an odorless, colorless, syrupy, sweet-tasting liquid. Ethylene glycol is toxic, and ingestion can result in death. The major end uses of ethylene glycol are as antifreeze, which accounts for over 50% of ethylene glycol's commercial uses, and as raw material in the production of polyester fibers, mainly PET, which accounts for 40% of total ethylene glycol consumption. Ethylene glycol is moderately toxic with an oral LDLO = 786 mg/kg for humans.

Mono ethylene glycol MC17: Guillotine shear of the loading arm on the 12" pipeline, formation of a pool of toxic vapour cloud on the 35^0 C concrete working platform. Stability Class D.

Toxic vapour from spill:

- 34 meters --- (300 ppm = ERPG-3)
- 44 meters --- (200 ppm = ERPG-2)
- 93 meters --- (50 ppm = ERPG-1)





Greater than 4000 ppm (AEGL-3)
Greater than 800 ppm (AEGL-2)
Greater than 52 ppm (AEGL-1)

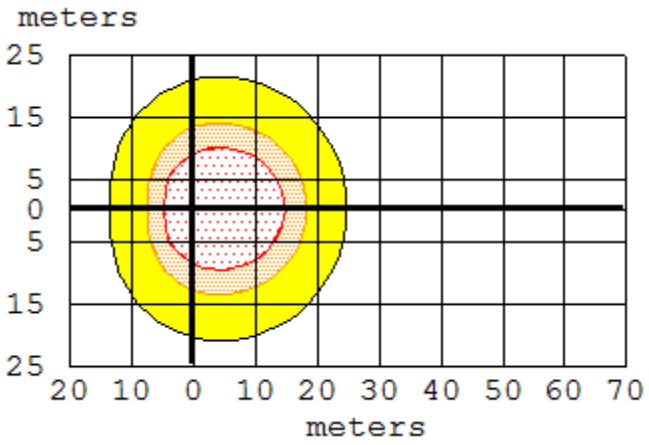
m. Styrene

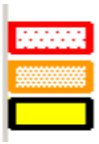
Styrene, chemical formula $C_6H_5CH=CH_2$ is a derivative of benzene. It is a colorless oily liquid that evaporates easily and has a sweet smell, although high concentrations confer a less pleasant odor. Styrene is the precursor to polystyrene and several copolymers. On 10 June 2011, the US National Toxicology Program has described styrene as "reasonably anticipated to be a human carcinogen". Styrene materials are used in rubber, plastic, insulation, fiberglass, pipes, automobile and boat parts, food containers, and carpet backing.

Styrene scenario MC18: Guillotine shear of the loading arm on the 12" pipeline, formation of a pool of evaporating flammable inventory on the 35^0 C concrete working platform, meeting with a source of igniting after 5 minutes of the holdup is drained, resulting in a pool fire, burning for 30 minutes. Stability Class D.

Thermal radiation from pool fire:

- Flame length 9 m
- less than 15 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)
- less than 18 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)
- less than 25 meters --- (2.0 kW/(sq m) = pain within 60 sec)





>=10.0 Kw/(sq. m) = potentially lethal within 60 seconds
>=5.0 Kw/(sq. m) = second degree burns within 60 seconds
>=2.0 Kw/(sq. m) = pain within 60 seconds

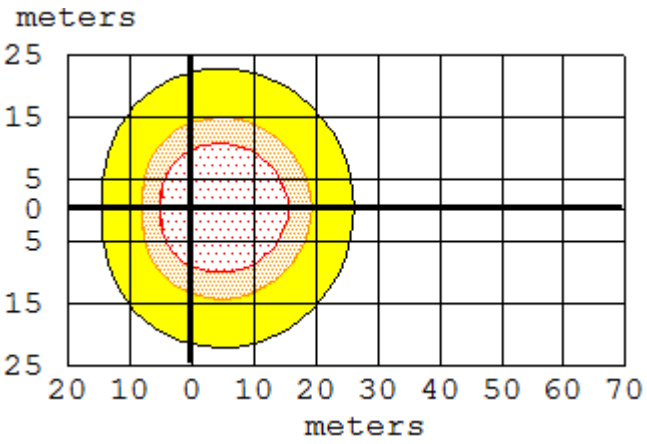
n. Toluene

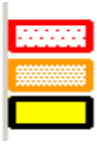
Toluene, is a clear, water-insoluble liquid with the typical smell of paint thinners. It is an aromatic hydrocarbon that is widely used as an industrial feedstock and as a solvent. Like other solvents, toluene is sometimes also used as an inhalant drug for its intoxicating properties; however, inhaling toluene has potential to cause severe neurological harm. Toluene is an important organic solvent, but is also capable of dissolving a number of notable inorganic chemicals such as sulfur.

Toluene scenario MC19: Guillotine shear of the loading arm on the 12" pipeline, formation of a pool of evaporating flammable inventory on the 35^0 C concrete working platform, meeting with a source of igniting after 5 minutes of the holdup is drained, resulting in a pool fire, burning for 53 minutes. Stability Class D.

Thermal radiation from pool fire:

- Flame length 10 m
- less than 16 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)
- less than 20 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)
- less than 26 meters --- (2.0 kW/(sq m) = pain within 60 sec)





>=10.0 Kw/(sq. m) = potentially lethal within 60 seconds
>=5.0 Kw/(sq. m) = second degree burns within 60 seconds
>=2.0 Kw/(sq. m) = pain within 60 seconds

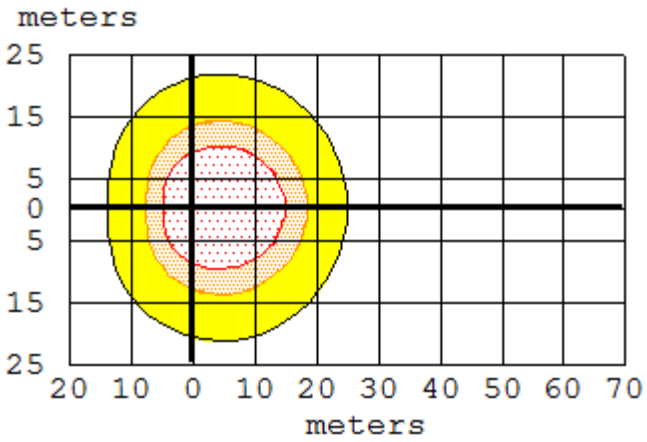
o. Xylene

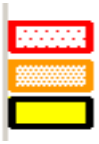
Xylene encompasses three isomers of dimethyl benzene. The mixture of *o*-, *m*- and *p*- is a slightly greasy, colourless liquid commonly encountered as a solvent. Xylenes represent about 0.5–1% of crude oil, depending on the source (hence xylenes are found in small amounts in gasoline and airplane fuels). It is mainly produced from reformate. Xylene's Melting point ranges from −47.87 °C (*m*-xylene) to13.26 °C (*p*-xylene). Density of xylene is around 0.87 g/mL and thus it is less dense than water. Xylene in air can be smelled at 0.08 to 3.7 parts of xylene per million parts of air (ppm) and can begin to be tasted in water at 0.53 to 1.8 ppm.

Xylene scenario MC20: Guillotine shear of the loading arm on the 12" pipeline, formation of a pool of evaporating flammable inventory on the 35^0 C concrete working platform, meeting with a source of igniting after 5 minutes of the holdup is drained, resulting in a pool fire, burning for 59 minutes. Stability Class D.

Thermal radiation from pool fire:

- Flame length 9 m
- less than 15 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)
- less than 19 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)
- less than 25 meters --- (2.0 kW/(sq m) = pain within 60 sec)





>=10.0 Kw/(sq. m) = potentially lethal within 60 seconds

>=5.0 Kw/(sq. m) = second degree burns within 60 seconds

>=2.0 Kw/(sq. m) = pain within 60 seconds

7.6 Risks due to handling of Liquified natural Gas

7.6.1 The LNG Terminal

A 08 MMTPA LNG import terminal is proposed in the Nandgaon port. The Terminal will be a typical marine LNG terminal with mandate comprising LNG unloading, LNG storage, LNG re-gasification into natural gas, and natural gas send out into country's gas grid. Salient features of the Terminal are given in Table-7.8. Alternatively, a 3.5 MMTPA jetty-moored FSU based LNG import facility is also under consideration to favour low capital investment, very low land requirement, and to enable quick set up in event of early joining

of gas JV partner and favourable gas procurement contract. Technical details of the FS-R-U is given in Table 7.9.

Table-7.8 Salient Features of the LNG Terminal

A	***Parameter***	***Feature***
1.	*Type of Terminal*	*LNG import terminal*
2.	*Activities covered*	*Unloading, Storage, Re-gasification, Sendout*
3.	*Rated capacity of the Terminal*	*8 MMTPA throughput of natural gas*
4.	*Duty and availability*	*All weather, 365 days operation*
5.	*Source of LNG*	*Various gas fields*
6.	*Storage capacity*	*3 x 1,90,000 m^3 tanks*
7.	*Type of tanks*	*Full containment (inner tank 9% nickel steel, outer wall – pre-stressed concrete), placed on concrete piles*
8.	*Facilities on LNG berth*	*a. Alongside draft – -17 m CD*
		b. Capacity of LNG vessel – 90,000 to 2,67,000 m^3
		c. Berth type – unloading platform, breasting and mooring dolphins connected by walkways on trestles
		d. Unloading arms – 3 DCMA, liquid arms, one vapour return arm, one hybrid arm, all 16" diameter
		e. LNG line – one, 48" PUF insulated line
		f. PERC – yes, on all arms
		g. Quick release mooring hooks – provided
		h. Design unloading rate – 12,000 m^3/hr
		i. Facilities on the Unloading Platform – impoundment basin (~160 m^3) , KO drum, cold flair
		j. Firefighting measures – remotely operated monitors
		k. Control Room – yes, on jetty, to supervise ship-shore splicing and on-berth vessel movement
9.	*LNG On-shore Terminal*	*a. Terminal area – 34.3 ha*
		b. FFL height of the Terminal from MSL – 38 m
		c. Major components of the On-shore Terminal *- Storage tanks - 3 x 1,90,000 m^3 tanks* *- Return gas blower, centrifugal - 18T/hr* *- BOG compressors – 3 nos, reciprocating, 10.5 T/hr each, one re-condenser* *- Gas engine generators (04 nos. 8.6 MW) for mainstay power* *- LP vertical centrifugal LNG pumps installed in LNG tanks - 401 T/hr* *- 6 nos + 1 HP LNG pumps, 205 t/hr each* *- Vaporizer system (ORV for continuous, normal operation and SCV 5+1 nos for intermittent, abnormal operation)* *- Flare stack, 80 m high, 60 T/hr* *- Metering and sendout* *- Truck loading facility (4 bays, each equipped wth 3" loading and 3" vapour return line) – 80 m^3/hr each* *- Firefighting system (3 electric and 6 diesel driven, discharge 850 m^3/hr) and fire water reservoir*

		- *Plant utilities* - *Administrative building and control room*
		d. Impoundment basin in the on-shore terminal - *Piping at LNG storage tank ~ 60 m^3* - *HP pump area ~ 150 m^3* - *Re-condenser area ~ 30 m^3* - *Truck loading area ~ 15 m^3*
		e. Detection and Control System *i. Distributed Control System (DCS)* *ii. Emergency Shutdown System (ESD)* *iii. Fire & Gas Detection System (FSGDS)* *iv. LNG Tank Level Temperature Density System (LTD)* *v. Concrete Tank Base Monitoring System.* *vi. Power Distribution Management System (PDMS)* *vii. Position Supervising System (PSS)* *viii. Berth Monitoring System (BMS)* *ix. Ship – Shore Communication System* *x. Vibration Monitoring System (VMS)* *xi. Metering System* *xii. Truck Loading Control System (TLCS)* *xiii. Package Unit Local Control Panels (LCP)* *xiv. Seismic Detection System.*
		f. ESD systems - levels and responses *a) ESD 01 – General Terminal shutdown* *Emergency shutdown sequence ESD1 applied for all process and utility systems in the entire Terminal (except essential services for safety of operators and plants).* *a) On General power failure* *b) On Fire or Gas detection* *c) On Earthquake* *b) ESD 02 – Production shutdown* *a. Emergency shutdown sequence ESD2 applied for all process systems. It is caused by major process abnormal conditions, local fire and gas hazard.* *i. On Fire or Gas detection* *ii. Instrumented trip* *c) ESD 03 – Unit level shutdown (partial Terminal operation)* *a. Unit shutdown means partial terminal shutdown, and starts when the continuous operation in the specific area, which is not connected to whole terminal by the piping such as jetty, is potentially unsafe but the predicted consequences are limited to the respective area or system.* *i. On Fire or Gas detection* *ii. Instrumented trip* *d) ESD 04 – Individual equipment shutdown* *a. Minimize the effect on the normal operational equipments.*
10.	*Design Codes*	• *NFPA 59A – Production storage & handling of LNG*

	followed	• *API 620 – Design & construction of large welded low pressure storage tanks* • *ACI 376-10 – Requirements for design & construction of concrete structure for the containment of refrigerated liquefied gases* • *OISD STD 194–Storage & handling of LNG* • *OISD 118 – Layouts for Oil & Gas Installations* • *OISD 113 – Area classification for electrical installations.* • *OISD 117 - Fire protection facilities for petroleum depots ,terminals* • *OISD-GDN-156 –Fire protection facilities for port oil terminals*

Table 7.9 Salient Features of the FS-R-U

A	***Parameter***	***Feature***
1.	*Type of Terminal*	*FSU, regassification on jetty deck*
2.	*Activities covered*	*Unloading, Storage, Re-gasification, Sendout*
3.	*Rated capacity of the Terminal*	*3.5 MMTPA throughput of natural gas*
4.	*Duty and availability*	*All weather, 365 days operation*
5.	*Source of LNG*	*Various gas fields*
6.	*Storage capacity*	*75,000 to 1,35,000 m^3 moss type tanks in a converted storage vessel depending on availability (three to four insulated LNG compartments depending on size of the vessel)*
7.	*Type of tanks*	*Double hull, full containment (insulation (plywood box, perlite flushed with nitrogen) supported aluminium sheet or INVAR) depending on type of FSRU vessel*
8.	*Facilities on FSRU berth*	*l. Alongside draft – -17 m CD*
		m. Capacity of LNG shuttle vessel – 75,000 to Q-Flex 2,10,000 m^3
		n. Berth type –moored FSRU, flexible connection to jetty by cryogenic hose, on-deck regasification by ORVs, BOG management (BOG compression and re-condensation)
		o. LNG line – one, 24" PUF insulated line
		p. Design unloading rate – 12,000 m^3/hr
		q. Firefighting measures – remotely operated monitors
		r. BOG compressors – 2 nos, reciprocating, 10.5 T/hr each, one re-condenser
		s. 3 nos + 1 HP LNG pumps, 205 t/hr each
		t. Vaporizer system (ORV)
		u. Metering and sendout
		v. Firefighting system (2 electric and 1 diesel driven, discharge 850 m^3/hr) based on marine water
		w. Control Room – yes, on jetty, to supervise ship-shore splicing and on-berth vessel movement
9	*Detection and Control System*	*xv. Distributed Control System (DCS)* *xvi. Emergency Shutdown System (ESD)* *xvii. Fire & Gas Detection System (FSGDS)* *xviii. LNG Tank Level Temperature Density System (LTD)* *xix. Power Distribution Management System (PDMS)* *xx. Position Supervising System (PSS)*

		xxi. Berth Monitoring System (BMS) *xxii. Ship – Shore Communication System* *xxiii. Vibration Monitoring System (VMS)* *xxiv. Metering System* *xxv. Truck Loading Control System (TLCS)* *xxvi. Package Unit Local Control Panels (LCP)*
10.	*Design Codes followed*	• *NFPA 59A – Production storage & handling of LNG* • *ACI 376-10 – Requirements for design & construction of concrete structure for the containment of refrigerated liquefied gases* • *OISD STD 194–Storage & handling of LNG* • *OISD 118 – Layouts for Oil & Gas Installations* • *OISD 113 – Area classification for electrical installations.* • *OISD 117 - Fire protection facilities for petroleum depots ,terminals* • *OISD-GDN-156 –Fire protection facilities for port oil terminals*

7.6.2 Identification of Hazards – Loss of Containment of LNG

LNG as pure material and under confinement is non-combustible due to low temperatures and being too rich to support combustion. All fire related risks of LNG are associated with natural gas produced due to vaporization of LNG.

7.6.3 Property of LNG

LNG is imported and stored as a cryogenic liquid. LNG contains methane between 80% - 95%, remaining ethane, less than 1% of propane, with helium, nitrogen and carbon dioxide in traces (relative composition varying depending on the gas field of origin). Properties of LNG are as follows.

- LNG Density: 424.49 kg/m^3 (lighter than water)
- LNG boiling point: -161^0 C
- Natural gas has a density of 0.8 kg/m^3, at 20^0 C under one bar pressure
- Flammability limits
    - Lower Flammability Limit (LFL): 5%,
    - Upper Flammability Limit (UFL): 15%
- 1 m^3 LNG = 600 m^3 of gas at 20°C

LNG as a cryogenic liquid is a relatively safe material to handle under insulated containment. LNG when in open and under conditions of heat ingress from ambient or conductive sources vaporises into natural gas which is flammable in a narrow range of concentration. Properties of LNG that have safety implications include auto-ignition

temperature, low temperature, heat of vaporisation, flammability limits, heat transfer rate of boiling liquid and specific gravity. The average auto ignition temperature of pure methane at atmospheric pressure is 537 ^{0}C, which is quite high, and rare to be encountered in typical normal storage and handling conditions. The lower and upper flammability limit of methane in air is 5% & 15% by volume. Methane being a light and buoyant gas disperses (both by advection and diffusion) rapidly under normal atmospheric conditions and dilutes beyond 5% within few meters of the point of release with a vapour cloud incapable to sustain ignition. LNG under confinement cannot ignite.

7.6.4 Identification of Hazard Scenarios and Consequence Analysis

The RA of the LNG terminal/FS-R-U is based on the following identified release scenarios from possible hazardous sources listed in Table-7.10**.** Except scenarios covering loss of containment of on-shore LNG or LNG transfer from/to the tanks, consequences of LNG terminal and FS-R-U will be similar in magnitude.

The consequence analysis has been carried out for Pasquill and Gifford atmospheric stability class[1] 'D – neutral' and 'F – stable'.

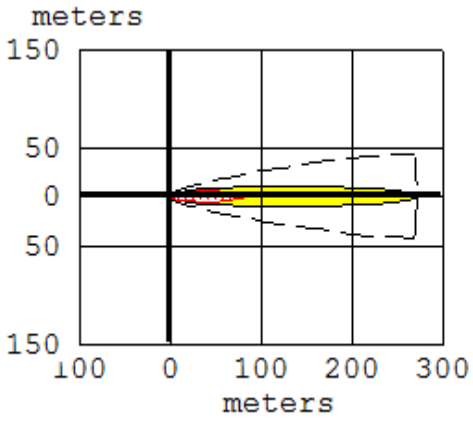
Table-7.10 Identification of Hazard Scenarios

Sr.	Failure Case	Failure Mode Type	Consequence
1.	*25 mm leak in 16" DCMA LNG unloading arm or LNG STS Cryogenic Hose of the FSU*	*Loss of holdup of one arm, LNG drained into concrete impoundment basin, evaporative dissemination, vapour cloud meeting with a source of ignition after one minute*	*Pool fire (**Figure 7.3** - **Scenario 01** - stability class D, **Figure 7.4** - **Scenario 02** - stability class F).* *As the site of release is not a congested area, formation of ignitable vapour cloud followed by UVCE is not possible.*
2.	*25 mm leak (flange or pipeline length) on 48' diameter insulated LNG berth-to-tank*	*Loss of 40% holdup of pipeline for the first 10 minutes until intervened, LNG drained on ground/water, evaporative dissemination, vapour cloud meeting with a source of*	*Pool fire (**Figure 7.5** - **Scenario 3** - stability class D, **Figure 7.6** - **Scenario 04** - stability class F).*

[1] Pasquill, F. (1961). *The estimation of the dispersion of windborne material*, The Meteorological Magazine, vol 90, No. 1063, pp 33-49.

	transfer pipeline operating at 08 Bar-g.	*ignition after five minutes*	*UVCE is not supported for typical, open-to-air LNG terminal – not congested setting. Application override – congested setting assumed. UVCE (**Figure 7.7** – **Scenario 5**, - Stability class D, **Figure 7.8** – **Scenario 6**, - Stability class F)*
3.	*25 mm leak on LNG LP pump header (flange or pipeline length) 20"inch diameter LNG pipeline operating at 12 Bar-g.*	*Loss of holdup of 80 m line, LNG drained into concrete impoundment basin, evaporative dissemination, vapour cloud meeting with a source of ignition after five minute*	*Pool fire (**Figure 7.9** - **Scenario 07** - stability class D, **Figure 7.10** - **Scenario 08** - stability class F).* *UVCE is not supported for typical, open-to-air LNG terminal – not congested setting. Application override – congested setting assumed. UVCE (**Figure 7.11** – **Scenario 09**, - Stability class D, **Figure 7.12** – **Scenario 10**, - Stability class F)*
4	*5 mm leak on exposed 26" NG send out pipeline (pipeline length) operating at 90 Bar-g.*	*NG jet leak meeting a source of ignition,*	*Jet fire (**Figure 7.13** – **Scenario 11**, - Stability class D, **Figure 7.14** – **Scenario 12**, - Stability class F)*

Figure-7.3 ***- Scenario 01 –*** *25 mm leak in 16" DCMA unloading arm/LNG STS Cryogenic hose of the FSU, pool fire, Stability Class D*

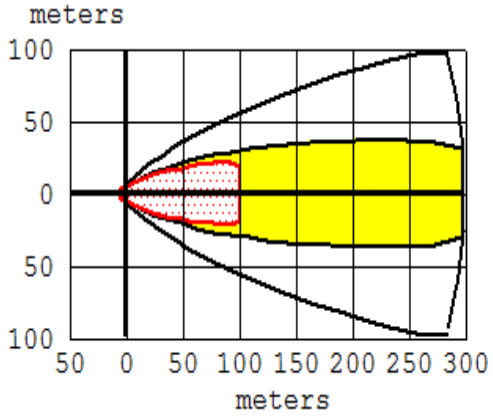


Thermal radiation from pool fire

Red : 83 meters --- (30000 ppm = 60% LEL = Flame Pockets)

Yellow: 274 meters --- (5000 ppm = 10% LEL)

Figure-7.4 ***- Scenario 02 –*** *25 mm leak in 16" DCMA unloading arm, pool fire, Stability Class F*

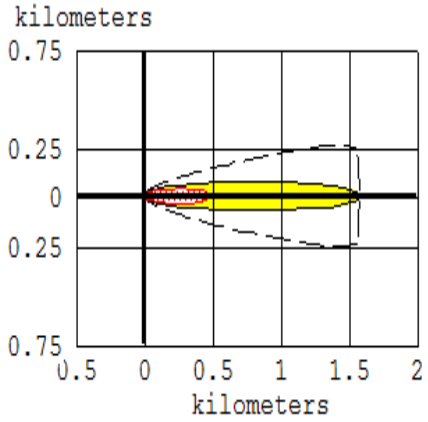


Thermal radiation from pool fire

Red : 101 meters --- (30000 ppm = 60% LEL = Flame Pockets)

Yellow: 299 meters --- (5000 ppm = 10% LEL)

Figure-7.5 ***- Scenario 03 –*** *25 mm leak in 48" LNG Ship to Tank pipeline, pool fire, Stability Class D*

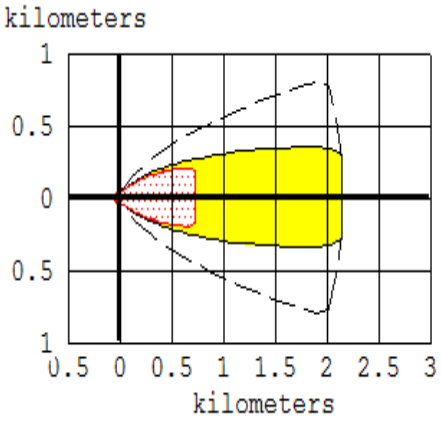


Thermal radiation from pool fire

Red : 453 meters --- (30000 ppm = 60% LEL = Flame Pockets)

Yellow: 1.6 kilometers --- (5000 ppm = 10% LEL)

Figure-7.6 ***- Scenario 04 –*** *25 mm leak in 48" LNG Ship to Tank pipeline, pool fire, Stability Class F*

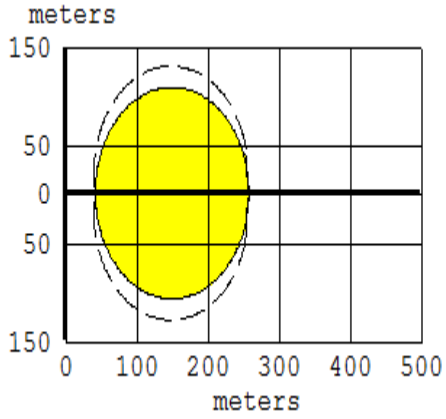


Thermal radiation from pool fire

Red : 730 meters --- (30000 ppm = 60% LEL = Flame Pockets)

Yellow: 2.1 kilometers --- (5000 ppm = 10% LEL)

Figure-7.7 ***- Scenario 06 –*** *25 mm leak in 48" LNG Ship to Tank pipeline, UVCE, Stability Class D*



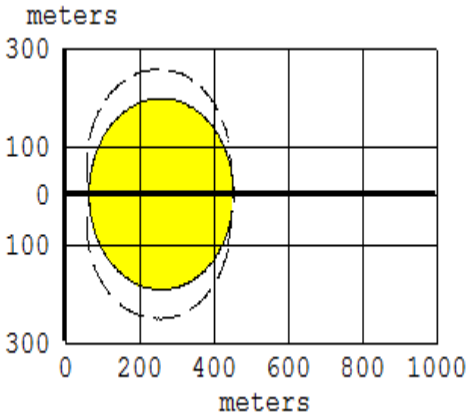
Blast overpressure

Red : LOC was never exceeded --- (8.0 psi = destruction of buildings)

Orange: LOC was never exceeded --- (3.5 psi = serious injury likely)

Yellow: 257 meters --- (1.0 psi = shatters glass)

Figure 7.8 ***- Scenario 06 –*** *25 mm leak in 48" LNG Ship to Tank pipeline, UVCE, Stability Class F*



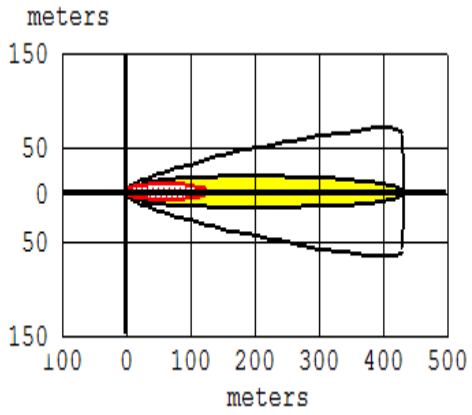
Blast overpressure

Red : LOC was never exceeded --- (8.0 psi = destruction of buildings)

Orange: LOC was never exceeded --- (3.5 psi = serious injury likely)

Yellow: 455 meters --- (1.0 psi = shatters glass)

Figure-7.9 ***- Scenario 07 –*** *25 mm leak in 20" LNG LP Pump line, pool fire, Stability Class D*

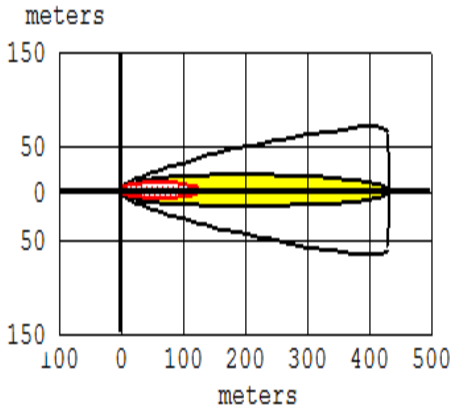


Thermal radiation from pool fire

Red : 125 meters --- (30000 ppm = 60% LEL = Flame Pockets)

Yellow: 434 meters --- (5000 ppm = 10% LEL)

Figure-7.10 ***- Scenario 08 –*** *25 mm leak in 20" LNG LP Pump line, pool fire, Stability Class F*

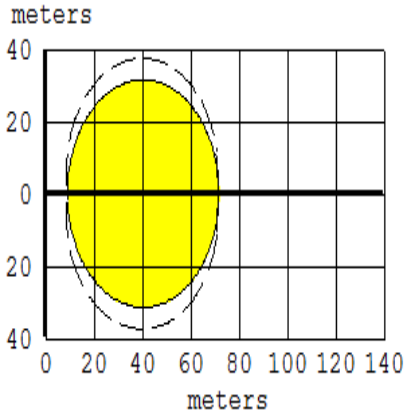


Thermal radiation from pool fire

Red : 167 meters --- (30000 ppm = 60% LEL = Flame Pockets)

Yellow: 522 meters --- (5000 ppm = 10% LEL)

Figure 7.11 ***- Scenario 09 –*** *25 mm leak in 20" LNG LP Pump line, UVCE, Stability Class D*



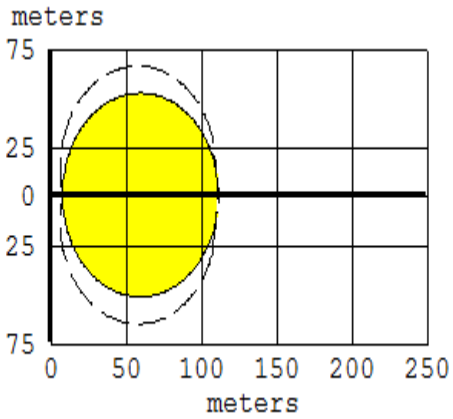
Blast overpressure

Red : LOC was never exceeded --- (8.0 psi = destruction of buildings)

Orange: LOC was never exceeded --- (3.5 psi = serious injury likely)

Yellow: 72 meters --- (1.0 psi = shatters glass)

Figure-7.12 ***- Scenario 10 –*** *25 mm leak in 20" LNG LP Pump line, UVCE, Stability Class F*



Blast overpressure

Red : LOC was never exceeded --- (8.0 psi = destruction of buildings)

Orange: LOC was never exceeded --- (3.5 psi = serious injury likely)

Yellow: 111 meters --- (1.0 psi = shatters glass)

Figure-7.13 ***- Scenario 11 –*** *1 cm leak in 26" NG send out line, jet fire, Stability Class D Max Flame Length: 1 meter*

Max Burn Rate: 69.6 kilograms/min
Total Amount Burned: 230 kilograms

Thermal radiation from jet fire
Red : less than 10 meters(10.9 yards) --- (10.0 kW/(sq m) = potentially lethal within 60 sec)
Orange: less than 10 meters(10.9 yards) --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)
Yellow: less than 10 meters(10.9 yards) --- (2.0 kW/(sq m) = pain within 60 sec)

Figure-7.14 ***- Scenario 12 –*** *1 cm leak in 26" NG send out line, jet fire, Stability Class F Max Flame Length: 1 meter*

Max Burn Rate: 71.4 kilograms/min
Total Amount Burned: 236 kilograms

Thermal radiation from jet fire
Red : less than 10 meters(10.9 yards) --- (10.0 kW/(sq m) = potentially lethal within 60 sec)
Orange: less than 10 meters(10.9 yards) --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)
Yellow: less than 10 meters(10.9 yards) --- (2.0 kW/(sq m) = pain within 60 sec)

Consequence distances for the scenarios for Stability Class D and F are given in the Table-7.11.

Table-7.11 Distance of consequences for identified scenarios

Sr.	***Scenario***	***Consequence***	***Stability Class D***	***Stability Class F***
1	*01 and 02 – 25 mm leak in 16" DCMA unloading arm*	*Pool fire*	*60% of LEL = Flame pocket – 83 m*	*60% of LEL = Flame pocket – 101 m*

2	*03 and 04 – 25 mm leak in 48" LNG Ship to Tank pipeline*	*Poo, fire*	*60% of LEL = Flame pocket – 453 m*	*60% of LEL = Flame pocket – 730 m*
3	*05 and 06 – 25 mm leak in 48" LNG Ship to Tank pipeline*	*UVCE*	*Blast overpressure 1.0 psi = shatters glass – 275 m*	*Blast overpressure 1.0 psi = shatters glass – 455 m*
4	*07 and 08 – 25 mm leak in 20" LP LNG line*	*Pool fire*	*60% of LEL = Flame pocket – 125 m*	*60% of LEL = Flame pocket – 167 m*
5	*09 and 10 – 25 mm leak in 20" LP LNG line*	*UVCE*	*Blast overpressure 1.0 psi = shatters glass – 72 m*	*Blast overpressure 1.0 psi = shatters glass – 111 m*

7.6.5 Failure Frequency associated with Loss of Containment

Quantitative risk is a product of failure frequency and consequence of the scenario. Failure frequencies of plant elements in the LNG terminal are given in Table-7.12.

Table-7.12 Failure frequency

Sr.	***Plant component***	***Failure Frequency per year***
1.	*16"unoading arm, 25 mm hole*	*5.0 E -7*
2.	*48" unloading header, 25 mm hole*	*2.5 E -7*
3.	*20" LP Pump header, 25 mm hole*	*6.0 E -7*
4	*26" send out heder, 25 mm hole*	*5.0 E -7*

It may be observed from the above failure frequency data that the likelihood of an incidence occurring in the 40 years assumed lifetime of the LNG terminal is extremely rare.

7.7 Risks due to Vessel Collision and Grounding

Vessel collision or grounding, onboard fire, explosion etc. are the consequences which may threaten integrity of the vessel, can endanger cargos on the vessel involved in he incident and may result in release of cargo in the sea. Vessel collision and grounding are more frequent and often result from out of control vessel movement.

The frequency of vessel collision is governed by the frequency of vessel encounter and the probability of collision given an encounter. From the records of accidents maintained at several major ports worldwide it has been considered that collision frequency is

proportional to the square of the traffic density and is directly proportional to the number of encounters. Casualty statistics maintained at UK ports indicate that collisions involving vessels account for 7% of all accidents and represent 0.024 for every 1000 vessel movements. Accident figures for India would be still lower considering lack of congestion in Indian ports.

The proposed all weather Port at Nandgaon has a dedicated navigational channel, not shared with any other Port. The proposed dedicated, two way channel will extend from the fairway from natural depths of -18 m CD or more so that the vessels of any other Port do not intermingle, thus eliminating ship interactions. The channel has been designed following PIANK guideline which considers safety as the primary requirement for selection of the channel width. Tug assistance will be provided in the channel and basin for safe manoeuvring and berthing.

Not all ship accidents result in oil spills. International Tank Owners Pollution Federation Limited (ITOPFL) has maintained a database of oil spills from tankers and other ships. Spills are categorized by size (< 7 t, 7 -700 t and> 700 t). Information is held for about 10000 accidents. Their data-base indicates that the vast majority of spills (83%) fall in the smallest category (< 7 t) and < 3% of accidents result in large spills. Hence, the probability of a large spill occurring along this coastal area is low.

Bulk release of oil can also result if a tanker goes aground rupturing cargo holds. The data-base of ITOPFL reveals that 34.4% and 28.9% of large spills (> 700 t) have occurred due to groundings and collisions respectively. Channel length and its width are the major factors controlling grounding in inshore waters. The ships are vulnerable to grounding in long and narrow channels particularly those which have several bends. From grounding incidents at several ports it has been considered that the channel length to width ratio gives a good indicting probability of encountering a grounding obstruction. Thus, the grounding frequency increases with increasing length of the channel and decreases with increasing width for a given length.

The grounding frequency may therefore be expressed as:

GF = K x L/W

Where G = grounding frequency

L = channel length

W = effective channel width

K = constant (normally taken as $1x10^{-5}$ per movement).

Hence, depending on frequency of ship movement the grounding probability increases or decreases. In case of the proposed Port, there will be no bends in the navigation channel and it will be dredged and maintained at – 18 m CD, practically eliminating grounding incidences inside the Port waters.

7.8 Disaster Management Plan

Emergency/disaster is an undesirable occurrence of events of such magnitude and nature that adversely affect operations, cause loss of human lives and property as well as damage to the environment. Coastal infrastructure are vulnerable to various kinds of natural and manmade disasters. Examples of natural disaster are flood, cyclone, tsunami, earthquake, lightning, etc., and manmade disasters are like major fire, explosion, sudden heavy leakage of toxic/poisonous gases, civil war, nuclear attacks, terrorist activities, sabotage, etc. It is impossible to forecast the time and nature of disaster, which might strike a common user infrastructure. An effective disaster management plan helps to minimize the losses in terms of human lives, assets and environmental damage and resumes working condition as soon as possible.

Disaster Management Plan (DMP) forms an integral part of any risk assessment and management exercise; any realistic DMP can only be made after proper risk assessment study of the activities and the facilities provided in the installation. Correct assessment and evaluation of the potential hazards, advance meticulous planning for prevention and control, training of personnel, mock drills and liaison with outside services available can minimize losses to the facility's assets, rapidly contain the damage effects and effectively rehabilitate the damage areas.

The liquid berths are proposed beyond 1.5 km from the shore aligned quey line of the port, separated by the Port basin, making the actual point of shore-ship transfer of the liquid chemicals very far away from the port backup area. In an event of toxic release or fire on the liquid berths, or on the pipeline corridor between the Pump House and the liquid berths only Port personnel present within 50 to 100 m (refer consequence footprints of MCLS scenario for chemicals proposed to be handled in the Port for fire and toxic release scenarios) of the of the point of release will be effected. These persons will be trained to quick leave the site of incidence and let the Port Fire and Safety Department personnel take charge of the situation. No incidence in the Port has likelihood of offsite consequences.

7.8.1 Approaches to Disaster Management Plan

Modern approach to disaster management involves the following two steps –

- Risk Identification
- Risk Evaluation

Risk identification entails:

- Identification of hazardous events in the installation, which can cause loss of capital equipment, loss of operation, threaten health and safety of employees, threaten public health and damage to the environment.
- Identification of risk important processes & areas to determine effective risk reduction measures.

Risk evaluation involves calculation of damage potential of the identified hazards with damage distances, which is then termed as consequence analysis as well as estimation of frequencies of the events.

Probability of any hazardous incident and the consequent damage also depends on:

- Wind speed
- Wind direction
- Atmospheric stability
- Source of ignition and also
- Presence of Port assets & population exposed in the direction of wind.

Action plan depends largely on results of risk assessment data and may include one or more of the following:

- Plan for preventive as well as predictive maintenance.
- Augment facilities for safety, fire fighting, medical (both equipment and manpower) as per requirements of risk analysis.
- Evolve emergency handling procedure both onsite and offsite.
- Practice mock drill for ascertaining preparedness for tackling hazards/emergencies at any time of the day.

7.8.2 General Nature of the Hazard

Operation of the Port involves two types of cargoes which may pose operational hazards: bulk solid cargo, mainly coal and Fertilizer/FRM, and liquid cargoes including POLs and chemicals.

Coal and Fertilizer/FRM cargoes have moderate to low fire hazard potential localized to the site of storage. Incidences of fires in these cargoes can be easily avoided and controlled easily if recommended practice for their handling is followed.

Incidences of pool fire are possible in events of loss of inventory from the Port pipeline which is laid above grade. While vapors evaporating from a pool of low-vapor pressure hydrocarbons and chemicals may be explosive under conditions of congestion, owing to low level of ambient confinement and high wind conditions, explosions are not possible in the Port.

Any small fire in the Port near the POL and chemical pipelines, if not extinguished immediately, can cause large scale damage and may have a cascading effect. Hence, liquid berths and pipelines require:

- A quick responsive containment and control system requiring well planned safety and fire fighting system.
- Well organized trained manpower to handle the process equipment & systems safely.

- Well trained personnel to handle safety and fire fighting equipment to extinguish fire inside the installation promptly as well as tackle any type of emergency.

7.8.3 Designated Hazardous Areas of the Port

Depending on the kind of operation, hazardous area within the battery limit of the Port may be subdivided into the following sections:

Activities	Place
a) Pumping of POL and chemical	Pump house
b) Pipeline conveying above grade	Pipeline corridor
c) Ship shore transfer	Liquid berths

Since some of the POL products are highly inflammable and explosive, fire hazard exists in all these areas. However, risk varies due to varying inventory of the material and operations involved.

The risk potential of the above areas has been discussed in the chapter on Consequence Analysis. The maximum credible hazard scenarios are found to be gasket failure, mechanical seal failure of pumps, loading arm failure on the liquid berths and small bore pipe line failure, etc.

Apart from the above, fire cannot be ruled out in substation & MCC as well as in other places from short circuiting and also secondary fire from nearby industries.

However, major accident may occur in the Port and call for emergency/disaster.

7.8.4 Disaster Preventive and Pre-Emptive Measures

After identification and assessment of disaster potential the next step in disaster management plan is to formulate and practice the preventive measures. Proper preventive and pre-emptive measures can reduce the disaster potential to a minimum.

Preventive and pre-emptive measures are taken from the design stage itself. Preventive measures which are to be taken during design stage:

- Layout of the Pump House, pipeline corridor and liquid berths with sufficient safety distances.
- Avoidance of low lying areas, which facilitate accumulation vapors of flammable material
- Use of proper material of construction for equipment and piping.
- Use of SRVs & Pop-off valves of proper size and capacity.
- Use of automatic as well as manual isolation valves at proper places.
- Proper instrumentation with interlock, trip and alarm system.
- Installation of vapor and heat detectors, and fire water system (sprinkler, hydrants, deluge valves, etc.) at proper places to detect release of flammable inventory and taking necessary automatic/manual action.

Apart from the above precautions in the design stage, procurement of equipment are to be done strictly as per specification/code and fabrication/erection of the equipment are to be done under supervision of competent and experienced personnel.

Some of the preventive & pre-emptive measures, which are to be taken during operational life are as follows:

a) Safety measures

Following safety tips should always be borne in mind while working in the Port to avoid emergency & hazardous situation.

- Follow specified procedures and instructions for start-up, shut down and any maintenance work.
- Follow permit to work system.
- Identify correctly the part of the pipeline in which work is to be done.
- Isolate the part, machine properly on which work is to be done.
- Release pressure from the part of the pipeline on which work is to be done.
- Remove flammable liquid/gases thoroughly on which work is to be done.
- Use non sparking tools.

b) Port Inspection

Apart from planned inspection, checks and tests should be carried out to reduce failure probability of containments.

- Pump house and pipeline during both their construction and operational life.
- Pressure relief valves to avoid fail danger situation. The safety relief valves connected with pumps and piping should be checked and calibrated at regular intervals according to specification.
- Critical trips, interlocks, & other instruments should be checked regularly to avoid fail danger situation.
- Vapor detection, heat detection & fire fighting system should be checked regularly to ensure proper functioning for avoiding emergency situation.
- Lightning protection system

c) Performance or Condition Monitoring

A systematic monitoring of performance or condition should be carried out especially for pumps and associated equipment, which may be responsible for serious accidents/disaster in case the defined limits are crossed.

- Vibration, speed & torque measurements for pumps, etc.
- Thickness and other flaw measurements in metals of pipelines, etc.

Many types of non-destructive testing/condition monitoring techniques are available.

X-ray radiography, acoustic emission testing, magnetic particle testing, eddy current inspection techniques etc. are used for detection of flaws and progression of cracks in metals. The above condition monitoring techniques should be applied regularly by internal/external agencies. Immediate corrective measures should be taken if any flaws are detected.

d) Preventive Maintenance

A schedule for preventive maintenance for moving machineries like pumps, compressors, etc. should be prepared based on experience in other similar operations as well as instruction of the suppliers. The schedule should be followed strictly during operation as well as planned shutdown period.

e) Entry of Personnel

Entry of unauthorized personnel will be strictly prohibited inside the Port liquid cargo battery limit. The persons entering the liquid cargo area will not carry matches, lighters etc. and hot work will not be permitted except in designated areas with utmost precaution.

7.8.5 Disaster Control/Response Plan

Disaster may arrive without any warning, unexpectedly in spite of all precautions & preventive measures taken. However, an efficient control/response plan can minimize the losses in terms of property, human lives and damage to the environment can be the minimum.

7.8.5.1 Objectives of the Plan

The plan should be developed to make best possible use of the resources at the command of the Port as well as outside resources available like State Fire Services, Police, Civil Defense, Hospitals, Civil Administration, neighbouring institution and industries.

It is not possible for the port to face a disaster single handed and calls for use of all available resources in the surrounding area. Advance meticulous planning minimizes chaos and confusion, which normally occur in such a situation and reduce the response time of Disaster Management Organization.

The objectives of Disaster Management Plan are:

- To contain and control the incident.
- To rescue the victim and treat them suitably in quickest possible time.
- To safeguard other personnel and evacuate them to safer places.

- To identify personnel affected/dead.
- To give immediate warning signal to the people in the surrounding areas in case such situation arising.
- To inform relatives of the casualties.
- To provide authoritative information to news media and others.
- To safeguard important records & information about the organization.
- To preserve damaged records & equipment needed as evidence for any subsequent enquiry.
- To rehabilitate the affected areas.
- To restore the facilities to normal working condition at the earliest.

7.8.5.2 Components of the DMP

An onsite emergency is one, which is having negligible effects outside the port premises and can primarily be controlled by internal facilities and resources available. Some help may be required from external agencies or local authorities. All the consequence footprint of the scenarios identified in the Consequence Analysis chapter indicate that the effects of the incidences will be well within the boundary, which can be mitigated by following the Onsite DMP.

An offsite emergency will affect the neighboring areas and population outside the port premises and would require substantial contribution from local authorities and institutions like police, civil defense, state hospital and civil administration in addition to state fire services. Offsite DMP will be needed in case of natural disaster of large magnitude such as tsunami and cyclone.

7.8.5.3 Onsite Emergency as Statutory Requirement

The requirement of an Onsite DMP with detailed disaster control measures was embodied for the first time in section 41B(4) of the Factories (Amendment) Act, 1987. The requirement is applicable to Ports handling flammable cargo per the First Schedule of the Act, item 29 entitled "Highly Flammable Liquids and Gases".

Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989, under Sections 6, 8 and 25 of the Environment (Protection) Act, 1986 concurrently provides the requirement

of an Onsite Emergency Plan by the occupier of accident hazard site, under rule 13, sub-rule 1.

7.8.5.4 Emergency Control Philosophy

The principal strategy of emergency control at the proposed Port is prevention of the identified major hazards. Since hazards can occur only in the event of loss of containment, one of the key objectives of detail engineering, construction, commissioning and operating of the Port is total and consistent quality assurance.

The second control strategy adopted for potential emergencies is surveillance of handling and storage of hazardous substances.

Yet another control measure adopted is early detection of any accidental leak of hydrocarbon and other flammable vapors by gas detectors and by trained and vigilant operating staff and activation of well-structured, resourced and rehearsed emergency plan to intercept the incident with speed and ensure safety of employees, assets, public and environment as a matter of priority.

7.8.5.5 Content of the Onsite DMP

Information to be provided by any MAH installation or an Isolated Storage has been prescribed in schedule 11 of the MSIHC Rules. This DMP has been prepared, in so far as is practicable, in accordance with the guidelines stipulated in the Rules.

Details that need to be furnished in the Onsite DMP per schedule 11 of MSIHC Rule, 1989 are:

- Name and address of the person furnishing the information.
- Key personnel of the Organization and responsibilities assigned to them in case of an emergency.
- Outside Organization if involved in assisting during an onsite emergency:
  - Type of accidents
  - Responsibility assigned.
- Details of liaison arrangement between the Organizations.
- Information on the preliminary hazard analysis:
  - Type of accidents.
  - System elements or events that can lead to a major accident.

- Hazards.
- Safety relevant components.

- Details about the site:
  - Location of dangerous substances.
  - Seat of key personnel.
  - Emergency control room.
- Description of hazardous chemicals at Port site:
  - Chemicals (quantities and toxicological data).
  - Transformation if any, which could occur.
  - Purity of hazardous chemicals.
- Likely dangers to the Port
- Enumerate effects of -
  - Stress and strain caused during normal operation.
  - Fire and explosion inside the Port and effect, if any, of fire and explosion outside.
- Details regarding
  - Warning, alarm, safety and security systems.
  - Alarm and hazard control plans in the line with disaster control and hazard control planning, ensuring the necessary technical and organizational precautions.
  - Reliable measuring instruments, control units and servicing of such equipments.
  - Precautions in designing of the foundations and load bearing parts of the building.
  - Continuous surveillance of operations.
  - Maintenance and repair work according to the generally recognized rules of good engineering practices.
- Details of communication facilities available during emergency and those required for an offsite emergency.
- Details of fire fighting and other facilities available and those required for an offsite emergency.
- Details of first aid and hospital services available and its adequacy.

An outline of these details is provided in the pages following under the headings stated above, in so far as the headings apply to the proposed Port.

7.8.5.6 Key Personnel of the Port and Responsibilities in the Event of an Emergency

It is to be understood that the first few minutes after the start of an incident are most vital in prevention of escalation. Therefore the personnel available at the site on round-the-clock basis will play an important role. Some of them will be the identified “Key Persons”. Since the liquid berths and Pump House are to be operated by highly skilled officers/operators with the help of “Port In-Charge/Dy. Port Manager”, in the emergency he will also act as “Chief Controller” for incidence and he will nominate different “Emergency Coordinators” to control emergency situation.

The role of various coordinators is to assess the situation from time-to-time, take appropriate decisions in consultation with the “Chief Controller” and to provide timely resources to the “Key Persons” to fight the emergency. “Key Persons” as far as is possible are available during shift on a round the clock basis. An organogram of the officers at the liquid cargo operations during emergency is presented as Figure-7.15**.**

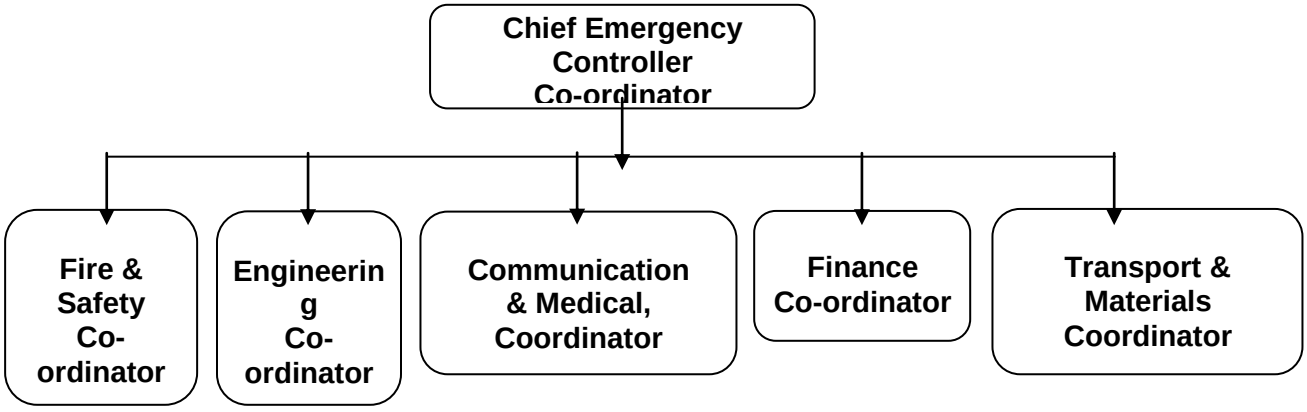


Figure-7.15 Organization Chart for Onsite Emergency Management Team

Key Personnel

The senior most officer present in the Port at the time of the incident will be the designated he “Chief Emergency Controller”.

Duties and responsibilities of “Chief Controller: and other “Coordinators” are as follows:

Duties and Responsibilities of Key Persons and coordinators

a. Chief Emergency Controller

He will report at the "Emergency Control Centre" and will assume overall responsibility of the works and its personnel. His duties will be:

(i) To assess the magnitude of the situation and decide whether a major emergency exists or is likely to develop, requiring external assistance. To inform District Emergency Chief (i.e. District Collector).

(ii) To exercise direct operational control over areas in the Port other than those affected.

(iii) Assess the magnitude of the situation and decide if staff needs to be evacuated from the assembly points to identified safe places.

(iv) To continuously review and direct shutting down of Port sections and operations in consultation with the other key personnel.

(v) To liaise with senior officials of Police, Fire Brigade, Medical and local administration, and pass on information on possible effects on the surrounding areas, outside the factory premises.

(vi) To liaise with various coordinators to ensure casualties are receiving adequate attention and traffic control movement within the work is well regulated.

(vii) To arrange for a log of the emergency to be maintained in the Emergency Control Centre.

(viii) To release authorized information to press through the Media Coordinator.

(ix) To control rehabilitation of the affected persons and the effected areas after the emergency.

b. Fire and Safety Coordinator

The main responsibilities of Fire and Safety Coordinator will be:

(i) To immediately take charge of all fire fighting operations upon sounding of the alarm.

(ii) To guide the fire fighting team and provide logistics support for effectively combating the fire.

(iii) To barricade the area at appropriate locations in order to prevent the movement of vehicular traffic.

(iv) To operate the Mutual Aid Scheme and call for additional external help in fire fighting.

(v) To organize relieving groups for fire fighting.

(vi) To inform the Chief controller and give "All Clear" signal when the fire emergency is over.

c. Engineering Coordinator

Responsibilities of Engineering Coordinator will be:

(i) To liaise with Chief Controller and various other Coordinators

(ii) To stop/regulate all operations within the Port

(iii) To switch off main Instrument Control Panel

(iv) To stop all engineering works and instruct contractors and their employees to leave the area

(v) To assess the water level in the fire water reservoir and supply engineering tools, fire-fighting materials and equipments to various Coordinators

(vi) To start all pumps to replenish water and switch on the fire engine for hot standby.

(vii) To liaise with transport Coordinator to arrange for external water supply and fuel for generators/engines

(viii) To attend mechanical fault/failure of fire water pump and facilities.

(ix) To assess situation in consultation with Chief Controller and if required, start/provide electric supply to certain areas/points.

d. Communication and Medical Coordinator

Duties and responsibilities of the Communication and Medical Coordinator will be:

(i) To liaise with Chief Controller and various other Coordinator.

(ii) To take over entire communication system (external as well as internal).

(iii) To arrange to distribute Walky-Talkie/ VHF sets to various other Co-ordinator.

(iv) To inform police, fire brigade, civil authorities, hospitals & request for speedy help.
(v) To arrange for vehicles/ambulance for evacuation and causalities.
(vi) To set and activate first aid centre and arrange to mobilize medical team
(vii) Arrange to procure required drugs & appliances.
(viii) Arrange to transfer causalities to other hospitals/first aid centre.
(ix) To maintain a register for causalities (type of injury, number, hospitalization, etc)
(x) To inform families of the causalities.

e. Finance Coordinator

The Asst. Manager (Finance) or his nominee:

(i) Release finances (Cash/Cheques, etc.) as directed by the Chief Controller.
(ii) Assist Material Coordinator in enactment of emergency procurement procedures and by deputing his staff.
(iii) To liaise with Insurance Company personnel.

f. Transport and Materials Coordinator

Duties & Responsibilities will be:

(i) To liaise with Chief Controller and other Coordinators.
(ii) To Arrange issue of materials from warehouse round-the-clock during the emergency period.
(iii) To arrange emergency procurements from local dealers or from neighbouring industries.
(iv) To arrange transportation of materials from warehouse to the site in consultation with other Coordinators.
(vii) To arrange for police help for control of traffic & public outside the affected area of the Port.
(viii) To arrange for entry for authorized personnel/vehicles only.
(ix) To mobilise necessary vehicles as required by various Coordinators
(x) To arrange for regulating the traffic inside the Port area.

(xi) To arrange to evacuate all unnecessary personnel from the Portand arrange for vehicles/ambulance for evacuation and casualties.

(xii) To control and disperse crowd from the scene of fire.

(xiii) To mobilize all the fire fighting spare equipment/ refills/hosepipes/trolleys etc. form the neighbouring units, if required.

(xiv) To monitor stock of all fire fighting equipment and replenish them as and when required.

7.8.5.7 Safety Hardware proposed to be installed for Liquid Handling Facility

The designated hazardous areas of the liquid cargo handling facility in the Port will be served by a number of sensitive flammable gas detectors, hooked to alarm in the Marine Control Room. The detectors will be strategically located to detect presence of flammable vapor cloud. The detectors will be supplemented by manually operated break-glass type fire alarm call points linked to electric sirens and a centralized and manned alarm annunciator panel.

All strategic areas, especially the Pump House shall be fitted with 'quartz heat-bulb' actuated medium velocity water sprinkler systems supported by fire fighting water pumps.
An extensive network of pressurized fire hydrant system set up in accordance with OISD 144 standard shall been installed to fight fire anywhere within Port and to cool pipelines and structures to ensure their safety during an incident, involving incidence of dangerous heat flux.

Adequate onsite manpower shall be suitably trained and equipped to carry out fire fighting operation efficiently.

A number of diverse fire fighting media such as DCP, CO_2 Fire extinguishers, etc. will be strategically located in various parts of the Port in suitable dispenser sizes.
Foam or any other equivalent substance will be used in adequate measure to cut down evaporation from a flammable liquid pool and thus inhibit fire and formation of a flammable gas cloud.

The design of the complete fire protection system is as per OISD norms.

Emergency Annunciation

Warning alarm, safety and security systems will be installed in the Port. One 3 km range Electric Siren will be installed on the roof of the Marine Control Room to announce the onset of an emergency.

The alarm will have facility to be triggered manually after activation of anyone of the break-in glass type fire-alarm call points, geographically located throughout the plant both in hazardous as well as in non-hazardous areas. Sirens can also be energized as and when a gas leak is detected.

Flammable vapor alarm will be set to activate by scanning network of vapor detectors spread near the liquid handling area in the Port site to detect presence of flammable vapor at 50 % of the LEL level. The audio-visual alarm will come on in control room alarm annunciator panel. Auto-sprinkler alarm will be provided in the Pump Room as well as in the MCR if any auto-sprinkler is activated through operation of heat fuse by a fire.

Communication Facilities to be provided for Emergency

- One 3.0 km range Electric Siren to announce nature of emergency.
- An Interport paging system in non-flame proof areas and as well as in flame proof areas will be provided for normal and emergency announcements and communication with master control in the MCR.
- For inter-location communications requisite number of P&T telephones will be provided including tie lines and hot lines for communication with district emergency services, authorities, hospitals, etc.
- The interport paging and public address system will have the following features-
    - All call with answer back
    - Group call with answer back
    - Interfacing with walkie talkies
    - Field call stations
- Walkie Talkies and mobile phones will be deployed for mobile-to-mobile and mobile-to-stationary communication.

- A broad communication diagram outlining interactions between various role players will be set up and rehearsed.

7.8.5.8 Details of First Aid and Hospital Services Available

Fully stocked first aid boxes shall be placed in the Port at strategic locations. A visiting medical practitioner will be made available on a part time basis during day. He will be available on call and round-the-clock for emergency duty. The onsite medical center will be equipped with facilities for treatment of mechanical injuries, burn injuries and electric shock. An ambulance will be available in the Port round-the-clock.

Personal Protective Equipment

The following PPEs and other emergency handling equipment will be stocked in the MCR to be issued to the trained Key Personnel during an emergency.

- Fire proximity suit.
- Fire entry suit.
- Self-contained Breathing Apparatus with one spare cylinder (30 minutes).
- Water gel blanket.
- Safety helmet.
- Rubber hand gloves for use in electrical jobs.
- Power tool
- Resuscitator.

The quantities available will be sufficient to meet the needs of emergency handling personnel.

7.8.5.9 Rehearsal and Testing

'Fire Drills' will be arranged periodically to test out the laid down system and facilities. The emergency handlers will also "act out" their individual roles in accordance with the emergency procedures laid down to demonstrate that the entire emergency response system can perform efficiently and accurately. Mock drills for emergency will be conducted twice a year.

7.8.5.10 Emergency Plan for Natural Disasters

Due to its location, the Port is exposed to natural disasters of cyclones and tsunami in greater measures than any other natural disaster. Both the disasters give a short to very short notice, have potential to cause sudden and widespread damage to the Port infrastructure and the population beyond it, and make recover efforts difficult due to total collapse of administrative and welfare machinery.

It is essential for DMPs of a Port to have special provision for meeting with the challenges of cyclones and tsunamis. Since they do not give a long lead warning, pre-meditate and pre-rehersed action between the first intimation and the onset of the event becomes crucial for effectiveness. Since both events involve mass evacuation and widespread public notice, DMPs for cyclone and tsunami can ill-afford to be complicated.

a. Emergency measures during a Cyclone

IMD usually gives a 24 to 36 hours early warning on the onset of cyclone right from the time a depression starts forming in the Arabian Sea. Aided by weather satellite, path of a cyclone can be traced almost in real time. The path of the cyclone can be reliably predicted and early warning/alerts can be given 10 to 12 hours prior to the hit of the cyclone. Table-7.13 gives the actions to be taken before, during and after a cyclone by the Port authorities.

Table-7.13 Actions to be taken in Cyclone Emergency

Sr.	***Action***	***Responsibility***
	A. Actions before the Cyclone	
1.	*The MCR will depute a Nodal Person to be on standby for receiving cyclone alert messages from the DG Shipping, DG Lighthouse and Lightships, Maritime Department of the state and Distt. Collector, as also from AIR and DD news telecasts and keep the MCR In-charge abreast of the situation.*	*MCR In-charge*
2.	*The Port In-charge will start taking Cyclone Action 12 hours before the forecast time of hit. He will issue cyclone warning in the Port by asking the Nodal Person to play out warning on the Port paging channel, and individual call to all the HODs including Port security at the gate complex to be on high alert for further instructions.*	*Port In-charge* *Nodal Person in MCR.*
3.	*The Port In-charge will order implementation of Port shutdown and evacuation 8 hours before the time of hit.* *Following actions will be taken:*	*Port In-charge*

Sr.	Action	Responsibility
	a. Entry to the Port will be stopped. All cargo trucks will be told to leave the Port premises in a coordinated manner assisted by the Traffic In-charge of the Port.	Transport and Materials Coordinator, Port Security
	b. Cargo handling operation on the Port backup (bulk cargo area and on the berths) will be stopped. All machinery will be folded back, retracted, fixed, moored and close-secured.	Dry Cargo Department
	c. All material handling on the berths will be stopped. Outriggers of the cranes will be lifted and secured, booms and hoists retracted and secured in position, and the cranes to be locked and tide down with tie down hooks provided on the berths.	Dry Cargo Department MCR Traffic and VTMS Incharge, Tug masters
	d. All vessels berthed on the Port will be unmoored and set to sail to the anchorage area assisted by tugs.	Dry Cargo Department
	e. All liquid cargo transfer on the liquid berths will be stopped. The loading arms will be unclamped, drained, folded and secured into vertical position. Liquid vessels will be given first right to sail.	Tug masters. Harbour masters.
	f. All tugs and other Port flotilla will be securely moored to the berths in the best wave shadow part of the berths.	Transport and Materials Coordinator
	g. All loose material stored on the Port will be covered by tarpaulin and secured on the ground through grommets to the hooks provided on the edges of the hard stands.	Transport and Materials Coordinator
	h. All vehicles and material movers will be parked on the landward side of wind obstructing structures such as ware houses and buildings. Vehicles will be closed, locked down with their parking breaks on.	Transport and Materials Coordinator
	i. The ventilators of the covered godowns will be opened to provide cross movement of cyclonic winds.	Port In-charge, Nodal Person, HODs.
	j. Port In-charge will ask the HOD through the Nodal Person to relieve all the employees on duty except few who will be needed for final shutdown.	Transport and Materials Coordinator
	k. A jeep with battery power loudspeakers will be pressed to announce Cyclone Warning in local language on the nearby area.	
4.	The Port In-charge will order complete evacuation of Port including the HODs 4 hours before the time of hit. Following actions will be taken:	Port In-charge, Nodal Person
	a. Security patrol party will announce evacuation in all the buildings by megaphone announcements.	Port security

Sr.	Action	Responsibility
	b. The MCR will be closed down systematically with all antennae lowered and secured, all equipment closed and powered off. All vessels at the anchorage will be asked to switch to VHS and UVHS channels as primary communication and maintain radio silence unless absolutely essential. MCR Communication will be put to roving mode. Communications will be handed over to the radio officer in the City office outside and away from the Port.	Port In-charge, MCR In-charge
	c. Port closure and security arrangements will be briefly communicated to the District Crisis Group Centre by the Port In-charge through the hotline.	Port In-charge
	B. Actions during the Cyclone	
1.	Port In-charge will be in contact with the Port personnel and District Crisis Group Centre on need basis through his VHS radio set from his residence or City office.	Port In-charge
	C. Actions after the Cyclone	
1.	Port In-charge will order assembly of all HODs at his residence or in the Port city office after winds velocities have come down below 50 km/hr.	Port In-charge, HODs
2.	Port In-charge will inspect damage in the Port personally along with relevant HODs and verbally instruct corrective and remedial measures to be taken. Following actions will be taken: a. The MCR will be reopened and all communication and navigation equipment restarted, calibrated and synchronised.	Port In-charge, HODs MCR In-charge
	b. Vessel stationed at anchored will be supplied with necessary supplies and spared if required by Port supply and pilot boats. Any medical causality will be rescued and hospitalized if necessary.	Harbour master
	c. All debris and wasted material spilled due to wind and rain will be collected, checked for contamination, and disposed off in a well-designed pit in the Port premises.	Transport and Materials Coordinator
	d. Damage to structural work of the Port, namely the cranes and other tall material handling structures (conveyor galleries, watch towers, building glasses) will be inspected and necessary repairs and cleaning will be undertaken. Structures whose stability is under question will be cordoned off till they are inspected in detail and cleared for general use.	Engineering department
	e. Water supply will be tested for portability, and other sanitary services resumed after suitable inspection. Water accumulated due to heavy rains will be drained and area	Communications and Medical Coordinator

Sr.	Action	Responsibility
	dried, sprayed with disinfectant, etc. *f. Status of Port will be communicated to the District Crisis Group Centre by the Port In-charge through the hotline*	*Port In-charge.*
3.	*After the Port housekeeping has been brought to order, all machineries will be sequentially tested. Port operations will be resumed with dry cargo handling vessels to be berthed first, followed by containers and liquid cargoes vessels.*	*Port In-charge.*
4.	*Port medical, logistics, communication and personnel facilities will be suitably extended to the Crisis Group Centre Team the leadership of the Distt. Collector for any further relief work as desired by the local and Distt. Administration.*	*Port In-charge.*

b. Emergency measures during a Tsunami

Early warning for a tsunami can be as short as one hour. Tsunami can be predicted by a network of seismic detection centers installed by the bordering nations after the December 2004 tsunami, as well as deep sea telemeterd buoys placed by the MoES. Tsunami warning will be communicated to the Port MCR by the District Crisis Group Centre by telephone/emergency hotline.

Rapid action after the alert is critical to effective tsunami response. Unlike cyclone, tsunami is not accompanied by tell-tale disturbed weather and high winds, therefore Port must effectively communicate and elicit urgent action in this regard. Table-7.14 gives the actions to be taken before, during and after a cyclone by the Port authorities.

Table-7.14 Actions to be taken in Tsunami Emergency

Sr.	Action	Responsibility
	A. Actions before the Tsunami	
1.	*The MCR will initiate high–intensity emergency tsunami warning through all communications channel including Port paging channel, and individual call to all the HODs, including Port security at the gate complex with clear instruction to shut down all operations possible within 20 minutes, and move as far as possible from the sea front using any means of transportation available, including running away.*	*MCR In-charge*
2.	*The MCR In-charge will carry out the following understanding authorization of the Port In-charge..* *Following actions will be taken:* *a. Entry to the Port will be stopped. All trucks and visitors will be driven away from the Port using one empty truck without creating any unnecessary traffic and congesting the roads/Port gate(s).*	*MCR In-charge* *Port Security*

Sr.	Action	Responsibility
	b. All cargo handling operation on the Port and backup will be stopped immediately. All machinery will be folded back, retracted, fixed, moored and close-secured. Outriggers of the cranes will be lifted and secured, booms and hoists retracted and secured in position, and the cranes to be locked and tide down with tie down hooks provided on the berths.	Dry Cargo Department
	c. Mooring ropes of all vessels berthed on the Port will be slackened. Vessels will be asked to be on full power for any during-tsunami power assists. Tugs will be pressed to turn and send off any inbound vessel in the channel. All vessels in the anchorage will be communicated tsunami alert. All tugs and other Port flotilla will be securely moored to the berths in the best wave shadow part of the berths.	MCR Traffic and VTMS In-charge, Harbour master, Tug masters Dry Cargo Department
	d. All vehicles and material movers will be parked on the landward side of wave obstructing structures such as ware houses and buildings. Vehicles will be closed, locked down with their parking breaks on.	HODs.
	e. All HODs will ensure rapid and complete evacuation of the Port.	
	f. MCR will be manned and operational with essential staff for communication and coordination.	
	g. Decision on electrical shut down will be taken by the MCR In-charge after consultation with the Port In-charge depending on the size of the Tsunami waves predicted and communicated.	
	B. Actions after Tsunami	
1.	Port In-charge will resume office within minutes of waves subsiding to below deck height. He will inspect damage in the Port personally along with relevant HODs and verbally instruct corrective and remedial measures to be taken. Following actions will be taken:	Port In-charge, HODs
	a. Vessels at the berths will be immediately attended for evacuation of any medical emergency.	MCR In-charge, Harbour master, Tug masters, Communication and Medical Coordinator
	b. All debris and wasted material floated over dye to wave hit will be collected, checked for contamination, and disposed off in a well designed pit in the Port premises.	Dry Cargo Department
	c. Damage to civil and structural work of the Port, namely	Engineering department

Sr.	Action	Responsibility
	the berths, cranes, etc. will be inspected and necessary repairs and cleaning will be undertaken. Structures whose stability is under question will be cordoned off till they are inspected in detail and cleared for general use.	
	d. Water supply will be tested for portability, and other sanitary services resumed after suitable inspection. Water accumulated due to wave hit will be drained and area dried, sprayed with disinfectant, etc.	*Communications and Medical Coordinator*
	e. Status of Port will be communicated to the District Crisis Group Centre by the Port In-charge through the hotline	*Port In-charge*
2.	*After the Port housekeeping has been brought to order, all machineries will be sequentially tested. Port operations will be resumed after starting the unloading and stacking equipment.*	*Port In-charge.*
3.	*Port medical, logistics, communication and personnel facilities will be suitably extended to the Crisis Group Centre Team the leadership of the Distt. Collector for any further relief work as desired by the local and Distt. Administration.*	*Port In-charge.*

Offsite action will be carried out in coordination with external agencies, whose responsibilities are listed as follows:

- Police
- Fire Brigade
- Medical Services
- Technical Agencies
- Rehabilitation Agencies
- Electricity Board

Responsibilities of the Services

1] Police

- To control traffic & mob by cordoning off the area.
- Arrange for evacuation of people on advice from the Site Controller/District Collector.
- Broadcast/communicate through public address systems to the community on advice from the District/Sub Collector.
- Inform relatives about details of injured and casualties.

2] Fire Brigade

- Fighting fire & preventing its spread.
- Rescue & salvage operation.

3] Medical/Ambulance

- First Aid to the injured persons.
- Shifting critically injured patients to the hospitals.
- Providing medical treatment.

4] Technical/Statutory Bodies

(Constitutes Factory Inspectorate, Pollution Control Board, Technical Experts from Industries)

- Provide all technical information to the emergency services, as required.
- Investigate the cause of the disaster.

5] Rehabilitation

- Arrange for evacuation of persons to nominated rescue centre and arrange for their food, medical and hygienic requirements.
- Coordinating with the Insurance Companies for prompt disbursement of compensation to the affected persons.
- Maintain communication channels of nearby industries like telephone, telex etc. in perfect working condition.

6] Electricity Board

- To regulate/re-connect the power supply to the Port if specifically asked for by the Port.

8 ENVIRONMENTAL MONITORING PROGRAMME

8.1 The Need

Monitoring is an essential component for sustainability of any developmental project. It is an integral part of any environmental assessment process. Any development project introduces complex inter-relationships in the project area between people, various natural resources, biota and the many developing forces. Thus, a new environment is created. It is very difficult to predict with complete certainty the exact post-project environmental scenario. Hence, monitoring of critical parameters is essential during project construction and operation phases.

Monitoring of environmental indicators signal potential problems and facilitate timely prompt implementation of effective remedial measures. It will also allow for validation of the assumptions and assessments made in the present study.

Monitoring becomes essential to ensure that the mitigation measures planned for environmental protection function effectively during the entire period of project operation. The data so generated also serves as a data bank for prediction of scenarios during construction and operation phases in similar projects.

8.2 Areas of Concern

From the monitoring point of view, the important parameters are resettlement and rehabilitation of project-affected persons, marine water quality, ambient air quality, noise, etc. An attempt is made to establish early warning system which indicate the stress on the environment. Suggested monitoring parameters and programmes are described in the subsequent sections.

8.3 Marine Water & Sediment Quality

8.3.1 Construction phase

The chemical characteristics of marine water quality shall be monitored once in three months during project construction phase, close to the major construction sites. Both surface and bottom waters should be sampled and analysed. The parameters to be monitored are as follows:

Marine Water

Physico-chemical parameters

- Light penetration
- pH
- Salinity
- Conductivity
- TDS
- Turbidity
- D.O.
- BOD
- Phosphates
- Nitrates
- Sulphates
- Chlorides

Biological parameters

- Chlorophyll *a*
- Primary Productivity
- Phytoplankton (No. of species and their density)
- Zooplankton (No. of species and their density)

Sediments Quality

Physico-chemical parameters

- Texture
- pH
- Total Kjeldahl Nitrogen
- COD
- Sodium
- Potassium
- Phosphates
- Chlorides
- Sulphates
- Arsenic

- Lead
- Mercury
- Hexavalent Chromium
- Organic carbon

Biological Parameters

- Benthic Meio-fauna
- Benthic Macro-fauna

The marine water and sediment sampling and analysis are conducted by an external agency. A provision of Rs.1.0 million/year has been earmarked for this purpose. Assuming construction phase is to last for 4 (four) years and considering as escalation of 10%, an amount of Rs. 4.64 million can be earmarked.

8.3.2 Operation Phase

The chemical characteristics of marine water quality should be monitored once in three months and biological parameters once a year during project operation phase. Both surface and bottom waters should be sampled and analysed. The parameters to be monitored are as follows:

Marine Water

Physico-chemical parameters

- Light penetration
- pH
- Salinity
- Conductivity
- TDS
- Turbidity
- D.O.
- BOD
- Phosphates
- Nitrates

- Sulphates
- Chlorides

Biological parameters

- Chlorophyll
- Primary Productivity
- Phytoplankton (No. of species and their density)
- Zooplankton (No. of species and their density)

Sediment Quality

Physico-chemical parameters

- Texture
- pH
- Total Kjeldahl Nitrogen
- COD
- Sodium
- Potassium
- Phosphates
- Chlorides
- Sulphates
- Arsenic
- Lead
- Mercury
- Hexavalent Chromium
- Organic carbon

Biological Parameters

- Benthic Meio-fauna
- Benthic Macro-fauna

The marine water and sediment sampling and analysis need to be conducted by an external agency. A provision of Rs.2.0 million/year has been earmarked for this purpose.

Effluent for coal stack yard needs to be monitored once in a month. The parameters to be monitored are pH, TDS and EC. An amount of Rs. 0.10 million has been estimated for this purpose.

8.4 Ambient Air Quality

8.4.1 Construction Phase

Ambient air quality monitoring is recommended to be monitored at three stations close to the construction sites. The monitoring can be conducted for three seasons. For each season monitoring can be conducted twice a week for 4 consecutive weeks. The parameters to be monitored are PM_{10}, $PM_{2.5}$, SO_2 and NO_2. An amount of Rs. 0.432 million/year would be required. Considering, construction phase of 4 (four) years and escalation of 10%, an amount of Rs. 2.01 million/year can be earmarked for this purpose. The ambient air quality monitoring during project operation phase can be conducted by an agency approved by Maharashtra State Pollution Control Board.

8.4.2 Operation Phase

The ambient air quality monitoring will have to be conducted at three locations. Air quality could be monitored for three seasons in a year. High volume samplers can be used for this purpose. The frequency of monitoring shall be twice a week for 24 hours for four consecutive weeks. The parameters to be monitored are PM_{10}, $PM_{2.5}$, SO_2 and NO_2. The ambient air quality monitoring during project operation phase can be conducted by an agency approved by Maharashtra State Pollution Control Board. An amount of Rs. 0.43 million/year can be earmarked for this purpose.

8.5 Noise

Personnel involved in work areas, where high noise levels are likely to be observed during project construction and operation phases. For such in-plant personnel, audiometric examination should be arranged at least once a year.

The noise level monitoring during construction and operation phases will be carried out by the project staff and a noise meter can be purchased. An amount of Rs.0.10 million has been earmarked for this purpose.

Neighbourhood (Upto radius of 1 km)

It is recommended that during project operation phase, monitoring of sensitive areas like schools and Medicare centres be conducted within a distance of 1 km radius of the harbour to ascertain noise levels at receptors, taking note of any excessive build-up in any particular direction.

8.6 Greenbelt Development

Sites of greenbelt development should be monitored once in every month during project operation phase to study the growth of various species and to identify the needs if any, such as for irrigation, fertilizer dosing, pesticides, etc. The monitoring can be conducted by project staff.

8.7 Summary of Environment Monitoring Programme

The summary of Environmental Monitoring Programme for implementation during project construction and operation phases is given in Tables 8.1 and 8.2 respectively.

Table 8.1: Summary of Environmental Monitoring Programme for construction phase

S. No	***Aspects***	***Parameters to be monitored***	***Frequency of monitoring***	***Location***
1.	*Marine water*			
	Physico-chemical parameters	*Light penetration, pH, Salinity, EC, TDS, Turbidity, Phosphates, Nitrates, Sulphates, Chlorides.*	*Once in three months*	*3 to 4 sites*
	Biological parameters	*Chlorophyll, Primary Productivity, Phytoplankton and Zooplankton*	*Once in three months*	*3 to 4 sites*
2.	*Sediments*			
	Physico-chemical parameters	*Texture, pH, Sodium, Potassium, Phosphate, Chlorides, Sulphates, Arsenic, Lead, Mercury, Hexavalent Chromium, OC*	*Once in three months*	*3 to 4 sites*
	Biological parameters	*Benthic Meio-fauna, Benthic Macro-fauna*	*Once in three months*	*3 to 4 sites*
3.	*Ambient air quality*	*PM_{10}, $PM_{2.5}$, SO_2 & NO_2*	- *Summer, Post-monsoon and Winter season.* - *Twice a week for 4 consecutive weeks per season*	*Close to construction site(s)*
4.	*Noise*	*Equivalent Noise Level*	*During peak construction activities*	*Construction Site(s)*

Table 8.2: Summary of Environmental Monitoring Programme for project operation phase

S. No	Aspects	Parameters to be monitored	Frequency of monitoring	Location
1.	Marine water			
	Physico-chemical parameters	Light penetration, pH, Salinity, EC, TDS, Turbidity, Phosphates, Nitrates, Sulphates, Chlorides.	Once in every month	3 to 4 sites
	Biological paramete	Chlorophyll, Primary Productivity, Phytoplankton, Zooplankton	Once in three months	3 to 4 sites
2.	Sediments			
	Physico-chemical parameters	Texture, pH, Sodium, Potassium, Phosphate, Chlorides, Sulphates, Arsenic, Lead, Mercury, Hexavalent chromium, OC	Once in every month	3 to 4 sites
	Biological paramete	Benthic Meio-fauna, Benthic Macro-fauna	Once in three months	3 to 4 sites
3.	Effluent from Coal s yard	pH, EC and TDS	Once in every month	Effluent outlet from Coal stack yard
4.	Ambient air quality	PM10, PM2.5, SO_2 & NO_2	- Summer, Post-monsoon & Winter seasons. - Twice a week for 4 consecutive week per season	Villages
5.	Noise	Equivalent Noise Level	Once per month	Project area sites within 1km of project area
6.	Greenbelt Development	Rate of survival and growth of various species	Once per month	Various plantation sites.

9 COST ESTIMATES

9.1 Environmental Management Plan (EMP)

The cost estimates for implementing Environmental Management Plan (EMP) shall be Rs.59.73 million. The details are given in the Table 9.1.

Table 9.1: Summary of cost estimate for implementing Environmental Management Plan

S. No.	***Parameter***	***Cost (Rs. million)***
1.	*Sanitary facilities at labour camps*	*4.50*
2.	*Treatment of effluent from coal stack yard*	*3.00*
3.	*Solid waste Management*	*10.88*
4.	*Treatment of effluent from workshops*	*1.00*
5.	*Provision of free fuel*	*33.20*
	Terrestrial Ecology	*1.0*
7.	*Greenbelt development*	*0.400*
8.	*Purchase of noise meter*	*0.10*
9	*Implementation of Environmental Monitoring Programme during construction phase (Refer Table 9.2)*	*6.65*
	Total	***59.73***

9.2 Environmental Monitoring Programme

The cost required for implementation of Environmental Monitoring Programme (EMP) during construction phase is Rs.6.65 million. The details are given in Table 9.2.

Table 9.2: Summary of cost estimates for implementation of EMP during construction phase

S. No.	***Parameter***	***Cost (Rs. million)***
1.	*Marine Ecology*	*4.64*
2.	*Ambient air quality*	*2.01*
	Total	***6.65***

The cost required for implementation of Environmental Monitoring Programme during operation phase is Rs.2.53 million/year. The details are given in Table 9.3.

Table 9.3: Summary of cost estimate for implementation of EMP during operation phase

S. No.	***Parameter***	***Cost (Rs. million/year)***
1.	*Marine water quality*	*2.00*
2.	*Ambient air quality monitoring*	*0.43*
3.	*Monitoring of effluent from coal stack yard*	*0.10*
	Total	***2.53***

10 CORPORATE SOCIAL RESPONSIBILITY (CSR) PLAN

10.1 Genesis

As a responsible corporate, JSW would integrate its environment, HR and ethical business policies with appropriate community engagement and gender equity. In tune with this, JSW Foundation works closely with the village communities and creates synergies with other verticals of the JSW group, to assimilate their intervention in a social development framework.

An independent Trust named JSW Foundation, administers the social development initiatives of the JSW Group companies. Every year, the Foundation in consultation with plant managements and CSR teams at the plants, finalizes set of activities that get built into the business plan. The Foundation lays emphasis on maintaining a continuum of social development thinking into the conduct of these activities.

The major activities of the JSW Foundation are in the areas of;

- Education
- Health
- Livelihood and Empowerment, Especially of Women
- Sports
- Environment
- Arts, Culture and Heritage

10.2 CSR Activity

The JSW Foundation is facilitating the social activities in the following core areas with the help of Municipal Corporation, Education and Health Department of State Government, Local Community and Non-Governmental Organization as a part of the CSR activity. For the proposed Nandgaon Port project, the JSW Foundation has proposed to expand the CSR activities in the project influence area for the socio-economic benefit of the local people.

10.2.1 Education Sector

JSW group has been in the forefront of the education sector. The foundation is facilitating the latest technology based Digi-Class Rooms with the help of PEARSON-UK. With this

technological advancement, yearly many students from the local community are getting benefited in the nearby schools of the project area. As part of the CSR plan for the proposed Nandgaon Port project, the JSW group is allocating more funds in this sector which will carry forward in the coming years.

Currently, JSW group is involved in the distribution of Mid-Day Meal to the local schools in co-ordination with the ISKCON Foundation. For the CSR plan of the Nandgaon Port project more additional funds shall be allocated for this program.

Apart from the main activities, JSW group as a part of its social responsibility has proposed to provide the following infrastructure periodically in the Schools and ITIs as required;

- Sports Room/Cupboard
- Arts Room/Cupboard
- Renovation works
- Staff Rooms/Renovation
- Anganawadi Room Renovation
- Toilets
- Drinking water facility
- Blackboards, Chairs, and Benches
- Playground development
- Compound wall

10.2.2 Water Supply

Water is an incredibly important aspect of our daily lives and an essential resource for life and good health. JSW group on its corporate social endeavor is providing the clean drinking water to the local community in co-ordination with the Water Life India Pvt. Ltd. (WLIP). This activity shall be further strengthened with the implementation of various water supply systems and restoration facilities like;

- Restore the ponds and wells
- Channelize the same for clean drinking water
- Construct small check dams, RWH etc.

10.2.3 Community Health

Unlike Education, the JSW group is always in the forefront of the development of the health sector since its inspection. The JSW group shall provide the health related facilities in the locally existing hospitals. Also, shall organize the health camps and blood donation camps in co-ordination with Smile Foundation as a part of the social activity plan for the Nandgaon Port project.

10.2.4 Sports Development

JSW group as a responsible corporate is always a step ahead in the sports development for the local youths. The group is encouraging the sports activities among the local youths by organizing various sports competitions in the villages. Also promoting various sports activities and training personals in the CSR villages. Apart from this, the JSW group shall promote/develop the sports activities with the additional funds as a part of CSR activity plan for the proposed port project. Also, participate in the local festivals and cultural activities to keep alive the local tradition.

10.2.5 Livelihood and Empowerment

JSW group as a responsible corporate shall strengthen the livelihood of the local fishing community by facilitating the necessary materials for the sustainable development of their fishing activities. Also, the group shall empower the local woman community through various training programs/schemes with the help of local governance as a part of the CSR activity plan for the proposed port project.

The following social activities shall be carried out as part of the livelihood and empowerment of the local community;

- Empowerment of local woman through vocational training
- Training for the Self Help Groups (SHGs)
- Training on fishing
- Training of fish processing and packing
- Employment opportunity to the local qualified students

10.2.6 Infrastructure Development & Environment

JSW group on its role of social responsibility has proposed to develop the internal roads, provide street lights, construct toilets for the local community as part of the sanitation programme, create play grounds etc.

JSW group as an environment responsible corporate shall involve in the plantations along the roads in the project influence area to protect the local environment as part of the CSR activity for the proposed port project.

For the heritage protection, the JSW group as a part of the social responsibility shall develop the following infrastructure like;

- Beautification of the “Hutatma Smarak”
  - Reconstruction of the fencing wall
  - Refurbishment of the monument
- Renovation of Temples
- Plantations

10.2.7 Infrastructure Development - Fishermen Community

The following infrastructure facilities are proposed to develop in the fishing villages for the empowerment of the fishing community;

a) Ice Factory

All fishing vessels prior to their sail for fishing need to carry ice block in sufficient quantity for preservation of fish. In addition to fishing, ice is also required for auctioning/ packing fish while transporting to the local market and also for preserving fish in the chilled storage freezing plants and fish processing plants. Therefore, it is necessary to develop an ice factory in one of the potential fishing village.

b) Common Facility Centre (CFC)

At present there are no common facility centre, and facilities for auctioning of fish in the fishing villages. Hence it is proposed to build a common facility centre in one of the fishing villages.

c) Fishermen Empowerment

Fishermen have been carrying out their business through Fishermen's Cooperative Societies. These Cooperative Societies will be assisted for purchase and maintenance of fishing equipment and accessories like fishing nets, machineries, etc. The assistance will be utilized and transferred to other Cooperative Societies like internal loaning, like model of Women Self Help Groups (SHG), to make the fishing business self-sustainable.

d) Strengthen fish landing facility

JSW group as a responsible corporate shall support the fishermen community to enhance their fishing activity. It is proposed to dredge the creek area to a desirable depth for the safe navigation of the fishing boats in tidal water as a part of the CSR activity based on the local demand and clearance from the authorities.

10.2.8 Employment Opportunity

Both direct and indirect employment opportunity shall be created due to this project development and equal employment opportunity shall be given to the local educated unemployed youths.

10.3 Budget

The statement showing the budget allotted by the JSW group for the Corporate Social Responsibility (CSR) activity is shown in the following Table 10.1.

Table 10.1: Budget for the CSR plan

(Figures in Lakhs)

S. No.	***Activities***	***Description***	***CSR Activity Existing***	***CSR Activity Planned***
1	*Education* *Services- In Schools*	➢ *Education sector and development of Educational facilities like Digi-Class rooms (PEARSON-UK), etc.* ➢ *ISCKON JSW Mid-Day Meal*	*3.0* *60.0*	*100.0*
2	*Water Supply*	*Development of water supply system*	*5.0*	*200.0*
3	*Community Health*	➢ *Provide health related facilities.* ➢ *Health Camps in consultation with the* ➢ *Smile Foundation.*		*50.0*
4	*Sports & Culture*	*Sports development & cultural activities*	*25.0*	*50.0*
5	*Livelihood & Empowerment*	➢ *Implementation of training programmes for woman empowerment, SHGs* ➢ *Training programme for educated unemployed youth*		*100.0*
6	*Infrastructure Development & Environment*	➢ *Development of internal roads, toilets, Playground, etc* ➢ *Beautification of "Hutatma Smarak", reconstruction of fencing walls, and refurbishment of monuments.* ➢ *Renovation of Temples.* ➢ *Plantations along the roads.*	*7.0*	*300.0*
7	*Infrastructure Development – Fisherman Community*	➢ *Ice factory* ➢ *Common facility centre* ➢ *Fishermen Empowerment* ➢ *Strengthen fish landing facility*		*700.0*
		Total	***100.0***	***1500.0***

11 DISCLOSURE OF CONSULTANTS INVOLVED IN THE CEIA STUDY

The EIA study has been conducted by WAPCOS Ltd., a government of India Undertaking under Ministry of Water Resources. WAPCOS Ltd. has a full-fledged Centre for Environment who has conducted the EIA study. The list of the Experts involved in the EIA study is given in Table 11.1.

Table 11.1: List of Experts involved in the CIEA study

S. No.	***Name***	***Designation***	***Educational Qualification***	***Experience (Year)***
1.	*Dr. Aman Sharma*	*Chief Engineer*	*BE Civil, ME(Envt)* *PhD (Envt. Engineering)*	*22*
2.	*Mr. P.D. Karkhanis*	*Additional Chief Engineer*	*M.Tech (Environment)*	*20*
3.	*Dr. A.K. Sharma*	*Chief (Lake & Wetland)*	*M Sc (Zoology)* *Ph.D (Fisheries)*	*21*
4.	*Mr. R.V. Ramana*	*Addl. Chief Engineer*	*B. Tech (Civil)*	*20*
5.	*Mr. V.A. Pai*	*Sr. Scientist (Gr.I)*	*M.Sc. (Agriculture)*	*18*
6.	*Mr. S. Selva Kumar*	*Dy. Chief Scientist*	*MA (Geography)* *MA (Development Planning Administration)*	*15*
7.	*Mr. S.M. Dixit*	*Sr. Engineer (Envt.)*	*BE (Civil)* *ME (Environmental Engineering)*	*8*

12 PUBLIC HEARING

12.1 BACKGROUND

The public hearing for the proposed development of All-Weather Multi Cargo Port in a Green Field Site at Village Nandgaon, Taluk. Palghar district Thane, Maharashtra has been conducted as per the EIA notification 2006. The Notice for the public hearing was issued both in Marathi (Lokmat and Loksatta) and English (The Times of India) newspaper on 5th September 2012. The public hearing was conducted by Maharashtra Pollution Control Board at Tarapur Vidya Mandir, Taki Naka, Boisar, Tal. Palghar, Dist. Thane, Maharashtra on 7th October 2012 at 11:30 AM.

The Panel Members for the meeting included Additional District Collector, Jawhar (Chairman), Sub-Regional Officer, Tarapur and Regional Officer, Thane, Maharashtra Pollution Control Board (MPCB), Sub-Divisional Officer, Dahanu, and Tahsildar, Palghar. The meeting was also attended by the representatives from the Project Proponent and the EIA Consultants M/s WAPCOS Limited, Gurgaon and M/s Fine Envirotech Engineers, Mumbai.

12.2 ISSUES RAISED BY THE PUBLIC DURING THE MEETING

The project proponent gave presentation about the project description and benefits from the project offered by the proponent to villages in the presence of the panel members and a large number of gatherings from the project area. During the public consultation meeting, the participants in the hearing were invited to give their comments and suggestions. The details of public hearing are given in Volume II of the Report. After detailed consultation based on the views of the locals, Panel members prepared the Minutes and proceedings.

The proceedings of the Public Hearing containing the views of the locals, complaints/suggestion by the locals and their clarifications from the Project Proponent, copies of the advertisements/notices issued in various newspapers, photographs of the Public Hearing along with CD containing video recording of the Public Hearing proceedings have been sent by the Regional Officer, MPCB, Tarapur to MPCB, Mumbai and the same were forwarded to the MoEF, New Delhi. The key issues raised by the public and their responses by

the project proponent are given in Table 12.1. The response to the questionnaire in the forms of support/oppose letters received during the public hearing are submitted separately.

Table 12.1: Queries raised by public and their response by the project proponent

S. No.	Complaints/Suggestions	Responses
01	Complaint emphasized on employment opportunity, and indicated that there will be unemployment due to loss of livelihood sources based on the fishing activities/business.	Adequate job opportunities, both direct and indirect would be created for the local youths. In addition they would be made employable through proper technical training.
02	Compliant indicated that fishing net will be destroyed due to vessel movement in the Port area. Fishing activity will be destroyed.	The Vessels will move in well-defined channels marked with buoys to avoid any damage to fishing nets.
03	Compliant indicated that spillage of oil and waste water will occur during the ship movement. Due to this the fish activity will be destroyed.	Spillage of oil and waste water is prohibited and would be monitored by the DG shipping and MPCB. In the event of any oil spillage it will be cleaned up through oil booms and dispersants.
04	Compliant indicated that there will be blockage in the creeks and it will impact on the fishing activity.	As per the modeling study by CWPRS, Pune no such adverse impact is envisaged.
05	Participants suggested for the improvement of the financial and social livelihood of the fisherman community and the farmers.	Agreed. The CSR activity is planned for the social benefit of the local fisherman and farm community.
06	Participants emphasized for the business opportunity due to the Port development and indicated that only contractors and businessman would get benefitted from the project.	Agreed. New business opportunity will be generated for the local people. Preference for small jobs will be given to the locals based on their qualification and expertise.
07	Participants emphasized that with this project development, there will be employment opportunity and the social amenities of the local people will improve and there will be overall development in the area.	Agreed.

S. No.	Complaints/Suggestions	Responses
08	Compliant suggested that JSW must invest for the social upliftment of the villagers and development of the local infrastructure.	The project proponent's scope with respect to employment, social benefit, and local infrastructure development and other CSR activities are committed during the Public Hearing.
09	Complaints indicated that the education sector will be affected due to the project development.	Education sector will be improved with the adequate CSR plan. Free scholarships will be given to the poor students.
10	Complaints indicated that the development of roads and widening of existing road is proposed, will the private land be acquired for the purpose?	The road and the rail corridor will be developed without affecting the present roads. The present roads wherever necessary would be strengthened and widened through the Public Works Department. The land requirement for such roads is much less and if any private land is involved, it will be purchased from the land owners directly through negotiations. Even if the government acquisition is necessitated, providing adequate compensation would be JSWIL's moral obligation.
11	Complaints indicated that there will be land acquisition on large scale. Displacement of fisherman community.	No land acquisition is required for this port project.
12	Complaints indicated that the land development through reclamation may change the water current direction, may cause destruction and risk to the villages in coastal area.	Model Studies carried out by the CWPRS, Pune on the shoreline evolution and morphological changes indicate no adverse impacts on the shoreline. Thus shoreline will be unaffected by the development.
13	Compliant indicated that breakwaters will be constructed on northern as well as southern side. Thus the tide flow would be difficult to analyze and may pose danger to the fishermen.	The construction of the breakwater will create tranquil conditions inside the harbor by dissipating the higher wave energies. The breakwaters do not have any other impacts on the tidal heights or any other marine parameters.
14	Compliant indicated the shoreline change in terms of erosion and accretion in the proposed project area.	The Institute for Ocean Management (IOM), Chennai, has carried out the shoreline study using satellite imageries of 38 years and field studies and found that the coastline in the proposed study area is mostly stable with occasional low eroding zone. The study report was prepared separately and submitted.

S. No.	Complaints/Suggestions	Responses
15	Compliant indicated that the intertidal zone is most fertile and rich biodiversity that will be destroyed due to land reclamation.	The near shore area of the port where reclamation is being proposed is rocky and mostly gets exposed in the low tides. Hence the biodiversity of this region is not very high. In addition, the reclamation would only make the micro-organisms to migrate and regroup after reclamation.
16	Compliant indicated that the polluted discharges from TAPS and MIDC shall be impounded due to construction of breakwaters.	The Northern breakwater is provided with 2m tidal accesses. Hence, free flow of water is allowed through the breakwater. The water exchange will keep the northern shoreline free from impounding.
17	Compliant indicated that the project require 800 m^3/day of water during the operation phase. But, there is no water supply either in Nandgaon or the nearby villages.	Operation phase requirement of water would be met by MIDC supplies. Alternatively, other sources would be explored except for ground water sources.
18	Compliant indicated that due to various cargos handling and transportations, the air and noise pollution and traffic shall be impacted in the nearby villages.	The movement of vehicles during the construction and operation phases has been discussed in the CEIA report and the appropriate mitigation measures have been suggested as a part of the Environmental Management Plan to control the air and noise pollution.
19	Compliant indicated that due to rock blasting and dredging there will be an increase in the temperature and CO_2 gas in the environment?	The majority of dredging will be carried out in soft soil. The removal of hard material for the port would be minimum and would be carried out in an environmental friendly manner without resorting to blasting.
20	Compliant indicated that the mangroves shall be destroyed which is a non- permissible activity as per the Law.	There are no mangroves in the proposed port area, and nearest mangrove patch is about 5 km away from the proposed project. Therefore, no destruction of mangroves is envisaged due to the proposed port development.
21	Compliant suggested for providing the details of the plantations in the Port area.	As per the CEIA report 8 ha of land is reserved for the green belt development.

ANNEXURE-I

National Ambient Air Quality Standards (Unit: μg/m^3)

S. No.	Pollutants	Time Weighted Average	Concentration in the Ambient Air	
			Industrial, Residential Rural and other area	Ecologically Sensitive area (notified by Central Government)
1	Sulphur Dioxide (SO_2) in μg/m^3	Annual*	50	20
		24 hours **	80	80
2	Nitrogen Dioxide (NO_2) in μg/m^3	Annual*	40	30
		24 hours **	80	80
3	Particulate Matter (Size less than 10μm), PM_{10} in μg/m^3	Annual*	60	60
		24 hours **	100	100
4.	Particulate Matter (Size less than 2.5μm), $PM_{2.5}$ in μg/m^3	Annual*	40	40
		24 hours **	60	60

Note:

* Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at a uniform interval.

** 24 hourly or 08 hourly or 01 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

ANNEXURE-II

Ambient Noise Standards

Area Code	Category of Area	Limits in dB(A)Leq	
		Day time	Night time
A.	Industrial Area	75	70
B.	Commercial Area	65	55
C.	Residential Area	55	45
D.	Silence Zone	50	40

Note: 1. Day time 6 A.M. and 9 P.M.

2. Night time is 9 P.M. and 6 A.M.

3. Silence zone is defined as areas upto 100 meters around such premises as hospitals, educational institutions and courts. The silence zones are to be declared by competent authority. Use of vehicular horns, loudspeakers and bursting of crackers shall be banned in these zones.

4. Environment (Protection) Third Amendment Rules, 2000 Gazette notification, Government of India, date 14.2.2000.